

"VESSEL HAVING A HIGH-SPEED PLANING OR SEMI-PLANING HULL"

THIS INVENTION relates to high speed marine craft hull forms of both mono hull and multi-hulled form.

The invention relates particularly to improving the hydrodynamic efficiency of high speed marine craft, principally to mono-hulled or multi-hulled vessels which would otherwise be of a planing or semiplaning nature, by the introduction of a very shallow but pressurised air cavity in the bottom of the craft's rigid hull. The improvement in overall hydrodynamic efficiency of ship hulls has been the subject of much research and the concept of introducing air beneath a ship's hull with the intention of improving it's hydrodynamic efficiency is not new. The non-amphibious side wall hovercraft (otherwise known as a surface effect ship, SES) is a prime example of such an application, although there are many others. Other examples of such prior art comprise US3742888, US4393802, US1824313, US1389865, AU-A-33446/84, AU-A-87515/83, AU-A-44236/79, GB2112718, GB2060505, GB1311935, JP3-243489, DE-A-3208884, DE-A-2831357, WO-A-85/00332 and EP-A-0088640.

In regard to that prior art however, the power requirement to maintain the air cavity at it's working pressure has been a relatively high proportion (typically 15% to 50%) of their main propulsion power requirements. Many of these designs also have the disadvantage of requiring flexible seals to maintain the air cavity in place. Another feature of these existing designs is the relatively large volume or depth of cavity employed which makes it difficult to maintain the design air pressure in disturbed sea conditions where air can rapidly leak from the cavity. This difficulty is a contributing factor to the normally high air supply system power requirement.

The invention relates to the improvement of hydrodynamic efficiency of a mono or multi hulled high speed marine craft. This is brought about by supporting a significant proportion of the craft weight on pressurised air, in the form of a thin film of air which is maintained under the bottom of the hull. This air film is maintained within the bounds of a shallow cavity integrated into the lower hull of the vessel. The arrangement reduces the resistance (both frictional and residuary resistance) to forward motion of the craft compared to an equivalent craft without the invention employed.

Accordingly the invention resides in a vessel having a high speed planing or semiplaning hull comprising;

- (a) a first portion located at the bow and configured to provide a forward planing portion;

- (b) a second portion aft of the first portion comprising a shallow cavity having a forward end defined by a step extending across the hull at the forward end of the second portion and a rib located to each side of the hull for the length of the second portion;

- (c) a pressurised air source being provided in the vessel and connected to the cavity to deliver air under pressure to the cavity through an outlet whereby the air is distributed substantially evenly into the cavity and in a manner which does not disturb the surface of the water below the cavity; and

- (d) a third portion aft of the cavity providing a seal at the aft end of the cavity and formed with one or more channels extending from the cavity to the stern

to permit the controlled loss of air from the cavity such that a substantial portion of the third portion has no contact with the air flowing from the cavity.

According to a preferred feature of the invention the forward planing portion is formed with a central rib which extends to each side of the central longitudinal axis and which extends from a position in the region of or forward of the water line to the step or a position forward of the step. The profile of the lower surface of the rib can be generally of corresponding profile to the hull to each side of the rib while the sides present a step in the profile of the hull. If desired, the depth of the step can vary along its length whereby it is at its maximum at an intermediate position along its length. If desired the deadrise of the rib can vary along its length being at its minimum towards its aft end. In addition, the rib may terminate forward of the step and in such a case the hull may be generally of constant profile between the aft end of the rib and the step. If desired the lower edges of the rib may extend beyond the face of the step. According to a preferred feature of the invention the rib is formed as a member supported from the hull which is capable of adjustment to vary the degree of protrusion of the rib from the hull. If desired, the rib is resiliently supported from the hull.

According to a preferred feature of the invention the forward planing portion is provided with a plurality of secondary ribs to each side of the central axis and which are configured and placed to control the water flow past the forward planing portion such that the water flow is substantially axial.

According to a preferred feature, the substantial portion of the third portion is formed as one or more regions of positive deadrise.

According to a further preferred feature the third portion has negative deadrise such that the substantial portion of the third portion is located to either side.

According to a preferred feature the ribs extend for at least a portion of the third portion.

According to a preferred feature the face of the third portion is inclined downwardly from the second portion to the stern. In addition, if desired the upper wall of the cavity is inclined downwardly towards the stern.

According to a further preferred feature of the invention the substantial portion of the third portion is adapted to accommodate propulsive units.

According to a preferred feature of the invention, the second portion is formed with a plurality of longitudinally spaced shallow cavities each defined by a step extending transversely across the hull at its forward end and a rib located to each side of the hull, the pressurised air source being provided in the vessel and connected to the cavities to deliver air under pressure to each of the cavities through an outlet. If desired, the air source to each cavity can be independent of the other cavities and the air pressure maintained in the each cavity can vary from the air pressure in the other cavities or can be equal. In addition, the air pressure in the cavities can be varied

In addition, if desired the forward cavities communicate with the adjacent aftmost cavity through passageways. If desired the passageways may be associated with means to regulate the degree of communication where the regulation is governed by aspects of hull motion such as hull speed, pitch and roll.

A benefit of the invention has been found to comprise a reduction in resistance of up to 35% with a total air supply power requirement of less than 5% of the required design propulsive power requirement. This means that the air supply system can be very small relative to the main propulsion machinery of the vessel.

Although the invention is applicable to what would otherwise be Vee or Round bottom high speed craft, the introduction of the invention significantly changes the underwater shape of the craft such that these conventional descriptions would no longer apply. The craft with the invention would be an essentially flat bottomed vessel with small side ribs and a very low deadrise underwater Vee bow. It is the nature of these significant changes and the effects that they have, which provides the high gain in overall efficiency which makes the present invention so different from the prior art. As a result, the hull is capable of a higher speed than is available in equivalent craft without an increase in power which would be expected with equivalent craft of a conventional form.

According to a preferred feature the sides of the cavity are sealed by straight or swept side ribs. The inner edges of the side ribs and the aft edges of the forward planing step are shaped to promote clean water separation and minimum turbulence.

According to a preferred feature the upper surface of the cavity top, which forms the upper boundary of the air cavity can be angled down, from its forward most end towards its aft end and the third portion is also angled down with an increased inclination. As a result, the third portion at least, by virtue of its increased angle of inclination compared to the second portion is contacted by

the water to create a seal at the aft end of the cavity, which is profiled to have hydrodynamic efficiency and to control the loss of air from the cavity. The third portion of the hull is formed with one or more channels to allow the air to escape to the stern of the hull through the one or more channels formed in the third portion. The presence of the channels serves to control and minimise the air flow rate from the cavities and substantially reduces the cavity air refill rate in rough sea conditions. In addition, the channels ensure that the remainder of the third portion is substantially free from any contact with the air from the cavity. This enables propulsion units to be located at the remainder of the third portion whereby their performance will not be inhibited by the air flowing from the cavity.

According to a preferred feature of the invention at least a rear part of the third portion is displacable vertically with respect to the hull to vary the inclination of the third portion. In this regard, the whole of the surface of the rear part of the third portion between the side ribs can be movable or it can be subdivided into segments located between the channels. The movable rear part can have or can provide one or more channels positioned in correspondence with the one or more channels in the third portion. Support for the movable rear part may be of a resilient form to provide for the at least partial absorption of shocks and the like, The movable rear part serves to enhance stability of vertical movement and to reduce excessive loadings on the stern portion of the vessel.

A vessel designed in accordance with the above has a distinguishing feature that the total volume of the air cavity is small compared to the static displaced volume of the hull. Typically the ratio of total air cavity volume to total static displaced volume is from 0.05 to 0.2.

