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U.S. NAVY

FERRO-CEMENT BOAT BUILDING MANUAL

VOLUME III

NAVAL SHIP SYSTEMS COMMAND
WASHINGTON D. C.

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INTRODUCTION

This is a record of the building of ten 42-ft. fishing boats in the Bahamas. It illustrates the methods, equipment and organization required to construct ten ferro-cement boats on a remotely situated beach, with relatively unskilled labor.

Much of this record is devoted to the fitting out of a ferro-cement boat. It is in some detail, and it concerns one particular design of fishing boat. The reader must bear in mind that many methods of building and fitting out ferro-cement boats exist and that other techniques might have been employed here with good results. What is important to remember is that speed and cheapness of construction were the standards demanded by the principals of this project. And, the workers engaged in the Bahama Islands had never before seen a ferro-cement boat.

THE CONSTRUCTION METHOD

The construction method chosen was the inverted wooden mold. For hulls up to 50 feet in length, and for utilizing unskilled labor, this method has been shown to be most efficient providing that adequate lifting and rolling gear is available.

The ten hulls were built simultaneously over molds constructed of low-grade spruce. The molds could not be used again and were removed after the concrete hulls had been steam-cured.

The advantages to this method of construction are:

a. The shape and fairness of the hull is first established and checked with the quick and easy-to-build wooden mold.

b. The use of air-powered staple guns to fasten mesh and rods to the hull mold is a quick and efficient method and can be performed with unskilled labor.

c. Lamination of the concrete skin is eliminated as the mortar is applied from one side only and vibrated through the hull shell reinforcing.

d. Sagging of large unsupported areas is avoided. The men work from the outside of the hull and downwards. In other construction methods the men work inside the hull and overhead, thereby greatly increasing construction effort and reducing the number of men who can effectively work at once.

The inverted wooden mold method is a tremendous aid to producing a fair hull in a short construction time. A criticism often raised of this method is the stripping out of the wooden mold after curing. This is always a slow and tiresome job but, in compensation, it can be carried out with unskilled labor.

The prefabricated superstructure, built on a one-unit mast and wheelhouse framework, was sheathed with plywood, completely outfitted, and bolted to the deck of the boat once afloat. The fish-hold was also prefabricated but installed prior to making the deck.

Significant of the efficiency of this construction method is that all ten boats were built and launched within a five-month period.

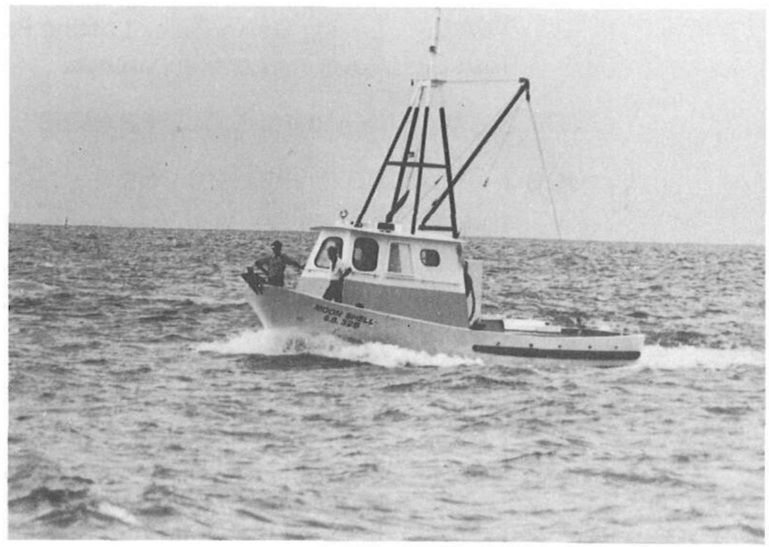
SUPPLIES

Construction materials and equipment were shipped by sea to Grand Bahama from the Port of Miami, U.S.A. Some materials were imported from as far away as Vancouver, Canada, and Sweden. At certain times lighter and more urgently needed equipment or fastenings were flown in. Delays were experienced once by a longshoremen's strike but more frequently by shipping documents not conforming to Bahamian Customs' regulations.

THE DESIGN

In its original concept the design was for a 42-ft. combination fishing boat with ferro-cement hull and decks. The heart of the boat as a "multi-purpose fishing machine" lay in the hydraulic power system, driven off the main engine, designed to operate a variety of rapidly interchangeable fishing rigs. The idea being that crews working these boats from remote islands in the Bahamas' chain would be able to haul crawfish traps, haul long-lines, to troll, even use a purse-seine, without the need for returning to the yard for rig modifications. Not all these varieties of rig would be carried on board these small 42-ft. boats at once. But the crew would be able to change the rigs themselves at their island anchorages without recourse to special tools and skilled mechanics.

The feature in the design which facilitates the equipment of the various rigs is the practical A-frame mast structure in piping which virtually eliminates the need for wire stays. The base of this structure also serves as part of the framework for the wheelhouse. From this mast frame a chain hoist can be suspended for lifting the main engine out for quick overhaul. The wheelhouse has a removable panel in its aft bulkhead through which the engine can be skidded onto the work deck by the crew. The work deck itself is beamy and clear for ease of handling traps. The hull freeboard is low for ease of fishing operations in the warm Bahamian waters.



A seawater ice-machine was mounted on deck, powered by a small diesel generator unit installed in the lazarette. Seawater ice, one ton every 24 hours, could be fed automatically into the insulated fish-hold.

Cruising speed was calculated at 10 knots. An intermittent capability of 12 to 13 knots in smooth water was found to be available. The boat proved to be highly maneuverable at sea. Enough fuel could be carried for ten-day fishing operations plus three tons of fresh water.

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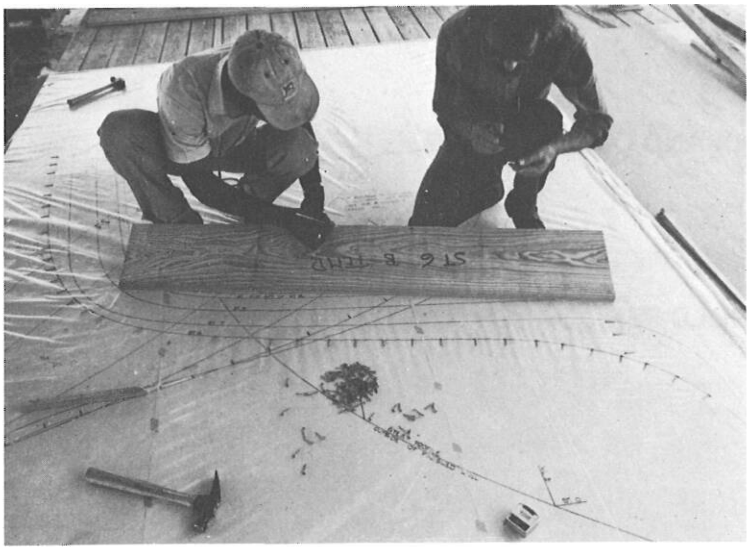


Nail heads driven on their sides into the lofting pattern lines.

The board to be cut being laid over the nail heads.

Standing on the board so that the nail heads will mark it.

The following pages document the building of ten ferro-cement fishing boats in the Bahamas. The order of construction is followed as closely as possible throughout. To simplify description the whole project has been divided into these six stages of construction:

Stage 1 — Building of the ferro-cement hull.

Stage 2 — Fabrication of component parts of the vessel.

Stage 3 — Installation of prefabricated component parts.

Stage 4 — Installation of engine and hull interior equipment.

Stage 5 — Installation of superstructure, finalizing hull and deck equipment systems, preparations for launching.

Stage 6 — Launching and sea trials.

These six construction stages each encompass a certain number of individual jobs which were carried out. As an aid to clarity and reference every job in every stage has been given a title and a number. But the job itself is often a complex operation, involving many distinct procedures which require explanation in a proper sequence. Many jobs, then, have been divided into tasks, each task given a title and a number. The result is a logical form of reference for pin-pointing any particular operation in the construction work. If reference has to be made, for example, to the fitting of the propeller shaft half coupling, the indication given will be:

Stage 4, Job 1, Task 2.

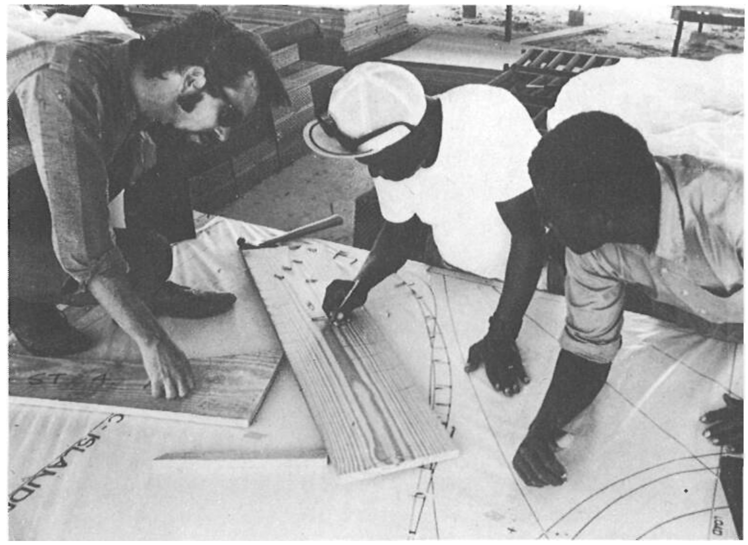
Stage 4 covers the Installation of Engine and Hull Interior Equipment; Job 1 covers the Main Engine Installation; and Task 2 refers directly to the fitting of the propeller shaft half coupling.

STAGE 1

JOB 1 - LAYING DOWN PATTERNS

TASK 1 — Laying Down Lofting Floor

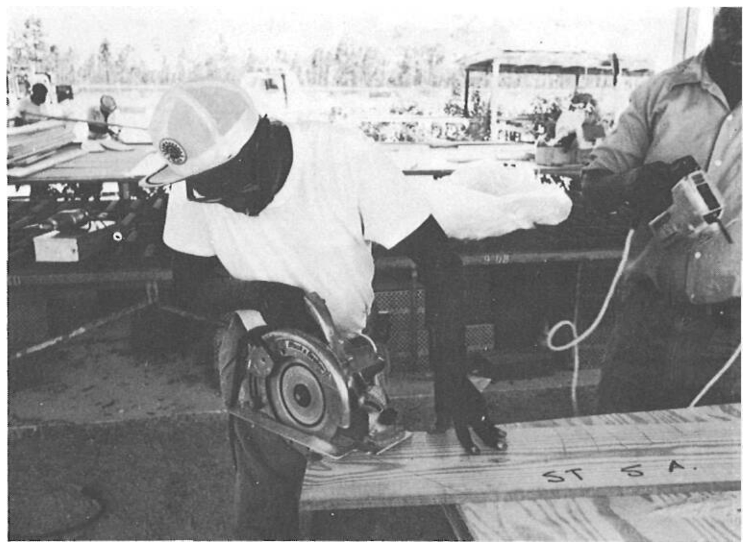
A lofting floor of plywood was laid down. The framing beneath it was absolutely level. Care was taken to ensure that the corners of the plywood sheets matched together. Note that plywood thinner than 1/2 inch (12.7 mm) should not be used for a lofting floor as it will not hold a nail properly, nor will it bear the weight of men working on it without distortion.



The marks left by the nail heads were penciled together.

TASK 2 — Laying Down Paper Lofting Patterns

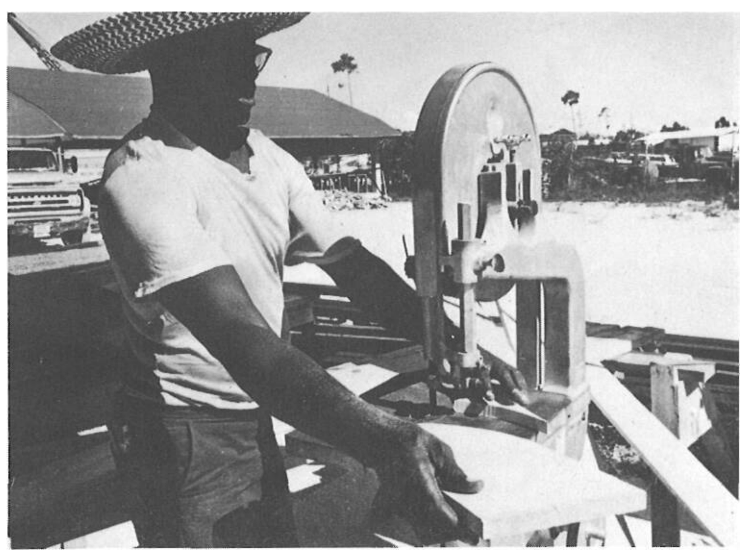
The paper lofting patterns were laid down on the lofting floor. These were smoothed out and all the wrinkles removed. The separate sheets of the paper patterns were joined carefully and the corners were diagonally checked to ensure that they were square. As ten boats were to be built at one time three sets of paper patterns were employed to speed the production of the hull mold frames. (See detailed instructions on lofting in Volume I.)



Saber and rotary hand power saws were used to cut the boards.

TASK 3 — Covering Lofting Patterns

The lofting patterns were covered with clear vinyl sheathing, 4 mm thick, for protection. Masking tape was used to hold it down at the corners.



Also a band saw.

JOB 2 - MAKING HULL MOLD FRAMES

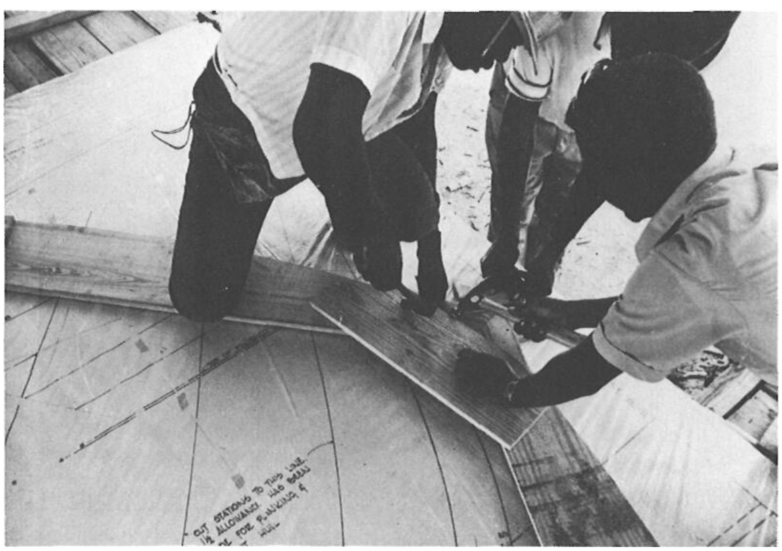
Most frames for the hull mold were constructed from several pieces of 1" x 10" (25.4 mm x 254 mm) board scabbed together. The easiest method of transferring the lines of the lofting pattern to the pieces of board is with the use of nails laid on their sides. The sharp edge of the heads of 1-1/2 inch (38 mm) dry-wall nails were hammered lightly into the pattern lines on two-inch (51 mm) centers. Half the nail head was driven into the line and the upper half left protruding. A board was then placed over the nail heads. A man stands on the board and his weight transfers the top of the nail heads to the board. The marks left by the nail heads were then joined by using a pencil and a flexible batten. The board was cut to the pencil line. On the straighter cuts a rotary hand saw was used. On the more difficult cuts or curves a band-saw or saber-saw was used. The frames were then placed back on the pattern lines and checked to make sure they had been cut accurately. The frame was adjusted slightly if required to make sure that it fitted the pattern perfectly. All the individual pieces for the frame were cut and scabbed together, using off-cuts of lumber. Two frames were made identically, one for each side. The frames were nailed together so that the scabs lay one down and one up. When the frames were set up the scabs then appeared on the same side.

The frames were carefully measured and joined together, making a full frame. The frames were attached to the set-up base; this was done with 2" x 4"s (51 mm x 102 mm). The center line and load waterline were carefully marked on each frame.

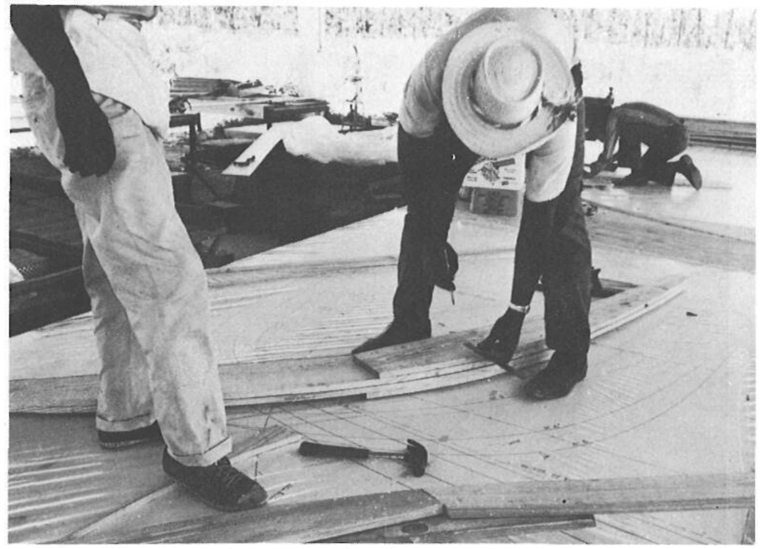
The frames were stacked in a neat pile. As ten boats were being built simultaneously, ten sets of each frame were made up at the same time.

The cut boards are checked against the pattern lines.

Trimming to fit center line.



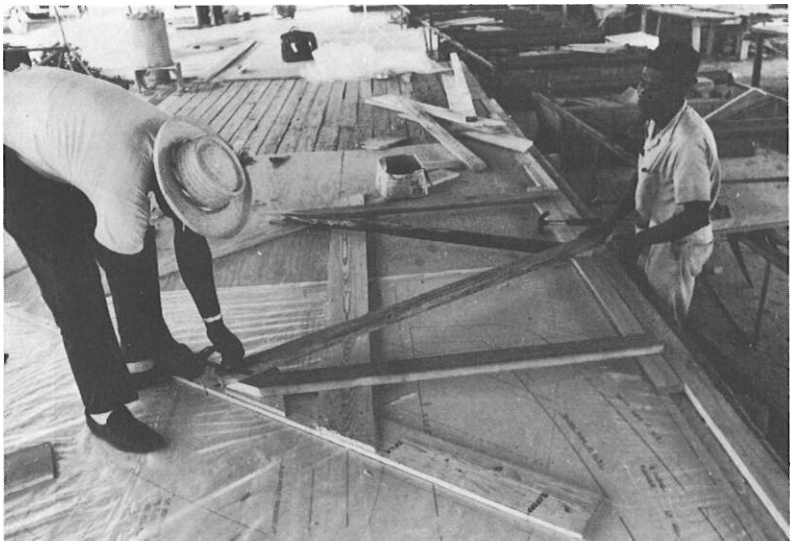
Nailing first half frame together.



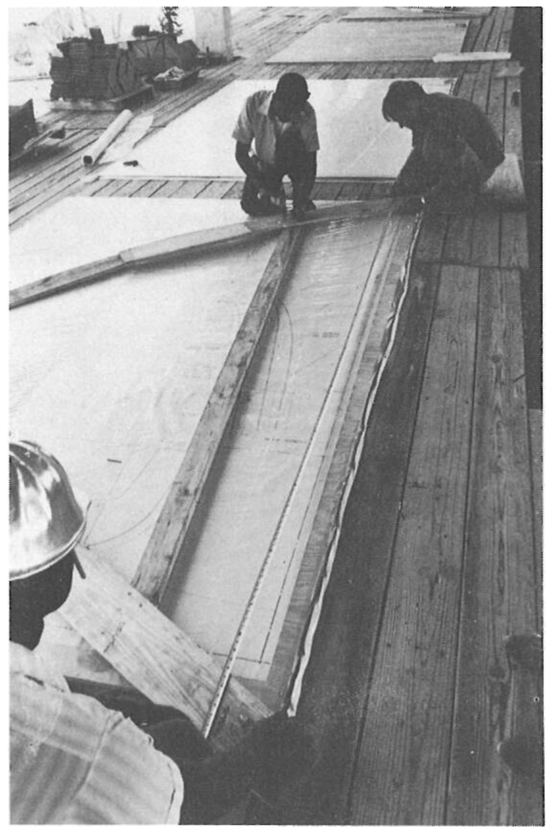
Two half frames assembled at once. Note position of scabs.

All hull mold frames measure from this Base Line.

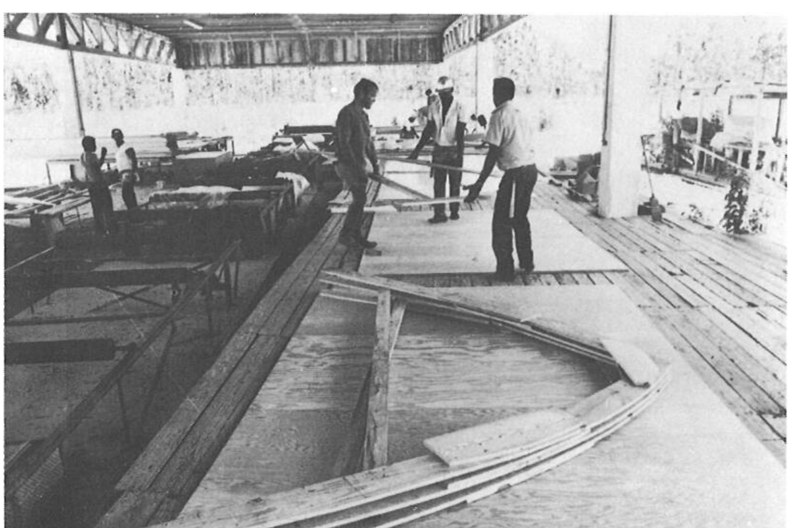
The frame measurements carefully checked before nailing together.



Mold Frame supports are braced.



Checking beam measurement at the rail cap.

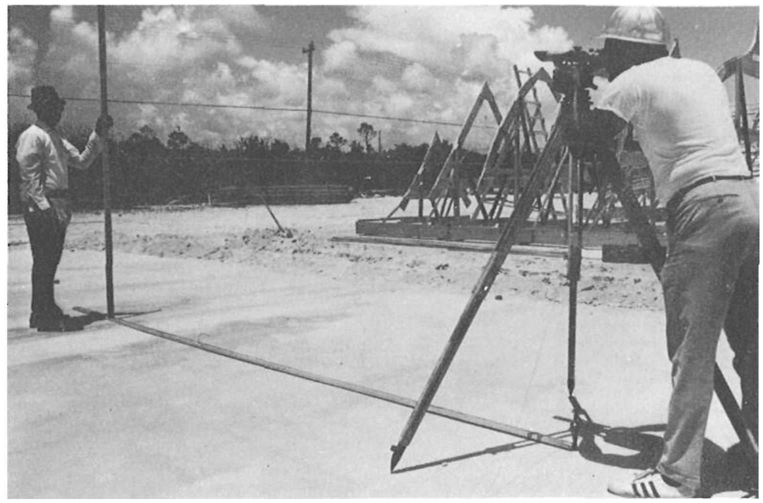


Frames are stacked carefully out of the sun.

JOB 3 - MAKING STRONGBACKS

TASK 1 — Strongback Main Bearers

The strongback main bearers, 42 ft. (12.8 m) long, were made of 14-ft. (4.2 m) lengths of 2" x 10" (51 mm x 254 mm) fir planking nailed together. (Double-headed nails were used so that the planks could be pried apart after the hulls had been rolled and the strongbacks were no longer needed. The planks were later utilized for scaffold boards.)



