United States Patent [19]

Payne

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[45] **Oct. 9, 1973**

[54] **HIGH SPEED BOAT WITH PLANING HULL**

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[73] Assignee: **Blade Hulls, Inc.,** Rockville, Md.

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[21] Appl. No.: **237,852**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 167,737, July 30, 1971, abandoned.

[52] **U.S. Cl.** **114/66.5**

[51] **Int. Cl.** **B63b 1/18**

[58] **Field of Search** .... 114/66.5 R, 66.5 F, 114/66.5 P, 66.5 S

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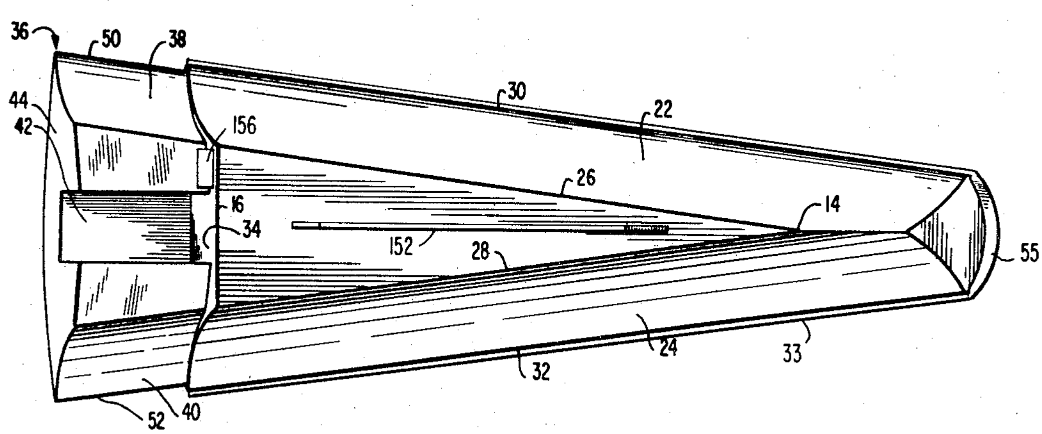
Primary Examiner—Milton Buchler
Assistant Examiner—Charles E. Frankfort
Attorney—Richard C. Sughrue et al.

[57] **ABSTRACT**

A boat capable of cutting through rough waves at high speed with astonishing stability has a hull provided with a flat planing surface which in plan is the shape of a thin wedge or delta. The sides of the boat rise upwardly and outwardly with a simple concave curvature from the two edges leading from a knife edge bow at the point of the wedge. The slender wedge shape moving through the water at high speeds develops continuous spray sheets up its sides which are intercepted by the outwardly curving portions of the hull sides. Spray rails or deflectors may also be utilized to intercept the spray sheet, such deflectors being inclined at a small angle to the bottom of the planing surface. The knife edge bow rises upwardly and forwardly with a concave curvature from the point of the wedge and eventually terminates in a forwardly sloped bow transom. A keel skeg minimizes side slipping. A stern transom, which rises substantially perpendicular to the trailing edge of the delta or wedge may have a rearwardly extending bustle secured thereto for buoyancy and roll stability at low speeds.

