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(54) **Boat hull.**

(57) A boat hull (10) of increased lift and efficiency is described. Lift is imparted by having a pair of contoured channels (18,19) along the chines (20,21) of the hull. The hull may be a single or multiple hull (12,14). In the case of multiple hulls (12,14) the contoured channels (18,19,52) may be provided along both the inner and outer edges. In a most preferred embodiment at least one hydrofoil (50) is mounted underneath the central bottom portion (17) of the twin-hulled craft (both with and without contoured channels) between the two hulls (12,14). This mounting position provides the hull (10) with the advantages of hydrofoil assistance without the obstruction of a convention hydrofoil mounting.

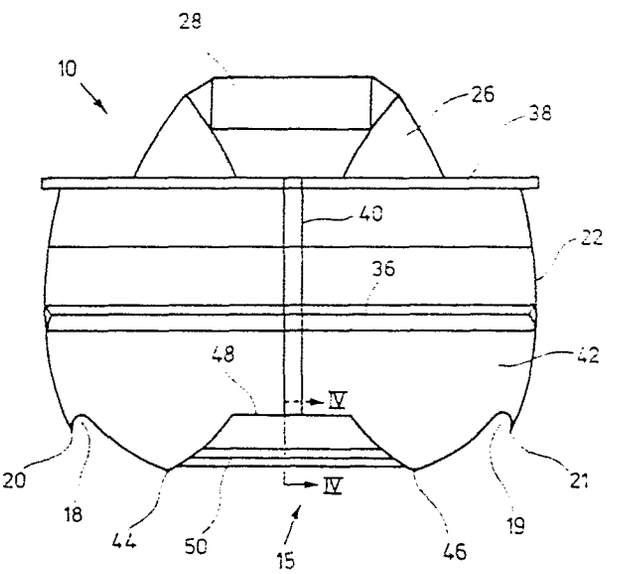

FIG 2

EP 0 249 321 A2

"Boat Hull"

This invention relates to a boat hull. More particularly it relates to twin hull boats but is not limited thereto.

Power driven boats are very inefficient in comparison with, for example, machines driven out of water. There are a number of aspects of fluid dynamics competing at the same time and a boat hull construction is a compromise of these. A desired construction is one in which the parameters are varied so as to achieve a net gain in efficiency.

It is an object of this invention to go some way towards achieving this desideratum or at least to offer the public a useful choice.

Accordingly, the invention may be said broadly to consist in a boat hull comprising a power boat bottom portion, the chines of which have contoured channels extending along at least a portion thereof, the arrangement and construction being such that in operation displaced water impelled upwardly and outwardly along the sides of said hull is deflected substantially downwardly to thereby impart lift to said hull.

Preferably the chines outside said contoured channels are rolled inwardly so as to allow water to pass laterally under the hull when the boat is moving lateraly on the water.

Preferably each said contoured channel is substantially semi-circular in cross-section.

In one embodiment the cross-section of each said channel diverges from front to rear.

In one embodiment the longitudinal axis of each said channel converges at a very acute angle with the water to the rear of the boat.

In one embodiment each said channel terminates at or adjacent the point where the hull converges upwardly into the bow so as to avoid deflecting water forwardly when the boat is travelling in a forward direction.

In another embodiment each said channel continues forwardly from the point where the bottom of the hull converges upwardly into the bow.

In another embodiment the invention may be said broadly to consist in a boat hull having twin hulls and a bottom portion between said hulls,

said bottom portion being inclined rearwardly to converge with the water so that at least the stern portion of the bottom portion between said twin hulls may be submerged when the boat hull is afloat,

a horizontal plane intersecting said bottom portion at the stern thereof being above a horizontal plane intersecting the lowest portion of said twin hulls,

the arrangement and construction being such that in operation foam on the surface of water entering the channel defined by the bottom portion and the twin hulls applies at least some lift to said boat hull.

Preferably sid bottom portion is substantially flat.

Preferably said twin hulls are substantially V-shaped.

In another embodiment there are provided multiple hulls with bottom portions between each said hull.

Preferably said bottom portion presents an angle of attack to the water in operation between 0° and 15°.