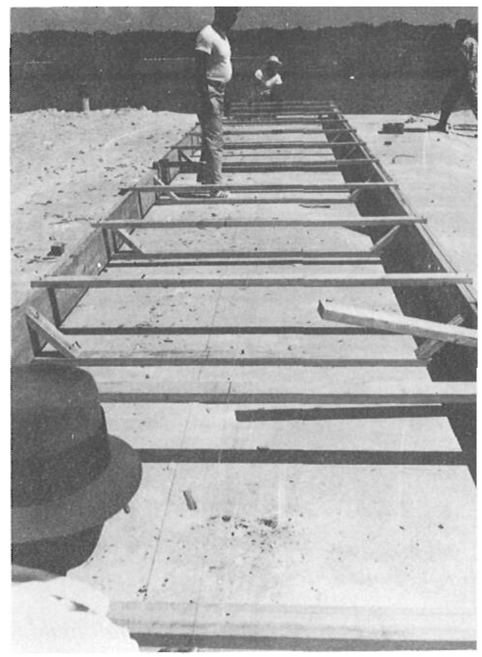
Checking concrete pads for level.

TASK 2 - Strongback Sleepers

Strongback "sleepers" were cut from 2" x 4" (51 mm x 102 mm) lumber and nailed to the two main bearers. The sleepers were then fastened to the concrete pad with cut nails.

TASK 3 — Leveling the Strongbacks

The strongbacks were carefully leveled throughout their entire length with the use of a transit. Shims were used in the low spots to achieve this. An accurate, square, and leveled strongback is absolutely essential before erection of the hull mold begins.

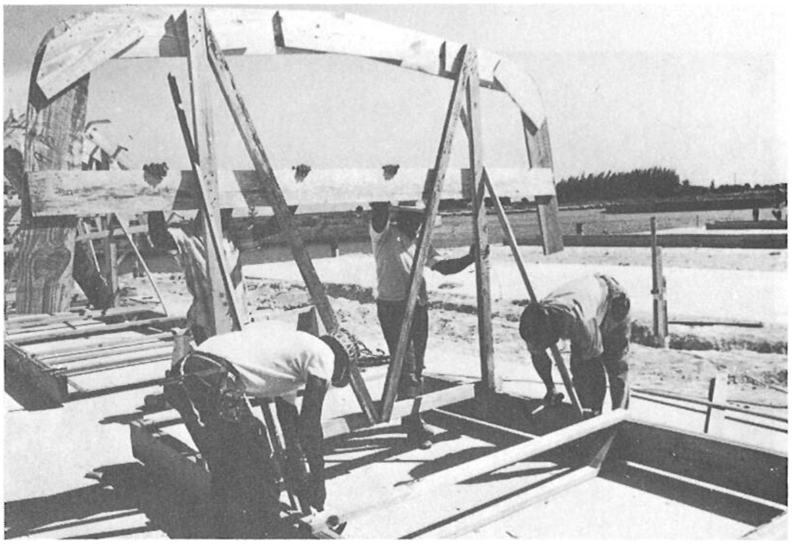


Strongbacks lying on sleepers. Upper cross-braces indicate hull mold frame positions.

TASK 4 — Cross Members and Center Line

Cross members cut from 2" x 4" (51 mm x 102 mm) lumber were nailed across the top of the strongbacks at each position where a hull frame was to be erected. A center line was established over the cross members by means of a chalk-line. The strongbacks were now ready to receive the hull mold frames.

Establishing the center line.

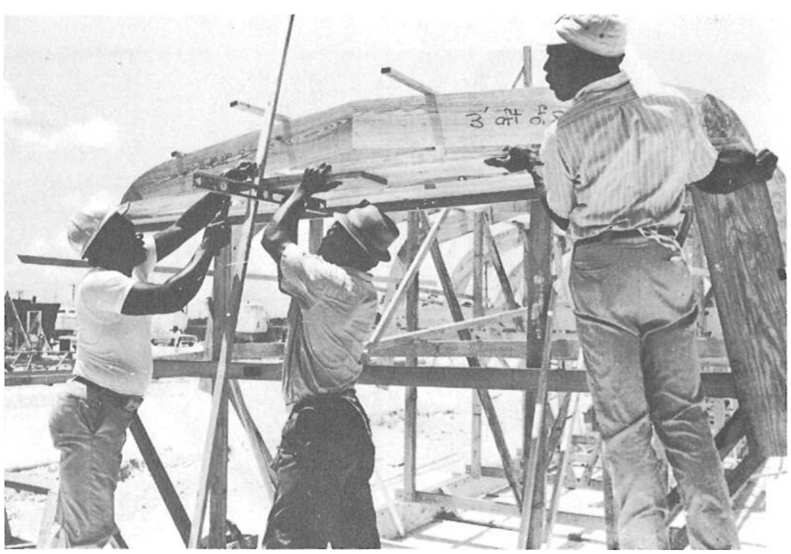


Aft frame has aft facing side butted to forward face cross-brace.

JOB 4 - ERECTING HULL MOLD FRAMES

The completed hull mold frames were handled into place on the strongbacks with care. Although all frames were numbered, some were so nearly identical in shape that confusion in the erection sequence was possible. From the midships line dividing fore and aft of the hull, fore-end mold frames were set up with their forward faces butting to the aft side of the strongback cross braces. Aft-end hull mold frames had their aft facing sides butted to the forward sides of the cross braces. In a similar manner, the scabs on the fore-end mold frames faced aft, the scabs on the aft-end mold frames faced forward. The reason for this being to prevent the mold planking from being pushed out of fair by a protruding scab edge. No frame edges were beveled. The higher edge of the frame was worked to when planking.

Handling the hull mold frames with care.



Setting up transom station.

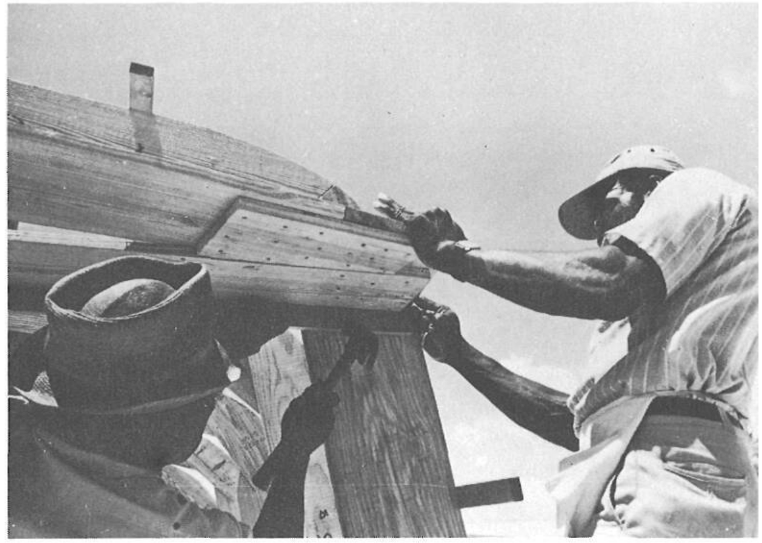
Preliminary leveling and erection.

TASK 1 - Erecting Hull Mold Frames

The hull mold frames were set up on the strongbacks and temporarily braced. The center line dividing port and starboard had previously been marked on the hull mold frames, also on the strongback cross braces. On erection of the frames the two marks were made to coincide.

TASK 2 - Plumbing and Bracing Hull Mold Frames

The frames were carefully plumbed, then finally braced. A straight-edged board was used to support the level while plumbing the long gap between the keel and the cross brace.



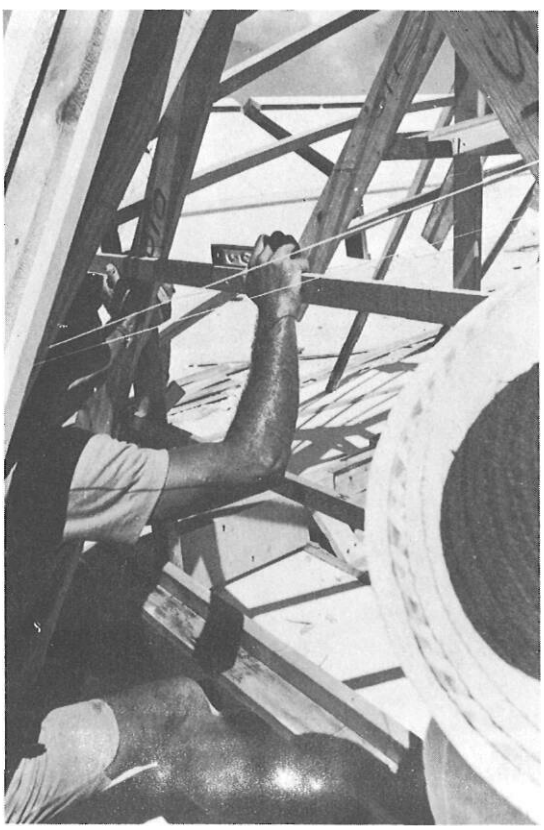
Attaching transom mold frame.

TASK 3 - Hull Mold Frames Rechecked for Plumb

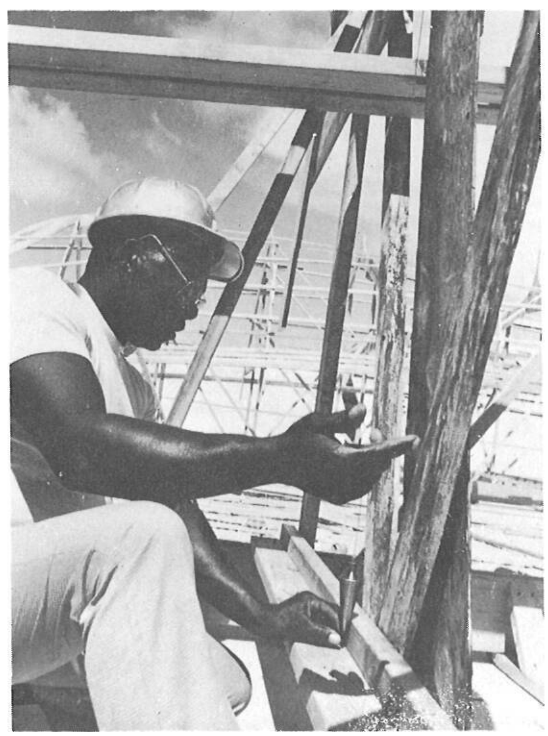
When the frames were all erected and braced they were rechecked for plumb.

TASK 4 - Leveling the Hull Mold Frames

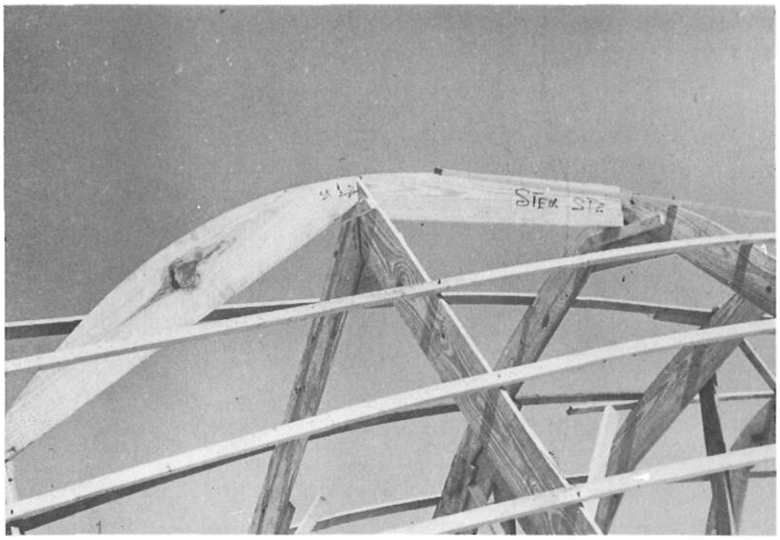
A straight-edged board was placed on the waterline marks on the frames and leveled across to ensure the frames were standing level athwartships. The frames were wedged up accordingly until they were all plumb, level and the waterlines lined up correctly.



Checking level of waterline.



Checking plumb of keel.



Stem *pieces at the forefoot. Fairing battens.*

TASK 5 — Transom Frames

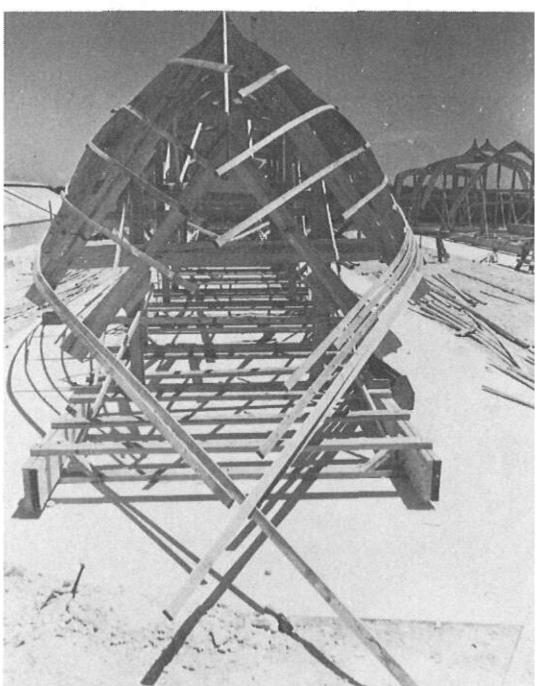
The horizontal frames for the transom were nailed in place; a short temporary block held them firmly in position. The transom framing was then leveled and braced.

TASK 6 - Stem Frames

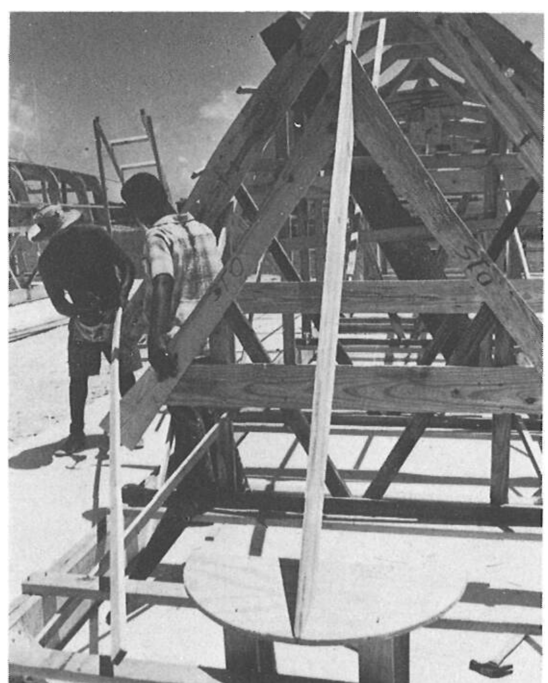
The stem pieces were nailed in place. A curved mold false piece was cut out of 3/4-inch (19 mm) plywood for the stem head and this was blocked up separately from the concrete pad as it came below the level of the strongback.

TASK 7 — Applying Fairing Battens

Fairing battens were then nailed in place onto the mold frames. Any hollows or humps in the future boat's hull could be easily spotted from the way these battens lay on the mold. These fairing battens were nailed on quickly so that the wooden mold would not warp out of shape in the hot Bahamian sun. 1" x 2" (25 mm x 51 mm) long, straight boards were used for fairing and bracing the frames. If a hump or hollow showed up, the frames were adjusted slightly until the whole framework was fair. By working from full-size paper patterns initially, we found the resulting wooden frames to be extremely accurate. Any errors in the completed mold crept in due to warped lumber or careless setting up.



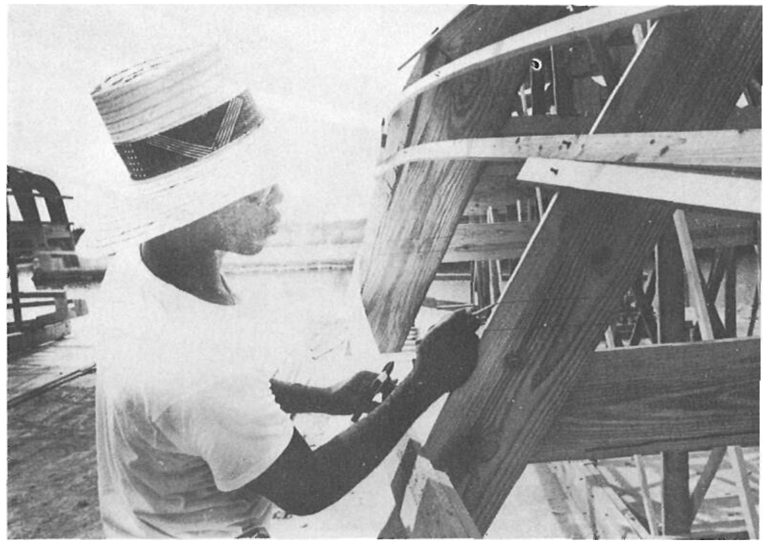
The hull mold braced and the fairing battens temporarily nailed.



Stem head mold piece.

JOB 5 - PLANKING THE HULL MOLD

The hull mold frames were planked over. The planking used was 1-1/2" x 3/4" (38 mm x 19 mm) spruce. The planks were spaced out on the mold with approximately 3/4 inch (19 mm) gap between each. The idea of the gap being to enable a man to check if proper penetration is being achieved at the time of the plastering. Considerable economy in time and materials is attained when a mold is planked leaving gaps in this way.



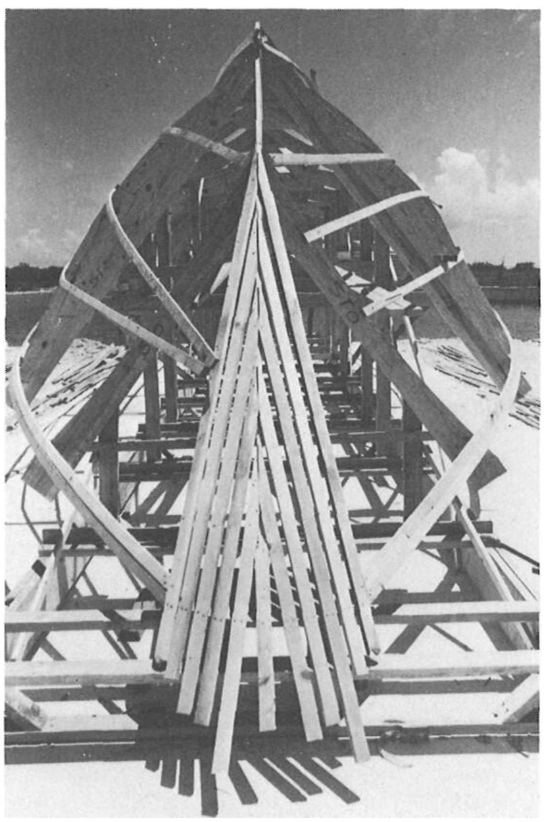
Marking the deck cutout.

TASK 1 - The Stem

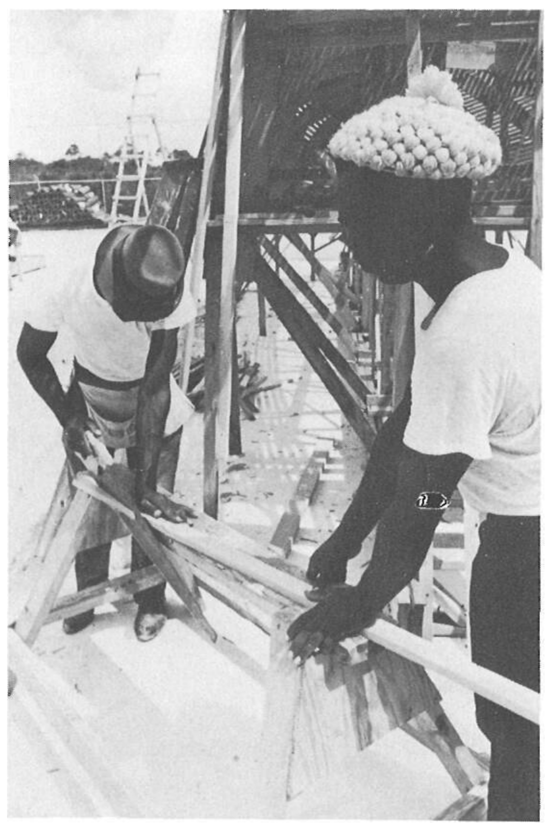
The stem was planked in the form of an inverted "V," as shown below.

TASK 2 - The Sheer and Deck Joint

The sheer and both sides of the deck joint were planked next. The sheer varied in height between the top of the bulwarks and the deck. That was, therefore, planked first so that gaps between the planks could be averaged out uniformly in this area.



Stem planking.

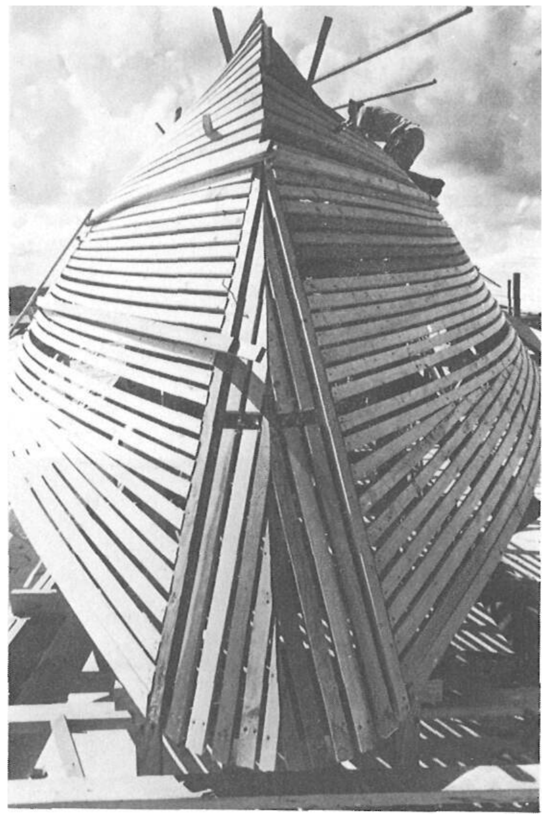


Cutting transom planking.

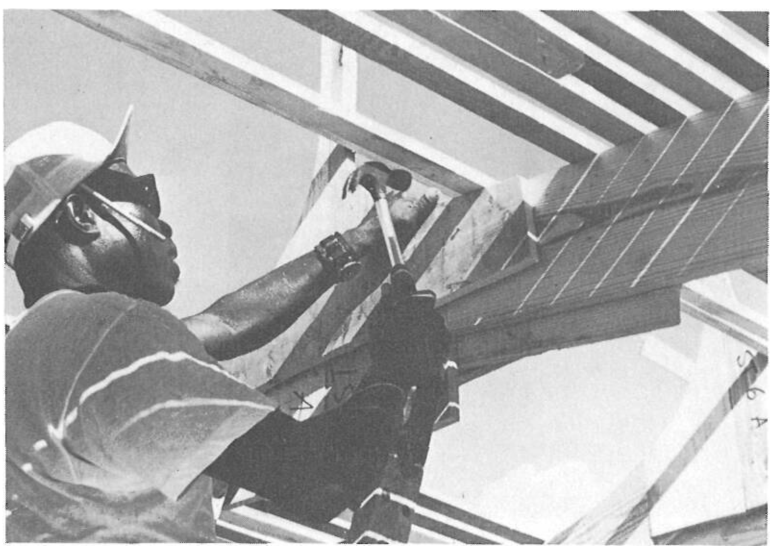
Splicing a plank.

TASK 3 - The Hull

The rest of the hull was then planked. The average length of the planks was 16 feet (4.9 m). To extend the full length of the hull the planks had to be spliced by nailing a two-foot (610 mm) butt block on the inside. Two and one-quarter inch (57 mm) common nails were used to hold the planking to the hull mold frames.



