Price $1.50

SEA WINGS
INSTALLATION AND OPERATION MANUAL
MODEL A70 HYDROFOIL KIT

DYNAMIC DEVELOPMENTS INC AFFILIATE OF GRUMMAN AIRCRAFT ENGINEERING CORPORATION

MANUAL FOR THE INSTALLATION AND OPERATION OF THE DYNAMIC DEVELOPMENTS, INC. MODEL A70 SEA WINGS[1] HYDROFOIL* KIT

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Grumman Aircraft Engineering Corporation

1 Registered Trade Mark
* Pat. No. 2,914,014

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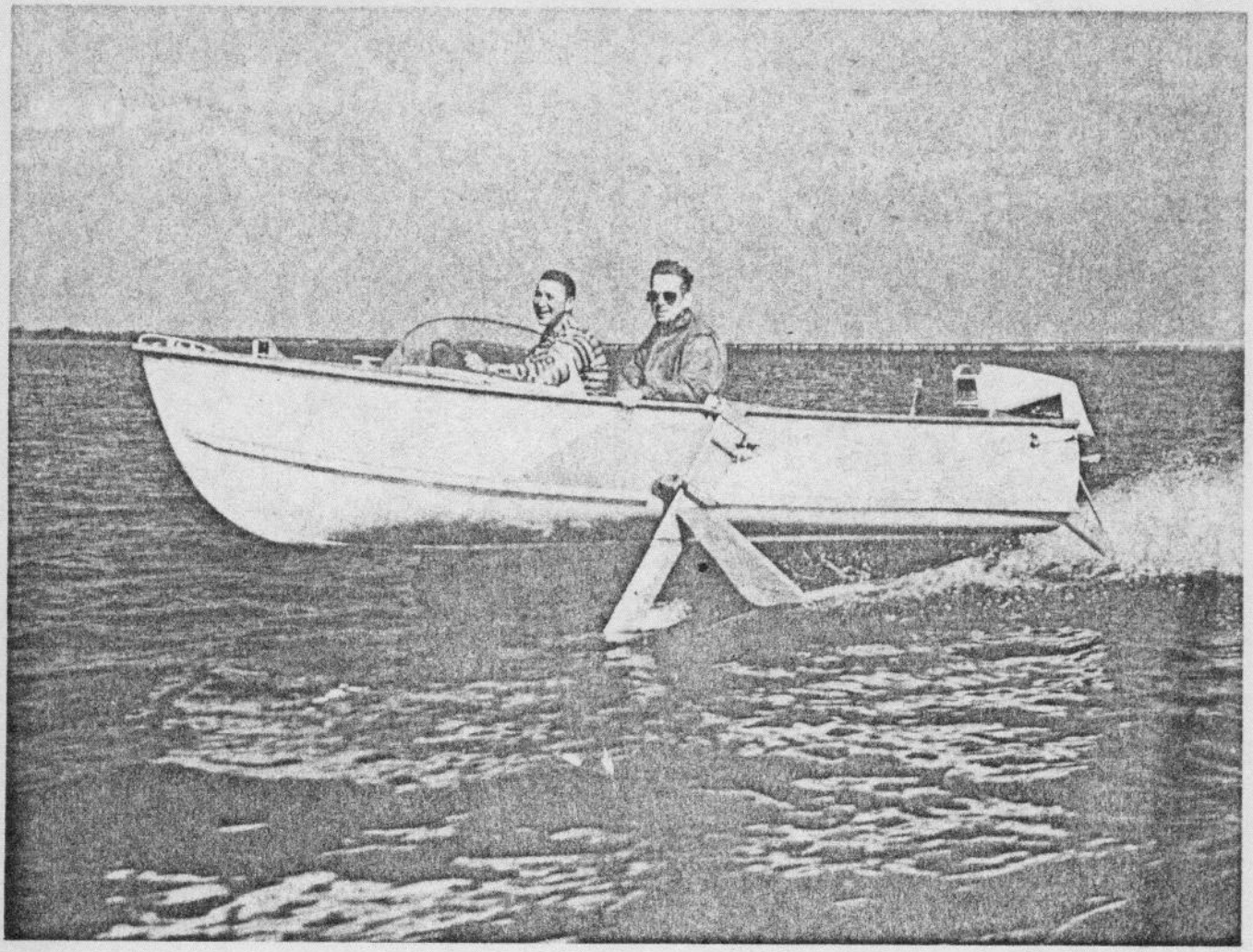
FOREWORD . . . . . VERY IMPORTANT!!!

Please read all of the following VERY carefully before proceeding further with the installation of your Sea Wings Hydrofoil Kit. The time that you spend now will be more than repaid by the time you save in installation. When these instructions are well understood, the rest is simple and easily accomplished. Failure to make the installation in accordance with these instructions will void all warranties on the foils and their operation.

Dynamic Developments, Inc.



Left: Myrel Harner's 1958 Grumman 14'-8" Hydrofoil Runabout with new Mercury 40 HP outboard engine and trailer. The original engine is a 35 HP Evenrude Lark

The International Hydrofoil Society (IHS) expresses its gratitude to member Myrel Harner who provided a copy of this Installation and Operation Manual and who is the owner of the "museum piece" Grumman Runabout shown in the photos on this page.

MODEL A70 SEA WINGS[1]

HYDROFOIL* KIT SPECIFICATIONS

The following are the specifications for the Model A70 Sea Wings hydrofoil kit. The kit has been designed for outboard boats rated for at least 35 hp motors in the 14 to 16 foot range whose weight does not exceed 1300 pounds equipped and loaded ready to run. They must have forward steering.

1. Weight of the kit installed . . . . . 100 lbs.
2. Maximum weight that foils will lift . . . . . 1400 lbs.
3. Maximum beam of boat allowable . . . . . 66 3/4"
4. Minimum beam of boat allowable . . . . . 48"
5. Maximum depth of boat allowable at main foil beam . . 25"
6. Minimum depth of boat allowable at main foil beam . . 21"
7. Maximum distance of main beam from transom . . . . 112"
8. Minimum distance of main beam from transom . . . . 84"
9. Transom motor slot must be cut down to . . . . . 14"
10. Recommended motor horsepower . . . . . 35 - 40 hp
11. Motor shaft length required . . . . . 20"
12. Propeller recommended . 3 blades, 10.3 x 13" or 14" pitch
13. Operating speeds:
    - A. foil borne . . . . . 18-20 mph
    - B. normal speed . . . . . 34-36 mph
    - C. maximum speed . . . . . 38-40 mph
14. Draft:
    - A. foils retracted . . . . . regular boat draft.
    - B. foils in running position . . . . . 20"

Structurally, it must be possible to bolt the tail strut fittings to the transom and to cut the motor slot down to 14 inches. It must be possible to pass the main foundation beam under the forward seat. Tank seats can be cut open along the front and opened up for access. They can be removed, modified and reinstalled after the beam has been put in place. Wooden seats can be removed if necessary to facilitate the positioning of the main beam. Fiber glass seats molded into the boat will have to be opened in some way to permit the passage of the beam under the seat. The gunwales at the main beam location must be able to take fastenings to secure the foundation plates to them.

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SEA WINGS HYDROFOIL KIT

Model A 70

Owner's Installation and Operating Manual

Introduction

The Dynamic Developments Sea Wings hydrofoil system is a precision system. Installation should not be undertaken until the instructions and drawings have been carefully read and understood. Before attempting to operate your boat on foils, read carefully the instructions for adjusting the foils properly. The more fully you understand these adjustments, the better will be the operation of the foils and more complete will be your enjoyment of your boat.

Components of the hydrofoil kit.

The kit contains all the elements required to assemble two main foils and a tail foil along with the means of attaching these foils to the hull of the boat. The main foils are of the swept, surface-piercing type mounted just forward of the center of gravity of the boat. The submerged foil is attached to the transom. The main foils are attached to the boat by means of a foundation system consisting of a main beam run through the hull and side plates attached to the beam-ends and the gunwales, to which the foils are hinged and locked. The tail foil is hung on the transom with fittings bolted to the transom.

The parts for the main foils are as follows: (Refer to Figure 7 for identification). The odd dash numbered parts are left hand parts and the even dash numbered parts are right hand parts. When no right hand part is specified the odd numbered part is used for both left and right hand.

1. Main strut assembly . . . . . part A70F10017-1 & -2
2. Main foil element . . . . . part A70F10013-1 & -2
3. Diagonal foil. . . . . part A70F10021-1 & -2
4. Tapered spacer . . . . . part A70F10017-15 & -16

The parts for the tail foil are as follows: (Refer to Figure 4 for identification).

1. Tail strut . . . . . part A70F10032-1 & -2
2. Tail foil . . . . . part A70F10029-1
3. Vertical tube assembly . . . . . part A70F10031-1 (2)
4. Diagonal tube . . . . . part A70F10030-1 (2)

Parts for the tail foil (Cont'd.)

5.	Compression block	part A70F10032-15	(2)
6.	Diagonal tail tube fittings	part A70F10036-1	(2)
7.	Tail strut fittings	part A70F10046-1	(2)

The parts for the foundations are as follows: (Refer to Figures 5 and 6 for identification).

1.	Main beam	part A70F10000-1	
2.	Back-up plate	part A70F10026-1	(2)
3.	Rubber seal boot	part A70F10023-1 & -2	
4.	Beam clips	part A70F10025-1, -2, -3, -4, -5, -6, -7, (2 of -7)	
5.	Beam insert	part A70F10045-1	(2)
6.	Foundation plate	part A70F10008-1	(2)
7.	Locking catch	part A70F10044-1 & -2	
8.	Hinge bracket	part A70F10006-3	(2)

Included with the kit are all additional necessary fastenings.

MAIN FOIL ASSEMBLY PROCEDURE

Figure 7 shows the main foil assembly. The parts required are the main strut assembly, A70F10017, the diagonal foil, A70F10021, the main foil, A70F10013 and the tapered spacer, A70F10017-15. Bolt the diagonal foil to the main strut using seven AN4-13A bolts through the foil and the bolt block on the main strut. Put in all the bolts before tightening the nuts. Tighten the nuts together so that the foil is brought down to the bolt block uniformly.

Bolt the diagonal foil to the main foil with four AN509-416R-31 and one AN509-416R-25 flat head screws. The -25 screw goes in the rear hole. Insert all of the screws into their holes and start them into their nuts that are embedded in the main foil. Screw them in until tight, bringing them down in succession by degrees. If one screw is tightened before the others are almost tight, it may bind the other screws so that they cannot be driven in completely.

Bolt the main foil to the bottom of the strut with three AN509-516R-22 screws. Position the faring piece, A70F10017-15 on the bottom of the foil before inserting the screws. Put in all of the screws and tighten them together to prevent binding. It may be necessary to spring the main foil slightly to align the holes in the foil with those in the strut.

Bend the end of the control wire into an L shape and insert it through the clip on the trim tab. Observe that one side of the clip is in line with the control wire tube. Insert the wire into the clip from this side. Bend

up the tip of the wire to hold the wire in the clip. Loosen the set screw in the trim tab control lever. Position the trim tab so that it lines up with the bottom of the foil. Position the control lever so that it is at right angles to the main strut. Tighten the set screw to hold the wire in the control lever. Periodically oil the control wire and tube to prevent binding of the control wire in the tube.

TAIL FOIL ASSEMBLY PROCEDURE

Figure 4 shows the tail foil assembly. The parts required are the two tail struts, A70F10032, tail foil, A70F10029, two vertical tubes, A70F10031, two diagonal tubes, A70F10030 and two compression blocks, A70F10032-15. Insert the compression blocks into the bottom ends of the struts. Fasten the struts to the tail foil using three AN509-416R-25 screws to each strut. Note that the foil is marked on one side "Bottom". Be sure that this side is on the bottom, as shown in the figure. Note also that the leading edge of the foil is the thick edge. Punch the heads of the screws with a center punch to lock them in place. Attach the diagonal tubes to the struts with the AN43B-11A eye-bolts and AN3-5 bolts. Attach the vertical tubes to the clips on the struts with the A70F10033 shear pins and cotter pins.