21 Claims, 21 Drawing Figures



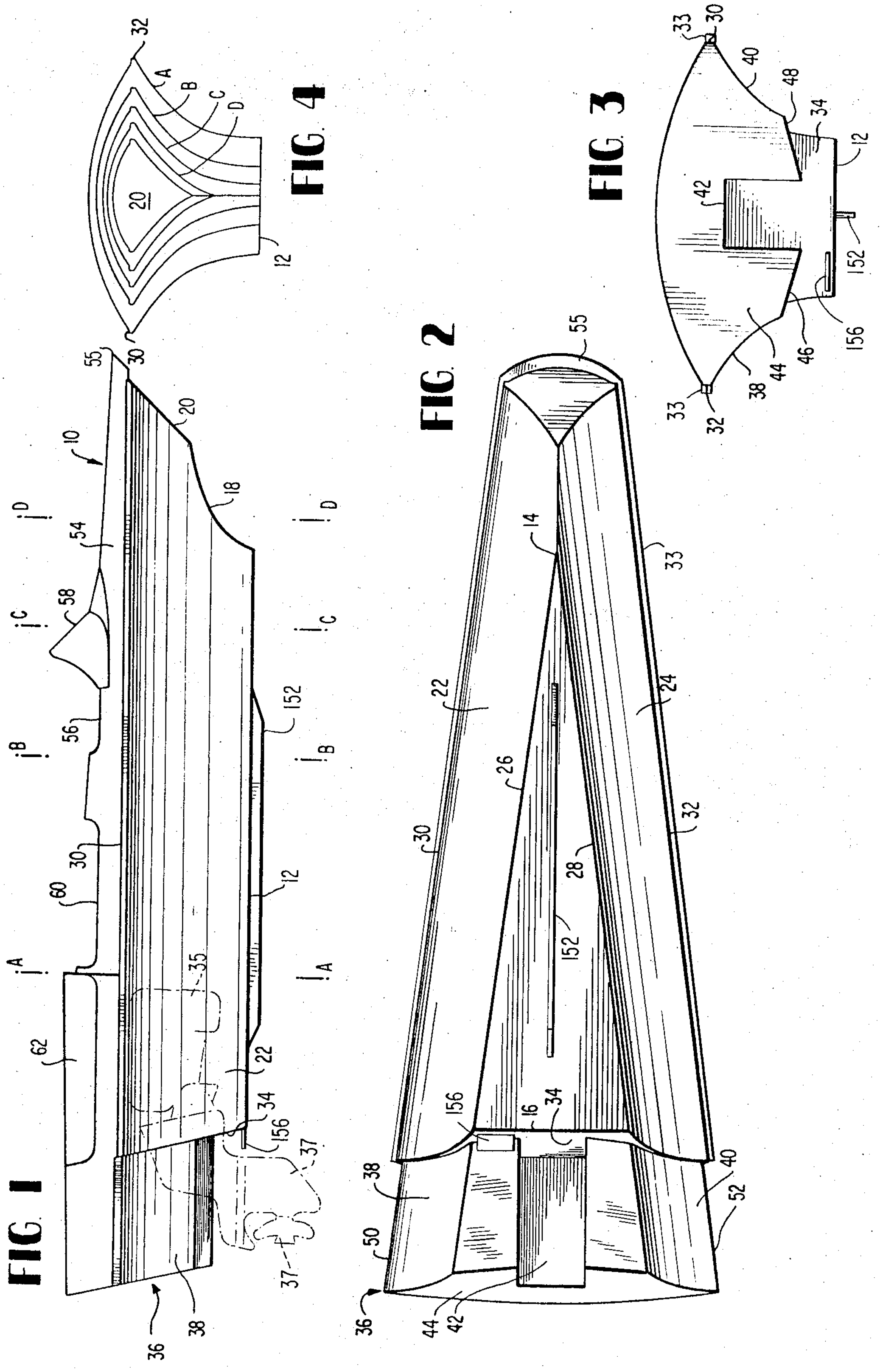


FIG 1

FIG 2

FIG 3

FIG 4

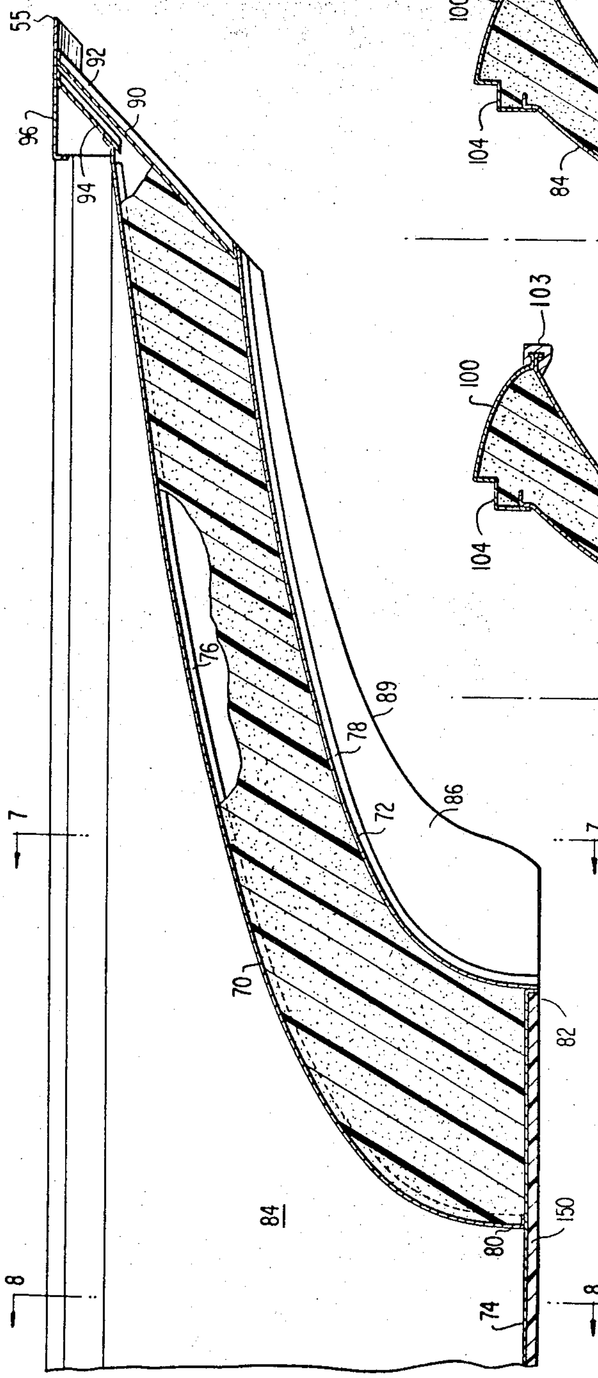


FIG 5

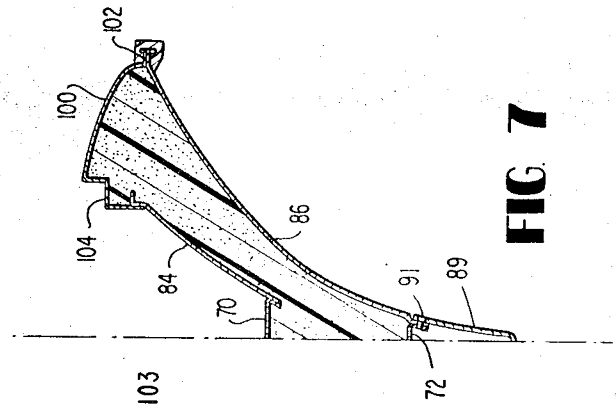


FIG 7

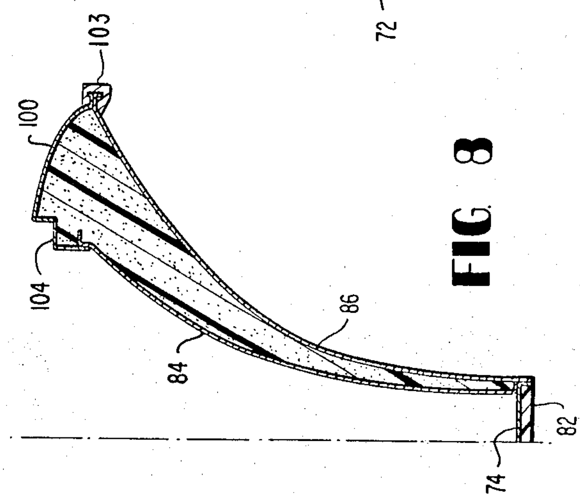
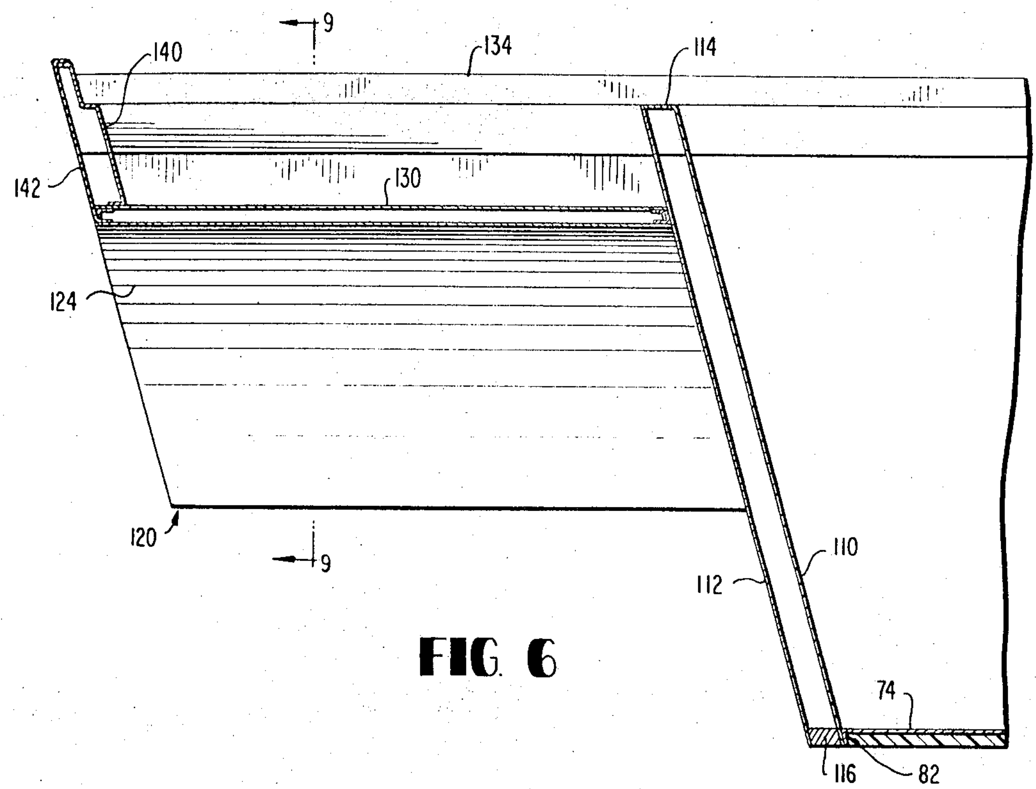