Hull mold nearly complete. Note deck cutout

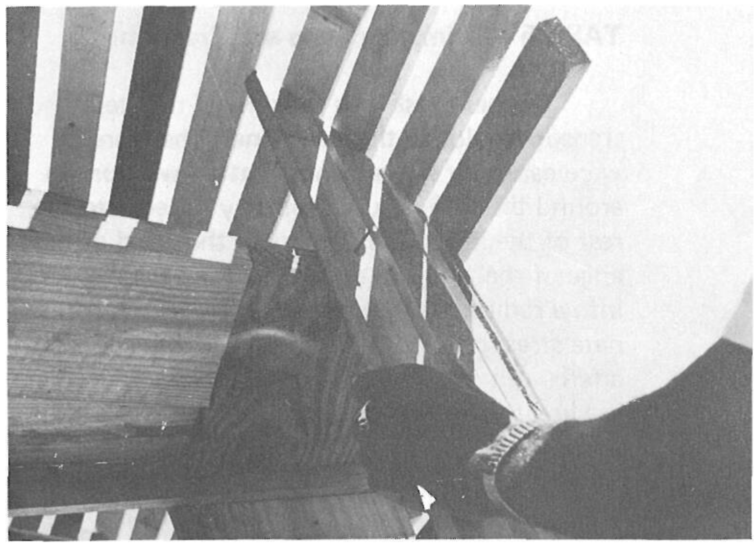


Reinforcing the keel mold.

TASK 4 - The Transom

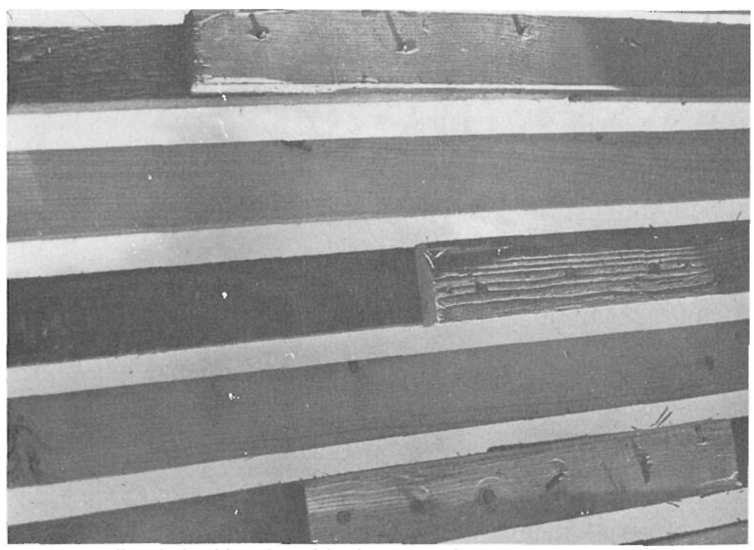
The transom was planked vertically. The planks were allowed to run wild past the transom sheer line as illustrated. The hull side planks were trimmed off after the transom planking was finished.

Transom mold takes shape.



Fitting transom planks.

Tapering planks for transom mold.

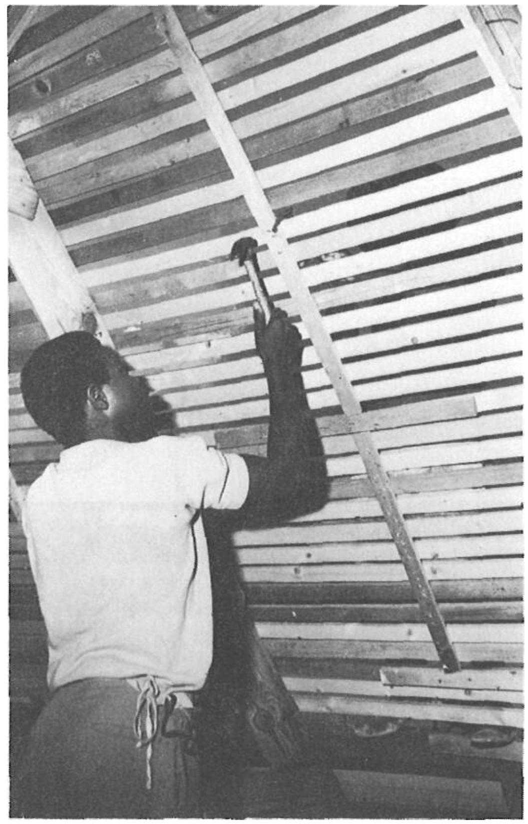


Spliced planking butt blocks seen from inside mold.

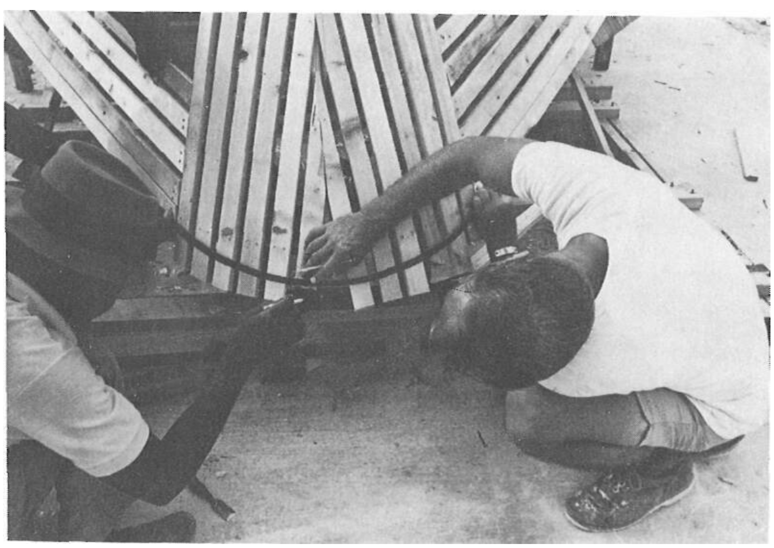
Sighting the run of the sheer.

TASK 5 — Trimming Stem and Transom

The next task was to trim off the stem and transom molds to the sheer line. These areas were carefully sighted and a batten was sprung around them to ensure that they faired into the rest of the hull. The corners of the mold at the edge of the transom and at the stem were sanded into a radius. This was done in an effort to eliminate stress points in these areas. If the corner of a ferro-cement structure is left sharp-edged, there is a great danger of the concrete cracking at this point.



Clench nailing intermediate plywood stiffening ribs.



Marking stem mold for trimming.

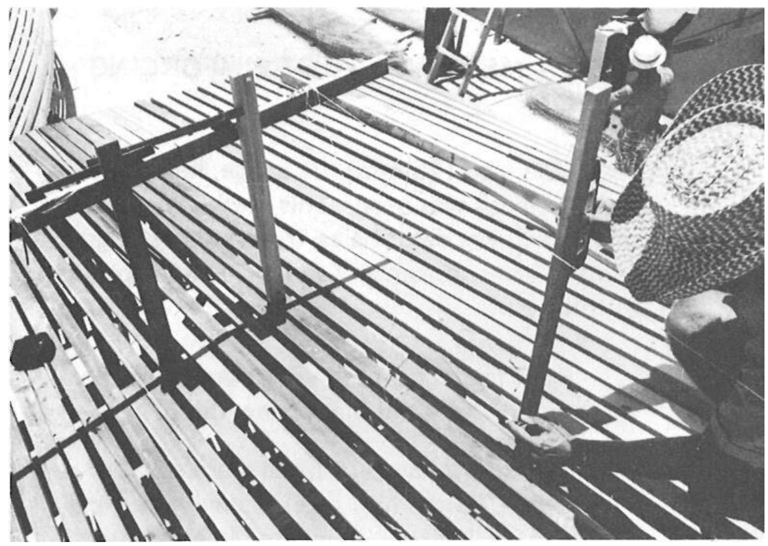
TASK 6 - Marking Out Bulkheads and Webs

Areas where bulkheads and webs were to be placed later were carefully marked out on the mold planking. These lines were inked in using a waterproof felt pen so that the marks could be found easily when the mesh and rods were applied.

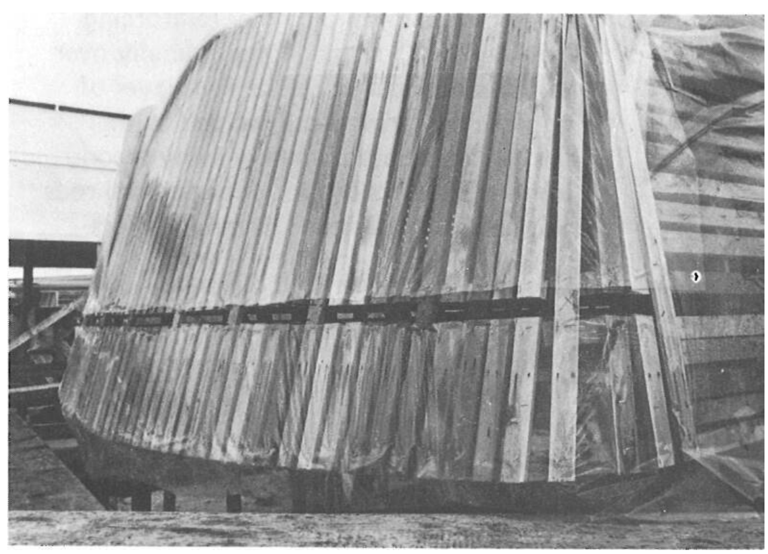
Locating webs and bulkheads.

TASK 7 — Marking Out Engine Bearers

The site for the engine bearers was established by first building a jig. The parallel lines representing the engine beds were transferred to the hull mold as illustrated. This was found to be the easiest method of doing this job, as there were quite severe curves in the hull at the engine room area.



*Stringing **for** engine bed location.*



Hull mold is sheathed with clear plastic sheeting. Note cutout at deck level.

Plastic sheeting is stretched taut and stapled.

JOB 6 - MESH AND ROD REINFORCING - HULL

One inch (25 mm), 21 gauge, hexagonal galvanized mesh was used. This mesh was the type manufacturers describe as "reverse twist," galvanized after weaving. Ten layers were applied as follows:

Four layers of mesh were stapled to the mold over 4-mil plastic sheathing.

Two more layers of mesh were stapled over 1/4-inch (6.4 mm) diameter vertical reinforcing bars which had been stapled on at 6-inch (152 mm) centers.

1/4-inch (6.4 mm) diameter reinforcing bars were then stapled longitudinally over this second layer of mesh. This layer of reinforcing bar was spot-welded to the first layer at approximately every second joint. This second layer of horizontal rods was applied on 3-inch (76 mm) centers.

The last four layers of mesh were hog-ring fastened to the outside of this last layer of rods.

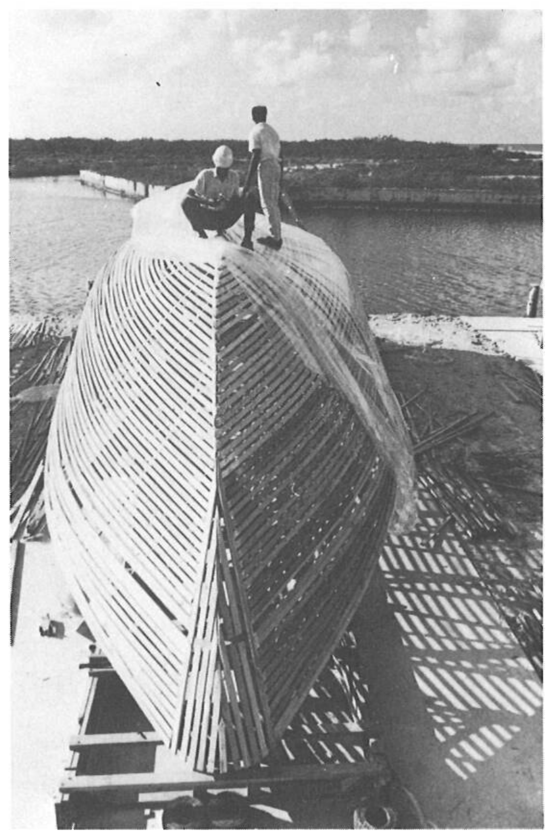
TASK 1 - Plastic Mold Cover

Clear plastic 4-millimeter sheathing was hand-stapled to the mold using small 3/8" x 1/2" (9.5 mm x 13 mm) staples. The plastic sheathing was cut away at the deck joint. This plastic sheathing was applied for two reasons:

1. To stop the moist mortar from falling through the joints and gaps between the wooden battens planking the mold.

2. To form a barrier between the wooden mold and the fresh mortar.

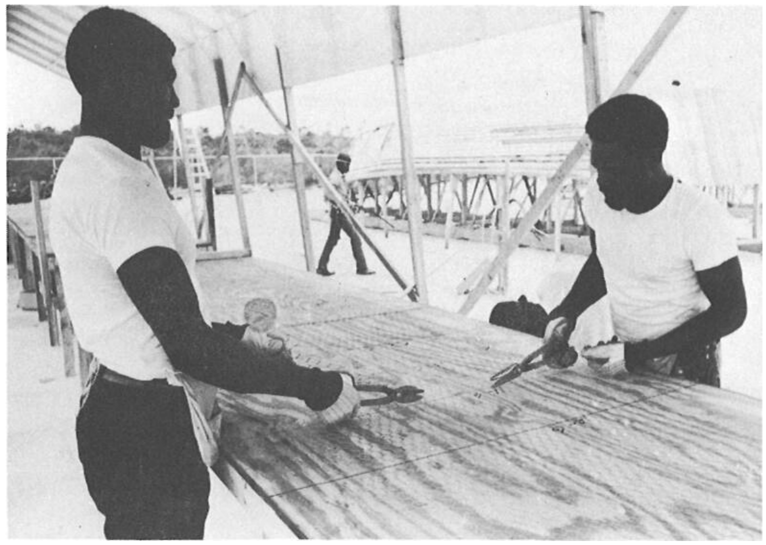
If no barrier were placed the wood would draw moisture from the new mortar and reduce its final strength. The plastic was smoothed down as much as possible over the mold.



Covering the completed mold with plastic sheeting.

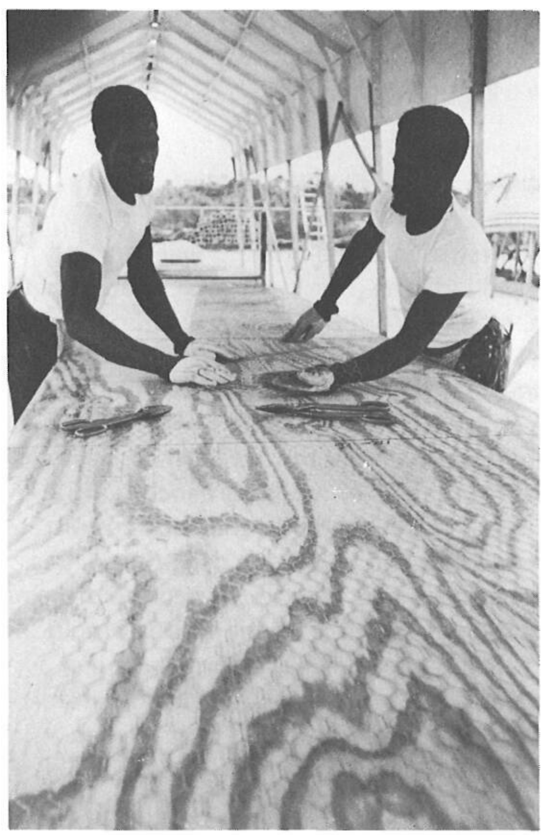
TASK 2 - Folding and Cutting Mesh

The mesh was delivered in rolls 36 inches (915 mm) wide by 150 feet (45 m) long. It was cut into lengths long enough to fit between the keel and the deck cut-out plus a six-inch (152 mm) surplus. This strip of mesh was then folded double on the bench. The mesh bench had been made four feet (1219 mm) wide with a spool at one end to hold the roll of mesh. Every foot (305 mm) distance from the roll of mesh had been marked with a line across the bench and the requisite footage. This speeded the measuring work of the mesh cutters when preparing great quantities of cut and folded mesh for the ten hulls. The men used tin snips or garden shears to cut the mesh. Mesh folded into 18-inch (457 mm) wide strips makes the job of applying it to the hull much easier.



Cutting the mesh.

Strips of folded mesh ready.



Folding mesh.

Cutting starter rods.

TASK 3 - Bending and Cutting Starter Rods

While the mesh was being folded and cut, a team was already bending the starter rods. These were made out of 1/4-inch (6.4 mm) diameter reinforcing bar. They were cut 12 inches (305 mm) long and bent at the center to a 90° angle. The rod was held in a vise and a length of pipe slid over one end. Using the pipe as a lever, a man could easily bend the rod to the desired angle. A large pile of starter rods was bent prior to being used on the hull.

TASK 4 — First Four Layers of Mesh

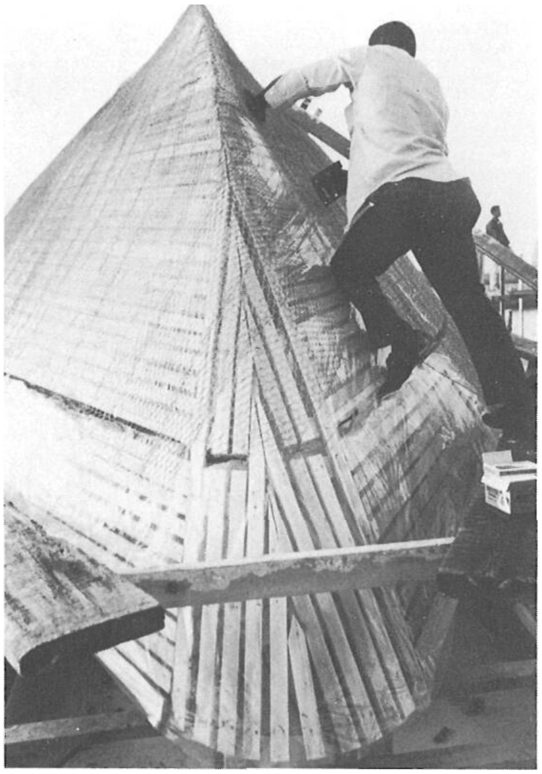
The first four layers of mesh were stapled to the mold over the plastic sheeting. Each length of mesh, already folded double, formed two layers. This first layer of mesh strips, 1-1/2 feet (457 mm) wide, was butted together. The second layer of mesh strips was laid out so as to cover the joints where the first layer was butted together, making a total of four layers of mesh. Six inches (152 mm) of mesh was tucked into the deck cut-out both from above and below the deck line. This mesh would be joined later to the deck reinforcing and would be plastered after the wooden mold had been stripped out. The mesh was applied with a hand staple gun using 3/8-inch (9.5 mm) long by 1/2-inch (127 mm) wide wire staples.

Bending starter rods.

TASK 5 - Making the Keel Shoe

While the first layers of mesh were being stapled to the mold, another crew was preparing the keel shoe. The keel shoe on these vessels was made from 5" x 2" (127 mm x 51 mm) channel iron, 1/4 inch (6.4 mm) thick. The channel was tapered at the front by cutting away two 18-inch (457 mm) long darts from the bottom of the channel and rewelding the sides into a point. The keel shoe was 28-1/2 feet (7.7 m) long. The last four feet (1.2 m) aft were angled upward. This was done in case the boat went aground. It could then slide over the sea floor without damaging the rudder which it helped support and protect. The channel iron keel shoe protected the concrete keel from chipping. Concrete is susceptible to chipping if sharp corners are not protected by a steel edge.

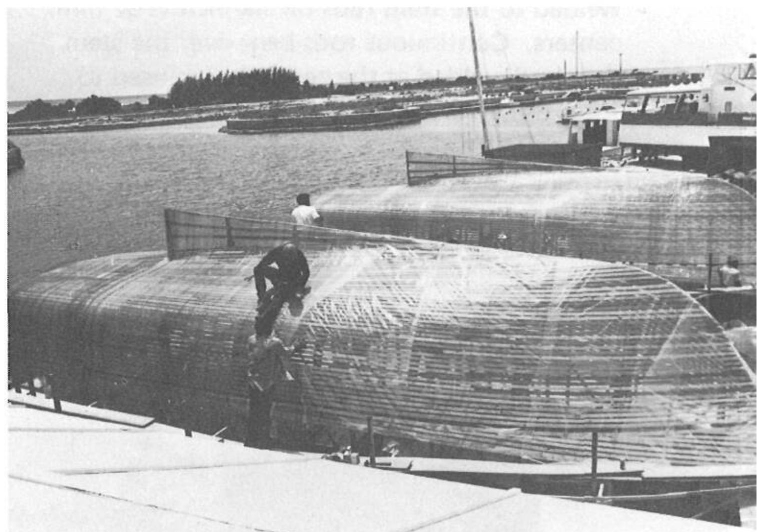
Starter rods for the keel shoe were made by cutting twelve-inch (305 mm) pieces of 1/4-inch (6.4 mm) diameter reinforcing bar and bending a right angle two inches (51 mm) from one end. These rods were welded to the channel



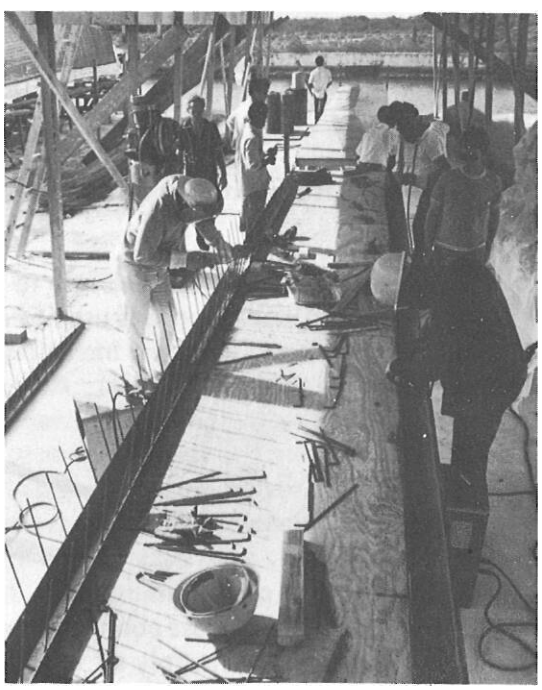
Stapling first layer mesh.

Tucking surplus mesh into the deck cutout.

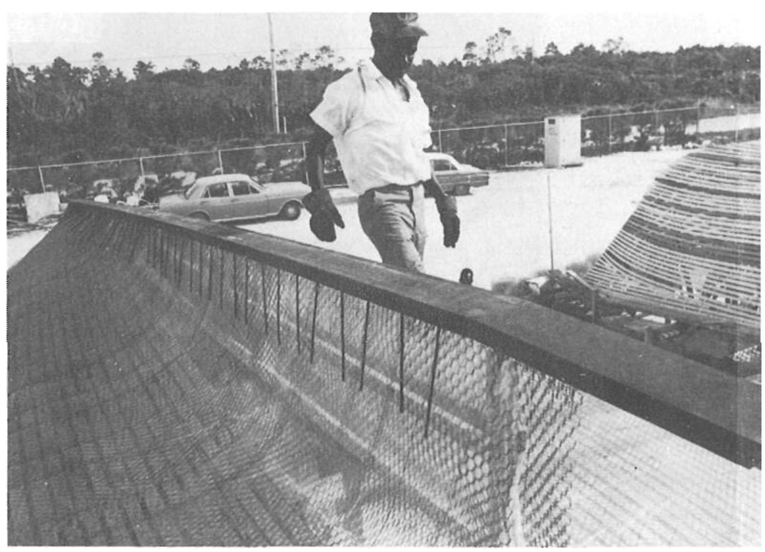
iron keel shoe at six-inch (152 mm) centers as illustrated. The starter rods began at the bow end of the keel shoe and stopped where the wooden mold ended at the "deadwood" part of the hull.