An example of the vessel designed in accordance with the above has a distinguishing feature that the power required to supply the air film is only a small percentage of the power required to propel the craft. Whilst the design flow rate of the air supply is related to the sealing arrangements of the particular cavity design, the design flow rate of the air supply is such that when multiplied by the design air pressure and divided by the efficiency of the pressurised air supply system, the resulting power is no greater than 5% of the Delivered Power required to propel the craft at its design speed in its design condition (where the Delivered Power is the power required to be delivered to the propulsion device to propel the craft at a certain speed).

A vessel designed in accordance with the above has a distinguishing feature that the pressure of the air in the cavity is such that this pressure multiplied by the non-wetted platform area of the cavity is equal to a significant proportion of the design weight of the craft which typically is of the order of 30% to 60% of the design weight of the craft.

According to a preferred feature the forward end of the upper surface of the cavity is formed with a transverse second step which reduces the depth of the cavity towards the forward end, said air being delivered to the cavity across the end face of the step and from a plurality of openings on the lower face of the step. Preferably the majority of the air flow is from across the end face of the step. According to a preferred feature the second step is formed by a plate member mounted transversely across the cavity. The entry of air into the cavity is such that the surface of the water below the cavity is not deformed by the air flow from the second step.

In an embodiment of the invention, the pressurized air is introduced from behind a flat plate mounted horizontally within the forward end of the cavity. The plate is provided with openings in its lower face to allow some air into the forward portion of the cavity. The air is contained in the cavity by planing sectors of the hull at the forward end which terminate in a straight or swept planing step. This step which forms the forward end of the cavity, is substantially forward in the craft, being a distance of 3% to 35% of the static waterline length of the craft aft of the forward perpendicular. The lower portion of this forward planing sector of the hull is made in the form of low deadrise Vee section.

If desired the plate can be angled and extended aft to a distance no more than half the length of the air cavity and provided with a sharp trailing edge to ensure clean separation of any water that should impinge on it. The deadrise angle of this plate may be equal to or less than that at the forward planing step. This feature can lead to improved performance of the air cavity in disturbed sea conditions.

Furthermore if desired, the plate can be constructed in an angled, stepped form all the way to the stern, with the deadrise angle of each step being equal to or less than the one immediately in front of it, the forward most step having a deadrise angle equal to or less than that of the forward planing step. This feature can lead to improved performance in calm and disturbed sea conditions particularly for high length to beam ratio vessels.

According to a preferred feature of the invention the channels may be provided with regulation means which are able to regulate air flow from the cavity. The regulation means may comprise vanes of the like which can be moved to

vary the cross-sectional area of the channels. The regulation of air flow can serve to provide a control for the trim and heel of the vessel.

According to a feature of an embodiment of the invention, the ribs are of substantially constant width throughout their length. Alternatively in another embodiment the ribs may decrease in width rearwardly of the step.

According to another preferred feature of the invention the transverse distance between the chines of the hull in the region of the step is at most equal to the transverse distance between the chines of the hull amidships.

The invention will be more fully understood in the light of the following description of several specific embodiments. The description is made with reference to the accompanying drawings of which:-

Figure 1 is an underneath plan view of a hull according to the first embodiment;

Figure 2 is a sectional elevation of a hull according to the first embodiment;

Figures 3A, 3B and 3C are cross-sectional views of the hull of Figure 2 at lines A-A, B-B, C-C respectively;

Figures 4A, 4B, 4C, 4D, 4E, 4F, 4G and 4H illustrate a variety of profiles for the embodiment along line D-D of Figure 2 and of Figure 10;

Figures 5A and 5B illustrate the relationship between the forward cavity depth and depth of the planing step area of the forward and rearward portion of the cavity respectively;

Figure 6 is an underneath plan view of a second embodiment having an extended plate;

Figure 7 is an underneath plan view of a third embodiment having a set of extended plates;

Figure 8 graphically illustrates the results from model tests of an example of the first embodiment where resistance trim, heave and the pressurised air pressure and flow rate are all shown as a function of ship forward speed;

Figure 9 is an underneath plan view of a hull according to the fourth embodiment;

Figure 10 is a sectional elevation of a hull according to the fourth embodiment;

Figure 11A, 11B, 11C are cross-sectional views of the hull of Figure 10 at lines A-A, B-B, C-C respectively;

Figure 12 is a side elevation of a form of the forward portion of a hull which can be utilised in each of the embodiments; and

Figures 13A, 13B, 13C, 13D, 13E, 13F and 13G are cross sections along lines A-A, B-B, C-C, D-D, E-E, F-F, G-G of the forward portion shown at Figure 12.

Figure 14 is a schematic view of the stern of a vessel according to another embodiment.

In all of the drawings the abbreviations CL mean Centreline and SWL means Static Water Line.

The first embodiment of the invention as shown at Figures 1, 2 and 3 comprises a high speed planing hull 11 which is formed with a forward portion 12 which has a generally conventional planning configuration except it incorporates a low deadrise planing section in its lower portion; and a second portion 13 which accommodate the cavity 14. The forward portion 12 is separated from the second portion 13 by a step 15 which defines the forward boundary of the cavity 14. The sides of the cavity 14 are defined by a narrow ribs 16 to each side of the hull of equal width or gradually becoming wider as they extend from the stern to the forward end of the cavity and forming lateral extensions of the forward portion. The wetted area of the hull at design conditions is shown crosshatched at Figure 1.

Figures 3A, 3B, 3C provide an indication of the cross-sectional configuration of the hull on the lines A-A, B-B, C-C of Figure 2.

As shown in Figures 3B and 3C the upper surface of the cavity 14 is substantially planar and as shown at Figures 2 and 3B and 3C the upper surface is inclined downwardly towards the stern of the hull. The ribs which form the sides of the cavity in the central portion extend to the third portion aft of the cavity and can have a low positive deadrise at the inner side of the rib. In addition, the mid-portion of the third portion can be formed to have a portion of positive deadrise to each side of the central axis.

As a result of the configuration of the cavity and the third portion of the hull, the air in the cavity is maintained in the cavity and any loss of air is generally controlled. Furthermore, the loss of air from the rear of the cavity past the third portion is effected through channels 20 formed between the cavity and the stern and

Figures 4A - 4H illustrate a variety of profiles available for the third portion along line D-D of Figure 2 where the third portion is formed of channels 20 which extend between the cavity and the stern. The presence of the channels serves to control the loss of air from the cavity and ensures that a substantial portion of the third portion is not in contact with air or air bubbles flowing from the cavity. This enables the location of propulsion units such as propellers or the like in the substantial portion whereby they are not affected by the air flowing from the cavity. The channels can if desired incorporate a flow control in the form of vanes which can be used to vary the cross-sectional area of the channels. In so doing some control can be provided for the trim and heel of the vessel.

The cavity 14 is pressurised from a pressure source (not shown) accommodated within the vessel which is connected to an outlet 17 provided in the upper wall of the cavity 14 towards its forward end. The outlet is associated with a plate 18 which extends across the cavity in the region below the outlet 17 intermediate of the depth of the cavity. Air delivered from the outlet 17 is delivered into the cavity from the rear edge of the plate 18.

Figures 5A and 5B illustrate the proportions between the depth H1 of the forward portion and rear portion of the air cavity respectively compared to the depth H2 of the planing step area of the rib portion 16. The relationship between these values in the forward portion of the cavity area is such that the depth H1 of the air cavity in that region is 10% to 40% greater than the depth H2 of the planing step area of the rib. Preferably in the forward region of the cavity the ratio of H1 and H2 is generally less than 0.5 and can increase in the aft portion of the cavity to be more than 0.5.

The relationship between the forward portion 12 is such that the distance L2 between the step 15 defining the forward end of the air cavity and the forward end of the waterline of the vessel 19 as compared to the waterline length L1 of the vessel is of the order of 0.05 and 0.40.

If desired the plate 18 may be extended such that it extends for a distance equal to up to half of the length of the air cavity as shown at Figure 6.