FIG 8


9
140
134
114
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110
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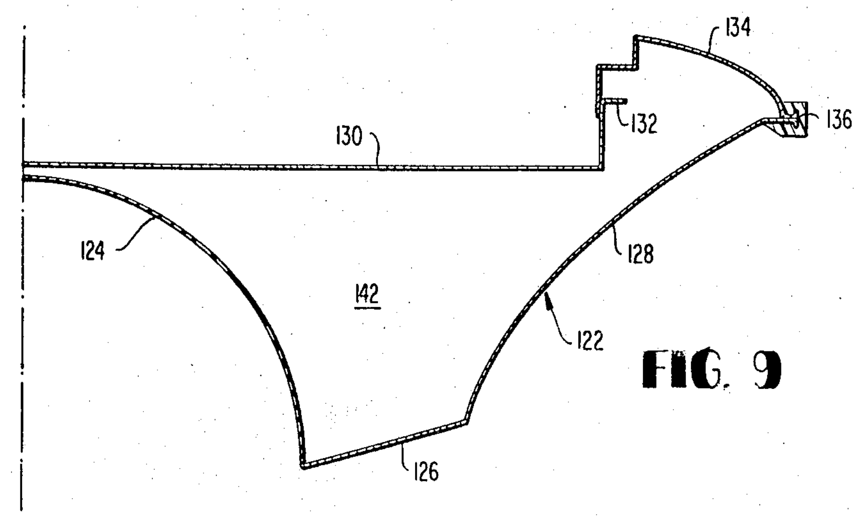
74
116
82

FIG. 6


134
132
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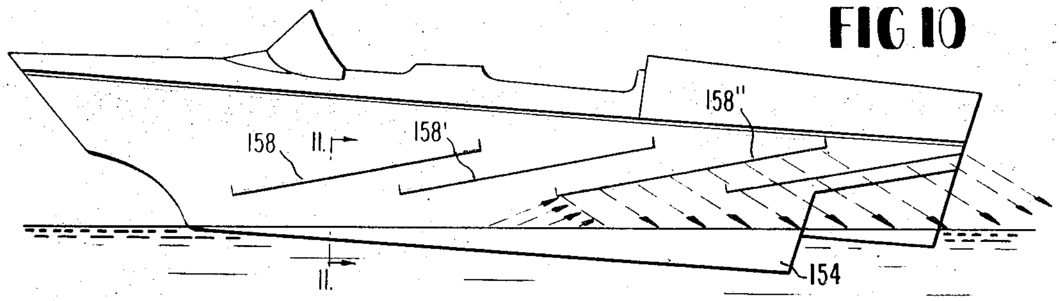
142
122
126

FIG. 9

FIG.10



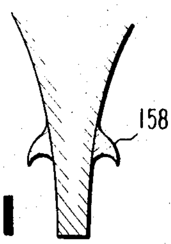


FIG.11

FIG.12

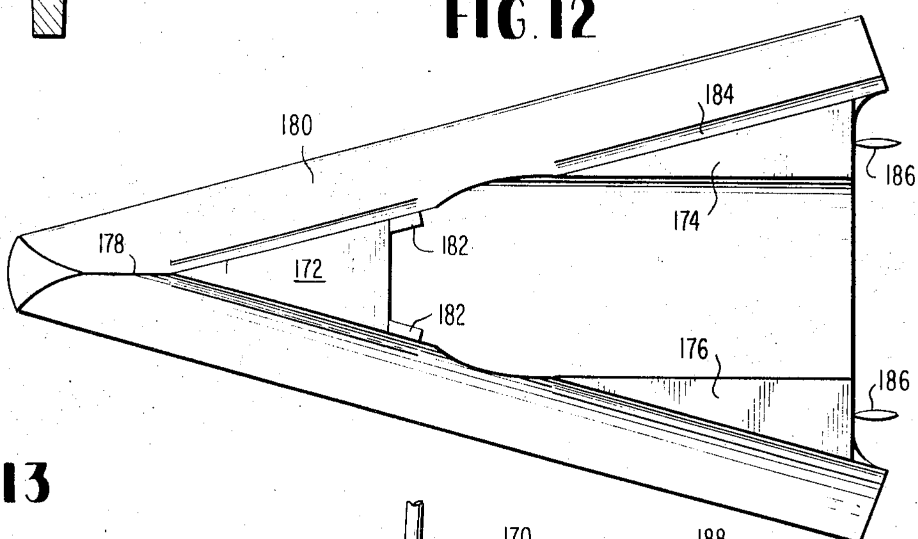
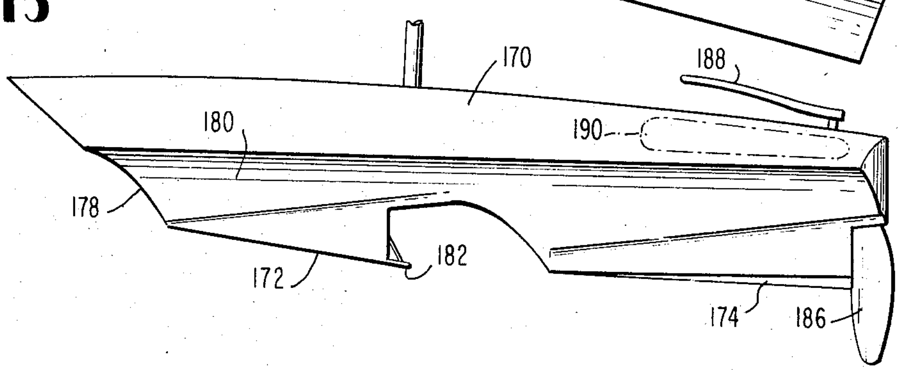