More preferably said angle of attack is between about 3° and 7°.

Most preferably said angle of attack is about 4°.

In another embodiment the invention may be said to broadly to consist in said embodiment as defined above comprising a pair of hulls or multiple hulls having chines with contoured channels as defined above.

Preferably each of said twin or multiple hulls is provided with an inner and an outer of the contoured channels.

In another embodiment the invention comprises a boat having twin hulls or multiple hulls with or without chines having contoured channels and including a hydrofoil mounted between said twin hulls or in the case or multiple hulls between each pair of hulls, which hydrofoil in operation is below the water line in the channel defined by the hull portions and the bottom portion of said hull.

Preferably said hydrofoil lies above a horizontal plane intersecting the bottom most portion of the twin or multiple hulls.

Preferably said hydrofoil is positioned approximately $^{1}/_{3}$ of the longitudinal distance forward of the stern.

Preferably there are two or more of the said hydrofoils.

In an embodiment where there are two hydrofoils one hydrofoil is preferably mounted in advance of the other hydrofoil.

Preferably one hydrofoil lies in a different horizontal plane from the other hydrofoil.

In one embodiment each said hydrofoil is aligned with its longitudinal axis intersecting a transverse vertical plane through said boat hull.

In another embodiment each said hydrofoil is V-shaped.

In one alternative said V of said hydrofoil is directed forwardly.

In another embodiment the V of said hydrofoil is directed rearwardly.

In another embodiment the V of said hydrofoil is directed downwardly,

In another embodiment the V of said hydrofoil is directed upwardly.

In another alternative said hydrofoil is crescent-shaped downwardly, forwardly, rearwardly or upwardly.

In one embodiment said hydrofoil has a cavitating hydrofoil shape.

In another emodiment said hydrofoil has a non-cavitating hydrofoil shape.

In a still further embodiment said hydrofoil has a super critical hydrofoil shape.

Preferably a craft incorporating each of the inventions defined above is between 2 and 70 metres in length.

Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:-

Figure I is a side elevation of a boat hull according to a first embodiment of the invention;

Figure 2 is a rear elevation of the boat hull according to a first embodiment of the invention;

Figure 3 is a perspective view of the boat hull of a second embodiment of the invention from slightly to the port of the bow;

Figure 4 is the fragmentary sectional view IV-IV shown in Figure 2;

Figure 5 is a side elevation of a boat hull according to a second embodiment of the invention;

Figure 6 is a rear elevation of the embodiment of Figure 5; and

Figure 7 is the view VII-VII shown in Figure 3.

The boat hull I0 according to the embodiment in Figures I and 2 comprises a pair of substantially V-shaped twin hulls I2 and I4. The V-shape is chosen so as to minimise the area of hull surface over which water travels. Other hull shapes may be selected.

Between the twin hulls there is a flat bottom comprising a bow portion I6 and a main portion I7. As is illustrated by broken lines in Figure I the main portion I7 inclines from bow to stern. The acute angle between this main portion I7 and the water as the boat is travelling forward is referred to herein as the angle of atack. Preferably the angle of attack is between 0° and I5°. Most preferably this angle of attack is approximately 4°.

The line of intersection 48 between the main portion I7 of the bottom and the transom 42 lies in a horizontal plane above the bottom most points 44 and 46 of the twin hulls I4 and I2 respectively.

The embodiment illustrated is constructed of aluminium. Because of the choice of the material the portions I6 and I7 of the bottom are substantially flat. With other materials of construction such as fiberglass the bottom portions can be curved upwardly merging smoothly with the sides of the hulls. Such curved bottom surfaces would also be inclined rearwardly to present the same angle of attack as described above. Floor portions I6 and I7 may be of flexible material.

To the outside of each of the twin hulls I2 and I4 are a pair of channels I8 and I9. These channels are substantially semi-circular in cross-section and converge smoothly on the inside with the outside of hull portions I4 and I2 and on the outside with the chines 2I and 20. The functions of channels I8 and I9 will be described in conjunction with the operation of the hull. Although the preferred cross-section is semi-circular as illustrated other cross-sectional shapes providing a substantially smooth transition between the hull bottom and the chine may be employed. Channels I8 and I9 may be of a substantially constant cross-section from forward to rear or the cross-section may diverge slightly from forward to rear.