In addition, according to a third embodiment as shown at Figure 7 a plurality of air outlets may be provided in the upper wall of the air cavity 14 and each may be associated with a ventilating plate 18 at spaced intervals along the cavity.

Figure 8 illustrates the results of testing an example of the embodiment shown at Figures 1, 2 and 3. The test model was representative of a vessel of a length of 74 metres and a displacement of 700 tonnes. The representations provide an indication of the resistance values, degree of trim, the degree of heave, the variation in air cavity pressure and variation of air supply or flow rate. In Figure 8A the solid line indicates the resistance curve of a vessel of corresponding configuration but not incorporating a cavity while the broken line illustrates the relationship of resistance and hull speed of the example of the embodiment.

Similarly, in relation to Figure 8B that figure illustrates by the solid line the angle of trim of an ordinary vessel of corresponding configuration to the example while the broken line illustrates the angle of trim of the example of the hull according to the embodiment.

Similarly Figure 8C illustrates the variation in heave for the vessel without the invention (the solid line) as compared with the vessel with the invention (the broken line).

Figures 8D and 8E illustrate the variation in air cavity pressure and air supply flow rate in a hull incorporating the invention as a function of hull speed.

The fourth embodiment of the invention as shown at Figures 9, 10 and 11 has a high speed planing hull 111 which is formed with a forward portion 112 which has a generally conventional configuration except that it incorporates a low deadrise planing section in its lower portion and a second portion 113 which incorporates a plurality of longitudinally spaced cavities 114. The forwardmost cavity 114 is separated from the forward portion 112 by a first step 115 which defines the forward boundary of the forwardmost cavity 114. In addition, each of the subsequent cavities is formed with a forwardmost step 115 which each represents the termination of the upper surface of the adjacent forwardmost cavity 114. In Figure 9 the wetted area of the hull under design condition is shown as crosshatched.

Figures 11A, B and C provide an indication of the cross-sectional configuration of the hull on the lines A-A, B-B and C-C of Figure 10.

The side of each cavity is defined by a narrow ribs 116 to each side of the hull of equal width or gradually becoming wider from the stern to the forward end of the cavity and which in each case forms lateral and longitudinal extensions of the portion of the hull forward of the respective step.

The upper walls of each cavity 114 are substantially planar but as shown in Figure 9 are inclined downwardly towards the stern of the hull whereby the ribs 116 of the respective cavity terminate on the upper wall of that cavity intersecting the plane of the ribs. This occurs immediately prior the transverse axes of the step of the following cavity. The cavities 114 are interconnected by second channels 125 to enable air to flow between the cavities. If desired each second channel may be provided with regulating vanes or like elements which can be adjusted to control the degree of flow through the second channels 114. The adjustment of the regulating vanes or the like can be effected manually or automatically according to the hull of the vessel and for the degree of roll of the vessel.

The ribs which form the sides of the cavity in the central portion can extend into the third portion aft of the cavity and can have a low positive deadrise at the inner side. In addition, the mid-portion of the third portion is formed to have a positive deadrise to each side of the central axis.

As a result of the configuration of the cavity and the third portion of the hull, the air in the cavity is maintained in the cavity and any loss of air is generally controlled. Furthermore, the loss of air from the rear of the cavity past the third portion is permitted in a controlled manner through channels 125 which are between the cavity and the stern.

The relationship between the forward portion 112 is such that the ratio of distance L_2 between the forward perpendicular of the forwardmost extent of the waterline which is marked FP and the forwardmost cavity step 115 to the waterline length of the vessel L_1 is between 0.03 and 0.35.

Each cavity 114 is pressurised from a pressure source (not shown) accommodated within the vessel which is connected to an outlet 117 provided in the upper wall of each cavity 114 towards its forward end. Each outlet 117 is associated with a plate 118 which extends across the cavity in the region below the outlet 117 intermediate of the depth of the cavity. Air delivered from the outlet 117 is delivered into the cavity 114 across the rear edge of the plate 118.

If desired the delivery of air to each of the outlets 117 may be effected from a common pressure source. Alternatively the air may be delivered to each cavity from an independent pressure source. This can improve the performance of the embodiment in rough sea conditions and in certain situations enables the air being delivered to each cavity to vary, which serves to optimise control of the motion and attitude of the vessel according to sea conditions by the varying the cavity air volume in each cavity. In addition, the pressure maintained in each cavity may vary from the air pressure in adjacent cavities.

As shown at Figures 12 and 13 the forward planing portion 12 of the hull of each of the embodiments can be formed to have a central rib 26, which extends to each side of the central axis. The rib has a cross-sectional profile which is an extension of the profile of the hull to each side of the rib, at any particular location along the rib however the rib serves to project its profile outwardly from the profile of the remainder of the hull. In addition, the rib extends from a position forward of the water line B-B to the step 15.

The function of the central rib is to shape the surface of the water in the region of the cavity and which forms the lower wall of the cavity such that there will be no

collapse of that surface and whereby the integrity of the cavity is maintained. The rib reduces in deadrise rearwardly along the hull. If desired the rib can terminate before the step in which case the profile of the hull between the central rib and step remains substantially constant.

In addition, if desired the rib can be formed as a support member which is movable inwardly and outwardly with respect to the hull according to the operating characteristics and water conditions. In addition or alternatively the member may be resiliently supported from the hull to provide some shock absorbing preparation.

In addition, the forward planing portion may be formed with (not shown) a plurality of secondary ribs in the form of fins or thin chines to each side of the central rib to further control the flow of water past the forward most portion to the second portion.

One combined benefit of these features is to reduce the vertical forces or heave exerted on the vessel in rough sea conditions.

If desired the plate of each of the embodiments may be dispensed with and the upper surface of the cavity can be formed with stepped configuration where air is delivered across the rear face of the step. The stepped upper wall of the cavity incorporates the feature of the plate of previous embodiments as an integral feature of the hull. Of course appropriate means must be provided to equalise the distribution of air across the rear face of the step.

Air is delivered into the cavity in each of the embodiments at a pressure such that the vertical force applied to the interior of the cavity is roughly equal to 30% to 60% of

the design weight of the vessel. In addition, the total cavity volume of the cavity is of the order of 5% to 20% of the displaced volume of the vessel.

According to another embodiment as shown at Figure 14 the surface of the third portion is formed to be displacable. The surface of the third portion is formed by several more segments 230 which are pivotally supported from their forward edge to be pivotable downwardly to vary the inclination of the surface of the third portion. The segments 230 are spaced to provide one or more channels which are in correspondence with one or more channels 220 in the third portion. The support for the segments (shown schematically in Figure 14 at X) is resilient to provide some shock absorbing properties. The resiliently displacable segment serve to provide some stability against vertical movement and reduce shock loadings on the third portion in rough seas.

It should be appreciated that the scope of the present invention need not be limited to the particular scope of the embodiment described above. In particular the invention has application to multi hulled vessels where each hull is formed with a cavity of the form described.



THE CLAIMS defining the invention are as follows:-

1. A vessel having high-speed planing or semi-planing hull comprising;

(a) a first portion located at the bow and configured to provide a forward planing portion;

(b) a second portion aft of the first portion comprising a shallow cavity having a forward end defined by a step extending across the hull at the forward end of the second part, a rib located to each side of the hull for the length of the second portion;

(c) a pressurised air source being provided in the vessel and connected to the cavity to deliver air under pressure to the cavity through an outlet whereby the air is distributed substantially evenly into the cavity and in a manner which does not disturb the surface of the water below the cavity; and

(d) a third portion aft of the cavity providing a seal at the aft end of the cavity in the form of an aft profiled surface formed with one or more channels extending from the cavity to the stern to permit the controlled flow of air from the cavity such that a substantial portion of the third portion has no contact with the air flowing from the cavity.

