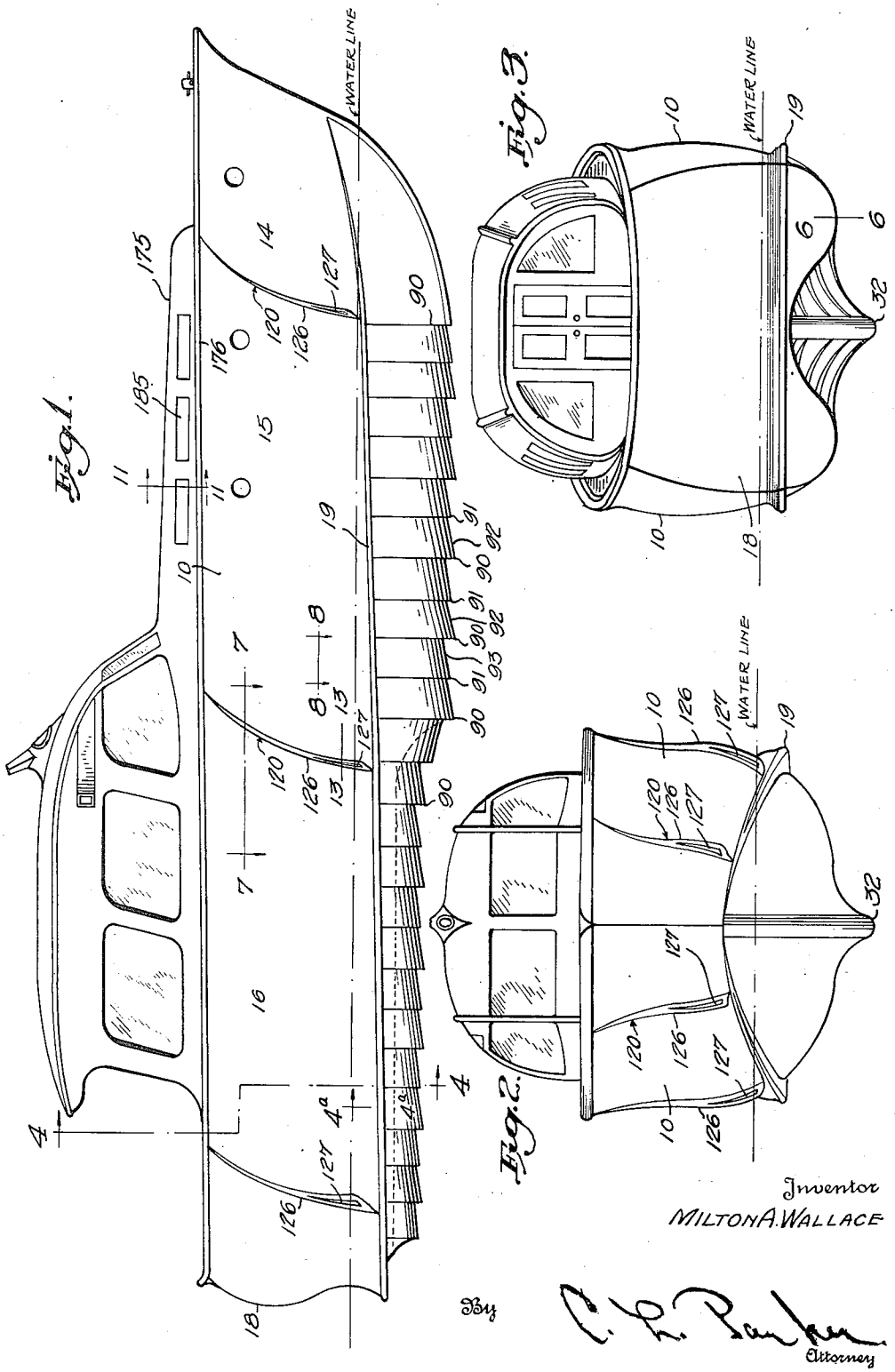
Aug. 10, 1948. M. A. WALLACE 2,446,860

BOAT

Filed June 29, 1945 5 Sheets-Sheet 1



Inventor
MILTON A. WALLACE

By

Attorney

Aug. 10, 1948. M. A. WALLACE 2,446,860

BOAT

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Fig. 4a

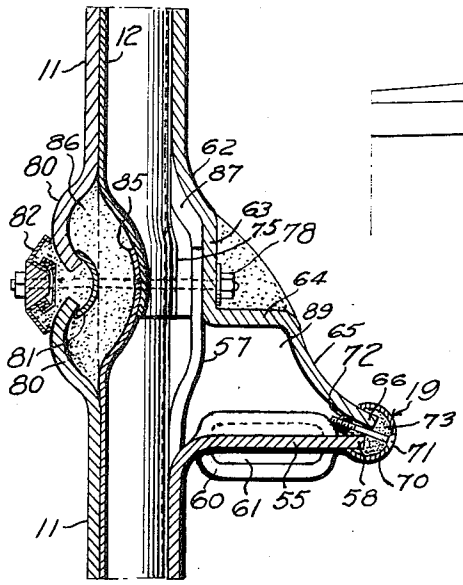


Fig. 4.

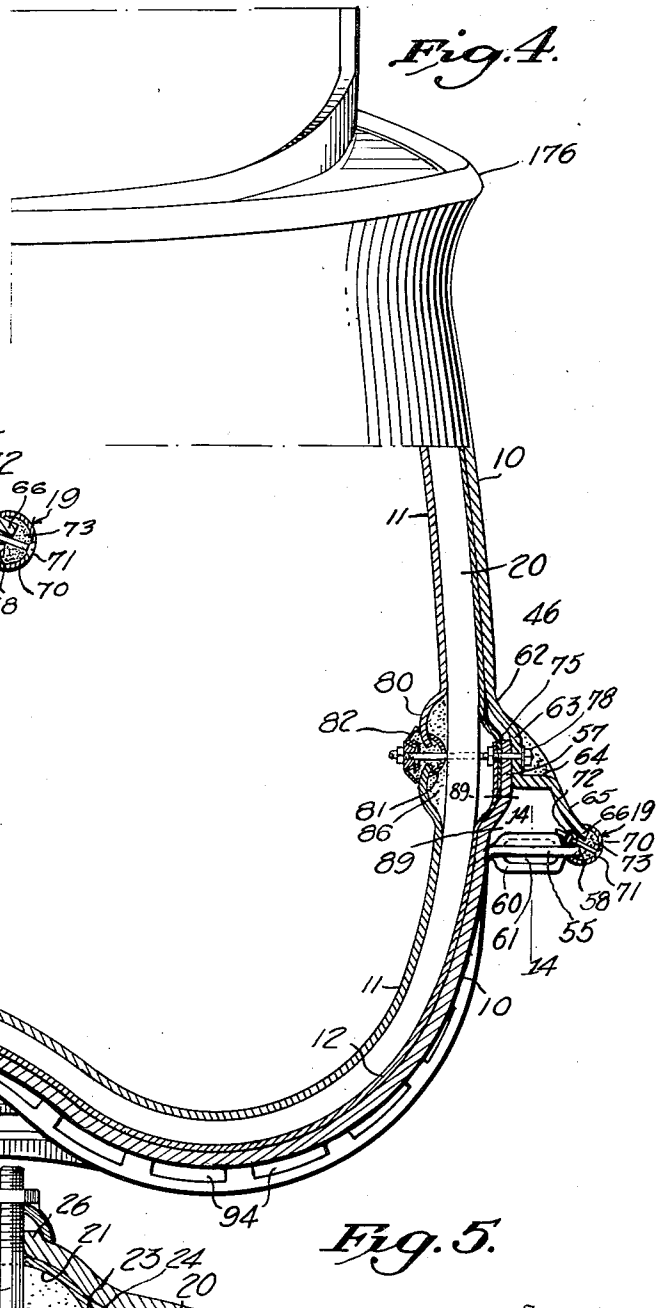
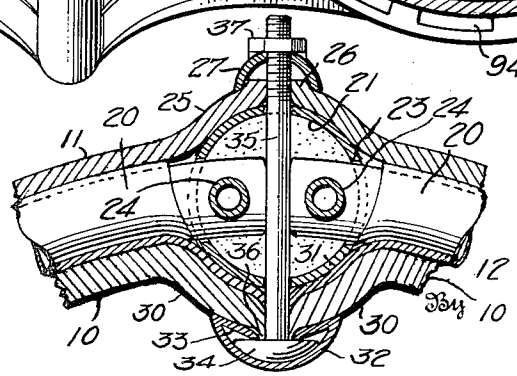


Fig. 5.



