Jan. 19, 1954 V. C. BABCOCK 2,666,406

BOAT HULL

Filed March 22, 1950

3 Sheets-Sheet 1

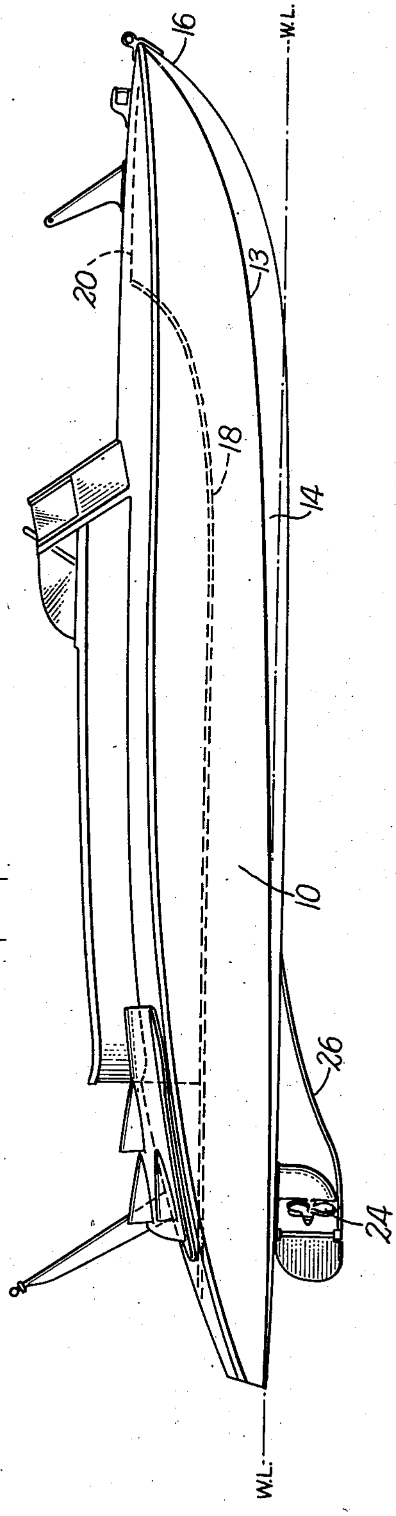

FIG. 1.

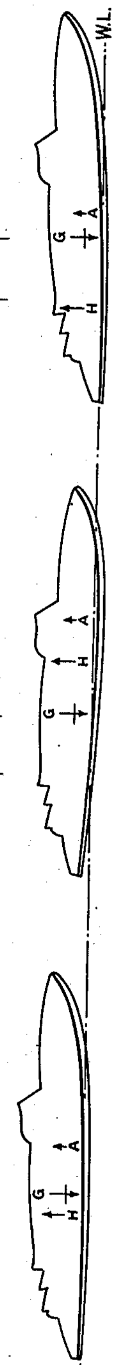

FIG. 4.

FIG. 3.

FIG. 2.