2. A vessel as claimed at claim 1 wherein the forward planing portion is formed with a central rib which extends to each side of the central longitudinal axis and which extends from a position in the region of or forward of the waterline to the step or a position forward of the step.



3. A vessel as claimed at claim 2 wherein the profile of the lower surface of the central rib is generally of corresponding profile to the hull to each side of the central rib and the sides of the central rib present a step in the profile of the hull.
4. A vessel as claimed at claim 3 wherein the depth of the step varies along the length of the step.
5. A vessel as claimed at claim 4 wherein the depth of the step varies in depth from a maximum depth at the steps forward end and a minimum at the steps aft end.
6. A vessel as claimed at claim 4 wherein the step has its maximum depth at an intermediate position along its length.
7. A rib as claimed at any one of claims 2, 3, 4, 5 or 6 wherein the deadrise of the central rib varies along its length to be at its minimum at its aft end.
8. A vessel as claimed at any one of claims 2, 3, 4, 5, 6 or 7 wherein the central rib terminates forward of the step wherein the profile of the hull between the end of the central rib and the step is of substantially constant profile.
9. A vessel as claimed at any one of claims 3 to 8 wherein the lower edges of the central rib extend beyond the face of the step.
10. A vessel as claimed at any one of claims 2 to 8 wherein the central rib is formed as a member, separately supported from the hull and which is movable from the hull to vary the degree of protrusion of the central rib from the hull.



11. A vessel as claimed at claim 10 wherein the central rib is resiliently supported from the hull.

12. A vessel as claimed at any one of the preceding claims wherein the forward planing portion is formed with a plurality of secondary ribs to each side of the central axis which are configured and placed to control water flow past the forward planing portion such that the water flow over the forward planing portion past the secondary ribs is substantially axial.

13. A vessel as claimed at any one of the preceding claims wherein the substantial portion of the third portion is profiled to have one or more regions of positive deadrise.

14. A vessel as claimed at any one of claims 1 to 11 wherein the third portion is profiled to have a negative deadrise such that the substantial portion of the third portion is located to either side of the central axis and wherein the one or more channels are provided along the centre of said third portion.

15. A vessel as claimed at any one of the preceding claims wherein the ribs extend for the length of the second portion to each side of the cavity to and for at least a portion of the third portion.

16. A vessel as claimed at any one of the preceding claims wherein the substantial portion of the third portion is profiled to accommodate propulsive units for said vessel.

17. A vessel as claimed at any one of claims 1 to 16 wherein the face of the third portion is inclined downwardly from the second portion to the stern.



18. A vessel as claimed at any one of the preceding claims wherein the upper wall of the cavity is inclined downwardly towards the stern.

19. A vessel as claimed in any one of the preceding claims wherein the second portion is formed with a plurality of longitudinally spaced shallow cavities where each cavity is defined by a step extending transversely across the hull at its forward end and a rib located to each side of the hull, pressurised air source being provided in the vessel and connected to the cavities to deliver air under pressure to each of the cavities through an outlet.

20. A vessel as claimed at claim 19 wherein the air source to each cavity is independent of the air source to the other cavities.

21. A vessel as claimed at claim 19 or 20 wherein by the air pressure maintained in each cavity varies from the air pressure in the other cavities.

22. A vessel as claimed at any one of claims 19, 20 or 21 wherein the air pressure in the cavities is capable of being varied.

23. A vessel as claimed at any one of claims 19, 20, 21 or 22 where the cavities communicate with adjacent cavities through passageways.

24. A vessel as claimed at claim 23 wherein the passageways are associated with regulation means to regulate the degree of communication.



25. A vessel as claimed at claim 24 wherein the regulation means is controlled by a control means to control the degree of communication through said passageways in accordance with aspects of hull motion such as hull speed, pitch and roll.

26. A vessel as claimed at anyone of the preceding claims wherein the forward end of the upper surface of the cavity is formed with a transverse second step which reduces the depth of the cavity toward the forward end, said air being delivered to the cavity across the end face of the step and from a plurality of openings in the lower face of the step.

27. A vessel as claimed at claim 26 wherein a majority of air flow is from across the end face of the step.

28. A vessel as claimed at any one of claims 26 or 27 wherein the second step is formed by a plate member mounted transversely across the cavity.

29. A vessel as claimed at claim 28 wherein the length of the second step is between 3% to 35% of the static waterline length of the vessel.

30. A vessel as claimed at any one of the preceding claims wherein the ratio of air cavity volume to static displaced volume of the vessel is between 0.05 to 0.2.

31. A vessel as claimed at any one of claims 26, 27, 28 or 29 wherein the upper face of the cavity is formed with a plurality of longitudinally spaced second steps and air is delivered from the end face and lower face of each second step.



32. A vessel as claimed at any one of the preceding claims wherein the ratio of the length of the waterline of the forward planing portion to the waterline length of the vessel is of the order of 0.05 to 0.40.

33. A vessel as claimed at any one of the preceding claims wherein the air is delivered into the second portion at a pressure such that the vertical force applied to the interior of the cavity is roughly equal to 30% to 60% of the design weight of the vessel.

34. A vessel as claimed at any one of the preceding claims wherein the surface of the third portion to each side of the one or more channels is profiled to provide a stable planing surface which is to be in constant contact with the water.

35. A vessel as claimed at any one of the preceding claims wherein the one or more channels are provided with a regulation means adapted to vary the cross-sectional area of the one or more channels.

36. A vessel as claimed at any one of the preceding claims wherein at least the rear part of the third portion is displaceable vertically to vary the inclination of the rear portion of the third portion.

37. A vessel as claimed at claim 36 wherein the rear part is resiliently supported.

38. A vessel as claimed at claim 36 or 37 wherein the rear part is formed with one or more channels which are in correspondence with the one or more channels in the third portion.



39. A vessel as claimed at any one of the preceding claims wherein the ribs are of substantially constant width throughout their length.

40. A vessel as claimed at any one of the claims 1 to 38 wherein the ribs decrease in width rearwardly from the step.

41. A vessel as claimed at any one of the preceding claims wherein the transverse distance between the chines of the hull in the region of the step is at most equal to the transverse distance between the chines of the hull amidships.

42. A vessel as claimed at any one of the preceding claims wherein the ratio of the distance between the forward perpendicular of the forwardmost extent of the water line and the step to the water line length of the vessel is between 0.03 and 0.35.