Inventor
MILTON A. WALLACE

By

Attorney

Aug. 10, 1948. M. A. WALLACE 2,446,860

BOAT

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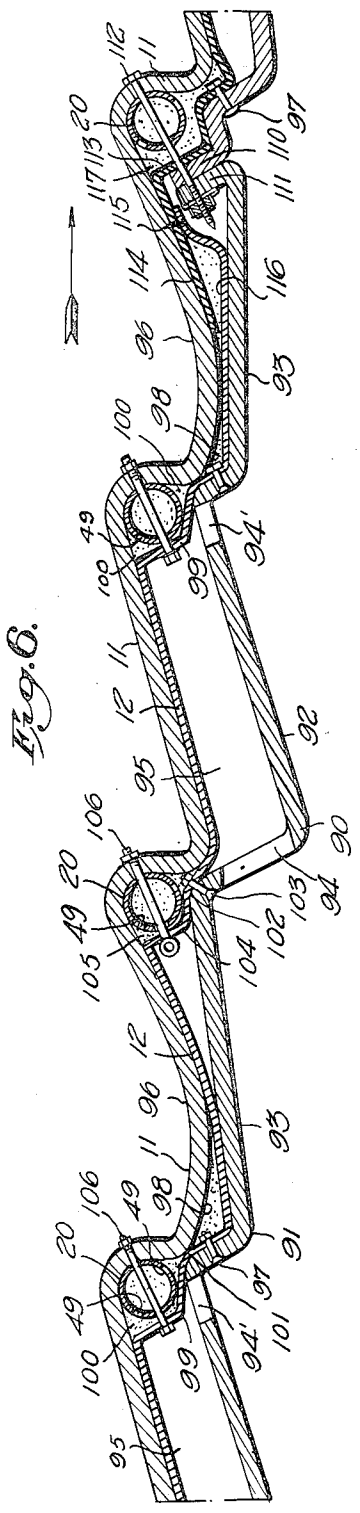


Fig. 6.

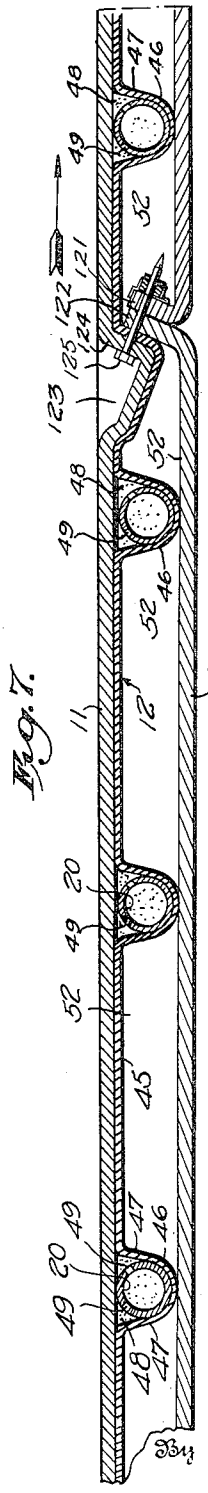


Fig. 7.

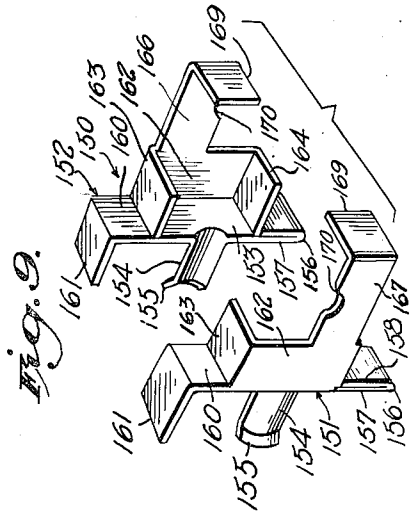


Fig. 9.

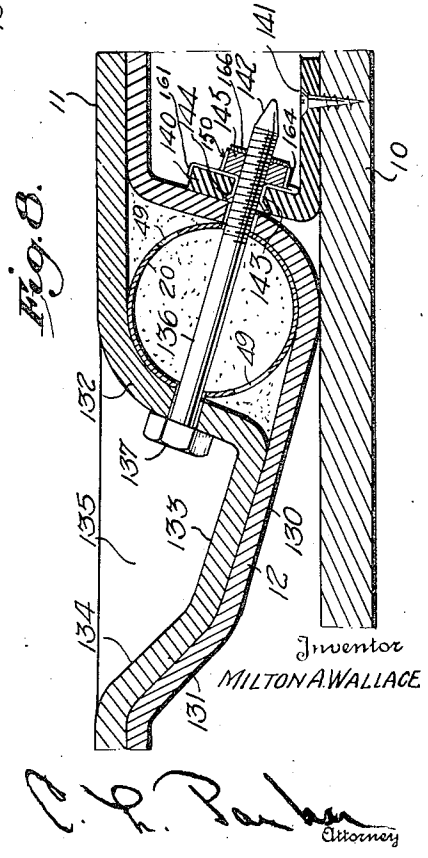


Fig. 8.

Inventor
MILTON A. WALLACE

Attorney

Aug. 10, 1948. M. A. WALLACE 2,446,860

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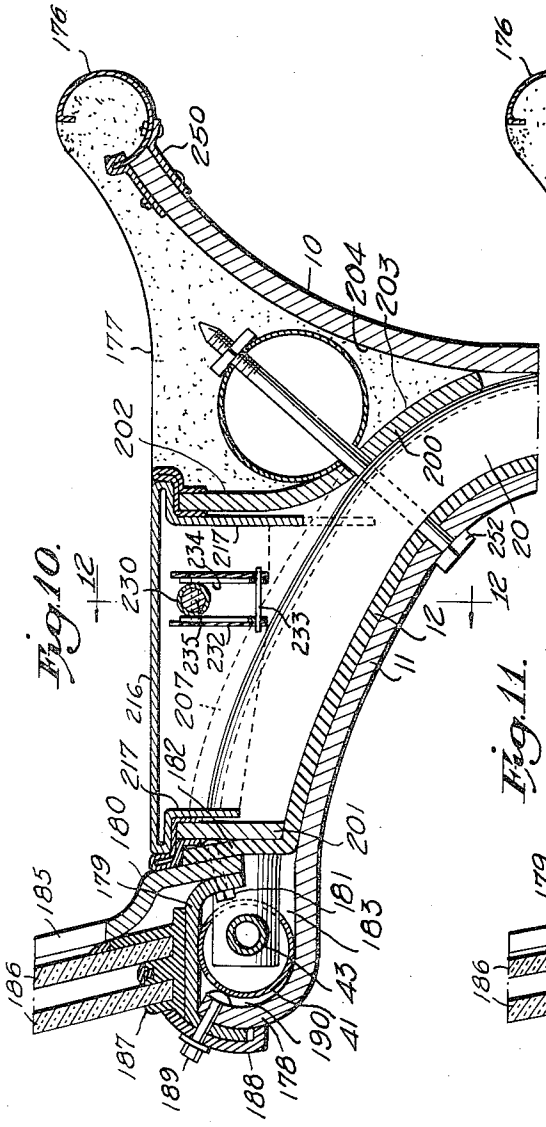


Fig. 10.

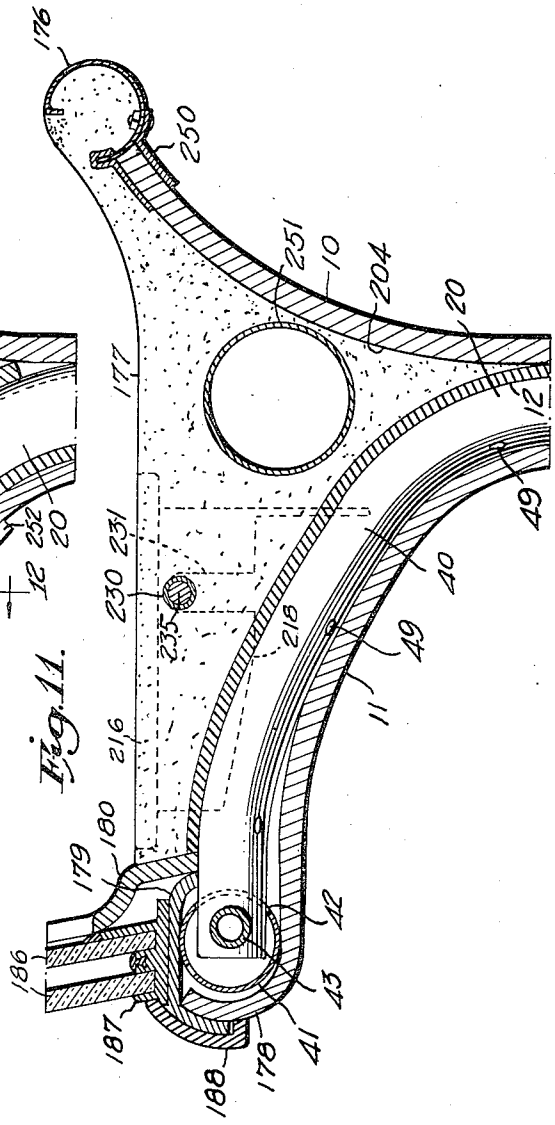


Fig. 11.