On smaller planing craft the sides 22 of the hull as they intersect with the chines 20 and 2I roll under slightly as can best be seen in Figure 2. The reason for this rolling under will again be discussed in relation to the operation of the hull. There are some hull constructions which do not require rolling under of the chines. Where the craft is a large vessel or where the chines are relatively high or where the craft is a semi-planing craft the rolling under is not requried.

As can be seen from Figures 2, 4 and 6 there may be provided a hydrofoil 50 mounted between the twin hulls I2 and I4 above a horizontal plane intersecting the bottom most portion of the twin hulls. The mounting of the hydrofoil in this position offers advantages over the normal mounting constructions for hydrofoils. The appropriate bracing can be provided within the twin hulls I2 and I4 and struts, which would be required in conventional hydrofoils, are not needed.

In the embodiment illustrated there is shown a single hydrofoil mounted substantially transverse to the direction of travel of the craft. In another embodiment the hydrofoil can be inclined at an angle to a vertical transverse plane. In another embodiment the hydrofoil can have a substantially V-shape. The V can be pointed forwardly, rearward, upwardly or downwardly or any combination of these. There may be multiple hydrofoils provided. Where there are two hydrofoils one may be mounted forward of the other. In such an embodiment

one would normally lie in a different horizontal plane from the other one. It is also possible to have a hydrofoil which is curved in any one of the four directions.

The remainder of the construction of the boat hull can be along conventional lines. In the embodiment illustrated there are provided side gunwales 24 and a rear gunwale 38. The superstructure comprises a front deck 26 and windsccreen 28. The cockpit and fittings may be of a conventional nature and are not illustrated.

The method of construction in a preferred embodiment is of a modular nature. The embodiment illustrated is constructed of aluminium but other conventionl boat building materials may be employed. In the embodiment illustrated the aluminium sections are welded at 30, 32, 34 and 40. A bow section forward of weld 30 and a stern section rearward of weld 34 (when viewing Figure I) are formed. Separately formed are modular intermediate sections between welds 30 and 32 and 32 and 34 respectively. In the embodiment illustrated there are two such intermediate modular sections. It will be appreciated by those skilled in the art that any number of modular sections up to the limits possible for the construction may be provided. This form of construction offers cost advantages over those currently being used. For strengthening purposes a rib 36 is formed comprising an inward crimp in the transom 42.

In operation there are three separate features of the hull according to the invention which assist in improving its operational efficiency. Each of these features may be used separately if desired. Each adds to the efficiency of the hull so that in combination one can achieve the greatest efficiency.

The improvement in efficiency provided by channels I8 and I9 will be discussed first. As a boat hull of a conventional construction travels through water driven by an outboard motor or by another propulsion unit, such as a jet drive or an inboard drive, water displaced by the hull passing though the water is directed outwardly and upwardly from the body of the hull. This spraying effect adds to the inefficiency of the hull as it is lost kinetic energy. By providing the channels I8 and I9 water travelling outwardly and upwardly on the outside edges of hulls I2 and I4 is deflected substantially downwardly and lifts the hull. In selecting the best compromises for the contour of the channels I9 and I8 one should seek to minimise the wetted area thus reducing friction between the water and the hull surface. The contour should also seek to achieve as smooth a transition as possible in deflecting the water so as to minimise the loss of kinetic energy.

It will also be seen that the sides of the boat were they intersect with the chines 20 and 2I are rolled inwardly. While the amount of roll will vary from boat to boat the purpose of this is to avoid a "tripping" effect as a boat is moving laterally over the water. Water will move laterally underneath the chines 20 and 2I when the boat is sharply turning instead of tripping it to flip it onto its side or upside down.

The embodiments illustrated in the accompanying drawings are planing craft. Other craft may have relatively high chines which would not trip the boat during turning. With semi-planing or non-planing craft tripping is not a concern and the outsides of the chines may well be flared outwardly to increase the lift achieved in this way.