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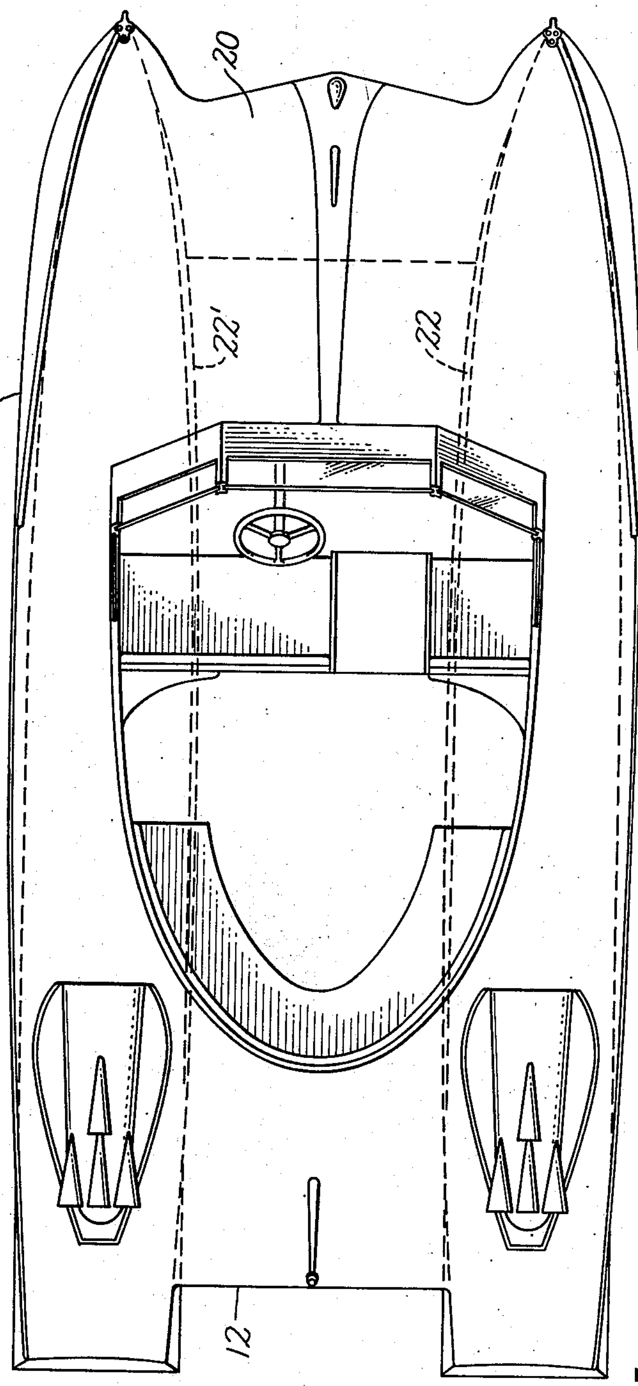

Fig. 5.

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FIG. 6.

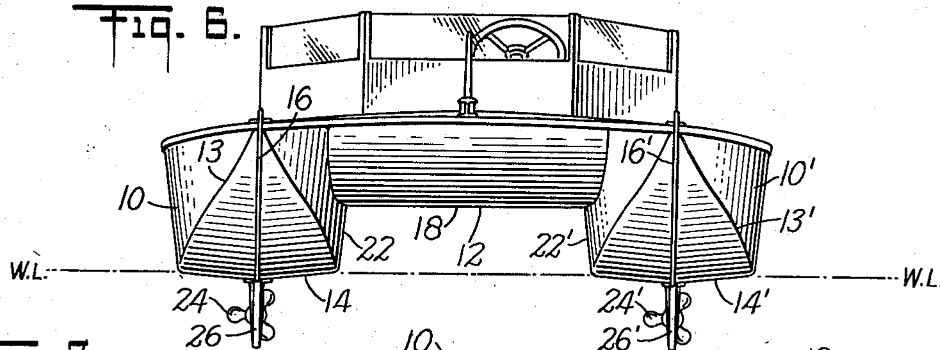


FIG. 7.

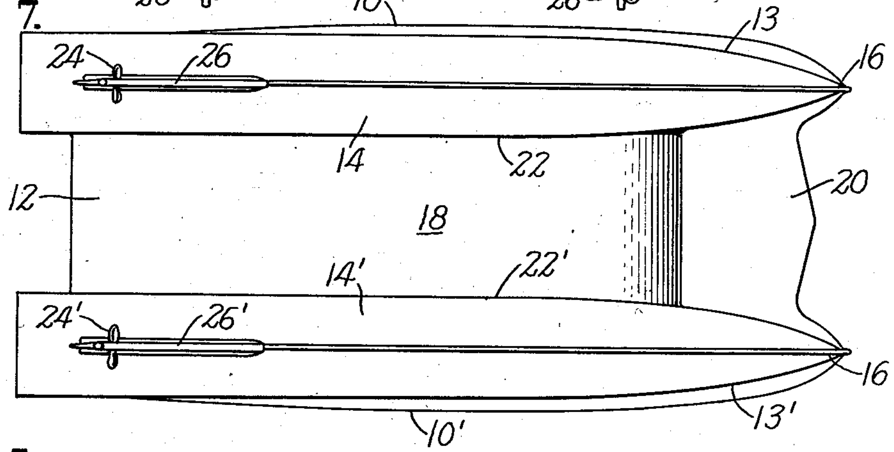


FIG. 8.