Inventor
MILTON A. WALLACE

By

Attorney

Aug. 10, 1948. M. A. WALLACE 2,446,860

BOAT

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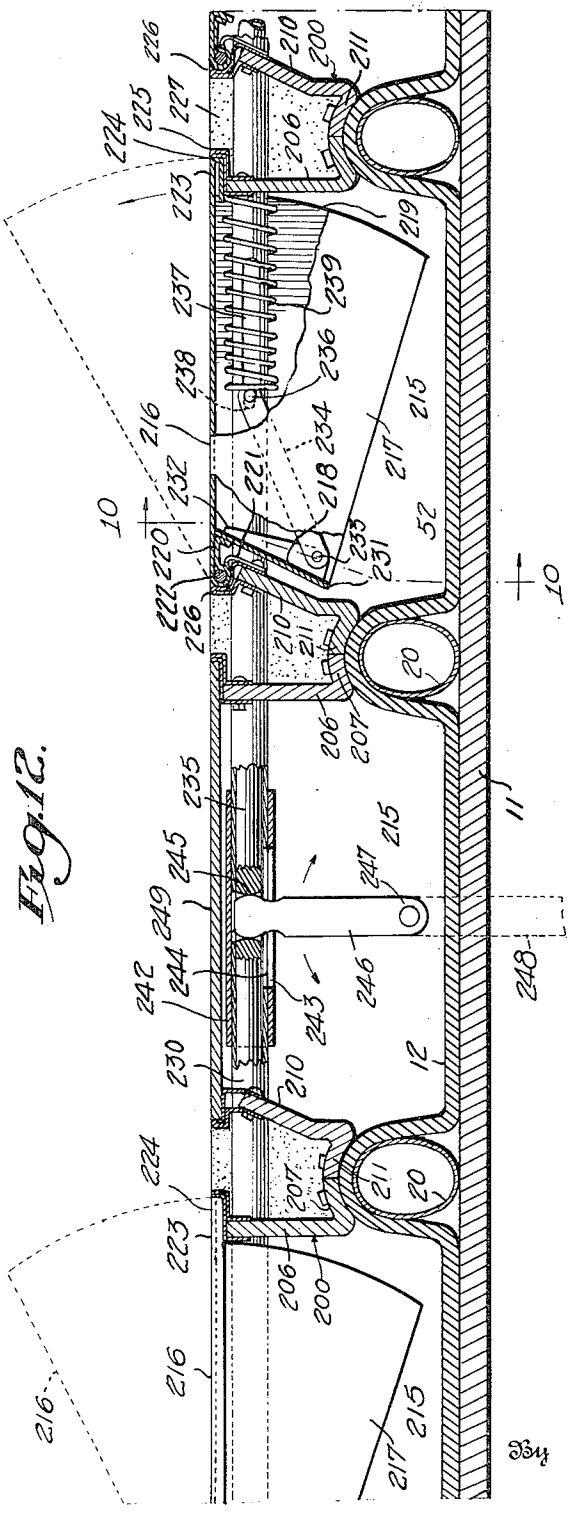


Fig. 12.

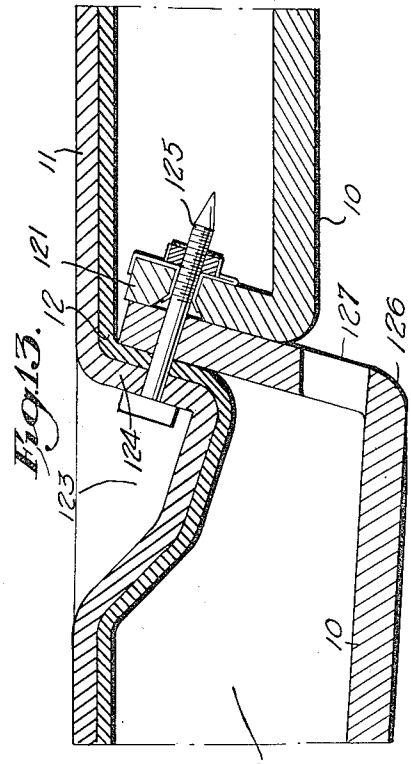


Fig. 13.

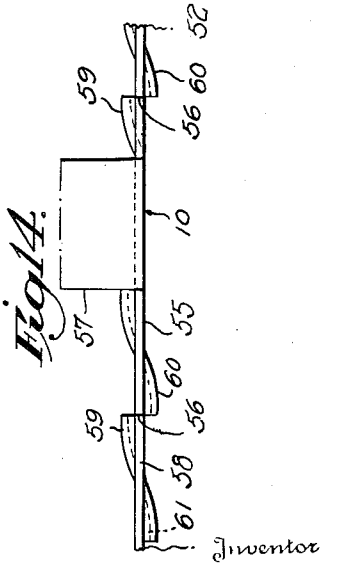


Fig. 14.

Inventor
MILTON A. WALLACE

By

Attorney

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UNITED STATES PATENT OFFICE

2,446,860

BOAT

Milton A. Wallace, Mystic, Conn.

Application June 29, 1945, Serial No. 602,267

16 Claims. (Cl. 114—67)

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This invention relates to boats.

In the construction of boats, for example, cruisers and yachts, it has been the common practice to proceed with the laying of the keel, the formation and setting of ribs, the cutting, fitting and fastening of the planking, etc. These and the various other operations involved require many man hours of labor for the custom cutting and fitting of the parts. As a result, much of the cost in the building of a boat of this character is involved in labor, thus requiring the selling of such boat at a substantially high price and limiting to a great extent the field of sale.

Moreover, certain hard and fast ideas have been followed in the hull construction of boats of this character, the principal idea being to so design the lines of the hull as to reduce the force required for displacing water as the boat is driven. However, in addition to the power required to displace the water in movement of the boat, it has been recognized that a substantial amount of power has been spent in overcoming the drag of the water against the hull surfaces.

So far as resistance to displacement of the water in movement of the boat is concerned, modern stream line designs have reduced this difficulty substantially to a minimum, but little or no progress has been made in overcoming the surface drag of the water on the hull of a boat. Smaller faster boats have been constructed with steps providing angular planes which come into operation only at relatively high boat speeds and with the use of a power plant of substantial size, to provide the effect of lifting the hull higher in the water, thus materially reducing the area of the hull in contact with the water. While this reduces surface drag, a construction of this character is applicable only to speed boats because of the boat speed necessary to render the construction operative. Moreover, power plants of substantial size are required to propel a boat at such speed as to render the hull planes effective for their intended functioning.

An important object of the present invention is to provide a boat structure which lends itself readily to the preformation of all of its component parts, thus very greatly reducing the amount of labor involved in the actual assembling of the parts.

A further object is to provide a boat structure of this character wherein the use of conventional ribs as such is completely eliminated, the structural strength necessary in the hull being provided in the preformed parts which are brought together to form the hull.

A further object is to provide a boat structure wherein the various hull skin components may be readily preformed by being pressed and cut from such formable materials as certain types of plywood, various plastics, aluminum, stainless steel,

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etc., the hull components thus preformed being capable of quick and easy assembly with a minimum expenditure of labor.

A further object is to provide such a boat structure wherein the hull skin components referred to above are so formed as to provide substantial beam strength transversely of the boat to permit the complete elimination of conventional ribs.

A further object is to provide such construction wherein the assembly of the parts not only provides for the quick and adequate fastening of the parts together, but also provides spaces for receiving suitable mastic or binding compositions whereby a completely leak-proof inner hull is provided, the fastening means employed being of such nature as to cooperate with the mastic or binding composition for tightening the hull joints in the event any leakage should occur.

A further object is to provide such a boat structure which affords means for feeding air into the water adjacent the hull surfaces in contact with the water to reduce the surface drag of the water on the hull, thus permitting the boat to be driven at substantially higher speeds with less power and without requiring relatively high boat speeds in order to be effective.

A further object is to provide a prefabricated hull structure embodying therein air passages for feeding air downwardly through the hull and discharging it into the water adjacent the surfaces of the hull in contact with the water, thus providing an air cushion beneath the boat and greatly reducing surface drag on the hull.

A further object is to provide, in combination with the air ducts referred to, a stepped hull construction wherein the air passing through the ducts is discharged into the water through the substantially vertical parts of the steps, thus completely satisfying any partial vacuum occurring through movement of the boat through the water, and accordingly substantially reducing the drag on the hull.

A further object is to provide novel controllable means for supplying air to the ducts referred to.