43. A vessel as claimed at any one of the preceding claims wherein the vessel comprises a mono-hulled vessel.

44. A vessel as claimed at any one of claims 1 to 42 wherein the vessel comprises a multi-hulled vessel.

45. A vessel substantially as herein described with reference to the accompanying drawings.

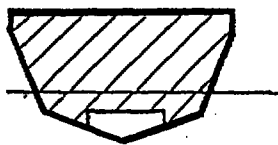
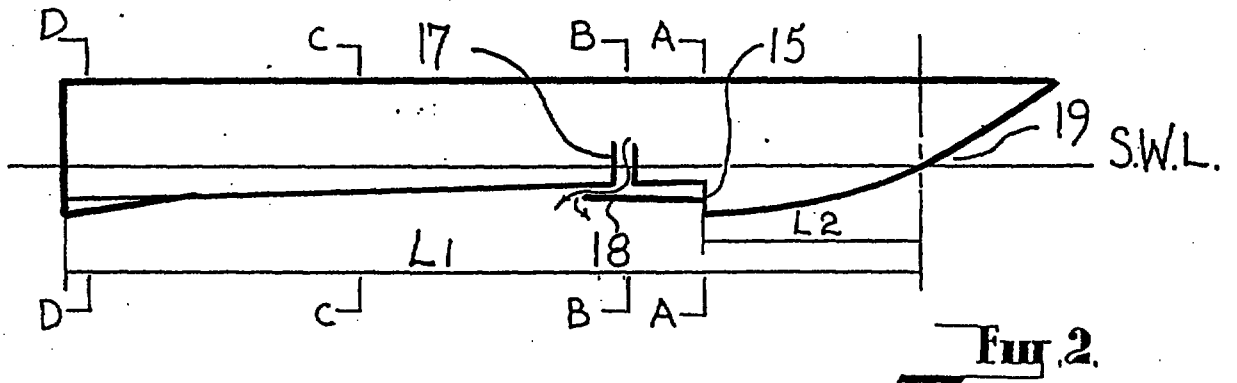
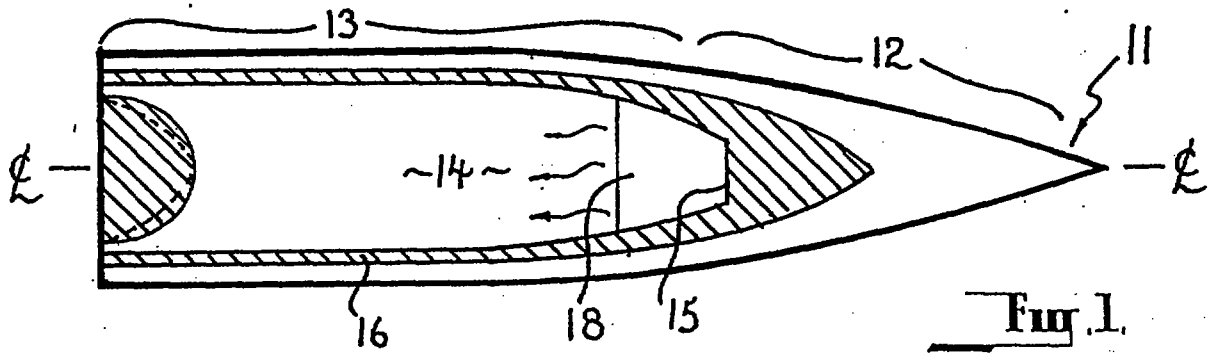


Fig. 3A,

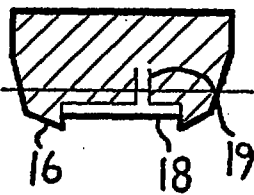


Fig. 3B,

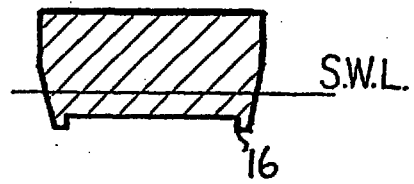


Fig. 3C,

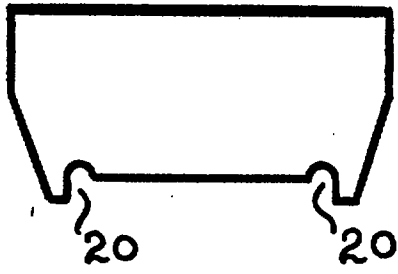


Fig. 4A,

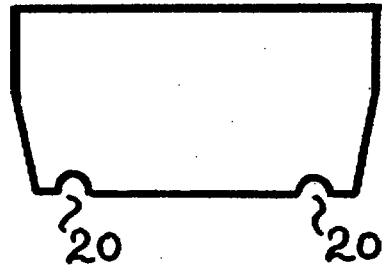


Fig. 4B,

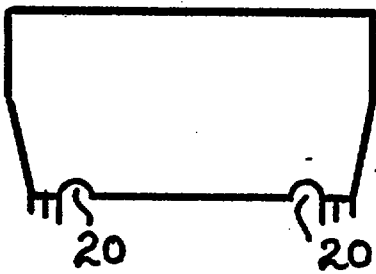


Fig. 4C,

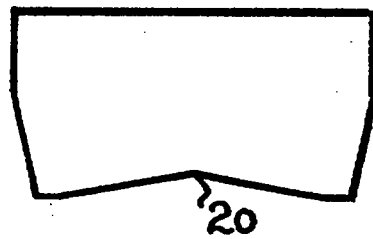


Fig. 4D,

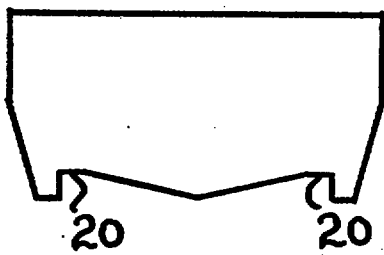


Fig. 4E,

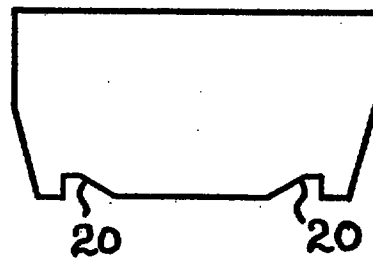


Fig. 4F,

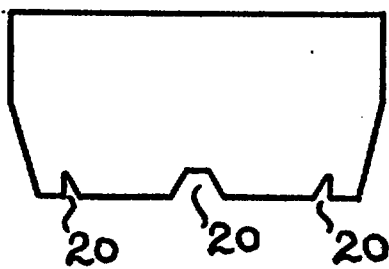


Fig. 4G,

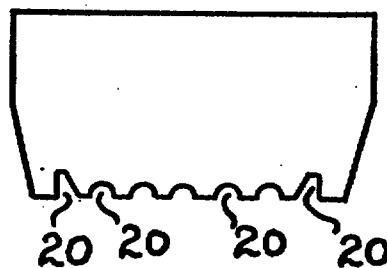


Fig. 4H,

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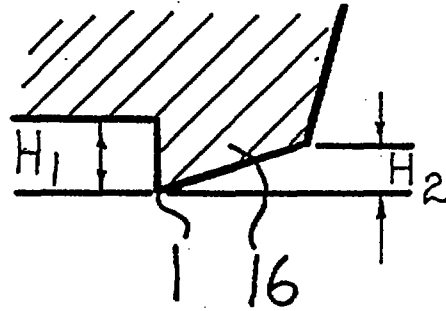


Fig. 5 A,

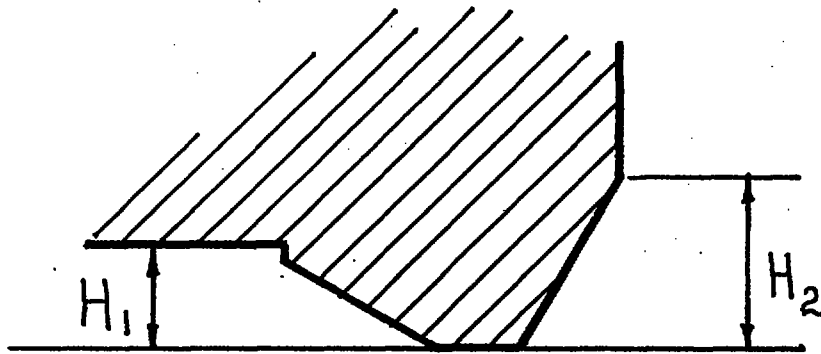


Fig. 5 B,

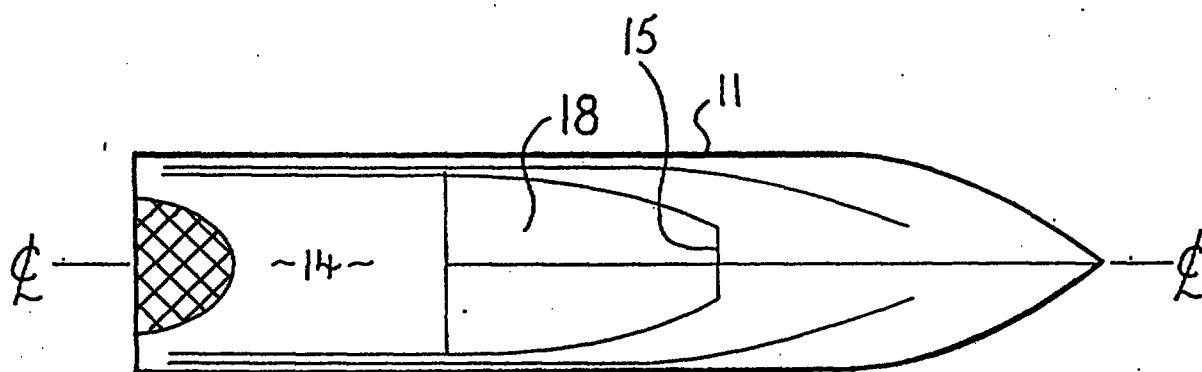


Fig. 6.

