

The Houlton Boat Company

To The Amateur Builder

January, 1979

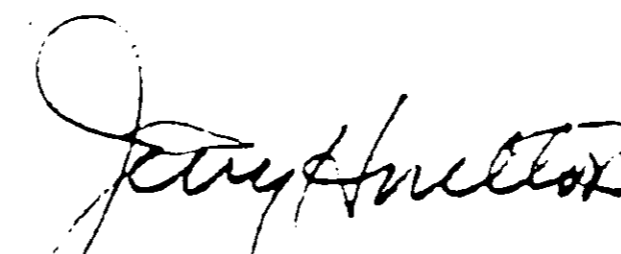
My experience in the Tornado class started in 1971 when I purchased a new fiberglass Tornado. I had sailed an old B-Lion for 3 years and as soon as I saw my first Tornado I had to have one.

When I decided to replace the glass boat, it seemed like a good idea to build a wood Tornado. I had seen some of the California "Woodies" and they were good-looking, strong, and fast.

I ordered a set of plans from England and after a careful review, I started asking questions of Tornado Sailors that had built their own boats. I found that many new construction ideas were being used that had not been formally written up. That's when these new construction notes actually began to take shape. There is nothing in the notes and plans that hasn't been tried and tested. The first draft copies were widely distributed and comments were sought to improve and clarify everything. Professional builders, amateur builders, and knowledgeable sailors all had good comments to add and these have been included.

If each amateur builder that uses these notes will take the time to write or call and offer his suggestions and ideas, these notes can be maintained and kept up to date. Every amateur will have worthwhile suggestions to make the boat stronger, or easier, or less expensive and others can benefit from these suggestions.

Good luck,


Jerry Houlton

6th Revision

Mailing Address: P.O. Box 966 • Oldsmar, Florida 33557, U.S.A. • 813/855-3435
Shipping Address: 13805 W. Hillsboro Avenue, Rt. 580 • Tampa, Florida 33603, U.S.A.

Recommendations for Building the Tornado

Introduction

These construction notes are written for the amateur to take advantage of the knowledge gained about the Tornado and about new construction techniques since the inception of the Tornado.

The notes are designed primarily with the idea that the amateur can build hulls as good as the professional if he is willing to take the time and care required.

From the original designers "introduction:"

"The performance of the boat is partly due to the low weight achieved by using the developed ply method of construction....Perfectly fair, round bilge hulls can be produced in a fraction of the time needed for fiberglass or cold moulded wood."

"The Tornado is basically a racing craft....As with any other class, no boat may take part in organized class racing unless it has a valid class measurement certificate. To obtain this the boat has to be measured by an Official Measurer to ensure that it conforms to the class rules...."

"The question of weight is very important, for if a boat is to be competitive its weight must be right down to the minimum allowed in the class rules. It is a common failing of amateur builders, especially with their first boat, to make too good a job and strengthen various parts unnecessarily....It is extraordinary how weight builds up when adding "a little extra" here and there.... Follow the instructions! If the boat comes out under weight, correctors can be fitted."

These plans will produce a boat approximately at minimum weight. One American Tornado sailor has estimated that every 10% of weight above the minimum costs 20 seconds per hour when racing in average winds.

The plans provide only two places where water could enter the hulls; at the inspection port on the rear deck, and at the removable bolt holes. A silicon sealant should be used when installing the removable beam bolts to avoid water coming into the hulls. Of course if permanent studs are used, there can be no leaks here. The boat will be air tight with the ports closed. Either a breathing hole must be provided in the hulls, or the inspection port covers must be kept loosely in the hulls whenever the boat is not being sailed, otherwise temperature variations may cause hull damage.

Adhesives, Epoxy and Fasteners

The WEST system^{Fil} of epoxy and adhesive additives (or other similar systems) is a major break-through for the Tornado class in building stiffer, stronger, and longer-lasting boats that are watertight and that will not absorb moisture. A major feature of the WEST system is the ability of the epoxy to penetrate into the wood and seal it. Fasteners are not required as part of the bonding process.

These construction notes have been written to take advantage of the WEST system. The Gougeon Bros. of Bay City, Michigan can provide information and materials.

Fiberglass Cloth

Fiberglass cloth use is more extensive in these construction notes than in the original plans. Sheathing the exterior of the hull with light-weight cloth offers advantages in improved abrasion-resistance and maintenance, and will not affect a natural finish if done properly.

Tools

The tools required are:

- A. Four "C" clamps with 3" throat, and 36 "C" clamps or spring clamps with 1" throat (the small clamps may be stationary clamps as available in many business offices)
- B. Thirteen (13) inner-tube rubber bands 2" in width
- C. Saber Saw
- D. Electric Drill
- E. High Speed Finishing Sander
- F. Block plane
- G. Several Sanding Blocks
- H. Protractor (Variable Angle)
- I. Router (optional) or wood chisel
- J. Staple gun
- K. The Scarffer (Gougeon Bros.)

Spars and Beams

Spars and beams are items that are beyond the talents of most amateurs. These items should be purchased. These plans were prepared using Sailcraft of Canada beams with two removable 3/8" bolts through the center of the main beam for each hull; the rear beam with one removable 3/8" bolt on the outboard side of each hull and two permanently mounted 3/8" bolts for the inboard bolt holders on each hull. Beams from any Tornado builder may be used. These same beams may be used with permanent studs instead of bolts provided that a beam strap is used on the inboard side of the main beam.

Rudders and Centerboards

It is recommended that rudders and centerboards be fiberglassed to improve abrasion resistance. They can be purchased and this is recommended until the amateur gains experience in this area.

Sails, Battens, and Trampoline

Many sailmakers recommend particular battens to be used with their sails. Most sailmakers also make trampolines.

Hull Fittings

The fore-stay tangs, shroud chainplates, trampoline tracks, rudder stocks, pintles and gudgeons can all be purchased from commercial sources or from a production Tornado builder.

Materials Recommendations for Hulls

<u>Sitka Spruce</u>	<u>Size</u>	<u>Length</u>	<u>Quan</u>
Gunwales	3/4"X3/4"	20'6"	4
Centerboard Trunk			
Front Inside Stringer	1 3/16"X5/8" } <i>3/4" X 30mm</i>	2'3"	2
Rear Inside Stringers	1 3/16"X5/8" }	2'5"	2
Bottom Outside Stringers	3/4"X1"	3'0"	4
Top Outside Stringers	3/4"X1 1/2" } <i>3/4</i>	3'0"	4
Beam Chocks	2 1/2" X 1 1/4"	12"	8

These are the only Spruce pieces needed if you purchase centerboards and rudders. Use good straight grain sitka spruce, at least for the gunwales. One piece 3/4" X 6" X 20'6" will provide for all the spruce needed.

Plywood

The only plywood recommended for hullsides is 4mm. Okoume gaboon mahogany with three equal plys. The quantity needed is 8 sheets, 4' X 8'. Two 4' X 32' scarfed sheets will provide the hullsides, decks, deck beams and deck stringers. The other two 4' X 8' sheets (which should be 3mm ply) will provide the centerboard trunks, bulkheads, and transoms. Some of the subassemblies are made up of double thick plywood. Scarfing of the ply is easily done using the SCARFFER tool supplied by the Gougeon Bros. along with their instruction booklet.

Copper

Soft copper wire 18 or 20 gauge, 60'

Expanded Close-cell Polystyrene

One piece - 5% moisture weight gain maximum, not dissolved by epoxy 4" thick 4' X 8'

Hull Fittings

Pintles and gudgeons (IYE rudder stocks)	1YE-2 each
4" circular screw-in port covers	RWO204-2
Rudder retainers	RWO76-2
Centerboard slot rubber <u>or</u> 4 mil. Mylar	HBC-2
Fore-stay tangs	RWO-230 (or equivalent)-2
Shroud chainplates	RWO-229 - 2
Beam bolt retainers (only if removeable beam bolts are used)	1/4" X 1 1/4" X 2"-tapped for 3/8" bolts-6
Main beam straps and studs	HBC

Fiberglass

3 or 4 oz. flat weave cloth	44-48" width - 20 yards
9 or 10 oz. flat weave cloth	36" width - 10 yards
9 oz. 3" glass tape	100'

WEST System - Gougeon

5 gal. Resin

1 gal. slow hardener (206)

4 bags - Microspheres

1 bag - Microfibers

1 can-small - Graphite powder

1 roller handle, 1 roller pan, 2 dozen roller covers

3 dozen glue brushes

1 pair - Super Mini pumps

1 box of mixing sticks, 1 large can of hand cleaner, 10 pair of disposable gloves, 2 spreaders.

WEST system manual, SCARFFER tool and instructions

Sandpaper

80, 160, 240, 400 grit wet and dry paper as needed. Recommend 3M or Addolox brand paper. Use 80 and 160 grit dry on bare wood, and 80, 240, and 400 grit wet on epoxied or painted surfaces.

Paint and Polyurethane

NOTE The hulls can be finished in natural wood, or be partly or completely painted. If you chose a natural finish, you will have to coat the exterior epoxy surface with polyurethane with a high ultra-violet screen to protect the epoxy.

The paint recommended is Dupont Imron. This paint comes in clear or color and is available from automotive supply sources. It may only be applied by spraying. When spraying is not possible, we recommend Z-Spar 1015 Captains Varnish for the clear and Z-Spar monopoxy for the color. The Dupont Imron seems to produce a better and longer lasting finish.

Suggestions about the WEST System

1. Read the instruction manual on the WEST system carefully.
2. Check the pumps regularly, the dispensing pump available from Gougeon works well and will save money if rented, as you will waste less epoxy. The ratio of resin to hardener is quite important.
3. For coating large surfaces use the rollers instead of a brush. The coats will be more even and less epoxy will be used. The rollers covers can be cut in half with a hacksaw.
4. Be sure to clean your hands every 10 minutes if they get epoxy on them. Use plastic gloves and keep your fingernails short.
5. Wear a face mask when dry-sanding epoxy. Wet sanding is generally recommended.
6. Epoxy coating all pieces before putting them in the hulls is much easier than coating when inside the hull.
7. White spots under the glass cloth are air bubbles. They can be dug out and filled with epoxy if the hull is to be finished natural.
8. When sanding large epoxied surfaces, it is easier to do if the surface is wiped off with ammonia and water first.
9. To fill a gouge on a curved surface, use semi-cured epoxy, cover with polyethelene film and tape tightly to the hull until cured.
10. All fillets used in these plans are microspheres with sufficient micro-fibers added to keep the fillet in place. Use the thickest fillets that are practical to work with to keep the weight down.

Recommended Sequence of Construction

1. Make the deck jig (do not cut out the center) and use as a large table with saw horses for preparing the sub-assemblies and jigs.
2. Cut out all Spruce pieces.
3. Scarf and cut out all plywood pieces, epoxy coat, (except hullsides), and assemble sub-assemblies.
4. Cut out the glass cloth for the exterior hullsides.
5. Prepare the jigs required.
6. Complete the deck jig.
7. Complete the bow-spacer jig.
8. Prepare bow-spacers.
9. Begin hull construction.

Jigs and Sub-Assemblies

Deck jig

Use 3/4" X 3/4' stringers of any material and use 3/16" or 1/4" plywood for the flat surface. The stringers need not be scarfed if small blocks are used next to the butt joint. The plywood should be scarfed.

1. Construct a panel 21'6" X 2'6" with the stringers epoxied around the outside edges.
2. Draw out the deck plan but do not cut out at this time.
3. Support the deck jig with sufficient saw horses to serve as a table until all jigs and sub-assemblies are made. Be sure the surface is flat.

Spruce Pieces

Cut out the spruce pieces according to the sizes on the materials list.

1. Gunwales
2. Centerboard trunk stringers
3. Beam chocks - epoxy coat all surfaces. These chocks may be made by bonding two 3/4" pieces together and cutting to 1 1/4".

Hullsides

Scarf two 4' X 32' pieces. It is very important that the hullsides are accurately measured and that the curve along the keel is fair. Use the plans to locate the hullside on the 4' X 32' sheet of plywood. Avoid walking or kneeling on the ply to avoid dents. Work on a flat surface and draw out the shape for the first hullside, it will be the template for the other hullsides.

1. Construct the datum line with the aid of a tightly stretched string. This should be raised sufficiently at each end to prevent it touching in between. Mark points vertically beneath the string and join them up with a straight edge.
2. Mark off stations 1 to 20 along the datum line with a STEEL measuring Tape. (Note: owing to the curvature which the sides will have after assembly, these stations will not agree with those used for measurement of the completed hulls).
3. Locate point 'B' (the bow tip) at the exact distances indicated from 'A' and 'C'. Then draw the vertical 'BA'.
4. Mark off stations 2 to 20 along the line 'BX' and then draw the station verticals.

5. Mark off all the offsets using a STEEL rule marked in millimeters.
6. Using a straight and uniform batten, draw a fair curve through the gunwale points and through the keel points from station 3 ft. to station 20 ft. 6 ins. Complete the bow with a thin batten.
7. Cut out oversize and sand down to the line.
8. Use this first hullside as a pattern to draw out the shape of the other three. Do this on a flat surface, weigh down the pattern to prevent movement, and use a sharp pencil or ball point pen.
9. Cut each out oversize and sand down to the line.
10. Select from the four hullsides the outboard and inboard sides of the starboard and port hulls and label on the inner surfaces.
11. Accurately transfer stations 2,5,10,14,16, and 20 to inside surfaces and edges of these three hullsides from the first, using a ball point pen.
12. On the inner surfaces of each hullside construct the positioning lines for the bowspacer, using a ball point pen.
13. On all surfaces draw a line around the keel 1 3/4" from the edge. On one outboard surface of each pair of hullsides draw a line around the keel 3/8" from the edge. Use a pencil.

Exterior Glass Cloth

Use a hullside as a template and cut out 4 pieces of cloth 2" oversize all around. Roll up and set aside.

Centerboard Trunks

1. Cut out the ply for the trunks using the 3mm ply to the pattern shape of the trunk side. Do not cut out the pivot slot. Mark one trunk side, cut out, and sand down to the line. Use the first trunk side as a pattern for the other three.
2. Determine two port and two starboard sides. Coat the inner surfaces with graphite and epoxy (about 20% graphite powder), re-coat and allow to cure. The graphite powder will make the surface smoother after sanding.
3. Sand smooth using 80 and 240 grit dry paper. A finishing sander is fine.
4. Apply the first coat of epoxy to outer sides, re-coat and staple spacers to sides. Use short staples that will not extend through the sides. Allow to cure and remove staples.
5. Match and mark two sides together, clamp with inner surfaces together, drill the 25mm pivot hole and cutout to the top of the trunk. Repeat for the second trunk. A router pattern may be made for the cutout to make this step more accurate.

6. Apply first coat of epoxy to spacer and cover, re-coat and staple cover to spacer. Allow to cure, remove staples, and coat covers with two coats.
7. Notch out the top stringers for the pivot slot, coat each surface with epoxy and clamp the top stringers to the trunk sides. The top stringer should extend 50mm forward on the front of the trunk and 25mm aft. Be sure the notch out is deep enough to allow the trunk side to cure flat.
8. Attach the bottom stringer to trunk sides. Coat each surface with epoxy and clamp together. Be sure the trunk sides are flat and allow to cure.
9. Prepare a centerboard template using the centerboard pattern and your centerboards. The shape of the centerboard may vary slightly from the pattern (usually fore-aft location of the handle) depending upon the manufacturer. The pivot hole is determined using the pattern, matching the pattern and the centerboard template below the waterline. Drill the pivot hole.
10. Lay the centerboard template on a trunk side with a piece of pivot tube in place. You will find that the centerboard template waterline will extend about 13mm below the trunk side. You can now determine the correct locations for the internal stringers. With the centerboard template in the down position and the waterline of the template the same distance below the trunk side fore and aft, mark the top and bottom locations of the rear stringer onto the trunk sides. The handle should touch the stringer at the top and clear the board at the bottom by 6mm when the board is in the up position. In the up position with the board inside the trunk at the rear by 6mm, the top of the board should touch the front stringer. At the bottom the stringer should clear the board by 5mm. Mark the locations for the front stringers on the trunk side. Repeat this step for one side of the other trunk. You are now ready to attach the stringers to one side of each trunk. The stringers should extend 6mm or more above and below the trunk side after attachment.
11. Coat the stringers and trunk sides with epoxy, re-coat, and clamp in place. You will be doing one side of each trunk. Be sure the trunk is flat and allow to cure.
12. Lay each centerboard in the trunk sides with the stringers installed. Lay a straight edge across the stringers and determine if the vertical stringers need to be planed down. The board should clear the trunk sides with minimum clearance (1-2mm). Plane down the stringers if necessary. Mark each centerboard and trunk port and starboard in case one centerboard is thicker than the other.
13. Align the matched trunk sides together and be sure that the pivot slot is aligned at the top and the bottom. Mark the second trunk sides carefully. Coat the stringers and the second trunk sides with epoxy, re-coat, and clamp together. Lay flat and allow to cure.
14. Plane the bottom stringers to fit the keel. The approximate angle will be 140 degrees but check the inner keel angle and plane in stages. You can check the fit by looking for light on the inside of the trunk.

15. Epoxy coat the bottom stringers when the fit is good. Allow to cure.
16. Coat all outside surfaces of the trunks with two coats of epoxy. Allow to cure. The trunks are now complete and ready for installation.

Main Bulkhead

1. Prepare a plywood template from the plans and use to make a second bulkhead. Cut out oversize and epoxy coat both bulkheads to other pieces for double thick ply. Weight down with a heavy flat object or staple together.
2. Allow to cure.
3. Cut out and sand down to the line.
4. Epoxy coat both bulkheads, two coats.

Middle Bulkhead

1. Prepare a plywood template and the bulkheads as done for the main bulkhead. Double thick ply.

Rear Bulkhead

1. Prepare to fit after the hull is shaped, double thick ply.

Transom

1. Prepare a plywood template from the plans as was done for the bulkheads.
2. Make two transoms to 8mm ply. Coat inner surfaces with two coats.

Deck Beams

The deck beams on each side of the beam channels are double thick ply.

1. Prepare a plywood template from the plans.
2. Cut out 29 deck beams for each hull (total 58). Cut the top curve slightly oversize and sand down to the line. Deck beams numbered 1 through 5 for each hull can all be cut out to the approximate #5 size. All the rest should be cut out to full size.
3. Number the deck beams according to the plans. Notch out the deck beams for the deck stringers. The notch should be 4mm wide and 25mm deep. This can be done by clamping a number of deck beams together and cutting with a radial saw, table saw, or saber saw.
4. Prepare 8 double thick deck beams for each side of the beam channels. Coat with epoxy and staple together or weight down with a heavy object. These are made from 16 of the deck beams previously cut out.
5. Epoxy coat all deck beams on each side and the bottom with two even coats.

6. Allow to cure.
7. The deck beams will be individually cut down to size when they are fitted to the hulls.

Deck Stringers

1. Cut out six 1860mm and six 2350 mm deck stringers 25mm wide. Cut out evenly to avoid sanding later.
2. Epoxy coat on each side and the bottom with two even coats.

Deck Sections

The deck sections should not be cut out until the hulls are out of the deck jig, however the pieces may be cut down to 425mm in width to provide sufficient ply for the other pieces.

Transom Jig

Cut out according to the plans.

Pit Prop and Tie (Station 16)

Cut out according to the plans.

Bow Jig

Prepare just prior to its use. Refer to construction notes.

Complete Deck Jig

1. Cut out the center of the deck jig accurately, following the general procedures used for making the first hullside. Also make the cut-outs which enable the deck jig to be tied to the hull.
2. Epoxy and clamp the inner stringers up to, but not overlapping the edge.
3. Epoxy and clamp on the various cross pieces.
4. Allow to cure.
5. Sand the inner surfaces smooth.

Bow-spacer jig

1. Use the center cut-out from the deck jig.
2. Draw the upper and lower sides according to the plans. Cut out oversize and plane down to the line.
3. The end blocks should be slightly deeper than the 4" foam. Epoxy and clamp in place. Be sure that the bottom side is exactly central under the top side.
4. Allow to cure.

Bow-Spacers

1. Cut out two pieces of foam to the maximum width of the bottom of the bow-spacer jig.
2. Epoxy coat a small piece to the each bow section to secure the length required in the bow-spacer jig.
3. Allow to cure.
4. Place the foam block in the jig and weight down or clamp together and cut-out slightly over-size with a hand saw.
5. Sand down to shape with a long sanding block.
6. If the moisture absorption rate is 5% or less, there is no need to epoxy coat the foam block.

All sub-assemblies and jigs are now prepared.

CONSTRUCTION

A. Prepare Hullside for wiring and fiberglassing, and epoxy on Gunwales

I assemble both hulls at the same time, with the exception of the time that each hull is in the deck jig.

Sub-assemblies

Both pair of hullsides
4 gunwales

1. Lay each pair of hull-sides accurately together on a flat surface with the 3/8" keel line up, and weight down to prevent movement. Drill 1/16" holes starting at the bow; 4 at 1" intervals, 2" intervals to station 2, 4" intervals aft, and 1" intervals the last 12". Be sure that one hole is exactly at station 20.
2. Lay the hull-sides flat, and epoxy and clamp gunwales to the hull-sides, making sure they are on the inside surfaces. They should butt right up to the edge of the hull-sides. Use all 40 clamps, 6" inches apart without fasteners. If clamps are not available, the ply can be stapled to the gunwales.
3. Allow to cure. Remove clamps or pull the staples out.
4. File and sand off the excess epoxy on the top of the gunwales.

B. Complete Preparation of hull-sides, wire up along keel and set up for fiberglassing. Part 1. Fiberglass along inside of keel. Part 2.

Sub-assemblies

Transom jig
44 3/8" (1127) 'pit prop'
Tie for station 16
Variable angle (protractor)

1. Taper the gunwale down to a point at the bow. Start the taper 250mm back. At the bow the gunwale should be planed right to the second ply.
2. Using a sanding block or plane, radius the INSIDE corners along the full length of the keel to the shape shown. From station 2 to bow sharpen the inside surface sharply, through one ply and back 13mm.
3. On both inside surfaces apply 50mm masking tape round the keel from station 2 ft. to station 20 ft. 6 in. at a distance 45mm in from the edge, butting up to the guide line previously drawn.
4. Lay the inside surfaces of the hull-sides together and LOOSELY join the keels by passing 100mm lengths of copper wire through the holes and twisting the ends together.

5. Insure that the hull-sides are exactly level fore and aft, then push the gunwales apart and insert the 1127mm pit-prop between them at station 12.
 6. Close the gap along the keel by twisting up the wires with a pair of pliers. Try to obtain a uniform 'corkscrew' effect by pulling as well as twisting. This helps prevent one wire simply winding round the other. Do not tighten completely at this time.
 7. Fit the variable angle to the outside of the keel at station 12 and measure the angle obtained with a protractor. Move the pit prop fore-aft by trial and error to obtain 142 degrees. (1127mm is nominally correct).
- If the pit prop is removed, leave another in its place to prevent the hull-sides closing up and straining the wires.
8. Wire on the transom jig. At the keel it should be 25mm aft of station 20. Tack a batten diagonally across to a gunwale to keep the transom jig perpendicular, if necessary.
 9. At station 5 install a clamp to each gunwale. Loop strong string through the clamps and pull inwards to obtain exactly 635mm across the gunwales measured to the outside of the ply.
 10. At station 16 clamp the tie across the gunwales to set the angle at the keel to 148 degrees. Measure angle with variable angle as before.
 11. Check that all the wires are tight and that the two sides butt together evenly along the keel.
 12. The wire will have formed into raised loops along the inside of the keel. Push the middle of these loops down into the 'V'. (But not so far that a gap is opened between the hull-sides). After this re-tighten the wires if they have loosened, and recheck the butt along the keel.

Part 2.

NOTE: The inside keel is filleted and glassed from station 2 to exactly 30mm in front of station 20. Avoid spilling resin on the hull-sides as when set it stiffens the ply, causing uneven spots when the hullsides are bent into the deck jib. (Even if most of the resin is wiped off). On no account fiberglass in front of station 2.

13. Support the hull in at least 3 places to insure a fair shape to the keel and balance horizontally.
14. Brush epoxy over the area along the keel between the masking tapes from station 2 to exactly 30mm in front of station 20.
15. Cut a 25mm mixing stick square across the end and use to fillet the keel. The idea is to fill the angle at the keel with the fillet

mixture and then to apply the 3" glass tape. The fillet will be flat across the top.

16. Roll up the 3" glass tape and soak for a few minutes in epoxy, squeeze out excess epoxy and lay the tape centrally at the keel. Use three pieces and do not overlap, just butt them together.
17. Remove the masking tape. Re-check the butt along the keel.
18. Allow to cure.

C. Fiberglass along the outside of keel.

NOTE: The outside of the keel is fiberglassed with one layer of glass tape, just as the inside was done. Use the 3" tape. Work with two pieces of equal length and butt together, do not overlap.

1. From station 2 to 13mm aft of station 20 only, cut the wires off flush with the hull. Do not, however, cut the wires securing the transom jig.
2. File the copper wires and sand down the sharp edges along the keel. Do not overdo the sanding however as the strength of the keel will be reduced. A nicely rounded shape is desirable.
3. Apply masking tape 45mm from each side of the keel from station 2 to the transom.
4. Brush epoxy over the area along the keel between the masking tapes. Fill any voids at the keel with fillets.
5. Lay the pre-soaked and squeezed out lengths of 3" tape centrally along the keel from station 2 to 13mm aft of station 20.
6. Allow to cure.

D. Push gunwales inwards and place within deck jig.

Fit transom

Sub-assemblies

Deck jig
Transom
Adjustable angle (protractor)

Materials

Rope or strap clamps

NOTE: The fiberglass along the keel must be fully cured before proceeding with this operation.

1. Remove the transom jig and other cross pieces.

2. Saw off the rear end of the assembly 10mm aft of station 20. Take care not to damage the ply at station 20. Sand the edges smooth.

NOTE: If the aft section is not cut away, there will be a dangerous stress concentration at the end of the fiberglass (inside) when the ply is bent into shape.

3. Place the deck jig reverse way up on the ground, or on multiple saw-horses, propped up 25mm on both ends to accommodate the reverse sheer of the hull. (i.e. the curve along the gunwales in side view.)

NOTE: The next steps are the most dangerous in the hull construction due to the possibility of the plywood splitting. Step 4 will remove the danger.

4. Turn the assembly gunwale up and wet with water along the inside of the keel line 6" up, from station 2 to station 20. Aft of station 18 wet to the gunwales. Turn the assembly keel up and wet 6" on each side of the outside keel from station 2 to station 20. Aft of station 18 wet to gunwales. Use a sponge or roller and repeat several times to allow the water to thoroughly penetrate the wood. Proceed with step 5 within a 1/2 hour.

5. Lay the assembly keel uppermost over the jig and with one person on either side push the gunwales into the jig working from bow to stern. Push the bow forward into the jig until it is tight. It is very important that the forward portion doesn't spring out again when nearing the stern as the ply at the transom will be put into undue strain. To prevent this, a third person should tie the jig to the hull at the front, center, and rear in turn as soon as the gunwales are inside the jig at those positions. A better way to secure the jig to the hull is by using adjustable strap clamps.

NOTE: The transom is under the greatest strain. As this part of the assembly is pushed into the jig, the two people should hold the keel up to keep a fair curve in the transom while the third person installs a clamped stick across the gunwales and up to the keel 3" forward of station 20 to maintain a fair curve while the ply dries.

6. Make certain the 3 strap clamps are tight. Then turn the hull and deck jig right side up. Support the deck jig with saw horses parallel to the hull sides about 3' high, and close to the hull. Be sure to maintain the curve of the gunwales by keeping the bow and stern about 1" lower than the center. You may support the keel from the floor at station 10 and station 14 to relieve some of the hull weight.
7. Check that the tip of the bow is as forward as it will go in the jig.
8. Check that the hull is free of twist by placing a batten across the gunwales near the transom and another at about station 8. Make sure the battens do actually touch the gunwales and not just excess epoxy

or the deck jig. Sight from the bow and line up the two battens which should, of course, be parallel. You may use a level also to check for twist at about every 4'. One person at the transom and one at station 8 can force out any twist between them. When this has been done, clamp the gunwales to the jig at station 16 to prevent further movement. Do not clamp anywhere else as the gunwales will be at an angle to the jig and clamping will force in the wrong shape. If gunwales don't touch the side of the deck jig, force apart and put in sticks to insure the correct shape.

9. Looking down on the deck jig and hull, apply 1" masking tape where the hull and deck jig meet to avoid epoxy drips that would make it difficult later to remove the hull from the deck jig.

Part 2

NOTE: Read the class rules carefully before doing step 1.

1. Mark the top of each gunwale 2 1/2" in front of station 20 and cut away the gunwale aft of this. (This distance is only correct for the double ply, 8mm. transom recommended.) The cut should be raked at the same angle as the transom which is 100 degrees to the gunwale. It can be marked with the adjustable angle. After the saw cut, chisel off the gunwale aft of the saw cut carefully in small sections to avoid damage to the ply.
2. The transom has been made slightly wider than the design width just at the deck level to accommodate small errors in the deck jig. By trial and error, sand down the transom equal amounts on each side, blending in with the correct shape until a push fit, but not a free fit is obtained at the gunwales. The transom should bear against the ends of the gunwale stringers, and the aft side of the transom should be 13mm in front of station 20 at the keel.

NOTE: The natural shape of the hull will be considerably different to the transom shape, and the transom will have to be forced down quite hard to make the hull-sides touch all round.

3. Clamp a suitable piece of wood (3" wide) across the top of the gunwales immediately in front of the transom. Force down the transom with a clamp at each side of the transom and slowly and evenly clamp down until the fit is tight.

NOTE: Be sure the transom area ply has dried thoroughly before proceeding to step 4.

4. After insuring that the transom fit is good, make a pencil line inside and outside where it touches the hull. Be sure to leave the transom clamp in place to hold the hull shape, and remove the transom.
5. Coat the edges of the transom with epoxy and also between the pencil lines. Allow sufficient time for the epoxy to penetrate the wood (at least 15 min.).

6. Make a medium fillet mixture. Coat the surface between the penciled lines and coat the transom edges. Install the transom again and fillet around the transom on the inside of the hull. Look at the outside surface and fill any small voids with the fillet mixture.
7. Remove temporary clamp after transom is installed.
8. Allow to cure.

E. Fit main and middle bulkheads Part 1
Fit beam chocks
Prepare glass cloth

Fiberglass inside of bow Part 2
Install bow-spacer, glass cloth, and main and middle bulkheads

Sub-assemblies

Materials

Main bulkhead	3" glass tape
Beam chocks	10 oz. glass cloth
Middle bulkhead	
Bow-spacer	

Part 1

1. Place the middle bulkhead in position at station 14. The curve along the top should meet the gunwales at the top inside edge. The fit should be snug even though the hull will be glassed when the bulkhead is installed.
2. Check the fit of the main beam chocks with the main bulkhead in place. It should be snug even though the hull will be glassed when the bulkhead is installed. Prepare 2 clamping sticks the proper length to hold the beam chocks against the hull-sides.
3. Prepare the glass cloth to be installed. The hulls will be fiberglassed according to the plans. In addition, prepare the second layers of 10 oz. cloth.
4. Cut 3" glass tape to fit from the top of the bow to station 2 on the inside of the keel.
5. Fit the two parts of the bow jig (made at this time) to the bow. Use the bow itself as the template and make the bow jig of 3/4" plywood. Do not install at this time.

NOTE: Preparation is now complete for the epoxy steps. The next steps must be done without delay to avoid the epoxy hardening until all of the hull-shaping components are installed. Three people are really necessary to get Part 2 done within 2 hours. If possible, turn your heat down to 60 degrees to delay the epoxy hardening.

Part 2

1. Glass and fillet around the inside of the bow with 3" glass tape as was done for the rest of the keel. Look at the bow from the outside and determine if you have a fair curve within 4" of the bow. If not, push small (1" x 2") pieces of foam into the bow from the inside to get a fair curve. If the ply pieces don't touch to station 2, tighten the copper wires. If the bow is not perfectly straight (it's not likely) install the bow jig at this time. This step is difficult because it is hard to keep hollows from occurring. Place the center of the bow jig at the edge of the ply and clamp easily to straighten the bow. Clamp at 6" intervals.
2. Coat the hull-sides with epoxy (one coat) from bow to transom on both sides. Use a 1" brush for the bottom of the gunwales and a roller for the rest.
3. Apply the first layer of 10 oz. glass cloth from the rear of the bow-spacer line to transom on both hull-sides, and below the bow-spacer. Wet in with epoxy and squeegee dry. The glass cloth should butt up against the bottom of the gunwales.
4. Apply a good second coat of epoxy to the wood below the bow-spacer.
5. Epoxy coat the sides of the bow-spacer and insert it holding it close to the top of the hull until it is forward to the proper position. Push the bow-spacer down to the positioning line marked on the hull-sides. Do this step carefully to insure that the bow-spacer does not slip below the line. Even 1/8" below the line will alter the hull shape and cause a hollow in the hull-side to occur.
6. Place the main bulkhead in position at station 10. Apply a medium fillet mixture to one side of each beam chock and wedge them into position under the gunwales. Wedge the beam chocks apart with the two clamping sticks previously prepared. Check the outside of the hull to be sure that the surface is fair.
7. Install the middle bulkhead from the front and push in gently to station 14.
8. Allow to cure.

F. Prepare rear bulkhead

Install rear bulkhead and beam chocks

Fiberglass above the bow-spacer

Fillet bulkheads and install second layers of glass cloth

NOTE: The original building plans do not provide for a bulkhead at the rear beam location. Many U.S. Tornado sailors recommended a rear bulkhead and it is included in this section. It may be installed when the hull is in the jig or after the hull is out of the jig.

1. The rear bulkhead may be installed with the rear beam chocks as was done with the main bulkhead or the beam chocks may be installed first. In either case, make up a rear bulkhead of double thick ply. The location of the bulkhead is at the center of the rear beam. Epoxy coat with two coats after cutting out the lightening hole.
2. Allow to cure.
3. Install beam chocks and rear bulkhead with a medium fillet. The hull will be curved at the beam chock location so use a good quantity of fillets to fill any voids between the hullsides and the beam chocks. Use clamping sticks to hold in place while curing.
4. Fiberglass the interior of the hull forward of the main bulkhead above the bow-spacer to the gunwale. Use 10 oz. glass cloth on both sides of the hull. Start the cloth at the bottom of the gunwales and overlap the bow-spacer by 25mm. The cloth should be installed from station 2 and overlap the glass cloth aft of the bow-spacer by 25mm.
5. The bulkheads were installed without fillets, and now is the time to add the additional strength. Apply medium fillets to both sides of the main, middle, and rear bulkheads and around the inside of the beam chocks and the transom, then install the second layers of cloth overlapping the bulkheads by 25mm.
6. Coat all wood surfaces to have two coats of epoxy.
7. Allow to cure.

G. Fit deck beams

Install deck beams

1. Fit each deck beam from the bow to the main bulkhead and from the middle bulkhead to the transom. The fit does not need to be exact as the deck beams will be installed with fillets.
2. Install all of the deck beams previously fitted. Use a fairly thick mixture and staple in place. Refer to detail drawing to show how staples are installed. Be sure to fillet the deck beams to the bottom and sides of the gunwales.
3. Allow to cure.

NOTE: Remove the hull from the deck jig and place in cradles deck side up. Complete the second hull up to this same point.

H. Finish transom and bow Part 1
Install beam channel deck beams

Fit centerboard trunk Part 2

Install centerboard trunk Part 3

Part 1

1. Cut off the ply aft of the transom and sand smooth.
2. Finish the bow exterior by filing, sanding, and glass taping as was done for the keel. Use one layer of 3" glass tape at the bow.
3. Allow to cure.
4. Measure from the bow and locate the aft edge of the main beam and the front edge of the rear beam. Draw a line across the gunwales perpendicular to the centerline of the deck. These dimensions are very important, read the class rules and be careful. Use a T square to mark the reference points across the hull, refer to the deck structure plan.
5. Install the main and rear beam channel deck beams, refer to the deck structure plan. Do not install the bottom of the channel yet, as you will want to reach into the hull at the beam location later. Cut the deck beams slightly oversize and sand until the fit is snug. Coat ends with epoxy, re-coat for absorption, and fit them into place. You may need to use staples to hold the deck beams until the epoxy cures. Fillet on the outside of the channel.
6. Allow to cure.

Part 2

NOTE: Fitting the centerboard trunk must be done carefully to insure that the boat will measure correctly. The trunk must be located so that the following conditions will exist after it is installed.