FOIL FOUNDATION INSTALLATION PROCEDURE

(Check List)

I. Set up building jig. (Figure 3)

a. Set up horses or supports and 2 x 4's or equal for foundation. Level both fore and aft and athwartships.
b. Lay surface of plywood or equal as wide as boat at stern and at approximate main beam location. Should be at least 24" high to permit foils to be lowered.
c. Lay out control lines on surfaces. 1 - keel center line. 2 - transom location perpendicular to keel center line. 3 - main beam location perpendicular to keel center line. (Do 3 after having located main beam in relation to transom. See discussion section "Locating the Main Beam".)

II. Mount tail fittings. (Figure 4)

a. Position boat on center line with point where transom and bottom skin intersect on transom control line.
b. Level boat athwartship and block it in that position.

II. Mount tail fittings. (Figure 4 - Cont'd.)

c. Locate center line of transom in vertical plane and mark it on boat.
d. Measure up from bottom of transom 8 3/8 inches and draw horizontal line to establish center line of fittings.
e. Locate positions of fittings on horizontal line from sketch and draw vertical center lines for fittings.
f. Position one diagonal tube fitting on its center lines and drill one bolt hole through transom. Bolt fitting in position temporarily.
g. Position other fittings on their center lines using a 1/4 " diameter rod or dowl through fittings to hold them in position, and to align them. Check for correct distance between fittings and for vertical and horizontal squareness. Drill through fitting bolt holes through transom for bolts.
h. Bolt fittings to transom.
i. Cut down motor slot to 14" height.
j. Attach assembled tail foil to fittings. Check for proper retract alignment.
k. Make initial tail foil angle of incidence adjustment.

III. Install main beam. (Figure 5)

a. Locate vertical center line and top of main beam on outside of boat skin from main beam control line.
b. Develope outline of beam on skin and cut out holes. Trim to fit beam.
c. Develop, make and install local reinforcements around hole, if required.
d. Determine main beam length, using temporary assembly of foundation plate and beam insert to main beam to establish fit of plate to gunwale. Cut beam to length.
e. Locate and drill beam-to-insert fastening holes in beam ends.
f. Assemble beam and back-up plates in boat. Fit beam clips around beam outside hull.
g. Slip rubber boot in place over main beam. Position clips and through drill pilot holes into hull, back-up plate and beam, for bolts.
h. Remove boot, spread sealer on hull and beam, and replace boot. Position clips and bolt them to hull and beam.

IV. Install foundation plate. (Figure 6)

a. Assemble locking bar, foundation and insert.
b. Install plate to beam ends and fit to gunwales to establish gunwale bolt locations and plate trim line.
c. Remove plate, drill and countersink plate for gunwale bolts, and trim plate to gunwale height.
d. Assemble plate to boat, bolting to beam end and gunwale.
e. Bolt hinge bracket to plate.
f. Install main foils with hinge pin through bracket and foil cap.
g. Lock foils in running position and check foil angle of incidence with level on bottom of main element.

FOIL FOUNDATION INSTALLATION PROCEDURE

(Dsicussion)

The Installation Jig

The installation jig (see Figure 3) provides a level surface and control lines from which to locate the tail foil fittings and the main beam. It should be the width of the boat amidships or slightly less, about a foot longer than the distance between the transom and the main beam center line and at least 24" high. Limiting the width to the beam or slightly less and raising the surface 24" permits the main foils to be lowered for fitting.

Make the jig from three 2 x 4's or equal cut to length. Nail the two plywood surfaces to the 2 x 4's as shown in the figure. Set the jig on saw horses. Level the surfaces in both length and crosswise directions. Scribe a center line the length of the jig. This will be the center line on which the keel of the boat will be placed. About 6" from the end of the jig, scribe the transom line at right angles to the keel center line. After the main beam center line location has been determined (see next section) lay off this distance from the transom line along the keel line. Lay off the main beam center line at right angles to the keel line at this point.

The care with which these lines are laid out and the maintenance of the working surface in a level plane will determine the success of your foil installation.

Locating the Main Beam

The Sea Wings hydrofoil system is a three point support system with the forward main foils bearing between 70% and 80% of the total load and the tail foil the remainder of the load. The tail foil therefore acts more as a balancing foil than as a lifting foil. In order for the forward foils to lift the greater part of the load they must be located near to and forward of the center of gravity of the boat. The center of gravity is the point where the loaded boat, including the foils, will balance if placed on a roller at right angles to the keel. Since in most conventional outboard boats with bow steering the seat is just forward of the center of gravity the main beam can be placed under this forward seat. Its exact location will depend on the frames, hull structure, etc. However, the distance from the intersection of the transom with the outside bottom skin at the keel should not be less than 84 inches. If the distance between the tail foil and the main foils is too short the fore-and-aft stability is affected and trimming the boat for proper foil operation in rough water becomes difficult. The foils will operate with the main beam center line as far forward as 112 inches from the transom. The ideal location is about 90 inches provided this places the passenger load about over the beam. The passenger load should never be forward of the beam.

Inspect the boat and decide where the main beam will fit best under the forward seat. Locate it between frames and clear of any basic structure of the hull. Measure the distance between the outside of the transom at the keel and the proposed center line of the beam. Lay off this distance on the installation jig as shown in Figure 3.

Positioning the Boat on the Installation Jig

Care in locating the boat on the installation jig is very important so that the control lines laid down on the jig will properly locate the foils on the boat. Position the boat as follows:

1. Align the boat's keel along the center line of the jig.
2. Position the intersection of the transom and the bottom at the keel over the transom line on the jig.
3. Place a straight-edge across the beam of the boat and with a level on the straight-edge, level the boat athwartship. The main beam can be used for this.
4. Block the boat in the level position and secure the blocks so that they will not work loose while work is being done on the boat.
5. While making the installation of the foils, make periodic checks of the set-up to insure that the jig or the boat does not shift out of level.

Installing the Tail Fittings.

The tail fittings consisting of the diagonal tube fitting, part number A70F100.36-1, and the tail strut fitting, part number A70F10046-1, are bolted to the transom. The tail foil assembly is attached to the fittings by shear pins, bolts and clevis pins. The arrangement permits the foil to be positioned for running or retracted for storage or trailering. Figure 4 shows the installation details. The procedure for making the installation is as follows:

1. The fittings are to be bolted flush to the transom. If the transom is not flat, the strut fittings must be mounted on wood pads to bring them into the same plane with the diagonal tube fittings.
2. Locate the vertical centerline of the transom and scribe it on the transom.
3. Measure up from the intersection of the transom and the bottom at the keel (point X, Figure 4) 8 3/8" (8.4"), and scribe a horizontal line. This is the center line of the lower fittings.
4. From the vertical center line, lay off to port and starboard along the horizontal line equal distances of 18 3/8".
5. Lay off two vertical lines at these points on the horizontal line. Check that the total distance between the two vertical lines is 36 3/4". These lines are the center lines for the strut fittings, part A70F10046-1.
6. Measure back towards the center of the transom 13 3/8" from each vertical line, along the horizontal line. Scribe short vertical lines. These will be the center lines of the diagonal tube fittings, part A70F10036-1. This location of the diagonal strut fittings allows a 10 inch clearance between the fittings. Check your motor bracket to be sure it will fit in this space. If not, move the fittings outboard enough to clear the bracket. This will require shortening the diagonal tube slightly by relocating the bolt hole in one end and trimming off the end of the tube.
7. Position one diagonal tube fitting on its vertical and horizontal center lines and drill through one bolt hole through the transom. Use 1/4" drill. Bolt the fitting to the transom with just one bolt temporarily.
8. Run a 1/4" diameter rod or dowl through the holes of the fittings, so that the fittings can be held in position on their center lines and aligned for drilling of all remaining bolt holes. Before drilling, check that the distance between the upper and lower ends of the strut fitting is 36 3/4" and that the diagonal tube fittings are 13 3/8" inboard of the strut

Installing the Tail Fittings (Cont'd.)

fittings. A small level held on the rod and against the sides of the fittings will help to check squareness.

9. Drill all bolt holes through transom, using a 1/4" drill.
10. Bolt fittings to transom with 1/4" bolts with wood washers, AN970-4, under the nuts. Recheck that all dimensions are correct and that the hinge line holes are in line.
11. Measure 14" height from transom bottom. Cut down motor slot to this height. Make slot wide enough to accommodate motor clamp. Be sure that any motor supports affected are re-strengthened. A 5/8" marine grade plywood pad on outside of transom in the way of the slot and motor, bolted to the transom, will restore any lost strength.

Mounting Tail Foil

The tail foil assembly is mounted on the tail foil fittings as shown in Figure 4. The struts are fastened to the lower end of the strut fitting with the strut shear pins, part no. A70F10033-1, and the diagonal tubes are attached with bolts and eyebolts to their fittings. The vertical tube is secured to the top of the strut fitting with the clevis pin, part no. A70F10038-3. The steps in attaching the tail foil assembly are as follows:

1. Bolt the eyebolts, AN43-7, to the diagonal tubes with the 3/16" AN3-6 bolts and nuts provided.
2. Guide the diagonal tube eyebolts into the diagonal tube fittings at the same time that the struts are positioned on the lower ends of the strut fittings.
3. Insert the shear pins through the struts, to hold the struts in place. Secure the shear pins with cotter pins.
4. Bolt the diagonal tube eye bolts to the tube fittings with nuts provided. Tighten nuts down snugly, then back them off half a turn to allow the eyebolts to turn in the fitting when the foils are retracted.
5. Position the adjusting screw in the vertical tube so that there is approximately 1 1/8" between the end of the tube and the center of the hole in the screw. Tighten the lock nut finger tight, to hold the screw in position.
6. Attach the vertical tube to the strut fittings with the clevis pin, part no. A70F10038-3. The clevis pin should be tied to the transom with a piece of line to prevent its loss overboard. Check angle of attack of the tail foil by measuring

Mounting Tail Foil (Cont'd.)

height of leading and trailing edge from leveled floor. They should be the same height or with the leading edge slightly lower than the trailing edge. Screw adjustment screw in or out to set correct position. Final adjustment will be made while running boat on its foils.

To retract the foil, pull out the clevis pins and pull on the vertical tubes. The foil assembly will rotate about the hinge axis so that the holes in the struts can be matched with the holes in the top of the strut fittings and the clevis pins can be inserted to hold the foil in the retracted position. If the holes in the strut do not match, file them so that the clevis pin can be positioned.

Installation of Main Beam

Figures 2 and 5 show the method of main beam installation. The parts for this installation are the main beam, part no. A70F10000-1; back-up plate, part no. A70F10026-1; beam clips, part no's. A70F10025-1, -3, -5, -7, rubber boot, part no. A70F10023-1 (for left side). The foundation plate, part no. A70F10008-1 and the beam insert, part no. A70F10045-1 are used to help determine the main beam length. The main beam control line locates the center line of the beam on the side of the hull in the fore and aft direction. The top of the beam is located 10 7/8" (10.9") above the outside skin of the boat at the keel. Once the center line and the top of the beam are located, the outline of the beam is drawn on the hull and is cut out for the beam. The following is the detailed procedure:

1. Check that main beam control line is at right angles to the keel line and that its ends are equi-distant from the ends of the transom control line. Check that the boat is at the transom control line and that it is still level athwartship.
2. Measure height of bottom skin at keel above jig. Add this to 10 7/8" to get height of top of main beam above jig surface. Scribe a horizontal line in the beam area on the side of the boat at this height.
3. Using a plumb bob or a square, transfer the vertical center line of the beam from the jig surface to the side of the boat, and draw it in.
4. Draw a line parallel to the beam top and 2 inches below it. This locates the bottom of the beam. The rear of the beam is square to the top and bottom and 3 inches aft of the center line. The shape of the leading edge can be obtained by using the back-up plate as a guide. Position it on the hull so that the top of the cut-out lays along the top line of the beam and

Installation of Main Beam (Cont'd.)