A further object is to provide a novel method of assembling the parts involved, particularly with respect to the placing of the mastic in the spaces where desired.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing:

Figure 1 is a side elevation of a boat of the private cruiser type embodying the invention,

Figure 2 is an elevation of the same looking from the bow end,

Figure 3 is a stern elevational view of the boat,

Figure 4 is a section on line 4—4 of Figure 1,

showing a portion of the boat, parts being shown in elevation,

Figure 4*a* is an enlarged fragmentary sectional view similar to the rubbing strake section of Figure 4, taken substantially on line 4*a*—4*a* of Figure 1,

Figure 5 is an enlarged fragmentary sectional view through the keel portion of the boat,

Figure 6 is an enlarged fragmentary sectional view on line 6—6 of Figure 3,

Figure 7 is an enlarged fragmentary horizontal sectional view taken substantially on line 7—7 of Figure 1,

Figure 8 is a similar view which may be taken on line 8—8 of Figure 1,

Figure 9 is a view on one of the blind bolt nut holding devices, the parts being shown separated with the elements thereof in the positions they will occupy when inserted,

Figure 10 is an enlarged fragmentary sectional view on line 10—10 of Figure 12,

Figure 11 is a similar view on line 11—11 of Figure 1,

Figure 12 is an enlarged fragmentary sectional view taken on the plane indicated by the numeral 12—12 in Figure 10,

Figure 13 is an enlarged fragmentary sectional view on line 13—13 of Figure 1, and

Figure 14 is a fragmentary side elevation of the rubbing strake portion of one of the lower outer skin sections.

It will become apparent that the hull structure of the present invention, in its preferred form, is formed of three "skins" namely, an outer skin 10, an inner skin 11 and an intermediate skin 12. Depending upon the design and size of the boat, these skins each may be made integral, or in sections, and all preferably are made sectionally for convenience in manufacture and assembly. For example, the outer skin 10, in Figure 1, is shown as being formed of sections 14, 15 and 16, forming the sides of the boat, and transom sections 18. These sections extend down to a rubbing strake 19, to be referred to later. Between the inner and outer skins 10 and 11 is arranged a plurality of pipes or tubes 20 each of which may be arranged approximately in a vertical plane, these pipes extending downwardly within the sides of the boat, thence inwardly toward the keel structure as shown in Figure 4. A relatively large pipe 21 which may be either integral or sectional, extends throughout the length of the boat. The pipes 20 (Figures 4 and 5) extend into the keel pipe 21 through openings 23 larger than the pipes 20, for a purpose to be described. Small tie pipes 24 extend from end to end of the boat through openings in the adjacent ends of the pipes 20 to tie them in position against substantial displacement, particularly when the parts are being assembled.

As shown in Figure 4, the keel edges of the inner skin 11 are shaped as at 25 to fit the keel pipe 21, and the adjacent edges of the shaped portions 25 are turned upwardly as at 26 to form short continuous flanges. These flanges are receivable in the open side of an elongated connecting member 27 which is semi-cylindrical in cross-section, as shown in Figure 5. Similarly, the keel edges of the outer skin 10 and intermediate skin 12 are shaped around the keel pipe 21, as indicated by the numerals 30 and 31. A fastening strip 32 lies along the bottom of the hull. This strip is arcuate in cross-section and has angular inwardly extending flanges 33 at its edges engaging the shaped portions 30 of the outer skins

10. The inner extremities of the flanges 33 seat against the heads 34 of a plurality of bolts, one of which is shown in Figure 5 and indicated by the numeral 35. The space between the inner edges of the flanges 33 is greater than the diameter of each bolt 35 to provide spaces for the downward extension of flanges 36 on the ends of the portions 30 of the outer skin. Each bolt 35 is provided at its upper end with a nut 37. The tightening of these nuts serves to clamp the various parts of the keel construction rigidly with respect to each other.

The pipes 20 and keel pipe 21 form parts of the framing of the boat, as will be apparent. As the pipes 20 approach the sheer line of the boat, they extend upwardly and inwardly as at 40 (Figure 11) and the upper inner extremities of these pipes extend into an inner frame pipe 41 shaped generally to correspond to the horizontal profile of the boat. The pipe 40 is provided with openings 42 through which the adjacent ends of the pipes 20 extend, and a tie pipe 43 extends through such pipe ends to prevent their substantial displacement from the pipes 41. Except adjacent its upper and inner extremity, as shown in Figure 11, each pipe 20 throughout its length lies against the inner skin 11. The intermediate skin 12, as clearly shown in Figure 7, has its portions 45 between adjacent pairs of pipes 20 lying against the inner skin 11. Where each pipe 20 occurs, the inner skin 12 is shaped as at 46 to extend around the pipe 20, the arched portion 46 engaging the outer skin 10. Each arched portion 46 (Figure 7) has its side portions 47 diverging toward the inner skin 11 to form pockets 48 for a purpose to be described, and at suitably spaced points, each pipe 20 is provided with openings 49 affording communication between the interior of each pipe 20 and the pockets 48. For a purpose to be more completely referred to later, the spaces between adjacent pairs of pipes 20 and between the outer skin 10 and inner skin portions 45 form air channels 52. From a point adjacent the rubbing strake 19, the three skins of the boat are preferably divided, and the lower sections are connected to the upper sections as shown in Figures 4 and 4*a*. Inasmuch as the sections of the skin are substantially continuations of each other, particularly as to their relationship to each other and to the pipes 20, they have been indicated by the same reference numerals. Referring to Figures 4 and 4*a* each lower section 10 has its upper edge portion turned outwardly to form a flange 55 which is split transversely as at 56, these splits being of any width proportionate to the distance between the pipes 20. For example, assuming in an average size pleasure cruiser that the pipes 20 are one foot on centers, three of the cuts 56 could be made in the distance between alternate pipes 20, that is, three cuts for each two feet of hull length. One of the flange elements for each three thus cut is turned upwardly as at 57, while the remaining two flanges of each three have their outer edges in horizontal alignment as at 58 for a purpose to be described. Inwardly of each outer edge 58, the associated flange has its leading edge bulged upwardly as at 59 and its following edge bulged downwardly as at 60, the latter forming an opening 61 with respect to the leading edge of the next following flange. As will become apparent, this provides for the rearward flow of air through each opening 61.

The lower edge portion of each outer skin 10 above the rubbing strake 19 curves outwardly as at 62 thence downwardly as at 63, thence out-

wardly at 64, and has its lower extremity turned downwardly and outwardly as at 65 to terminate in a flange 66. This flange will be arranged adjacent aand parallel to and slightly spaced from the flange edges 56. A clamping strip 70, slightly more than semi-cylindrical in cross-section, receives the flange edges 58 and 66, and fastening elements 71 pass through the clamping strip 70 and through a continuous member 72 lying in the angle between the flange portions 58 and 66. The space within the clamping strip 70 is filled with a suitable mastic as at 73 to seal the joint thus provided. In Figure 4, the plane of section is through one of the pipes 20, although such pipe is shown in elevation. Since the pipe is in the plane of section, the intermediate skin 12 will have its portion 46 shown therein, outwardly of the pipe 20. The upper and lower sections of such intermediate skin have overlapping edges 75 lying against each upturned flange 57, and the latter, in turn, lies against the downwardly extending portion 63 of the upper outer skin 10. These various elements are adapted to be secured together by a bolt 78 extending therethrough, and also extending through and beyond the pipe 20.

The adjacent horizontal edges of the upper and lower sections of the inner skin 11, Figure 4, are turned inwardly and then downwardly and outwardly as at 80. A clamping strip 81, approximately semi-cylindrical in cross-section, engages the adjacent edges of the upper and lower sections of the inner skin, and each bolt 78 extends through the clamping strip 81 and is provided at its inner end with suitable clamping means generally indicated by the numeral 82. This specific attaching and clamping means forms per se, no part of the present invention and need not be described in detail.

As shown in Figure 4a, the adjacent horizontal edges of the upper and lower sections of the intermediate skin 12 overlap as at 85, and the adjacent portions of the intermediate skin, together with the clamping strip 81 and the adjacent portions of the inner skin 11 form a mastic-receiving pocket 86 which communicates with the pockets 48 to receive mastic therefrom in a manner to be described. The spaces between the overlapping edges 85 and the outer skin sections of the boat form passages 87 (Figure 4a) affording relatively unrestricted communication between the passages 52 (Figure 7) and corresponding passages to be referred to in the lower hull portion between the inner and outer skin sections. The passage 87 also communicates with the passage 89 (Figures 4 and 4a) formed above the flanges 55, for the passage of air through the openings 61.

Below the strake line, and starting at a point somewhat rearwardly of the stem of the boat, the outer skin is pressed or shaped to form alternate relatively high steps 90 and intermediate relatively low steps 91, the bottom surfaces of the steps 90 sloping upwardly and forwardly as at 92 preferably at a greater degree to the horizontal than the corresponding surfaces 93 of the steps 91. The rear wall of each step 90 is provided with a series of elongated openings 94 (Figures 4 and 6) while each bottom wall 92 is provided near its forward end with openings 94'. Each step 90 and its bottom portion 92 forms with the intermediate skin 12 a passage 95 communicating with one of the passages 52 (Figure 7) and with which the openings 94 and 94' communicate, as will become apparent. The passages 52 occur between each

adjacent pair of pipes 20, whereas the passages 95 occur with respect to alternate pairs of pipes 20. Above each step bottom 93, the inner skin 11 curves downwardly theretoward as at 96 and the intervening skin 12 contacts with both the inner skin portion 96 and the step bottom 93 to afford a support for the latter. Rearwardly of such contact, the inner skin 12 follows the step bottom 93 in contact therewith and extends upwardly along the inner face of the rear portion of the step and is secured thereto as at 97. A pocket 98 is formed between the inner and intermediate skins 11 and 12 adjacent the fastening elements 97 and this space will be filled with mastic in a manner to be described.