- A. Vertically aligned in the hull at deck and keel centerline.
 - B. Aligned in the fore-aft plane so that the leading edge of the centerboard on the outside of the keel will fall within the measurement tolerance.
1. Mark the deck centerline on the top of the aft channel deck beam.
 2. Draw a clearly visible line at the inside center of the keel from 2" aft of the main bulkhead to 1" forward of the middle bulkhead. To insure that this line is in the center of and parallel to the keel line, drill two small (1/16") holes vertically up from the keel. These holes will be filled when the trunk is installed.

3. The way to find the exact location of the leading edge of the centerboard on the outside of the keel is to prepare the bow measurement template from the plans and measure the distance aft. Make a mark on the outside of the keel in the center of this rules tolerance.
4. Drill a 1/16" pilot hole through the keel into the hull. This is the reference point necessary to fit the centerboard trunk.
5. Measure the distance from the front of the bottom outside stringers to the leading edge of the centerboard template when fitted in the trunk. Add 5mm for the angle aft through the keel of the centerboard. This total measurement is the distance forward of the reference point that the front of the stringer must be placed to locate the trunk in the fore-aft plane. Make a mark in the hull.
6. Cut off the front ends of the top stringers until the bottom stringers fit the mark on the keel.
7. The trunk is now fitted and ready to install.

Part 3

1. The trunk is bedded down on a layer of medium fillet. Fillet the keel starting 13mm up from the keel center. Coat the top front stringers, the aft deck beam, and the bottom of the trunk with epoxy and place in position. Look down inside the trunk and align the trunk to the center line drawn on the keel. Be sure the trunk is forward to the aft main beam deck beam. Clamp the trunk down to the keel with clamping sticks attached to the gunwales at the front and rear of the trunk, use sufficient pressure to hold the trunk firmly to the keel without distorting the shape of the hull. Clamp the top front stringers to the deck beam at the centerline of the deck beam. Verify that the trunk is still aligned to the keel center line after clamping is complete. Be sure that the aft end of the trunk at the deck level is in the center of the hull.
2. Allow to cure.
3. Make a medium fillet mixture and bed in around the trunk and between the stringers on both ends of the trunk.
4. Prepare a piece of spruce to go between the rear of the trunk and the middle bulkhead. Coat with epoxy, fillet, and push into place to attach the trunk to the bulkhead.
5. Fit and install the deck beams from the rear of trunk to middle bulkhead.

NOTE: Prepare a 4mm ply deck template with a concave edge using the building plans. This will be used for beveling the gunwales and for sanding the deck beams and deck stringers before decking.

I. Bevel gunwales and sand deck beams
Install chainplates
Install deck beams to trunk side

Step 1

1. Plane down the outside edge of the gunwales to continue the curve of the deck beams. Use the template to insure the correct shape. Use a long sanding block to finish shaping the gunwales and all deck beams.
2. Locate the exact center of the forestay tang on the inboard side of each hull and mark. The dimension to the center of the cut out is 1992mm forward of the aft edge of the main beam, this allows for the aft rake of the tang.
3. Drill a series of holes from the outside of the hull to the inside at the approximate angle that the tang is to enter the hull and file the opening smooth. This opening should be 1/8" below the sanded gunwale. The actual exit angles are 16 degrees aft and 136 degrees from the vertical of the hullside at the exit point.
4. Locate the point on the opposite side of the hull that is a continuation of the tang at the correct angle of entry and mark.
5. Prepare a strip of wood that the tang is to be bolted to and mount in position just below the tang entry hole and across to the other side of the hull. Use a liberal amount of fillet under the gunwale and on the other side of the hull to secure in place. Two strips of 4mm ply, 3" wide (epoxied together) will suffice or use one piece of 1" square sitka with 4mm ply triangular plates on both sides of the hull.
6. Allow to cure.

Step 2

1. Locate the exact center of the shroud chainplate on the outboard gunwale and mark. Read the class rules carefully. The dimension to be used is 715mm aft of the aft edge of the main beam.
2. Drill a series of holes through the top of the gunwale next to the ply at an angle of 8 degrees forward of the perpendicular to the gunwale. File the opening smooth and insure that the shroud chainplate will fit.
3. Epoxy three strips of ply (6", 4", and 2") (the length of the chainplate) together and mount to the outside hull surface at the shroud location. The purpose is to shape the pieces to the contour of the hull. Use an innertube rubber band to hold in place until the epoxy is cured. Protect the exterior hull surface with a piece of polyethelene.
4. Allow to cure.

Step 3

1. Fit forestay tangs in place, drill and bolt loosely. The center of the attachment hole should be 30mm from the hullside on top.
2. Remove, wet thoroughly with epoxy, and re-assemble. Tighten bolts securely.
3. Coat the entire assembly with epoxy, bolts included, and fill any voids where the tang enters the hull with epoxy.
4. Allow to cure.

Step 4

1. Remove shroud chainplate support pieces from hull sides.
2. Use a router or chisel and notch support pieces to fit chainplates.
3. Fit chainplates to support pieces using countersink head 1/4" bolts. Countersink them into the chainplates. The center of the attachment hole should be 30mm above the gunwale. Assemble loosely and fit into the hulls with the correct exit angles. The exit angles are 8 degrees forward from vertical, and 75 degrees inboard from the deck at the exit point. Remove the chainplate assemblies, disassemble, epoxy coat and re-assemble, tightening the bolts securely.
4. Set assemblies aside and allow to cure.

Step 5

1. Use a liberal amount of medium fillet and mount shroud chainplates in hull. Use a large clamp just below the gunwale and one or more sticks below to hold in place. The assembly should butt up against the gunwale. Do not distort the hull shape when clamping in place.
2. Allow to cure.

Step 6

1. Plane the top of the trunk to continue a fair line to the top of the deck beams. Use the deck template previously made.
2. Fit the deck beams to the trunk sides and fillet into place. Be sure to avoid altering the longitudinal shape of the top of the trunk.
3. Allow to cure.

J. Cut Out Keel Trunk Slot Part 1
Fit beams
Install channel bottoms Part 2

Part 1.

1. Locate the ends and sides of the trunk slot at the keel by drilling pilot holes. Drill a 1" hole at each end of the trunk. Draw lines parallel to the inside of the slot and cut out with a saber saw. File and sand the edges smooth.

NOTE: The beams are fitted before the decks are installed.

2. Set up the hulls in preparation for fitting the beams so the following conditions exist:
 - A. Deck centerlines are equidistant at bow and stern and within the measurement rule tolerance. Measure at the forestay tang and just aft of the rear beam.
 - B. The diagonals from the bows to the sterns are equal.
 - C. A straight edge laid across the hulls at the bow and stern is horizontal. Use a good level. Do not use the main beam as a straight edge as it will have a slight curve due to the pre-tension of the dolphin striker.
 - D. Set both hulls upright by dropping a plumb line through each centerboard trunk just aft of the bottom front edge of the trunk. Suspend the plumb line at deck level exactly on the deck center line. This should be exactly at the trunk center. Look along the keel and set the hulls so that the keel is aligned to the plumb line. Measure the keel centerline separation just aft of the main beam and be sure that the difference, if any, is within the rules tolerance.

NOTE: This entire hull setup procedure is slow and tedious, so to be sure that you will not need to do it again after cutting out the beam cutouts, make whatever jigs that you can to hold the hulls rigidly in place.

3. Make a re-check of all of hull setup.
4. On the inboard side of both hulls at the main and rear beam locations, draw lines parallel to and exactly 23mm below the edge of the gunwale. This dimension allows for 5mm for the deck and its installation.
5. Determine the precise fore-aft location of both beams and mark.
6. Lay the rear beam across the hulls at the rear channels and measure the precise distance from the beam to the lines drawn parallel to the sheer line on the inboard hullsides. Then on the outboard hullsides draw lines parallel to the sheer the same distance below the beam as on the inboard side.

7. On all four hullsides at each side of the beam, draw a perpendicular line from the sheer to the lines below the beam.
8. Repeat steps 6 and 7 for the mainbeam. Since the main beam is pre-curved, the horizontal lines on the outboard side should be 2mm lower than the inboard side.
9. Make templates to the shape of the main and rear beams.
10. Center each template between the vertical lines at the beam channels and mark the shape to be cut out.
11. Use a saber saw and cut out each channel on both sides of the hull close to the line. Use a file and straight edge across the hulls to get the shape right. Seat the beams until they fit to both sides of each hull.
12. Re-check the hull setup.

Part 2.

1. Fit the 4mm ply bottoms for all the beam channels as close below the cutouts for the beams as you can. At the main beam, be sure to allow space for the dolphin striker and its fasteners.
2. Epoxy coat all pieces.
3. Allow to cure.
4. Install channel bottoms with a fillet mixture and staple in place to the bulkheads. Fillet to the deck beams.

K.	<u>Install beams in channels</u>	<u>Part 1</u>
	<u>Install beam bolts and/or studs</u>	<u>Part 2</u>
	<u>Reinforce bolt retainers</u>	<u>Part 3</u>
	<u>Install jib strop plate retainers</u>	<u>Part 4</u>

Part 1

1. Coat the bottom and sides of both beams with a release agent where the beam will enter the hull. A paste wax with several coats and wiped smooth works well. Be sure to fill the grooves where the dolphin striker attaches to the beam.
2. Fill the rear beam channels with a soft microsphere mixture. Use plenty so that it will be squeezed out.
3. Lay the rear beam across the channels and push down gently until the beam is seated completely. Wipe away excess microspheres as the beam is seated. Innertube clamps laid diagonally across the beams and around the hull are tightened to insure complete seating.
4. Repeat the same process for the main beam.

5. Re-check alignment again before the microsphere mixture cures.
6. Allow to cure.

NOTE: Regardless of your choice of beams, the previous steps will be the same. Depending on your choice and method of attachment, the next steps may need to be altered. Permanent studs are recommended for both beams at each point, however a beam strap is required for the inboard sides of the main beam due to the curvature of the beam. Permanent studs are stronger, lighter and easier to install than removable bolts.

Part 2

1. After the microsphere mixture has cured and after the clamping straps are removed, the bolt or stud holes should be drilled. Use a long 3/8" drill bit and drill down through the beams into the hull. Remove end caps and look inside the beam as you are drilling to avoid enlarging the holes in the beams. Drill all holes for both beams and be sure to drill all the way through the beam chocks for the removable bolts. For the permanent studs drill 65mm into the beam chock on the inboard side and 50mm on the outboard side. Fit the studs in place and cut to length.
2. Remove the beams. If the beams are stuck in the microsphere mixture, heat the beams on the inside with a torch and they will come off. Use moderate heat and allow time for the beam to cool and contract. Repeat several times, if necessary.
3. Fit the beam bolt retainer plates for the bolts. You may need to chisel or drill to provide sufficient space for the retainer plates under the beam chocks.
4. Enlarge the bolt holes into the hulls slightly with the 3/8" drill for those bolt holes that will have removable bolts. Use a pipe cleaner and epoxy coat those bolt hole edges to seal the wood.
5. For the permanent studs, fill the 65mm hole with epoxy and allow to sit for 15 minutes. Push the studs in slowly and wipe away all excess epoxy.
6. Allow to cure.
7. Re-install the beams again unless you have used permanent studs. Install the bolts with the retainer plates. For the removable bolts, epoxy coat the retainer plates (except near the tapped hole) and tighten firmly in place.
8. Prepare a fillet mixture and fillet around the retainer plates.
9. Allow to cure.

Part 3 (Not necessary if permanent studs are used)

1. Remove beams and set aside.
2. Turn the hulls deck down.
3. Prepare a fillet mixture and fillet around the retainer plates again to increase the bonding surface, be sure to avoid the tapped holes.
4. Allow to cure.

Part 4

1. Install 3/4" X 1/2" strips of Spruce under the inboard gunwales as reinforcement for the cross-hull jib strop plate. The reinforcement strips should be from 36" to 50" aft of the rear of the main beam.

- L. Sand deck structure Part 1
Install stringers
Prepare decks Part 2
Install decks

Part 1

1. Use a long sanding block and sand the gunwales and deck beams. Use the deck template to insure the fit.
2. Install the deck stringers using epoxy in the notch outs. Use a single staple, if necessary, to hold the stringers in place. A single small fillet where the stringers join the deck beams is sufficient.
3. Allow to cure.
4. Sand the deck structure, coat with epoxy, and sand lightly to remove bumps.

Part 2

1. Fit each deck, mark each piece Port or Starboard and set aside. Hold the ply tight to the hull and mark the outline on the underside of the ply. Drill out holes and file smooth for the shroud chain-plates and the permanent studs. Cut out the ply pieces 3mm oversize.
2. Prepare three pieces of 15mm by 20mm wood to the length of the front deck to be used for clamping sticks at the deck center and the gunwales.
3. Make chalk marks on the outside of each hull at each deck beam location. These marks will be used to locate the clamping straps.
4. Epoxy coat one deck piece on the inner side and set aside.

5. Fillet the deck beams, gunwales, and stringers with a medium fillet mixture.
6. Re-coat the deck piece on the inner surface with epoxy and place on top of the deck structure.
7. Set the clamping sticks on the deck and pull the deck down tight with 50mm innertube strips at each deck beam.
8. Wipe off all excess fillets and allow to cure. Repeat for each deck piece.

M. Finish deck edges and channels
Prepare hull surface for glassing

1. Use a plane or router to remove the deck edges. Bevel the edges to a well rounded shape. On the outboard hull sides from the main beam to the transom increase the radius of the bevel to 10mm for easier trapezing. Sand the edges smooth.
2. Remove the deck edges in the channels to continue the beam shape. A small Surfboard plane replacement blade held by hand works well.
3. Sand the entire hull using 160 grit paper on a large sanding block. It is necessary to be sure that the hull surface is completely fair and the long sanding block helps. A 75mm by 300mm block is sufficient.
4. Do not be concerned if you have any small nicks or gouges as they will be filled later.

NOTE: The choices available for finishing include painting, natural wood finish, or a combination of the two. The glassing and epoxying steps are the same in any case.

N. Fiberglass and flo-coat hulls
Prepare for finishing

Fiberglassing the exterior hull surfaces has two advantages. First and foremost, it increases the abrasion resistance substantially. It has some additional benefit in increased flex strength. There are two general techniques: you can glass over the bare wood or epoxy coat the surface and after it is cured, lightly sand and fill where necessary before glassing. The second technique appears to be the best and it is described here.

1. Coat the hulls lightly with a single coat of epoxy to seal the wood.
2. Allow to cure and sand lightly to remove bumps. Fill any nicks with epoxy, allow to cure, and file smooth.
3. Lay the glass cloth previously prepared on the hullside and tape in several places so that it will not slide off.

4. Use a spreader to apply the epoxy over the cloth. Make small batches of epoxy and start at the bow by pouring small amounts of epoxy on the hull and spreading it out thinly. The idea is to squeeze the cloth tightly to the hull using a minimum amount of epoxy. The grain of the cloth will show but the color will be of the wood.
5. Wipe off any drips that go over the edges to avoid having to sand them later.
6. Don't worry about the cloth overlap at the deck and keel at this time.
7. Don't be concerned if you can still see the weave of the cloth because when the surface is coated again with epoxy, the weave will disappear. If you can see any white spots on the surface, apply a little additional epoxy and smooth in, these will be air bubbles under the cloth. You will need a well lighted work area to be able to see these spots.
8. Allow the surface to semi-cure and then take a razor blade and trim the cloth at the sides of the hull. This should be done when the cloth at the edges has become fairly stiff.
9. Allow to cure and repeat for all hull surfaces.
10. Look the surfaces over and sand or file off any bumps. If white spots did occur, cut the cloth out carefully and fill with epoxy. Allow to cure and sand and file the spots smooth. File and sand the edges of the surface only.
11. Glass the deck before cutting out the centerboard trunk opening. Allow to cure.
12. Carefully drill pilot holes and locate the ends of the trunk slot and widen to the sides. Draw lines parallel to the inside of the slot and cut out with a saber saw. Be careful not to scratch the walls inside the trunk. Sand and file the edges smooth and bevel slightly. The router can be helpful here.
13. Flo-coat each surface using a roller and spread the epoxy evenly. The first coat will close the pores of the cloth about 60%. Allow the first coat to cure and apply a good second coat to complete the process. Allow to cure.
14. Wet sand the hulls smooth with 80 and 180 grit wet paper. Use a long flat sanding block with the 80 grit paper. You can use the sanding block or a high-speed finishing sander with the 180 grit paper. Be sure to use plenty of water as you go along to keep the paper from loading up and then scratching the surface.
15. If you use 4 oz. flat weave cloth and follow the procedures above, you will have added about 7# of weight to the hull. If you choose to eliminate the glass cloth and replace it with additional coats of epoxy, the weight added would be about 5#. Glass cloth is recommended.

0. Install gasket material Part 1
Install deck ports Part 2

Part 1

1. For the centerboard trunk gasket, draw lines 5/8" from the edges of the trunk all around. Notch out carefully with a router set to the depth of the gasket material to be used.
2. Bevel the edges at the trunk slot to leave a gap so that the gasket material can deflect downwards when the board is down.
3. Install the gaskets with a good quality waterproof contact cement.
4. After the adhesive cures, draw a line down the center of the gasket and cut with a razor blade carefully. If you use Mylar, install as two separate pieces. The edges should butt together but not overlap at the center of the trunk.
5. Fair in the gasket material and sand smooth.

Part 2

1. Mask over the area to be cut out to prevent scratching the surface.
2. Draw the circle required to the size of the inner flange of the port.
3. Drill a pilot hole inside the circle and cut out with a saber saw.
4. Drill slightly undersize screw holes.
5. Sand 6mm around the exterior of the cut out to make a good bonding surface.
6. Apply a medium microsphere fillet, coat the inside surface of each screw hole, and screw down the inspection port with small stainless screws. Do not draw the lateral edges down tightly as it will be easier to screw the port in if it is not curved. Wipe away excess microspheres.
7. An option here is to use only one screw fore and aft, the microspheres will come up into the screw holes in the port and seal perfectly.

NOTE: The hulls are now ready for the finishing.

- P. Finish Hull Surface Part 1
Install Fittings Part 2
Measure for Trampoline Part 3

Part 1

1. If you choose to have any part of the hull surfaces painted, mask off the rest of the hull with masking tape and newspaper. For large

areas to be painted use a spray gun. For stripes, small areas, or the boat name, use a small can of spray paint. For a waterline on the hulls, use the plans.

2. Allow to dry and wet sand the painted surfaces with 400 grit wet paper.
3. Natural wood surfaces will need to be coated with clear polyurethane having an ultra-violet sun screen. Coat all painted surfaces also. The easiest way to spray the hulls is to suspend them by the beam studs and spray the entire hull at one time. Mask off the chainplates, channels, studs, ports, and centerboard gasket. See paint recommendations previously mentioned.
4. Allow to dry and wet sand with 400 grit wet paper.

Part 2

1. Assemble the hulls with the beams.
2. Install the trampoline tracks centered between the beams. Use 20mm stainless wood screws to hold the tracks in place. Start at one end of the trampoline track, drill a slightly undersize hole, epoxy coat the hole with a nail and install the screw. Drill the next hole and repeat the process. The trampoline track will be bent slightly as you go along to accommodate the curve of the hull. Use Philips-head Screws, they are easier to install and remove later for re-finishing. If your trampoline track has a jib strop slider, use 30mm screws in the area where the strop will meet the hull.
3. Install the rudder gudgeons and pintles next. Use a rudder measuring template.
 - A. Assemble the hulls and beams on a trailer or in cradles and level the rear beam.
 - B. The pintles and gudgeons should be as far apart vertically as possible to spread the load.
 - C. Align carefully in the vertical plane at the center of the transom using a plumb line.
 - D. Drill and bolt through the transom using large washers inside. Lock nuts are unnecessary if the nuts are epoxied onto the bolts. Tighten firmly.
 - E. With the rudders in place, mark the screw holes for the plastic rudder retainers. Remove the rudders and drill the screw holes for the rudder retainers.
4. To locate the tiller connector holes, set the rudders vertical with the hulls and align by measuring the distance at the rudder leading edges and at the trailing edge of the rudders at the keel. When the measurements are equal, wedge in place and drill the necessary holes in the tiller connector.

5. Install the stick-on non-skid tape on the outboard gunwales from the main beam to the transom. Wrap around the gunwale with most of the tape on the hullsides. The recommended location is from 2' in front of the main beam to the transom.

Part 3

1. Measure for the trampoline by taking measurements across the hulls at every 12" starting at the main beam. Measure to the edges of the trampoline track. Measure from the aft edge of the main beam to the rear beam. Make a drawing of these dimensions to be used for the trampoline supplier.

NOTE: The hulls are now complete and the boat is now ready to be rigged.

PROCEDURE FOR INSTALLING TRAMPOLINE LACING EYES

1. Be sure to install 1/2" x 3/4" x 1 1/2" blocks under the gunwale at each location to be drilled.
2. Use a 9/16" wood drill bit and mark for 5/8" total depth of a hole. Bright colored tape works well as a marker.
3. Mark the inboard sides of each hull starting at the rear of the main beam. The first mark is 6" aft of the beam, and the spacing between marks is 6" for the remaining marks. The top of the hole to be drilled should intersect where the deck and hullside meet.
4. Drill each hole carefully keeping the drill vertical to hullside. If the point of the drill goes through the wood, fill the hole with thickened microspheres and allow to cure.
5. Adjust the hulls so that the hullsides at the deck area are level and fill each hole with a 206 mixture about 2/3rds full.
6. Push shackles into hole and use a 3" piece of plastic soda straw to align the shackles parallel with the deck edge and to hold the shackles up high enough to allow for the lacing line.
7. Allow to cure.
8. Remove soda straws, and fill holes to the top using a syringe. If you align the hulls so that the shackles are horizontal, the syringe filling can be done to the top without over-flow. If you are careful no sanding will be required.

NOTE: Trampoline lacing eyes are installed after all finish sanding is done, just before varnish or paint.

Recommendations - Hull Measurement

<u>Class</u>		
<u>Rule</u>		
8.i.	Deck Centerline Separation	2625mm
9.f.	Beams Set Into Hull	28mm
9.i.	Rear Edge of Main Beam Aft of Bow	3100mm
9.j.	Front Edge of Rear Beam Aft of Bow	5335mm
11.d.	Leading Edge of Centerboard Aft of Bow Template	2480mm
16.a.	Shroud Chainplate Aft of Aft Edge of Main Beam	715mm
16.c.	Forestay Chainplate Forward of Aft Edge of Main Beam	1985mm
16.d.	Bridle Height	840mm

Rigging The Boat

The best way to decide how to rig your boat is to attend several regattas, look carefully at the faster boats, and discuss what you see with the Tornado sailors present. Ideas about rigging change and are dependent upon the way helmsman and crew divide the responsibilities while sailing.

Another source of information is a good sailmaker. If you buy sails from a sailmaker you can usually expect him to provide advice.

The following notes are general in nature and will help you get started.

Trampoline

With the hulls set up, slide the tramp on the boat from the front. A one-piece tramp of block polypropylene is good. If the material is sewn at a 45 degree angle to the hullsides it will stretch tightly from the rear. Be sure to have the following:

- A. One or two pockets at the front for halyard tails.
- B. Hiking straps sewn on at the front and tied at the rear beam.
- C. Lashings under the tramp at the main beam for anchor and paddle.

Jib Strop

There are several ways to attach the jib blocks to the boat.

- A. Jib strop across the hulls. This strop may be moved fore/aft on the jib strop plate or on trampoline track slides and the blocks may be moved inboard/outboard several ways.
- B. A pair of fore/aft jib strops attached between the beams.
- C. Blocks mounted on the hulls used in conjunction with a barber in-haul on the boom.

The first alternative is the easiest and most flexible. Recommend 3mm (1 X 19) wire covered with 1/4" plastic tubing.

Jib System

The jib blocks are usually ratchet blocks with becketts and adjustable cleats and the jib sheet is usually a continuous 3/8" sheet line with 2-part purchase. A barber outhaul can be fitted to the ends of the main beam to pull both lines outboard for off wind sailing.

Mast-Standing Rigging

Shrouds

Recommend 3mm (1 X 19) wire with a nicopress and thimble fitting at the top and a turnbuckle or halfturnbuckle at the hull attachment point.

Forestay

Recommend 3mm (1 X 19) wire with a nicopress and thimble fitting at the top and a turnbuckle at the bridle attachment point.

Forestay Bridle

Recommend 3mm (1 X 19) wire with fork terminals for hull attachment and one fork-one eye terminal for attachment to the forestay turnbuckle.

Diamonds

Recommend 3mm (1 X 19) wire with fork terminals at the top and shroud adjusters at the bottom. Don't forget to install the plastic sail protectors when preparing the wire.

Mast-Running Rigging

Main Halyard

Recommend 1/4" line (62') with halyard ring for the top of mast.

Jib Halyard

Recommend 3mm (7 X 7) wire. Swage a shackle with a retainer pin to one end, and a thimble to the other end. A halyard tail of 3/16" or 1/8" line is sufficient. The halyard wire should be attached to a 3 or 4 part purchase device to allow adjustment of the jib luff.

Trapeze Wires

Recommend 2mm (1 X 19) wire with thimbles at the top. At the bottom, a trapeze handle and a block for 1/4" line. Use a short line led through the block and attach the trapeze ring to one end and tie a knot at the other end. At the knotted end attach shock cord (3/16") and lead through the main beam to the other trapeze wire.

Boom

Mast Angle Control

There are two general ways to limit the rotation of the mast. The control line from the mast rotator can be attached to the boom or from the base of the mast to a pair of lines under the trampoline that lead to the two hulls.

The recommended method is to lead the mast rotator control line to a clam cleat mounted on the top of the boom.

Main Downhaul (Luff Tension)

A minimum of a 6 part downhaul is required to be able to adjust the main easily. There are numerous ways to arrange the purchase including:

- A. A pair of triple blocks
- B. A "magic box", mounted on or in the mast
- C. A drum winch mounted on the mast

The easiest method is to use a pair of small triple blocks with the control line leading to a clam cleat mounted on the top of the boom.

Clue Outhaul

The clue should be attached to a roller traveler mounted on top, or inside, the boom. The amount of travel needed is 8-10". A minimum of a 4 part purchase is needed to outhaul the sail. The inhaul is controlled by heavy shock cord (3/8").

Mainsheet System

A 7 or 8 part purchase system is recommended. Roller bearing blocks are a real asset. A ratchet block as the last block with a cam cleat mounted on it can be used in steady air. The sheet line (3/8") can be a continuous line and serve as the sheet for the 2 part traveler control line also. Attach the blocks well aft on the boom to rotate the mast.

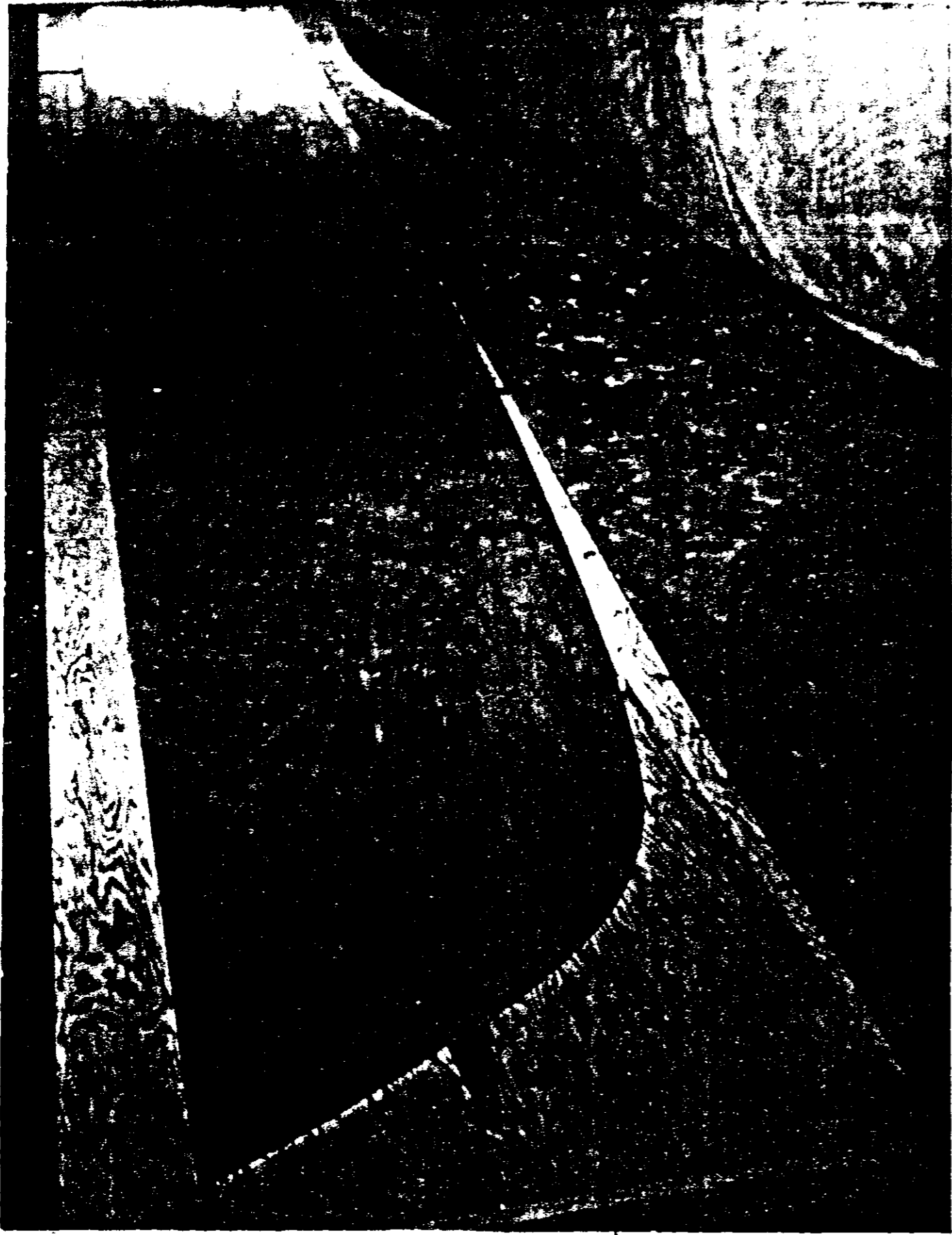
Centerboard Control

The centerboards can be controlled with friction tape or with control lines and cleats. Direct control with friction tape works well with a good crew and is very clean. This method should not be used if you sail in water having a lot of weeds, control lines are better in this case.

PHOTOS

1. An excellent scarf joint glued with WEST epoxy. They should be kept at least 4 feet from the transom.
2. The full hullside drawn, cut to shape, and matched to the other hullside. Ready now for wiring up.
3. Hullsides wired together, gunwales wedged apart to get the correct keel angles, and the inside keel glassed.
4. A deck jig on the right built from the plans. Rough cradles on the left to support the hullsides until the inside keel is glassed.
5. Copper wires have been cut off and the keel sanded. Masking tape being installed before outside keel glass is put on.
6. Hull being wetted down in preparation for folding into the deck jig. The other hull ready for this step also.
7. Hull inside the deck jig and held in place with three strap clamps. The deck jig is supported by parallel sawhorses. Note the support stick holding the transom shape while the wood dries.
8. Deck jig turned over and supported by the sawhorses. Ready now to fit transom.
9. Transom fitted and epoxied into place. A fillet on the inside completes the glueing process. Fasteners are unnecessary. Note how the clamps force the transom down to the hullsides.
10. Main bulkhead in place. A loose fit is desirable since 10 oz. glass cloth will be between the bulkhead and the hullside.
11. Main bulkhead epoxied in place and held there by the beam chocks. Foam bowspacer installed.
12. Hullsides completely glassed and coated. Siamese cat observing it all.

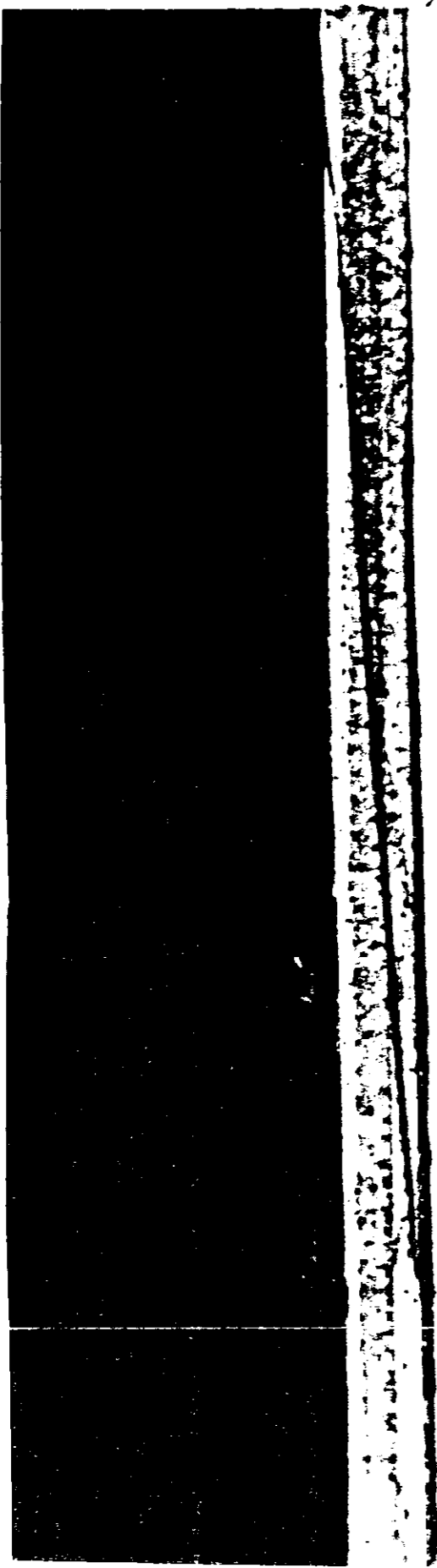
2.



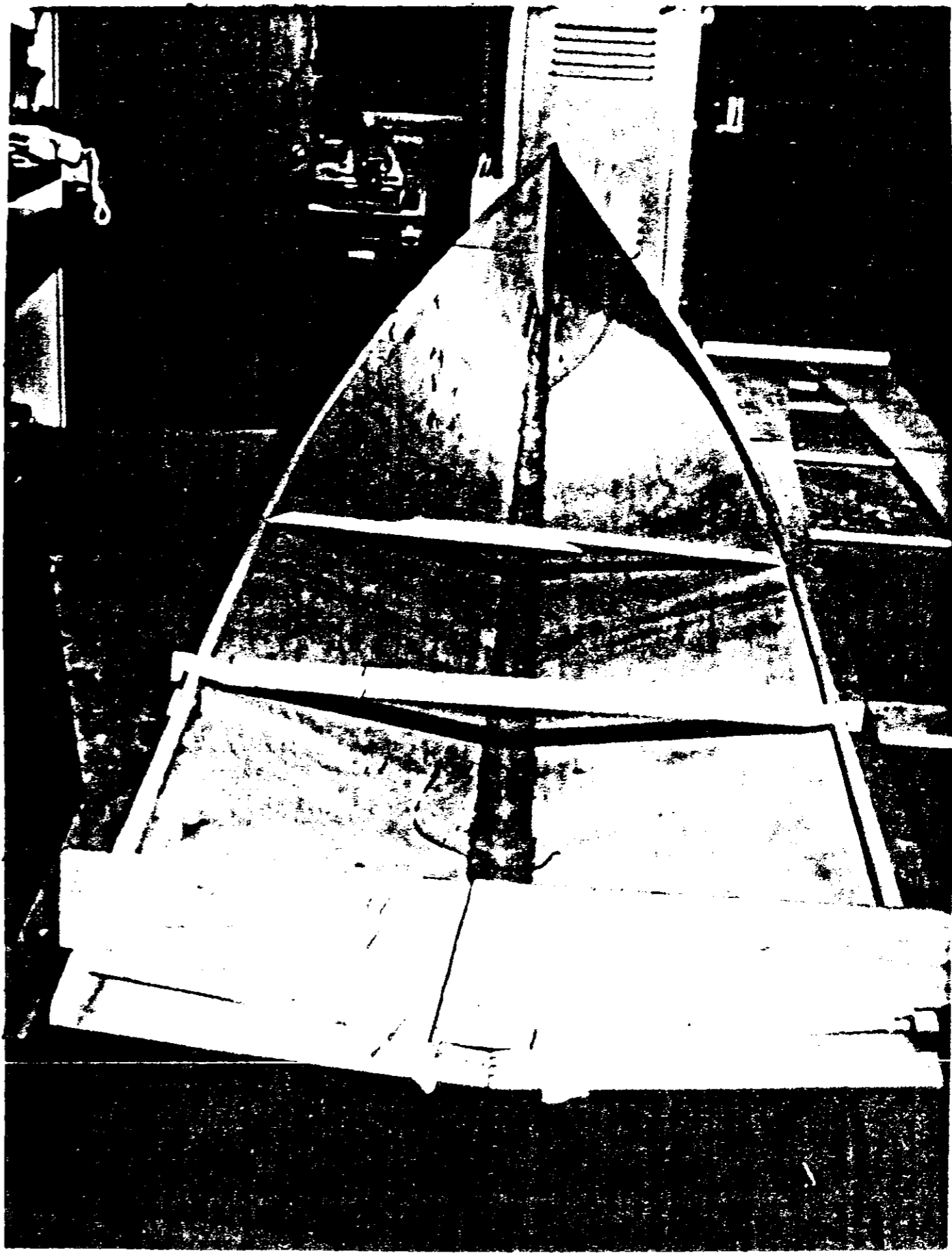
4.