14. Remove beam from boat and scribe line around beam 3/8" in from both ends, for center-line of beam-to-insert fastenings. Position insert into beam ends so that holes in insert are half covered by the beam. Transfer the center-lines of the holes in the insert to the beam, to cross the line already drawn around the beam. Use a square or a straight edge. Center-punch the beam for the hole locations and drill 1/4" or 5/16" holes for the bolts.
15. Clean off the burrs and fit the inserts into the beam to check the match of the holes in the beam to the holes in the insert. Correct any errors with a rattail file or drill.
16. Put beam back into boat with the back-up plates on the beam inside the boat. Position the beam so that its ends are flush with the gunwales. Do this with a square or the foundation plates. Draw a line around the beam at the hull for future location reference.
17. Fit the beam clips around the beam. Open or close the angles of the clips as required and cut the flanges where they interfere with each other, so that the clips will fit flush to the beam and the side of the boat.
18. Position clips and through-drill 1/4" holes through all pilot holes. For wood or fibreglass hulls use all holes. For aluminum hulls drill outer row of holes as rest are not required. Do not let drill come through back up plate so close to the beam that nuts cannot be fitted to the bolts. If one or two bolts are slipped into place to hold the clips, it will make the drilling easier. If the hull or beam interferes with the drilling process, the pilot holes must be marked and the beam moved out of the way so that the holes can be drilled.
19. Slide boot on beam and mark bolt holes on boot. Punch holes in boot. It is possible to drill holes in the rubber while positioning the clips but the boot must be securely clamped between the hull and the clips and the holes well cleaned out with the drill in order to open a hole large enough for the bolts.
20. Assemble one beam seal before starting the other. Spread sealer on boat side and on beam around joint where boot will touch. Slide boot into position and press it in tightly at corners for close fit. To keep excess sealer off hull and beam, use masking tape around clip area.

Installation of Main Beam (Cont'd.)

21. Position clips and bolt them on. Bolt to the hull before the beam. The clips may pull the side of the boat and so cause the beam to shift position in or out if the clips are bolted to the beam before the sides. Check the beam reference line against the hull on the opposite side of the boat while assembling the first side to make sure that the beam is not shifting. Run all bolts from outside in. Draw up nuts evenly around the clips so that pressure is applied evenly. This is particularly important when there is a wooden doubler around the hole to keep from cracking the wood. As bolting is proceeding check to see that the beam is remaining in position.
22. Trim off excess rubber to the edge of the clips and wipe off with turpentine any sealer that has squeezed out.

Installation of the Foundation Plate

Figure 6 shows the details of the foundation plate installation. The parts for the foundation plate installation are the plate and insert used in the beam installation and the hinge bracket, part no. A70F10006-1 and the locking catch, part no. A70F10044-1. Bolt the insert, plate and locking catch in position per Figure 6. Fit insert into beam end and position plate against gunwale. Mark location of gunwale fastenings and top trim line on the plate. Remove the plate assembly, drill and countersink the screw holes, and cut off the excess plate top. Reposition the plate, through drill the gunwale for the screws, and bolt the plate to the gunwale and the beam. The detailed steps for this installation are as follows:

1. Bolt the insert, locking catch and plate together as shown in Figure 5. Check that the top of the insert makes a 58° angle with the leading edge of the plate.
2. Fit the insert into the beam end and position the plate against the gunwale. Mark on the plate the line for the gunwale fastenings and the trim line for the top of the plate.
3. Remove the plate assembly from the beam. Lay out the hole locations for the fastenings, center punch them and drill with a 1/4" drill. Countersink with a 82° tool to a depth sufficient to bring the screw heads flush with the surface of the plate.
4. Cut off excess of plate along trim line. Note that plate is not cut off in area under the hinge bracket (the T-shaped part of the plate). Deburr and smooth up the cut with a file.

Installation of the Foundation Plate (Cont'd.)

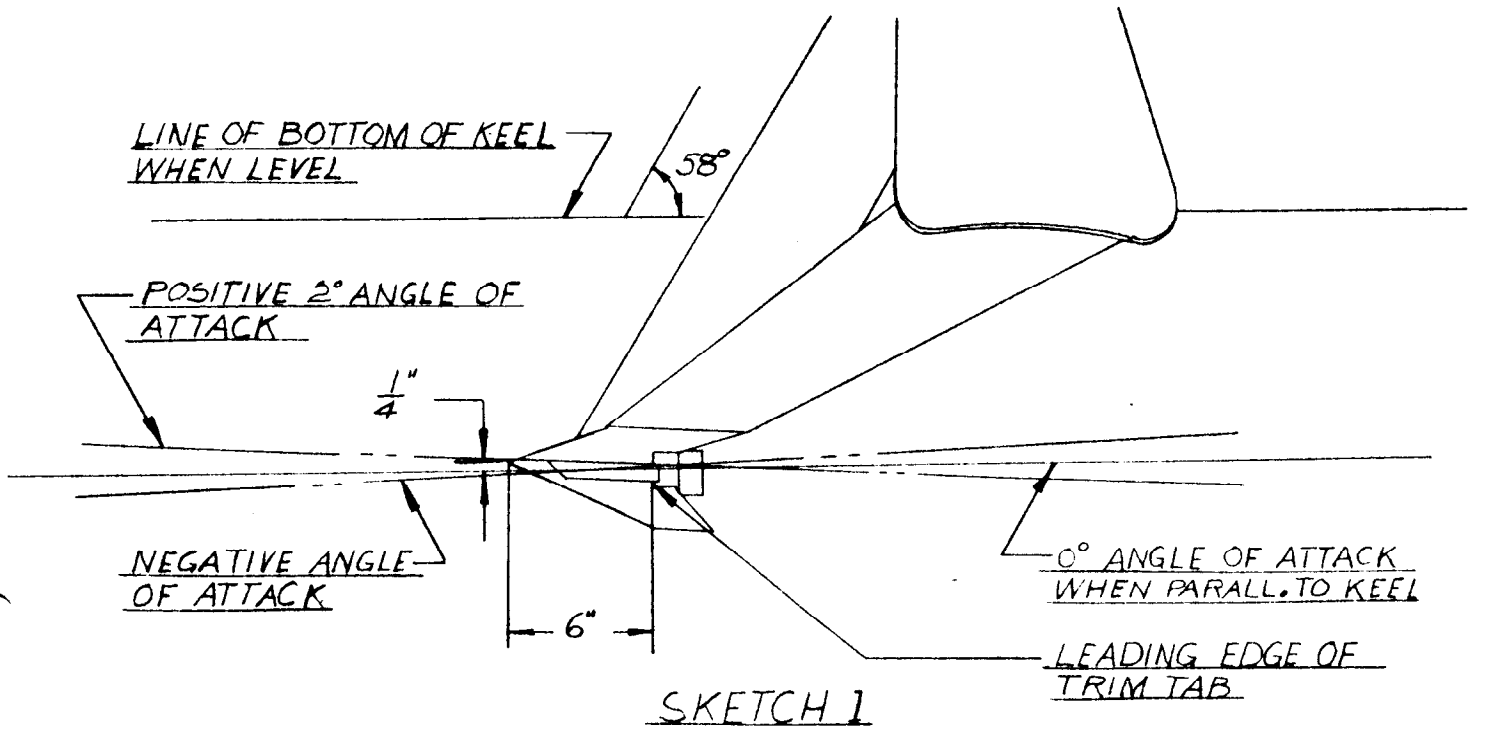
5. Check plate against gunwales to see that all fastenings for the hinge bracket can be inserted and bolted up after the plate is on. If there is interference, the bolts must be put in position before fastening down the plate. Notch out the gunwale where required.
6. Fit insert and plate into position. Through drill gunwale 1/4" for screws. Bolt plate to gunwale with machine screws, shimming as required to hold plate fore and aft. Bolt the beam to the insert. Check that the leading edge of the plate is at 58° to the top of the beam in a fore and aft direction and that the plate is at a right angle to the end of the beam.
7. Bolt the hinge bracket to the plate temporarily with a bolt at each end. Insert hinge pin, part no. A70F10038-1, through bracket. Sight down along side of hinge pin to face of the locking catch face. These two lines should be parallel. If they are not, then the foundation plate shim must be changed to bring the hinge pin parallel to the locking catch face.
8. Remove the hinge pin and position the main foil strut in the bracket and reinsert the hinge pin. Lower the strut into the running position and check that the locking catch shear pin in the strut will enter the bushing in the locking catch. If it will not, loosen the bracket bolts and reposition the bracket so that the pin will go into the hole, and that the strut will lock. Tighten the bracket bolts. Unlock and relock the strut, then check the operation. See that the shear pin enters its hole and that the side of the strut fits flush to the face of the locking bar. Rounding the shear pin and chamfering the bushing in the pin hole will help the pin to enter the hole.
9. Remove the strut from the bracket and install the rest of the bracket bolts. When main foil is assembled, install it in the bracket. Recheck the locking action. Bend the locking spring as required to insure that it will latch over the handle and hold it securely in the lock position. Correct fit of the locking spring is very important, to prevent the foil from unlocking and shearing off while running.

Procedure for Checking Main Foil Alignment

Because hydrofoils are moving at such high speed relative to the water, it is very important that the alignment of the foils to each other and to the boat be quite accurate. Although the trim tabs will overcome some misalignment, the less there is of it the better the performance will be from the installation.

Procedure for Checking Main Foil Alignment (Cont'd.)

The angle of attack of the leading edge of the main foils should be the same within one degree, and should be 2° positive.



SKETCH 1

To check this, first check that the keel of the boat is level on the jig, then lower the foils to the running position and lock them. Check that the struts are in a vertical plane by holding a level against the side of the upper struts. The best method to check the angle of attack is with a bevel protractor equipped with a level. Hold the protractor up under the bottom of the foil alongside the fairing piece in a fore and aft direction. The instrument will give a direct reading of the angle of attack that the foil makes with the horizontal.

An ordinary level can also be used. Hold the level up under the bottom of the foil in a fore and aft direction, beside the fairing piece and touching the leading edge of the trim tab. The top of the level should be held level athwartship. Thus the level will touch the bottom of the foil at one point at the tab. Since the distance from the tab to the tip of the foil is six inches, this tip should be 1/4 inch above the top of the level if the foil has its correct 2° angle of attack. A wedge made six inches long and 1/4 inch high placed on the top of the level would greatly help taking this measurement as the level and wedge could then be held against the bottom of the foil for a more accurate reading.

Procedure for Checking Main Foil Alignment (Cont'd.)

If there is a difference between the foils, or if the angles of attack are less than 1° (1/8 inch above the level) the foils will have to be adjusted to correct alignment. The closer that the 2° can be held the better the performance of the foil system.

To correct the angle of attack of the foils, loosen the hinge bracket bolts on the foil that is out of line. Since there is a small amount of play in the bolt holes, rotate the bracket in position to make the angle 2°. Tighten two bolts to hold the bracket and check the foil with the level. If this does not bring the foil into position, then the bracket will have to be moved on the foundation plate.