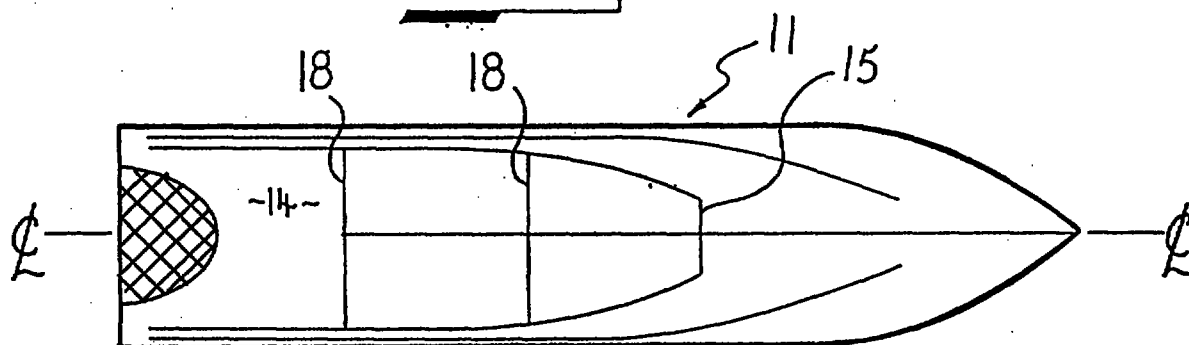


Fig. 7.

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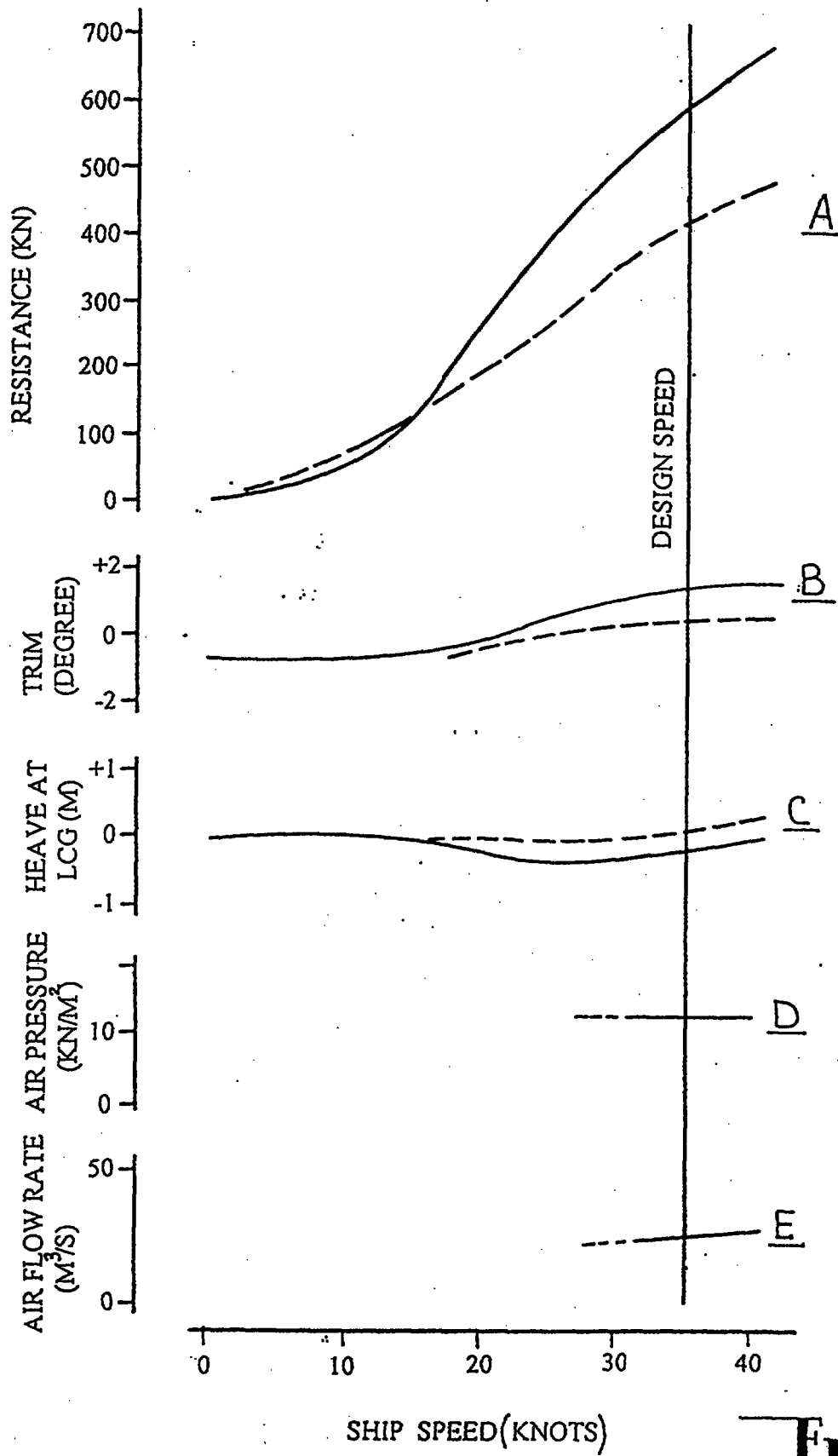


Fig. 8.

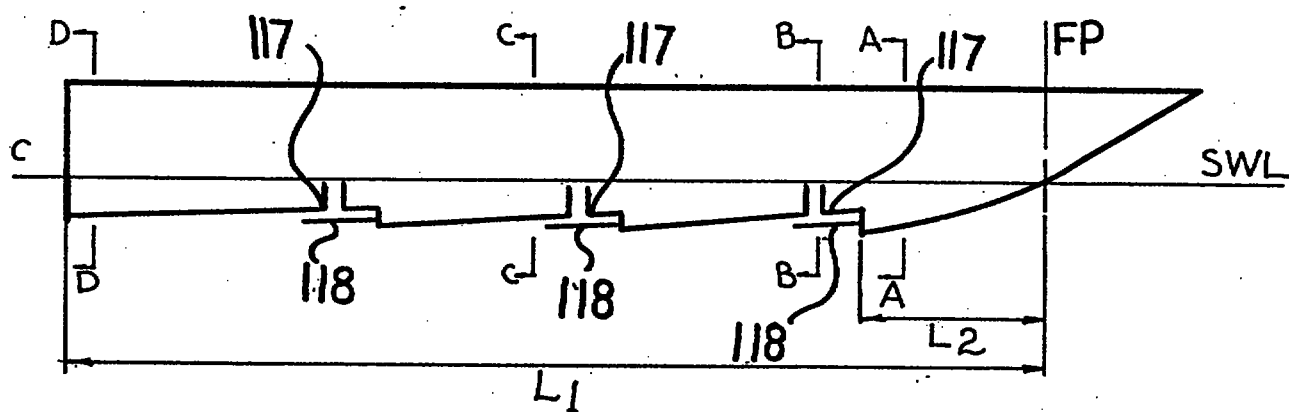
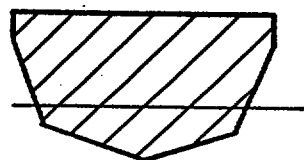
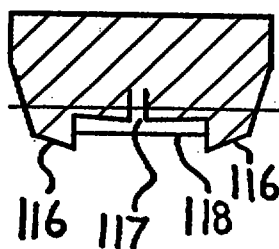


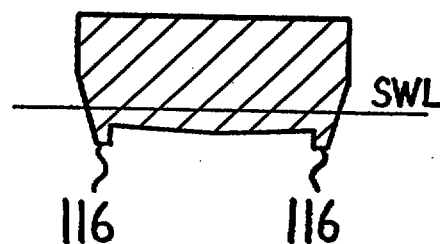
Fig. 10.