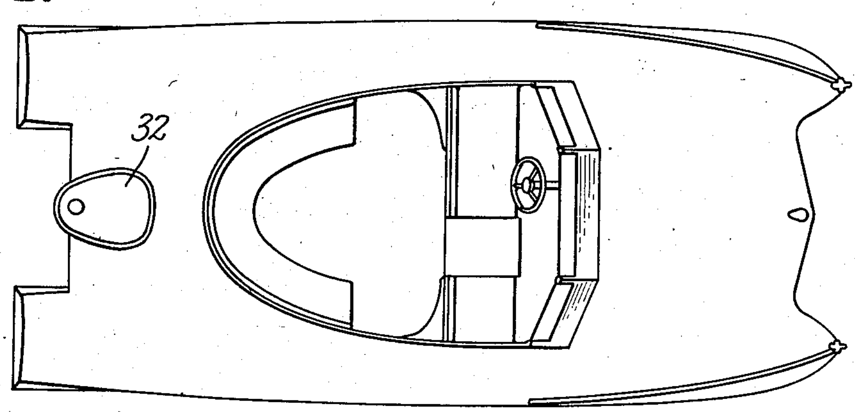
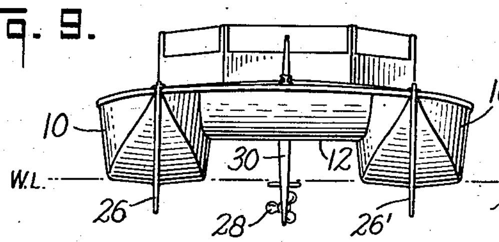


FIG. 9.



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2,666,406

BOAT HULL

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10 Claims. (Cl. 114—61)

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This invention relates to boat hulls, and particularly hulls for motor-driven boats, but not necessarily being limited thereto.

It is among the objects of the invention to provide a boat hull having the several advantageous characteristics of good stability, longitudinal, lateral and directional; capability of relatively high speeds at low power; maneuverability; shallow draft; and susceptibility to economical manufacture, operation and maintenance.

These, and other desirable objects apparent hereinafter, are accomplished by the present invention, a suitable embodiment of which is described herein and shown in the accompanying drawings, in which:

Figure 1 is a lateral elevation of a boat whose hull embodies features of the invention;

Figures 2, 3 and 4 are diagrammatic lateral elevations of the boat underway, illustrating the variation in forces acting upon the boat when it is, respectively, in normal attitude; in bow-down attitude, i. e. at low angle of attack; and in bow-up attitude, i. e. at high angle of attack.

Figures 5 and 6 are respectively top plan and front elevational views of the boat;

Figure 7 is a bottom plan view of the boat, at slightly reduced scale;

Figures 8 and 9 are respectively top plan and front elevational views of another hull showing an alternative arrangement of driving propeller within the scope of the invention.

As shown particularly in Figures 6 and 7, the hull comprises a pair of laterally spaced floats, generally indicated at 10 and 10′, with a continuous bridge structure, generally indicated at 12, extending therebetween. The aspect ratio (i. e., the ratio of waterline length to beam) of the floats is low enough to allow the floats to "plane" on the water, yet high enough to give the craft good directional stability. Ratios ranging from 6:1 to 10:1 have been found satisfactory. The keel line runs substantially parallel to the waterline for approximately two-thirds of the length from the stern forward, then has a gradually increasing upward sweep to the stem 16; the chine line 13 starts at approximately the same elevation as the keel at the stern, and runs forward with a slight rise for the first half portion of the hull and then with gradually increasing rise to the stem 16. This arrangement makes the bottoms of the hulls 10—10′ substantially flat at the stern, of shallow V section throughout the center portion, and with deeper V section toward the stem 16. As

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shown in Figures 5 and 7, the floats 10, 10′ are of substantially uniform width throughout the major portion of their length, gradually tapering in their forward portions to relatively sharp prows 16, 16′. Advantageously, the displacement of the floats is sufficient that the waterline of the hull when at rest is below the bottom wall 18 of the bridge structure 12.

Referring now to Figure 1, it may be seen that the bottom wall 18 of the bridge structure 12, which extends between the floats 10, 10′ throughout a major portion of their length, is substantially straight and horizontal throughout most of its length, with a forward portion 18a having a gradual upsweep. From the forward end of this upswept portion of the bridge structure 12 projects an overhanging deck or brow 20 which serves, among other functions, as a spray shield.