Remove the bolts from the bracket. With the lock shear pin in its hole and the locking handle locked, move the strut with the bracket attached until the foil angle is correct. Clamp the bracket to the plate and redrill the bolt holes into the plate. Since this will probably elongate the existing holes in the foundation plate, drill two of the holes in the flat part of the bracket as new holes, through the bracket and the plate to keep the bracket from shifting. Rebolt the bracket to the plate. Check that the foil angle is still correct and that the foil will lock and unlock.

Safety Features

A safety strap must be secured to each main foil and the transom to retrieve the foil in the event of a shear-off. This strap should be made of at least 1 x 19 wire 1/8" diameter shackled to the main foil strut and a strong eye in the transom. A hole is provided in the strut for the shackle.

Whenever the main foils are retracted, they should be secured together with a line or a bungee fitting hooked to the locking handles.

Some motors will require a splash shield around the motor shaft or on the transom to prevent spray running up the motor strut and over the transom into the boat. These can be made from sheet aluminum and bolted in position.

Each time the boat is to be run, check that all fastenings in the foil system are tight. Pay particular note to the bolts securing the locking handles to the main struts and to the fit of the locking catch.

Do not attempt to run without the locking handle shear pin functioning properly. This pin serves the very important purpose of taking out fore and aft motion in the whole foil mounting and helps to support the load of

Safety Features (Cont'd.)

the boat on the foils. Without the pin in place, sudden reverse loads on the foil such as occur when the boat drops off the foils in rough water can cause the handle to unlock and shear off the foil.

Radical maneuvers of the boat on foils can impart sever loads on the motor mount. It is suggested that strong transom plates be used to prevent the motor clamps from shifting on the transom. An alternative is to screw a short piece of angle to the transom above the motor clamp location to prevent the clamps from slipping up.

A pitot tube is installed in the right hand tail strut. Running a rubber tube from the pitot tube to the speedometer will enable speed readings to be taken while foil-borne.

HYDROFOIL OPERATION

Introduction

Sea Wings as the name implies are wings similar to those of an airplane, except the medium is water instead of air. Sea Wings are designed to balance the total weight of the boat between the two main foils and the tail foil. Properly adjusted, the main foils carry between two thirds and three quarters of the load while the tail foil carries the remainder.

As in an airplane lift is achieved by pressure differentials caused by the flow of water over the foil surfaces as the foils are driven through the water. As the lift is controlled by the speed of the foils through the water the boat must be powered by an outboard motor sufficiently powerful to quickly accelerate the boat and hold it at speed when running. Motors in the 35-40 hp range with high thrust propellers are the recommended size. Lighter motors can be used but at a sacrifice of carrying capacity, speed and maneuverability. Larger motors will not necessarily improve performance and may over-power the boat and foils.

The Sea Wings will lift the hull clear of the water at between 15 and 20 mph. Normal operating speed range will be from 34 to 38 mph depending on load, sea state and trim of boat. Since these foils are designed to cavitate and lose lift at about 40 to 42 mph this is the maximum that they can be driven.

The main foils are of the surface piercing type; that is, the tips pierce the water surface and are mounted at a fixed angle of incidence to the hull. This type has two variables affecting the resultant lift of the foils at

Introduction (Cont'd.)

a given speed: (a) foil area - area varies with the amount of foil protruding from the surface of the water; (b) angle of attack with the water flow.

The tail foil is a fully submerged type with a variable angle of incidence to the hull. This type has a constant lifting area and the resultant lift at a given speed will vary with its angle of attack to the water flow.

When the boat is at rest in the water, the main foils are completely submerged. As the speed is increased, lift from the main foils begins lifting the bow of the boat faster than the stern, producing a sufficient angle of attack for take-off. As forward speed is increased, the tail foil produces sufficient lift to overcome hull suction and the hull clears the water. At this point the drag of the hull is removed and the boat rapidly accelerates.

Lift on the main foils is determined not only by the speed of the foils through the water but also by their angle of attack to the water flow. Since the main foils are fixed to the hull the trim of the boat as determined by the angle of incidence of the tail foil will control the angle of attack of the main foils. With the correct tail setting and forward speed the boat will rise off the water. As the hull clears and speed increases with the reduction of drag the upper part of the main foils come out of the water thus reducing the lifting area of the main foils. At some point between 7 and 10 inches above the water the lift on the main foils plus that on the tail foil balances the weight of the boat, and the boat will continue to ride at this height. The boat at this time should be running with the bow about 2 or 3 degrees of trim angle higher than the stern.

There are two basic adjustments for the Sea Wings Hydrofoil:

1. Tail foil incidence angle to the hull which is accomplished by lengthening or shortening the vertical tube on tail foil assembly.
2. Trim tab position on the main foils to increase or decrease of these foils.

Before starting the adjustment of the Sea Wings position the motor angle adjustment in the notch nearest to the transom. This keeps the bow from being forced up by the motor and stalling the main foils with too steep an angle of attack.

Tail Foil Incidence Adjustment

1. Check both adjustable tail struts for initial adjustment so that leading and trailing edge of tail foil are level, or leading edge slightly lower than trailing edge.
2. Check position of both main foil tabs for mid point, tab trailing parallel to bottom surface of foil. Tab control levers should be at right angles to strut.
3. The following tail foil adjustment operation must be accomplished in CALM water, as rough water makes refinement of this adjustment very difficult.
4. Tail foil adjustment runs should always be made with 2 adults in forward seat of boat.
5. Proceed slowly to calm area suitable for hydrofoil operation. Advance throttle all the way and as the boat accelerates, the hull should clear the water (take-off) at approximately 15 to 20 mph. Throttle back after take-off to limit speed to 25 mph. If the water is calm, the boat will remain foil borne without intermittent dropping off up to about 28 mph. Above this speed, the boat may tend to ride too high and will intermittently drop in because of inadequate immersion of the main foils. This condition is corrected when main foil tabs are adjusted, covered later in the tab adjustment sequence.
6. If the boat will not take off with tail foil strut adjustment stated in item 1 and main foil tab adjustment of item 2, above, decrease the length of both tail struts (turn clevis fitting clockwise) one complete turn and rerun the boat. Continue to shorten length of tubes, until boat does take off. Check foil operation at 28 mph - Boat should remain foil-borne in calm water at this speed.
7. On the other hand, if with the adjustments noted in parts 1 and 2 the boat takes off, but with a high trim angle (bow riding high above stern) and it will not remain foil borne in calm water at 28 mph, increase the length of both tail struts (turn clevis fitting counter clockwise) 1/2 turn and rerun the boat to check foil operation at 28 mph. Continue to increase the length of the tube 1/2 turn at a time until boat remains foil-borne and bow is riding about 3 or 4 degrees higher than the stern.

Main Foil Tab Adjustment

The purpose of the main foil trim tabs is to provide a means of increasing or decreasing lift from the main foils to regulate the amount of main foil immersion at high speed.

Main Foil Tab Adjustment (Cont'd.)

Having established a good tail foil adjustment for take-off at speeds below 28 mph in calm water, the trim tabs may now be adjusted for best high speed performance. This is best done with two persons of approximately equal weight in the forward seat.

NOTE: The terms "UP" and "DOWN" used in the following procedure refer to the direction of the tabs when the main foils are down in the running position. Movement of the trim tab control lever down raises the trailing edge of the trim tab and decreases lift of the foil. Raising the control lever lowers the trim tab and increases lift.

Starting with the control levers at right angles to the strut so that the trim tabs are parallel to the bottom of the foil, run the boat at full throttle. Observe the position of the water line on the main foil. Raise or lower the control levers so that the water line is about two inches above the bend line in the main foil. This is the best water line to run at in smooth water. For best rough water operation, lower the control levers so that the water line is about two inches below the tip of the diagonal foil. This will increase the water drag on the boat and slow it some, but it will give a smoother ride. The boat can be run in rough water at a high water line, but the foils will come out of the water as they pass through the waves and, since the lift comes from the top of the foils as with an airplane wing, lift will be lost and the boat will have to immerse the foils sufficiently to recover its lift. Thus the ride will not be as smooth as when the boat is trimmed to run to keep the foils covered at all times. Of course, running at a slower speed in rough water will also keep the foils covered as with the slower speed lift will be reduced and more foil area will be required in the water to support the the boat.

The important thing to remember about the trim tabs is that they will increase or decrease the lift of the main foils. They can and should be adjusted as operating conditions warrant, to give the kind of ride desired. Experimentation with their action with the boat under various load conditions and various sea conditions will demonstrate the best way to position them for any combination of the two.

Rules for Trimming the Boat

The secret of getting the best performance from your Sea Wings is to understand how best to trim the boat for any particular set of operating conditions. Do not feel that once adjustment has been made, that it should not be changed even though the boat may not appear to be doing its best.

Rules for Trimming the Boat (Cont'd.)

Only by experimenting with various combinations of tail and trim tab fittings will you have an idea of what or what not to do.

The most important adjustment is that of trim as established by the angle of incidence of the tail foil. Since the main foils are fixed to the foundations and cannot be moved, their angle of incidence to the flow of water past them is controlled by the trim of the boat. Since the lift of the main foils is derived from their angle to the flow of water, it is very important that the angle be correct. Since the trim of the boat is controlled by the tail setting, it is important that the tail must be properly adjusted to obtain the best lift from the main foils.

If the trim of the tail foil is too flat, it will raise the stern of the boat before the main foils have had a chance to build up lift and the boat will be held onto the surface of the water. If the tail foil is trimmed so that the leading edge of the foil is too far below the trailing edge, (Negative trim), the boat's stern will be pulled down. This in turn will greatly increase the lift of the main foils and the boat will come up quickly at the bow, but the stern will not get off the water. The forward foils will then begin to stall just as an airplane that is put into too steep a climb, and it will fall off first to one side and then to the other. Somewhere between these two extremes lies the correct trim for the tail foil, and it lies about where the bow is 3 or 4 degrees above the stern. Once this trim is found, it will probably be satisfactory for most loads. If a heavy load is to be carried, it may be necessary to increase the trim angle by screwing in on the rod ends a turn to increase lift. Also, pull up on the tab control levers to add as much lift as possible from the trim tabs. Note that in making any adjustments on the tail, do it by either a half or at most one whole turn at a time. This adjustment is a very sensitive one and it is very easy to over-correct.

Also important to trim is the correct placement of weights in the boat. Do not stow heavy weights in the bow or stern. Keep them around the middle of the boat. In carrying passengers, experiment with seating in front and on the middle seat. Three in front or two in front and one in the middle will work. Two and two should work. But, if all the weight is put on the middle seat or if too much weight is allowed too far aft the boat will not get up on the foils.

Remember that the Sea Wings have been designed to carry a maximum of 1400 pounds. If the boat is over-loaded, it will not be able to lift itself onto its foils. Therefore, the lighter it can be kept, the more payload it can carry.

Rules for Trimming the Boat (Cont'd.)

If sea weed builds up on the foils or motor strut, it will increase the drag on the foils and so slow up the boat so that it will not stay foil-borne. It will also prevent take-off. To clear weed, back down a few yards and it will float clear so that operation can be resumed.

Handling Sea Wings

Smooth water operation differs from that of conventional runabouts only in the turns. Foil boats have very little bank angle and no skid. Thus, they turn like automobiles. Build up sharp turn experience slowly so that you will be used to the centrifugal forces that can be developed in a tight turn. It is very important to warn passengers who are riding for the first time of this flat turn characteristic so that they will expect it. With practice, you will find that a slight reduction of throttle from high speed setting just prior to initiating the turn will start the boat into the desired turn more easily, at which point the throttle may be advanced to maintain the desired speed in the turn. Remember that a tight turn builds up drag quickly and the boat may not be able to stay completely foil-borne until speed is allowed to increase at the end of the turn.