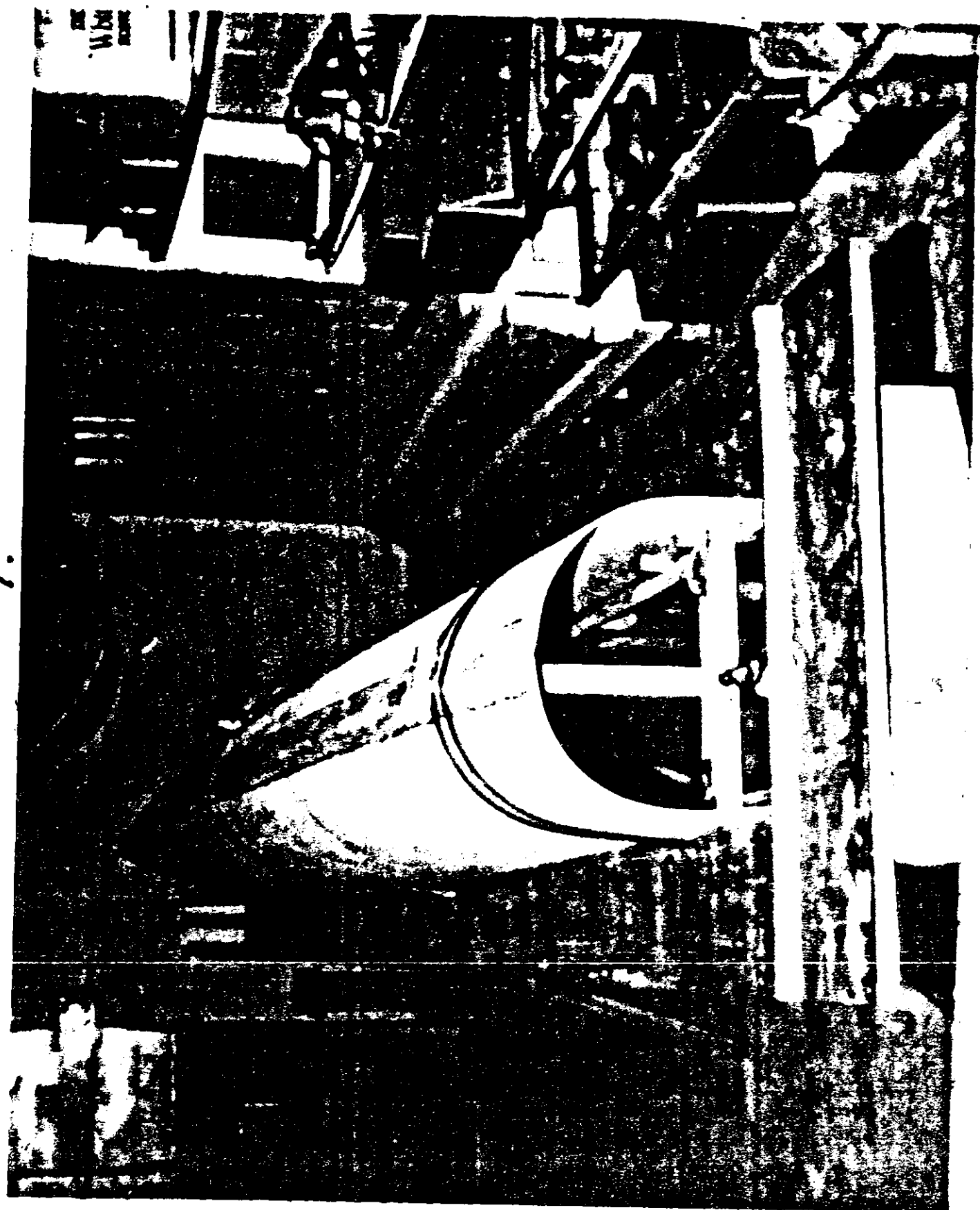
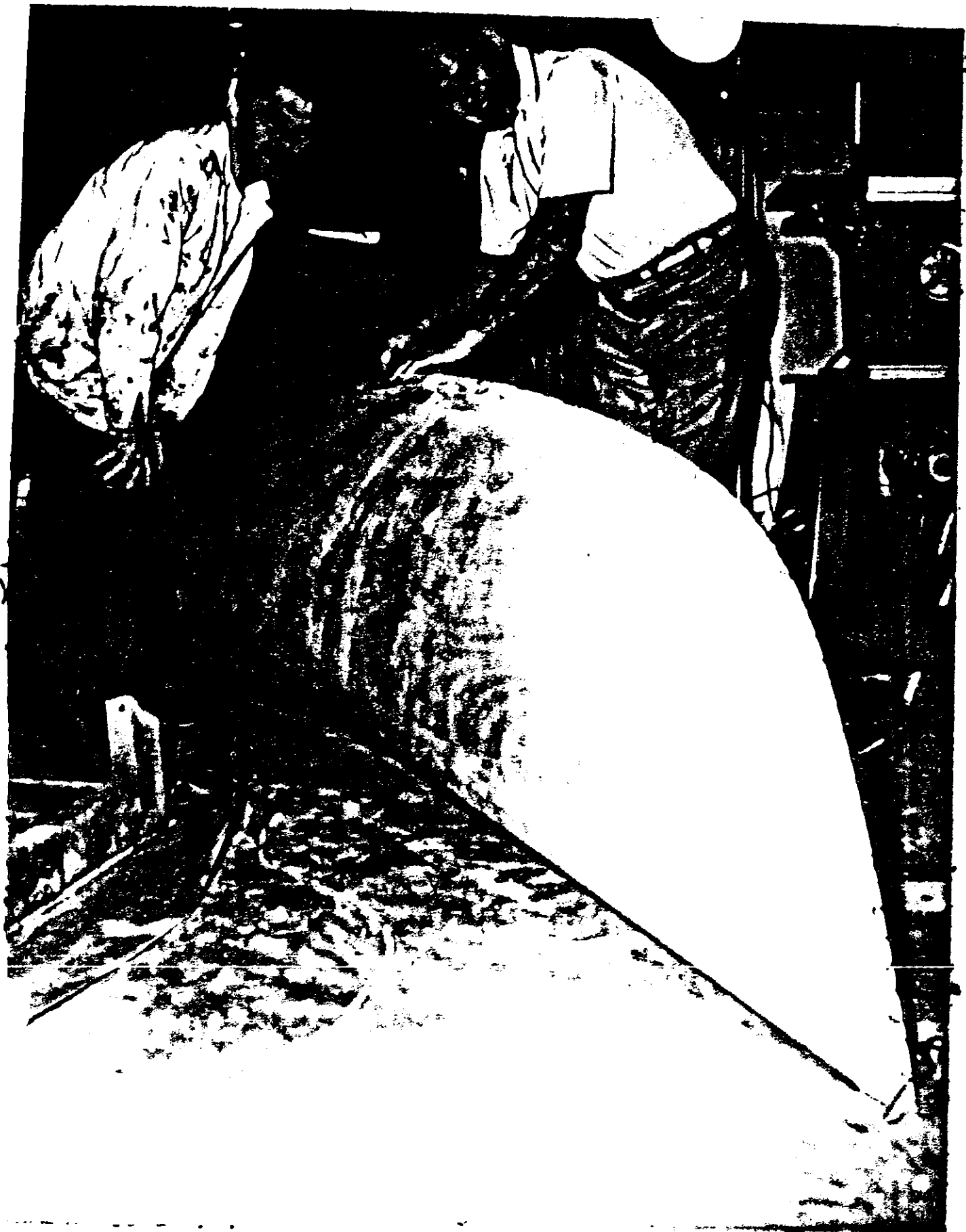
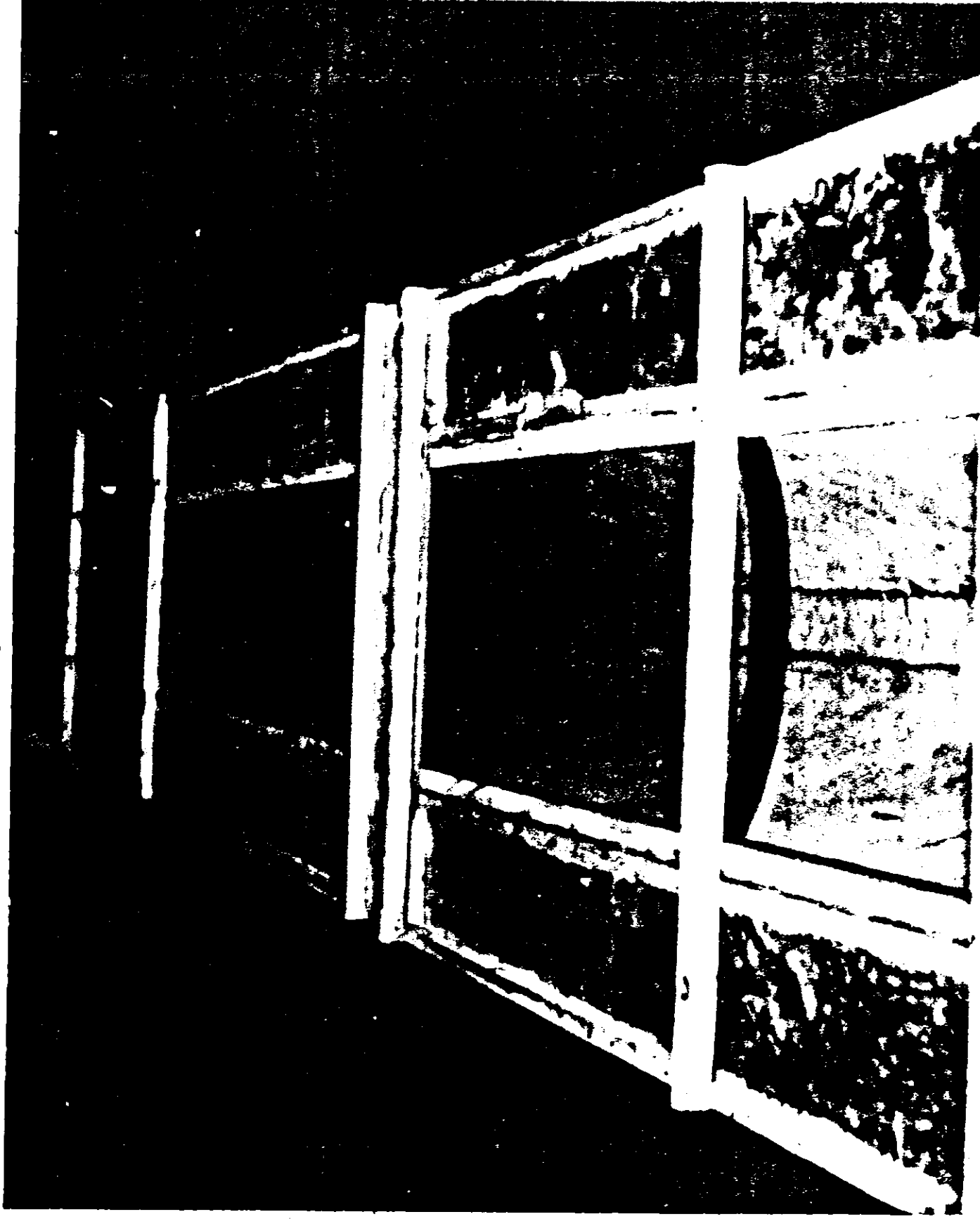
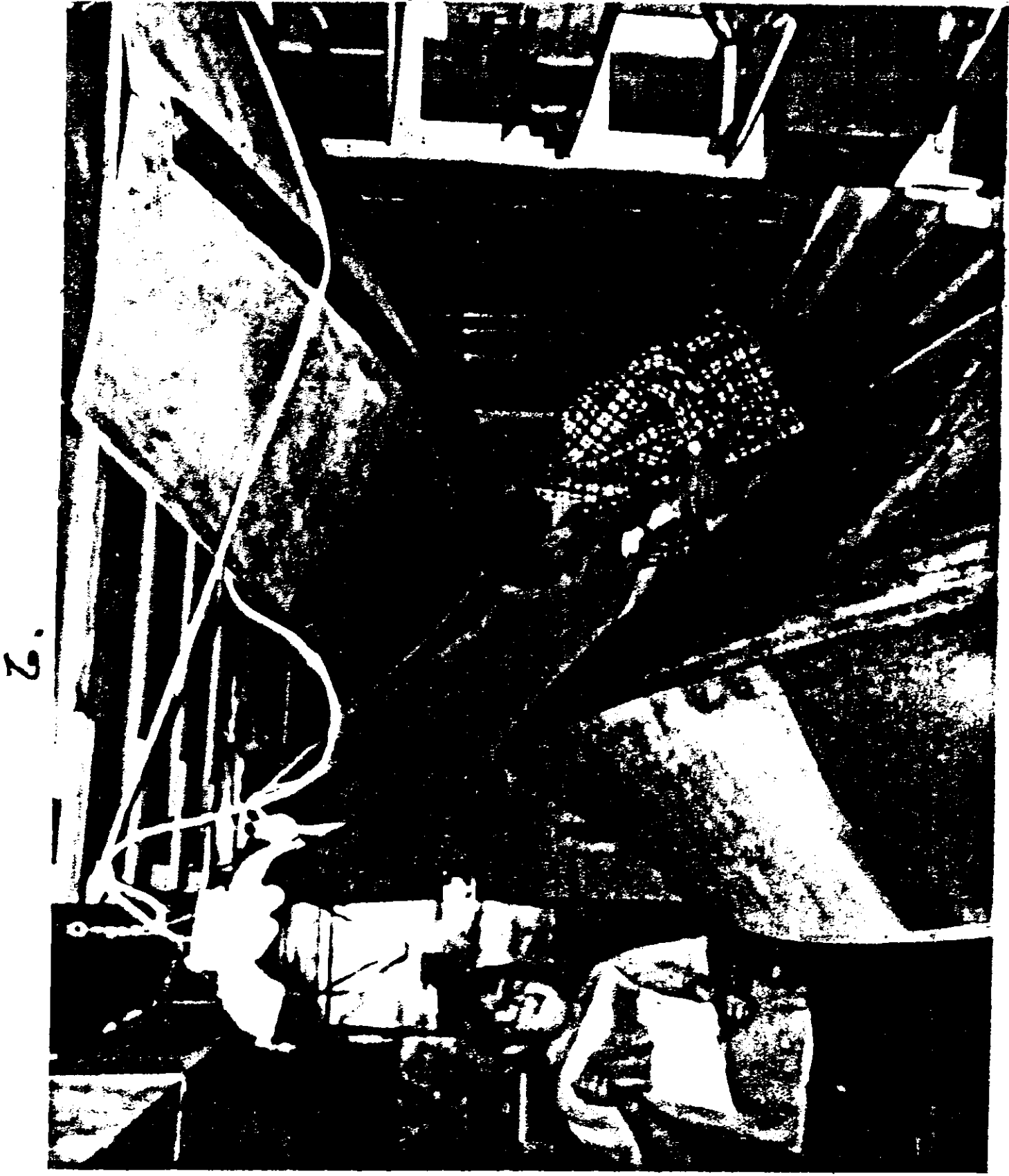


1.



3.





10.



12.

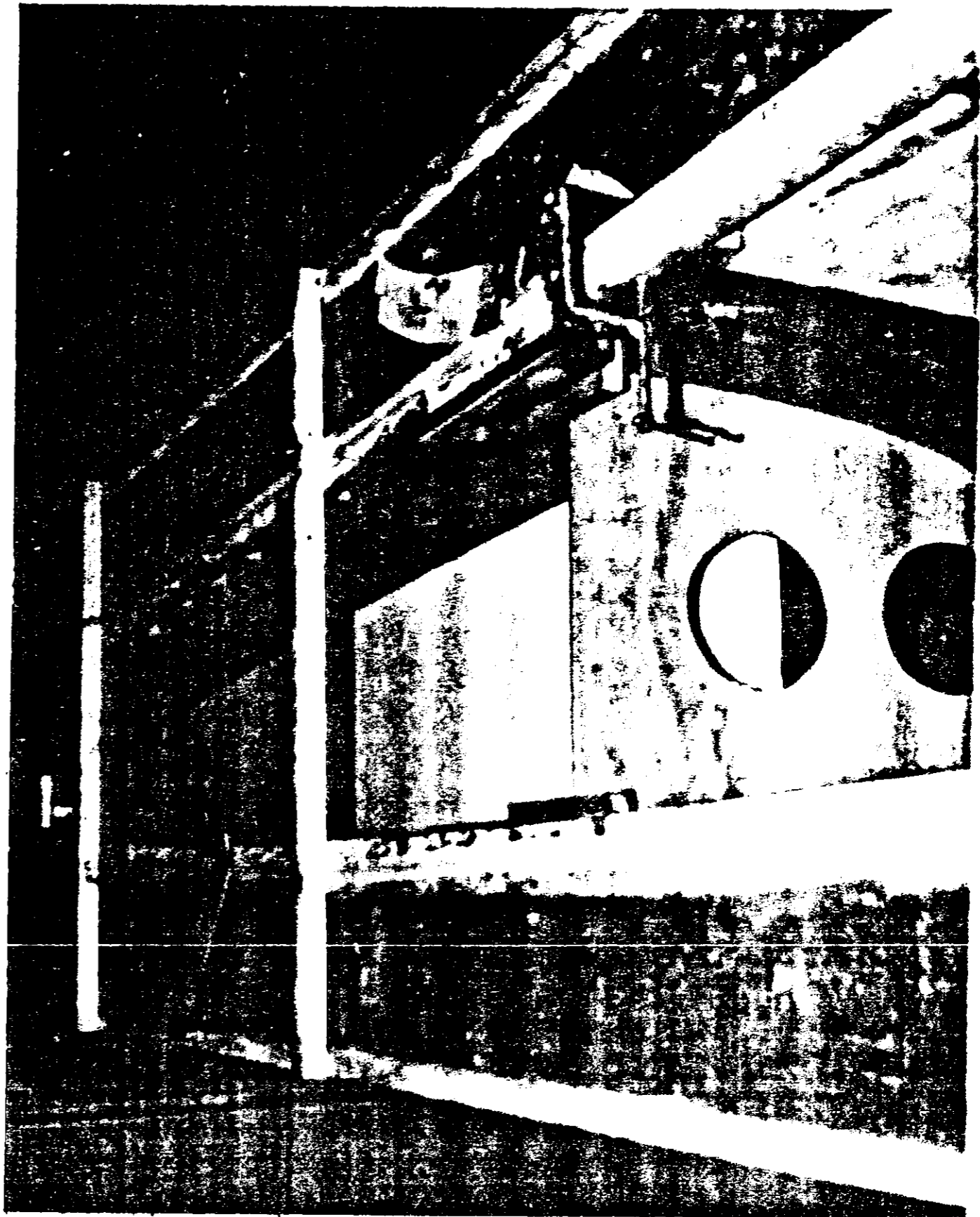


13. 1307 1307 1307

9.

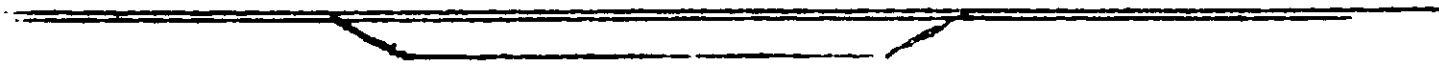


11.

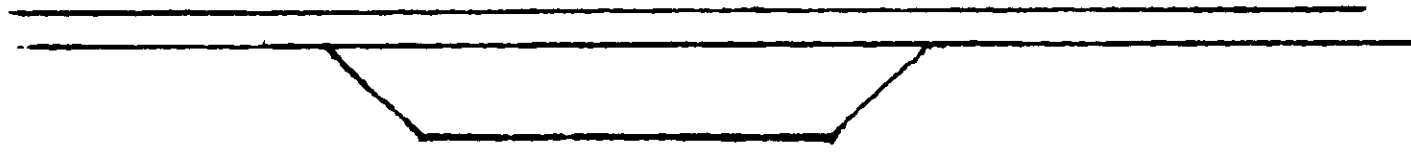


FITTING BEAM CHOCKS

TOP VIEW



SIDE VIEW



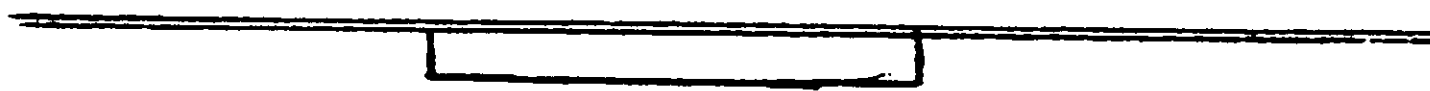
END VIEW



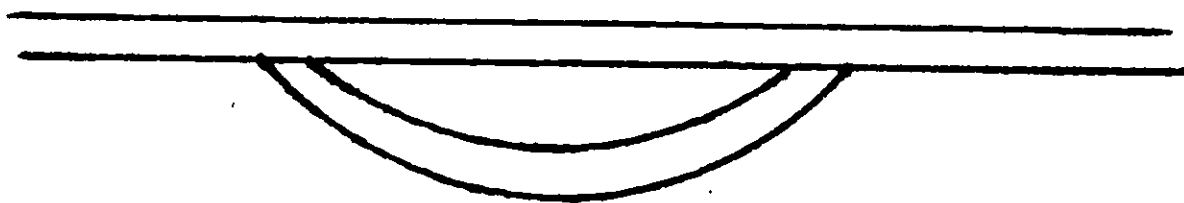
NOTE: CENTER THE BEAM CHOCKS AT THE CENTER OF BEAMS.

HBC PLY KIT (LAMINATED VENEER CHOCKS)

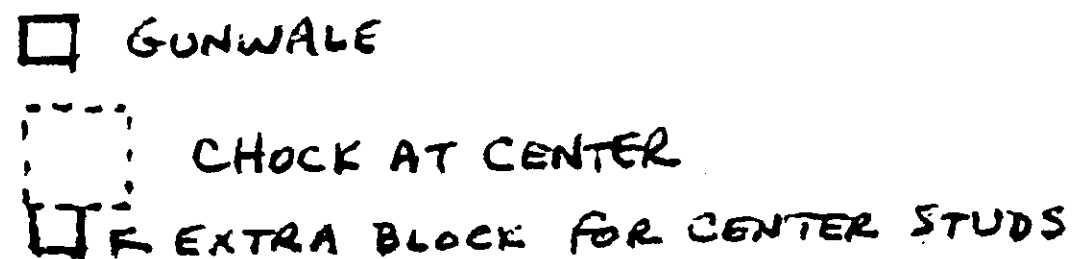
TOP VIEW



SIDE VIEW



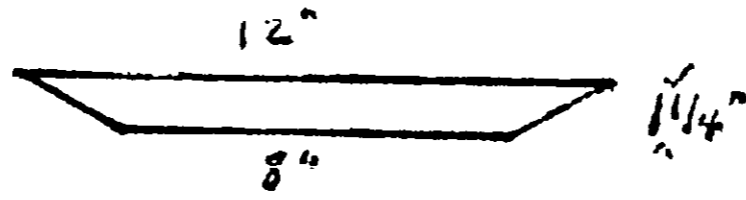
END VIEW



NOTE: PLY DISH IS FITTED TO TOP OF BEAM CHOCK.
CHOCK IS SET DOWN FROM GUNWALE TO ALLOW
BEAM TO CLEAR PLY DISH BY 2MM AFTER
BEAM CUTOUT IS MADE.

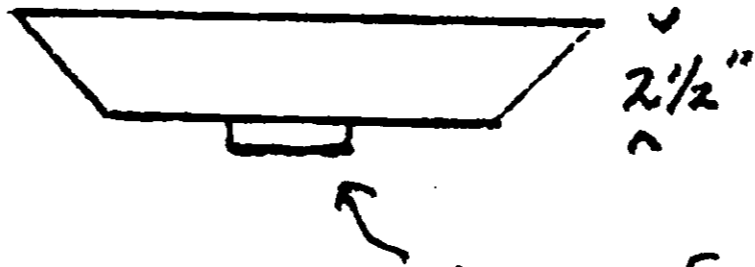
BEAM CHOCKS

TOP VIEW



NOTE: MAKE FROM 1 OR MORE PIECES OF SITKA SPRUCE

SIDE VIEW



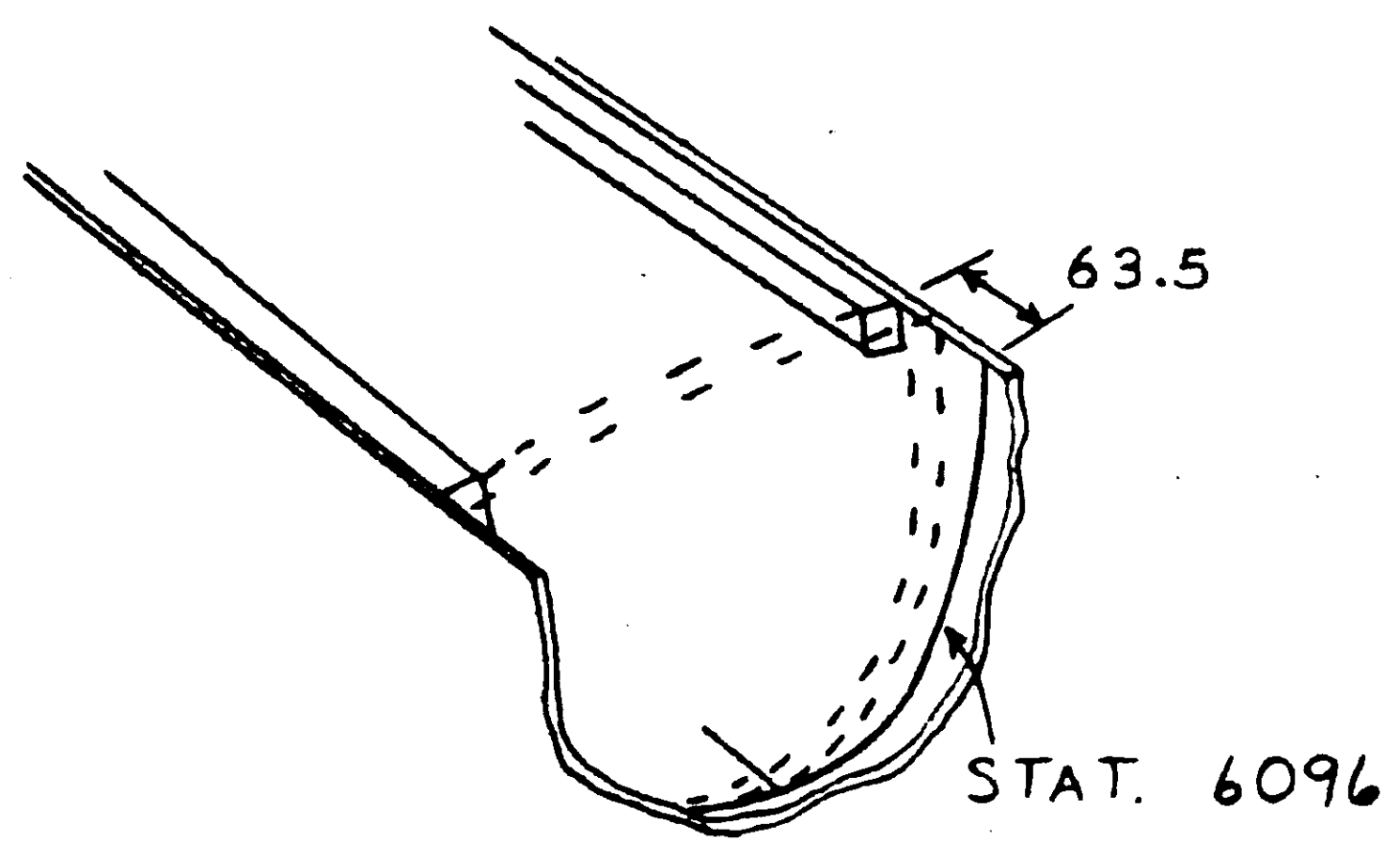
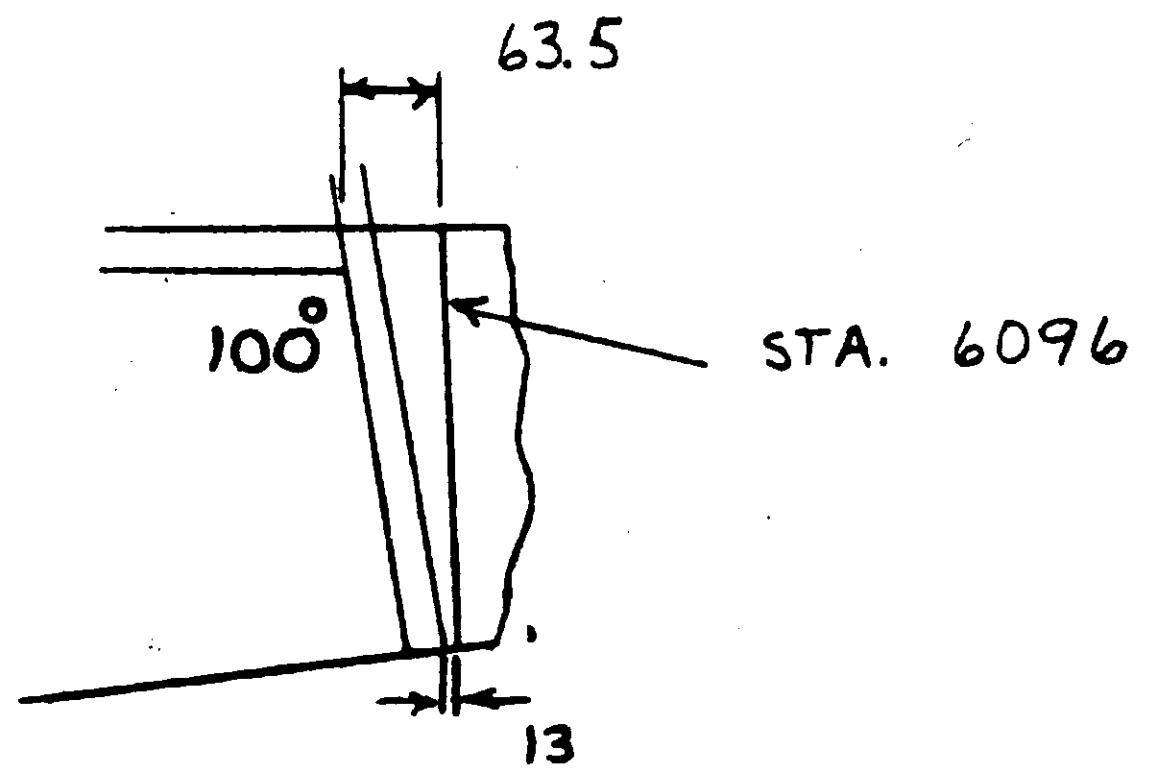
NOTE: FOR THOSE CHOCKS THAT WILL HAVE CENTER STUDS OR BOLTS, ADD THIS PIECE 1" D, 1 1/4" W, 3" L.

HBC BEAM CHOCKS (PLY KIT)

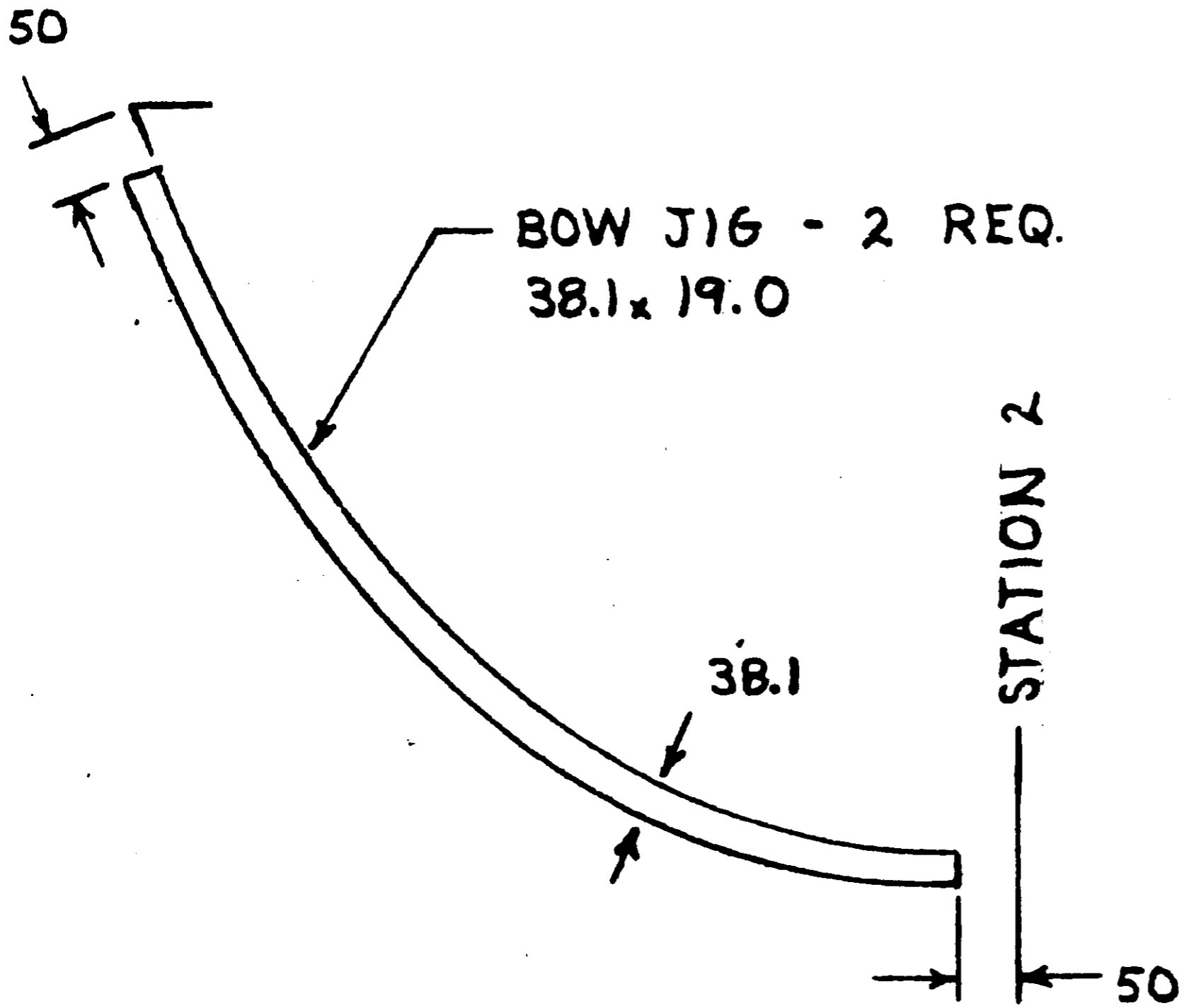
SIDE VIEW



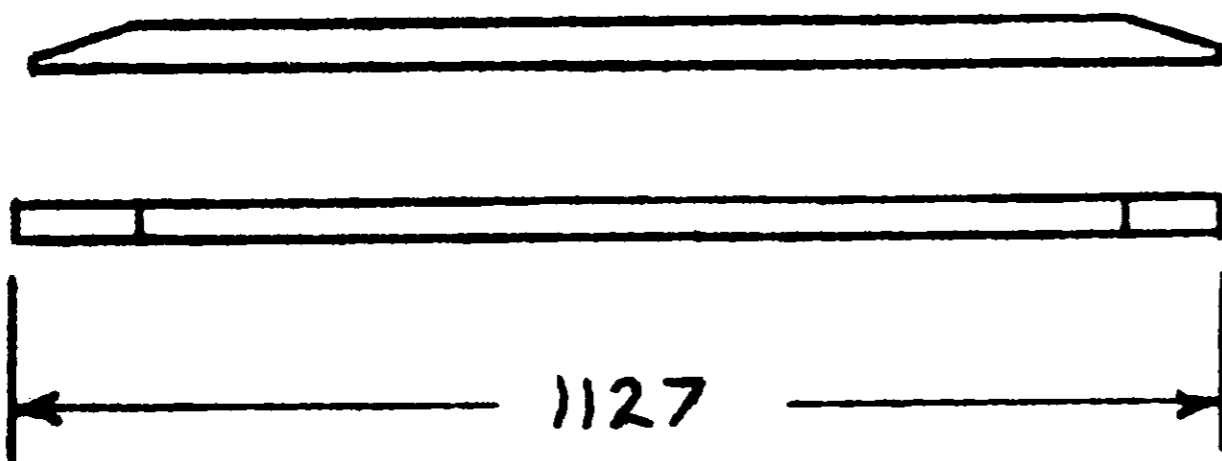
NOTE: MADE FROM 14 LAMINATES OF SITKA VENEER



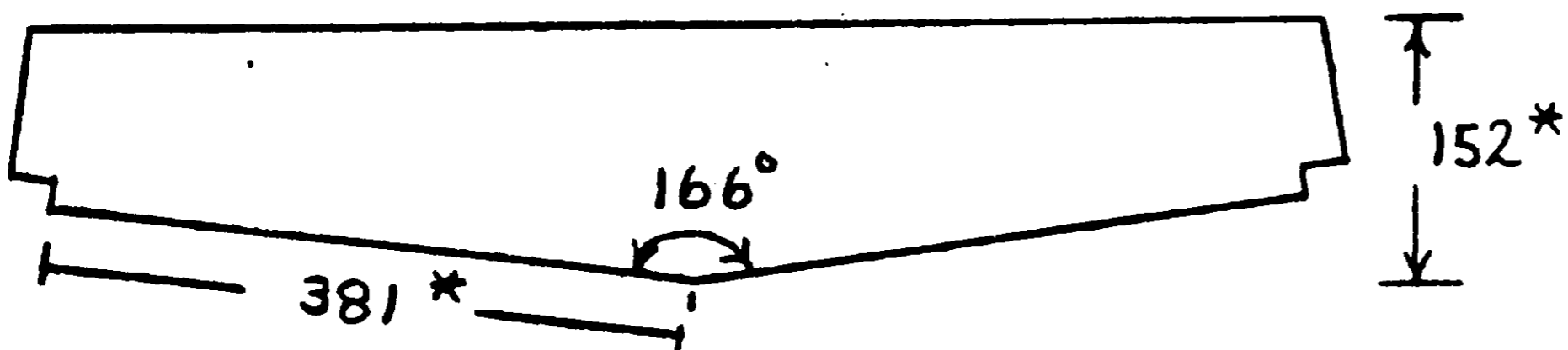
[REDACTED]	
TRANSOM LOCATION	
	SK-



STATION 12 PROP.