The second factor affecting the efficiency of travel of the boat through the water is the lift provided in the chanel I5 which is defined by the bow portion I6 and the main portion I7 of the flat bottom between the twin hulls I2 and I4. This inclined flat portion traps air bubbles and foam on the surface of the water as it moves over the water. Most of the foam is created by the inner bow waves of of the hulls I2 and I4, particularly a their point of intersection. The bow portion I6 of the flat bottom can also deflect waves downwardly to create foam. The main portion I7 of the bottom rides up on this foam to provide a certain amount of lift on the bottom portion of the hull as it passes over the water. While the angle of attack may be between 0° and I5°, it has been found that the optimum angle of attack is preferably 3° -7°, most preferably 4°. With other shaped hulls other angles of attack may provide better efficiency. If the angle of attack is too small then there will be no dynamic lift provided by this portion of the hull. If the angle of attack is too great the hull portion I7 will create too much drag.

The third factor in increasing the efficiency of the operation of the boat hull according to the invention is the provision of a hydrofoil 50. Hydrofoil 50 may be of any conventional shape. The type of hydrofoil to be employed depends on the type of craft and the speed at which it operates. Thus, cavitating, non-cavitating or supercritical hydrofoils may be employed as is appropriate for the craft. In the embodiment of Figure 4 hydrofoil 50 is provided with a flap 53 to vary the amount of lift provided.

Hydrofoil 50 can be positioned at any convenient point between twin hulls I2 and I4. In the preferred embodiment it is positioned approximately $^{1}/_{3}$ forward from the stern.

It has been found that hydrofoil 50 gives performance superior to that expected from a hydrofoil operating at the particular submergence depth. While the reason for this is not completely under-

stood it is believed foam entering channel I5 as the boat travels through water is compressed by hull portion I7 to increase the vapour pressure above hydrofoil 50 to increase its performance in operation.

The constructional advantages of hydrofoil 50 will be readily apparent to those skilled in the art. Conventional hydrofoils usually extend in a crescent-like manner to either side of a boat hull or have to be cantilevered to great depth below the boat hull. Such structures require very sophisticated materials and add greatly to the construction costs. Such hydrofoils require a relatively deep draught off the plane and because of the reach of the hydrofoil to either side of the hull cannot be manoeuvered readily close to wharves. All of these disadvantages are eliminated by the provision of the hydrofoil in the position illustrated between the hulls.

The position of hydrofoil 50 between the hulls but above the bottom most portions 44 and 46 of the twin hulls I2 and I4 also seeks to avoid accidental damage to the hydrofoil should the hulls contact the bottom. However, it would be possible to increase the depth of operation of the hydrofoil by mounting then at a greater depth if desired.

The embodiments illustrated in Figures 3, 5, 6 and 7 incorporate changes at the stern and at the bow of the craft. Those at the stern will be discussed first. Referring firstly to Figure 6 it has been shown that the aft and 49 of the central floor portion of the hull has been lowered and has an inverted "V" shape. This lowers the center of gravity of the cockpit of the boat without altering any other factors. As will be seen in Figure 7 and Figure 3 there is provided a contoured channel 52 on the inner side of hull I2 running in channel I5 toward the stern of the boat. This channel serves the same function as channel I9. It extends rearwardly to the vicinity of the hydrofoil 50 in a preferred embodiment.

In the embodiment illustrated in Figures I and 2 the channels I8 and I9 end where the bow portion of the boat begins to turn upwardly. This is to ensure that the channels do not deflect water forwardly thus impeding the progress of a boat hull. On some hulls this is unnecessary and the channels I8 and I9 can be continued forwardly towards the bow to converge smoothly with the bow surface. This is illustrated by edge 23 in Figures 3 and 5.

The construcions illustrated are intended to be used on pleasure craft but the same constructional principles can be used for craft for purposes up to 70 meters in length. Other variations of construction incorporating the principles of the invention as defined herein will be apparent to those skilled in the art.

Claims

I. A boat hull (I0) comprising a power boat bottom portion (I2,I4), characterised in that the chines (20,2I) of the bottom portion (I2,I4) have contoured channels (I8,I9) extending along at least a portion thereof, the arrangement and construction being such that in operation displaced water impelled upwardly and outwardly along the sides of said hull (I0) is deflected substantially downwardly to thereby impart lift to said hull.