Mesh being hung from keel to sheer.



Welding keel shoe starter rods.



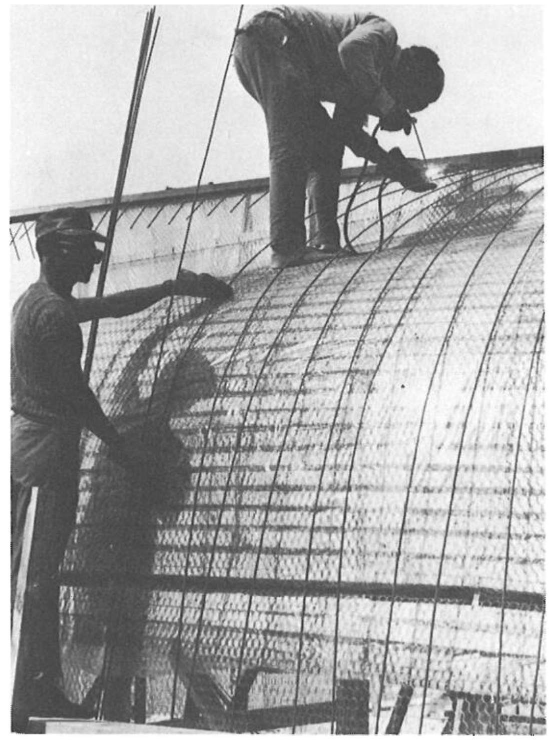
Keel shoe *laid* in place.

TASK 6 - Positioning Keel Shoe

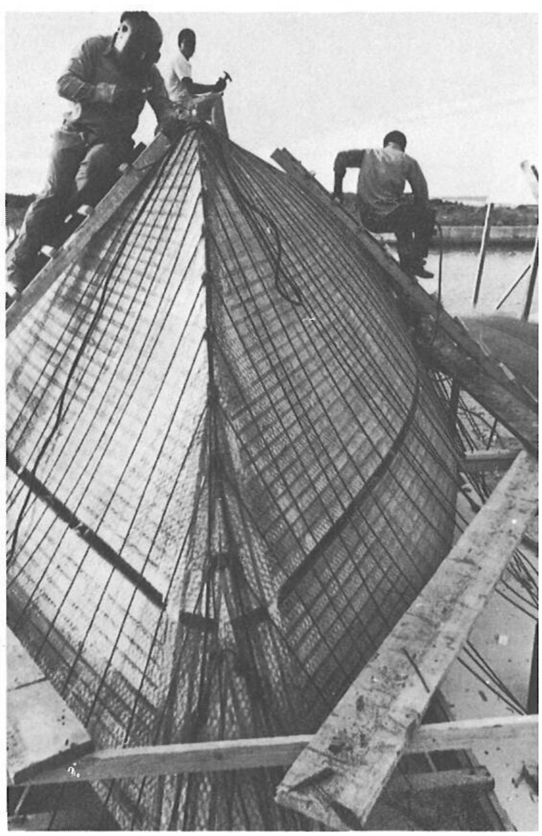
The keel shoe was then set in place on the upside-down hull mold. The starter rods were stapled to the wooden mold and thus held the keel shoe firmly in position. The starter rods at the stem had to be bent outwards to allow the keel to drop into place.

TASK 7 - Stem Reinforcing Rods

Stem rods were welded to the keel shoe. Eight 1/4-inch (6.4 mm) diameter reinforcing bar rods were welded firmly to the bow end of the keel shoe. From there, they ran down the stem in a widening fan shape. A horizontal rod was welded across the wide edge of the fan at the bow screed line. Next, vertical rods were welded to the stem rods on six-inch (152 mm) centers. Continuous rods bent over the stem rods and welded at the centers were used to form these verticals.



Welding vertical rods to keel shoe starter rods.



Preparing stem.

TASK 8 - Welding Keel Shoe to Hull Reinforcing

Vertical rods were welded to the keel shoe starter rods. These rods were lap welded for approximately two inches (51 mm). The vertical rods were allowed to extend about a foot (305 mm) past the sheer line.

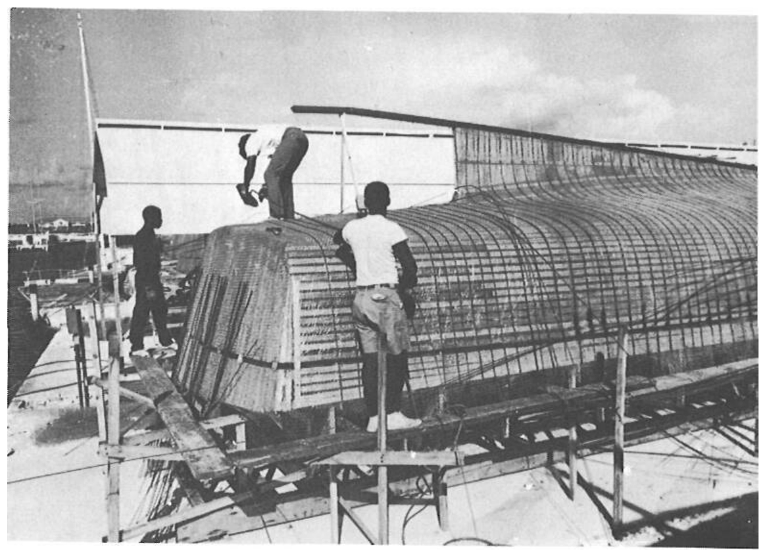
TASK 9 - Placing Rods with Air-Power Staple Guns

The vertical rods were stapled firmly to the hull. An air-powered staple gun was used to do this job. The staples used were one inche long by 1/2 inch wide (25 mm x 12.7 mm). As ten boats were being built simultaneously, twelve staple guns were used in the yard. Air was supplied by a large compressor which supplied air at 120·lbs. pressure to the guns. The air was distributed around the job by a network of two-inch (51 mm) pipes). These pipes terminated in 3/8-inch (9.5 mm) diameter air hose connection manifolds. Each manifold could supply air to eight guns at one time if required.

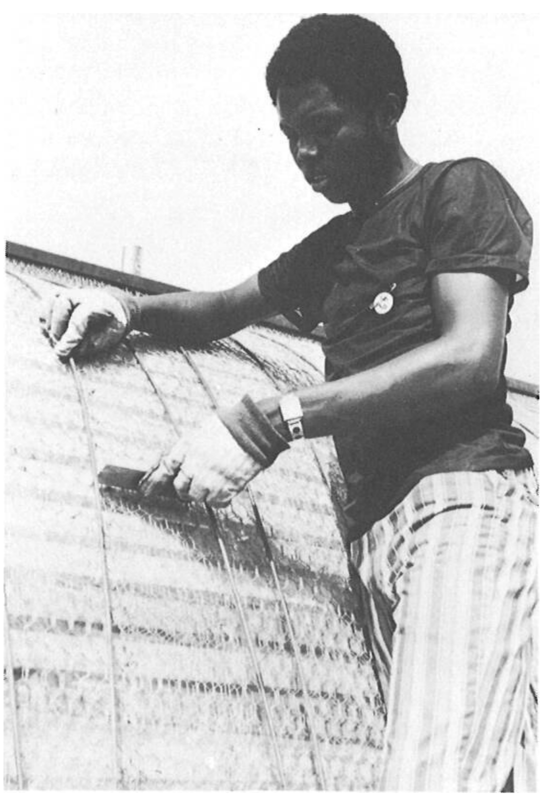
TASK 10 — Reinforcing at the Deadwood

Vertical rods at the stern of the vessel were stapled over the hull, abaft the deadwood, as one contiguous rod. (The keel shoe extended over part of this area.) The keel was only 5 inches (127 mm) wide at the deadwood. This aft section of the keel shoe was left free of mesh and rod until after the installation of the stern tube. One-piece vertical rods were also run across the hull mold at the deadwood section. (These rods would form the top of the solid keel aft of the stuffing box and over the stern tube.) As the stern tube was to be bedded in solid concrete, the bottom half of the keel in this area was poured while the hull was upside down. The top half was poured after the hull had been rolled. This is explained in more detail later when the stern tube installation is discussed (Job 7). The transom, at this point, was left free of rods. All transom rods were set in place at the time when the horizontal rods were applied to the hull (Task 13).

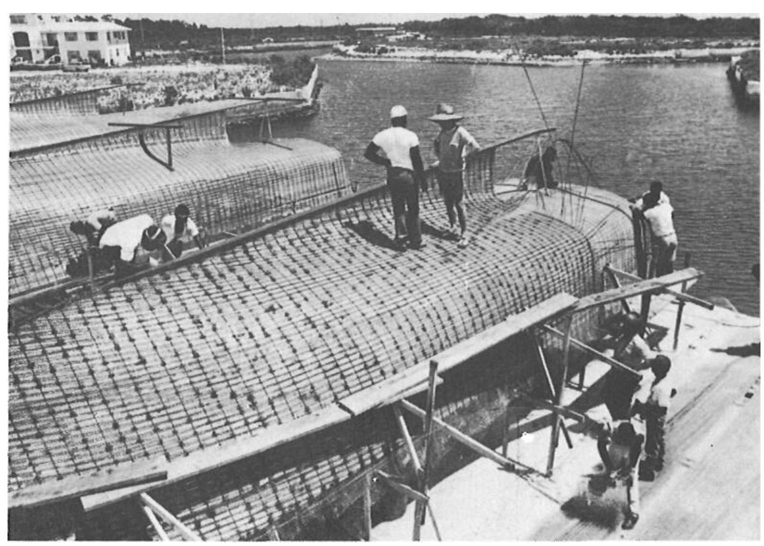
Stapling the vertical rods down with air-powered staple gun.



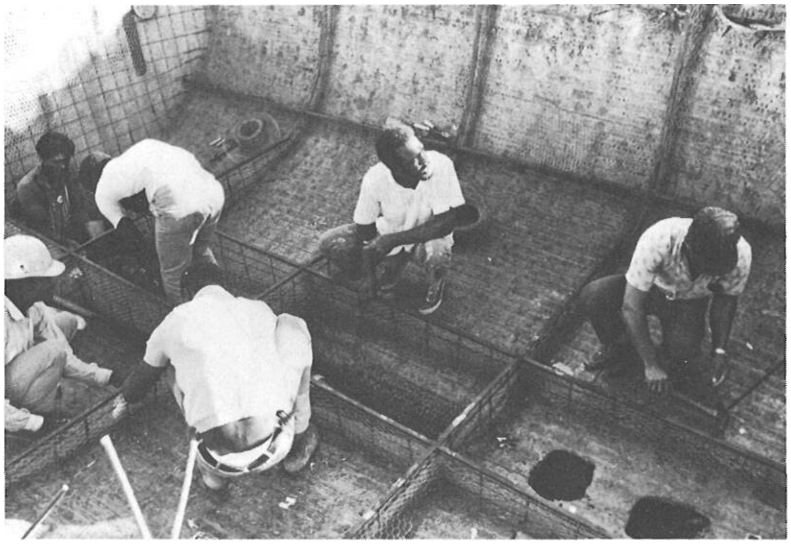
Running one-piece rods over the aft section.



Spacing rods.



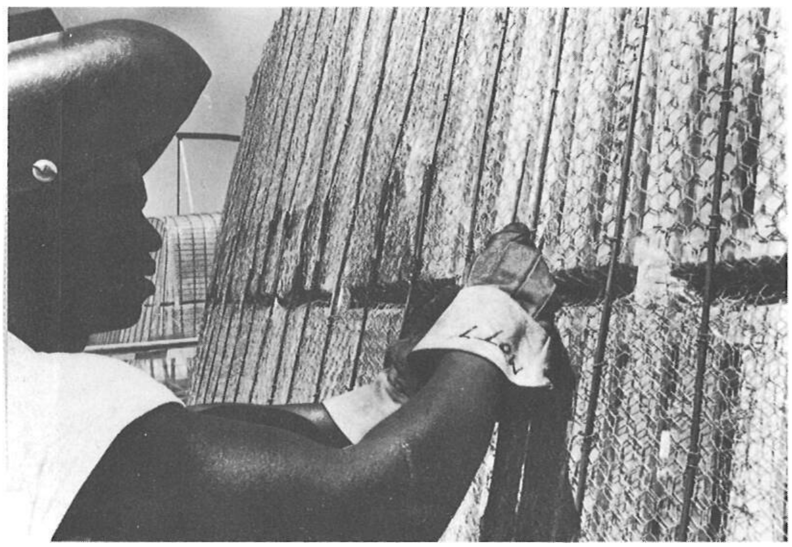
Rod and mesh application.



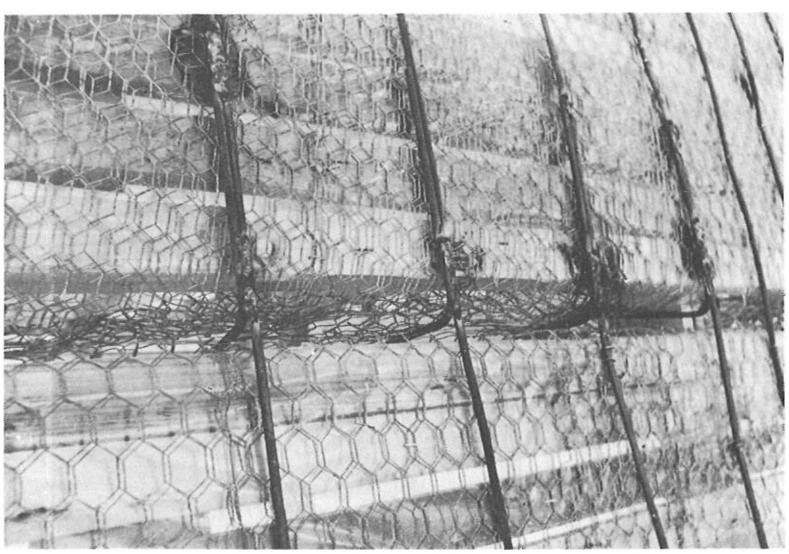
Out-of-sequence shot for illustrating hull construction above keel deadwood area. The two holes above the deadwood will be filled with concrete later.

TASK 11 - Deck Starter Rods

Once the vertical rods were in place, the starter rods for the deck were welded to them as per illustration. These starter rods would be joined into the deck reinforcing structure later. The starter rods were lap welded to the vertical hull rods. They extended into the deck joint to a minimum length of six inches (152 mm). The workers were careful to keep these rods neatly lined up as they would later determine the join of the deck to the hull sheer.



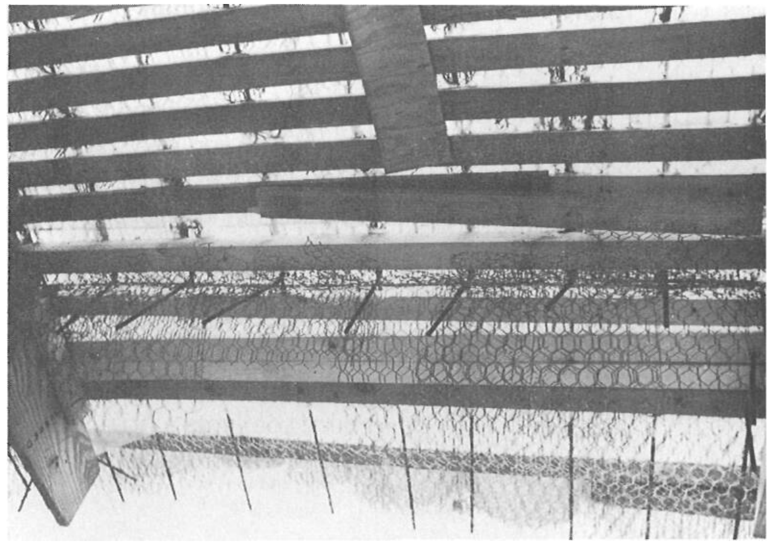
Welding deck starter rods.



The deck starter rods extend inwards for six inches (152 mm).

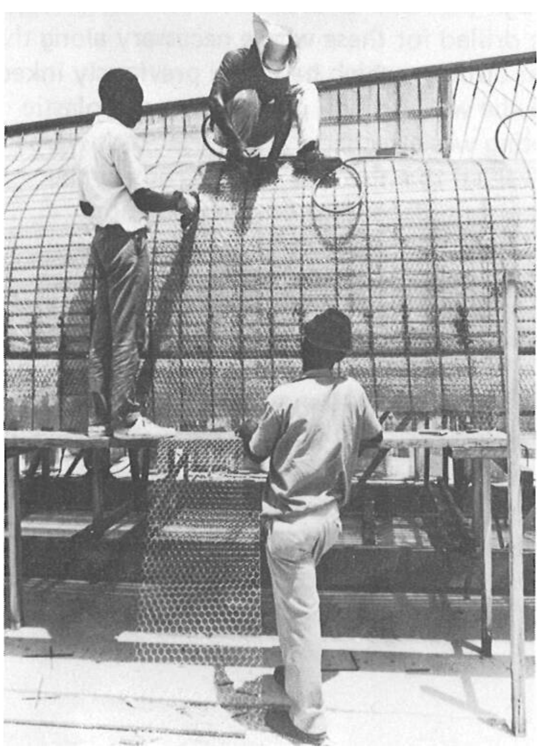
TASK 12 — Two Layers of Mesh Between the Reinforcing Rods

Two more layers of mesh were stapled over the mold. Again 1" x 2" (25.4 mm x 51 mm) wide staples were used. The folded mesh was not lapped but just butted. Care was taken so that the layers of mesh did not build up too much with overlapping, for if the mesh became too thick it would be difficult to get the mortar to penetrate the mesh properly. Layers of mesh were not applied to the transom at this point.

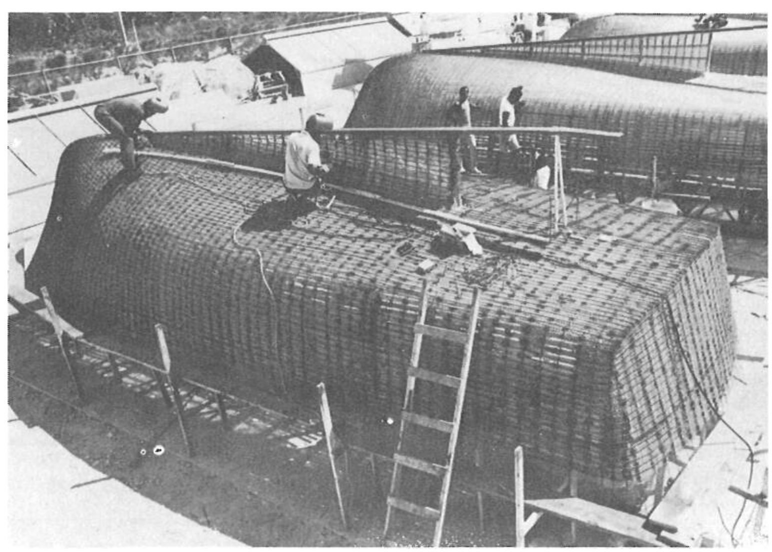


Deck starter rods and mesh shown extending inside the mold.

Welding the deck starter rods.



Applying two layers of mesh over the vertical rods before placing the horizontal rods.



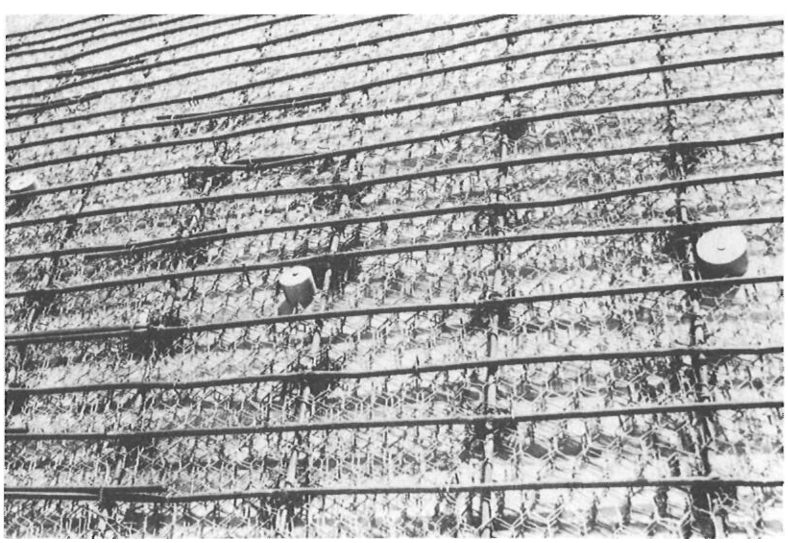
The horizontal rods applied.

TASK 13 — Horizontal Reinforcing Bars

The horizontal rods were welded on. Where a rod terminated on the hull it was lapped for six inches (152.4 mm) with another rod and spot-welded. All the rod joints were treated in this same way. The rods were stapled at approximately three-inch (76 mm) centers. Every second intersection of horizontal with vertical rods was spot welded. As there were two layers of mesh between the vertical and horizontal rods, the mesh was faired smooth in this small area. Care was taken not to burn too large a hole in the plastic sheeting where the rod welding took place.

TRANSOM REINFORCING

The horizontal rods running along the bottom of the hull were bent over the transom, making a curved edge. (If the corner of a ferro-cement structure is left sharp, there is a great danger of the concrete cracking.) These horizontal rods then became the vertical reinforcing rods in the transom. Two layers of mesh were stapled on. The horizontal rods running along both sides of the hull were bent around the stern (making a curved edge). These rods were then joined across the transom and became the horizontal reinforcing in the transom. The intersections of vertical and horizontal rods were spot welded alternately as on the other areas of the hull.



Wooden blanks for future through-hull fittings.

TASK 14 - Blanking-Out for Through-Hull Fittings

Wooden plugs of the same diameter as each through-hull fitting were cut out and placed on the mold in the exact position where the future through-hull fitting was to be installed later. These were cut from doweling and made one inch (25.4 mm) deep. A hole was drilled in the center of the doweling to ensure that the plug did not split when nailed to the mold. The mesh was cut away under the plug and trimmed neatly at the edges. Some attempt was made to place the doweling in a position clear of the intersecting rods. Some of the through-hull fittings were to be through-bolted later, and if the concrete drill happened to hit a reinforcing rod in the concrete it would be difficult to make a neat, small hole for these bolts.

TASK 15 - Starter Rods for Webs, Bulkheads, Etc.

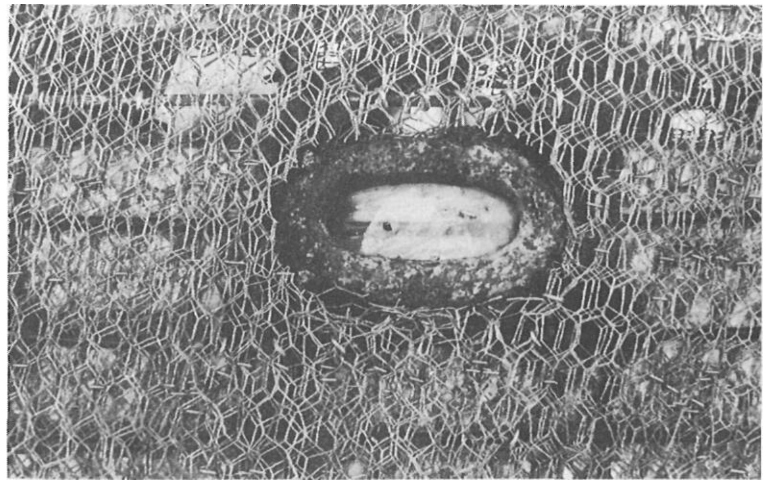
Starter rods for the stem, webs, bulkheads, bilge stringers, and engine beds were welded in place. These starter rods were placed at approximately six-inch (152 mm) centers. They were six inches (152 mm) long where they extended through the hull. Quarter-inch (6.4 mm) holes were drilled for these where necessary along the set of outlines which had been previously inked onto the wooden hull mold before the plastic sheeting was attached. The starter rods were lap-welded to either the vertical rods or the horizontals, depending on their position.