STATION 20 JIG

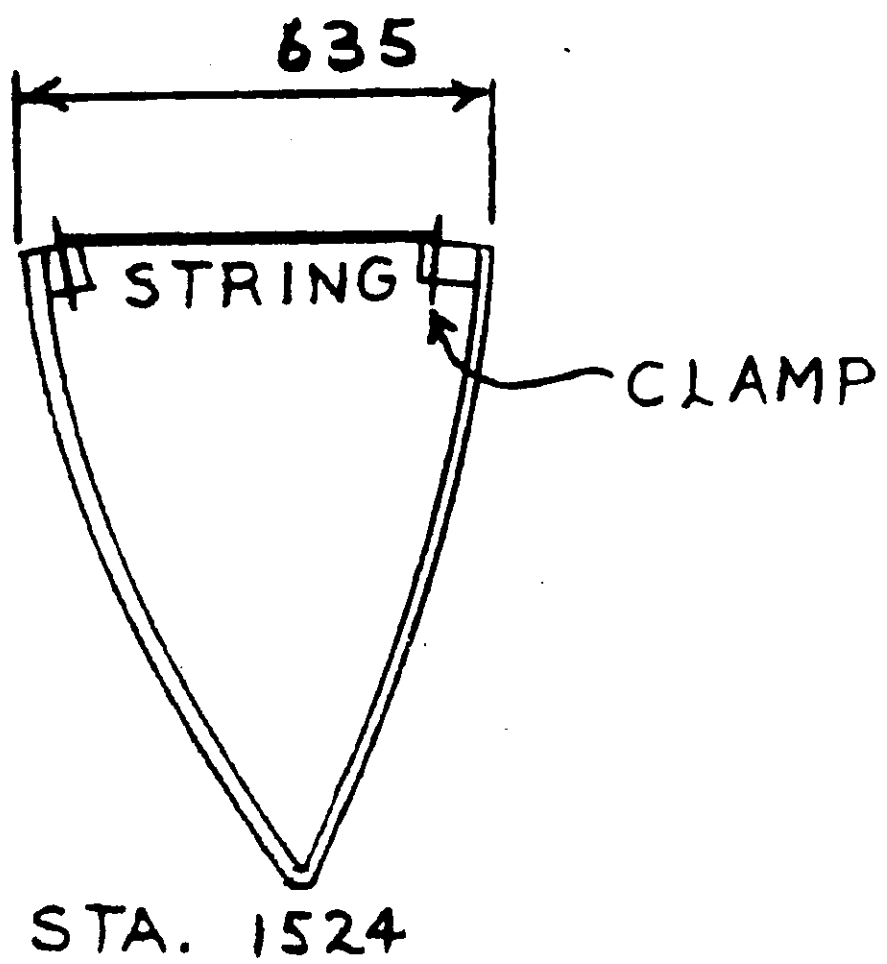
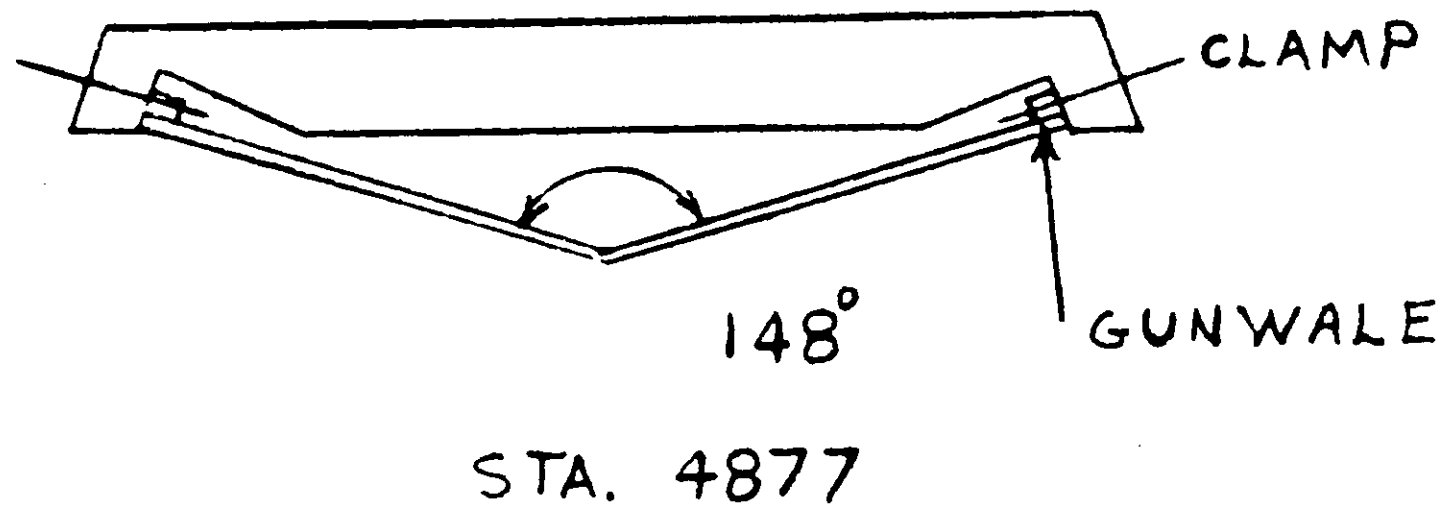
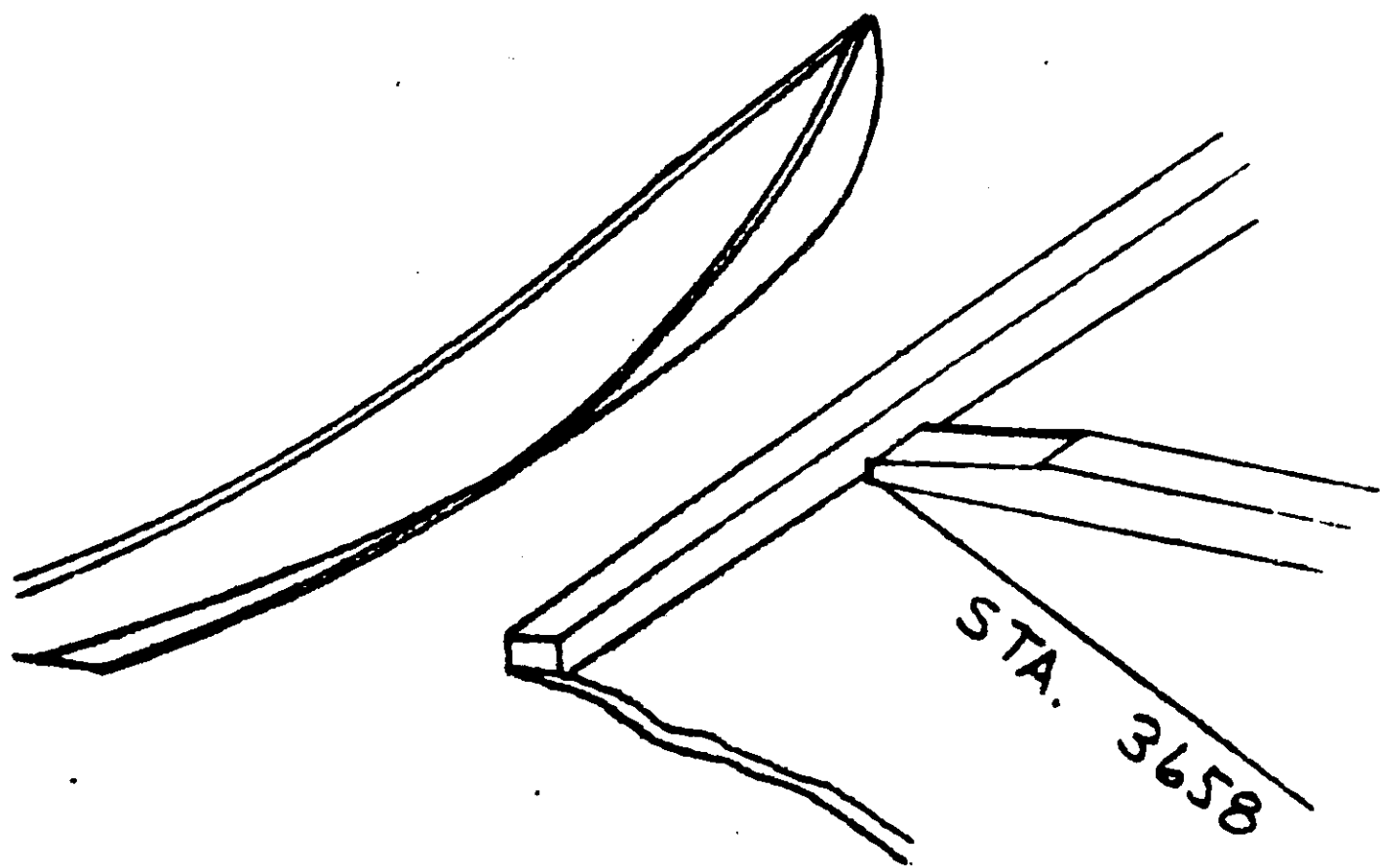
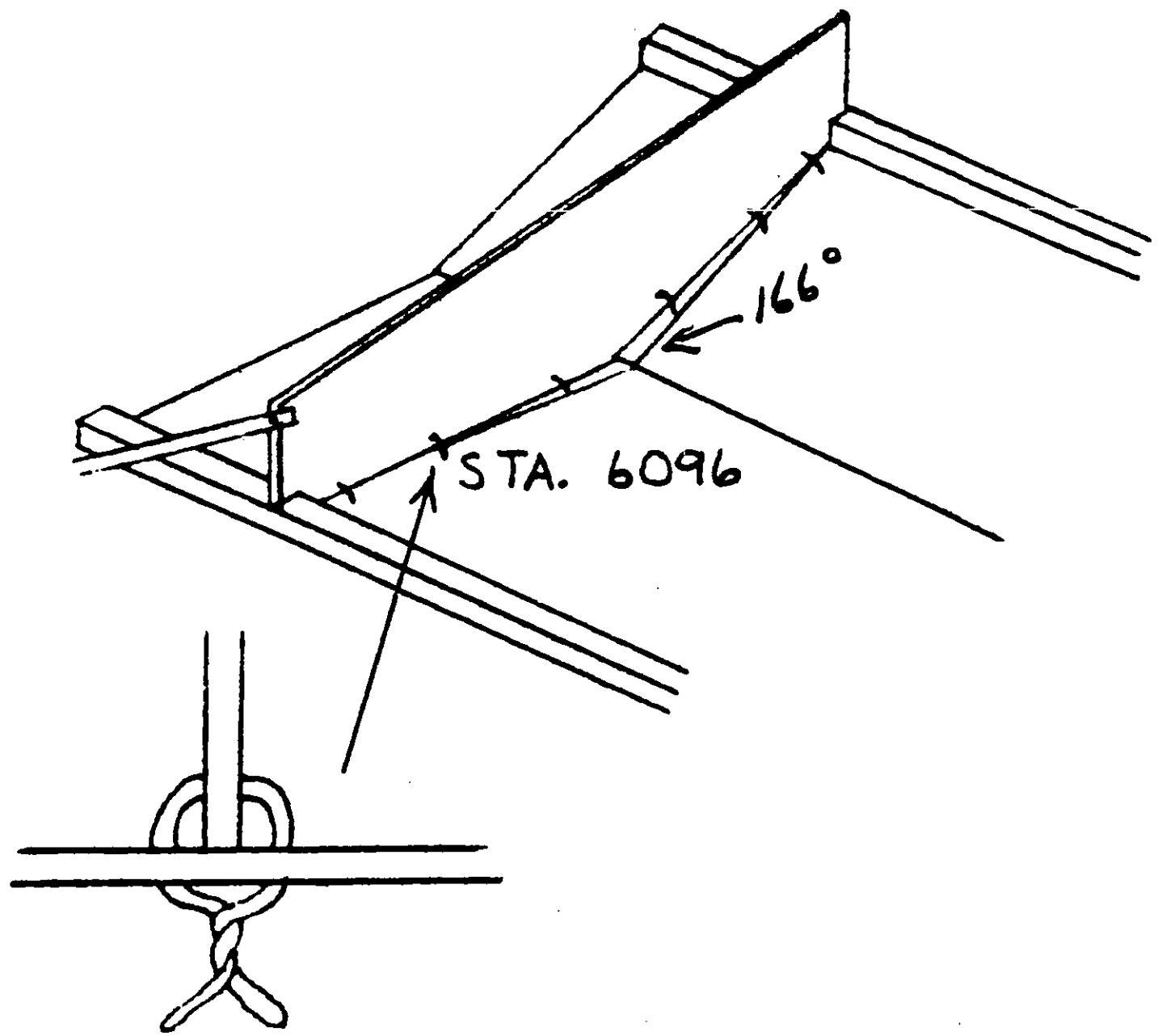
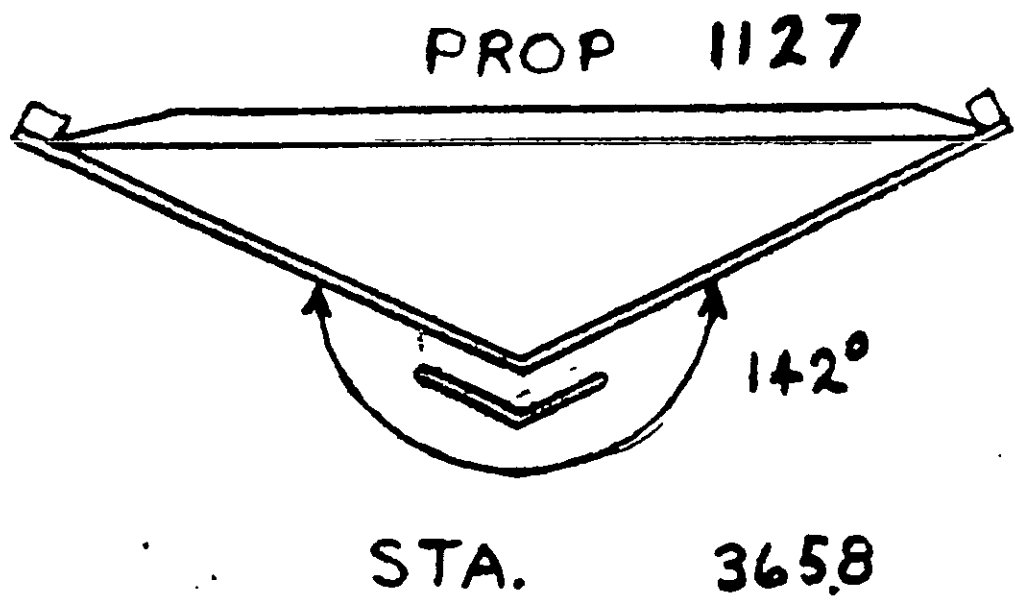


* = APPROX.

[Redacted]

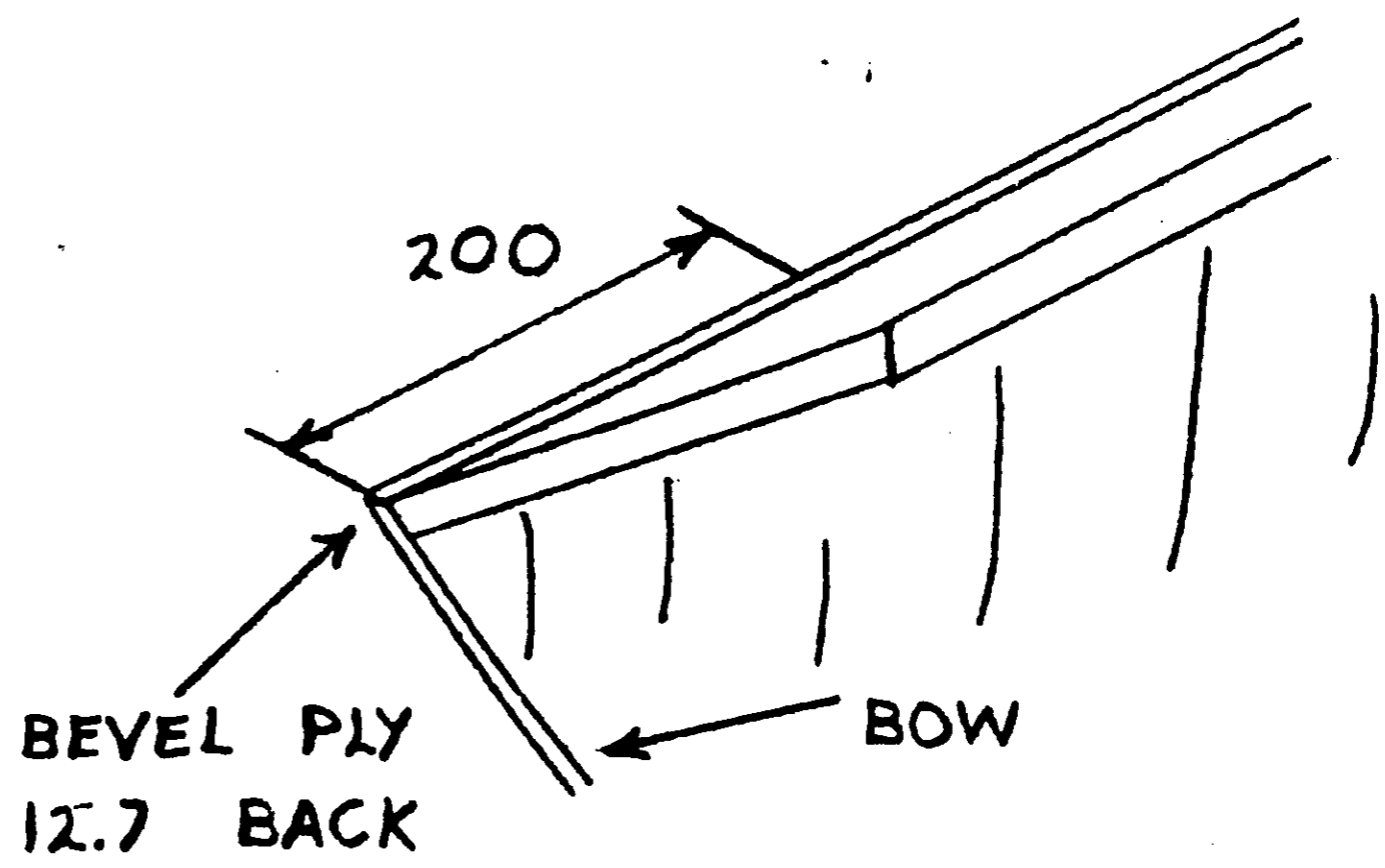
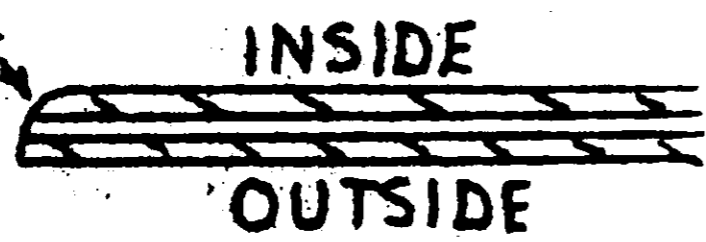
KEEL ANGLE JIGS

SK-



KEEL ANGLE JIGS	
	SK-

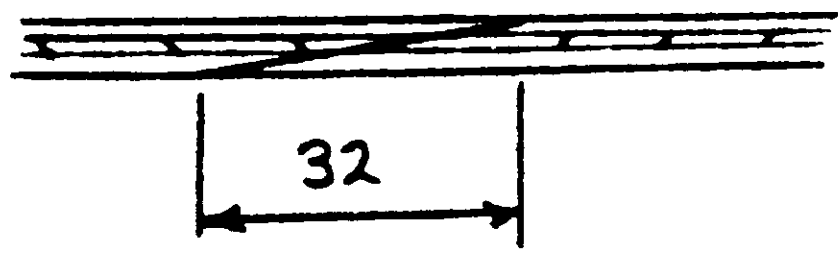
RADIUS AT
KEEL



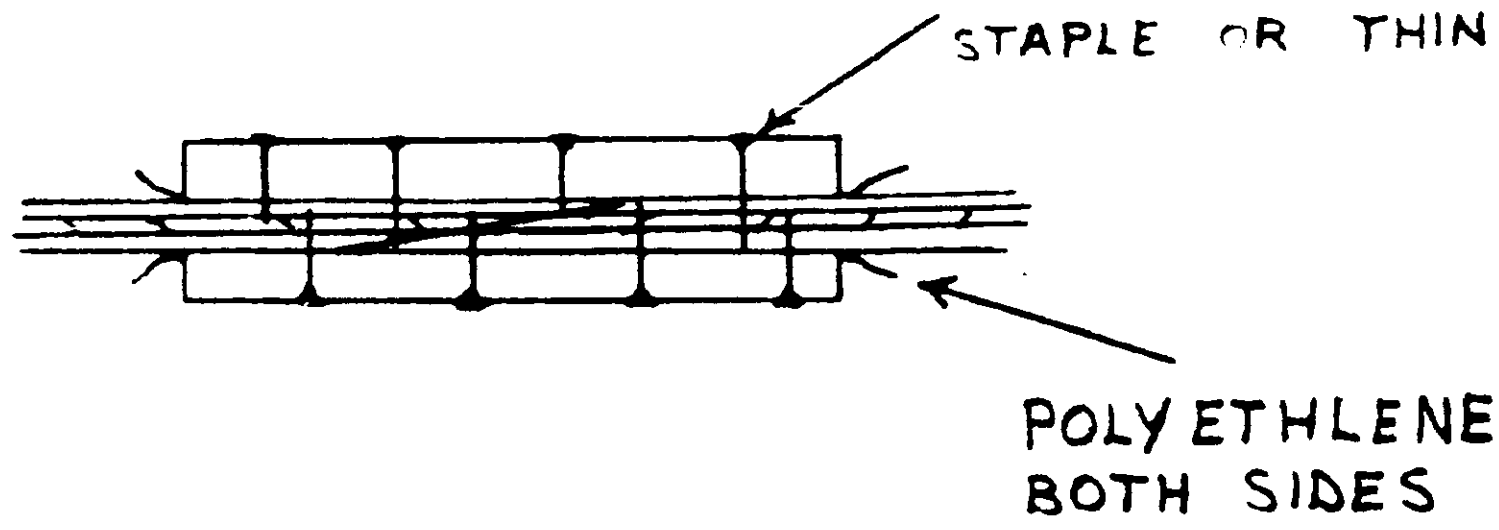
CONSTRUCTION NOTES

SK-

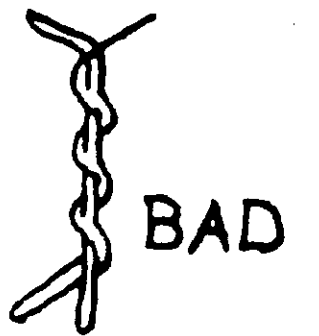
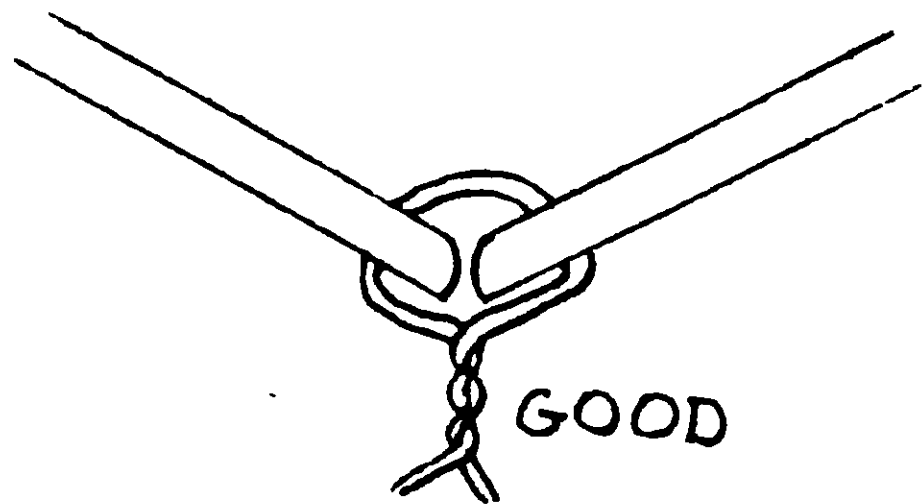
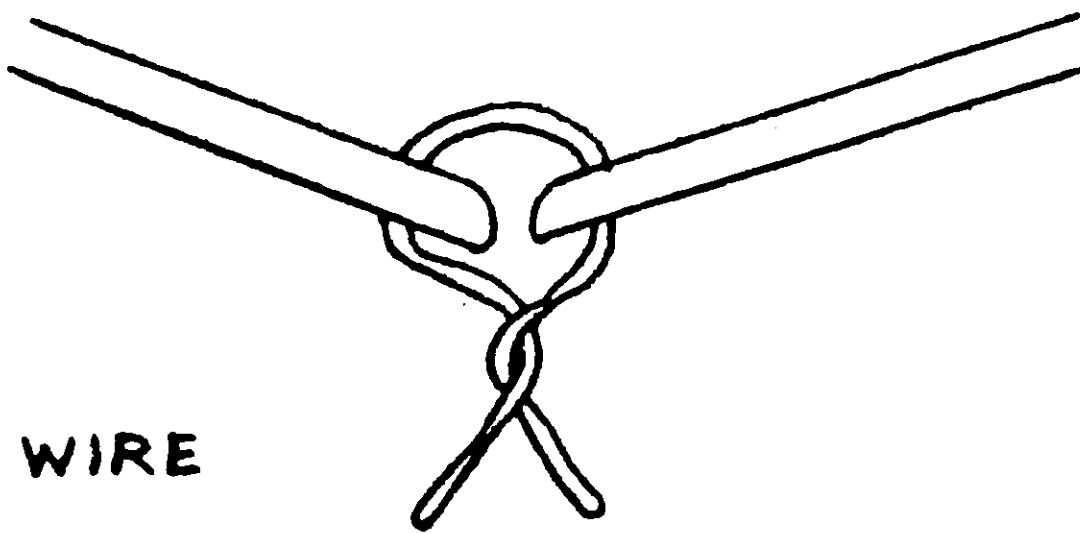
SCARF JOINTS



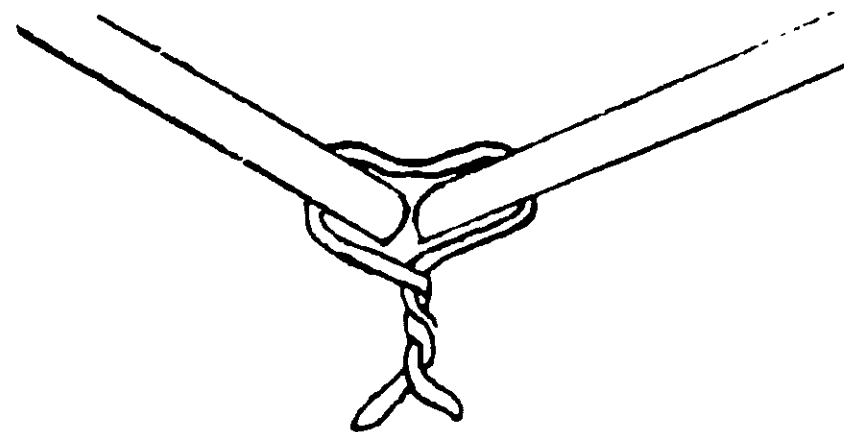
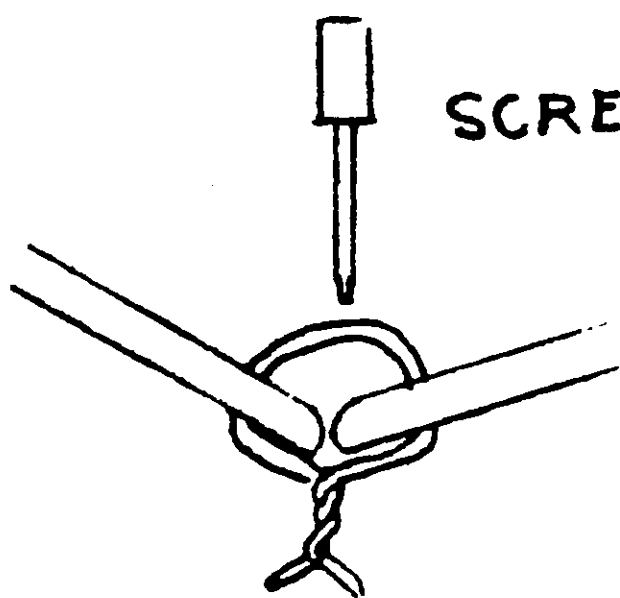
8 TO 1 SCARF



5" WIRE

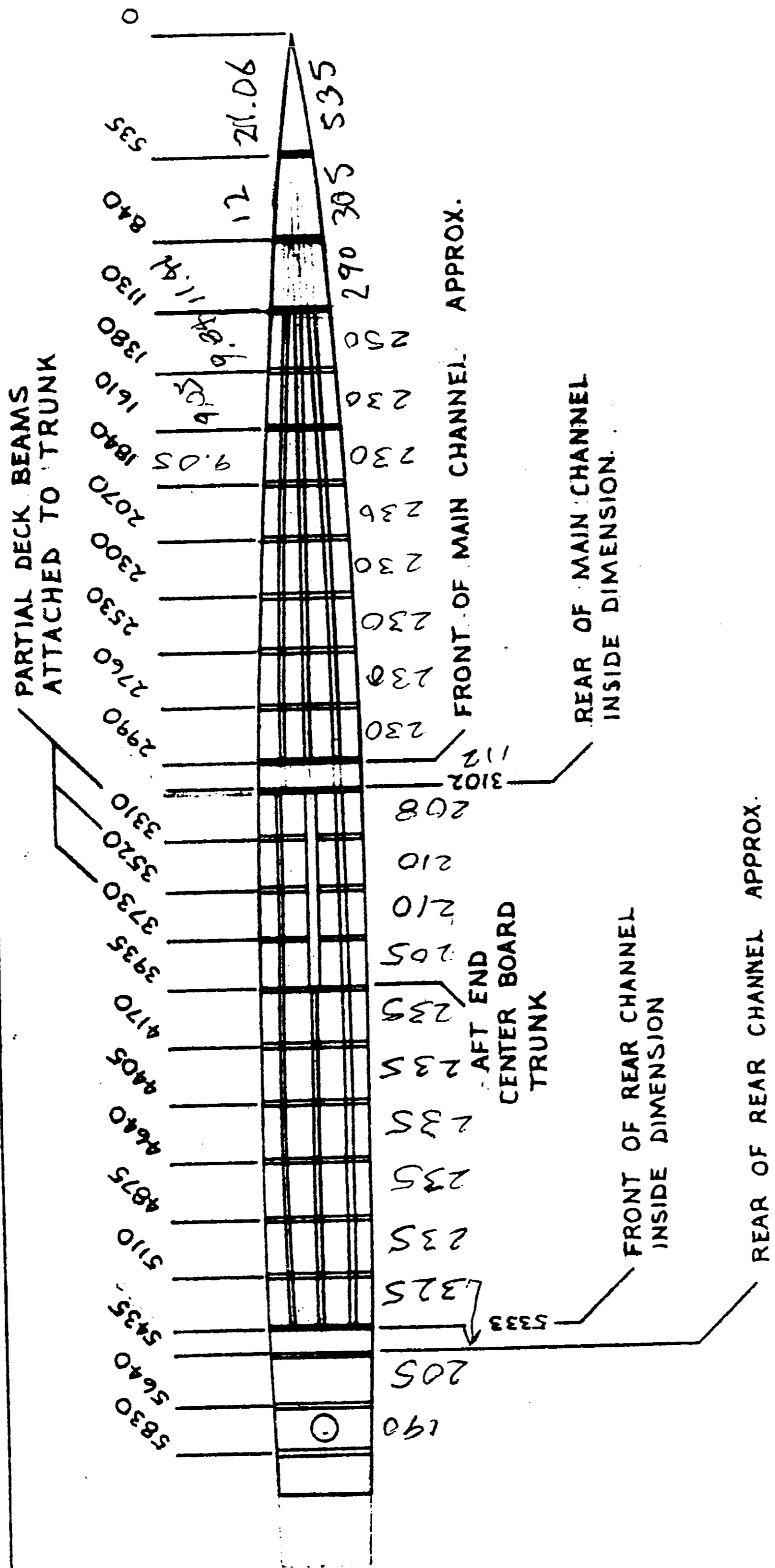


SCREW DRIVER



CONSTRUCTION NOTES
FOR KEEL

SK-



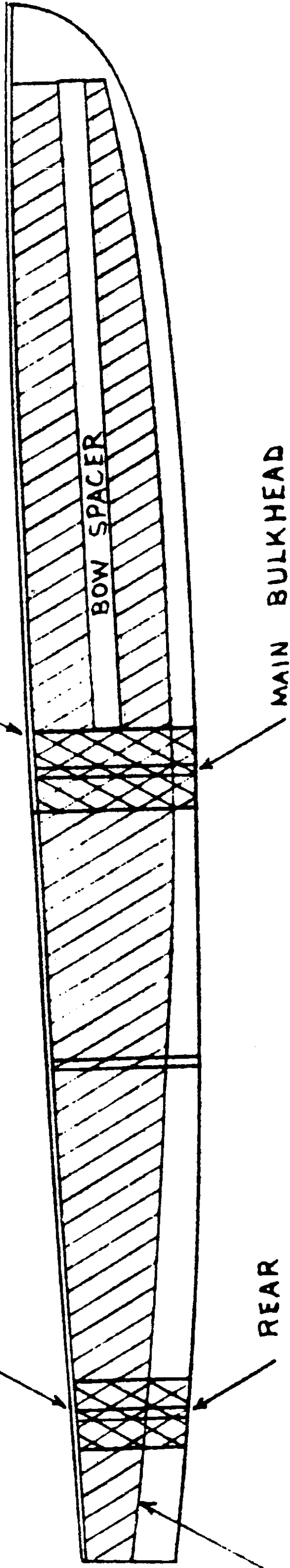
NOTE: STRINGERS ARE 4 MM X 25 MM CHANNELS ARE 4 MM WIDER THAN BEAMS

10/2/20

TORNADO DECK BEAM AND STRINGERS	WRO
SHEET NO.	