FIG.13



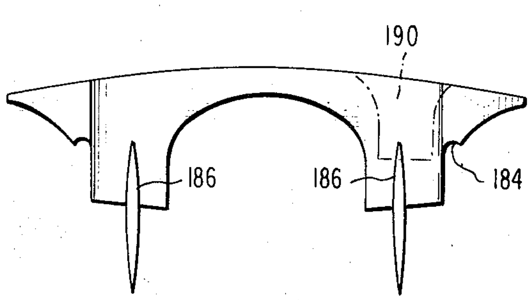


FIG.14

FIG.15

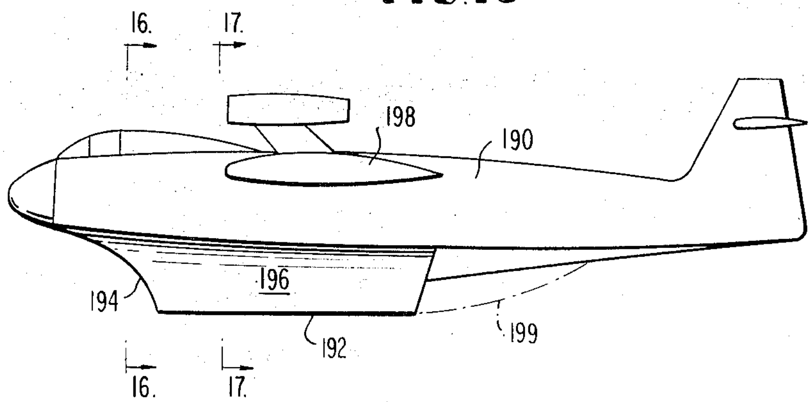


FIG.16

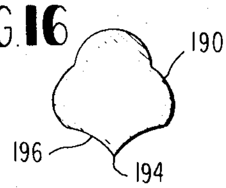


FIG.17

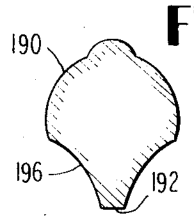
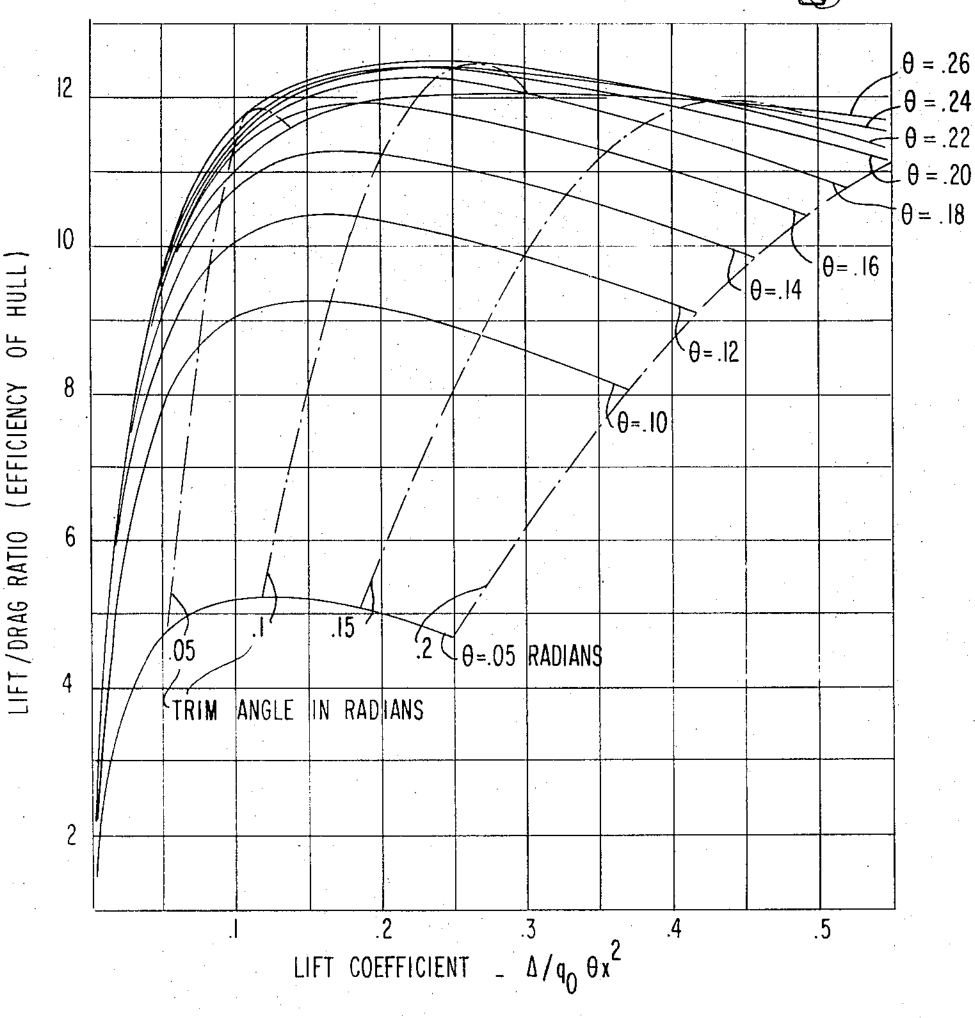