Rough water operation requires the selection of the best depth setting of the trim tabs for the smoothest ride. In very rough water, running at reduced throttle is recommended even though the hull may be occasionally on the water. Even at 15 mph the foils are giving lift which keeps the boat from pitching and rolling. It is normal that the foils will operate best when going into a rough sea rather than with it. This is because in running with the sea relative motion between the waves and the foils is reduced and therefore so is lift. Thus the boat may occasionally come down off the foils, but will immediately pick up again. Speed selection in a rough following sea must be made to give the most comfortable ride. In crossing large boat wakes, you should have no problem with those coming toward you, but care should be taken with those going in your direction, as lift can be lost quite suddenly in these short, sharp waves.

The tail struts present a large vertical area in the water when the boat is hull-borne and poor maneuverability will result if both main foils are retracted with the tail foil immersed. When pulling up to a dock or another boat, retract only that foil adjacent to the dock or boat. For the same reason, always lower the outboard main foil when pulling away from a dock or boat.

As the foils are not treated with anti-fouling paint, (but are salt water protected) they should be stowed in the retracted position when the boat is moored for two hours or more.

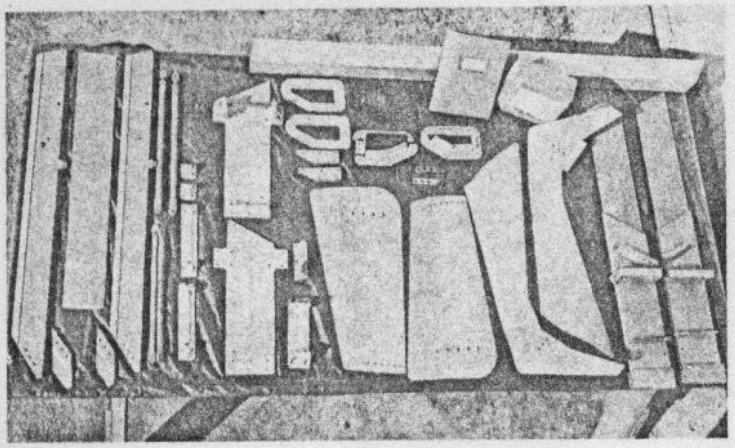
Handling Sea Wings (Cont'd.)

The Sea Wings-equipped boat draws more water than the conventional runabout and the problem of running aground is a serious one. While the design of Sea Wings incorporates shear pins in both the main and tail foils, serious damage to hull and foils may result from running aground. USE CAUTION!! Know the depth of the water where you plan to operate and if any doubt exists, retract the foils and operate on the hull. A minimum of 2 1/2 feet of water is required for safe operation.

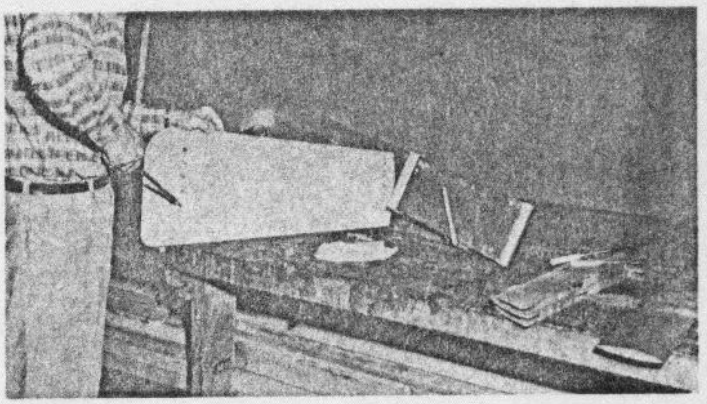
While operating Sea Wings, keep a sharp lookout for objects in the water as contact with large enough objects will shear off the foils. The action of shearing off either one or both main foils is not a dangerous one. As the foil is sheared, the boat drops down onto the water on that side, maintaining its course all the while. Throttling back stops the boat normally. The foil is caught in the safety wire and is retrieved for reinstallation with new shear pins. The tail foil will not separate from the boat if its pins are sheared. It will partially retract.

It is recommended that shear pin replacement be performed on the beach or dock by driving out the old pins and inserting new ones. Use cotter pins to safety them in place. Use only shear pins furnished by Dynamic Developments for replacement.

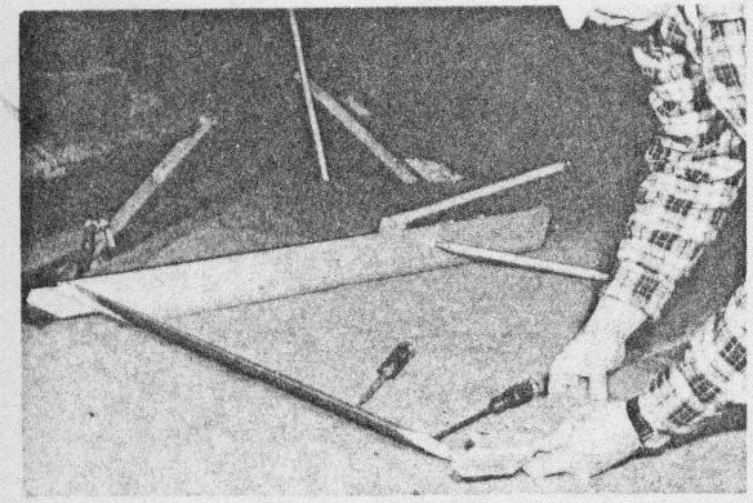
Operating the Sea Wings equipped boat improves with practice, as understanding of the interaction of trim, speed and weight distribution grows. It does not take long before you will be able to realize the full capabilities of your boat and the additional pleasure that your Sea Wings have brought to your boating activities.



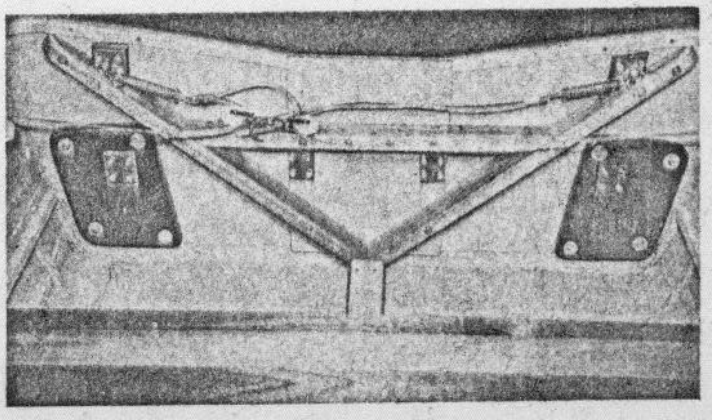
Parts for Model A 70 Sea Wings Hydrofoil Kit



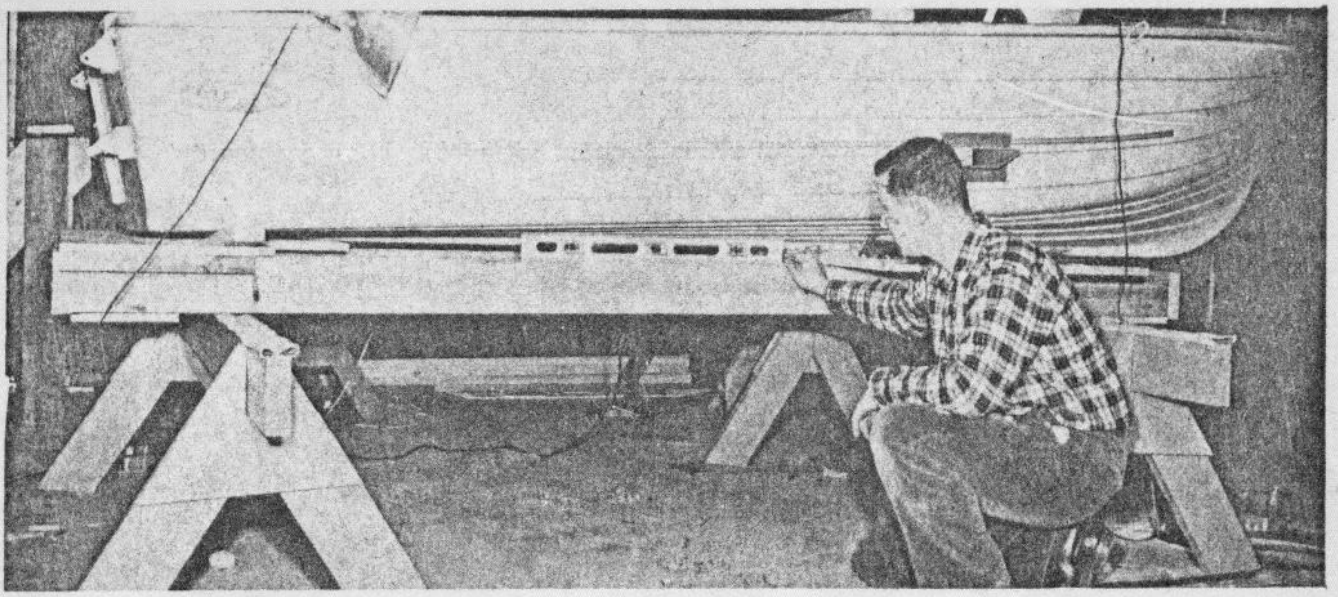
Assembling main foil. Bolt diagonal foil to strut before attaching main foil element.



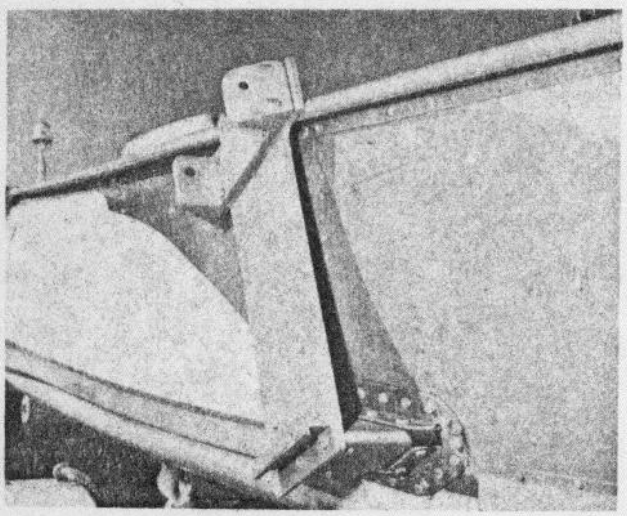
Assembling tail foil.



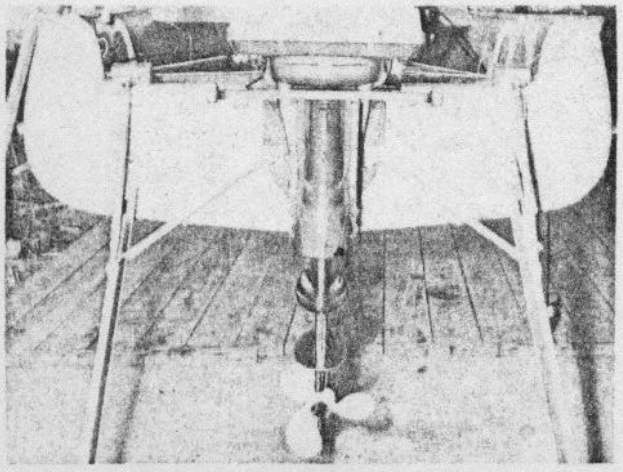
Typical wooden doublers to reinforce hull in the way of attaching bolts. Use for both main beam and tail fitting bolts.