406.4 WIDE INBOARD
304.8 WIDE OUTBOARD

304.8 WIDE INBOARD
203.2 WIDE OUTBOARD



REAR BULKHEAD

MAIN BULKHEAD

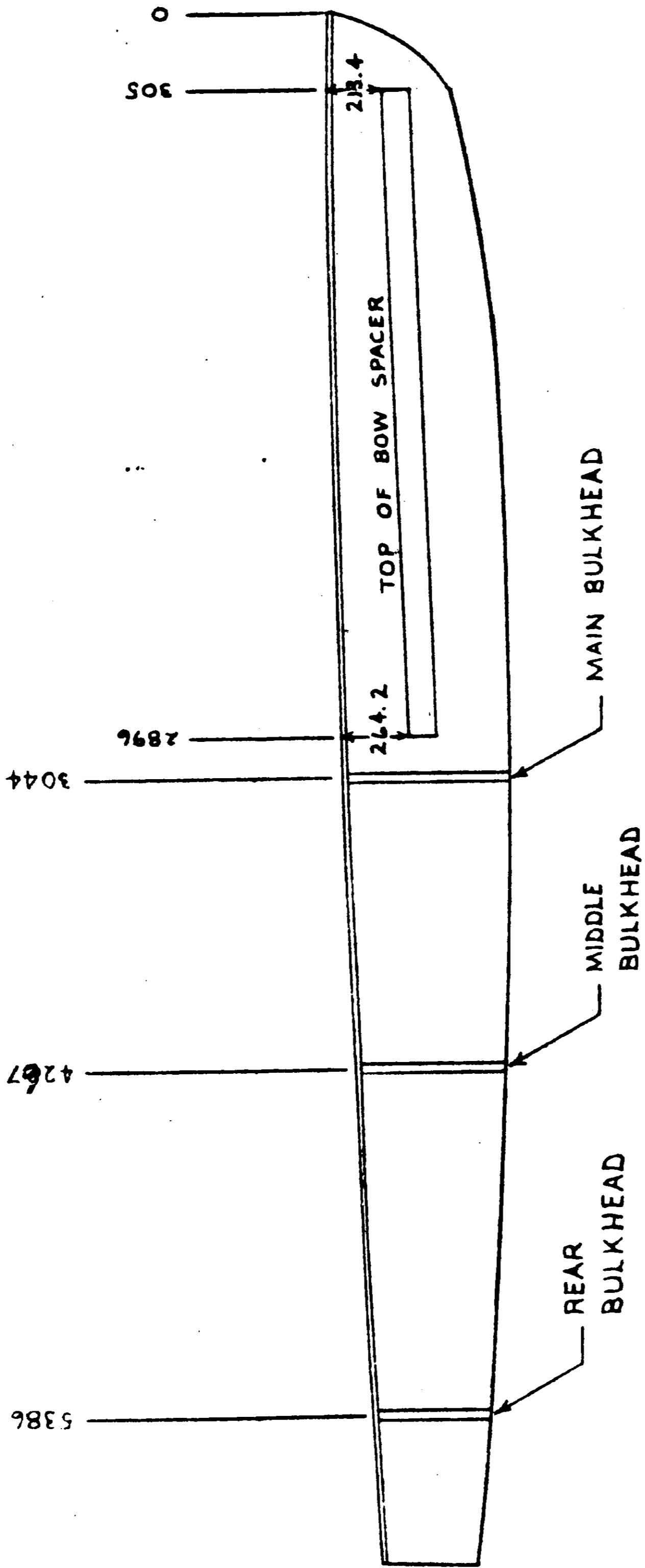
THIS LINE 25.4
BELOW MAJOR
AREA OF HULL
CURVATURE

ONE LAYER CLOTH

TWO LAYER CLOTH

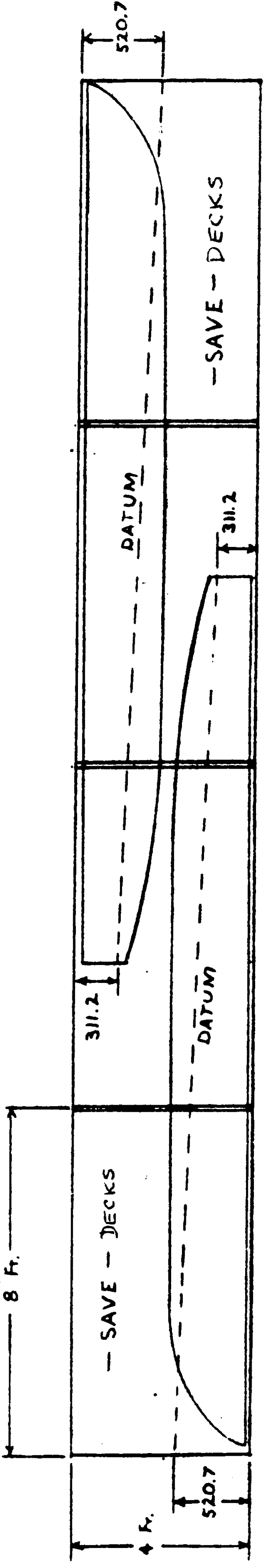


TORNADO,
INSIDE GLASS CLOTH
WRO



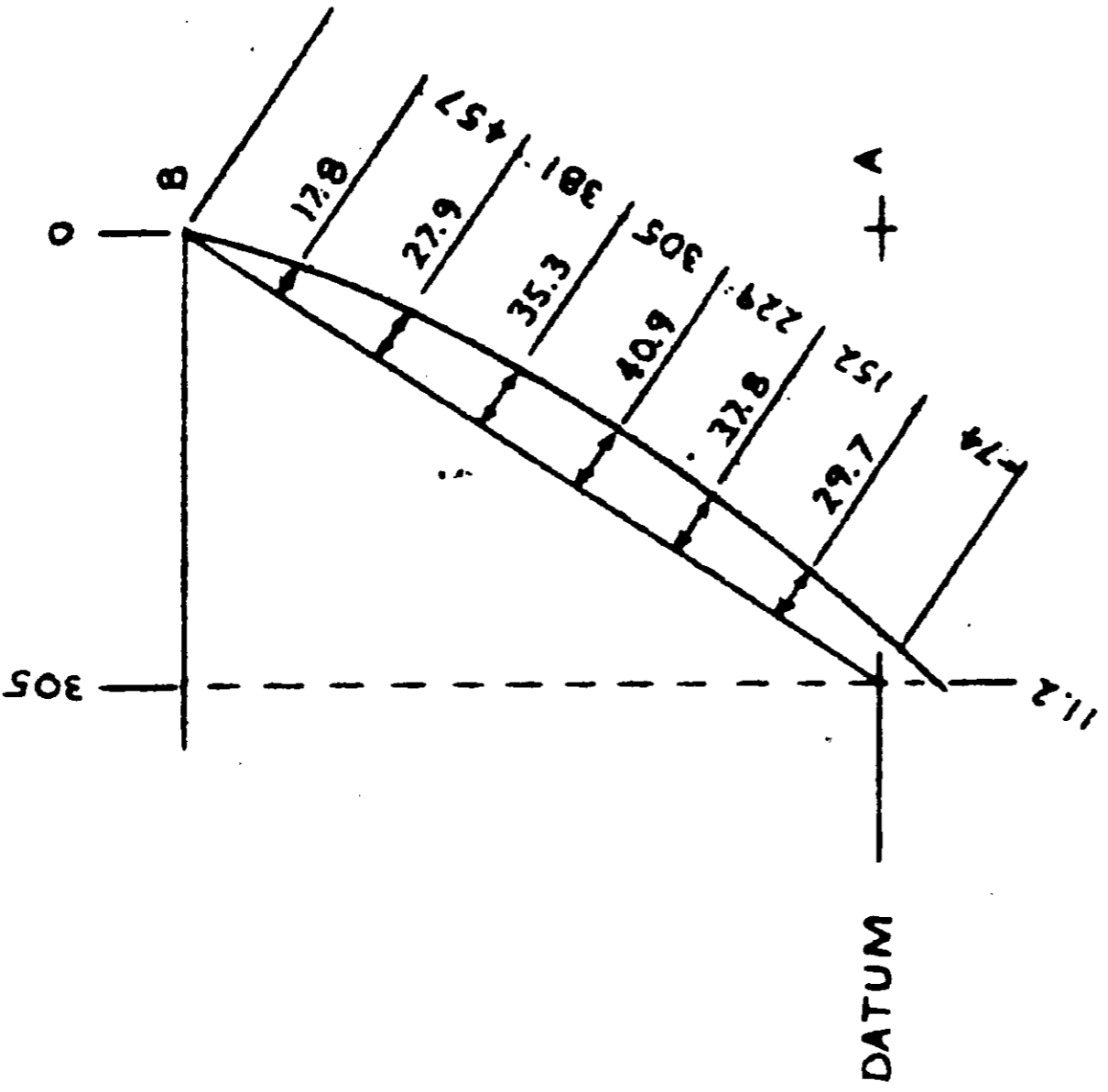
TORNADO, BULKHEAD
 BOW SPACER LOCATION
 SHEET NO. 6 WRO

0134
 014

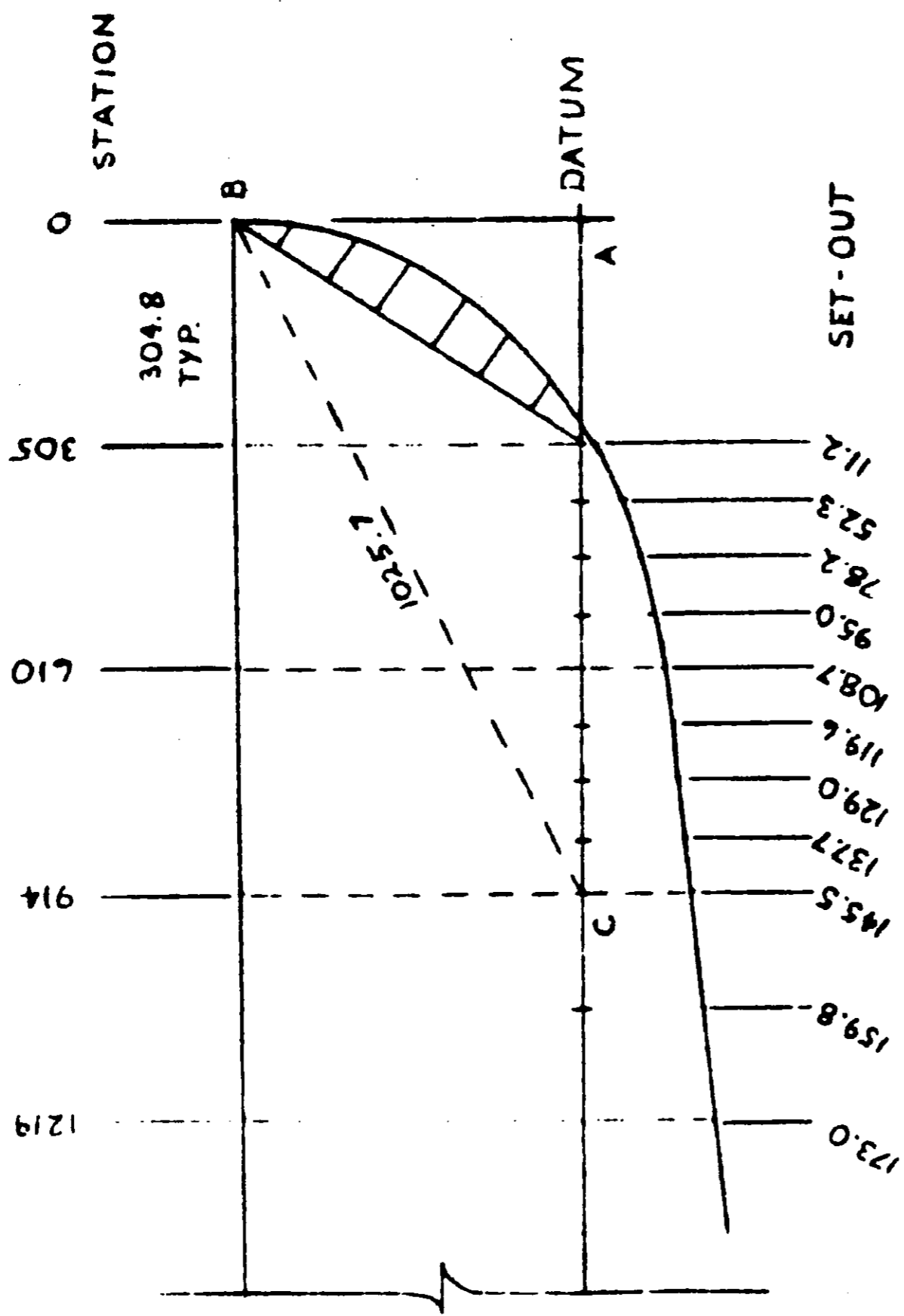


TORNADO HULLSIDE
 LAY-OUT
 SHEET NO. 6

WRD



BOW STEM OFF-SETS



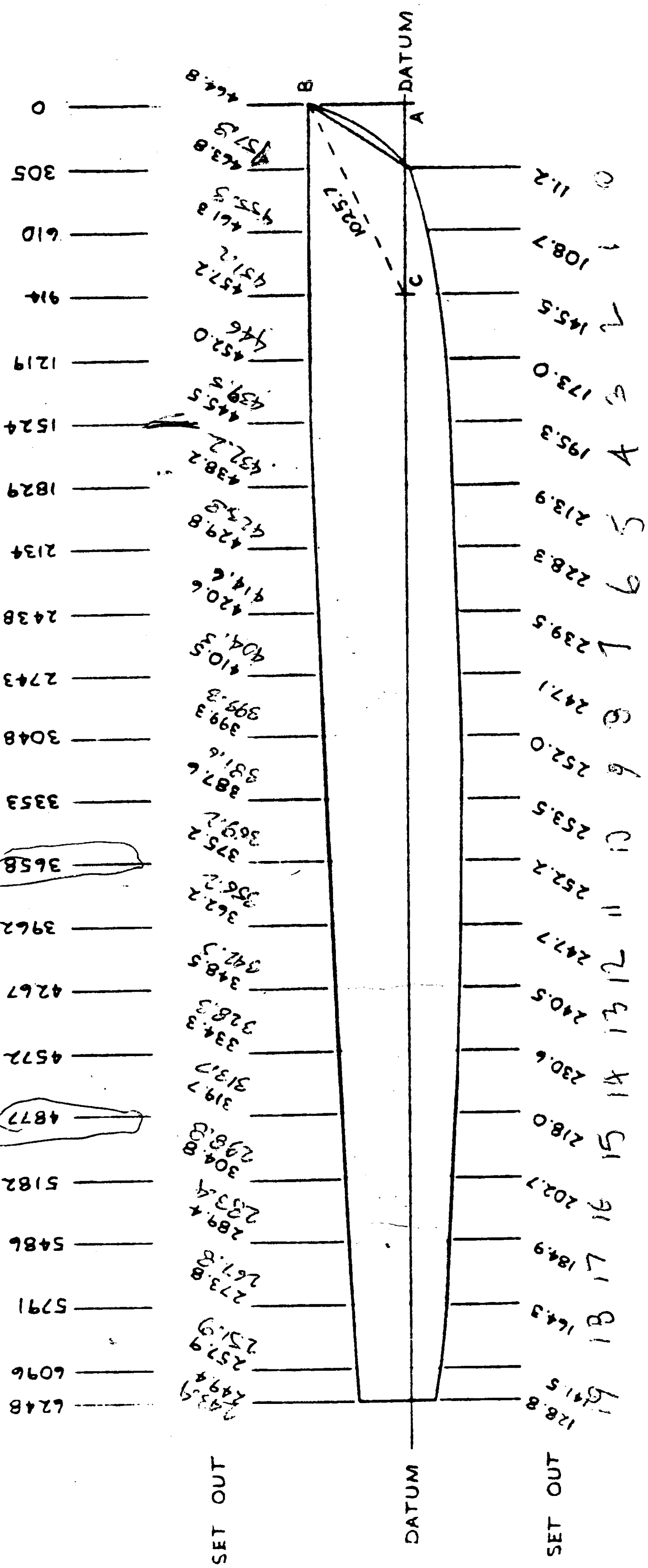
$\frac{1}{2}$ & $\frac{1}{4}$ POINT OFFSETS

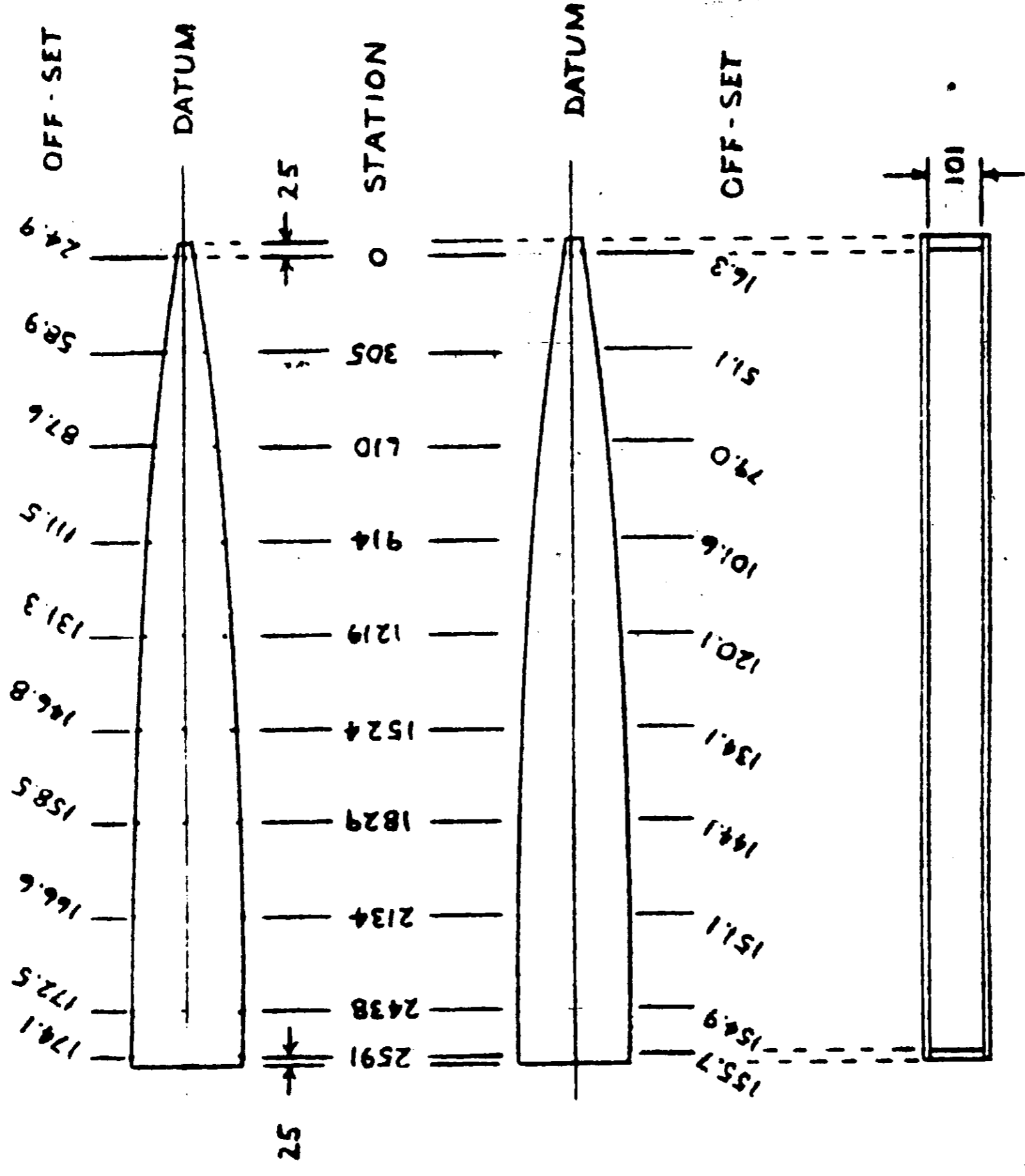
134.3

TORNADO
BOW HULLSIDE DETAIL
SHEET NO. 2 WRO

A

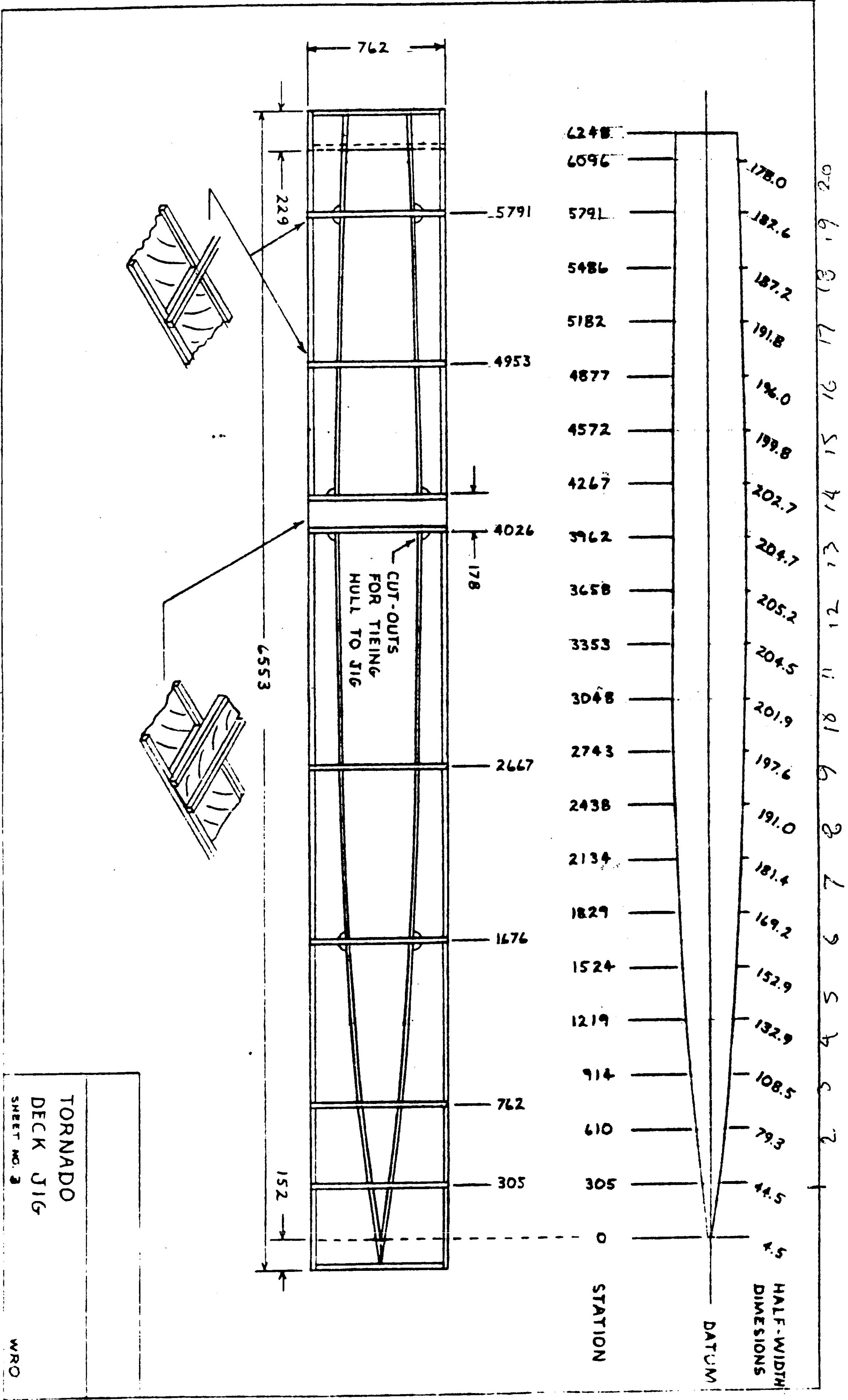
TORNADO
HULL SIDE DIMENSIONS
SHEET NO. 1
WRO





TORNADO
 BOW SPACER CUTTING JIG
 SHEET NO 4
 WRD

2591
 2438
 153

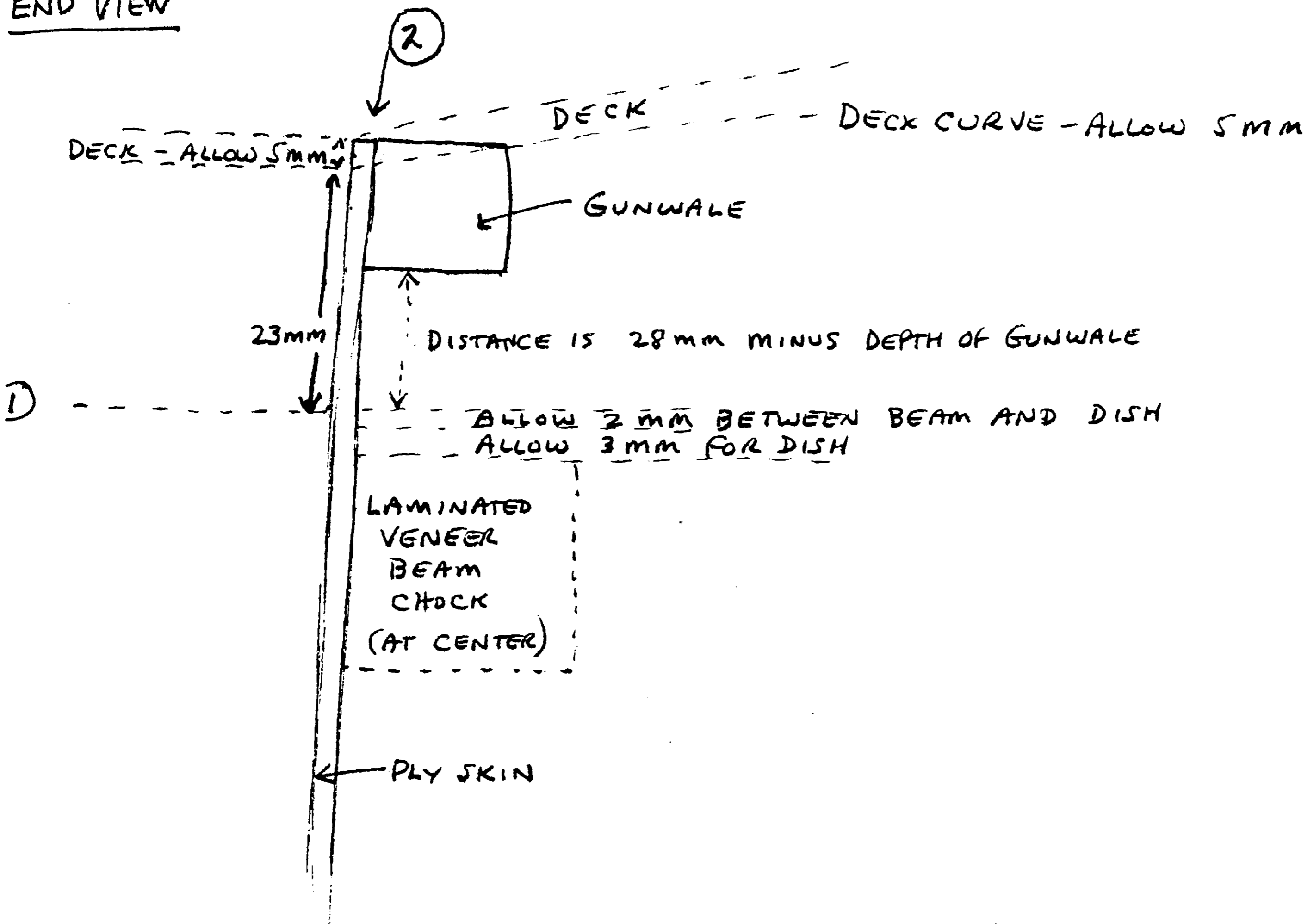


TORNADO
DECK JIG
SHEET NO. 3

WRO

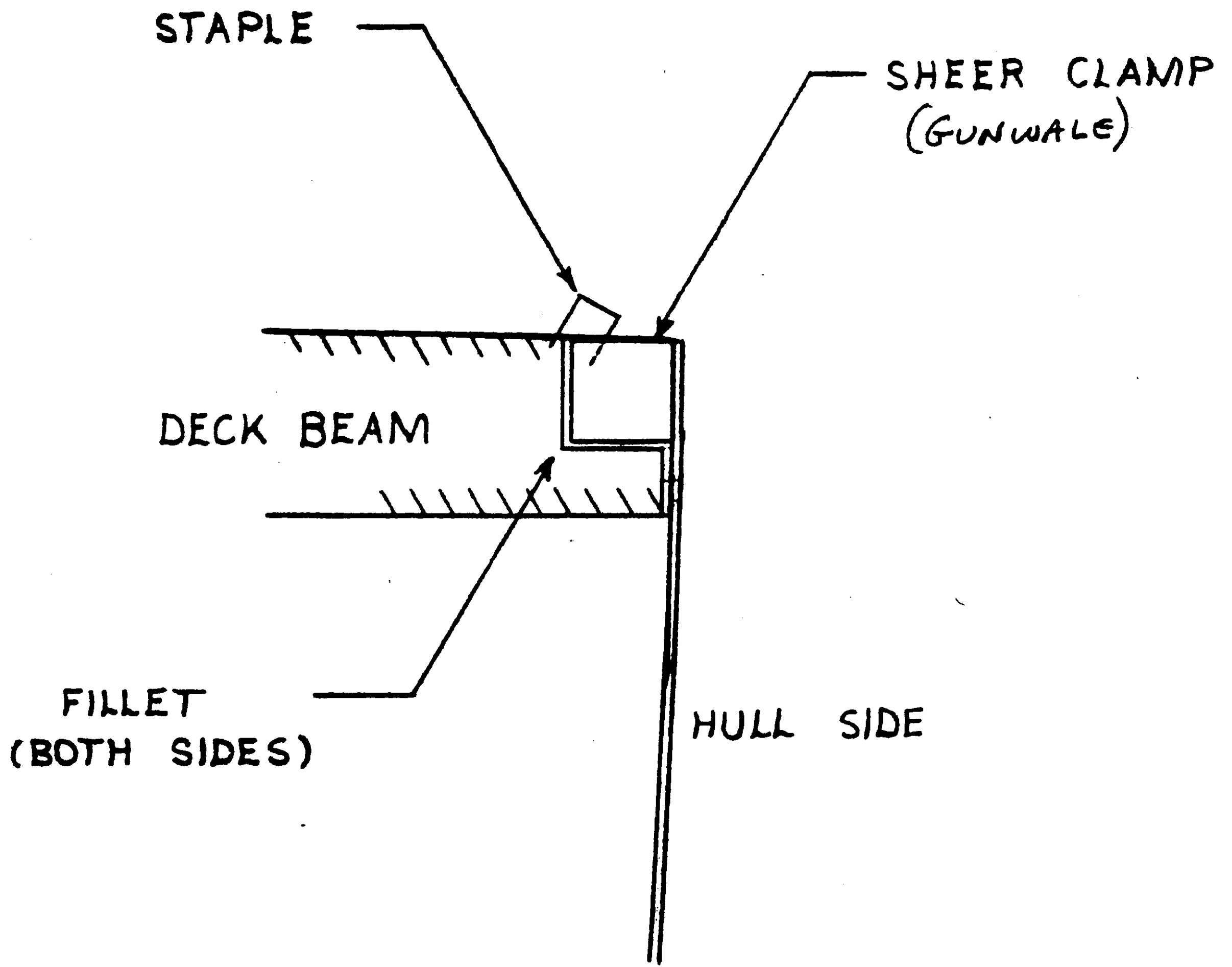
FITTING BEAM CHOCKS AND DISH (HBC KIT)

END VIEW



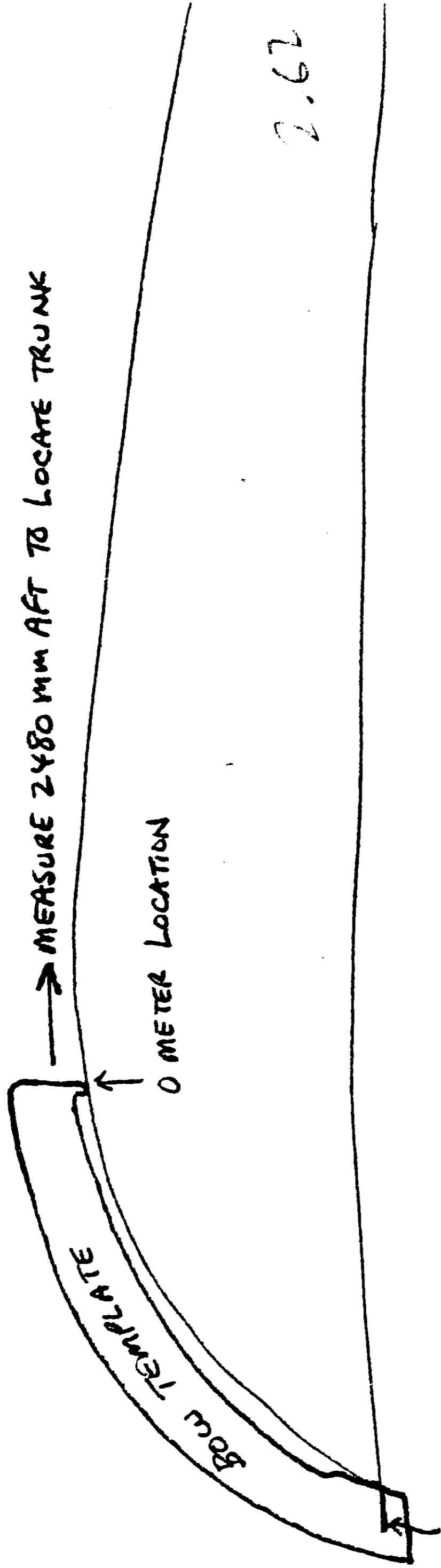
① DEPTH OF CUTOUT FOR REAR BEAM INBOARD AND OUTBOARD, MAIN BEAM ON INBOARD SIDE. MAIN BEAM ON OUTBOARD SIDE IS 2mm LOWER TO ALLOW FOR PRE-CURVE OF MAIN BEAM. NOTE THAT FOR THE MAIN BEAM ON THE INBOARD SIDE A FURTHER SMALL CUTOUT MUST BE MADE TO ALLOW THE DOLPHIN STRIKER TO ENTER THE CHANNEL AND THE DISH MUST BE LOWERED ENOUGH TO ALLOW FOR DOLPHIN STRIKER STRAP AND FASTENER HEADS.

NOTE THAT THE SHEER ROUNDING AND THE ADDITION OF THE DECK ARE BOTH 5mm, THEREFORE THE MEASUREMENT OF 28mm MAY BE DONE BEFORE SHEER ROUNDING.