Thus, referring to Figures 5, 6 and 7, the inner walls 22, 22′ of the floats 10, 10′ and the bottom 18 of the bridge structure 12 form through the hull a tunnel of generally rectangular cross-section extending fore and aft. The sides of a tunnel, which are formed by the inner walls 22, 22′ of the floats 10, 10′, are substantially vertical and parallel to each other throughout a major portion of their length. The ceiling of the tunnel, which is formed by the bottom wall 18 of the bridge structure 12, is substantially horizontal and therefore substantially perpendicular to the sides of the tunnel throughout a major portion of its length. The forward end of the tunnel has a pronounced funnel or bell-mouth shape, by virtue of the tapering of the floats 10, 10′ and the upsweep of the forward end 18a of the bottom 18 of the bridge structure 12, an effect further accentuated by the overhanging brow 20.

Substantially the entire beam of the hull above the line of the bottom of the bridge structure 12 is available as utility space. In Figure 1 there has been illustrated a cockpit for the craft, with a suitable arrangement of seating and controls.

In the particular embodiment shown, twin engines (not shown) are employed, one located astern in each of the floats 10, 10′. These engines, through offset shafting, drive screws 24, 24′ which are mounted in fin and rudder assemblies 26, 26′ projecting beneath the centerlines of the floats 10, 10′.

When the boat is under way, the bottoms 14, 14′ of the floats 10, 10′ have a planing action, which causes the craft to ride extremely high in the water. The lines WL throughout the figures indicate the approximate position of the waterline when the boat is under way at normal cruising speed. Thus it can be seen that the tunnel under the hull is completely clear under such circumstances. As the boat moves forward, the funnel-shaped forward end of the tunnel scoops in air which is forced or "rammed" aft into the portion of the tunnel of lesser cross-section, where it is compressed and exerts an upward pressure or lift against the bottom wall 18 of the bridge structure 12. This serves to raise the hull even farther out of the water, so that the craft literally skims across the surface, with only a few inches of the floats 10, 10' submerged.

The particular novel structural features of a hull made in accordance with the present invention give it the additional and important advantage of extraordinary stability. The dual or "catamaran" type of hull, the general principle of which has been heretofore known and employed, inherently possesses excellent lateral stability, due to the concentration of hydrodynamic lift near its outboard extremities. The present invention provides structural features which add to this inherent lateral stability uncommon degrees of longitudinal and directional stability.

Figures 2, 3 and 4 diagrammatically illustrate the manner in which the longitudinal stability is accomplished. In these figures, the arrow G indicates the longitudinal position of the center of gravity of the boat, the arrow H the longitudinal center of hydrodynamic lift force effective upon the boat, and the arrow A the longitudinal center of aerodynamic lift. The center of gravity G of course remains fixed despite changes in attitude of the boat. The center of hydrodynamic lift H and the center of aerodynamic lift A, however, shift longitudinally with changes in attitude.

When the boat is in its normal attitude, as shown in Figure 2, the hydrodynamic lift, which is a composite of the effects due to displacement of water by the floats 10, 10' and the upward force exerted by the planing of the floats upon the water, has its longitudinal center H slightly abaft the longitudinal center of gravity G. The longitudinal center of aerodynamic lift A, which lift, as above described, is produced by compression of air in the tunnel beneath the boat, is considerably forward of the center of gravity G. While the hydrodynamic lift has greater magnitude than the aerodynamic lift, the moment arm of the hydrodynamic lift—that is, its longitudinal distance from the center of gravity—is shorter than that of the aerodynamic lift so that the effective moments of force or torque of the two lifts exactly cancel and the craft tends to remain in perfect balance.

Figure 3 illustrates the shift of the centers of the aerodynamic and hydrodynamic lift when the craft is momentarily in a bow-down position, that is, a position of lower angle of attack than shown in Figure 2. The center of hydrodynamic lift H has moved considerably forward of the center of gravity G, due to a shift in the longitudinal center of displacement, and in the effective longitudinal center of the planing surface, as can be seen. Also, since the ceiling of the tunnel is now inclined downwardly toward the bow, it has in the portion near the bow a markedly reduced cross-sectional area, which results in locally increased aerodynamic pressure. Accordingly, the center of aerodynamic lift has instantaneously moved forward along the boat an appreciable distance. Both the centers of hydrodynamic lift and of aerodynamic lift are now well forward of the center of gravity and augment rather than cancel each other to exert a considerable torque which tends rapidly to restore the craft to its normal position of balance.