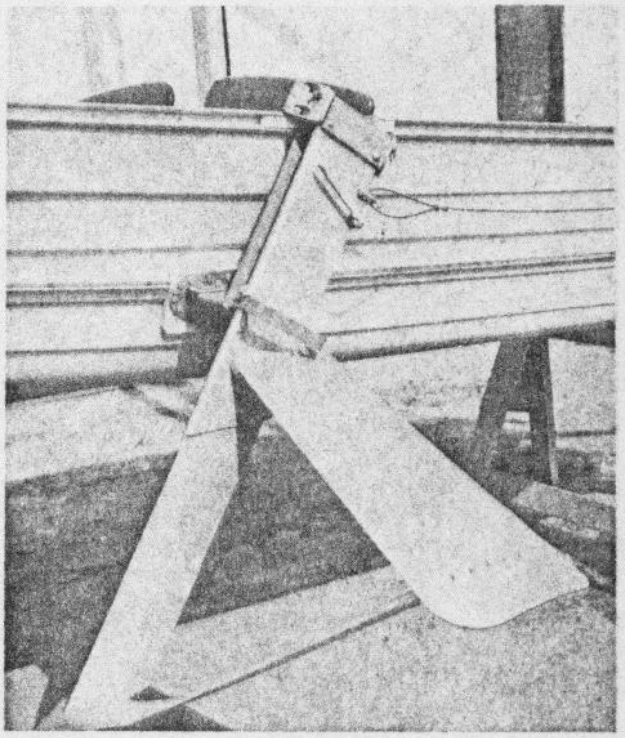
Boat on building jig. Keep surfaces level for and aft and athwartship. Level boat athwartship and block securely to prevent shifting.



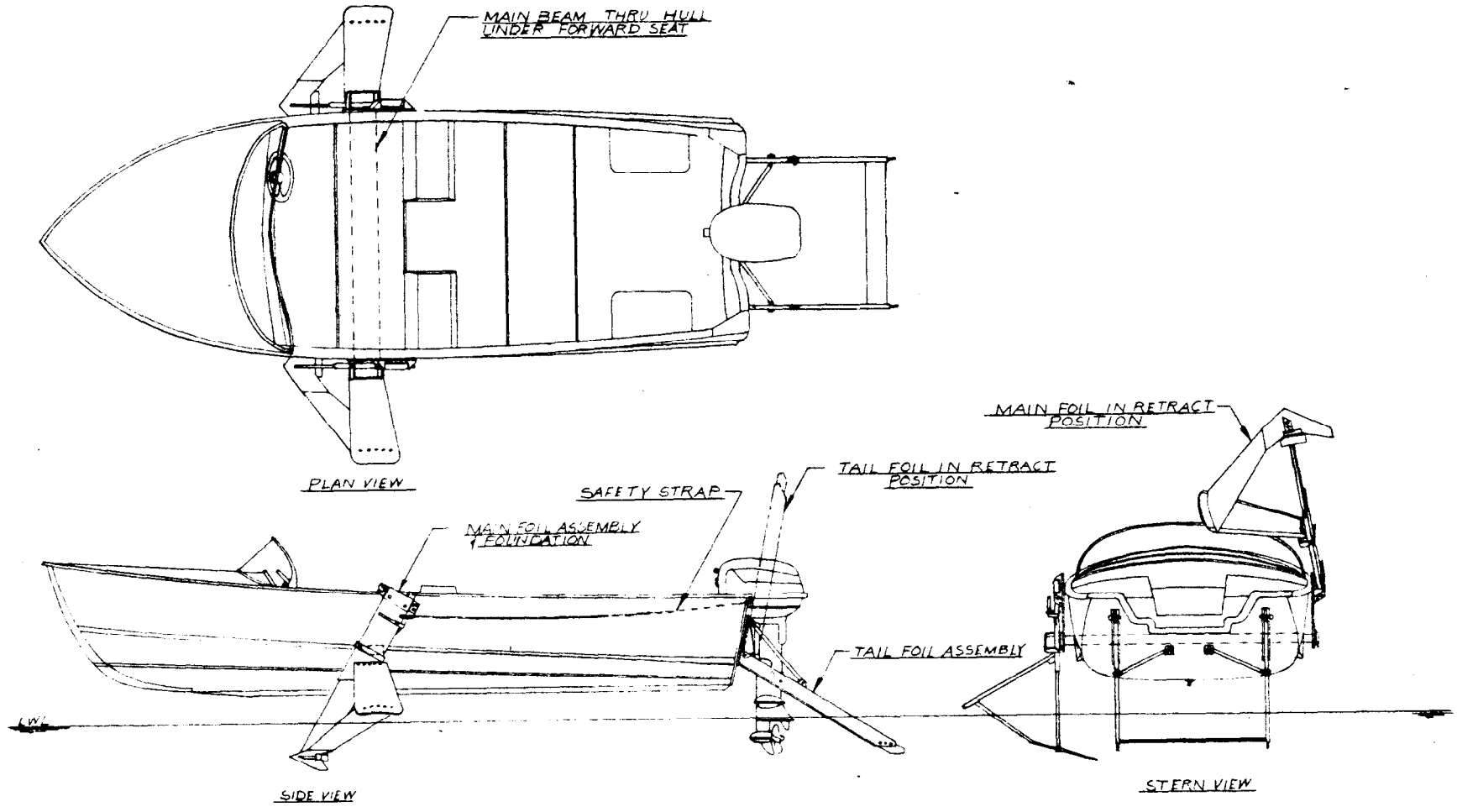
Detail of main foil foundations. Note single row of bolts for aluminum hull. Position of parts is determined by position of main beam in hull.



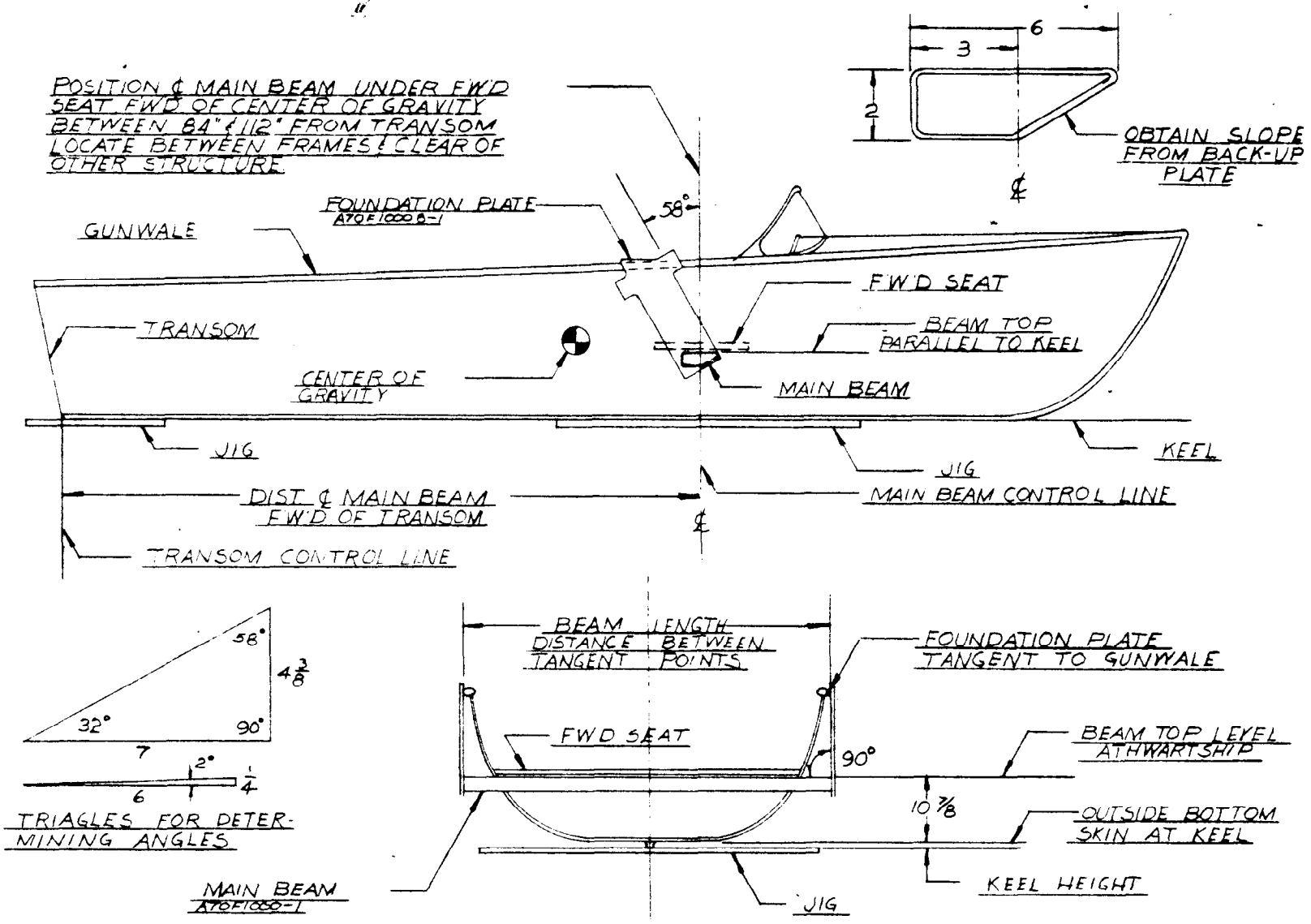
Detail of tail installation. Note transom cut down to 14" at motor slot. Note block behind tail strut fitting attached to transom to support top of fitting.



Detail of main foil installation. Note safety strap attached to foil and transom; doubler around main beam on lapstrake hull; shim at gunwale to support foundation plate parallel to keel; positive locked position of handle locking catch.