2. A boat hull as claimed in claim I characterised in that said contoured channels (I8,I9) are rolled inwardly so as to allow water to pass laterally under the hull (I0) when the boat is moving laterally on the water.

3. A boat hull (I0) having twin hulls (I2,I4) and a bottom portion (I6,I7) between said hulls, characterised in that said bottom portion is inclined rearwardly to converge with the water so that at least the stern portion (48) of the bottom portion (I7) between said twin hulls may be submerged when the boat hull is afloat, a horizontal plane intersecting said bottom portion (I7) at the stern (42) thereof is above a horizontal plane intersecting the lowest portions (44,46) of said twin hulls, the chines (20,2I) of each of said twin hulls being provided with a contoured channel (I8,I9) as defined in claim I, the arrangement and construction being such that in operation foam on the surface of water entering the channel (I5) defined by the bottom portion (I7) and the twin hulls (I2,I4) and water in said contoured channels (I8,I9) apply at least some lift to said boat hull.

4. A boat hull as claimed in claim 3 characterised in that each of said twin hulls (I2,I4) is provided with an inner (52) and an outer (I9) of said contoured channels.

5. A boat hull as claimed in claim 3 or 4 characterised by a hydrofoil (50) mounted between said twin hulls (I2,I4) which hydrofoil in operation is below the water line and in the channel (I5) defined by the hull portions (I2,I4) and the bottom portion (I7) of said hull.

6. A boat hull as claimed in claim 5 characterised in that said hydrofoil (50) lies above a horizontal plane intersecting the bottom most portions (44,46) of said twin hulls (I2,I4).

7. A boat hull (I0) having twin hulls (I2,I4) and a bottom portion (I6,I7) between said hulls, characterised in that said bottom portion (I7) is inclined rearwardly to converge with the water so that at least the stern portion (48) of the bottom portion (I7) between said twin hulls (I2,I4) is submerged when the boat hull is afloat, a horizontal plane intersecting said bottom portion (I7) at the stern (48) thereof is above a horizontal plane intersecting the lowest portions of said twin hulls (44,46) and a

hydrofoil (50) is mounted between said twin hulls (I2,I4), the arrangement and construction being such that in operation foam on the surface of water entering the channel (I5) defined by the bottom portion (I7) and the twin hulls (I2,I4) and said hydrofoil (50) passing through water apply at least some lift to said boat hull.