Ex. 11A.



Four 11B.



Fug. 11c.

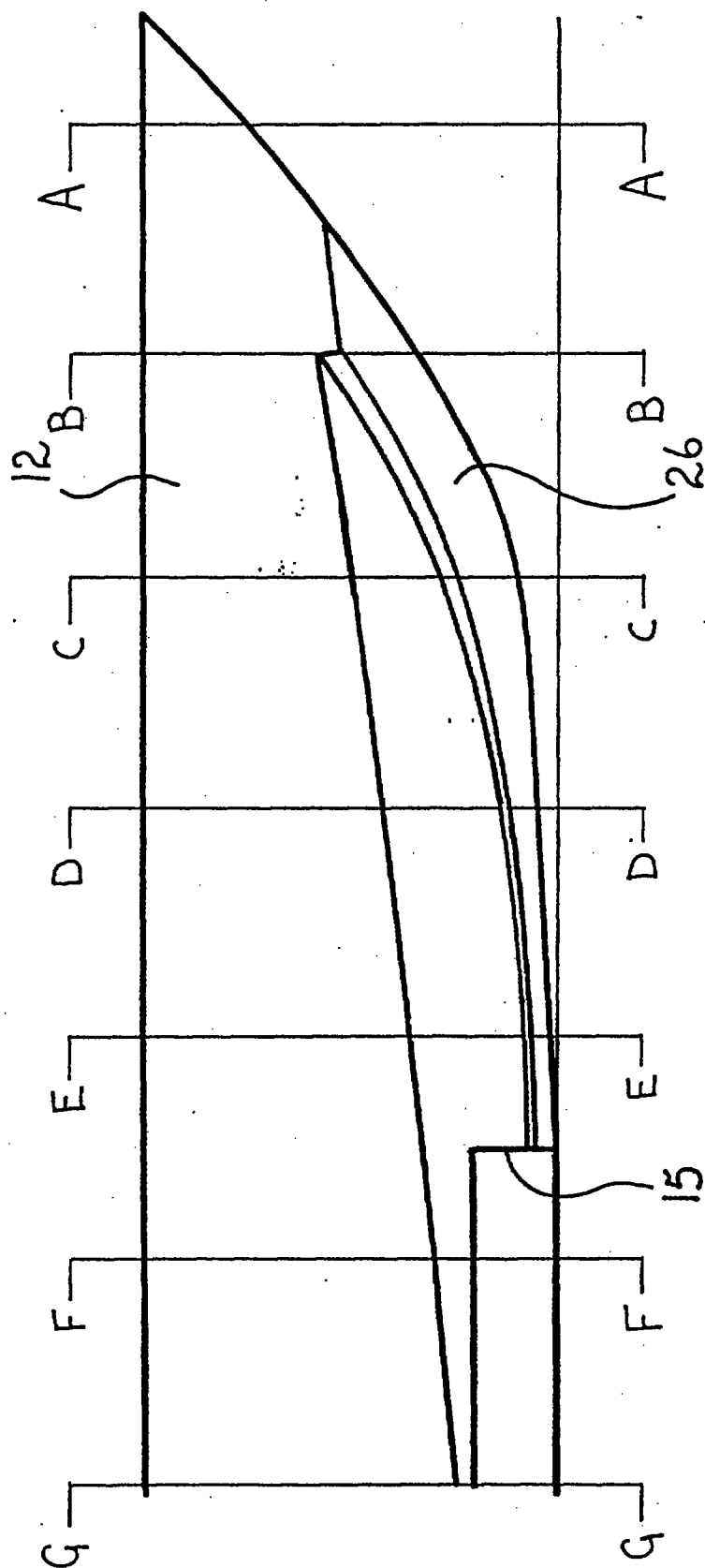
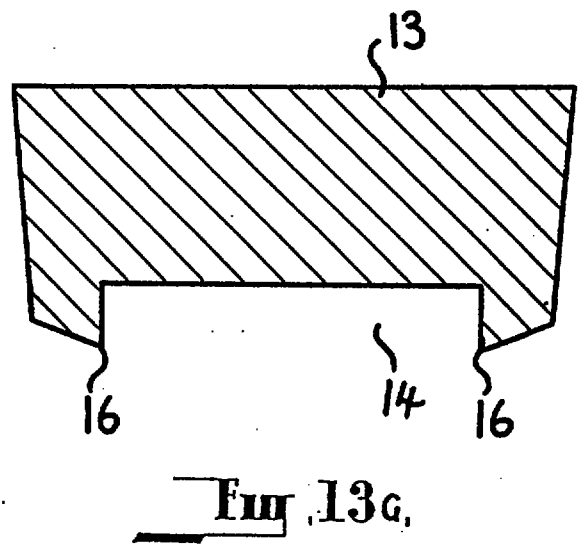
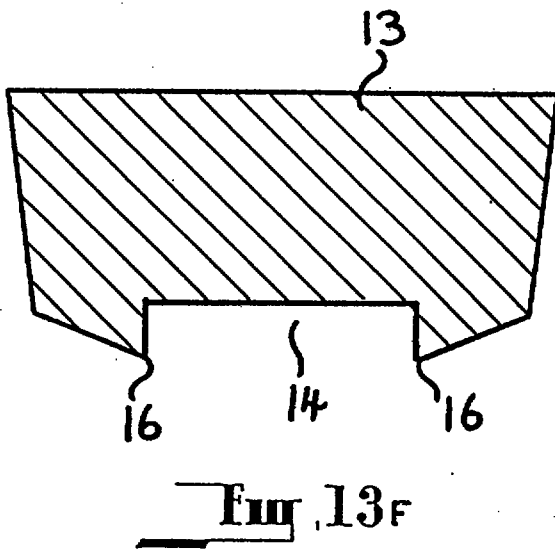
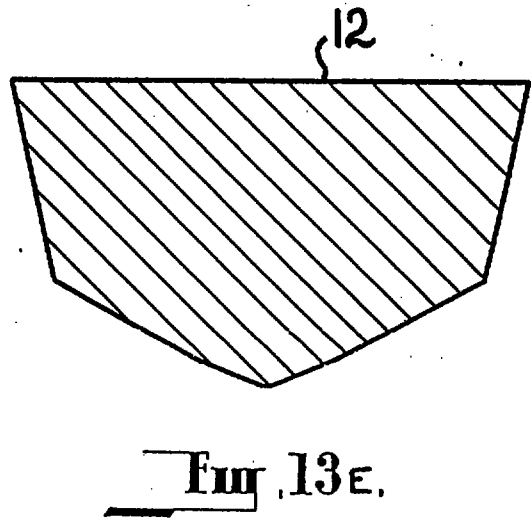
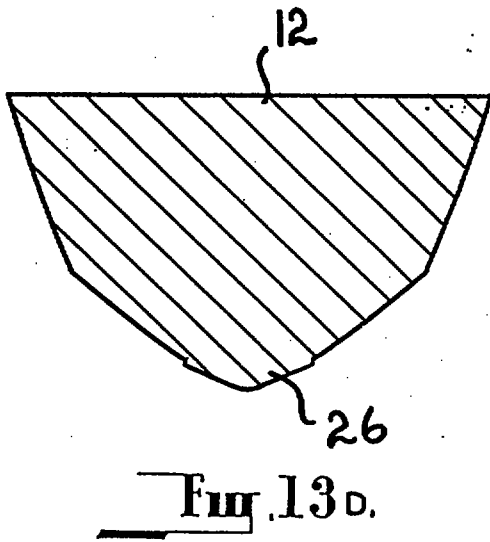
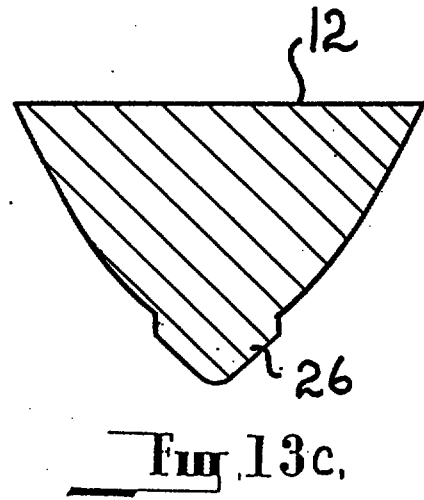
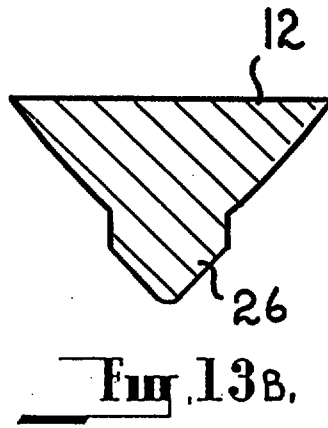
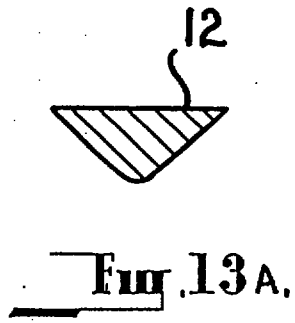