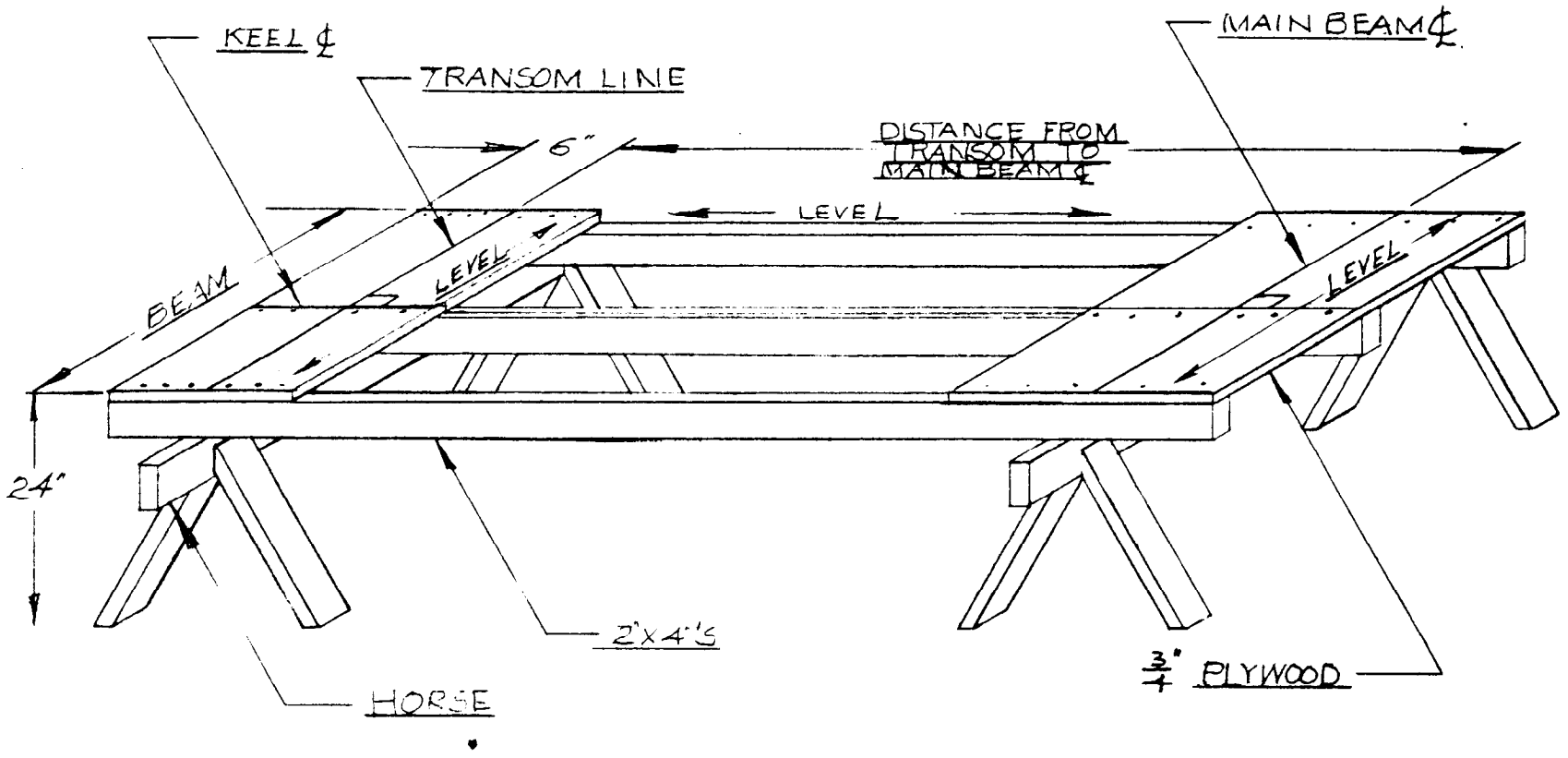


SEA WINGS HYDROFOIL KIT INSTALLATION
MODEL ATO
DYNAMIC DEVELOPMENTS, INC.
FIGURE 1



LOCATION & LENGTH OF MAIN BEAM

FIG. 2



INSTALLATION JIG

1. MAKE WIDTH EQUAL TO BEAM AMIDSHIPS OR SLIGHTLY LESS TO PERMIT LOWERING FOILS ON JIG FOR FITTING
2. MAKE OVERALL LENGTH AT LEAST 1 FOOT LONGER THAN DISTANCE BETWEEN TRANSOM AND MAIN BEAM ℄
3. MAKE PLYWOOD SURFACES A CONVENIENT SIZE TO GIVE STIFFNESS TO JIG AND PROVIDE WORKING AREA AROUND CONTROL LINES

FIGURE 3

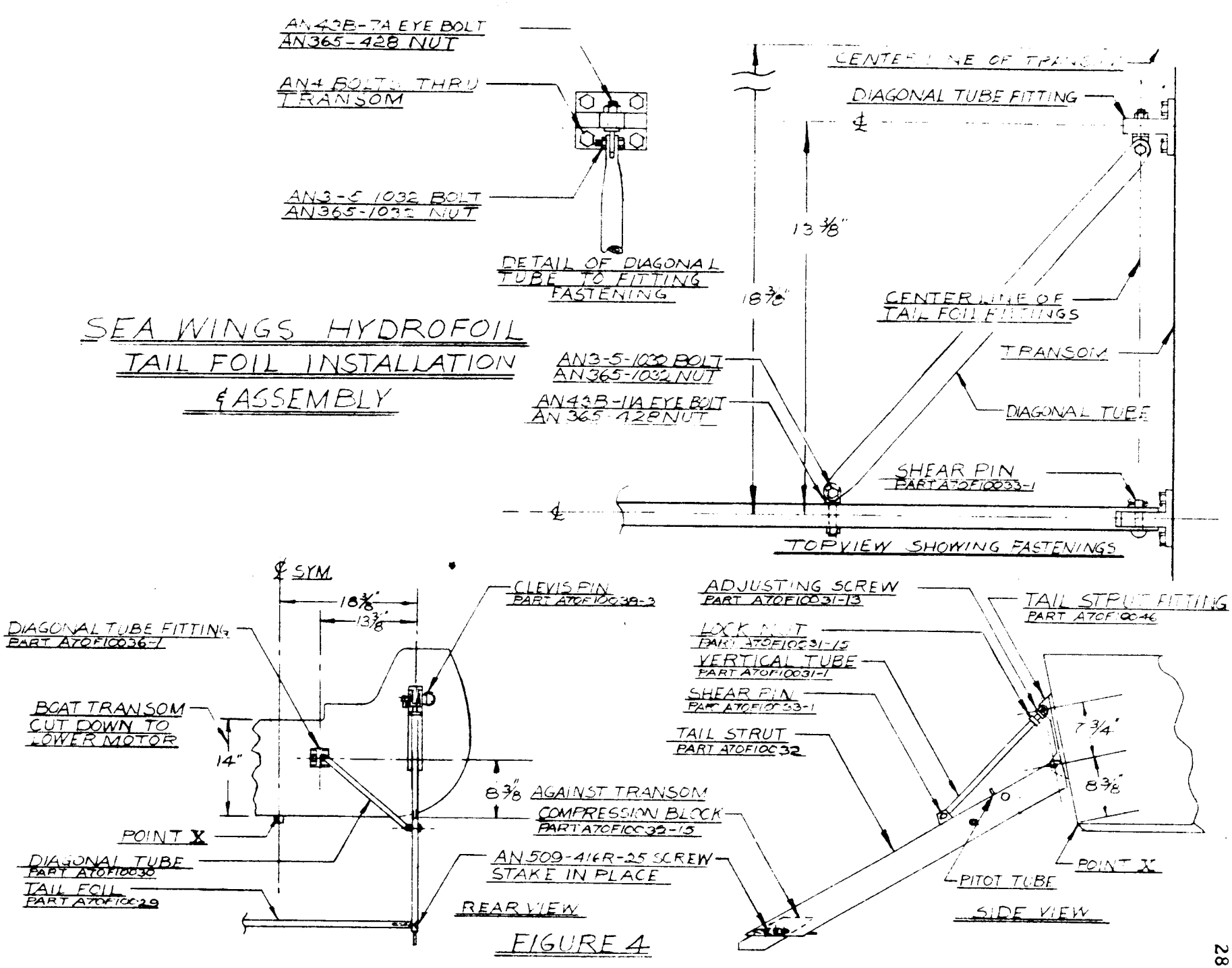
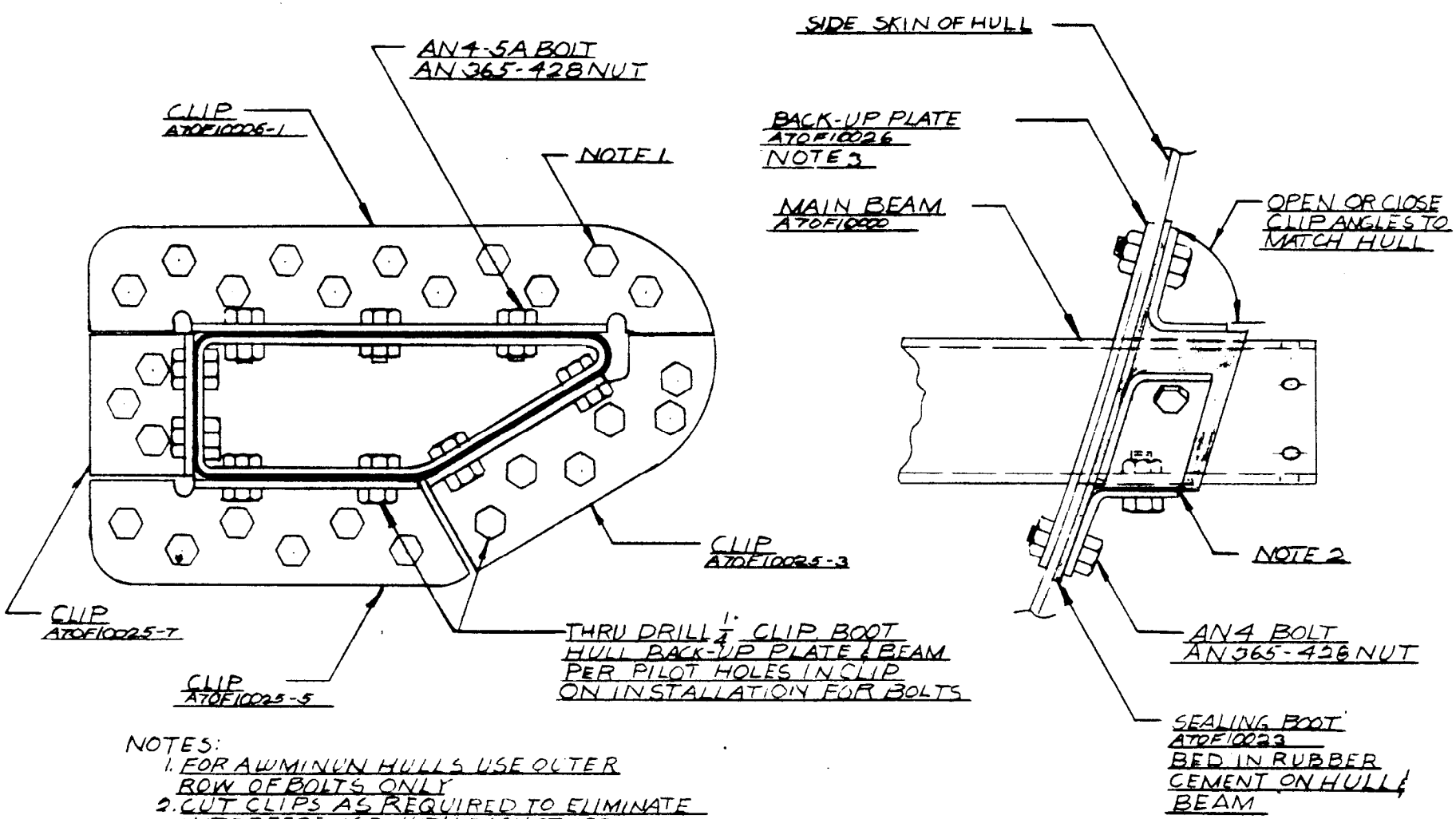

AN4B-7A EYE BOLT
AN365-428 NUT
AN4 BOLTS THRU TRANSOM
AN3-5 1032 BOLT
AN365-1032 NUT
DETAIL OF DIAGONAL TUBE TO FITTING FASTENING
SEA WINGS HYDROFOIL
TAIL FOIL INSTALLATION
& ASSEMBLY
CENTER LINE OF TRANSOM
DIAGONAL TUBE FITTING
13 3/8"
18 3/8"
CENTER LINE OF TAIL FOIL FITTINGS
AN3-5-1032 BOLT
AN365-1032 NUT
AN4B-11A EYE BOLT
AN365-428 NUT
TRANSOM
DIAGONAL TUBE
SHEAR PIN
PART A70F10033-1
TOP VIEW SHOWING FASTENINGS
℄ SYM
18 3/8"
13 3/8"
CLEVIS PIN
PART A70F10039-3
DIAGONAL TUBE FITTING
PART A70F10036-1
BOAT TRANSOM CUT DOWN TO LOWER MOTOR
14"
8 3/8" AGAINST TRANSOM
COMPRESSION BLOCK
PART A70F10032-13
POINT X
DIAGONAL TUBE
PART A70F10030
TAIL FOIL
PART A70F10029
AN509-416R-25 SCREW
STAKE IN PLACE
REAR VIEW
ADJUSTING SCREW
PART A70F10031-13
TAIL STRUT FITTING
PART A70F10046
LOCK NUT
PART A70F10031-15
VERTICAL TUBE
PART A70F10031-1
SHEAR PIN
PART A70F10033-1
TAIL STRUT
PART A70F10032
7 3/4"
8 3/8"
POINT X
PITOT TUBE
SIDE VIEW