8. A boat incorporating a hull as claimed in any preceding claim.

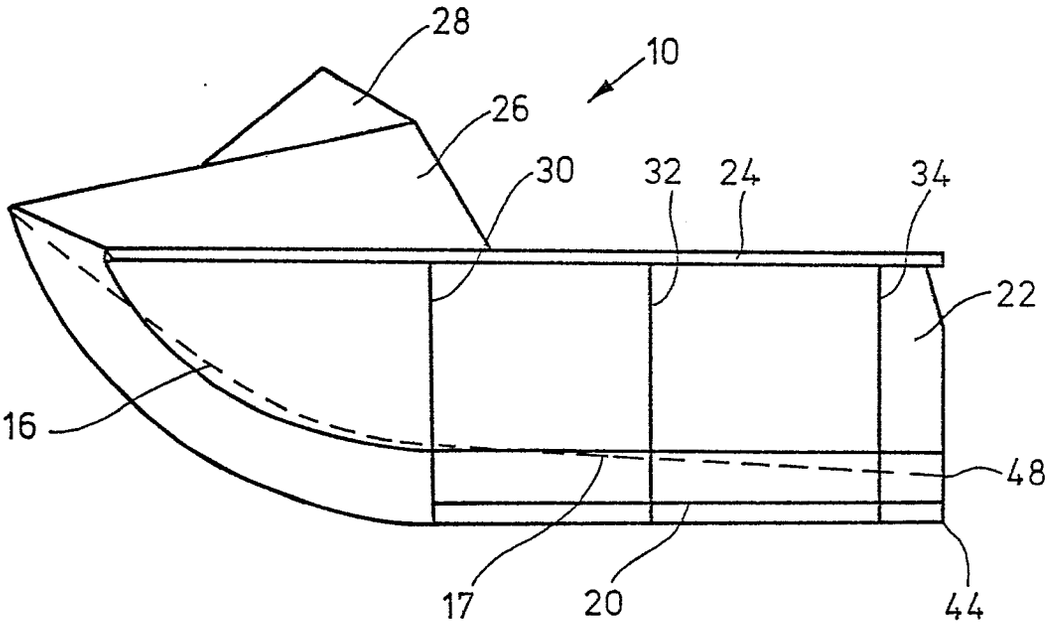

FIG.1

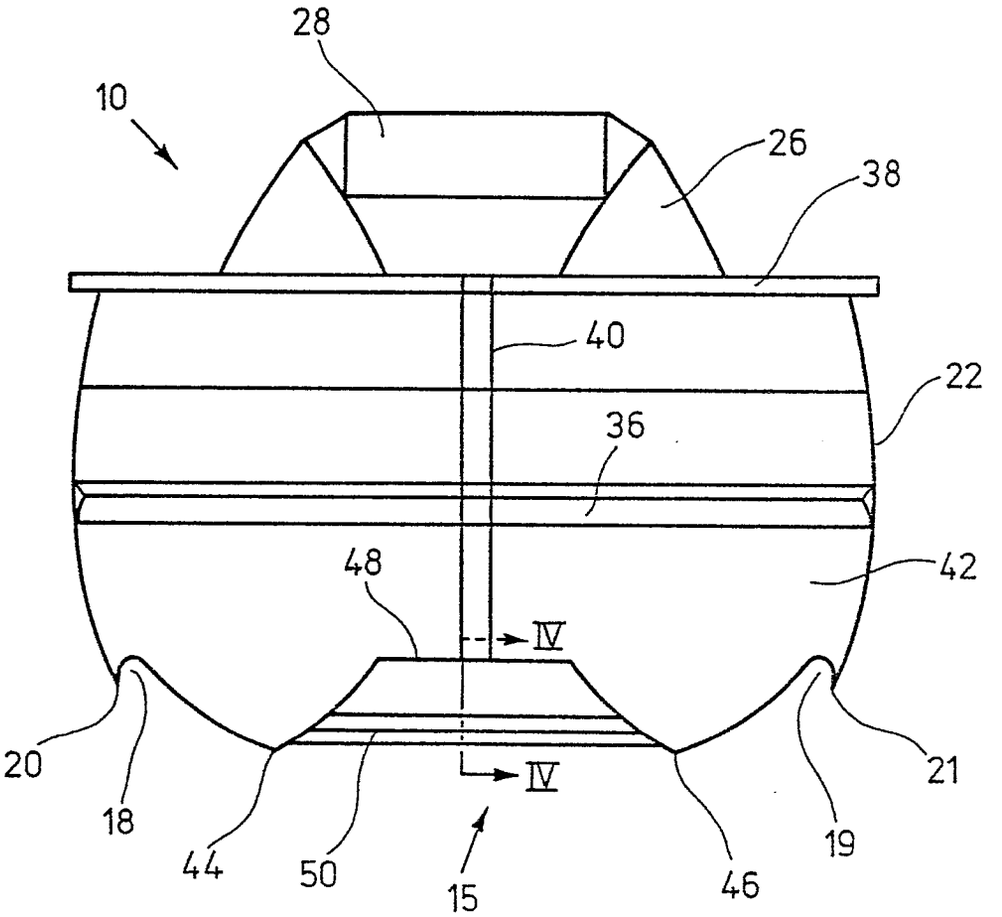