Adjacent the forward end of each step 90, the inner skin 12 generally follows around the adjacent pipe 20, as at 99, but preferably not in contact therewith for a purpose to be described. At the upper end of each skin portion 99, the intermediate skin will again contact with the inner skin 11 and follows therealong, as shown in Figure 6. The spacing of the portions 99 of the intermediate skin from the respective pipes 20 is to provide spaces 100 to receive mastic flowing thereinto from the pipes 20 through some of the openings 49. Each space 98 is filled with mastic from the adjacent space 100, there being a relatively loose fit at the point 101 between the inner and intermediate skins for the passage of such mastic.

Adjacent the forward end of each step bottom 93, the intermediate skin 12 follows around the outer skin as at 102 and is secured thereto by fastening elements 103. The intermediate skin then generally follows around, but not in contact with each associated pipe 20, as at 104, and then turns to follow the contour of the inner skin portion 96. The space 105 between each intermediate skin portion 104 and the adjacent pipe 20 is adapted to receive mastic in the same manner as the space 100, and this mastic flows around the adjacent end of the fastening element 103 in the same manner that it flows around the fastening elements 97, thus providing leak-proof cells for the fastening elements referred to. Each inner skin portion 99 and 104 is secured to the adjacent pipe 20 and to the inner skin 11 by fastening elements 106, some of which are of particular types, but form no part per se of the present invention and need not be referred to in detail.

Joints between forward and rear sections of the outer skin may be made as shown in Figure 6. These joints may occur between forward and rear sections of the outer skin as shown in the same figure. The adjacent ends of the outer skin will be turned upwardly to form contacting flanges 110 and 111, and a bolt 112 passes through these flanges, through the adjacent portion of the inner skin 12, through the adjacent pipe 20 and then through the inner skin 11. The bolt 112 and associated elements are preferably of a particular type used in other joints in the boat structure, and will be further referred to in detail later. The portion of the intermediate skin 12 adjacent the bolt 112 preferably lies against the flange 110, as at 113, and the rear extremity 114 of such portion of the intermediate skin lies against the inner skin portion 96. The forward edge of the next adjacent rearward intermediate skin section extends along the adjacent step bottom 93, thence upwardly to terminate in a curved portion 115 lying against the skin portion 114. This arrangement of the elements re-

ferred to forms a pocket 116 having a sufficient degree of communication with the adjacent pocket 98 to receive and be filled with mastic. The pipe 20 through which the fastening elements 112 extend discharge mastic into the adjacent pocket 117, this mastic flowing downwardly around the pipe 20 to cover the adjacent fastening element 97. The inner end of this fastening element will be sealed, and the mastic in the pocket 116 seals the overlapping and engaging intermediate skin portions 114 and 115.

The means for joining forward and aft sections of the outer skin 10 above the rubbing strake is shown in Figure 7 toward the top of the boat and in Figure 13 at a point relatively close to the rubbing strake. In this connection, it is pointed out that it is desirable in boats of average size, for example, in the ordinary pleasure cruiser, to make the outer skin above the rubbing strake in sections, and these sections cannot have their joints completely hidden in any practicable manner. This fact is taken advantage of in the present construction by utilizing such joints for supplying additional air for discharge beneath the hull, and to add to rather than detract from the appearance of the boat. These joints, for example, as generally indicated by the numeral 120 in Figure 1, preferably are formed curved and slope downwardly and rearwardly toward their lower ends to add to the attractive and "racy" appearance of the boat. The joints referred to may be formed as indicated in Figures 7 and 13. The adjacent edges of adjacent outer skin sections are turned inwardly to form flanges 121 and 122 arranged in contact with each other. Adjacent such flanges, the inner skin 11 and intermediate skin 12 are extended inwardly as shown in Figures 7 and 13 to provide a pocket 123, the rearwardly facing wall 124 of which is arranged parallel to the flanges 121 and 122. A bolt 125, of a special type similar to the bolt 112 (Figure 6) and to be referred to in detail later, extends through the flanges 121 and 122 and wall 124 to fix these elements together with respect to each other. The outer surfaces of the outer skin 10 are approximately flush at the upper sheer line and the forward edge of the rear outer skin section diverges outwardly toward its lower end as shown in Figure 1, and as will be apparent from a comparison of Figures 7 and 13. Toward its lower end, therefore, the forward end of the rear skin section 10 is offset substantially outwardly as at 126, this offset forming a portion of the flange 122 and being provided therethrough with openings 127 which admit air into the adjacent passage 52. The joint referred to is therefore utilized in the functioning of the structure and adds to the appearance of the boat.

The three skin layers and the pipes 20 are secured to each other in the manner shown in Figure 8, bolt means being employed, which is similar to the bolt means 112 in Figure 6 and 125 in Figures 7 and 13. Referring to Figure 8, a fastening means is employed for the purpose stated at each pipe 20 and at spaced points therealong. The intermediate skin 12, instead of being arched over the pipe 20 as shown in Figure 7, has the portion thereof adjacent one side of the pipe 20 extending tangentially therefrom as indicated by the numeral 130, and then bent inwardly as at 131 back into its normal plane, which is the plane shown between the pipes 20 in Figure 7. The inner skin 11 is formed as at 132, partly around the pipe 20, and then extends angularly as at 133 against the intermediate skin portion 130. The inner skin then extends inwardly at a sharper angle as at 134 to lie against the intermediate skin portion 131. The inner skin portions 132, 133 and 134 are of limited width as will become apparent and form pockets 135.

A bolt 136, similar to the bolts 112 and 125 previously referred to in a general way, is arranged with its head 137 in the pocket 135 shown in Figure 8. The bolt 137 extends through the inner skin, through the pipe 20, through the intermediate skin 12, and then through an angle bracket 140 secured to the outer skin 10 in any suitable manner, as by screws 141. The bolt 136 is provided with a tapered end 142 to facilitate its insertion through the skins 11 and 12 and pipe 20 and through an opening 143 formed in the bracket 140. This opening is somewhat larger than the bolt and has its end toward the pipe 20 flared as at 144 for a purpose to be described. A nut 145 is threaded on the bolt 136.

Means is associated with one of the bolts 145 for maintaining them in position for the blind-securing of the parts, the pocket in which the nut 145 is arranged being inaccessible when the parts are assembled. The nut holding device is shown in position on the nut in Figure 8 and is illustrated in detail in Figure 9. This device is indicated as a whole by the numeral 150 and comprises complementary sections 151 and 152, each of which is formed of a single sheet of relatively soft metal, for example, lead, tin, etc. Each section has a base portion 153 from the center of which extends a substantially semi-cylindrical member 154 flared at its ends as at 155, and it will be apparent that the members 154 are insertable in the opening 143 (Figure 8) for the assembly of the elements. Each base section 153 is extended to form a lip 157 to seat therewith against the surface to be gripped by the nut 145. The lip 157 is bent back upon itself to form a lip 158, as shown in Figure 9, for a purpose to be described.

Opposite the lip 157, each base section 153 is extended to form a lip 160, also in the plane of the base section, and at its end, each lip 160 is bent to form a perpendicular lip 161. This lip is engageable with a side of an element to which the bolt is connected to prevent the turning of the nut. For example, the lips 161 would be engageable with the inner end of the flange 111 (Figure 6) and with the inner ends of the flange 121 (Figure 13) in the previously described uses of the present bolt construction. In Figure 8, the lips 161 are shown engageable with the adjacent end of the bracket 140.

The body of each complementary section 151 and 152 is bent perpendicular to the base section 153 as at 162 to form a wall engageable with one side of the nut. At opposite ends, the wall 162 of each section is bent perpendicularly inwardly as at 163 and 164, the lips 163 thus formed on the two sections cooperating with each other to form a wall engageable with one side of the nut 145, and the two lips 164 in the two sections cooperating for the same purpose at the opposite side of the nut. The inner ends of the lips 158 seat against the lips 164 to assist in assuring against distortion of the nut holding device under any torque transmitted to the nut upon the tightening of the bolt. Each wall 162 is provided with an arm portion normally extending therefrom in a common plane therewith as indicated by the numerals 166 and 167. These arms are of a width approximately equal to the over-all width

of the nut holding device when the parts are assembled, the arms 166 and 167 being offset from each other to permit them to be folded into position, as will be described. Each arm 166 and 167 terminates in a perpendicular lip 169, engageable against the outer face of the wall 162 of the other section 151 or 152 when the device is assembled.