FIG.21



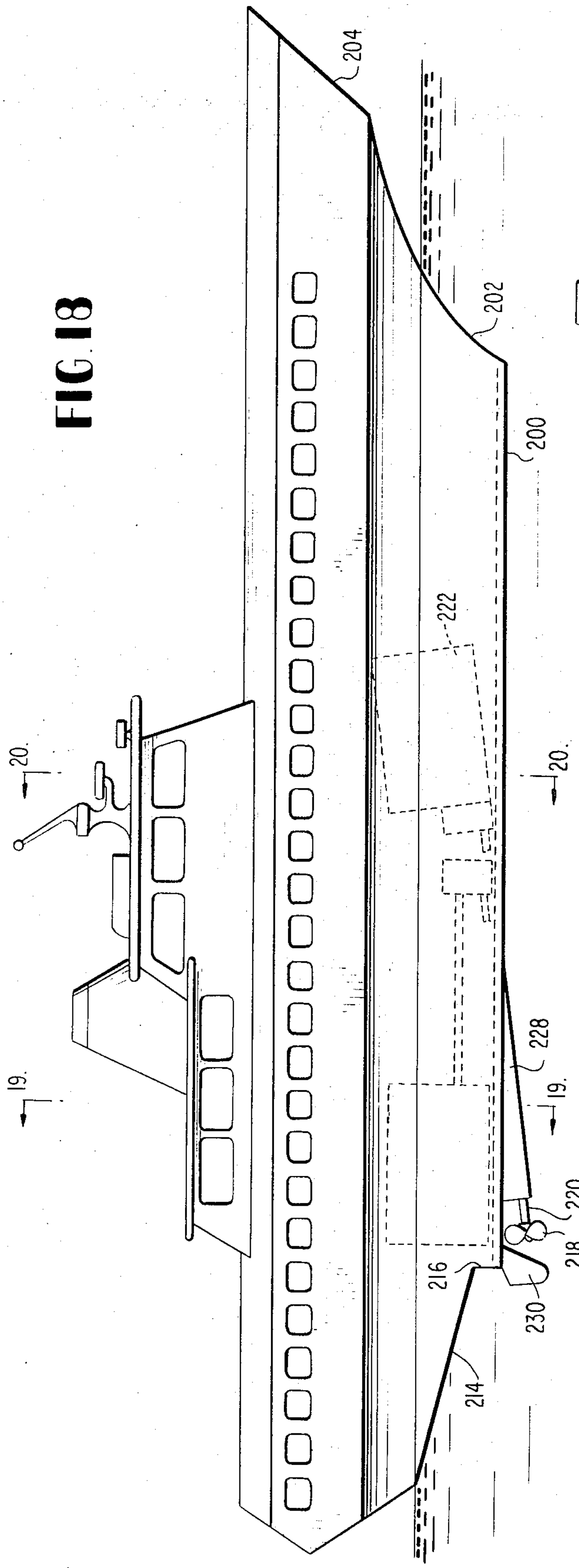


FIG.18

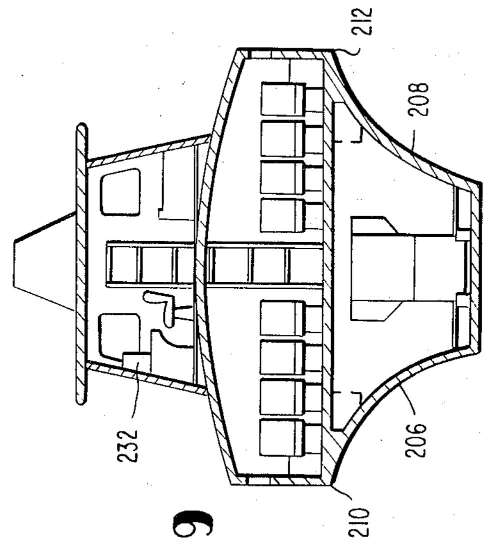


FIG.19

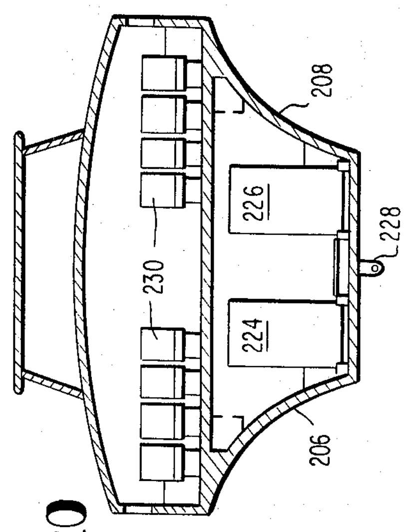


FIG.20

HIGH SPEED BOAT WITH PLANING HULL

RELATED APPLICATIONS

This application is a continuation-in-part of my prior application Ser. No. 167,737 filed July 30, 1971, now abandoned in favor of this application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a high speed boat which does not slam or pound waves but cuts through them to ride smoothly at high speed even in rough seas.

2. Prior Art

The long established means of water transportation is the displacement hull which is supported by buoyancy. The speed of such a craft is limited by the high skin friction caused by large surface area in contact with the water, the pressure drag due to waves generated by the hull's passage through the water and the suction forces on the bottom of the hull tending to pull deeper into the water as speed increases. The planing hull was developed in an effort to circumvent these disadvantages and it was found that certain hull shapes, characterized by "open" water line planforms at the stern experience a net positive pressure when underway, so that the hull lifts out of the water with a consequent reduction in wetted area. The reduction in wetted area, and the more favorable flow around that part of the boat still in the water, permits a planing craft to be accelerated through the region of high pressure drag caused by wave making, provided the boat has sufficient power. On calm water, a planing hull is very efficient and speeds approaching 100 m.p.h. are normal for quantity produced "sport boats" and speeds in the order of 200 m.p.h. are achieved by racing hydroplanes. Unfortunately, water is rarely smooth, and in waves such boats are subject to pounding which is physiologically intolerable and can also break up the hull strucutre. Thus, although it is both efficient and simple, the planing craft is not able to operate at high speed in waves.

Because there is a great need for water craft capable of high speeds, many alternative vehicle concepts have been developed in attempts to evade the problem of pounding. Some of these prior art developments are the surface piercing hydrofoils, fully submerged hydrofoils, air cushion vehicles, captured air bubble craft, super critical displacement hulls and submarines. It would be inappropriate to analyze the characteristics of each of these vehicles here, but it should be noted that only submarines and fully submerged hydrofoils have clearly circumvented the pounding problem while all are much more complicated than a planing boat. This added complexity manifests itself in greatly increased first cost, decreased reliability and severe operation limitations of one kind or another.

The planing craft only planes on a small portion of its bottom at high speeds. When such a craft encounters a wave, the lifting area is greatly increased and the craft experiences the upward acceleration which is the most marked feature of pounding. Because of the inertia of the water in the wave, the magnitude of this acceleration is much greater and would be calculated simply from the increase in wetted area. Thus, the problem which exists is derived from the fact that most planing craft have planing surfaces which are much too large. Others have utilized the "deep V" in hull design in order to reduce pounding. Although it is generally supposed that a deep V somehow cushions the impact, it actually reduces the efficiency of the lifting surface and hence, in effect, constitutes a reduction of the planing surface size for a given boat size. Unfortunately, the deep V not only does not reduce the wetted area, but actually increases it thereby leading to higher skin friction drag.

Hydrofoils raise the hull of the boat up out of the water so that high speeds can be obtained but the hydrofoil is limited in rough sea operations by the distance the hull is raised out of the water. Thus, with waves above a certain size, the boat will be subjected to the same severe pounding that ordinary planing craft are subjected to.

SUMMARY OF THE INVENTION

The present invention provides a high speed boat with a planing hull which is not subjected to pounding in waves but cuts through the waves, thereby giving the boat an amazingly steady level ride. The boat is not only efficient at high speed but has excellent seaworthiness at low speed due to its low natural frequencies in roll, and pitch. At high speed, the boat is stabilized by spray sheets thrown up that contact the hull sides.

The boat is simple and rugged in construction. Preferably, all of the exterior surfaces of the boat are either planar or provided with a simple curvature as opposed to other high speed boats all which include compound curvatures, thus increasing cost and complexity.

The boat of the invention is provided with a unique bow configuration which allows the boat to knife through most waves, thereby reducing the pounding effect, however with extremely large waves, the lift characteristic of the inclined bow transom enables the boat to ride over such waves.

The boat of this invention is provided with delta-shaped or thin wedge-shaped planing surface with the sides of the boat extending upwardly and outwardly with a concave curvature from the leading edges of the delta or wedge. Such a configuration substantially reduces the wetted area giving a reduction in skin friction. It also produces continuous spray sheets from the sides which contact the outwardly curving sides to provide both stabilization and lift. The delta-shaped bottom is normally submerged so that passage through a wave does not result in an increase in lifting area. The delta-shaped configuration of the deck results in the aerodynamic center being located well aft to provide a boat which is almost impossible to "flip." The concave curvature of the sides of the boat, allows the boat to bank into far tighter turns than was ever possible with prior art boats. The same concave curvature of the sides also leads to a relatively dry cockpit in rough weather since the spray thrown upwardly is directed outwardly and downwardly rather than upwardly as is customary with boats having a convex hull configuration. These spray sheets add to stability in turns. Deflector rails may be placed on the sides of the hull to intercept the continuous spray sheets, a keeel skeg may be used on the bottom of the hull to minimize side slip, and trim tabs or other means may be utilized to counteract propeller torque. While a single wedge shaped hull is desired in most cases for a powered craft, a number of separate but connected slim wedge shaped hulls are useful in other vessels, e. g., a sailing trimaran with one wedge forward and two wedges aft.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of the boat according to the present invention.

FIG. 2 is a bottom plan view of the boat shown in FIG. 1.