TASK 16 - Starter Rods for Water Tanks and RudderBearing

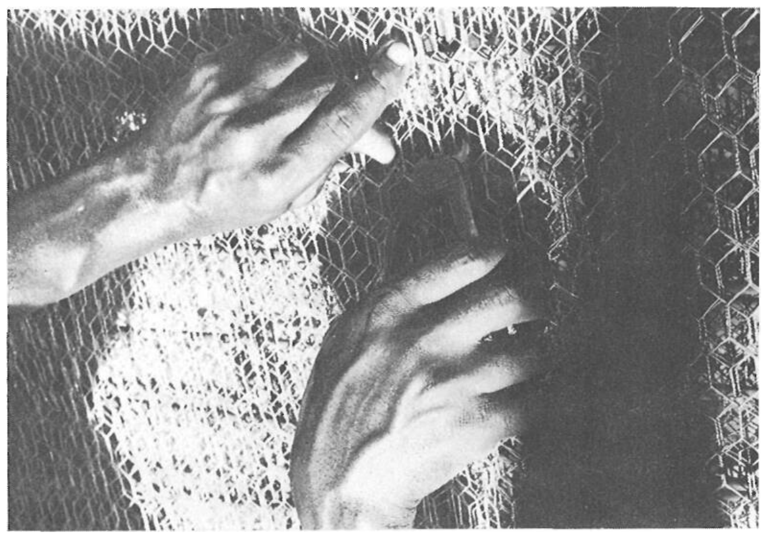
Special starter rods were placed for the water tanks aft. A description of how these were built follows later. A circle of starter rods was welded to the hull cage where the rudding bearing would be placed. The machine hub for the rudder bearing was later welded to these rods.

TASK 17 - Scuppers

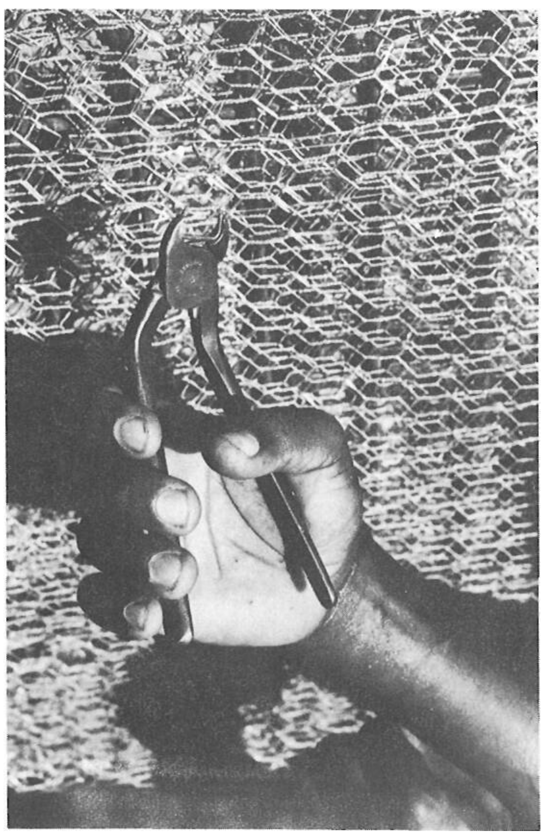
One-inch (25.4 mm) chain links were welded to the hull reinforcing cage where scuppers were to be placed. These links were aligned and welded in at deck level. Note that exposed steel pieces such as scuppers or screeds which require welding in place to the hull reinforcing before plastering should always be cleaned and protectively coated. Heat damage to the coating caused by welding can be touched up afterwards, before plastering.



Chain-link scuppers.



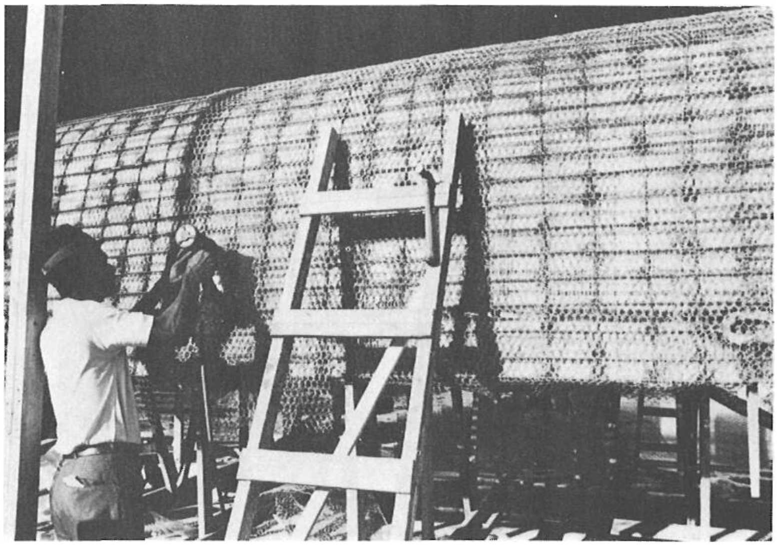
Clipping mesh taut with hog rings.



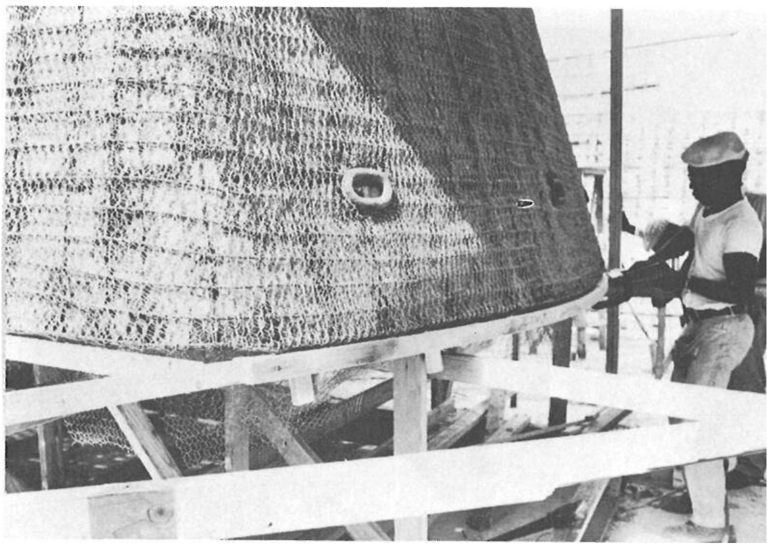
Hog ring pliers with an open 3/4-inch (19 mm) hog ring in the jaws.

TASK 18 — Last Four Layers of Mesh Reinforcing

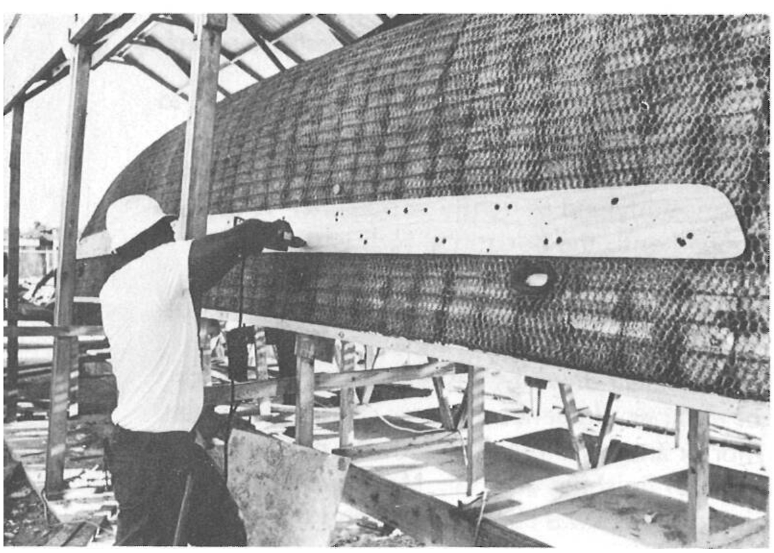
The last four layers of mesh were stapled to the hull mold. They were laid in the same way as the first layers. The mesh was fastened down as smoothly and as tightly as possible. It was clipped onto the horizontal rods with 3/4-inch (19 mm) hog rings. [One-half inch (12.7 mm) hog ring staples which do a neater job could not be located at the time.] All edges of the mesh were stapled down tightly so that no stray ends of mesh would penetrate later through the fresh mortar and thus interfere with the plasterers' work in finishing the hull. Mesh over the chain link scuppers was clipped away and the ends fastened down neatly.



Applying last four layers of mesh.



Fixing the sheer screed for the plasterers.



Pattern for setting the hull guard bolts.

TASK 19 - Sheer-Line Screed

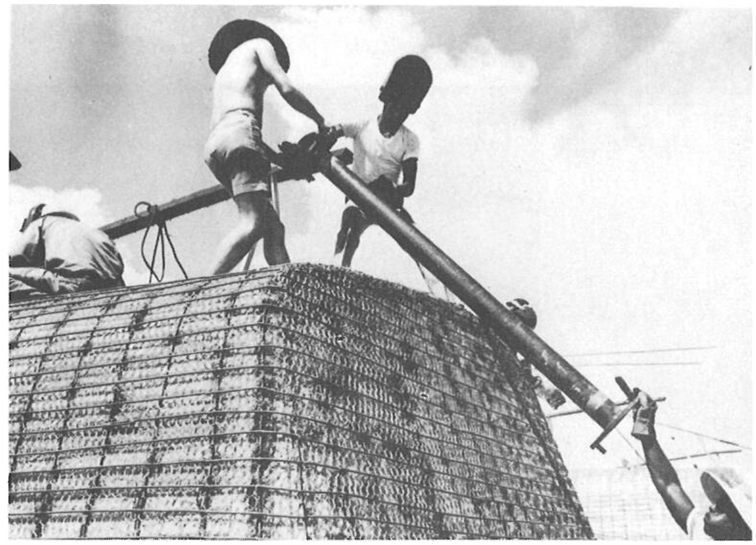
The rod and mesh running over the sheer line were bent towards the inside of the hull (this reinforcing would later form the bulwark cap). The mesh had to be clipped away around the mold frames to facilitate bending it inwards. A screed was formed at the sheer line. The screed was made of straight, long boards, two layers of 3/4" x 2" (19 mm x 51 mm) lumber and one layer of 3/8-inch (9.5 mm) plywood, all laminated together. The joints were lapped. The screed was then 1-7/8 inch (47.6 mm) thick. The cement along this area of the hull would be made 1-1/8 inch (28.6 mm) thick as the cement on the edge of the sheer would later be ground to a round edge to prevent chipping. The mesh and rod reinforcing on the hull was approximately 7/8 inch (22.2 mm) thick when completed. The screed board was nailed to the mold frames above the sheer. The screed board would provide a neat finished edge for the plasterers to work to.

TASK 20 - Blanking-Out Hull Guard Bolt-Holes

The next job was to set the through-bolts for the guard into the hull mold. A guard pattern of plywood was made up and nailed to the hull mold. Half-inch (12.7 mm) holes were drilled into the mold where the bolts were to pass. The guard pattern was then removed. Bolts were hammered into these holes, flush with the top of the mesh, and greased. This saved much time later on when the guards were installed for it eliminated the need to drill through the concrete skin. The mesh was then checked and faired all over the hull.

JOB 7 – STERN TUBE

The stern tube on these vessels was made up from a length of four-inch (102 mm) I.D. schedule 40 steel pipe. It was eight feet (2.4 m) long. A 1/2-inch (12.7 mm) plate steel flange was welded to both ends. The flanges were cut to match the stern cutlass bearing base on one end, and the stuffing box housing base at the other end. Stainless steel studs were welded to these flanges to receive these future fittings. The stern tube was the same width as the hollow inside area of the keel deadwood.



The stern tube: First component part to be installed.

TASK 1 - Stripping Out Keel Mold Frames

First the wooden mold frames inside the keel were stripped away. The welded reinforcing bars the keel shoe now held this area of the deadwood in shape.

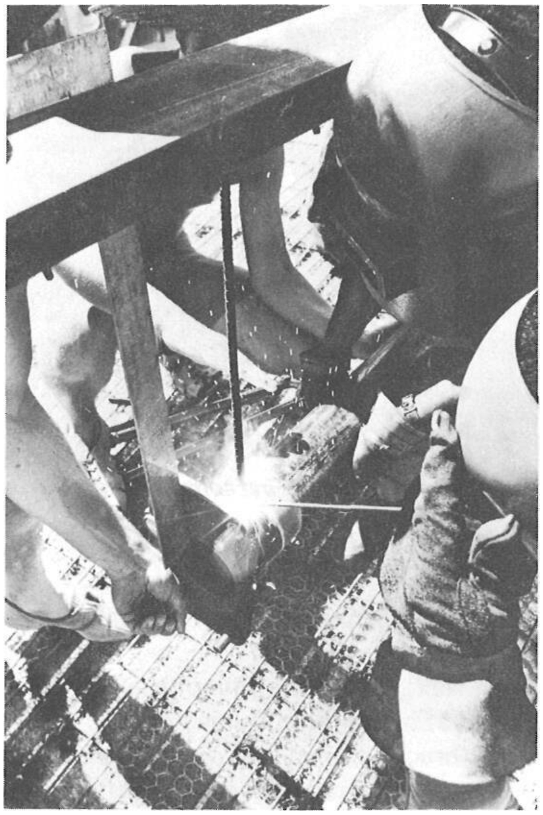
A hole is cut in the keel reinforcing.

TASK 2 - Stringing Propeller Shaft Center Line

Next, the center line of the vessel was established at a hull mold frame near the bow. A cross brace was nailed across the moid frame at the level denoting the angle of entry of the shaft. (The center line of shaft is shown on the plans.) This horizontal line was established by measuring from one of the reference waterlines which had been previously marked on the hull mold frame.

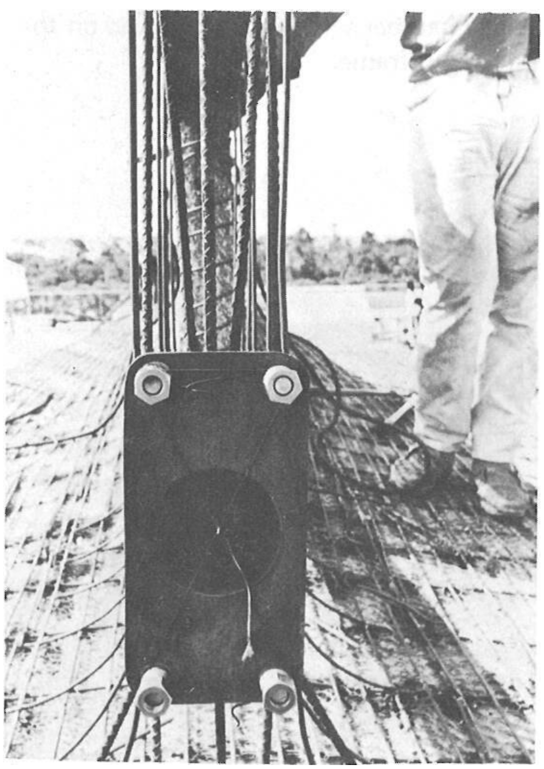
Propeller shaft center line is extended to the bow for accurate alignment.

TASK 3 - Positioning Stern Tube, Welding Deadwood Reinforcing

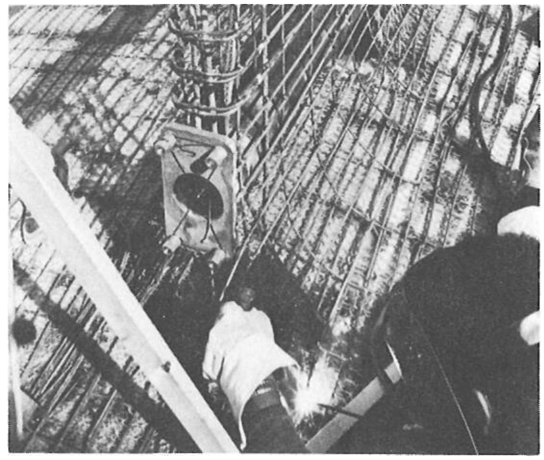


Welding and aligning the cutlass bearing end of the stern tube at the stern post.

An aperture was cut into the rod and mesh reinforcing in the keel section, facing aft, and the stuffing box end of the stern tube was pushed through at this point. The positioning of the stern tube is highly critical. If it is fixed slightly out of alignment, the engine and shaft will be forced to lie considerably off-center. As aids to an exact positioning plywood covers were fastened over the open ends of the stern tube and a small hole drilled in the exact center of each cover. To align the stern tube, a string was drawn taut through both the center holes in the plywood covers to the marked center line brace at the bow. When the stern cutlass bearing end was judged in position, it was fastened firmly in place by welding pieces of 1/2-inch (12.7 mm) diameter rod from keel shoe to stern tube. At this stage the stuffing box end of the stern tube (inside the keel cavity) could still be adjusted slightly if further alignment were necessary. This done, 1/2-inch (12.7 mm) diameter reinforcing bars were welded on six-inch (152 mm) centers to the hull vertical bars, spot-welded to the stern tube and welded to the keel shoe. The reinforcing cage at the deadwood section was completed by welding 1/4-inch (6.4 mm) diameter rods on two-inch (51 mm) centers running horizontally over the vertical rods. These horizontal rods were then welded to the horizontals on the rest of the keel.



The center of these diagonally strung wires is exact for the stern tube. A taut string was drawn through from it to represent the proper shaft center line.



Rod reinforcing complete.

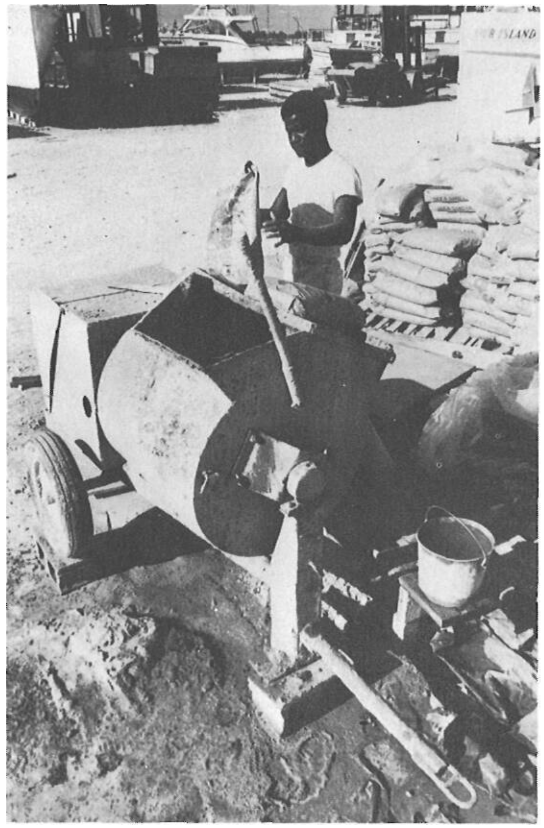
JOB 8 – PLASTER HULL

The mortar used for the hulls was a mixture of clean, graded silica sand, local Bahamian Portland Cement Type II, and drinking-type water. This silica sand, of the grading and particle shape used in high-strength structures, was shipped from Florida in 50- and 100-pound (22 and 44 Kg) bags. The sand content used was as follows: one 50-pound (22 Kg) bag of coarse grade, one 100-pound (44 Kg) bag of medium grade and one 50-pound (22 Kg) bag of fine grade. To this graded sand was added two 80-pound (31 Kg) bags of Portland Cement Type II and just sufficient water to make the mortar workable into the hull mesh reinforcing.

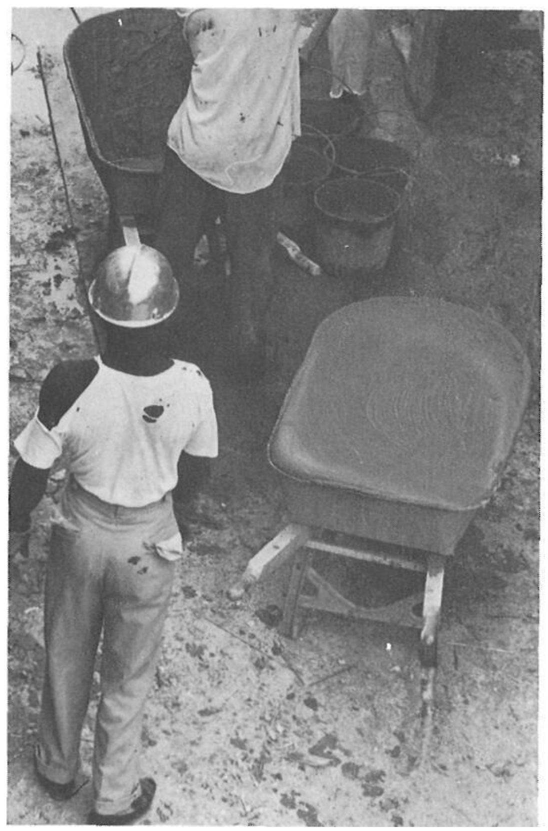
The ambient temperature during hull plastering was about 85° F (30°C). Eight plasterers were employed to do the plastering. Three electric vibrators were used in the operation, also four wheelbarrows for carrying mortar.

There was one plasterer for roughly every 100 square feet (9 m^2) of surface area of hull. The mortar was all applied within the first three hours of starting the job in the morning; that is to say, by 10:30 A.M. The plasterers worked through the lunch hour, and the hulls were all finished by 2:30 P.M. The plasterers were then allowed to go home after cleaning their tools. They were credited with an eight-hour work day. It was their custom to take it easy for the first hour in the morning while the laborers were adjusting scaffolding, etc. The plasterers then had two hours of hard application work. For the rest of the day they spelled each other vigorously at troweling the hull, allowing two plasterers to take breaks and rest at any one time.

Retarders or additives were not used.



Plasterers' paddle-type mixer.



Fresh mortar lined up.

Contractor's wheelbarrow.

TASK 1 - Placing the Shelters

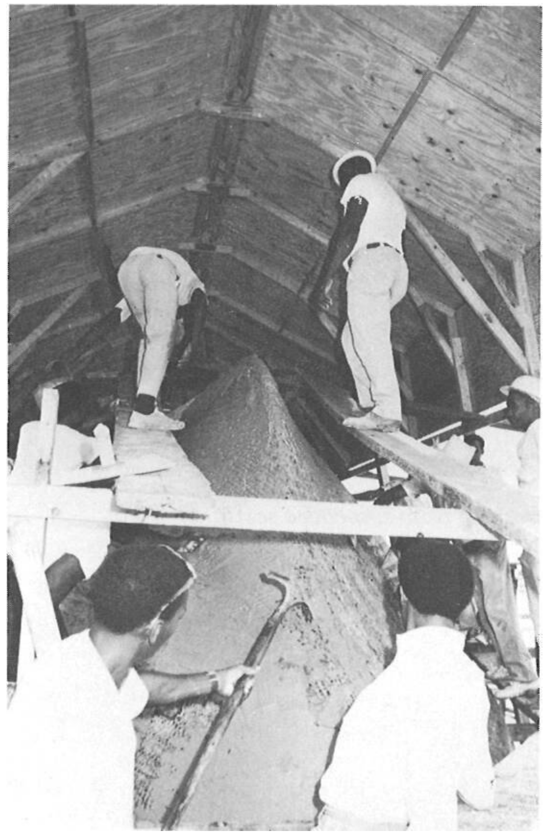
The sun shelters were moved into place over the hull which was scheduled to be plastered. The sun shelters were made from 2" x 4" (51 mm x 102 mm) trusses and 5/16-inch (7.9 mm) exterior sheathing grade plywood tops. They were just high enough to enable the comporter to straddle them and pick them up. These shelters were made in 24-foot (7.3 m) sections. We had two vessels lined up, one behind the other, on a 96-feet (20.2 m) long concrete pad, so that four sections of sun shelter completely covered each pad. The yard used a total of 16 portable shelter sections, also four fixed sections which served as the workshop. By leaving any two rows of boats uncovered, there was always a place to move the shelters onto when a hull required rolling.