[REDACTED]	
INSTALLING DECK BEAMS	
	SK-

FITTING THE CENTERBOARD TRUNK

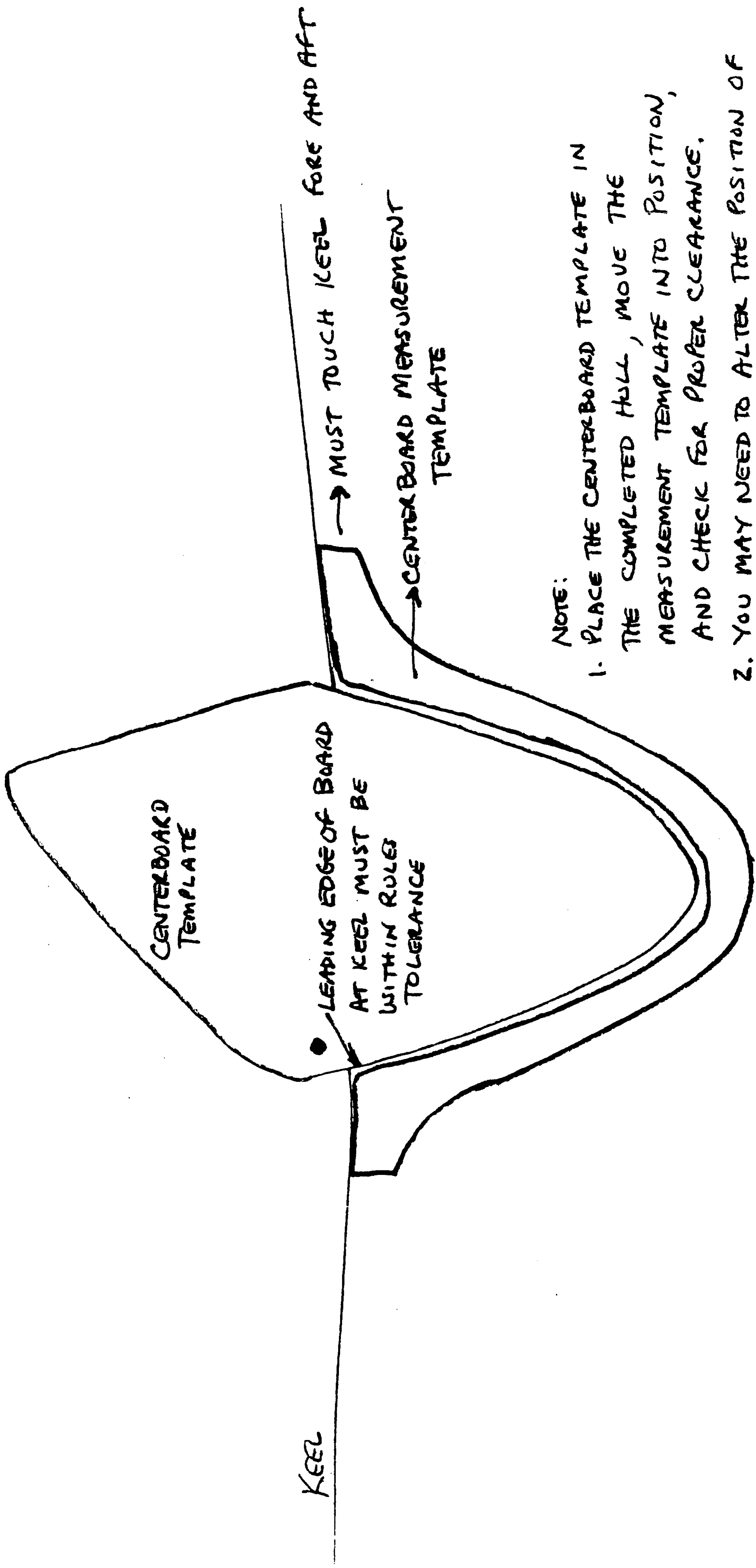


US NAVA
 USPTO
 TRADE

1. ALIGN UNDECKED BOW WITH REFERENCE LINE ON BOW TEMPLATE
2. MARK THE KEEL AT THE AFT EDGE OF THE BOW TEMPLATE, THIS IS THE '0 METER STATION
3. MEASURE 2480 MM AFT TO LOCATE THE REFERENCE POINT FOR INSTALLING THE TRUNK. SEE CONSTRUCTION NOTES.

REF. LINE

FITTING THE CENTERBOARDS



NOTE:

1. PLACE THE CENTERBOARD TEMPLATE IN THE COMPLETED HULL, MOVE THE MEASUREMENT TEMPLATE INTO POSITION, AND CHECK FOR PROPER CLEARANCE.
2. YOU MAY NEED TO ALTER THE POSITION OF THE PIVOT IN THE CENTERBOARD SLIGHTLY, SO DO THIS STEP BEFORE DRILLING THE PIVOT HOLE IN THE CENTERBOARDS. SEE CONSTRUCTION NOTES.

BELLOWS

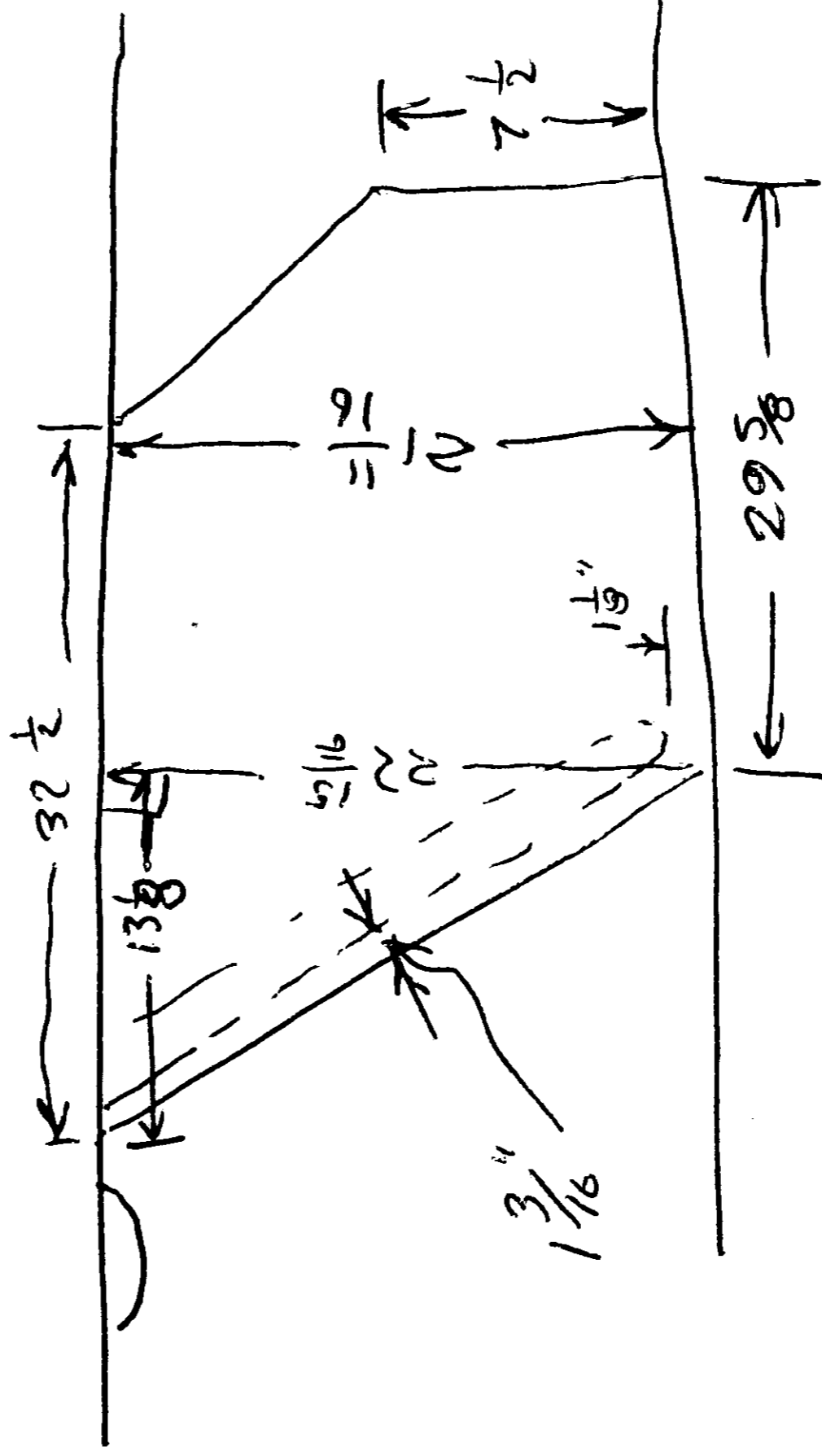
REAR INBOARD $90\frac{1}{4}$

OUTBOARD $110\frac{1}{2}$

FRONT INBOARD

OUTBOARD

$1\frac{1}{4}$ " $w \pm \frac{1}{32}$



SLOT $1\frac{1}{8}$ " WIDE

RIGGING THE REAR BEAM

1. INSTALL END CAPS

THE CAPS SHOULD BE FITTED SNUGLY IN THE BEAMS. IF TOO TIGHT FILE WHERE NECESSARY. THE CAPS MUST BE INSTALLED BEFORE THE BEAM IS INSTALLED ON THE HULLS. DRILL STUD HOLE IN OUTBOARD SIDE IF STRAPS ARE NOT TO BE USED OUTBOARD. STRAPS MUST BE USED ON THE INBOARD SIDE SO TRAVELER CAN PASS FREELY.

2. INSTALL BEAM STRAPS

AFTER THE BEAM IS FITTED TO HULL, RIVET THE BEAM STRAPS TO THE BEAM. THIS ASSURES CONTINUED CORRECT ALIGNMENT.

3. INSTALL EYE STRAP ON AFT EDGE OF BEAM

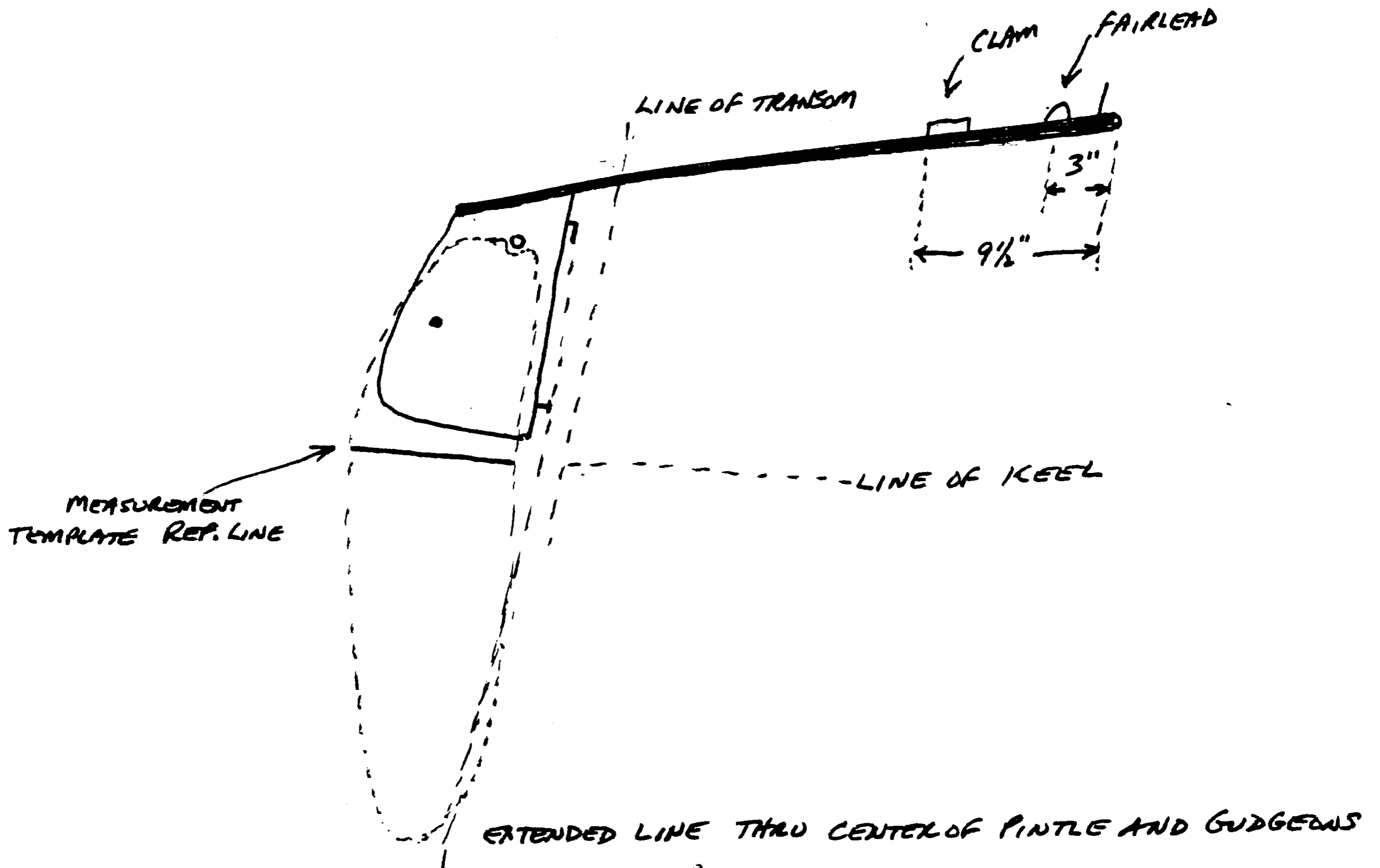
INSTALL THE LARGE EYESTRAP IN THE CENTER OF THE BEAM 1" UP FROM BEAM CENTERLINE. THIS EYESTRAP IS THE "DEAD-END" FOR THE TRAVELER CONTROL LINE.

4. INSTALL TRAMP LACING LUGS.

INSTALL THE 9 TRAMP LACING LUGS ON THE AFT EDGE OF THE BEAM AT THE CENTERLINE. THE FIRST LUG IS IN THE CENTER OF THE BEAM; THE OTHER DIMENSIONS FROM THE CENTER ARE, 10½", 1'9", 2'7½", AND 3'4". INSTALL WITH S.S. POP RIVETS.

5. AFTER BEAM HAS BEEN FITTED TO HULL, RIVET THE END CAPS TO THE BEAM. SLIP THE TRAVELER CAR ON FIRST.

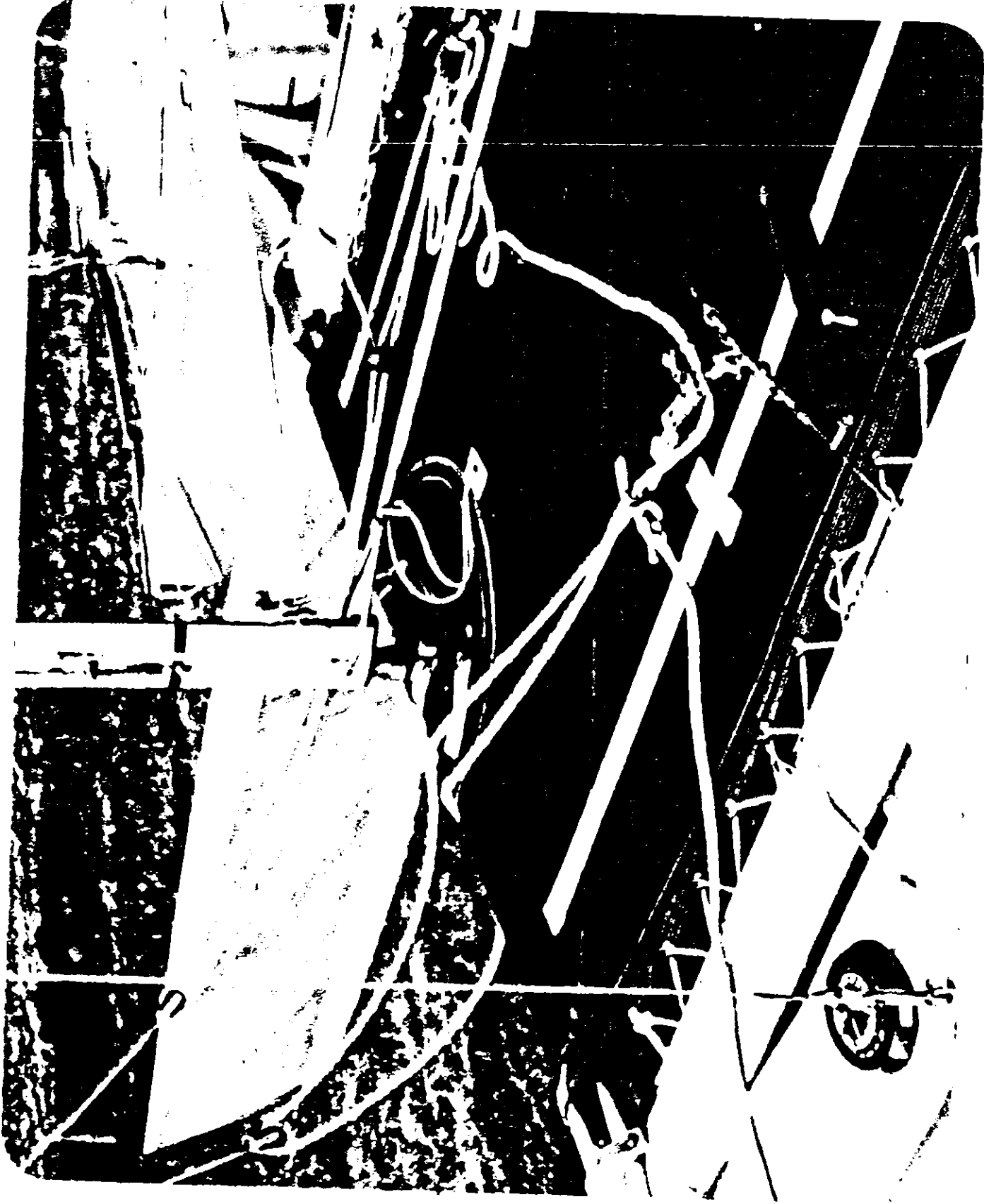
RIGGING IYE STOCK AND RUDDER



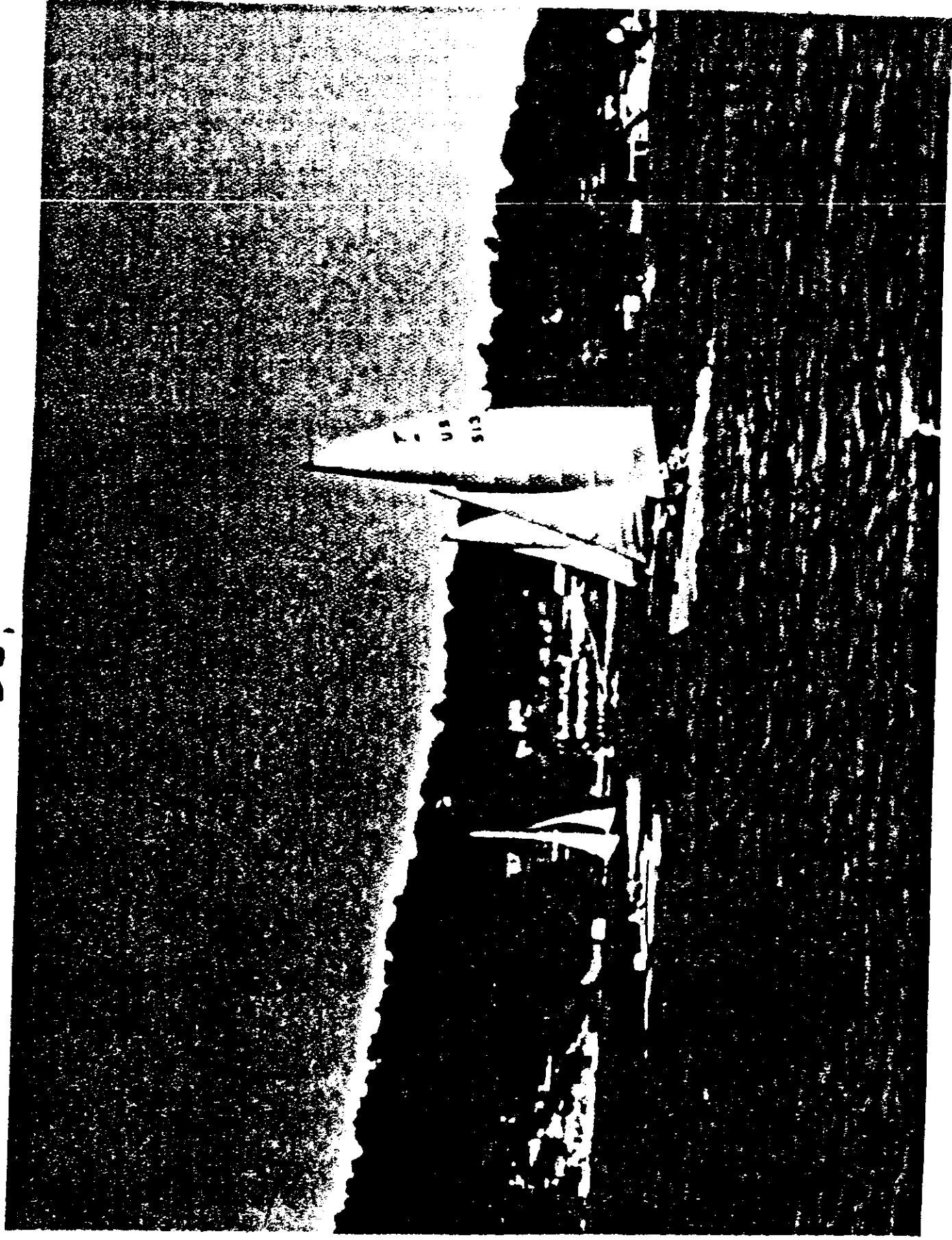
1. IMPORTANT DIMENSIONS ARE:

- MEASUREMENT TEMPLATE REFERENCE LINE ON THE LEADING EDGE OF RUDDER MUST BE SLIGHTLY ABOVE THE EXTENDED LINE OF KEEL (2-3mm).
- LEADING EDGE OF RUDDER AT THE KEEL SHOULD BE AS CLOSE TO KEEL AS POSSIBLE BUT NOT CLOSER THAN 15mm (CLASS RULE). SUGGEST 20mm.
- NOMINAL RAKE OF RUDDER SHOULD HAVE $1\frac{1}{8}$ " OF RUDDER IN FRONT OF AN EXTENDED LINE THRU THE CENTER OF THE PINTLES AND GUDGEONS. THIS DIMENSION IS BASED ON RUDDER DISTANCE FROM KEEL OF 20mm, AND TRANSOM RAKE MEASURED AT 35mm FORWARD OF KEEL ON MEASUREMENT CERTIFICATE. IF THE DISTANCE OF THE RUDDER FROM THE KEEL OR TRANSOM RAKE ARE DIFFERENT, COMPENSATE APPROPRIATELY.
GOOD LUCK!

30.



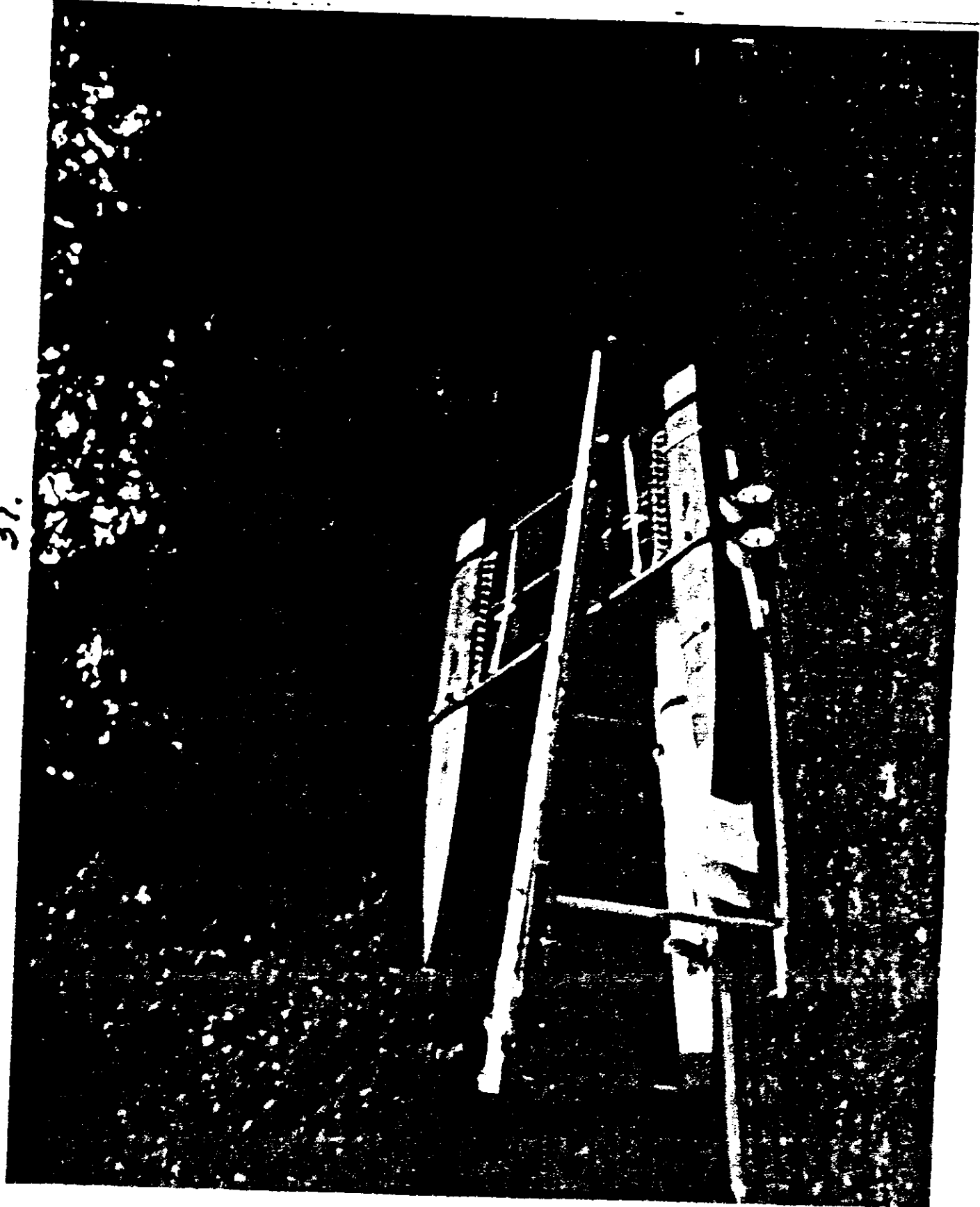
32.



29.

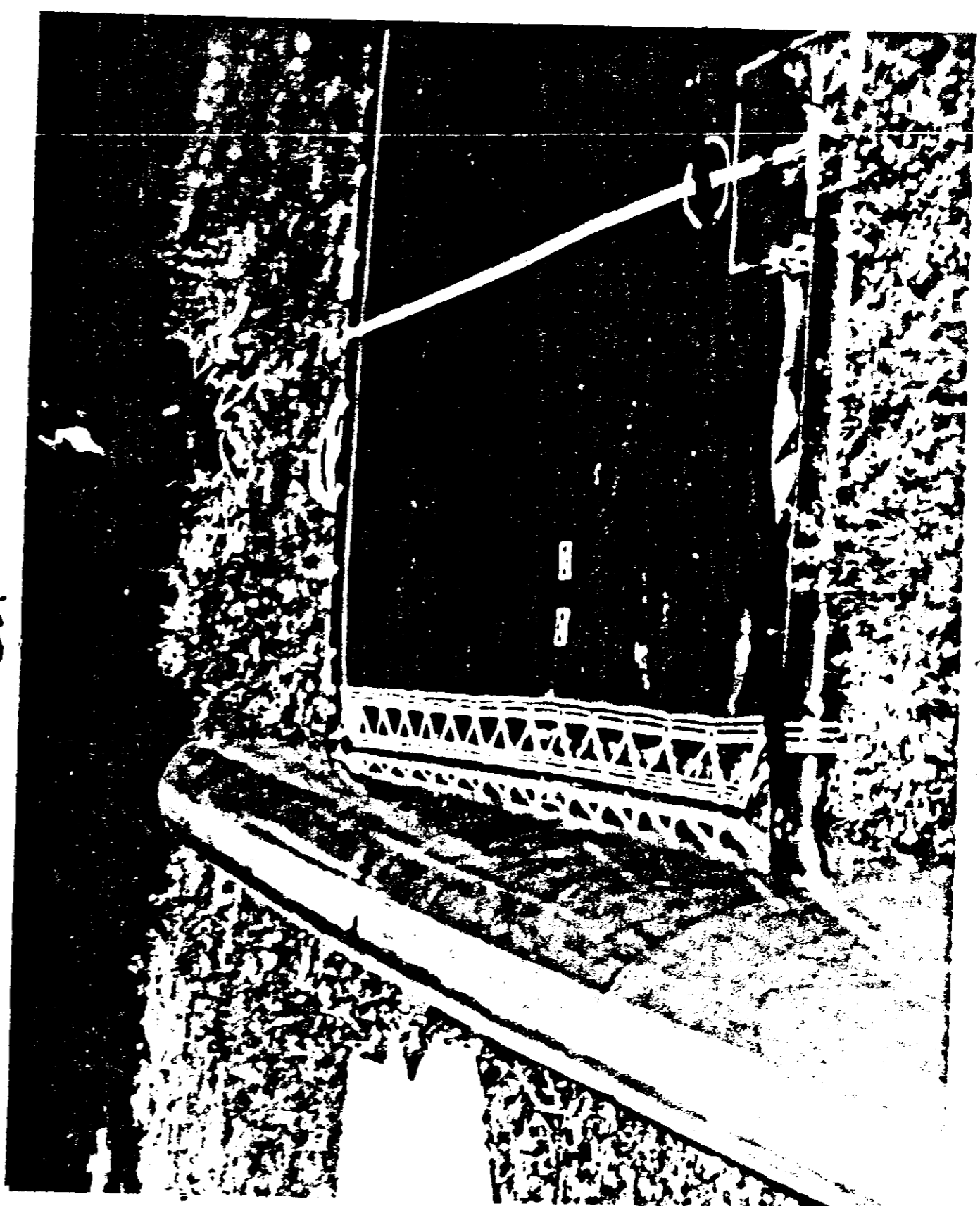


31.

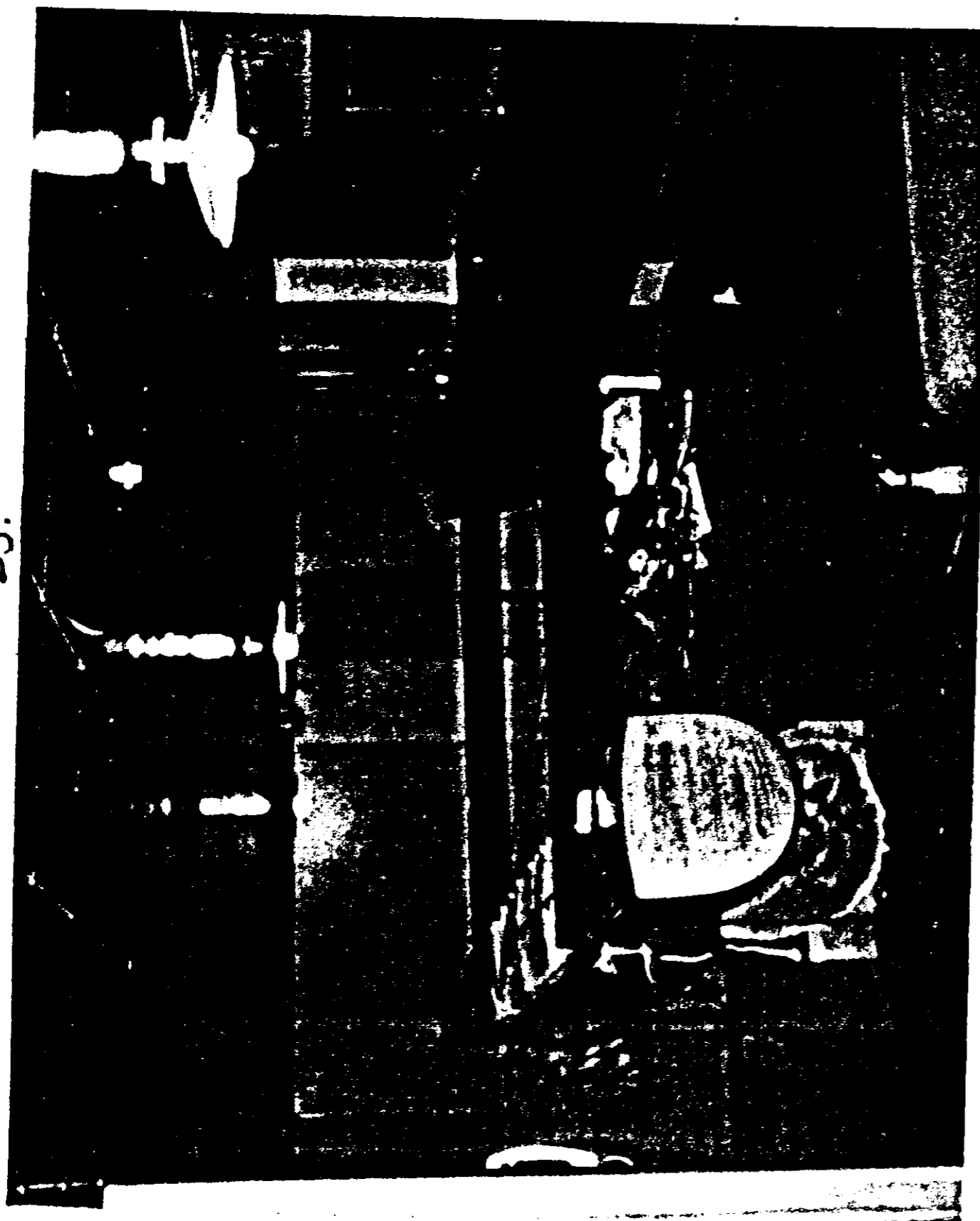




26.



28.

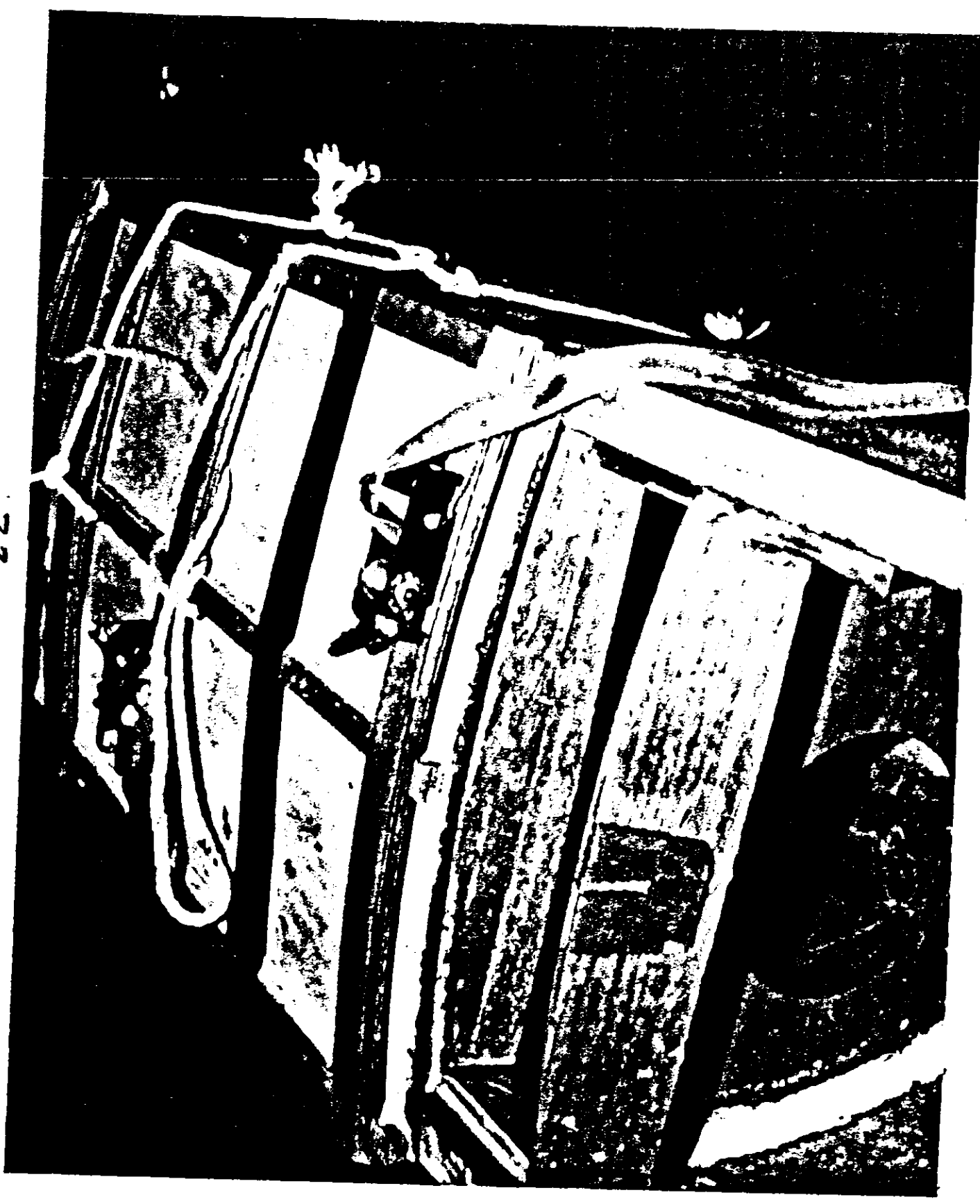


25.