FIG. 3 is a stern view of the boat shown in FIG. 1.

FIG. 4 is a schematic front view of the boat shown in FIG. 1, illustrating the configuration of the bow transom and the progressive cross sectional configuration of the boat at selected points from the bow toward the stern.

FIG. 5 is a longitudinal partial cross sectional view of a modified boat construction having the overall external configuration similar to that shown in FIG. 1.

FIG. 6 is a longitudinal partial sectional view of the stern section of the modified boat construction.

FIG. 7 is a cross sectional view taken along the line 7—7 of FIG. 5.

FIG. 8 is a sectional view taken along the line 8—8 of FIG. 5.

FIG. 9 is a cross sectional view taken along the line 9—9 of FIG. 6.

FIG. 10 is a side elevation of a modification showing a plurality of deflectors or spray rails on the side of the hull.

FIG. 11 is a detailed sectional view taken along line 11—11 of FIG. 10 showing a spray rail in section.

FIGS. 12, 13 and 14 are bottom plan, side elevation and sectional elevation views respectively of a modification of this invention in the form of a sailing trimaran.

FIGS. 15, 16 and 17 are side elevation and sectional views (2) respectively of a modification of this invention in the form of a sea plane.

FIGS. 18, 19 and 20 are side elevation and two sectional views of a modification of this invention in the form of a larger boat, e.g., a large passenger ferry.

FIG. 21 is a graph of the lift drag ratio plotted against the lift coefficient for various trim angles.

DETAILED DESCRIPTION OF THE INVENTION

A powered boat 10 having high speed planing capability in rough seas, is provided with a delta-shaped planing surface 12 with the apex 14 disposed adjacent the bow and the base line 16 disposed adjacent the stern. The delta or thin wedge shaped planing surface need not be formed of straight sides as good results are also obtained if the long sides of the delta or wedge are slightly convex or concave. The bottom of the planing surface also need not be perfectly flat but may vary to some concavity.

The bow of the boat immediately adjacent the planing surface is formed as a concave knife edge 18 which extends upwardly and forwardly from the planing surface 12 and terminates in a bow transom 20 which is flat and angled at approximately 45° relative to the planing surface 12. The sharper the knife edge, the less spray will be thrown up at this edge.

The sides of the boat 22 and 24 extend upwardly and outwardly from the edges or chines 26 and 28 respectively of the long sides of the delta-shaped planing surface 12. The concave configuration of the sides 22 and 24 is conveniently a simple curvature and the sides terminate at the upper edge in gunwales 30 and 32. As an example of a simple curvature a cubic curve can be used. Such a cubic curve could be $y = a_0 + a_1 \cdot z + a_3 \cdot z^3$ where y is a lateral dimension, z is height above the planing surface and a_0, a_1 and a_3 are constants. A spray rail 33 is along each gunwale. A transom 34 extends upwardly relative to the planing surface 12 and is joined thereto along the base line 16 of the delta-shaped configuration.

A bustle 36 may be secured to the transom 34 to provide additional roll stability, especially at lower speeds, when the boat is not planing. Sides 38 and 40 of the bustle have a slightly different curvature than the sides of the boat but could be a continuous extension of the sides 22 and 24 of the boat. The bustle 36 is provided with a channel 42 extending from the boat transom 34 to the bustle transom 44 to provide the necessary clearance for the drive train between the engine 35 inside the boat and the propeller 37. On opposite sides of the channel the bottom of the bustle has two angular surfaces 46 and 48 which are stepped relative to the planing surface 12 so they are not in contact with the water while the boat is planing. The gunwales 50 and 52 of the bustle are shown in a stepped manner relative to the gunwales 30 and 32 on the main hull but the gunwales on the bustle could be a straight continuation of the gunwales on the boat hull.

The decking and interior configuration of the boat may vary considerably. In the embodiment shown in FIGS. 1 – 4 inclusive, the decking 54 is provided with a convex curvature between the gunwales and is continuous relative to the boat per se and the bustle. The forward portion of the decking 54 extends outwardly over the blunt bow transom 20 a short distance and functions as a spray deflector. That is, when the blunt bow transom 20 strikes a wave and causes spray, the spray will not fly back into the passenger's face as it will be deflected by deflector 55. This deflector will also incidentally provide some lift from this spray deflection. A forward cockpit 56 is provided for the driver with a suitable wind screen 58. An aft cockpit 60 is provided for the passengers and rearwardly of the passengers, is the engine hatch 62 which is flush with the decking 54 in the closed position. In the preferred embodiment, the plan configuration of the decking will be delta-shaped similar to the planing surface but of greater area thereby locating the aerodynamic center well aft to prevent flipping of the boat at high speeds.

FIG. 4 clearly shows the flat bow transom 20 and the various cross sectional configurations A, B, C and D taken along the lines A—A, B—B, C—C and D—D respectively in FIG. 1. FIG. 4 also shows the concave curvature of the sides 22 and 24 as they rise from the progressively widening delta-shaped planing hull 12.

The boat hull, according to the present invention, may be constructed from any suitable material such as plywood, fiberglass or metal and the size of the boat may vary considerably from a small runabout to a large ocean line type vessel since the principles of construction are valid for all sizes. By utilizing the concave sides having only a simple curvature, it is extremely economical and easy to construct the boat. In view of the wave cutting characteristics of the boat in rough water, it is unnecessary to provide an extremely heavy, strong internal frame, since pounding is minimal.

FIGS. 5 – 9 inclusive show a specific embodiment of the boat wherein a metalic skin, such as aluminum, is used for the hull. The boat shown in FIGS. 5 – 9 is substantially identical in configuration to the boat shown in FIGS. 1 – 4 and differs only in detailed construction features which are primarily internal of the boat. The only superficial difference is best shown in FIGS. 6 and 9 and involves only the shape of the tunnel in the bustle which provides the necessary clearance for the drive train. In this embodiment, the tunnel is curved to facilitate the construction using metal sheets as opposed to the rectangular tunnel shown in FIGS. 1 – 4.

FIG. 5 shows two internal bow plates **70** and **72**. Each of the bow plates **70** and **72** is provided with a concave curvature which extends upwardly and forwardly from the bottom of the boat which is defined by a delta-shaped plate **74**. The bow plates **70** and **72** have flanged edges **76** and **78** for attaching the sides of the boat thereto. The bottom edge of the plate **70** has a flange **80** for securement to the plate **74** and the three edges of the delta-shaped plate **74** are bent downwardly to form similar attaching flanges **82**. The bow plate **72** is substantially narrower throughout than the bow plate **70** as best shown in FIG. 7. The inner and outer side walls of the hull **84** and **86** are secured to the bow plates **70** and **72**. The outer wall **86** stops at the bow plate **72** and separate knife edge component **89** is attached by fastenings **91** shown in FIG. 7.