Into buckets and up onto the mortar board.

From mortar board into the hawk.

TASK 2 - Erecting Plasterer' Scaffolding

After the sun shelter was in place, scaffolding was erected all around the hull. Two inch by ten inch 14-ft. (51 mm x 254 mm x 4.3 m) long planks were used for scaffolding boards (many of these had previously served as strong-back main bearers). Some scaffolding was hung from the sun shelter roof.

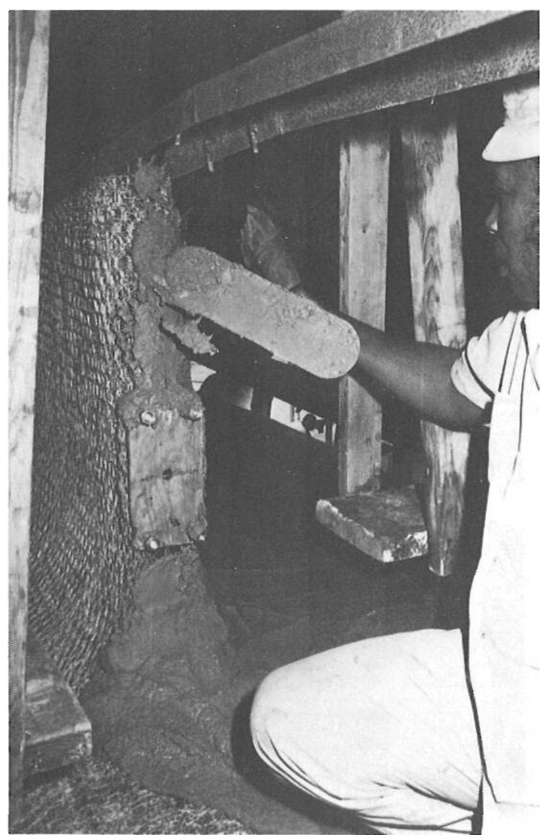


Shoveling mortar directly onto the hull.

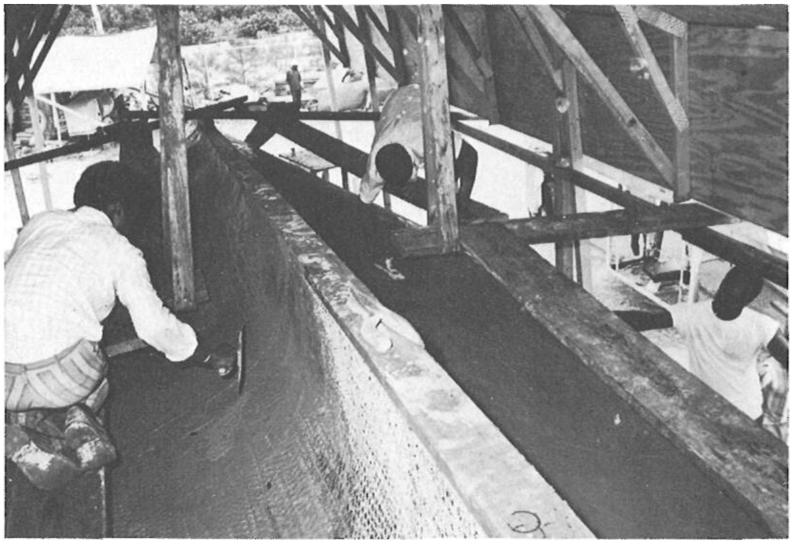
TASK 3 — Preparing the Cement Mixer

The cement mixer was made ready. This was a commercial, paddle-type mixer as used by the plastering trade. We blocked the mixer up on timbers, giving it sufficient height for the mortar to be dumped directly from the barrel into the wheelbarrows.

Trimming the loaded hawk.



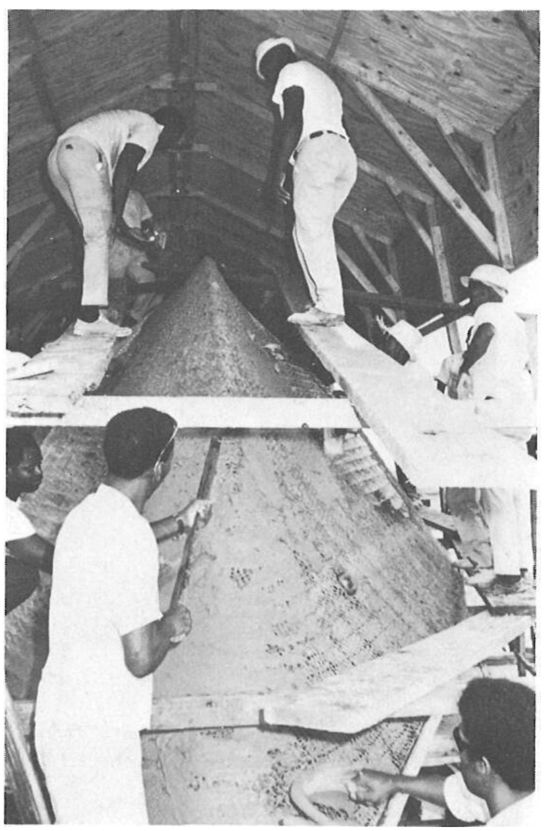
Applying mortar to the stern post. Note suspended scaffolding.



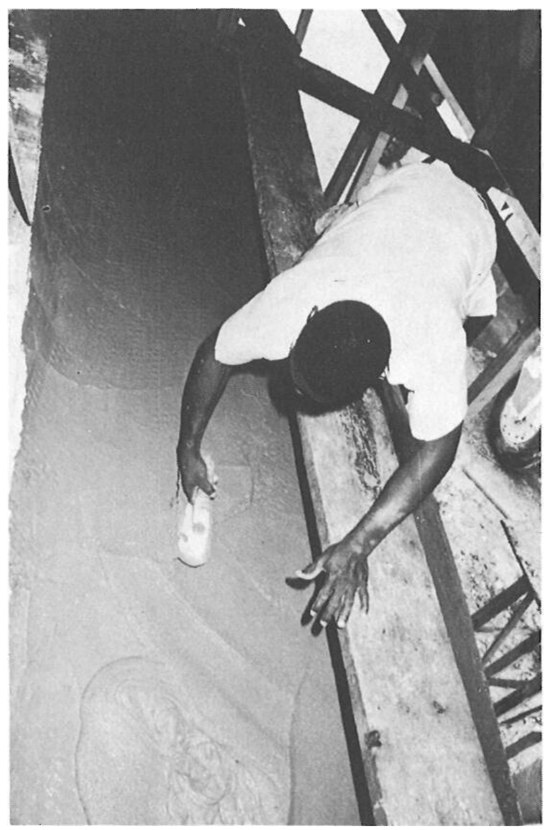
Working from suspended scaffolding.

TASK 4 - Preparing the Water

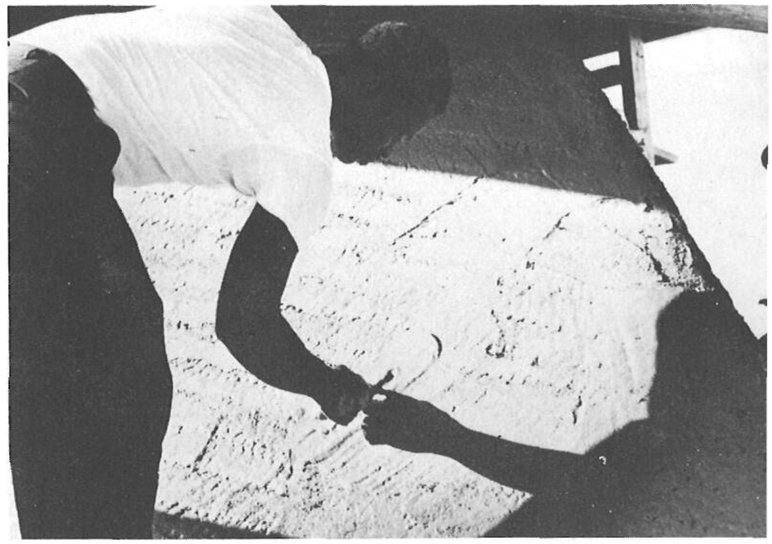
Steel drums of pure drinking water were set up beside the mixer. We used two 55-gallon (14 l) drums. One was always being filled with water while the other was being emptied for the mixing process.



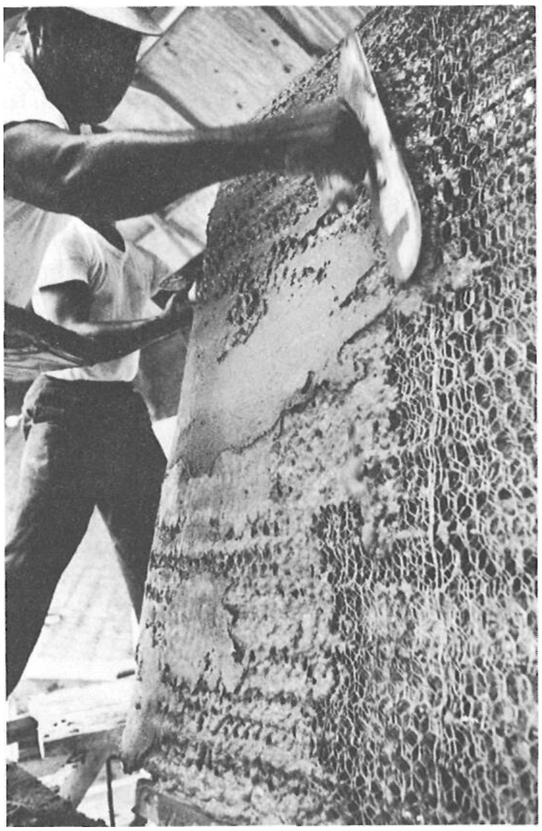
Pencil-type vibrator being used on the stem.



Working the plaster in, vibrating from inside the mold.



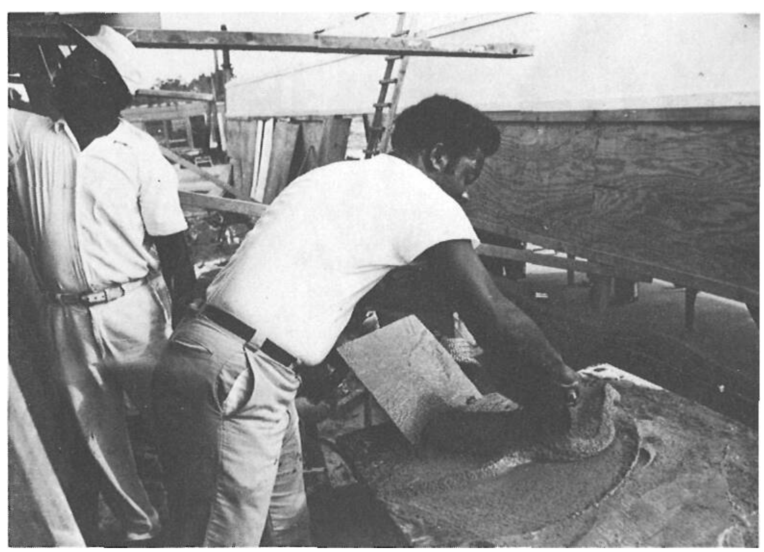
Bow being vibrated from inside the mold.



Near vertical faces are difficult for good penetration.

TASK 5 - The Mixer Man

The mixer man started work one-half hour before the plasterers were ready to start work on the hull. He lined up all four wheelbarrows filled with fresh mortar, as a lot of mortar was required quickly when the plastering started.



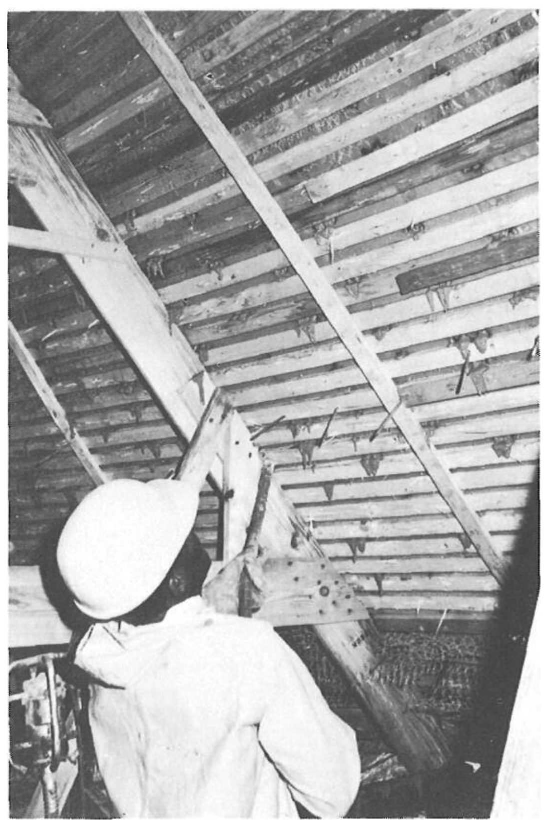
Scooping onto the hawk.

Vibrating at the bulwarks.

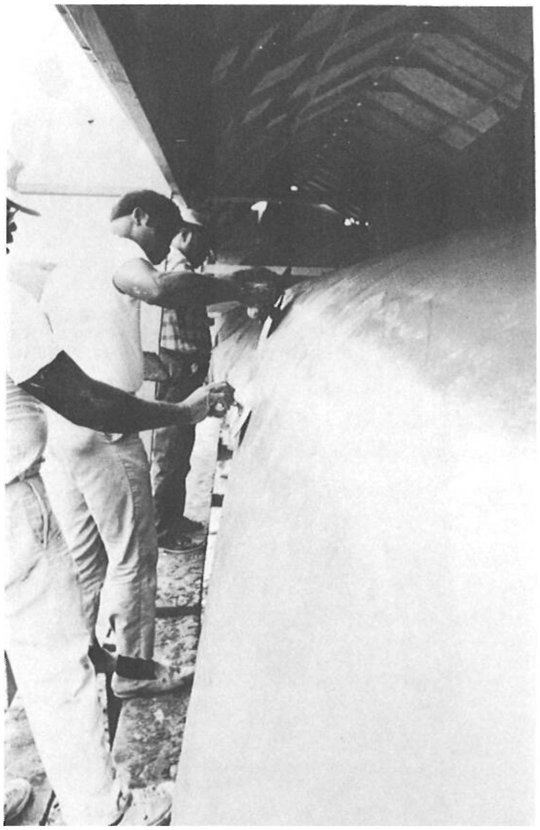
TASK 6 - Plastering the Hull

Plastering began. First a heavy coat was applied all over the hull. Men stationed inside the hull mold began systematically vibrating the mold planking and checking the gaps between the planking for mortar penetration. The plasterers were deployed around the hull on the scaffolding, each with a section to cover. Once the mortar had all been applied to the satisfaction of the men vibrating and checking, the excess mortar was then scraped back to the mesh. This excess mortar was discarded. A new thin coat was troweled over the hull and allowed to start setting. When it started to set the hull was sponge troweled, the sponge trowel being used in a circular motion to smooth out surface irregularities. As soon as the sponge troweling was finished, the final steel troweling began. This was carried on until the hull surface had set up too hard to be worked on any further, and was as smooth and fair as the plasterers could make it.

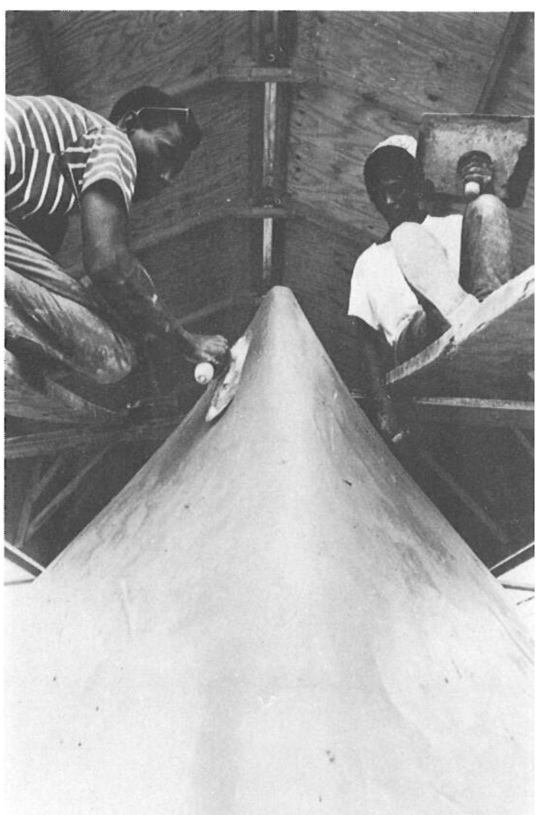
Vibrating along the planking and checking the gaps for penetration.



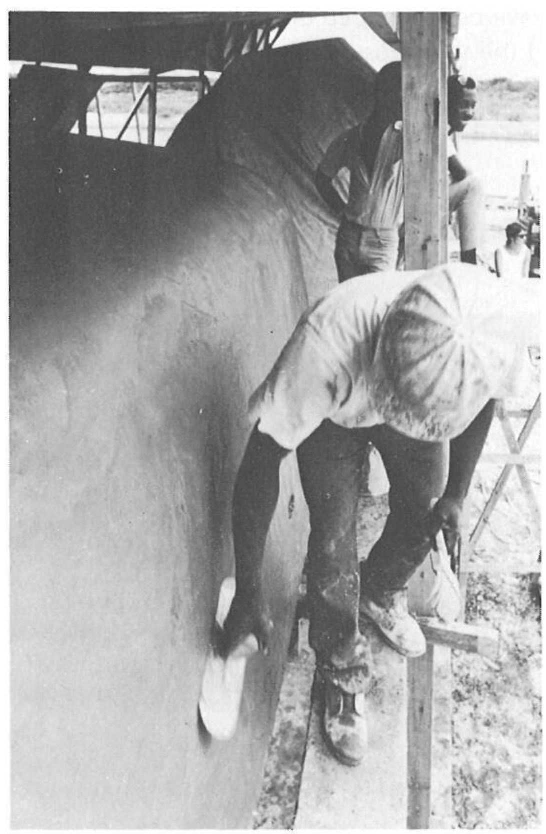
Well vibrated mortar seeps through the weld bums in the plastic sheeting.



Final skim coat is troweled on.



Troweling before sponge finishing.



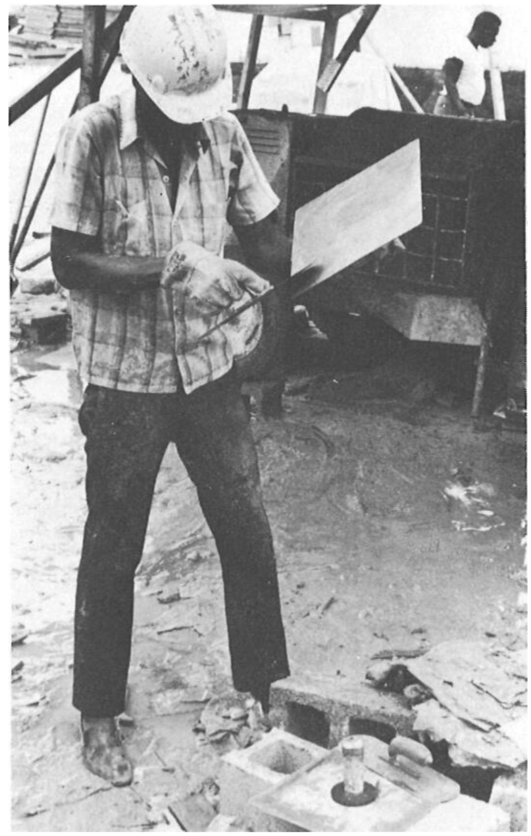
The sponge-finished skim coat is troweled smooth.

Final touches. The mortar is hardening.

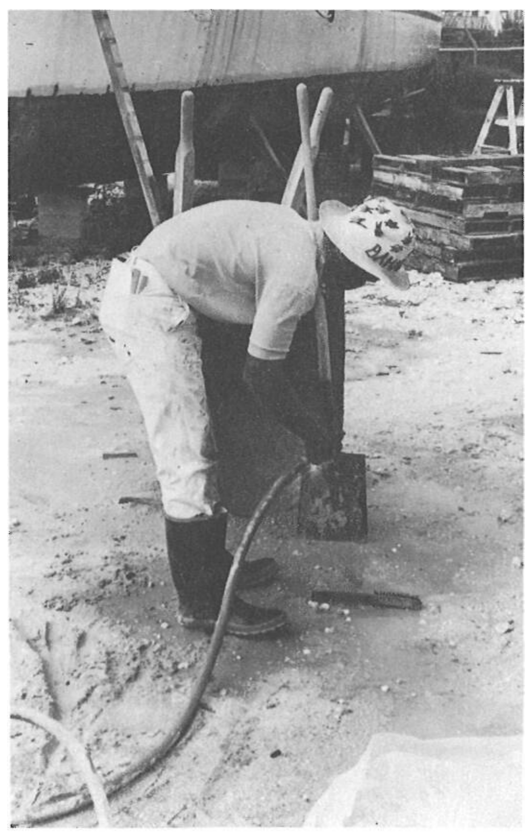
TASK 7 - Cleaning Tools

Clean up. All the tools were thoroughly cleaned and washed, ready for the next day's plastering. We plastered, on the average, four hulls per week. The hull plastering schedule could have been stepped up to one hull per day had the yard possessed sufficient tools for the hull mesh reinforcing to be readied in time.

Cleaning the electric pencil-type vibrator.



Cleaning hawks and trowels.

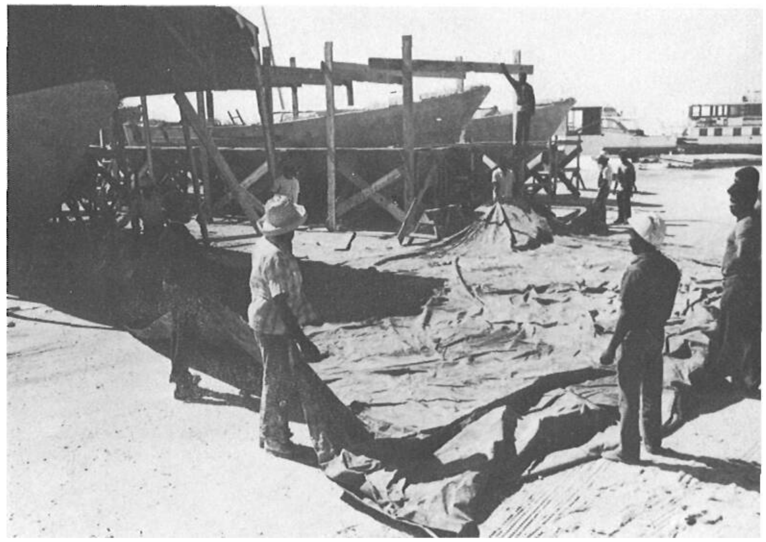


Cleaning shovels.