In Figure 4, the boat is shown in a momentary bow-high position or at greater angle of attack than shown in Figure 2. The center of hydrodynamic lift H, as would be expected, has now shifted well abaft the center of gravity G, because only the after portions of the floats 10, 10' are submerged. Also, since the tunnel now has its smallest cross-sectional area in the stern portion, the center of aerodynamic lift A has moved some distance aft from its normal position as in Figure 2. While the center of aerodynamic lift A is still forward of the center of the center of gravity G, the magnitude of aerodynamic lift has been considerably diminished by virtue of the fact that the forward portions of the floats 10, 10' are now clear of the water, allowing some of the air which would otherwise be rammed into the tunnel to "spill" out of the tunnel to either side between the bottoms 14 and 14' of the floats and the surface of the water. Thus, the torque produced by the diminished aerodynamic lift, acting upon a shortened moment arm, is greatly reduced, while the undiminished hydrodynamic lift operating on a substantial lever arm aft of the center of gravity G, strongly urges the stern of the boat upwardly and tends to restore the boat to its normal attitude.

It will thus be seen that any change in longitudinal attitude of the boat, however slight, causes an instantaneous shift in the center or magnitude of lift, producing a force which tends immediately to restore the boat to normal attitude. The result is a longitudinal stability not previously possible.

The effect of the shifting of aerodynamic lift will be beneficial no matter how small its magnitude. However, for best results it has been found advantageous to maintain a ratio of aerodynamic to hydrodynamic lift of at least 1 to 20. This is accomplished by proper proportioning of the cross-sectional area of the tunnel at its mouth and at its major portion, and by the proper proportioning of the area of the bottom wall 18 of the bridge structure 12, with respect to the displacement of the boat. Also, to afford a substantial shift of the center of aerodynamic lift with change in attitude of the boat, it has been found preferable to extend the uniform rectangular portion of the tunnel for at least 75 percent of the length of the craft at the waterline.

In a full size test boat, the longitudinal stability was so good that the usual tendency to nose up when power is applied or increased, or to nose down when power is suddenly cut off, was substantially overcome. Further, the inherent lateral stability was such that it did not heel over on turns, and a large man could jump from one gunwale to the other without producing noticeable rocking motion.

As the boat picks up speed, it merely rises in the water with little change of attitude until the bottoms 14, 14' of the floats merely skim or skid on the surface of the water. This allows the boat to move forward without the necessity of moving vast volumes of water aside, as is necessary with the usual displacement type of hull; the boat leaves but the slightest wake astern. Thus, it can attain surprising speeds at low power.

Moreover, since the aerodynamic lift increases as the quantity of air passing through the tunnel is increased, the boat actually makes as good or better speed upwind as downwind. The lower power requirement reduces the initial cost of the boat, as well as lowering fuel consumption and increasing its operating range. Its points of deepest draft, the tips of the fin and rudder structures **26**, **26'**, are only of the order of one foot below the surface in a boat of the size illustrated, so that it can negotiate extremely shallow waters with safety. This light draft confers the additional advantage of rendering steering unusually easy.

The light draft and the conformation of the floats **10**, **10'** which adapt them for planing both longitudinally and laterally also provides the advantage of excellent static directional stability. It is well known that a quartering sea, wherein the horizontal wave motion has a component transverse to the boat, causes a boat having the conventional displacement type hull to yaw, because such a hull presents a large area to the waves and is necessarily carried with them to some extent. With the present hull, however, the transversely moving waves slide beneath the shallow bottoms of the floats **10**, **10'**, and the craft is not carried off course.

The slight V shape of the bottoms **14**, **14'** of the floats illustrated give the craft sufficient "bite" to afford good dynamic directional stability and allow the craft to make good a straight track through the water. The flattening of the bottoms **14**, **14'** toward the after ends of the floats keeps the center of hydrodynamic lift well aft and overcomes the usual difficulty of excessive drag in hulls with high aspect ratio (relatively long and narrow hulls).