Each arm 166 and 167 is notched centrally of its length as at 170 for the passage of the bolt end therethrough. In using the device, one of the sections 151 or 152 is inserted in position with its extension 154 arranged in the opening 153. The extension 154 of the other section is then inserted in position. The edges of the section 154 have sufficient clearance with respect to each other so that the extension 154 of the second section may be tilted and inserted in position. The nut is then placed within the wall portions 162, 163 and 164, in engagement with the base sections 153, whereupon the arms 166 and 167 are bent over the nut in flat engagement with the outer ends thereof with the lips 169 engaging the outer faces of the respective walls 162. When the parts are thus assembled, it is impossible for either sections 151 or 152 to swing away from the other section, which would be necessary for the removal of either section, and accordingly the nut holding device will be retained in position until ready for use. A number of the joints of the boat employ the nut holding device referred to, and the latter likewise is employed in connection with the fastening of the parts as shown in Figure 8. When the parts are assembled, each nut 145 will be held in its proper position, and the bolt may be inserted and tightened from an accessible point.

The invention is shown in the present case as being employed in connection with a cruiser of the trunk cabin type, the trunk cabin being generally illustrated by the numeral 175 (Figure 1). It will be apparent, however, that the invention is applicable to any type of boat. Between the sheer line 176 (Figures 1, 10 and 11) and the cabin, is formed a deck 177 more fully referred to below. As previously stated, the upper portions of the skins 11 and 12 curve upwardly and inwardly toward the pipe 41, and the skin 11 turns partly around this pipe as indicated by the numeral 178. A cap strip 179 bridges over the tops of the pipe 41 and the upper edge of the inner skin portion 178. An outer cabin wall 180 has its lower edge bolted as at 181 to the cap strip 179, and this bolt passes through the upturned edge 182 of the intermediate skin. The bolts 181 form leak-proof joints between the three elements through which it passes, and these elements, together with the pipe 41 in the adjacent portion of the inner skin 11 form a mastic-receiving pocket 183.

The cabin wall 181 is apertured as at 185 to form port holes which may be closed by glass panes 186 supported and sliding in metal or other stripping 187. Within the cabin, a shaped molding strip 188 has its upper edge engaging the strip 187. Bolts 189 pass through the strip 188, the cap strip 189 and the upper end portion 178 of the inner skin, to secure these elements together. This arrangement forms a mastic receiving pocket 190.

A series of air inlet boxes each indicated as a whole by the numeral 200 is arranged in the deck 177. Each of these boxes comprises a substantially vertical inner wall 201 having its lower edge seated on the intermediate skin 12, as shown in Figure 10. Each box further comprises an outer wall 202 which extends substantially vertically downwardly and then curves downwardly and outwardly as at 203, following the curvature of the portions of the intermediate skins covering the pipes 20 and terminating in contact with the outer skin 10, as shown in Figure 10. The wall 202 and outer skin 10 above the point of contact of such elements form a mastic-receiving pocket 204.

Each box 200 (Figure 12) lies between an adjacent pair of pipes 20 and the series of boxes may extend as far along the deck 177 as practicable, that is, the series of boxes may be as long as the doors associated therewith, to be referred to below, can be readily operated. Referring to Figure 12, each box 200 comprises a forward wall 206 having a flange 207 at its lower edge shaped transversely and longitudinally to fit over the adjacent portion of the intermediate skin 12, the flange 207 extending from the inner wall 201 to the outer wall 202 as shown in dotted lines in Figure 10.

Each box 200 further comprises a rear wall 210, the upper portion of which is inclined to the vertical for a purpose to be described. At its lower edge, each wall 210 is provided with a flange 211 shaped transversely and longitudinally of itself to fit the portion of the inner skin 12 arranged over the adjacent portion of each pipe 20. It will be apparent that the space inside each box 200, indicated by the numeral 215 in Figure 12, forms the upper end of each air passage 52. Each space 215, except as referred to below, is adapted to be closed by a door 216 having opposite side walls 217 and a rear wall 218. The front of each door is open as at 219. Each door is provided with a hinge element 220 cooperating with a hinge element 221 carried by the adjacent wall 210, and receiving a hinge pin 222, the hinge thus formed preferably being of the piano type. Each door has its top wall at the front and sides thereof extended to form a flanged portion 223 seating in a recess 224 formed of shaped metal or other stripping 225. Adjacent the hinge of each door, a strip 226 is secured to the corresponding wall 210 to cooperate with the next rearward strip 225 to form a mastic-receiving pocket 227, each of these pockets communicating with the pocket 204 (Figure 10).

A pipe 230 extends longitudinally beneath the deck as shown in Figure 12, and all of the elements through which the pipe extends are slotted, for example, the walls 206 and 210, the lower portion of the strip 226 and hinge 221, and the lower portion of the hinge elements 220. The wall 218 of each door is slotted as at 231 from a point above the pipe 30 to its lower end. A plate 232 is secured to the wall 218 on each side of the slot 231, and opposite links 234 are pivoted as at 233 to the plates 232. Within the pipe 230 is a rod or shaft 235 and within each door 216 this shaft carries a transverse pin 236 extending through opposite slots 237 in the pipe 230. Each pin 236 also is relatively slidable with respect to the rod 230 by means of relatively short slots 238 through which each pin extends. A spring 239 has one end engaging each pin 236 and its other end engaging the adjacent wall 206 to urge the pins 236 toward the left as viewed in Figure 12 to tend to move each door toward closed position.

Suitable means are provided for operating the rod 235. Such means may be arranged wherever desired, and in Figure 12 the operating means is

shown as being associated with the rod 235 and sleeve 230 within one of the pockets 215. The pipe 230 is divided into fore and aft sections rigidly connected by a sleeve 242 slotted as at 243. The pipe 230 is slotted as at 244 while the rod 235 is provided with a slot 245, the slots 243, 244 and 245 being in a common plane for the insertion of the upper end of a lever 246. The slots 243 and 244 are elongated, while the slot 245 is shaped to receive the rounded upper end of the lever 246 so that movement of the latter will impart movement to the rod 235. The lever 246 is carried by a shaft 247 journaled in suitable brackets (not shown) and the shaft 247 extends into the interior of the boat for connection with a lever 248, also fixed to the shaft 247. Operation of the lever 248, either manually or by power, will rock the lever 246 to actuate the rod 235 and simultaneously move the doors 216 to open or closed positions. The pocket 215 utilized for the operating mechanism for the rod 235 will not be provided with one of the doors 216, but preferably is covered by a plate 249 which may be removed to provide access to the operating mechanism referred to.

The sheer line 176 may be formed of a split tube as shown in Figures 10 and 11, and this tube may be connected by any suitable means 250 to the outer skin 10. A framing tube or pipe 251 is arranged in the pocket 204 and after the placing in position of the various structural elements including the boxes 200, bolts 252 are inserted as shown in Figure 10 through the tube 251, box wall 203, pipes 20, inner skin 11 and intermediate skin 12, thus anchoring these elements rigidly to each other. The tube or pipe 251 preferably does not fit tightly against the outer skin 210, these elements being spaced slightly from each other. After the placing of all of the structural elements having to do with the deck 177, a body of a suitable mastic material is inserted in the pocket 204 at each side of the boat and taken into the lower portion of the pocket 204 around both sides of the pipe 251, the mastic at the outer side of this pipe filling the bottom of the pocket 204. The mastic also fills the pockets 227 (Figure 12) and the surface of the mastic is troweled or otherwise flattened flush with the top of the boxes 200 and then curving and sloping upwardly to terminate flush with the top of the sheer line pipe 176. The mastic is preferably of a type that will set fairly hard but not perfectly rigidly, thus providing a tread surface while at the same time possessing some degree of resiliency.

The operation of the apparatus is as follows:

The component parts of the boat are not only so arranged as to perform highly meritorious functions, but also to facilitate the assembling of the parts. Inasmuch as certain features having to do with the assembly of the boat are not germane to the present invention, such features will not be described in detail. The structural parts of the boat are preformed for assembly, and the shapes of the various parts are shown in the drawings except for the specific formation of the sections forming the inner skin 11. The shapes of such sections will depend upon the particular interior design of the boat, since it is convenient and effective to so design the sections of the inner skin that the edges thereof can be fixed to the bulkheads. For the purpose of the present invention, the inner skins can be considered to be sectional in so far as they are so illustrated in Figure 4.

Generally speaking, the keel pipe 21, Figure 4, is first laid, and the pipes 20 assembled with respect thereto, whereupon the tie pipes 24 are inserted to generally hold the lower ends of the pipes 20 in proper position. The same assembly is followed relative to the pipes or tubes 41 (Figures 10 and 11), the upper ends of the pipes 40 being inserted into the pipe 41, whereupon the tie pipes 43 are inserted. It will be understood that the tie pipes employed are relatively thin and flexible to permit them to accommodate themselves to the curves of the larger pipes in which they are inserted. The inner skin sections 11 are then placed in position and in practice will be secured to the bulkhead supports (not shown). For the purpose of the present invention, it will be assumed that the inner skin sections are merely held in position for the time being by any suitable means.