JOB 9 – STEAM CURING

The hulls were steam cured for 24 hours at a temperature of 150° F (66° C). A steam pipe, perforated for its entire length, was placed under the inverted hull and a rubberized canvas steam tent drawn completely over. The temperature was carefully brought up to 150° F (66°C) in a period of four hours. Twenty-four hours were then maintained at this prescribed tern- - perature until, finally, it was allowed to drop slowly to ambient temperature of 85° F (30° C).

The Island of Grand Bahama is formed essentially of coral. It has extensive natural reservoirs of fresh water in its coral base but this imparts a high content of lime into the water. This local phenomenon was brought sharply to our notice when we attempted to steam cure the second hull of the series. The steam generator heating coil, after only 24 hours' use, was found to be completely blocked with a solid deposit of lime. Thereafter, a water purifying unit was connected to the steam generator which considerably reduced the lime deposits. But a lesson had been learned. If production-line steam curing is envisaged, a standby steam generator should be obtained. With an ambient temperature of 85° F (30° C) in the Bahamas a short interruption in the carefully controlled steam-curing remperature curve will not have such serious results as would occur in near-zero conditions elsewhere.

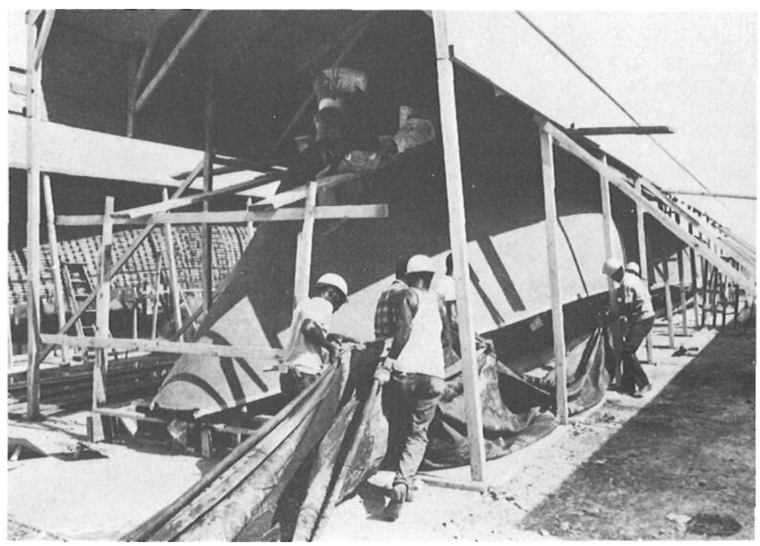


Opening out the steam tent.

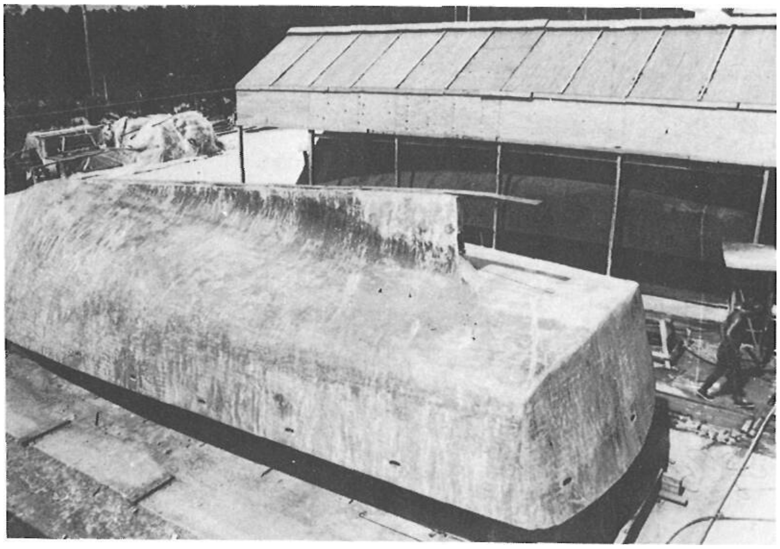
TASK 1 - Before Steam Curing

The hull was left untouched for 18 hours after the plaster finishing work had ceased. This allowed the hull to set-up hard enough for the men to drag the steam tent over it. It is not advisable to start steam curing too soon, as the jets of hot water from the steam pipe may wash some of the mortar off the hull while it is still green.

Before steam curing began the wooden screeds were removed from around the hull sheer. If these screeds were not removed the wood would absorb moisture from the mortar near the screeds, leaving the area weak and crumbly later.



The steam tent being hauled to yesterday's plastered hull.



TASK 2 — Preparing the Steam Distribution Pipe

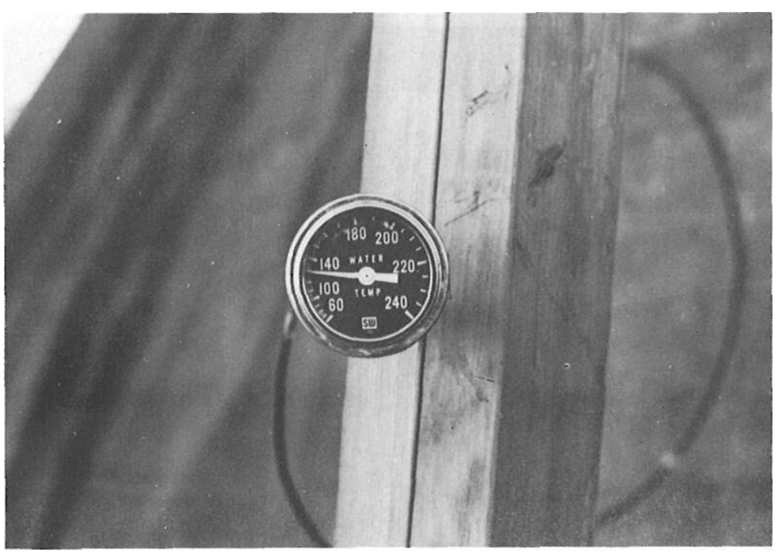
This was made from two 21-foot (6.4 m) lengths of one-inch (25.4 mm) galvanized pipe. One-eighth inch (3.1 mm) diameter holes were drilled in the pipes about one inch (25.4 mm) apart. The steam hose led into the pipes at the "T" joint in the center. The pipe was placed under the inverted hull, along its length.

TASK 3 - The Steam Tent

The steam tent was checked for tears. It was then draped over the hull. This job required about 15 laborers, as the rubberized canvas was heavy and would snag on any obstruction. When in place the steam tent completely covered the hull, with plenty of excess canvas laying around the sides and on the ground.

TASK 4 — Temperature Control

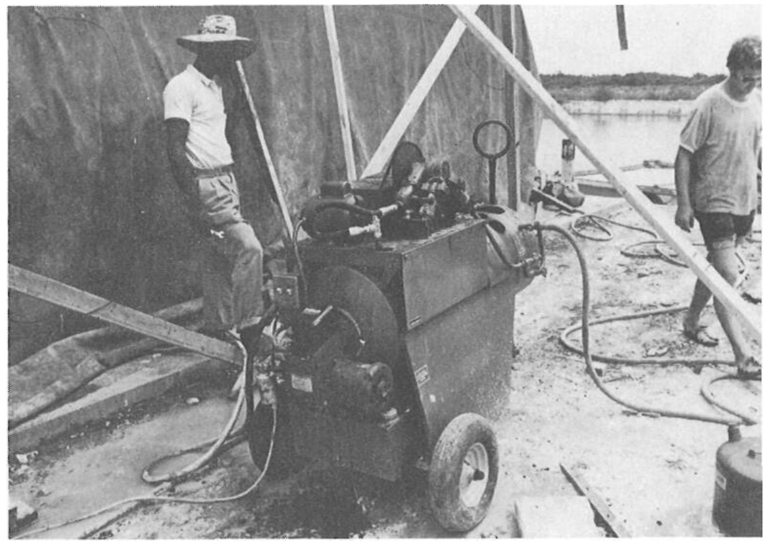
The six temperature gauges were set up. Three were placed on each side of the hull. A constant watch was kept on the gauges and the steam generator output was adjusted according to the desired temperature curve.



Temperature rising slowly to prescribed 150°F (66°C).

TASK 5 - The Steam Generator

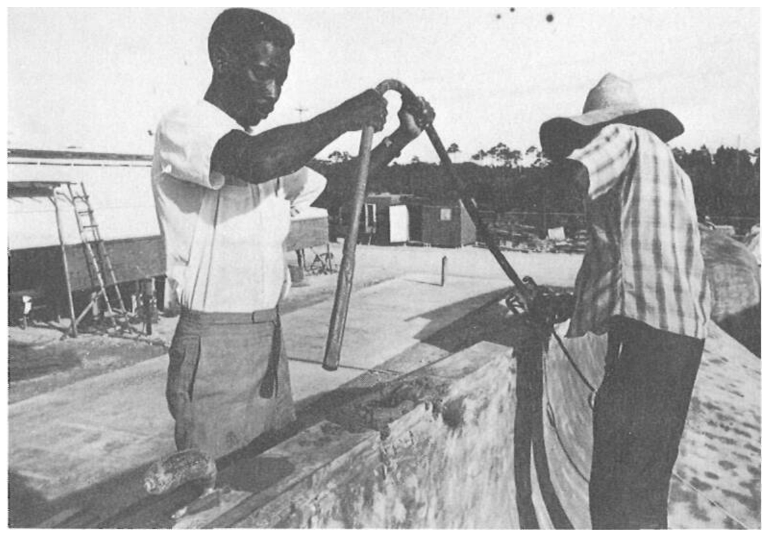
Finally, the steam generator itself was connected by hose to the steam pipe, also to the fresh water supply. Shifts were run on the steam generator while it was in operation. The steam generator consumed about 100 gallons of kerosene to steam cure one hull. The small fuel tank required filling every hour which conveniently coincided with the hourly temperature recording schedule.



Kerosene-fired steam generator.

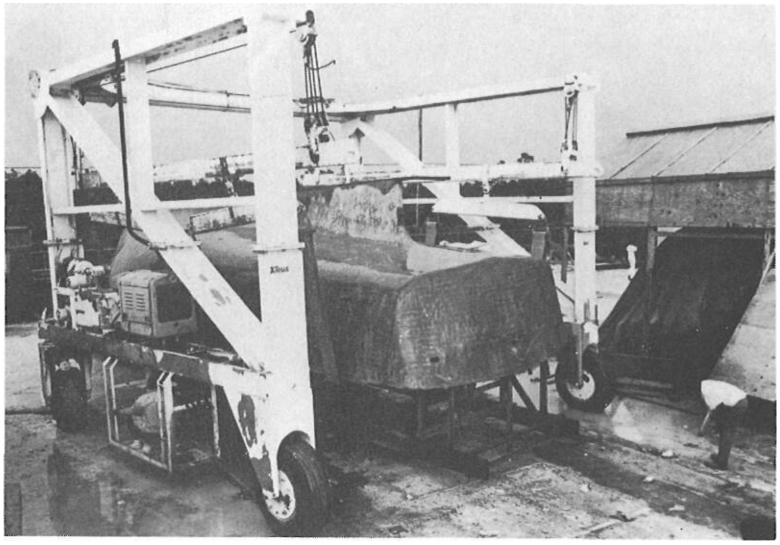
TASK 6 - Filling the Deadwood

After curing the hull, and before rolling the hull, the deadwood cavity beneath the keel was filled with mortar. A hole, one foot (305 mm) long and four inches (102 mm) wide, was cut out of the bottom of the steel keel shoe using a cutting torch. Mortar was poured into this hole and vibrated until the cavity was filled. The top part of this deadwood cavity, above the stern tube, was later plastered.

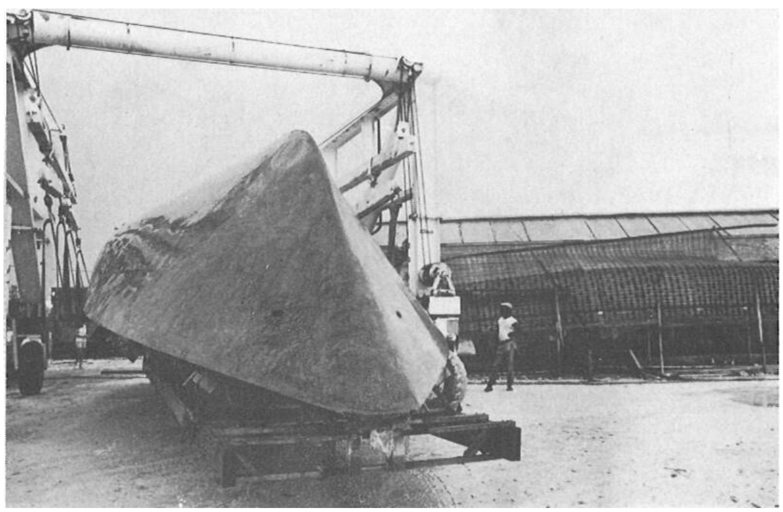


Vibrating mortar poured into deadwood area.

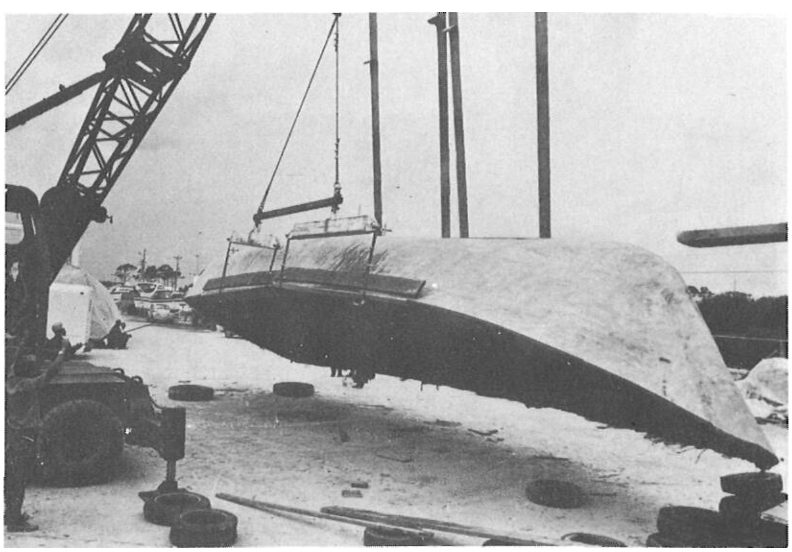
Pouring and vibrating.



By comporter to the rolling site.



The strongback is removed.



Fore and aft balance correct, rolling begins.

JOB 10 – ROLLING HULLS

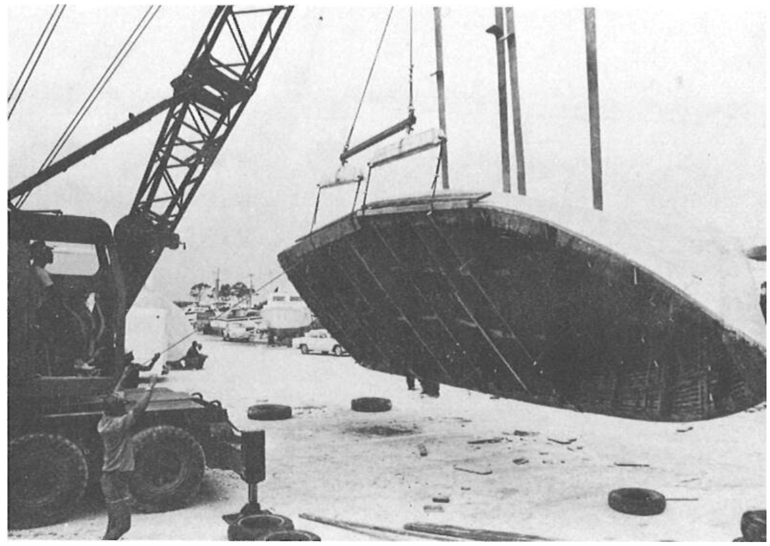
The hulls were picked up with a boat comporter and carried to the selected rolling site in the yard. The hull mold framing was left complete inside the hull until the boat arrived at the rolling site. Here the strongbacks and supports were knocked out of place and the hulls were lowered onto a cushion of old motor tires. There were usually three or four hulls prepared for rolling at once in order to reduce crane rental costs. A 35-ton mobile crane was used. The slings had been previously rigged. It took an average of one hour to roll each hull. This was the procedure followed. The hull was picked up in the slings. The main lifting line and the restraining lines were hooked one on each side of the hull. The hull was lifted gently to check its balance fore and aft in the slings. Then rolling began with the crane operator hauling up on one line and slacking off on the other. The hull rolled comfortably 180° inside the 12-inch (305 mm) wide canvas webbing slings borrowed from the comporter.

TASK 1 — Transferring Waterline Marks to the Hull

Before removing the sun shelters the waterline reference points were transferred back to the hull from the shelter support legs. These had been transferred to the shelter legs prior to plastering. At that time the marks could still be seen clearly on the hull mold through the overlying mesh. These lines were clearly marked on the hull exterior and were used for reference while leveling the hull after it had been rolled. After the hull was leveled, these lines were carefully transferred back to the shelter legs as the hull marks would become obliterated during priming and painting. When the hull painting was finished, the waterline reference points were again transferred back to the hull. Antifouling paint was applied up to this line shortly before launching.

TASK 2 - Moving the Hulls to Rolling Site

The shelters were then removed by the comporter. The hulls were picked up and transported to the rolling area. (There was not enough room between the concrete pads to maneuver the crane, so the hulls had to be shifted to a cleared site in the yard for this job.) While the hulls were still suspended in the comporter slings a sledge hammer was used to knock out the strongbacks and all the braces. The frames were cut off level with the sheer so that no wood was left hanging under the hull. The hull was then lowered onto a good cushion of tires.

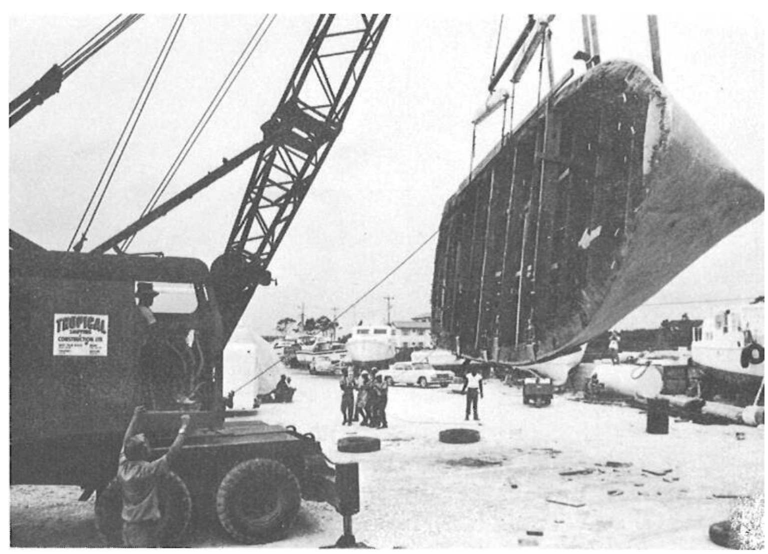


A slow, careful lift on the wire rope slings.

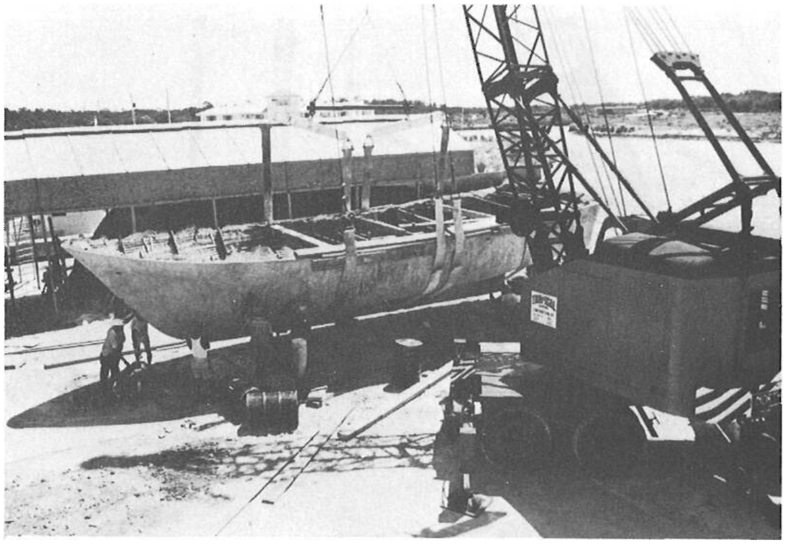
TASK 3 — Bracing Hulls Athwartships for Rolling

When the first hull was lifted by the crane the fore and aft balance point was measured. Sling positions were then marked on the remaining hulls at these points. Inside the hull cross braces were fastened at these points on the sheer line. There is a tremendous amount of stress placed on the sheer during rolling, so it was braced athwartships with 8" x 8" (203 mm x 203 mm) timbers. These braces were cut to length, wedged firmly in place, and nailed to the mold frames. Diagonal cross-bracing was nailed between these 8" x 8" compression braces.

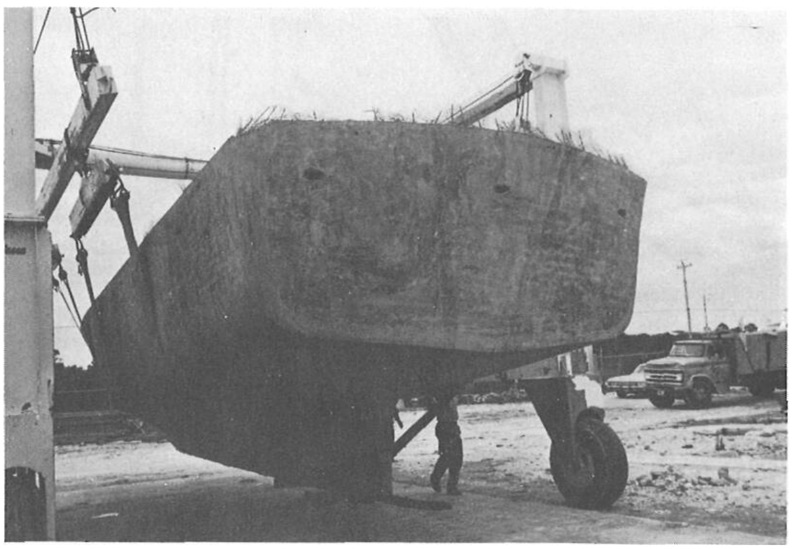
An easing down of the canvas webbing slings.



Rolling over, athwartship bracing visible.



The hull rolled upright inside the canvas webbing slings.



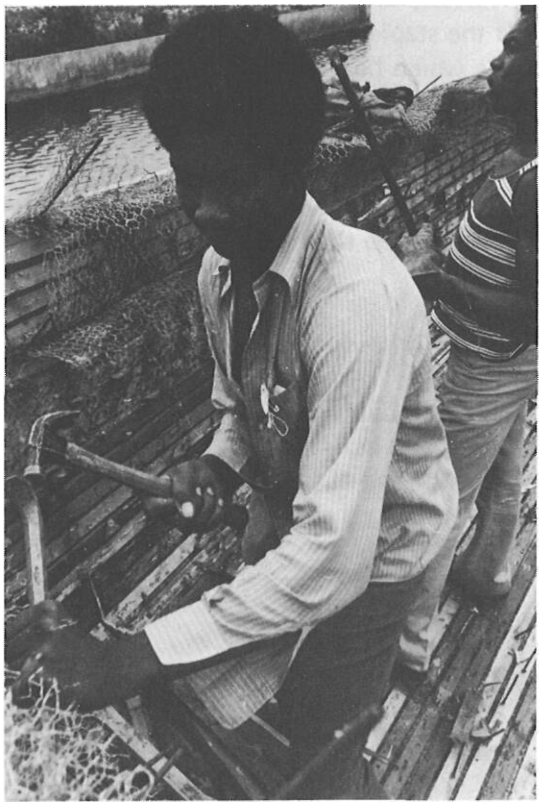
By comporter back to the pad.