FIGURE 4

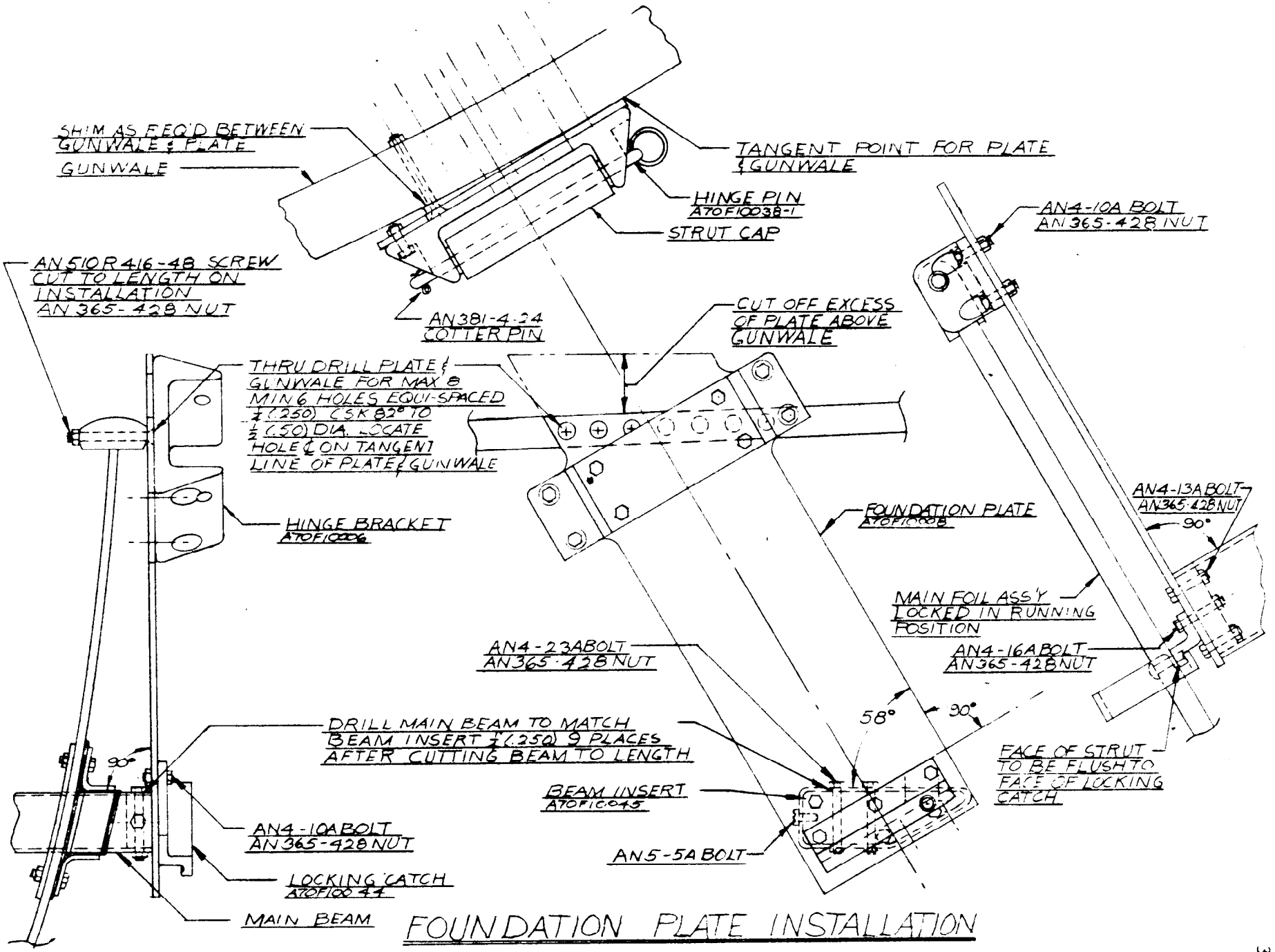


NOTES:

1. FOR ALUMINUM HULLS USE OUTER ROW OF BOLTS ONLY
2. CUT CLIPS AS REQUIRED TO ELIMINATE INTERFERENCE WITH EACH OTHER
3. FOR LIGHT HULLS SUCH AS MOLDED PLYWOOD OR FIBERGLASS INSTALL DOUBLER BETWEEN HULL & BACK-UP PLATE.

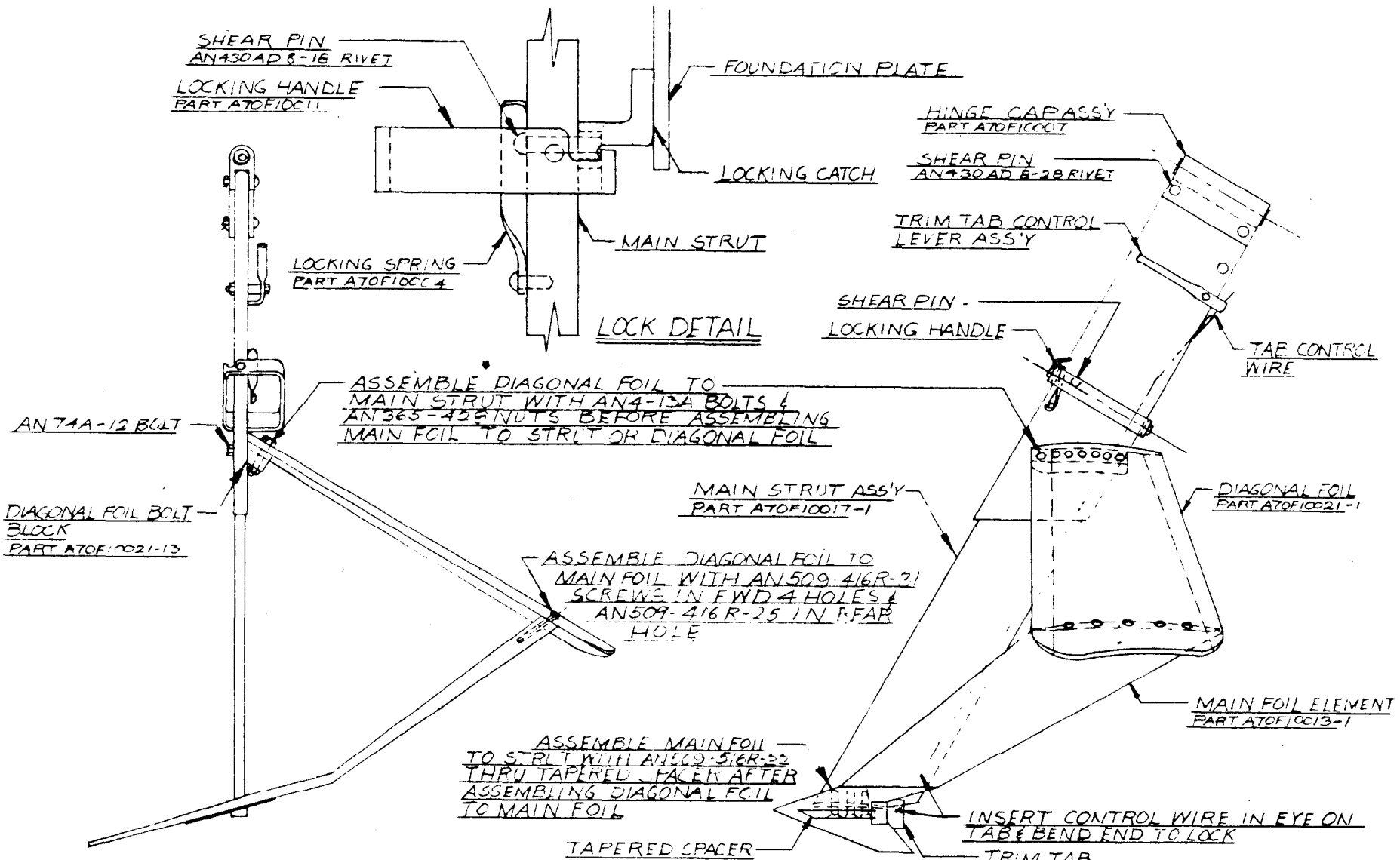
MAIN BEAM SEAL INSTALLATION

FIGURE 5



FOUNDATION PLATE INSTALLATION

FIGURE 6



MAIN FOIL ASSEMBLY

FIGURE 7

From: "Bishop, Bob J. (Corporate)" <BISHOBO@mail.northgrum.com>
To: "'Barney C. Black'" <webmaster@foils.org>
Cc: president@foils.org, treasurer@foils.org
Subject: RE: Permission to Reprint Historical Document
Date: Thu, 20 Feb 2003 13:48:09 -0800
X-Mailer: Internet Mail Service (5.5.2653.19)
X-OriginalArrivalTime: 20 Feb 2003 21:48:23.0863 (UTC) FILETIME=[CAC59C70:01C2D929]

You have Northrop Grumman's permission to reprint the historical documents listed below. Please let me know if there's anything else I can help with.

Bob Bishop
Manager, Corporate Public Information
Northrop Grumman Corporation
(310) 201-3458

-----Original Message-----
From: Barney C. Black [mailto:webmaster@foils.org]
Sent: Sunday, February 16, 2003 11:14 AM
To: Bishop, Bob J. (Corporate)
Cc: president@foils.org; treasurer@foils.org
Subject: Permission to Reprint Historical Document

Hello, Mr. Bishop:

I am seeking permission on behalf of the International Hydrofoil Society (IHS) to reprint two historical documents produced in the late 1950s and 1960s, copies of which I have at hand:

- *Manual for the Installation and Operation of the Dynamic Developments, Inc. Model A70 Sea Wings Hydrofoil Kit*, June 1959 (Revised Dec 1959) by Dynamic Developments, Inc. of Babylon, L.I., NY, affiliate of Grumman Aircraft Engineering Corp.

- *Development and Testing of Fully Submerged Hydrofoils with Drag Vane Control Installed on 15-ft Runabouts*, by Robert C. Muncie, Report No. 63-13-M- (M-20)(R) of 25 April 1963. "The program described herein was funded by the Grumman Aircraft Engineering Corp, and was performed between July 1962 and March 1963 from the Grumman Barge Facility at Jakobson's Shipyard, Oyster Bay, Long Island, NY."

I am also interested in finding other technical reports and historical documents related to the 15-ft hydrofoil runabout and hydrofoil kit. I don't know if there is an historical archive for such material, but if so I would like to contact that office. There is interest in this particular Grumman project from individuals who have obtained and want to restore these boats, from hobbyists who want to add hydrofoils to their pleasure craft, and from various technical professionals who work with Advanced Marine Vehicles and are interested in their history.

IHS is making available on CD-ROM historical technical documents related to Advanced Marine Vehicles (AMVs). Many, but not all of these documents were produced in various US Navy AMV development projects. The first such CD-ROM, released about a year ago, contains 58 documents and sells for $5.00, including shipping and handling worldwide, or free to libraries. We anticipate releasing a second CD-ROM of documents shortly. Information about the first CD-ROM is available on our website at http://www.foils.org

IHS is an all volunteer, not-for-profit organization of and for people who design, build, operate, or simply are interested in commercial, military, research, or recreational hydrofoils of any size... power, human power, or sail.

I picked your name off the NG website as a point of contact, so if this request needs to go to someone other than yourself, please forward it! If you would like to discuss by phone, please call me during business hours at 571-218-3250; I am in the Systems Integration Project Office established by Integrated Coast Guard Systems (ICGS) in Arlington VA (NG Ship Systems is one of the ICGS joint venture partners). My "real job" when I am not doing volunteer work as the IHS webmaster is as a Coast Guard civilian assigned to the Deepwater Project.

Sincerely yours,
Barney C. Black

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IHS Needs YOU!
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