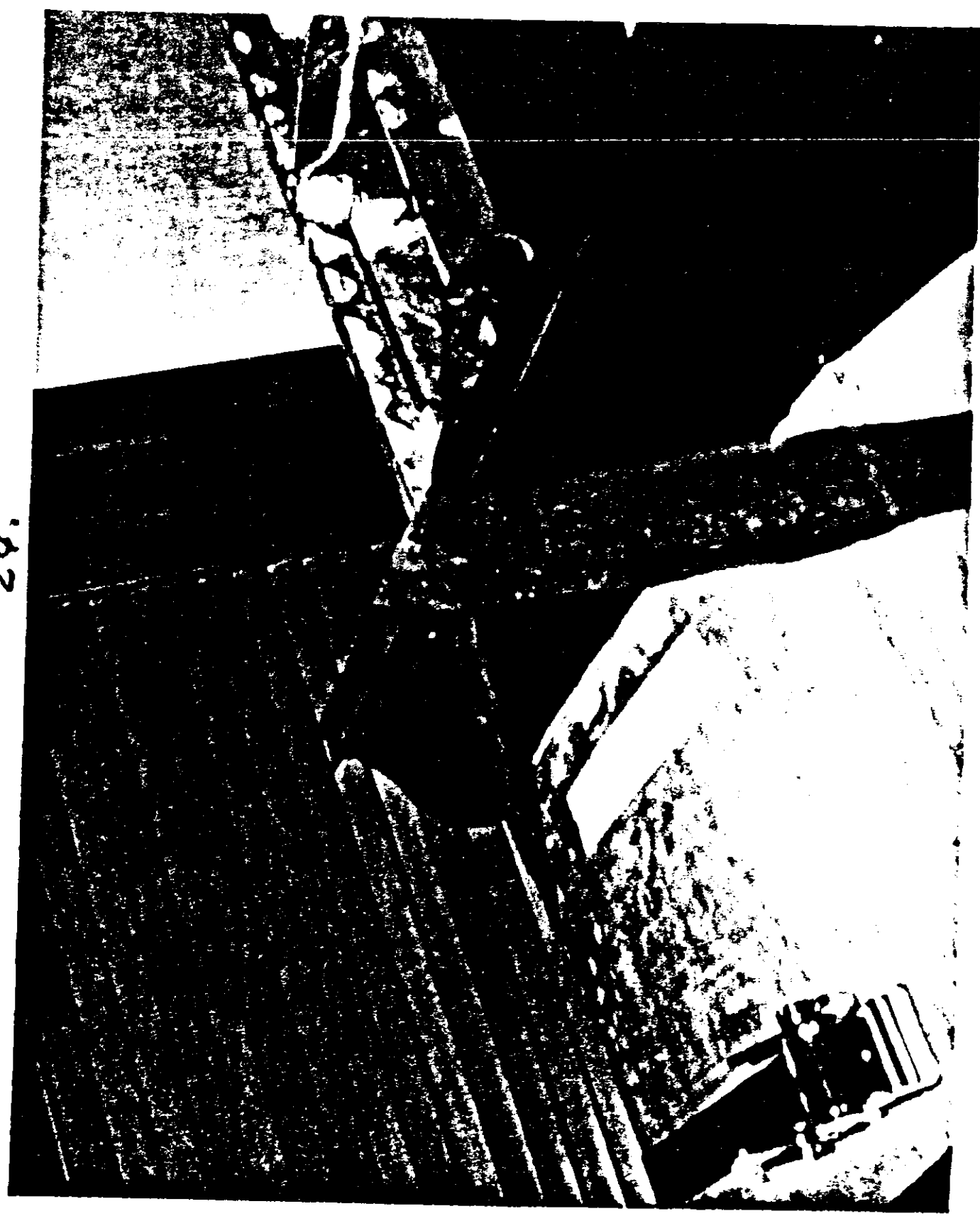


27.

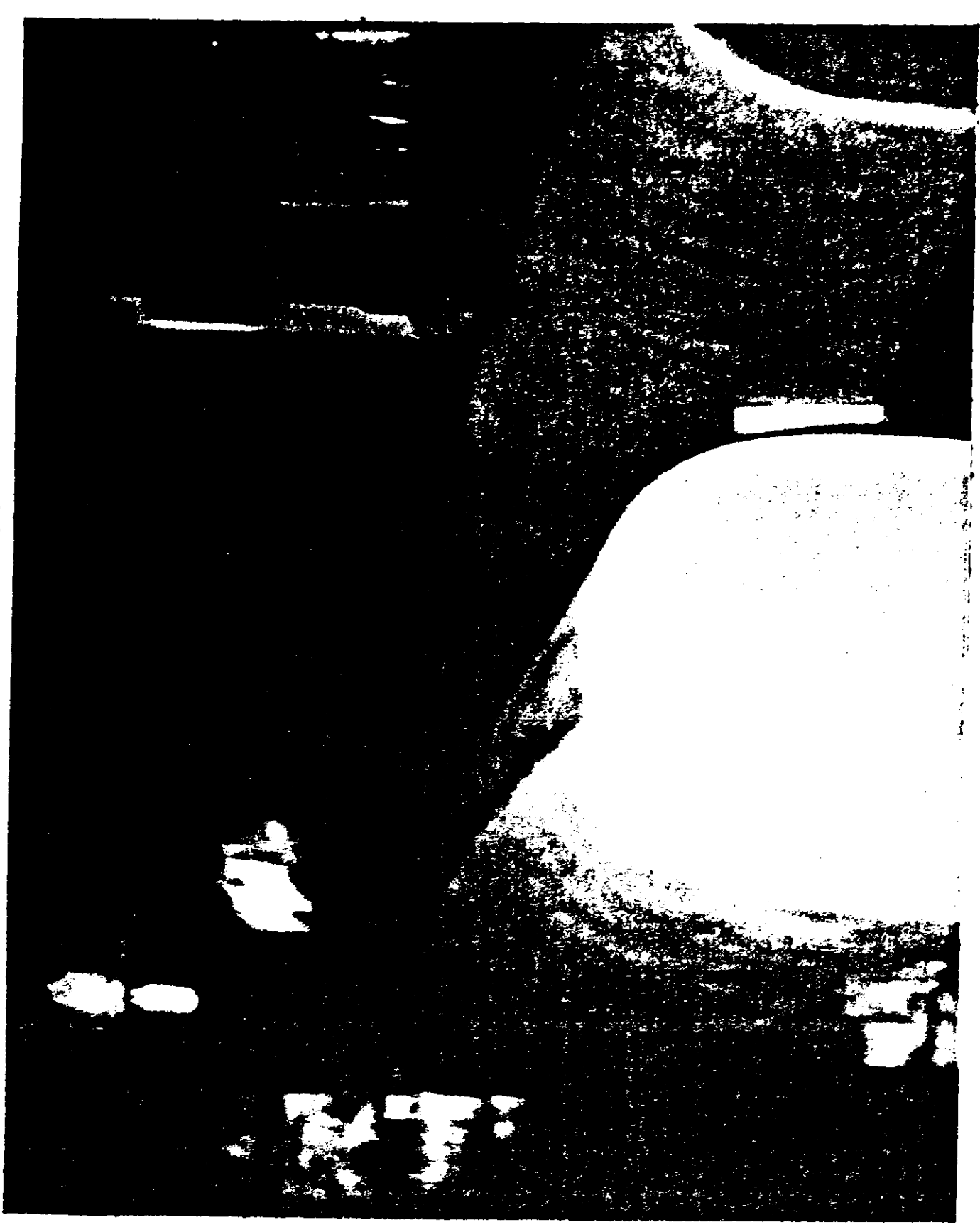
22.



24.



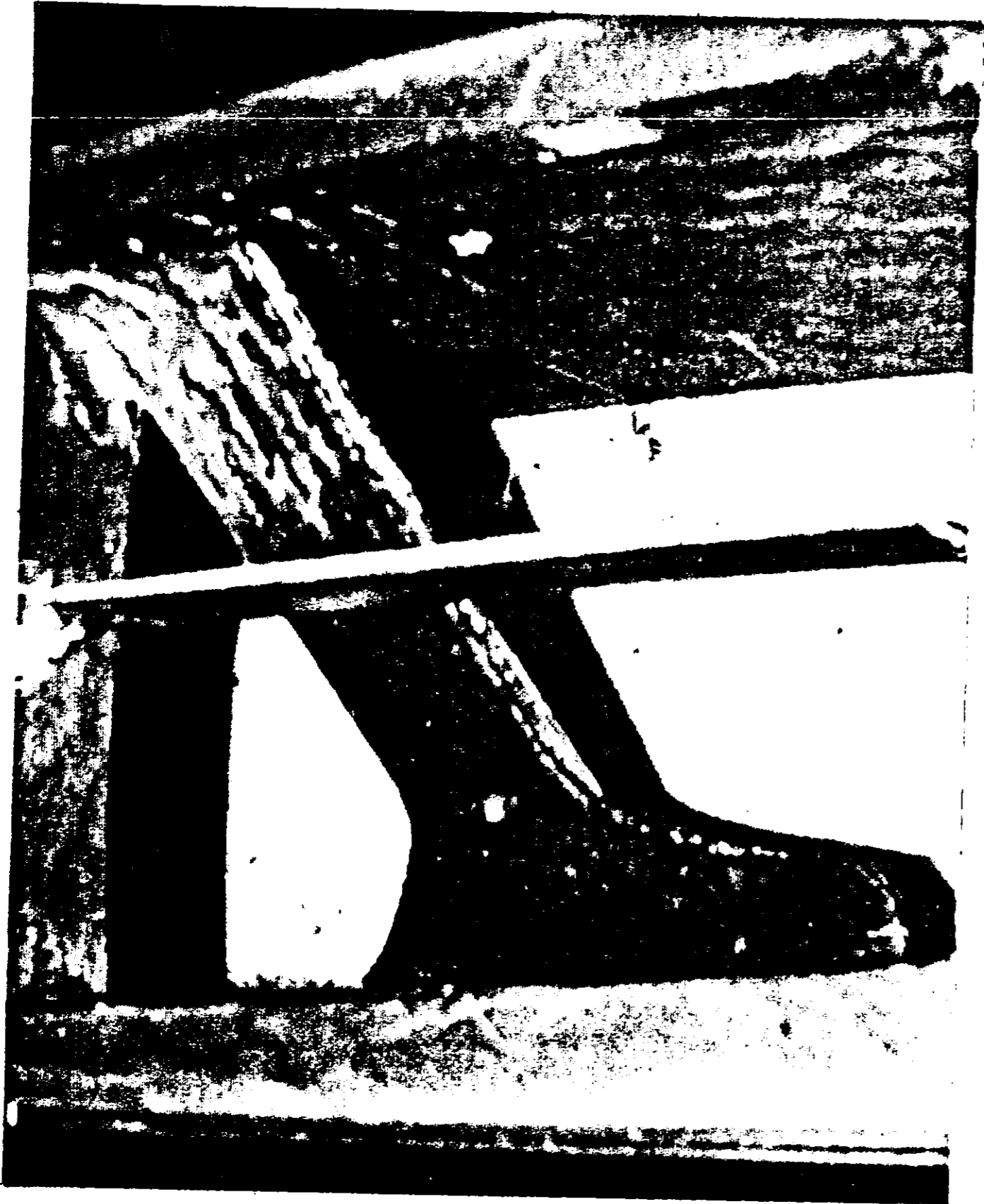
21.



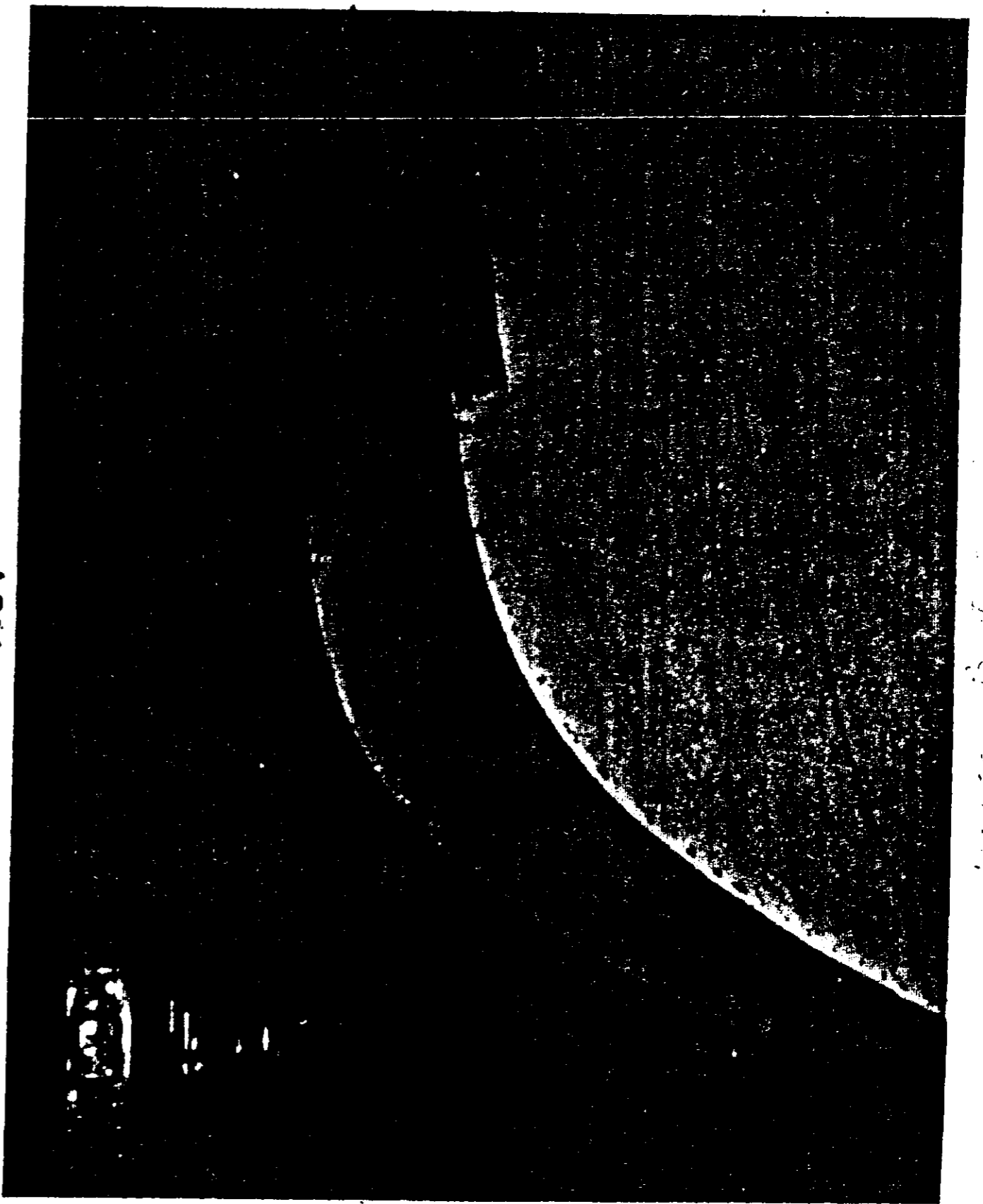
23.



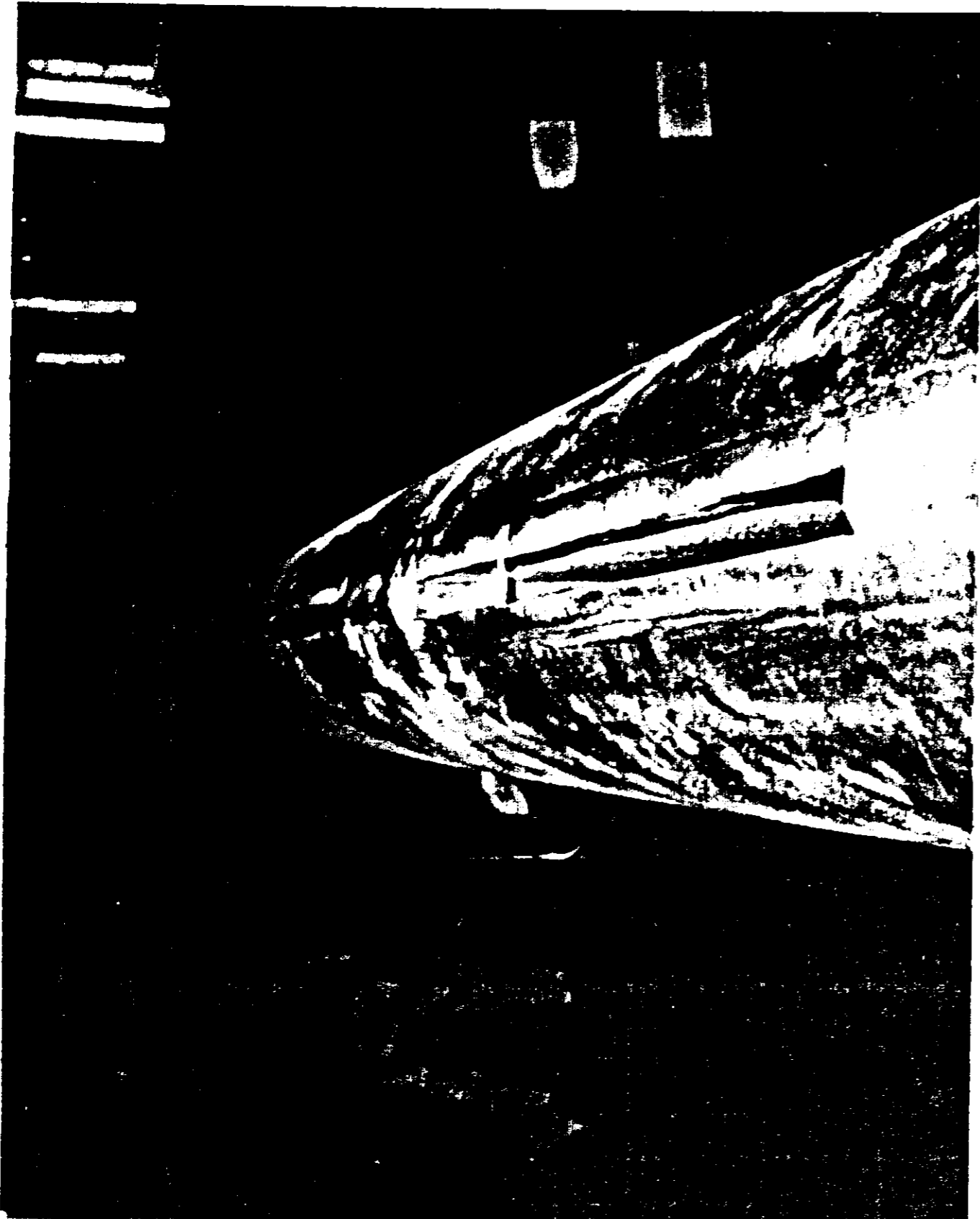
18.



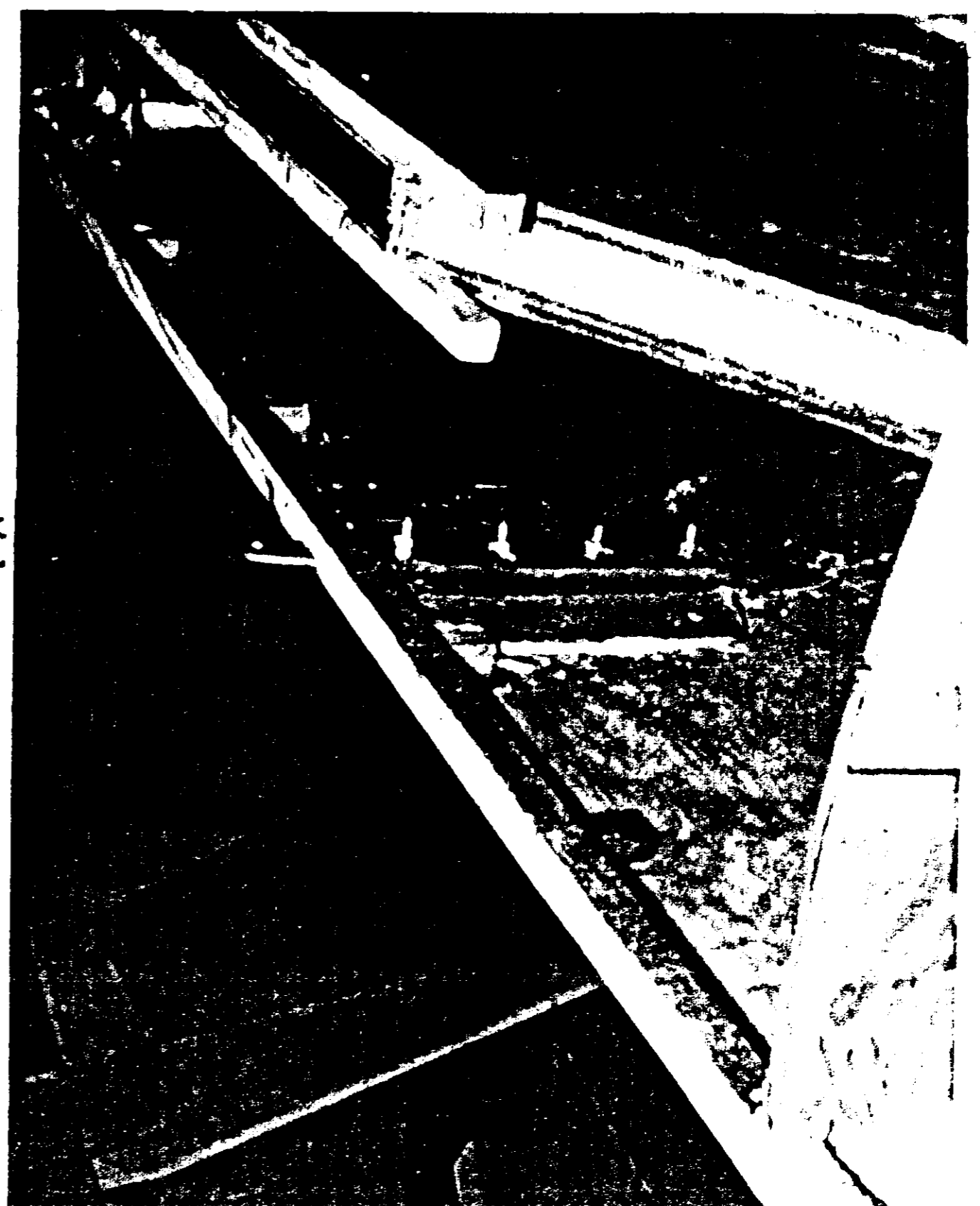
20.



17.



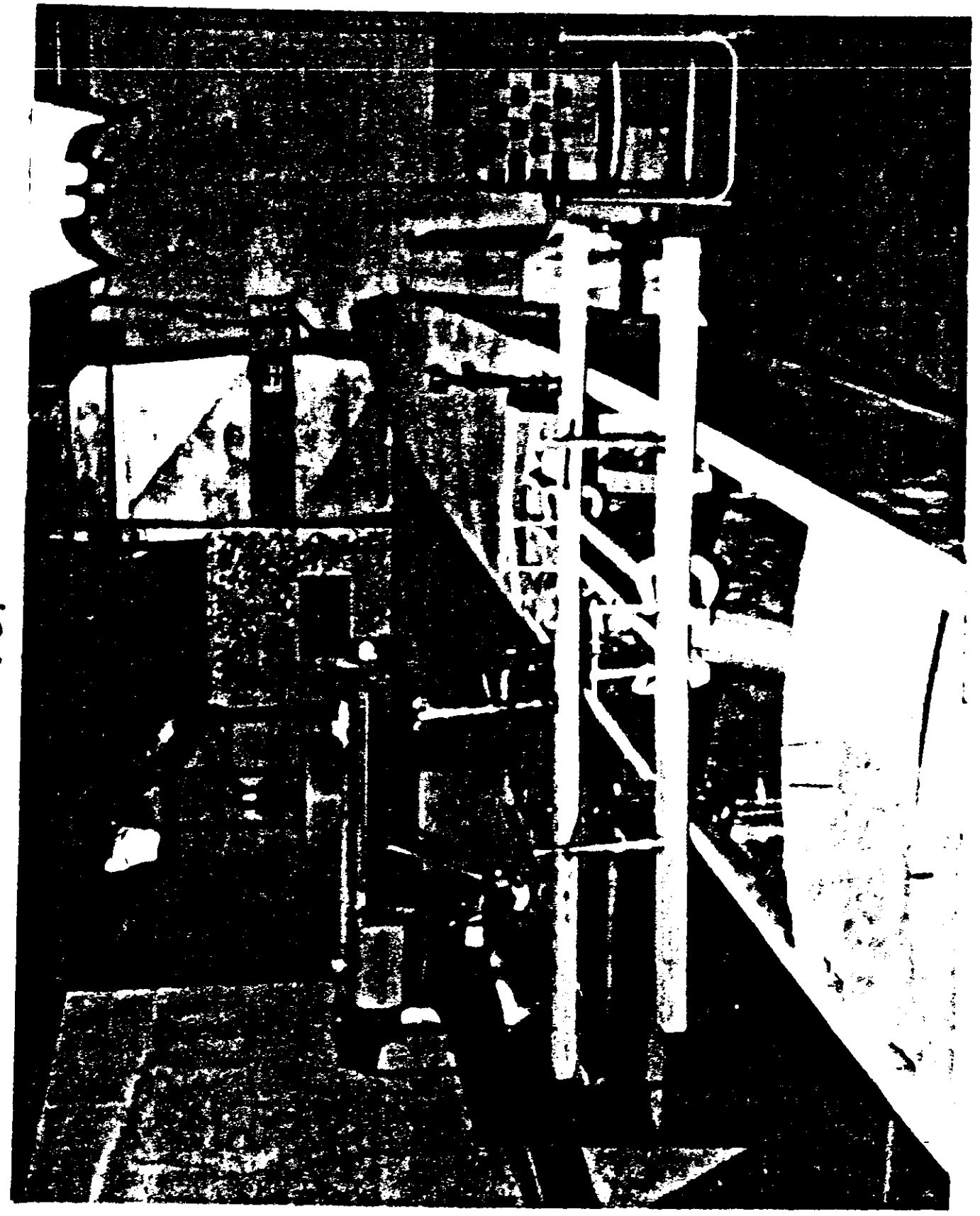
19.



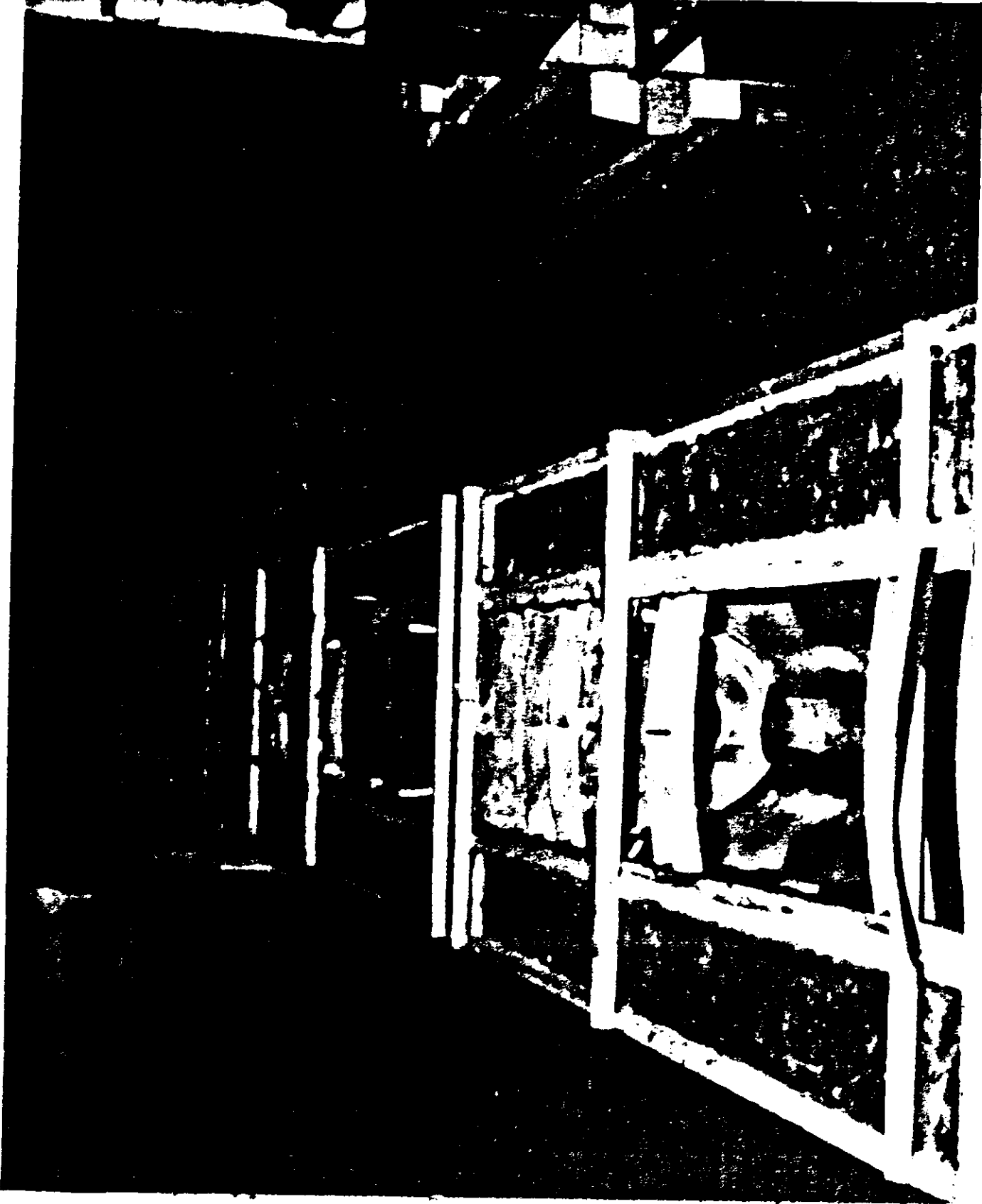
14.



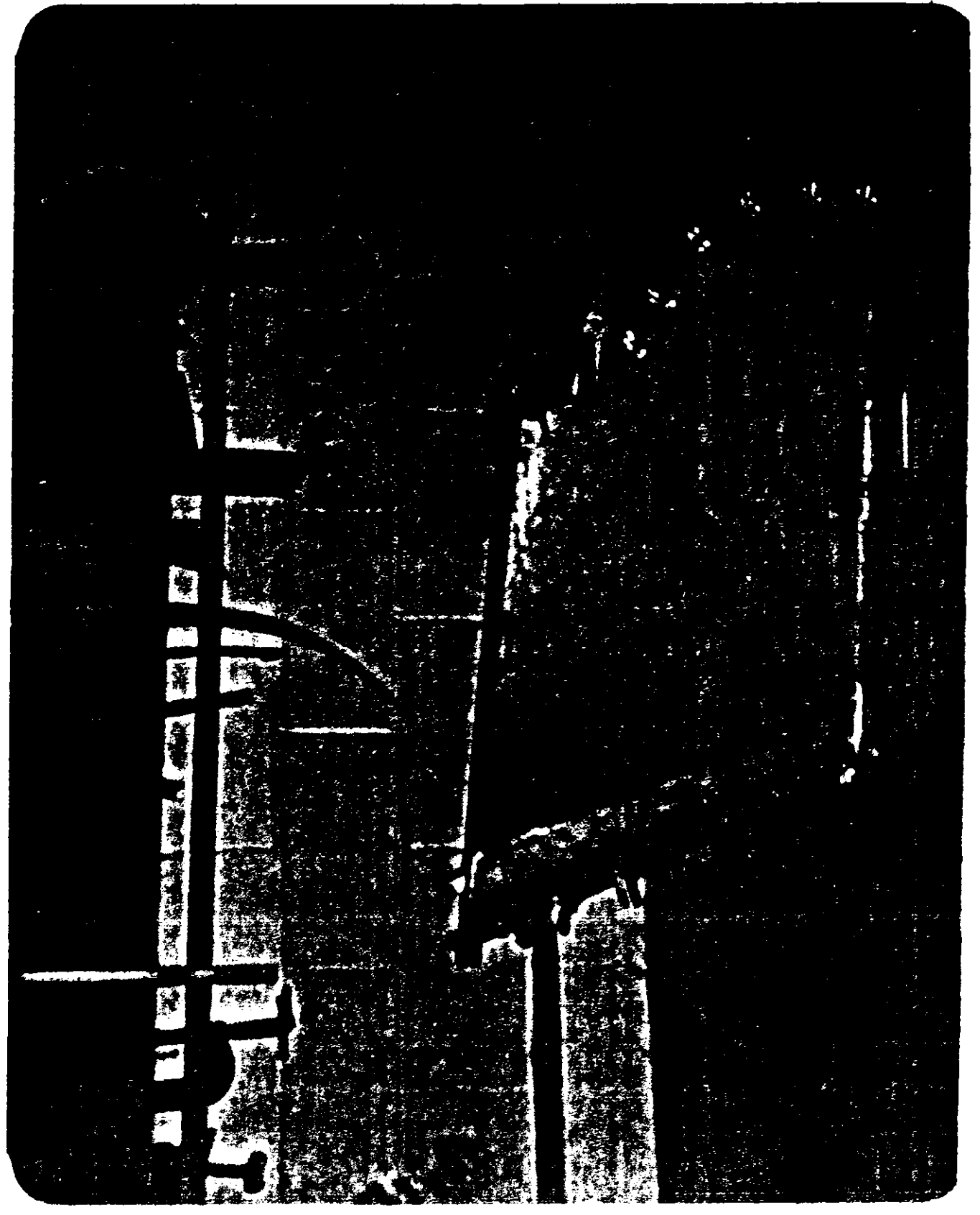
16.



13.



15.



PHOTOS

13. All bulkheads completely filleted and all deck beams installed that can be at this stage. Hull may be removed from deck jig at this point.
14. Centerboard trunk sides graphite epoxied on the inner surfaces and stringers epoxied in preparation for making the trunks.
15. The finished trunk with pivot slot.
16. Centerboard trunk epoxied in place and clamped.
17. Keel area of trunk cut out and filled and sanded smooth.
18. Forestay tang epoxied and filleted in place. Support piece is two layers of 4mm ply. Note large glue surface on the opposite side of the hull.
19. Shroud chainplate installed. Note large glue surface. Chainplate is set into the triple support piece.
20. Both hulls constructed, bows ready to be glassed. A nice touch here is to plane off the bow past the wire holes, install a solid wood bow stem, and plane to shape.
21. Transom view of both hulls.
22. Rear deck being installed with clamp straps and deck jig.
23. Trunk installed with remaining deck beams and stringer. Ready for fitting of beams.
24. Rear beam installed in channel with microsphere fillet. Clamped in place and curing. Alignment perfect.
25. Hulls aligned and beams installed. The next steps are to install studs and then the middle deck.
26. Hull has been sanded and glass being installed. Edges are trimmed when epoxy is semi-cured.
27. Hulls varnished ready for final wet sanding and buffing.
28. View showing Mylar slot gaskets, laced trampolene.
29. A beautiful custom ply Tornado at the Olympic Trials.
30. A Gougeon Tornado at the Trials. Note the very clean rig, laced tramp and jib strop.
31. Two Tornados ready for travel.
32. The whole point of amateur building. Super boats racing!

International TORNADO Class Rules

Date of International Status: May 1968

Authority: International Yacht Racing Union, 60 Knightsbridge, London, SW1X 7JX, England

1. GENERAL

- (a) The official language of the class is English and in the event of dispute over interpretation the English text shall prevail.
- (b) These rules shall take precedence over the measurement form and the plans.
- (c) Neither the I.Y.R.U. nor the International Tornado Association accept legal responsibility in respect of these rules or any claim arising therefrom.
- (d) Where there is no National Authority or the National Authority does not wish to administer the class, its function as stated in these rules shall be carried out by the International Tornado Association or its delegated representatives.

2. BUILDING FEE

- (a) A building fee shall be paid by the builder on every boat built whether or not the boat is subsequently measured and registered. A building fee of half the amount specified in rule 2(a) shall be paid on each replacement hull.
- (b) For each boat built, kit made, or set of parts supplied, the builder shall pay to the International Tornado Association headquarters, c/o E. R. Holloway Ltd., Lavenham, Sudbury, Suffolk, England, the appropriate building fee as defined.
- (c) An official building fee receipt shall be issued to the builder by the Association. These shall be numbered consecutively.
- (d) The official building fee receipt shall be delivered by the builder to the owner on delivery of the hull, kit or set of parts.
- (e) For the purposes of this rule "builder" shall include a constructor of hull shells and a manufacturer of hull kits or sets of parts.

3. BUILDERS

- (a) Professional builders of the Tornado shall be only those recognised and registered by the I.Y.R.U. and boats or hull kits shall only be built for sale by these builders.
- (b) Recognition shall be subject to review and withdrawal by the I.Y.R.U. and professional builders shall be required to satisfy the I.Y.R.U. through the I.T.A. or the relevant National Authority of their competence to build the Tornado.
- (c) Additional professional builders may be recognised by the I.Y.R.U. at the recommendation of the International Tornado Association and the relevant National Authority, provided that a requirement can be shown for an additional source.
- (d) Bona fide amateur builders shall be permitted.