Fig. 12.



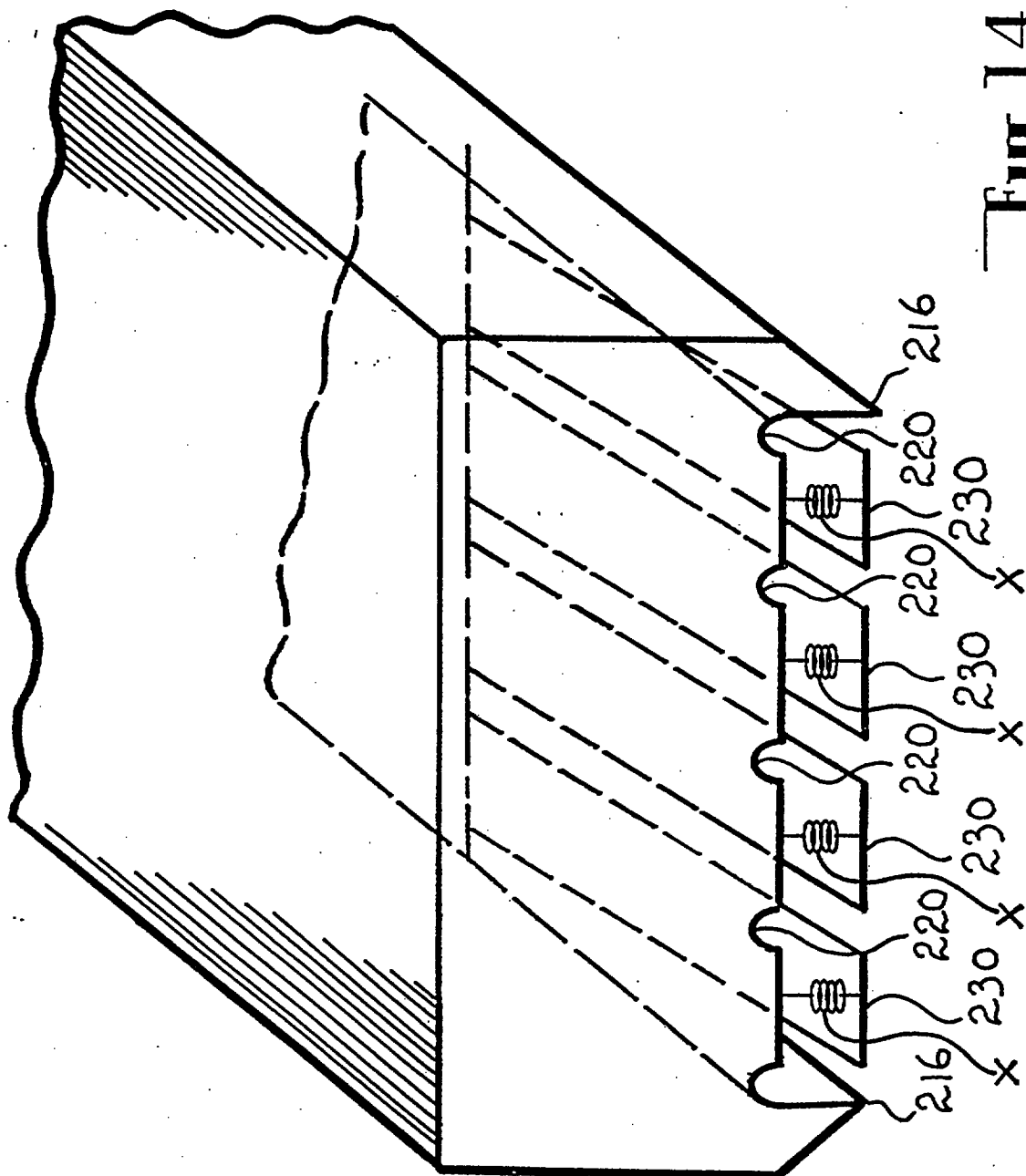


Fig. 14

REPLACEMENT SHEET
Date :

ABSTRACT

This Sheet Has Been Replaced



A vessel having high-speed planing or semi-planing hull comprising;

(a) a first portion (12) located at the bow and configured to provide a forward planing portion;

(b) a second portion (13) aft of the first portion comprising a shallow cavity (14) having a forward end defined by a step (15) extending across the hull at the forward end of the second part, a rib (16) located to each side of the hull for the length of the second portion;

(c) a pressurised air source provided in the vessel and connected to the cavity (14) to deliver air under pressure to the cavity through an outlet (17) whereby the air is distributed substantially evenly into the cavity and in a manner which does not disturb the surface of the water below the cavity (14); and

(d) a third portion aft of the cavity (14) providing a seal at the aft end of the cavity in the form of an aft profiled surface formed with one or more channels (20) extending from the cavity (14) to the stern to permit the controlled flow of air from the cavity (14) such that a substantial portion of the third portion has no contact with the air flowing from the cavity.

Abstract

"Vessel Having a High-Speed Planing or Semi-Planing Hull"

A vessel having a high-speed planing or semi-planing hull comprising;

- (a) a forward planing portion located at the bow;
- 5 (b) a shallow cavity aft of the forward planing portion, defined by a step (15) extending across the hull and a rib (16) located to each side of the hull for the length of the shallow cavity;
- (c) an air source to deliver pressurised air into the cavity evenly and in a manner which does not disturb the surface of the water below the cavity (14); and
- 10 (d) a profiled surface aft of the cavity (14) which provides a seal, said profiled surface formed with channels (20) extending from the cavity (14) to the stern to permit the controlled flow of air from the cavity (14) such that a substantial portion of the profiled surface has no contact with the air flowing from the cavity.

Fig.2