FIG. 2

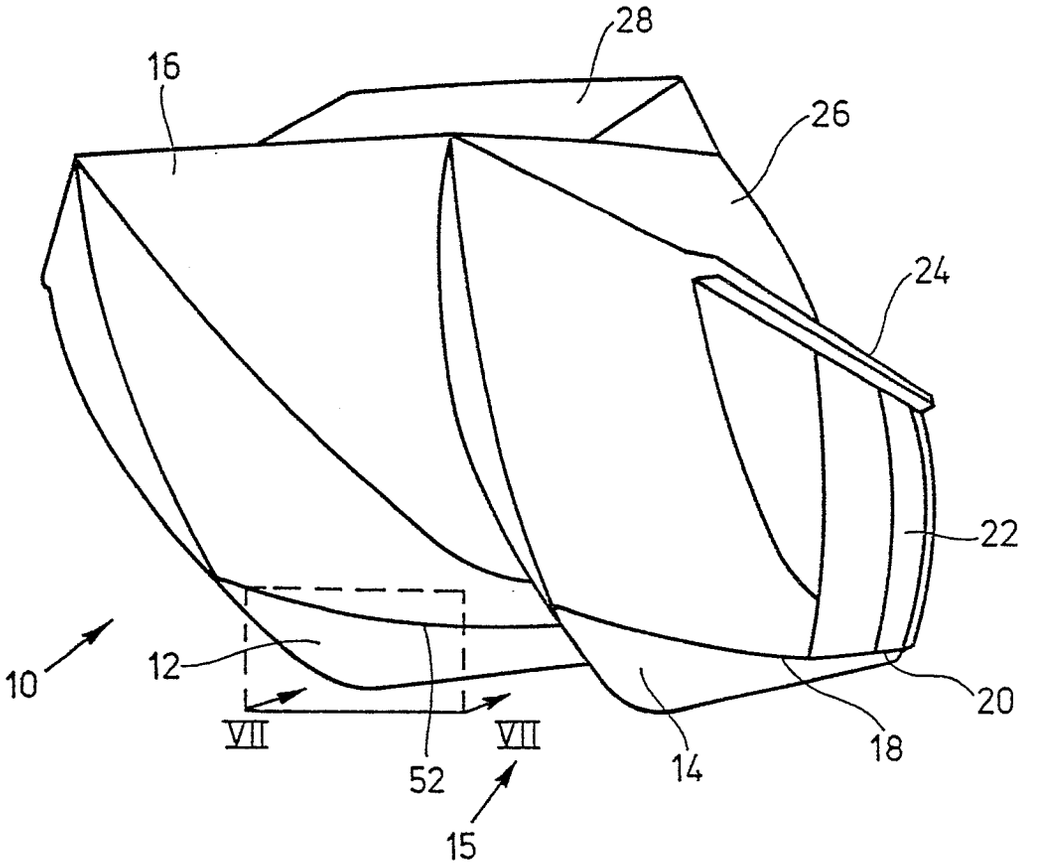

FIG. 3

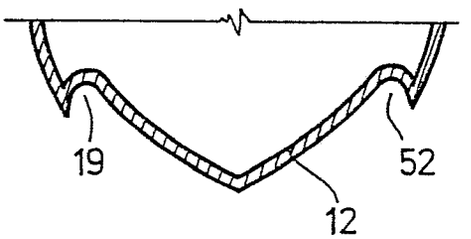

FIG. 7

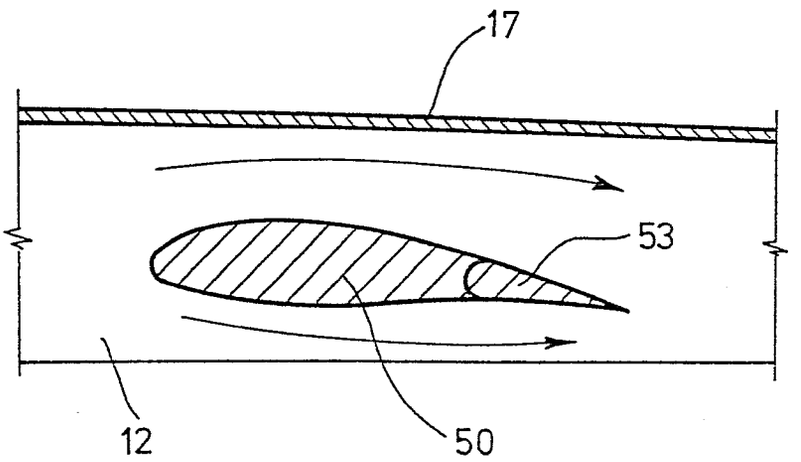

FIG. 4