The intermediate skin sections 12 are then placed in position and the bottom sections thereof will be secured by the bolts 106 (Figure 6). The upper intermediate skin sections are then placed in position and the securing devices 82, and bolts 137 (Figure 8) are placed, thus anchoring the inner skin sections. The lower outer skin sections are then placed in position and their forward and after edges anchored by the bolts 112 (Figure 6). The various other fastening elements are then assembled, for example, the bolts 78 (Figure 4), the bolts 125 (Figure 7), and the bolts 71 (Figure 4), these bolts being placed after the assembling of the rubbing strake element 70. The clamping strips 27 and 32 (Figure 5) are then assembled and the hull is completed.

The boxes 200 (Figures 10 and 12) are then placed and fixed in any suitable manner whereupon the frame pipe 251 (Figures 10 and 11) is placed in the pocket 204 and anchored by the bolts 252.

The assembly of the other elements will then proceed as has been predetermined by the most efficient methods, but which are not important in connection with the present invention. After complete assembly of the boat has been accomplished, a suitable mastic in semi-fluid condition is pumped into one or both ends of the pipes 21 (Figures 4 and 5) and 41 (Figures 10 and 11). This mastic, from the pipe 21, flows around and into the open ends of the pipes 20, and escapes from the pipes through the various openings therein (for example, the openings 49 in Figures 6, 7 and 8) to fill the pockets 100 and 105 (Figure 6), 68 (Figure 7) etc. This mastic serves to provide a completely leak-proof inner hull formed by the inner skin 11, all joints and openings around bolts being sealed by the mastic where any leakage into the inside of the boat could reasonably occur. The mastic employed is of a permanently elastic nature, thus permitting the tightening of the bolts associated with the joints at which any leakage into the inner hull could occur. For example, the joint contacted by the device 82 in Figure 4*a*, the joint at the keel pipe, etc., can be readily tightened. The mastic flows from the adjacent pocket 100 into the pocket 93 (Figure 6) and thence into the pocket 116 to seal the overlap formed by the inner skin ends 114 and 115.

The deck 177 (Figures 10 and 11) is then formed by placing a suitable mastic in the pockets 204 and 227 (Figure 12) the latter pockets opening directly at their outer ends into the pocket 204 at each side of the boat. The mastic is packed down around both sides of the frame pipes 251 at opposite sides of the boat, and is forced outwardly around such pipes into the bottom of the pockets 204. The top surface of the mastic is troweled smoothly to the shape shown in Figures 10 and

11, flush with the tops of the doors 216 (Figure 12). This mastic is preferably one of the available type which sets sufficiently hard to withstand wear, but which permanently retains a reasonable degree of elasticity.

It will be apparent that all of the main structural features of the boat are preformed to fit when placed and secured in position. The pipes 20, while adding some rigidity to the hull are preferably relatively light and form carriers for the mastic pumped into the keel pipe, and act as forms for the mastic flowing radially outwardly therethrough into the pockets 48, etc. They also cooperate for the formation of the intermediate skin 12 therearound to form the air passages 52 above the strake line. It will be noted in Figure 6 that the vertical, or substantially vertical portions of the inner and outer skins provide great beam strength in such skins, thus rendering the use of conventional ribs unnecessary. The various parts of the boat, being pre-formed, are easily assembled by skilled workers with a minimum amount of total labor, there being no custom cutting or fitting of any of the parts.

It is well known that in addition to the resistance encountered by a boat in overcoming the inertia of the water through which it passes, the drag of the water against the surface of the hull of the boat causes very substantial additional resistance. It is largely because of the surface drag that power boats require engines of substantial size in order to drive them even at reasonable speeds through the water. The drag so greatly increases in proportion to increases in boat speeds that a much larger engine is required in a given boat in order to increase the boat speed even to a relatively small extent. Efforts to reduce the resistances to movement of a boat through the water have been directed along the lines of streamlining to reduce the amount of power necessary to displace water as the boat moves forwardly, and along the lines of providing steps in the bottoms of the hulls to tend to lift the boat as it moves forwardly. However, streamlining has its limitation from a practical standpoint since it reduces the beam and consequently the capacity of the boat, and it has no effect of overcoming surface drag. The provisions of steps in a boat also has serious limitations in that it requires the constant expenditure of substantial power to maintain the forward speed of the boat sufficiently high to raise the boat sufficiently to render the planes effective.

The drag on the hull tends to create a vacuum between the surface of the water and the surface of the hull, and it is to this tendency that the drag may be largely attributed. The present invention is effective for materially reducing the drag by eliminating the tendency for the creation of a vacuum against the water-engaging surfaces of the boat. The doors 216 (Figure 12) are preferably closed when the boat is not in use and are opened as shown in dotted lines in Figure 12 when the boat is in motion. The opening of these doors by operating the lever 248 admits air into the pockets 215 which communicate with the upper ends of the passages 52 (Figure 7), the design shown providing a pocket 215 forming the upper end of each passage 52. With the boat in motion, air will flow downwardly through the passages 52 (Figure 7) thence outwardly into the continuous passage 89 (Figure 4a) and this passage communicates with the upper ends of the passages 95 (Figure 6). It will be noted that the passages 95 occur between alternate pairs of pipes whereas the passages 52 occur between each adjacent pair of pipes 20. The latter thus are adapted to supply ample air for discharge downwardly through the passages 95 and openings 94 and through the openings 61 (Figure 4) in the bottom of the passage 89. As to the openings 61, it will be noted that the flange 55 (Figure 4) is pre-formed as shown in Figure 14 to form upper and lower bulged portions fore and aft of each flange section 58, the downwardly bulged portions 60 serving to provide some lift and to form the openings 61 through which air is discharged to assist in reducing surface drag. This air, if necessary, will flow downwardly to a certain extent along the outer hull if any drag along such surfaces tends to create vacuum conditions.

Air flowing downwardly through the passages 95 will be discharged beneath the bottom of the boat through the openings 94 (Figures 4 and 6) and this air will prevent the formation of any vacuum pockets with the tendency for the formation of such pockets, the drag on the hull thus being eliminated. Any drag occurring toward the forward end of each step 90 will be relieved by the flow of air through the openings 94', and under any operating conditions, any upward reaction of pressure of the water and air past the end of each step 91 can be satisfied by the releasing of such pressure upwardly through the openings 94'. Inasmuch as the drag on the bottom of the boat tends to create a partial vacuum, the air will be fed downwardly and discharged through the various openings by atmospheric pressure acting above, assisted by any pressure generated by the motion of the boat and the scooping of the air into the pockets 215 (Figure 12) by the upwardly and forwardly inclined walls 216. In view of the vacuum conditions which tend to exist as a result of the drag, air discharged through the bottom openings will tend to flow toward the areas of lowest pressure, thus automatically relieving any vacuum conditions at the points where they occur to the greatest extent.

Moreover, the openings 94 are provided at the rear of steps 92, and these steps function to tend to lift the hull to some extent as is true of conventional stepped-bottom constructions. In this connection, it is pointed out that in prior constructions using bottomed steps, it has been necessary to use substantial power to drive the boat forwardly at a substantial speed in order to take advantage of the steps. No such power is necessary in the present case because of the great reduction in the drag on the bottom. The feeding of air through the openings 94, therefore not only functions in itself to reduce the surface drag between the water and the boat bottom, but also functions to permit greater advantage to be taken of the stepped bottom arrangement.

As previously stated, it is difficult in the building of a boat from pre-formed outer hull sections to completely hide the joints between the sections. In the present case this has been taken advantage of by utilizing the joints to improve the "racy" appearance of the boat and also to supply additional air for discharge beneath the bottom of the boat. Referring to Figures 1, 7 and 13, it will be noted that the breaks between adjacent outer skin sections 14, 15, 16 and 17 are made on a downwardly and rearwardly sloping curve, and instead of attempting to hide the joint between such sections, it is accentuated by making the forward end of each section 15, 16 and 17 extend outwardly to some extent, the exposed surface of the portion 126 of each skin section

tapering to increase in width toward its lower end. The relatively wide portion of the outward offset thus provided has openings 127 therein for the admission of additional air into the adjacent passages 52.

As previously stated, the doors 216 (Figure 12) are opened and closed by operation of the levers 246 and 248. The lever 248 moves the rod 235 longitudinally and this rod imparts movement to the respective doors through the pins 236, links 234 and pins 233. The door operating mechanism is preferably so designed that when the rod 235 is in its extreme door-closing position, the rear end of each slot 238 is spaced from the associated pin 236. The closing movement of the doors is effected by the springs 239, and the arrangement referred to prevents possible engagement of the rear end of either slot 238 with the pin 236 to prevent any door from completely closing. In other words, any inaccuracy in making might result in the rod 235 being in the extreme door-closing position without one or more of the slots 238 having moved far enough to complete the closing of such door or doors. By extending the slots 238 somewhat further rearwardly than necessary the complete releasing of the pins 236 to permit the doors to be closed by the springs 239 is assured.