Figures 8 and 9 illustrate an alternative embodiment having a single driving screw **28** mounted at the lower end of a streamlined column **30** projecting downwardly from the bridge structure **12** at the lateral center of the after end thereof. The screw **30** may be powered by an engine **32** mounted on the upperside of bridge structure **12** directly above the screw **28** and coupled therewith by means of a shaft extending through the column **30**. A driving arrangement of the general type illustrated in Figures 8 and 9 may be readily provided by means of a conventional outboard motor. Such a system has exhibited extraordinary effectiveness and efficiency. When an outboard motor is used, the craft may be steered by bodily rotation of the motor and its propeller, or, alternatively, by a separately movable rudder mounted directly behind the propeller, or by a pair of rudders in assemblies **26**, **26'** on the two floats, as already described.

It will be appreciated that the present invention accomplishes the aforementioned as well as other desirable objects. It should be emphasized, however, that the embodiment shown and described is intended as merely illustrative and not as restrictive of the invention.

I claim:

1. A boat hull comprising a pair of laterally spaced floats and a continuous bridge structure extending between the upper portions of said floats, said floats and said bridge structure shaped and arranged so as to provide below the operating waterline of said hull two discrete hull portions, and above the operating waterline forming a longitudinally extending tunnel throughout a major portion of the length of said floats, the top of said tunnel being formed by the bottom wall of said bridge structure and having a generally smooth surface which is substantially parallel to the operating waterline for a distance from its after end in the order of magnitude of two thirds of its length and with its remaining portion forward expanded upwardly and forwardly to a cross-sectional area at least twice that of its said after portion, the longitudinal elements of the sides of said tunnel, formed by the inner walls of said floats, being substantially parallel to each other throughout a major portion of their length, whereby said tunnel has substantially uniform cross-sectional area throughout a major portion of its length and a portion opening to at least double such cross-sectional area at its forward end.

2. A boat hull as claimed in claim 1, wherein the ratio of length to width of said floats is between 6:1 and 10:1.

3. A boat hull as claimed in claim 1 wherein the bottoms of said floats are formed in their forward portions to the transverse shape of a shallow V, gradually blending to a generally flat transverse shape at their after extremities.

4. A boat hull as claimed in claim 1 wherein said floats are of sufficient displacement that the waterline of the hull when at rest is below the bottom wall of the bridge structure.

5. A boat hull as claimed in claim 1 wherein the bottoms of said floats are relatively flat transversely and have an upswept portion forward, whereby to give said floats a planing action on the water.

6. A boat hull as claimed in claim 1 wherein the bottoms of the floats are relatively flat longitudinally whereby a relatively small increase in the angle of attack of said hull causes a substantial forward portion of the bottoms of the floats to clear the water.

7. A boat hull according to claim 1 wherein the bottom wall of the bridge structure is substantially horizontal for at least seventy-five percent the length of said hull at the waterline.

8. A boat hull comprising a pair of laterally spaced floats having inner walls approximately vertical and disposed substantially parallel to one another throughout a major portion of their length with a tapered portion forward, and a continuous bridge structure extending between the upper portions of said floats to form a tunnel throughout a major portion of their length, said bridge structure having a bottom wall substantially horizontal from its after end throughout about two-thirds of its length and with its remaining forward portion upswept to provide an entering cross-sectional area of said tunnel at least double that of its after portion, thus forming above the operating waterline of said hull a clear tunnel having substantially uniform rectangular shape and size throughout a major portion of its length with a flared portion forward.

9. A boat hull as claimed in claim 1 wherein the top of the forward portion of said tunnel extends upwardly and forwardly for a portion of its length and then forwardly approximately parallel to the operating waterline for the remainder of its length.

10. A boat hull comprising a plurality of laterally-spaced floats and a continuous rigid connecting structure extending between the upper portions of said floats, said floats and said connecting structure forming longitudinally-extending tunnels between said floats throughout a major portion of their length, the longi-

tudinal elements of the sides of said tunnels, formed by the inner walls of said floats, being substantially parallel to each other throughout a major portion of their length, the tops of said tunnels being formed by the bottom wall of said connecting structure and having generally smooth surfaces which are substantially parallel to the operating waterline for a distance from the after ends of said tunnels in the order of magnitude of two-thirds of their length and with their remaining portions forward opening upwardly and forwardly to cross-sectional areas equal to at least twice that of their uniform after portions.

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