The bow transom **90** extends upwardly from the bow plate **72** at substantially a 45° angle relative to the bottom **74** and has flanged edges **92**. An inner bow transom **94** extends parallel to the bow transom **90** but extends only downwardly as far as the innermost bow plate **70** to which it is secured. Both bow transoms **90** and **94** are secured to a deck plate **96** and the outer skin **86** of the boat along their flanged edges. In all instances the various members may be secured to each other by any suitable means, such as riveting or welding.

The decking **100**, FIGS. 7 and 8, is provided with a flange **102** for attachment to the upper edge of the outer skin **86**. The joint of flange **102** is encapsulated in rubber or the like **103** to form robust spray rails which also serves to protect the hull against impact, e.g., with the dock. The decking is provided with a step at **104** for receiving any internal cross structure such as the bow hatch, engine hatch, or the like so that these structural members will be flush with the decking **100**. The inner edge of the decking **100** is secured to the inner skin or wall **84** of the hull.

In FIG. 6 the transom has an inner wall **110** and an outer wall **112**, which may be of integral one-piece construction joined by an upper cross member **114**. The bottom edges of the transom are separated by and secured to a crossbar **116** and the inner wall of the transom **110** is secured to the downwardly turned flange **82** of the bottom plate **74**.

The bustle **120** has bottom and side member **122** with a semicircular curvature at **124** to define the tunnel which provides the necessary clearance for the drive train. The member **122** also has a flat bottom portion **126** which extends outwardly at a small angle relative to the horizontal and an upwardly and outwardly curved side portion **128** of a concave curvature which is a continuation of the curved sides of the boat. The bustle also has a cross member **130** with an upwardly and outwardly turned flange **132**. A decking member **134** with a configuration similar to the decking member **100** is secured to the flange **132** and the edge of the side **128**. A gunwale **136** is formed as a continuous line along the entire length of the boat and is encapsulated in a resilient material as described above. A bustle transom has an inner wall **140** and an outer wall **142**, which extend upwardly at an angle parallel to the main boat transom.

As seen from the previous detailed discussion of the various components, a double walled boat hull is provided. The entire chamber defined by the dual wall structure may be filled with any suitable buoyant cellular material such as polystyrene foam or the like to provide buoyancy of flotation tanks. The various members of the boat hull are defined chambers of watertight construction. An epoxy concrete **150** or other suitable material completely fills the depression defined by the flanges **82** on the delta-shaped base plate **74**. This epoxy concrete which has considerable weight per unit volume provides a sealing means for the various seams and also provides the correct degree of ballast necessary to provide the boat with roll stability when in a displacement mode. Numerous other materials may be used as ballast and separate sealing means may be used to seal the seams. Also, the ballast may be located above the delta-shaped planing surface within the boat.

As stated previously, the bustle is not an absolutely essential feature to the present boat construction but if used, does provide additional roll stability at low speeds. The voids in the bustle structure may also be filled with a foam material similar to that shown in FIGS. 5, 7 and 8.

In order to minimize side slip when turning, the boat is provided with suitable side slip prevention means such as a keel skeg **152** as shown in FIGS. 1 – 3 or a fin keel **154** on the bottom of the planing surface as shown in FIG. 10.

When the boat is planing with the forefoot of its bow above the waterline, a turn can cause side slip. This side slip can cause the chine to drop and "dig in" resulting in unpleasant lateral deceleration. The use of side slip prevention means in the form of a keel skeg or fin keel on the bottom of the planing surface serves to minimize side slip.

The torque from the propeller causes the thin wedge shaped hull of this boat to tend to list to one side. This is compensated by torque counteracting means which in a preferred embodiment can be a simple trim tab **156** on one side of the aft end of the planing surface of the hull as shown in FIGS. 1 – 3. This trim tab could be adjustable, but this is not necessary. Moreover, other means of counteracting torque can be used to provide a rolling moment equal and opposite to the propeller torque moment. Additionally, such torque opposing means could incorporate the engine cooling water inlet in the trim tab.

As an example of this invention, an 18 foot marine plywood boat built in accordance with the principles disclosed above knifed through 3 and 4 foot waves of the Chesapeake Bay at speeds between 35 and 50 miles per hour with the boat carrying three people having approximate gross weight of 2,200 pounds. The power was transmitted to a cupped prop at approximately 4,400 r.p.m. by a Mercruiser 140 h. p. engine. On the straightaway and in turns the ride was exceptionally stable even when small craft warnings and high seas forced other boats to harbor. Boats built in 22 foot length with aluminum hulls have cleanly parted waves of 4 – 5 feet high and wave lengths of 20 – 40 feet at speeds near 50 miles per hour with no pounding as compared with the best of conventional hulls which have to drop speed to keep control. The boats have consistently crossed the Chesapeake Bay in winds of 20 – 40 knots and are outstandingly safe in rough weather at all speeds of operation. When the boat gets underway the hull lifts progressively and rapidly to move from a displacement mode to a planing mode. When initially accelerating, the bow raises but then trims in a few seconds to provide a smooth ride. The knife edge bow cuts through some waves and passes over some. When underway, the planing bottom of the hull functions as a planing surface. Spray sheets spray up from each side edge of the hull aft of the knife edge bow and these aid in supporting and stabilizing the boat. Because the hull is "super critical," i. e., it has a resonant frequency less than the frequency of encounter of waves, acceleration of the boat in rough seas makes the ride even smoother.

As shown in FIGS. **10** and **11** the side surfaces **22** and **24** of the boat may be provided with a plurality of deflectors or spray rails **158, 158′** and **158″**. These are to take advantage of the spray sheets and increase the lift to drag ratio. As a slender wedge such as the hull of this boat moves through the water at high speeds, spray sheets develop up and along the sides. The spray sheet will go upwardly and outwardly from the bow of the boat and from the side edges, and the spray angle may vary along the length of the hull. The water in the spray sheet has kinetic energy which is utilized as the spray sheet hits the curve of the hull; in other words, the spray sheet momentum is reacted as a lift force on the boat by deflecting it back downward. While the outer curved surfaces of the sides **22** and **24** of the hull can and do accomplish this, an additional effect can be obtained by utilizing deflectors or inclined spray rails **158, 158′** and **158″** as shown in FIG. **10**. The spray rails are inclined at an angle to the normal inclination of the boat while planing so that the pressure drag is partially offset by a forwardly acting component of the resulting force.

Summarizing, the boat of this invention utilizes a fully submerged planing surface with a thin wedge shape so that lift area is not increased when it passes through the wave, nor is the boat decelerated by a bluff bow shape. Propelling such a thin wedge shape through the water results in the development of lateral spray sheets, the momentum flux in which is comparable to the total lift on the bottom. The sides of the boat deflect these spray sheets outward, substantially recovering this momentum flux; or if desired, deflectors can be utilized to deflect the spray sheet outward and downward, thus recovering even more lift. If the boat banks, then the spray sheet on the low side becomes thicker and its additional momentum provides the necessary "roll stiffness." The same is true in side slip, except that the spray sheet on the side to which it is slipping becomes thicker adding force to oppose the side slip. A most dramatic example of the power in these spray sheets is obtained when the boat is trimmed with the bow very high, then jumped sideways drift off a wake. Upon reimpact with the water, it starts to trip in the direction of motion; at the same time the spray sheet rises up the side and pushes it back again. The resultant wiggle takes a very short space of time.