The fastening device illustrated in Figures 8 and 9 is particularly useful in the placing of securing bolts one end of which is blind and inaccessible. The parts shown in Figure 9 are assembled as previously described prior to the placing in position of the member to which it is connected, the nut associated with the device thus being held in proper position for the reception of the associated bolt, while the nut is prevented from turning while the bolt is being inserted.

While the boat is at rest, it will be apparent that water will be present in the passages 95 up to the water line indicated in Figure 1. This does not affect the buoyancy of the boat, however, since the inner and intermediate skins 11 and 12 completely seal the interior of the boat against the entrance of water. As soon as the boat is driven forwardly, the generation of drag conditions beneath the boat promptly empties all of the pockets 95, and air starts to flow in the manner previously described. This emptying of the passages 95 increases the displacement of the boat compared to its normal displacement when at rest, and the buoyancy of the boat is thus increased and it is lifted somewhat in the water, thus reducing drag. The strake line of the boat is normally hidden beneath the water except for the forward narrow end thereof, and accordingly is not noticeable in the appearance of the boat. The downward sloping of the strake line also provides some lifting tendency and any drag which might occur therebeneath is minimized through the discharge of air through the openings 61.

From the foregoing it will be apparent that the present construction is such as to permit the building of boats at a much lower cost because of the very great reduction in labor costs incident to cutting and fitting conventional parts. Such labor costs are the greatest item in the building of power boats, aside from the power plant. The functioning of the invention in greatly reducing the surface drag of the water against the hull permits the use of a much smaller and lower cost power plant in a boat of given size, and accordingly the total cost of the boat to the purchaser is very substantially reduced.

I claim:

1. A board comprising a hull formed of a plurality of ribs, inner and outer skins arranged respectively inwardly and outwardly of said ribs, an intermediate skin lying against one of said first named skins between said ribs and extending over said ribs in contact with the other of said first named skins whereby said intermediate skin and said other of said first named skins define air passages, the upper ends of said passages communicating with the atmosphere and the lower ends of said passages extending through said outer skin below the water line of said hull.

2. A boat constructed in accordance with claim 1 provided with a deck fixed with respect to said skins, said deck having openings through which the upper ends of said passages communicate with the atmosphere.

3. A boat constructed in accordance with claim 1 provided with a deck fixed with respect to said skins, said deck having openings through which the upper ends of said passages communicate with the atmosphere, a door for each of said deck openings movable to a closed position substantially flush with said deck, and common means for opening and closing the doors at each side of the boat.

4. A boat comprising a hull formed of inner and outer skins spaced from each other, means between said skins defining upwardly and downwardly extending air passages, a deck for said hull having openings communicating with certain of said passages for the admission of air thereto, such passages opening through said outer skin below the water line of the hull, a door for each opening, each of said doors being hinged to swing upwardly and downwardly between open and closed positions, and means for operating the doors at each side of the boat, such means comprising a link connected to each door, a pin carried by each link, and a slidable rod having an opening therethrough to receive each pin whereby sliding movement of said rod will impart movement to the associated doors.

5. A boat constructed in accordance with claim 4 wherein the opening in each rod is a slot one end of which is engageable with the associated pin to swing one of the doors to open position, each slot having its other end spaced from its associated pin when the corresponding door is in closed position, and spring means urging each door to closed position.

6. In a boat hull, inner and outer skins spaced from each other, tubular ribs arranged between said inner and outer skins and provided with openings, an intermediate skin lying against one of said first named skins between said ribs and curving around each rib into contact with the other of said first named skins, and a body of a mastic filling said ribs and extending around said openings into the spaces formed between said ribs, said intermediate skin and the first named skin against which said intermediate skin lies between said ribs.

7. In a boat hull, inner and outer skins spaced from each other, tubular ribs arranged between said inner and outer skins and provided with openings, an intermediate skin lying against one of said first named skins between said ribs and curving around each rib into contact with the other of said first named skins, and a body of a mastic filling said ribs and extending around said openings into the spaces formed between said ribs, said intermediate skin and the first named skin against which said intermediate skin lies be-

tween said ribs, the spaces between the portions of said intermediate skin which extend around adjacent pairs of said ribs forming air passages communicating at their upper ends with the atmosphere and opening through said outer skin beneath the water line of said hull.

8. In a boat hull, a tubular keel, a plurality of tubular ribs having open lower ends extending into said keel, a pair of skins one arranged inwardly of said ribs and the other arranged outwardly thereof, said skins being fixed with respect to said keel and said ribs, an intermediate skin lying against one skin of said pair between said ribs and being curved around each rib into contact with the other skin of said pair, said ribs being provided with openings, said ribs, said intermediate skin and the first mentioned skin of said pair forming spaces communicating with the interior of said ribs through the openings therein, said spaces, said ribs, and said keel being filled with a body of a mastic.

9. A boat hull comprising inner and outer spaced skins, means arranged between said skins forming air passages therebetween, said means comprising a plurality of ribs, said passages being open at their upper ends to the atmosphere and having their lower ends opening through said outer skin below the water line of the hull to discharge air into the water adjacent the hull bottom, said inner skin and said ribs extending upwardly and inwardly adjacent the top of the hull, and said outer skin flaring outwardly to the sheer line of the hull, and a body of a mastic material arranged within the flared portion of said outer skin and forming a deck for the boat.

10. A boat hull comprising inner and outer spaced skins, means arranged between said skins forming air passages therebetween, said means comprising a plurality of ribs, said passages being open at their upper ends to the atmosphere and having their lower ends opening through said outer skin below the water line of the hull to discharge air into the water adjacent the hull bottom, said inner skin and said ribs extending upwardly and inwardly adjacent the top of the hull, and said outer skin flaring outwardly to the sheer line of the hull, a plurality of boxes arranged between the upwardly and inwardly extending portions of said ribs and through which said passages communicate with the atmosphere, each box having an outer wall extending downwardly and then following the configuration of the adjacent portions of the ribs substantially into contact with said outer skin to form pockets in conjunction therewith, and a body of a mastic in said pockets forming a deck for the boat and extending between adjacent pairs of said boxes.

11. A boat constructed in accordance with claim 10 wherein each box is provided with a door adapted to assume a horizontal position flush with the top of the associated box and with said deck, and means for opening said doors for the admission of air to said passages.

12. A boat hull comprising an inner skin, and an outer skin formed of forward and after sections having their adjacent edges provided with inturned flanges, means for securing said flanges and said inner skin with respect to each other, and means between said skins cooperating with said outer skin to form air passages, the forward edge of the after outer skin section being offset outwardly from the after edge of the forward outer skin section, such offsetting increasing from top to bottom to present a forwardly facing wall forming a part of the flange of the after outer skin section, such wall being provided with an opening for the admission of air into one of said passages.

13. A boat hull comprising an inner skin and an outer skin, said outer skin being made up of a pair of pre-formed sections having adjacent edges terminating in inwardly extending contacting flanges, the inner skin being provided with a recess including a wall substantially parallel to said flanges, and a bolt structure securing said wall and said flanges with respect to each other.

14. A boat hull comprising an inner skin and an outer skin, said outer skin being made up of a pair of pre-formed sections having adjacent edges terminating in inwardly extending contacting flanges, the inner skin being provided with a recess including a wall substantially parallel to said flanges, and a bolt structure for securing said wall and said flanges with respect to each other, said bolt structure comprising a nut arranged between said inner and outer skins, a holding device supported by the adjacent flange for fixing said nut with respect thereto and preventing the turning thereof, said flanges and said wall having openings alined with the opening in said nut, and a bolt projecting through said opening and threaded through said nut, said bolt having a head arranged within said recess in contact with said wall.

15. In the method of sealing a structural joint wherein two structural sheets bridge around a tubular member having openings therein, and contact with each other on opposite sides of said tubular member in spaced relation thereto and forming pockets therewith extending along the tubular member, and wherein a bolt extends through the sheets and through the tubular member, the step which comprises forcing a sealing mastic through the tubular member to escape through the openings therein and fill said pockets and seal around said bolt.

16. The method of sealing against leakage a boat hull having spaced inner and outer skins, a tubular member therebetween provided with openings, an intermediate skin contacting with said inner skin up to a point spaced from the tubular member and then extending therearound whereby the tubular member cooperates with said intermediate skin and said inner skin to form spaces, and a bolt extending through said intermediate skin, said tubular member and said inner skin, the step which comprises forcing a sealing mastic through said tubular member to fill the latter and to escape through the openings therein to fill said spaces.

MILTON A. WALLACE.

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