4. REGISTRATION

- (a) No boat shall be allowed to race in the class unless it has valid class Measurement Certificate. Application for measurement and registration shall be the responsibility of the owner who shall apply to his National Authority for a sail number and measurement form, submitting at the same time the proposed name of the boat and the building fee receipt.
- (b) Each country shall issue sail numbers which shall be consecutive commencing from "one" and the number shall be preceded by the official national letters. The National Authority shall enter the sail number of the boat on the building fee receipt.
- (c) No two boats in the class registered in the same country shall have the same name.
- (d) The owner should arrange the attendance of a recognised Measurer who shall complete the measurement form and, if satisfied, shall certify thereon that the boat complies with the class rules.
- (e) The measurement form, when complete, shall be returned by the owner to his National Authority, together with any registration fee required by the National Authority. On receipt of these a measurement certificate shall be issued to the owner.
- (f) A National Authority may charge a registration fee.
- (g) Change of ownership invalidates the certificate but re-registration may be effected by returning the old certificate to the National Authority, together with an application in writing containing the name and address of the new owner and the appropriate re-registration fee if any. Re-measurement is not necessary.
The National Authority shall issue a new certificate to the owner.
- (h) Notwithstanding anything contained in these rules, the International Tornado Association or the I.Y.R.U. shall have the power to refuse or withdraw the certificate of any boat.

5. MEASUREMENT

- (a) This is a one-design class. A certificate may be refused even if the specific requirements of the rules are satisfied. Interpretations of these rules shall be made by the I.Y.R.U. which shall consult the I.T.A. The Measurer shall report on the Measurement Form anything which he considers departs from the intended nature of the design of the boat, and shall not sign the form. A copy of the incomplete form together with a full explanation of the points in question shall be immediately sent to the I.T.A. Secretariat for a ruling in writing.
- (b) Templates used for official measurement or re-measurement shall be issued by the I.Y.R.U.
- (c) Only an official Measurer recognised by the National Authority shall measure a boat, spars, sails and equipment, and sign the declaration on the Measurement Form that it complies with the class rules. Payment for the Measurer's services is the responsibility of the owner.
- (d) A Measurer shall not measure a boat, its spars, sails and equipment, owned or built by himself.
- (e) It is the responsibility of the owner to see that the boat, its spars, sails and equipment are correctly measured and to ensure that they thereafter comply with the current class rules.
- (f) All certified boats shall be liable to re-measurement at the discretion of the National Authority or Race Committee, but only by an official Measurer.
Any boat re-measured and found not to comply with the class rules may be disqualified.
- (g) A certificate shall be invalidated by structural alteration, replacement of components, or repair of the boat and the boat shall be re-measured in respect of the affected parts by an official Measurer.
- (h) New sails shall be measured, and registered on the class measurement certificate by an official Measurer.

6. RECOGNITION MARKS

- (a) The sail number and national letters of the boat shall be carved or indelibly marked into the outside of the port transom.
- (b) The sail numbers, national letters and class emblems shall be placed on both sides of the mainsail, at approximately two-thirds of the height of the sail above the boom. Sail numbers, letters, and emblem shall sharply contrast in colour with the sail. The sail numbers and letters shall be placed at different heights on the two sides of the sail, those on the starboard side being uppermost. The emblems shall be placed above the letters and numbers.

If the emblems are placed back-to-back it is recommended that the tail should slope towards the leech of the sail.

Letters and numbers on the sails shall be of the following minimum size:
Height 300mm; width 200mm (except figure 1 and letter l).
- (c) Sail makers marks, if any, shall be placed near the tack of sails and shall not exceed 150mm by 150mm.

7. MATERIALS

Hulls, centreboards and rudder blades shall be made only of one or more of the following materials: wood, glass fibre, foam plastics, plastic fibres with a modulus of elasticity less than 100,000 kg/cm², resins, paints, glues and normal metal fastenings.

Except for such fastenings, all materials when dry to measurer's satisfaction shall be of high electric resistivity. Equipment may be used by the I.Y.R.U., or its delegated representatives, to detect materials of low resistivity such as metals and carbon fibre and a boat may be disqualified or have its certificate withdrawn if low resistivity is found which the measurer believes cannot be explained by normal metal fastenings or fittings.

*Kevlar, or any similar fibre, shall not be used in the hulls and sails, rudders, centreboards, riggings and battens of the Tornado Catamaran.

Tornados built using such prohibited materials shall remain illegal: however, they shall be permitted to race in the club and local events for evaluation purposes, provided they are registered with I.T.A. (not the National Authority) and also provided:

- i) both hulls are indelibly marked on the outside of the transoms with a letter "X" and with a number allocated by the I.T.A.
- ii) the mainsails have a letter "X" of size and position in accordance with Rule 6(b). The letter "X" shall be either in addition to or instead of national letter(s).

The building fee as stated in Rule 2, shall be paid in respect of each experimental boat although it remains illegal. Such illegal boats will not be permitted to race in qualifying open meetings of any kind. National Championships, European Championships, World Championships, or the Olympic Games.

*Du Pont Trade Mark for its aramid (Aromatic polyamide) fibres.

8. HULL MEASUREMENT

- (a) The hull shall be inverted. The bow template shall be applied with the projections touching the skin.

Template no. 5 shall be positioned 5 metres abaft the after edge of the bow template (i.e. 6 metres abaft the stem head length datum, which represents the stem head of a boat built to the mean tolerances) and shall touch the skin at the keel and be equidistant from the sheerlines.

The bow template shall be adjusted to bring the inscribed datum line in coincidence with a base line which shall be horizontal and pass through the hole in template no. 5.

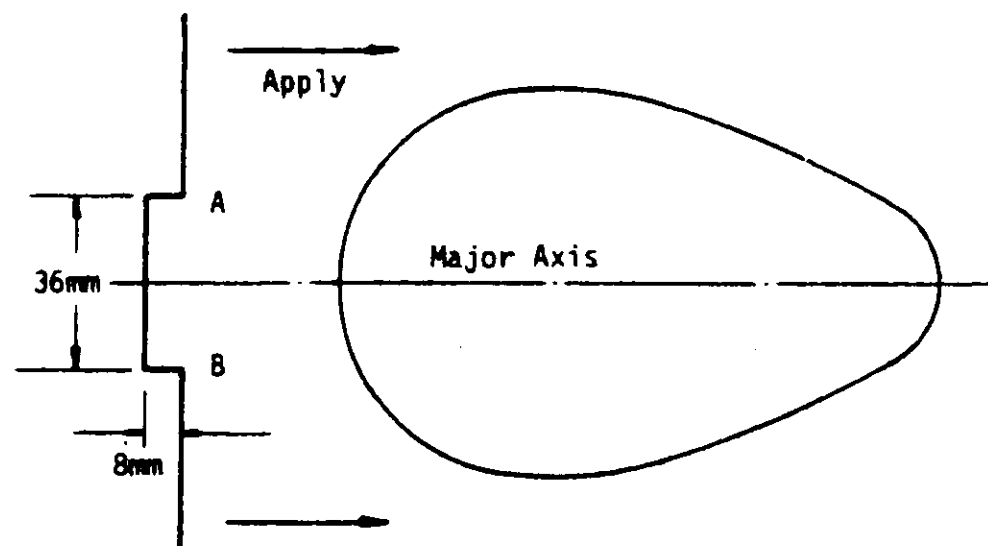
The remaining measurement templates shall be positioned 0, 1, 2, 3.3 and 4.2 metres abaft the after edge of the bow template, touching the skin at the keel and at each station the template shall be equidistant from the sheerlines.
- (b) Each of the templates positioned 0, 1, 2, 3.30, 4.20 and 5 metres abaft the after edge of the bow template shall touch the hull at, either the centreline inscribed on the template, or within the raised section on the template and on both sides of the inscribed centreline.
- (c) The base line shall pass through the holes in the templates and shall clear templates 1, 2, 3.3 and 4.2.
- (d) The clearance between any template and the stem or the hull shall not exceed 10mm, except that within 10mm of the centreline inscribed on the respective template the clearance shall not exceed 3mm on template 0 and 2mm on templates 1, 2, 3.30, 4.20 and 5.
- (e) The sheerlines at all stations shall not be above or below the tolerance marks on the templates. The radius at the sheer measured perpendicular to both the deck and the topside shall not exceed 12mm.
- (f) The skin shall not project beyond the transoms which shall be flat and square across the hulls.
- (g) The hull shall not extend more than 5096mm nor less than 5070mm abaft the after end of the bow template.
- (h) The aft surface of the transoms at sheerline level shall be not more than 50mm nor less than 30mm forward of the aftermost point of the hull.
- (i) The difference between the deck centreline separation and the keel centreline separation immediately abaft the main beam shall not exceed 10mm.
- (j) The distance between deck centrelines shall be not more than 2630mm or less than 2590mm.
- (k) The difference in length between the diagonals from the tip of each bow to the aft edge of the opposite transom at the inner sheerlines shall not exceed 50mm.
- (l) The centreplanes of each hull and its centreband case shall coincide.
- (m) With the deck crown template normal to the deck and square across the hull, the clearance between deck and template shall be not more than 5mm except in way of recesses or pads for ports and fittings.
- (n) The builder shall certify that the boat with full racing equipment, and with both hulls swamped, shall support 160kg. If the boat is found at any time not to comply with this requirement the certificate shall be invalid.
- (o) No rigging or control devices shall pass through the hull.

9. BEAMS

- (a) The hulls shall be joined by a main beam and rear beam. There shall be no beam or strut attached to the hulls other than the main beam and rear beam and there shall be no beam or strut connecting the main beam and rear beam.
- (b) The main beam and rear beam shall each be straight aluminium alloy tube of constant section along its length, except that where a mast-section with integral track is used, the track may be opened, but not cut away, to provide an entry for a trampoline bolt rope. Holes may be drilled in the beams for fastenings.
- (c) The major diameter of the main beam section shall be not more than 135mm nor less than 112mm. The minor diameter of the section shall be not more than 91mm nor less than 74mm.

section shall be not more than 91mm or less than 65mm except that where an external or partly external travel track is extruded integrally with and on top of the section, the overall projected diameter including such track shall not be less than 83mm or more than 108mm. An extrusion incorporating an integral mainsheet track shall only be permitted if the design has been submitted to and approved by the I.Y.R.U.

- (e) The wall thickness of the sections shall not be less than 2mm.
- (f) The main beam and rear beam shall each be in one continuous piece. They shall be let into the deck and their lower surfaces shall be not more than 35mm nor less than 25mm below the inner sheerlines.
- (g) The major axis of the sections shall be parallel to the sheer. The beams shall be rigidly attached to the hulls but shall be easily removable.
- (h) A template, of shape below, applied to the leading surfaces of the main beam and rear beam as shown shall touch the beam only at points A and B



- (i) The rear edge of the main beam shall be not more than 3115mm nor less than 3095mm abaft the stemhead length datum, as inscribed on the bow template.
- (j) The front edge of the rear beam shall be not more than 5344mm nor less than 5324mm abaft the stemhead length datum as inscribed on the bow template.
- (k) The main beam shall be fitted with a strut and tie; the underside of the tie in way of the strut shall be not less than 235mm nor more than 255mm below the underside of main beam; the line of the tie shall meet the underside of the main beam not less than 970mm nor more than 1122mm from the centreline of the strut; the tie may be cable, rod, or flat stock with a thickness of not less than 3mm the leading edge of which may be rounded but not sharpened, to not more than 1.5mm from the leading edge; the strut shall be of circular cross-section of diameter not less than 24mm. The maximum deflection of the beam in any direction over its full length at rest, without the mast being stepped, shall not exceed 15mm.
- (l) Any device for adjusting the main beam strut or tie shall remain locked whilst racing.
- (m) There shall be no fairings.

10. TRAMPOLINE

- (a) A trampoline shall cover the area between the main beam, rear beam and inner sheerlines, except that a maximum gap of 130mm is allowed along the fore and aft centreline and around the perimeter for lacing.
In addition to these gaps and the necessary lacing eyes, holes not exceeding 0.1 square metre in total area are allowed in the trampoline. The area of each hole shall be taken as the area of the enclosing rectangle. (A net trampoline is not permitted. For the purpose of this rule, net shall be defined as a material where the intersection of warp and weft are knotted, welded or in any other way treated to space the warp and weft apart.)
- (b) There shall be no trampoline or other covering whatsoever in front of the main beam or behind the rear beam except that the trampoline material may be wrapped round the beams.
- (c) If the trampoline is wrapped round the main beam in the form of a sleeve, the sleeve including any lacing shall extend not more than 185mm aft of the front of the beam, and shall not incorporate any padding. Double trampolines are prohibited.

11. CENTREBOARDS

- (a) Two centreboards shall be fitted, one in each hull. Each centreboard shall pivot about one point only, relative to the hull, and shall be capable of being raised completely so that it does not project below the line of the keel. The line of the keel shall be the continuation of the keel line in way of the centreboard case. The pivot point shall be aft of the line of the underwater leading edge of the centreboard and not more than 100mm from it.
- (b) Dagger boards are prohibited.
- (c) In the fully down position the underwater profile of each centreboard shall not overlap or be more than 10mm away from the centreboard template, both ends of which shall touch the keel line.
- (d) In the fully down position the front edge of each centreboard at the line of the keel shall be not more than 2485mm nor less than 2465mm abaft the aft edge of the correctly positioned bow profile template.
- (e) The maximum thickness of each centreboard shall not exceed 29mm. In the fully down position the maximum thickness of each centreboard at the line of the keel shall be not less than 25mm.
- (f) The surface of each centreboard below the line of the keel shall nowhere be concave. The cross-sections of each centreboard shall be substantially symmetrical about its fore and aft centrelines.
- (g) The centreboards shall have no moving parts.

12. RUDDERS

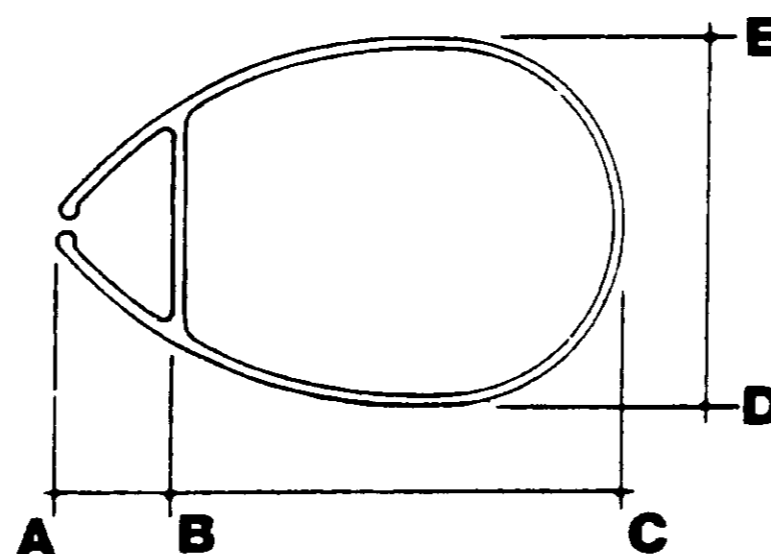
- (a) In the fully down centred fore-and-aft position the profile of each rudder blade shall not overlap nor be more than 10mm away from the rudder blade template, the forward top edge of which shall neither be below nor more than 10mm above the line of the keel. The leading edge of the rudder shall be no closer than 12mm to the transom at the line of the keel.
- (b) The rudders shall be hung on the transoms on normal fittings and shall have devices to retain them in the event of a capsizing.
- (c) With the rudders in the fore-and-aft position the centre planes of each hull and its rudder shall coincide.
- (d) Dagger and fixed rudder blades are prohibited.

13. WEIGHT

- (a) The total assembled weight of hulls, correctors if any, main beam, rear beam, trampoline, centreboards, rudders, tillers, connecting arm, tiller extensions, main sheet track or wire horse, main sheet traveller or slide, jib sheet strop(s), and all fittings bolted, screwed, or permanently fixed to the boat shall be not less than 127 kg nor more than 145 kg when in dry condition to the measurer's satisfaction. Not included in this weight are spars, standing rigging or main sheet and foresail sheet lines and blocks, and all other loose and easily removable gear.
- Correctors shall be attached inside of the main beam or immediately beneath the main beam in each hull or on the outside of the main beam.
- The total weight of correctors shall not exceed 5 kg. This shall apply to boats first registered after February 1977.
- (b) If correctors are altered or removed the boat shall be re-weighted by an official measurer and a new certificate obtained.

14. MAST

- (a) The mast shall be an inherently straight aluminium alloy extrusion of constant section, with integral track and of the general shape shown on the diagram. The exterior surface shall be designed to be smooth, however, the interior may be altered to change the wall thickness, either by the inclusion of ribs or by gradual changes of thickness. Mast sections shall be permitted only when the design has been approved by the I.Y.R.U.



- There shall be one web only. Dimension A C shall be not less than 112mm or more than 135mm and dimension D E shall be not less than 74mm nor more than 91mm measured externally. The ratio A B : A C shall be not less than 0.11 or more than 0.35. The wall thickness shall be not less than 1.8mm.
- (b) The extrusion may be tapered above a point 7190mm from the lower end of the mast extrusion and the track opened or cut away below a normally positioned sail entry point, but the shape shall be not otherwise altered.
- (c) Tapering shall be only achieved by cutting a single "V" slot down the front of the section, closing it and making a single continuously welded butt joint. The girth of the mast at the bottom edge of the top measurement band shall be not less than 240mm and the taper shall not be hollowed:
- when viewed from the side, by more than 5mm from a string line stretched taut along the leading edge of the tapered section of the mast between the bottom edge of the top measurement band and the lower edge of the taper. This measurement shall be taken when the mast is horizontal with the major axis of the section horizontal.
 - when viewed from forward, by more than 3mm from a string line stretched taut along the side of the tapered section of the mast, at its widest points, between the bottom edge of the measurement band and the lower edge of the taper.
- This measurement shall be taken when the mast is horizontal with the major axis of the section vertical.
- (d) The forestay and shrouds shall be attached to the mast at a single point, within 40mm of the extrusion surface and not more than 7190mm nor less than 7140mm from the lower end of the mast extrusion.
- (e) The trapeze wires shall be attached to the mast and not to the standing rigging. The attachment point shall be not more than 50mm from the attachment point for the shrouds and forestay, and may be the same point.
- (f) The mast shall be stepped on the centreline of the boat and its vertical centreline shall intersect the main beam in any position to which the mast may be rotated.
- (g) A measurement band shall be painted round the mast with its top edge not more than 390mm nor less than 340mm from the lower end of the mast tube extrusion. A second measurement band shall be painted with its bottom edge not more than 8915mm above the top edge of the first. (Measurement bands shall be in a colour contrasting with that of the spar.)
- (h) When stepped, the lower end of the mast extrusion shall be not more than 90mm above the top of the main beam.
- (i) With the mast horizontal and simply supported at the bottom end of the extrusion and at the bottom edge of the top measurement band only, the mast weight bearing on the support at the top band shall be not less than 10.5 kg. This weight shall be measured with gooseneck, running rigging and normally attached diamond rigging, but without shrouds, forestay and trapezes, and all slack in the mainsail and jib halyards shall be pulled to the butt so that the sail attachment fittings are against the upper halyard sheaves. Halyard tails shall be coiled and attached to the mast butt. With the mast rigging and fittings in the same condition the total weight shall be not less than 23 kg.
- (j) Mast jacks and adjustable mast steps are prohibited.

15. BOOM

- (a) The boom may be of any material, but shall be inherently straight and of constant section throughout its length.
- (b) Excluding fittings, the boom shall pass through a 100mm diameter circle.
- (c) The weight of the boom including only the mainsheet attachment points and equipment for controlling the mast spanner, tack downhaul, clew outhaul and leech-line (but not including the leech-line itself) shall not be less than 3.5 kg.

16. STANDING RIGGING

- (a) There shall be one shroud only to each hull, the attachment point being on the outer topsides and not more than 728mm nor less than 708mm aft of the after edge of the main beam measured along the sheer to the point of intersection with the plane of the shrouds. The distance between the outer surface of the chain plate and the outer surface of the topside shall not exceed 15mm.

- (b) The mast shall carry one pair of diamond stays only, which shall be rigged to a spreader of unfaired round tube or rod of diameter 15mm minimum.

The diamonds shall be rigged between external tangs fastened to the outside of the mast. Diamond stays may be passed through a fairlead, permanently fixed to the mast above the lower tangs. The distance between the diamond attachment point on the upper tangs and the attachment point on the lower tangs, or the fairlead, shall not be less than 6000mm. The distance between the diamond attachment point on any tang and the nearest fastening of that tang to the mast shall be not more than 75mm.

The points of intersection of the diamond wires and the spreaders shall be not less than 790mm apart measured in a straight line.

- (c) There shall be one forestay only, which shall be attached to a strop between the hulls. The forestay strop attachment point to each hull shall be not more than 50mm from the inner sheerline and not more than 1990mm nor less than 1965mm forward of the after edge of the main beam measured to the centre of the attachment hole in the fitting fixed to the hull.

The line of each half of the forestay strop shall not pass above the inner sheerlines when the boat is rigged.

- (d) The point of intersection of the lines of the forestay and each half of the forestay strop shall lie on the centreline of the boat and shall be not less than 838mm from a straight line joining the inner sheerlines where they intersect the plane of the forestay bridle.

This measurement shall be taken with the forestay strop in a vertical plane and with an upward force of not less than 2 kg and not more than 6 kg applied vertically at the centreline of the boat.

- (e) Struts, stays, or devices which limit the natural fore and aft movement of the forestay and forestay strop are prohibited.
- (f) There shall be no other standing rigging.
- (g) All standing rigging shall be circular in section and shall have no fairings. Rod rigging is prohibited. The minimum diameter of the shroud, diamond wires, forestay and forestay strop shall be 3mm.
- (h) Adjusting the standing rigging whilst racing is prohibited. Standing rigging shall be adjusted only by means of rigging screws or turnbuckles, shackles, shroud adjuster plates and lashing. Any of these shall be locked, wired or otherwise firmly secured while racing.
- (i) The weight of the forestay, forestay strop, shrouds, trapeze wires and handles and shackles, rigging links and adjusters used to attach these to the mast and the hulls shall be not less than 1.7kg.

17. SAILS

- (a) The rig shall consist of mainsail and headsail.

The I.Y.R.U. International Sail Measurement Instructions 1974 shall apply where no conflict with these rules arises. Reinforcement having the effect of stiffening the sail be permitted only within a distance from each corner of 595mm for the mainsail and 440mm for the headsail. Beyond this limit sails shall comply with I.Y.R.U. International Sail Measurement Instructions. Battens shall be removed from the mainsail for measurement.

- (b) The sails shall be of woven material and shall be capable of being stowed in a sail bag of normal dimensions. Windows of unwoven material to a total maximum area of 0.3 square metres shall be allowed in any sail. The area of each window shall be taken as the area of the enclosing rectangle.

- (c) **Headsail**

- (i) The "triangulation" method of measurement shall be used if the width of the sail at the head exceeds 50mm. For the purpose of this rule the width at the head shall be measured at right angles to the luff through the highest point of the sail on the luff, to the line of the leech, extended if necessary.
- (ii) The length of the leech shall be not more than 5435mm. The length of the luff shall be not more than 5800mm. The length of the foot shall be not more than 1985mm.
- (iii) At a point on the leech 200mm down from the head, the nearest point on the luff shall be not more than 100mm distant.
- (iv) At the half leech point the nearest point on the luff shall be not more than 850mm distant. The half point shall be found by folding head to clew and smoothing the sail out flat.
- (v) The distance from the head to the centre of the foot shall be a maximum of 5620mm.
- (vi) As many as three battens are allowed in the leech only. Each batten shall be perpendicular to the leech, not be more than 200mm in length and not more than 20mm in width.
- (vii) The leech shall be in no place convex.
- (viii) Zip "Velcro" and sleeve luffs are allowed.
- (ix) The headsail shall be carried on the forestay. The tack shall not extend below the intersection of the forestay with forestay strop. A device shall be used to prevent adjustment of the tack below this point.
- (x) Headsail clew boards larger than 60mm in any dimension are prohibited. Only one sheet attachment point is permitted.

- (d) **Mainsail**

- (i) "Head" shall be the highest point of the sail outside the mast; "tack" shall be the point of intersection of the line of the foot with the line of the aft edge of the mast; "clew" shall be the point of intersection of the line of the foot with the line of the leech from above the bottom batten.
- (ii) The mainsail shall be set within the inner edges of the measurement bands on the mast.
- (iii) The sail shall be loose-footed and shall be attached to the boom or boom fittings by tack and clew cringles.
- (iv) The foot, when smoothed out for measurement shall be straight with no shelf or built-in flow.
- (v) The tack and clew cringles, together with associated roping and sail reinforcement, may extend below the line of the foot, but such extension shall be wholly contained within rectangles of 350mm x 50mm. Tack and/or clew boards may be fitted below the line of the foot of the mainsail provided they comply with the dimensions stated above. Alternatively, a tack board within the perimeter of the sail and not exceeding 120mm in any dimension shall be permitted.
- (vi) There may be a full length batten along the foot and not more than 10 others.
- (vii) There shall be no other battens and no batten may exceed a width of 55mm or protrude more than 150mm beyond the leech of the sail.
- (viii) The battens shall have no moving parts.
- (ix) The battens shall not incorporate carbon fibres.
- (x) The distance from head to clew shall be not more than 8650mm.
- (xi) The headboard shall not exceed 120mm in any dimension.

- board.
- Any hollows in the leech in way of width measurement points shall be bridged with straight lines for measurement.
- (xiii) At a point on the leech 500mm down from the head, the nearest point of the luff shall be not more than 385mm distant, measured across the full width of the sail including the bolt rope.
- (xiv) At the $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ leech points the nearest point on the luff shall be not more than 2260mm, 1955mm and 1270mm distant respectively, measured to include the bolt rope.
- The $\frac{1}{4}$ leech point shall be found by folding head to clew and smoothing the sail flat.
- The $\frac{1}{2}$ and $\frac{3}{4}$ leech points shall be found by folding the clew and head to the $\frac{1}{2}$ leech point and smoothing the sail flat.
- (xv) The distance from the clew to a point on the luff 500mm from the line of the foot shall be not more than 2355mm measured to include the bolt rope.
- (xvi) The mainsail shall be hoisted in the integral luff groove of the mast extrusion, and shall not be fitted with a sleeve or double luff or other fairing device.
- (xvii) When measured and found to be in accordance with these rules, the sails shall be legibly and permanently endorsed with the date of measurement and the measurer's signature. New, or substantially altered, sails shall be measured by a recognised measurer and the details recorded on the official certificate in the space provided.
- (xviii) One leech line only is permitted. This shall run externally through the batten ends or through a sleeve not exceeding 35mm width from the leech edge. When the mainsail is equipped with a leech line the upper end of it shall terminate at the head-board.
- (xix) Controls for the leech line and clew shall be mounted on or in the boom only and shall not extend to any other part of the boat.
- (xx) The luff downhaul control shall be mounted only on or in the boom or on but not in the mast, and shall not be interconnected with any other control.
- (xxi) There shall be no mainsail controls other than the leech line, clew adjuster, luff downhaul, Cunningham eye downhaul, mast rotation control, mainsheet and traveller and main halliard.

18. MAINSHEET

A mainsheet traveller system is permitted if the traveller runs in a substantially straight line vertically and horizontally along the rear beam only, or on a wire horse attached only to the rear beam. The track shall be considered to be substantially straight if it departs from a straight line by not more than 10mm.

19. MISCELLANEOUS

- (a) No hiking aid shall be allowed except for foot loops, toe straps, trapeze gear and any line for retaining crew position on gunwale. The trapeze gear shall be used only by one person at a time who shall have at least one foot in contact with the boat.
- (b) Trapeze gear worn by the crew or helmsman shall be buoyant.
- (c) The following are prohibited:
Foresail booming out spars, foresail booms, boom vang or kicking straps, hydrofoils, outriggers, ballast, suction bailers, keel bands except in way of centreboard slot, rubbing strakes, spray deflectors, chines, and any projection from the skin other than normal fittings.

20. EQUIPMENT

The following equipment shall be carried on board whilst racing:

A paddle not less than 1000mm long; a lifebuoy or personal buoyancy for each member of the crew.

An anchor is not required unless so specified in the Sailing Instructions, in which case it shall be of not less than 2.5kg weight with not less than 30 metres of line.

21. PERSONS ON BOARD

The crew (including helmsman) shall consist of two persons.

OFFICIAL TEMPLATES

The set comprises:

- Bow template
- 0, 1, 2, 3.3, 4.2 and 5 hull templates
- Centreboard template
- Deck camber template
- Rudder template

DECLARATIONS

(1) To be signed by Measurer:

I certify that I have measured and weighed this catamaran, that the particulars on this form are correct, and that to the best of my knowledge the catamaran complies with the rules and restrictions of the International Tornado Class at present in force, except as stated below.

Measurer's Comments:

Name of Measurer (Block Capitals)

Recognised by (National Authority)

Signature of Measurer

Date

(2) To be signed by Builder:

I certify that:

- (a) This boat with full racing equipment with both hulls swamped will support 160 kg.
- (b) This boat has been constructed according to the official rules of the International Tornado Class.
- (c) This boat is built in accordance with the spirit and letter of the Measurement and Class Rules.

Name of Builder (Block Capitals)

Signature of Builder Date

15(b)	54	BOOM Does the boom excluding fittings pass through a 100mm diameter circle?		Yes/No	
		STANDING RIGGING			
16(b)	55	Outside diameter of diamond spreader	15	.....
16(b)	56	Distance between diamond attachment points on upper and lower tangs	6000	.....
16(b)	57	Distance between diamond attachment point on any tang and the nearest fastening of that tang to the mast		.....	75
16(b)	58	Straight distance between points of intersection of diamond wires over spreaders	790	.....
16(g)	59	Diameter of standing rigging	3.0	.....
		WEIGHTS			
13(a)	60	Weight of hulls, main beam with any correctors, rear beam, trampoline, centreboards, rudders, tillers and extensions, connecting arm, mainsheet track of horse with traveller or slide, jib sheet strops and permanently fixed fittings	127kg	.....	145kg
13(a)	61	Weight of correctors (if any)		.....
14(i)	62	Mast weight with gooseneck, diamonds and running rigging; spar being horizontal with supports at lower end of extrusion and top measurement band	23kg	.....
14(i)	63	Weight on top measurement band support	10.5kg	.....
15(c)	64	Weight of boom including mainsheet attachment points, equipment for controlling mast spanner, tack downhaul, clew outhaul and leech line (but not including leech line itself).	3.5kg	.....
16(i)	65	Weight of forestay, forestay strop, shrouds, trapeze gear and shackles, rigging links and adjustors	1.7kg	.....
		EQUIPMENT			
20	66	All equipment required by the rule is provided		Yes/No	
		SAILS			
7	67	Does sail material comply with rule 7?		Yes/No	
		HEADSAIL: Serial number			
		Maker			
17(b)	68	Total area of transparent unwoven panels, taken as area of enclosing rectangle		.....	0.3m ²
17(c)(i)	69	Width of sail at head		.....
17(c)(ii)	70	Leech		.....	5435
17(c)(ii)	71	Luff		.....	5800
17(c)(ii)	72	Foot		.....	1985
17(c)(iii)	73	Width from luff to point on leech 200mm from head		.....	100
17(c)(iv)	74	Width from luff to half leech point		.....	850
17(c)(v)	75	Distance from head to centre of foot		.....	5620
17(c)(vi)	76	Number of battens if any		.....	3
17(c)(vi)	77	Maximum length of battens		.....	200
17(c)(vi)	78	Batten width		.....	20
17(a)(c)(x)	79	Does sail comply with rules 17(a) and 17(c)(x)?		Yes/No	
		MAINSAIL: Serial number			
		Maker			
17(b)	80	Total area of transparent unwoven panels taken as area of enclosing rectangle		.....	0.3m ²
17(d)(iv)	81	Foot is cut straight and flat		Yes/No	
17(d)(v)	82	Does sail comply with rule 17(d)(v)?		Yes/No	
17(d)(v)	83	Foot batten is fitted		Yes/No	
17(d)(vi)	84	Number of other battens other than foot batten		.....	10
17(d)(vii)	85	Batten width		.....	55
17(d)(xviii)	86	Maximum distance from leech edge to edge of sleeve for leech line, if fitted		.....	35
17(d)(x)	87	Distance from head to clew		.....	8650
17(d)(xi)	88	Greatest dimension of headboard		.....	120
17(d)(xiii)	89	Distance from clew to point on luff 500mm from line of foot		.....	2355
17(d)(iv)	90	Width from luff to point on leech 500mm from head		.....	385
17(d)(xv)	91	Width from luff to ¼ leech point		.....	2260
17(d)(xv)	92	Width from luff to ½ leech point		.....	1955
17(d)(xv)	93	Width from luff to ¾ leech point		.....	1270
17(a)	94	Does sail reinforcement comply with rule 17(a)?		Yes/No	
	95	Sails have been endorsed by the measurer		Yes/No	

No.	No.				
		HULLS – upright and assembled			
6(a)	11	Is the registered sail number cut or indelibly marked in port transom?		Yes No	
8(l)	12	Are the centreboard cases fitted on the hull centrelines?		Yes No	Yes No
8(o)	13	Does any rigging or control device pass through the hulls?		Yes No	Yes No
8(i)	14	At main beam, difference between deck centreline separation and keel centreline separation.		.....	10
8(j)	15	Deck centreline separation (test at several points along length of hulls)	2590	.....	2630
8(k)	16	Difference between diagonals		.....	50
8(m)	17	Greatest clearance between deck and template at any point along length of hull		.....	5
8(e)	18	Maximum radius at the sheer		.....	12
9(i)	19	Aft edge of main beam from stemhead length datum	3095	.....	3115
9(j)	20	Forward edge of rear beam from stemhead length datum	5324	.....	5344
16(a)	21	Shroud attachment points abaft aft edge of main beam	708	.....	728
16(c)	22	Forestay stop attachment points forward of aft edge of main beam	1965	.....	1990
16(c)	23	Forestay stop attachment points from sheerline		.....	50
16(c)	24	Lines of forestay stops pass below inner sheerlines		Yes/No	
16(d)	25	Distance of intersection of lines of forestay and both forestay stops from a straight line joining the inner sheerlines in way of stop attachment points	838	.....
		BEAMS			
9(b)	26	Are the beams straight, constant section, aluminium alloy tubes?		Yes/No	
9(c)	27	Main beam – major diameter	112	.....	135
9(c)	28	Main beam – minor diameter	74	.....	91
9(k)	29	Maximum deflection of main beam – without mast stepped		.....	15
9(d)	30	Rear beam – major diameter	100	.....	135
9(d)	31	Rear beam – minor diameter if			
		(a) mainsheet track separate	68	.....	91
		(b) mainsheet track integral	83	.....	108
9(e)	32	Least wall thickness of beams	2	.....
9(f)	33	Depth of lower surfaces of beams below the inner sheerlines	25	.....	35
9(h)	34	Does template touch leading edges of beams at only 'A' and 'B'?		Yes/No	
9(k)	35	Depth of underside of tie below the underside of main beam at strut	235	.....	255
9(k)	36	Distance of junction of tie and main beam from strut centreline	970	.....	1122
9(k)	37	Tie thickness	3	.....
9(k)	38	Rounding of leading edge of tie – radius		.....	1.5
9(k)	39	Strut – outside diameter	24	.....
		TRAMPOLINE			
10(a)	40	Greatest gap at edge or at fore and aft centreline		.....	130
10(a)	41	Total area of additional apertures or net inserts – measured as areas of enclosing rectangles		.....	0.1m ²
10(c)	42	Distance aft of sleeve and lacing from front of main beam if trampoline wrapped around		.....	185
		MAST			
14(a)	43	Fore and aft dimension of section	112	.....	135
14(a)	44	Athwartships dimension of section	74	.....	91
14(a)	45	Thickness of walls	1.8	.....
14(a)	46	Does mast section comply with the other requirements of rule 14(a)?		Yes/No	
14(c)	47	Girth at bottom of top measurement band	240	.....
14(d)	48	Standing rigging attachment point, distance from mast surface		.....	40
14(d)	49	Standing rigging attachment point, distance from lower end of extrusion	7140	.....	7190
14(e)	50	Distance of trapeze attachment from shroud and forestay attachment point		.....	50
14(g)	51	Top edge of lower measurement band from lower end of extrusion	340	.....	390
14(g)	52	Lower edge of top measurement band from top edge of lower band		.....	8915
14(h)	53	Bottom of mast extrusion above top of main beam		.....	90