While the foregoing description is applied to a powered planing boat, the theory of operation and the shape of the hull are not so limited. For example, the invention can be applied to a sailing trimaran as shown in FIGS. **12, 13** and **14.** In this case the hull **170** is formed of three slim wedges **172, 174, 176** with the slim wedge **172** forward and the other wedge sections **174, 176** aft. The bow configuration still includes the knife edge **178** and the outwardly flaring concave sides such as side **180**; these sides flare outwardly of each of the wedge shaped sections, except for the inboard sides of the aft wedge sections. Trim tabs **182** may be used to trim the boat in pitch and roll, and flaring side deflectors **184** may also be provided. Of course, the boat has the conventional rudder **186** and control **188** and may have optional footwells **190** in each of the aftmost wedge sections. This embodiment of a trimaran could be powered.

FIGS. **15, 16** and **17** show application of the principles of this invention to the body of a flying boat, i. e., a seaplane. The plane fuselage **190** is constructed with the bottom in accordance with the principles of this invention including a thin wedge shaped planing surface **192** with a knife edge **194** at the bow thereof and outwardly curving sides **196.** The plane may have retractable wing tip floats **198** and a retractable fairing **199.**

The principles of operation of the FIGS. **12 – 14** and FIGS. **15 – 17** embodiments are the same as the principles for the other described embodiments.

FIGS. **18 – 20** show a further embodiment of the invention as applied to a larger ship, in this case an 85 foot long passenger ferry. The principles of the invention are the same. That is, the boat has a thin wedge shaped planing bottom **200** with a sharp knife edge concave bow portion **202** and above it, a blunt inclined bow portion **204.** Concave sides **206** and **208** extend upwardly and outwardly from the sides of the bottom to gunwales **210** and **212.** In this case the bustle **214** is behind a step **216** at the end of the planing surface or wedge shaped bottom. A propeller drive **218** is below the planing surface, not behind it. Propeller shafts **220** are connected to the propellers from each of three diesel engines **222, 224, 226.** A keel skeg and fairing **228** are provided for each shaft and steering is by means of one or more rudders **230.** The space above the gunwales can conveniently have rows of seats **230** for passengers with a control cabin **232** on top. This 85 foot long, 200 passenger ferry cruises at 40 knots and has ninety tons gross weight. It is powered by three **1450** horsepower diesels.

FIG. **21** is a plot of the lift drag ratio, an indication of the efficiency of the hull against the lift coefficient. The lift coefficient is a non-dimensional coefficient equal to the pressure supporting the boat over the dynamic pressure in the water. In the equation Δ equals the total weight, q_0 equals the dynamic pressure of the water which in turn is one-half times ρ times v^2 where ρ equals the mass density of water (about 2 slugs per cubic foot) and v equals the velocity of the boat in feet per second. θ is the wedge angle (one-half the included angle of the apex of the wedge) and x is the length of the planing surface in feet. The trim angle is the angle of trim in the water. Both the trim angle and the wedge angle are expressed in radians. The wedge angle, the curve of the side and the height of the gunwales can vary depending upon the condition the boat is designed for. However, with the criteria applicant has disclosed, these choices would be apparent to skilled boat designers. As can be seen from FIG. 21 the preferred included angle of the wedge apex is between about 10° and 30° for most applications.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention. For example, although the plan form of the planing surface has been described as a delta or thin wedge, its sides need not be straight in plan as they can be concave or convex. Also the sides of the boat can curve inward near the planing surface before curving upwardly and outwardly.

What is claimed is:

1. A boat having a planing hull capable of operating with stability at high speeds in rough seas comprising:

a. a thin wedge shaped planing surface forming a bottom of the hull with the apex of the wedge at a bow portion of the hull,

b. a knife edge at a lower portion of the bow of the hull extending upwardly and forwardly of the apex of the wedge,

c. a forwardly inclined blunt bow transom forming the upper portion of the bow of the hull above the knife edge,

d. concave sides of the hull extending upwardly and outwardly along the sides of the wedge shaped planing surface and positioned to intercept spray sheets thrown up from sides of the planing hull to assist in stabilizing the boat.

2. A boat having a planing hull as in claim **1** wherein the knife edge is forwardly inclined in a concave manner and the blunt bow transom if flat.

3. A boat having a planing hull as in claim **1** wherein said concave sides are each defined by a smooth simple curve in only one direction and extend over the entire surface of the sides of the wedge.

4. A boat having a planing hull as in claim **1** further comprising turning side slip minimizing means secured to the bottom of the hull.

5. A boat having a planing hull as in claim **4** wherein the side slip minimizing means is a keel skeg along a longitudinal axis of the hull.

6. A boat having a planing hull as in claim **4** wherein the side slip minimizing means is a fin keel positioned on a longitudinal axis of the hull.

7. A boat having a planing hull as in claim **1** further comprising spray sheet deflector means attached to the concave sides of the hull.

8. A boat having a planing hull as in claim **7** wherein the spray sheet deflector means are inclined at an angle to the planing surface.

9. A boat having a planing hull as in claim **8** wherein the spray sheet deflector means comprise a plurality of separated spaced deflector sections.

10. A boat having a planing hull as in claim **1** further comprising propeller torque counteracting means on the hull.

11. A boat having a planing hull as in claim **10** wherein the propeller torque counteracting means is a trim tab attached to one side of the bottom rear of the planing surface.

12. A boat having a planing hull as in claim **1** wherein the included angle of the apex of the wedge shaped planing surface is between 10° and 30°.

13. A boat having a planing hull as in claim **1** wherein the boat is driven by motive power.

14. A boat as set forth in claim **13** further comprising a bustle portion secured to and extending aft of said stern transom, said bustle having a bottom surface stepped up relative to said planing surface, concave sides having a curvature similar to the curvature of the sides of the boat along said wedge-shaped planning surface and a central longitudinally extending notched portion in the bottom surface to provide clearance for a stern drive extending through the stern transom.

15. A boat having a planing hull as in claim **13** wherein the motive power is engine means carried by the hull driving propeller means under the planing surface.

16. A boat having a planing hull as in claim **1** wherein the boat is a flying boat and the hull is a portion of a fuselage.

17. A boat having a planing hull as in claim **1** wherein the boat is a trimaran with a hull as defined in front and a pair of spaced apart wedge shaped spaced apart hulls aft.

18. A boat having a planing hull as in claim **17** wherein the aft hull sides are concave on their outer surfaces only.

19. A boat having a planing hull as in claim **1** further comprising a spray protector extending outward from the bow forwardly of the top portion of the blunt bow transom.

20. A boat as set forth in claim **1** wherein said wedge shaped planing surface is defined by a triangular sheet of material having integral flanges about the periphery which form a receptacle and further comprising ballast means disposed in said receptacle forming smooth bottom surface.

21. A boat as set forth in claim **1** having a deck which is wedge shaped similar to said planing surface but having a larger area.

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