TASK 4 - Preparing the Rolling Slings

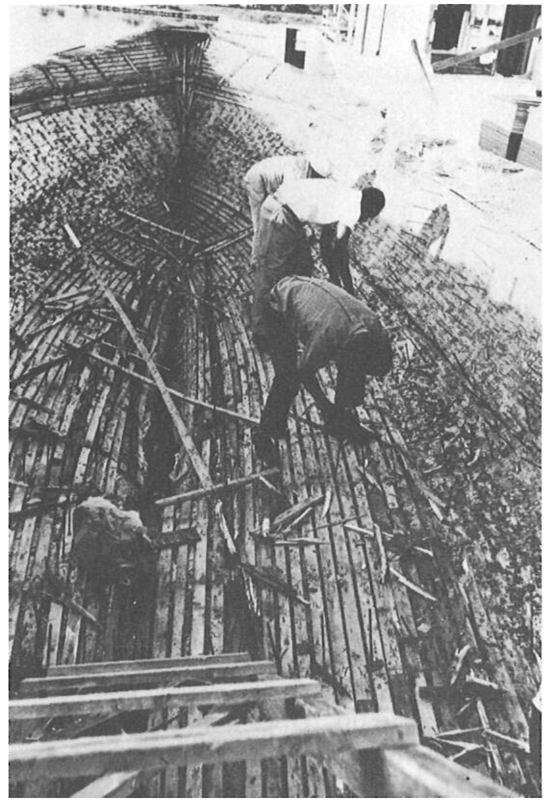
As the hull was to be rolled 180° the rolling slings were required to be marginally longer than that required to pass completely around the hull at its center section. The four broad canvas webbing slings borrowed from the comporter were not quite long enough for this. To extend them four lengths of 3/4-inch (19 mm) diameter steel cable were prepared and shackled to the web slings on the end which was to be hoisted. This allowed the hull to roll into the comfortable web sling.

TASK 5 - Supporting the Hull Level

The hull was blocked up level. A large pile of keel blocks was cut from 4" x 12" (102 mm x 305 mm) timbers. These were about two feet (610 mm) long. A boat building job needs hundreds of blocks for supporting hulls and equipment. The bilges were supported with 55-gallon drums, blocks and wedges. Plenty of drums were used for they have a tendency to collapse if too much weight is placed on them.



Claw hammers and light wrecking bars to remove mold planking.



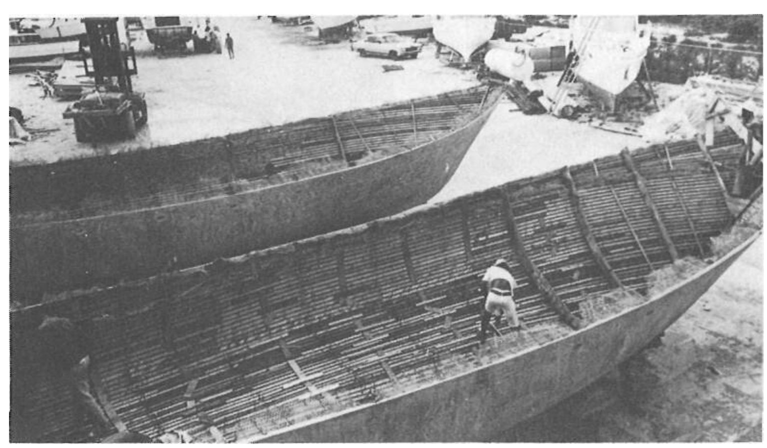
The strippers work from the sheer downwards.

JOB 11 - STRIPPING AND GRINDING HULL INTERIOR

The wooden mold frames and planking were completely stripped out of the hull. This is never a pleasant job, especially if the men laying the mesh have been generously disposed with the use of their air staple guns. It took, on the average, two men three days to strip the mold out and a further three days to grind off the protruding staple ends and clean up the interior of the hull.

TASK 1 — Removing the Hull Mold Frames

The mold frames were stripped out. These mold frames could not be salvaged for future boats as they had warped with steam curing and were generally in pretty rough shape at this stage. This job does not take long when tackled with an eight-pound (4 Kg) sledge hammer.



Knocking the mold frames out.

Grinding off the staple ends.

TASK 2 — Removing the Mold Planking

To remove the planking the laborers used crow bars. A plank was started at one end and then carefully pried up. Once a man understood how to strip the mold, the planks would generally come away in one piece. Inevitably some of the laborers grew to dislike this job and, on several occasions, men lost their tempers and drove their crow bars right through the hull. While these holes were easily repaired, efforts were made to avoid having this happen. Their main source of annoyance were the staple ends protruding from the concrete shell. Protective clothing was issued so that men would not be hurt by the staple ends.

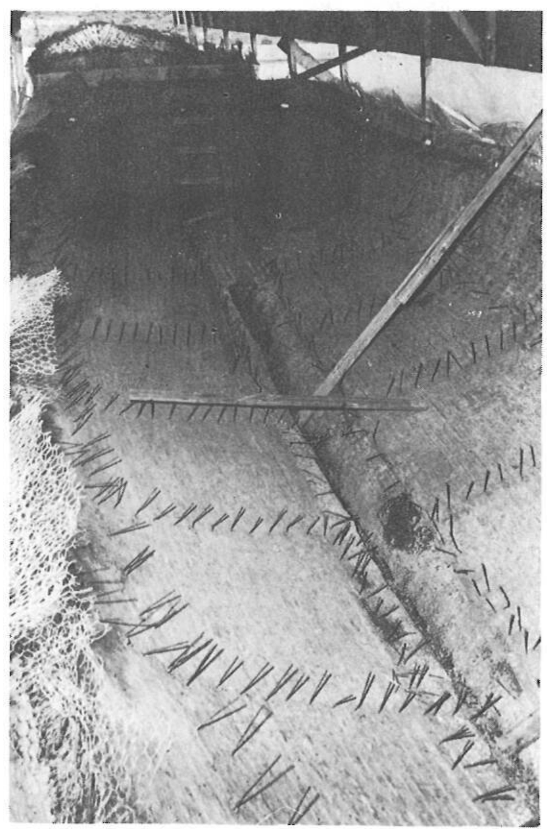
Clipping off staple ends in awkward places.

TASK 3 - Removing the Staple Ends

The laborers used rotary angle-grinders to cut off the staple ends and any little lumps of concrete which had fallen through weld burns in the plastic sheeting. Carborundum steel cut-off discs were used for removing the staple ends. We used, on an average, 12 cut-off discs for each boat. They wore down fast with contact against the hard concrete shell.

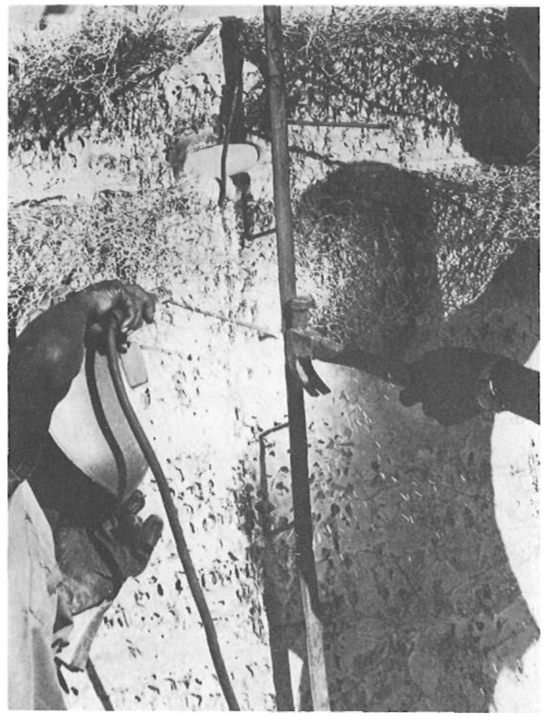
TASK 4 — Finishing Touches and Clean-Up

Final removal of staple ends close to the deck mesh, and in hard-to-get-at corners, was done with a pair of end-cutting pliers. All scraps of plastic were removed and the hull was cleaned out.



A cleaned hull. Starter rods deck and rail cap mesh remain.

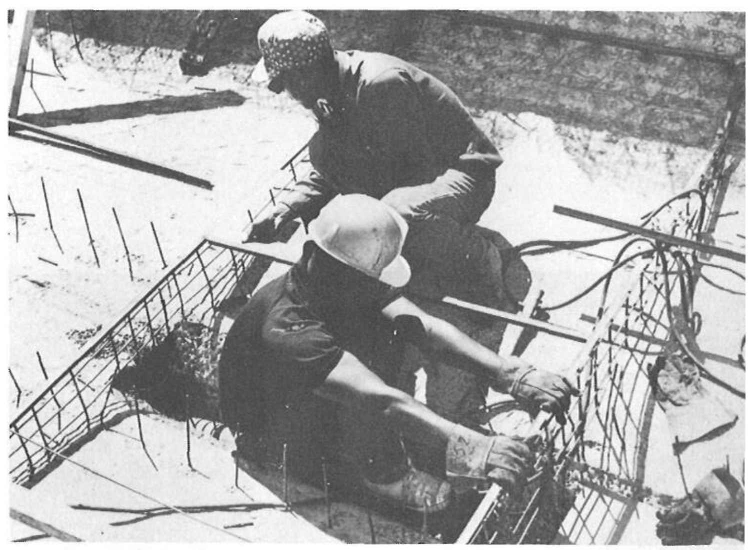
Welding T-bar screed to bilge stringer starter rod.



T-bar screed on web is welded to bilge stringer.

JOB 12 - MESH AND RODS - INTERIOR BULKHEADS, STRINGERS, WEBS

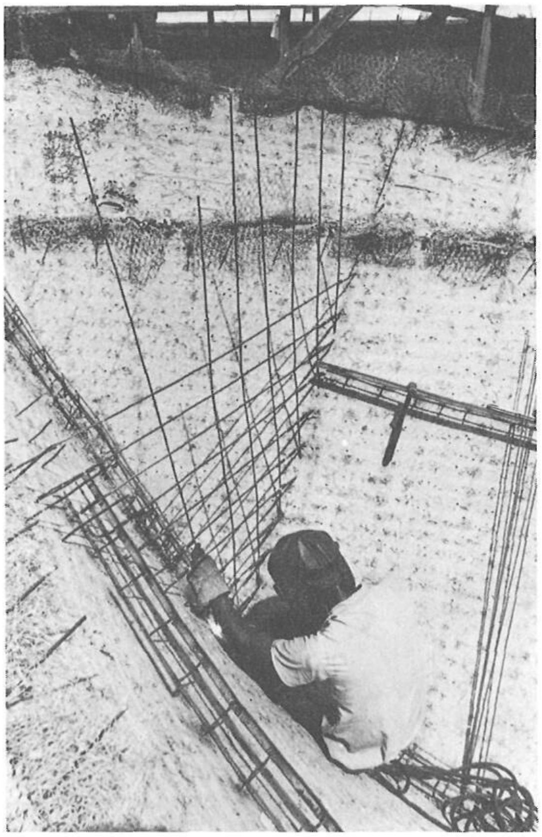
The interior bulkheads and webs were built in for the structural strength they lend to the hull. The layers of mesh were reduced from ten layers as used on the hull to four layers for interior webs, stringers, bulkheads, engine beds, etc. This was done for economy of material and labor. As these interior structures did not have to be impervious to saltwater, and were not subject to the same type of stresses as the hull, not as much mesh reinforcing was required. All the interior joints of 1/4-inch (6.4 mm) diameter rebar were spot-welded at their intersections. The mesh was clipped to the rods with hog rings. The water tanks' bulkheads, however, were made with ten layers of mesh in the same way as the hull.



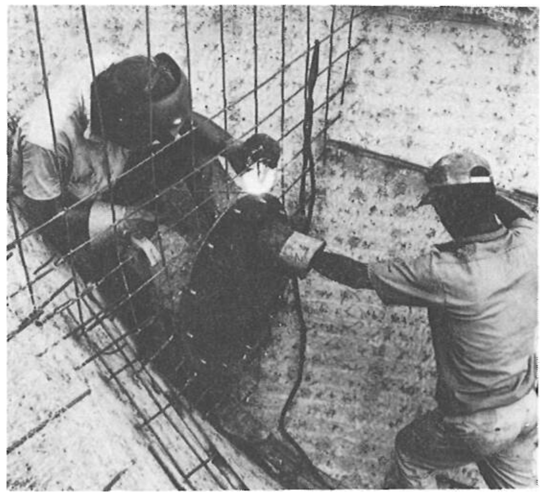
Webs at the shaft alley.

TASK 1 – Trimming and Straightening Starter Rods

All the starter rods for stringers and webs were trimmed to length. Bolt cutters were used to clip the rods. The rods were first straightened, where necessary, then a piece of pipe, cut to length, was slid over the rod to act as a guide for trimming.



Fore bulkhead reinforcing.



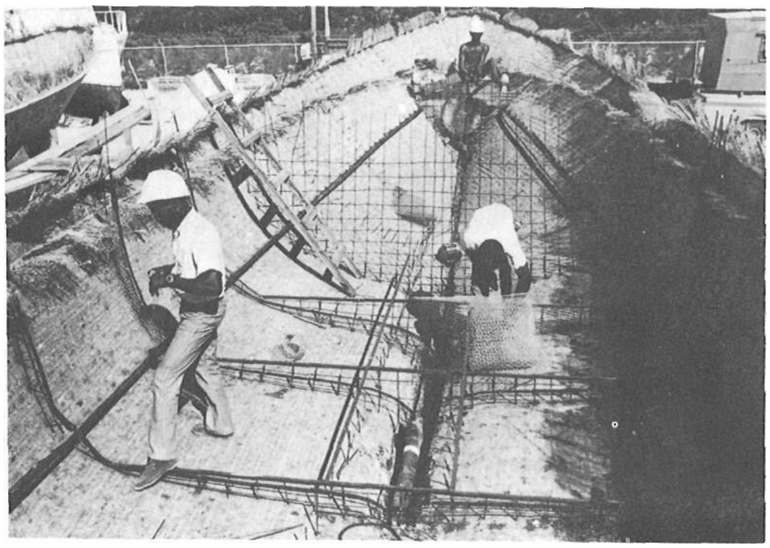
Welding inspection hatch in place.

TASK 2 - T-Bar Web and Bulkhead Screeds

T-bar, 1" x 1" x 1/8" (25 mm x 25 mm x 3.2 mm), was welded to the tips of the longitudinal stringer starter rods. A length of 1/4-inch (6.4 mm) diameter rebar was welded to the starter bars, parallel to the T-bar, for additional reinforcing. T-bar was used on all the exterior edges of the hull interior concrete panels. The T-bar protected these edges from chipping and acted as a screed for guiding the plasterer's trowel.

Task 3 — Forward Bulkhead Reinforcing

The forward bulkhead rod reinforcing was welded first. The starter bars emerging from the hull were joined by straight lengths of 1/4-inch (6.4 mm) diameter rebar on a horizontal plane. Vertical bars were then welded to these. The reinforcing rods when completed formed a six-inch (152 mm) grid. All the bulkheads were done in this same manner. The vertical rods were left protruding above the deck to be trimmed off later to the proper length.



Stringers, webs and bulkhead reinforcing progresses.

TASK 4 — Placing Inspection Hatches

The inspection or access hatches to the stem and stern compartments were welded in place to their respective bulkhead reinforcing grids. The rods were merely clipped out in the required space and the rod ends welded to the edge screed of the circular access hatch frames.

TASK 5 — Placing Wheelhouse Base Frame

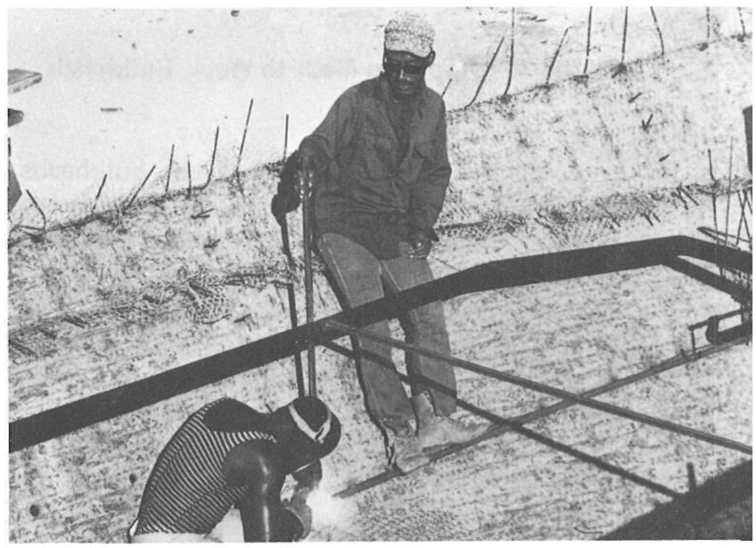
The steel base frame for the wheelhouse had been fabricated jointly with the superstructure framework. The bolt holes for both frames had been match drilled and each frame given the same number for identification purposes.

A center line was first strung over the bulkhead reinforcing and the center pointed marked. The wheelhouse base frame was carefully handled into position, aligned, and welded to the vertical rod reinforcing in the fore and aft engine-room bulkheads. The siting and level of the base frame were critical factors in this operation. The completed superstructure would later be bolted down to the base frame. All predrilled bolt holes would have to match and the wheelhouse base lie absolutely flat to it.

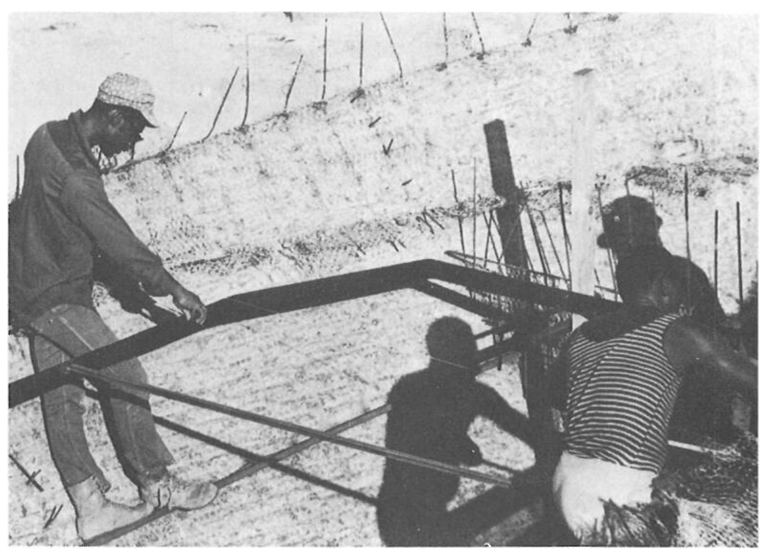
TASK 6 - Fish-Hold Webs and Stringers

The T-bar and longitudinal rods were welded to the starter rods to the fish-hold shaft alley stringers. The fish-hold webs were welded into these stringers. The top of the fish-hold webs and stringers form a base for the prefabricated fishhold so care was taken to ensure that there were no deformations in these structures and that they were all level.

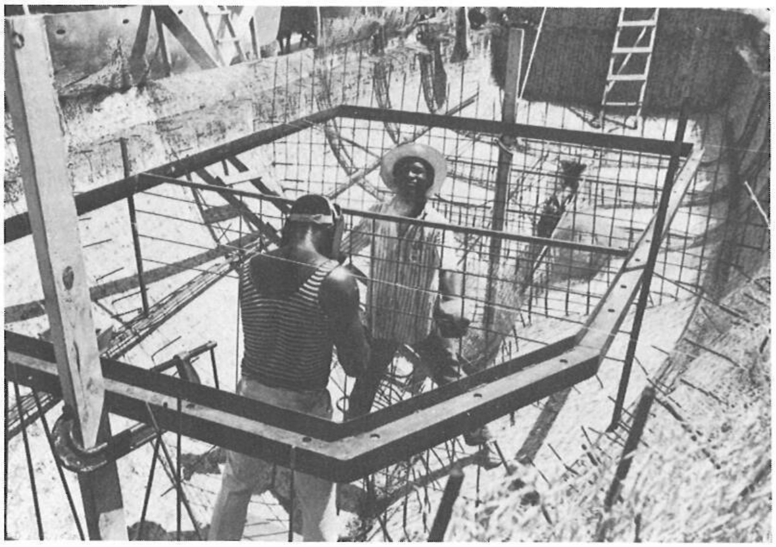
Wheelhouse base frame handed in.



Aligning wheelhouse base frames.



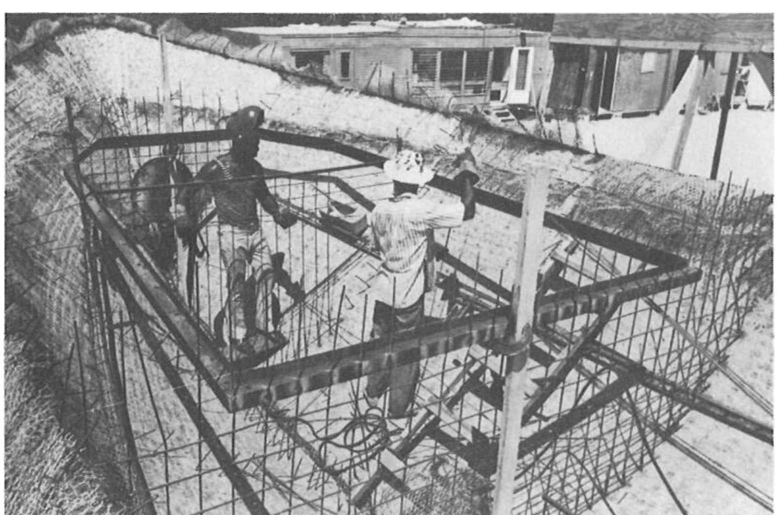
The base frame must be level and true.



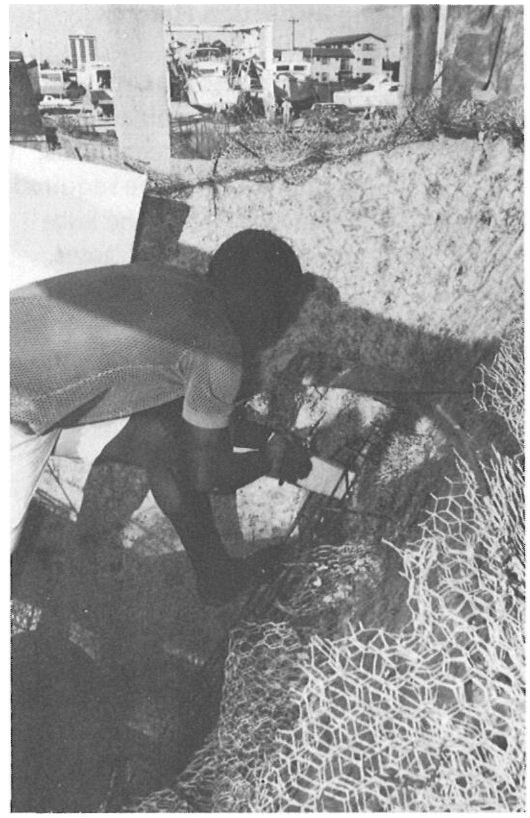
Wheelhouse base frame welded into position; forward engine room bulkhead takes shape.

TASK 7 - Applying Mesh to Webs, Bulkheads, Etc.

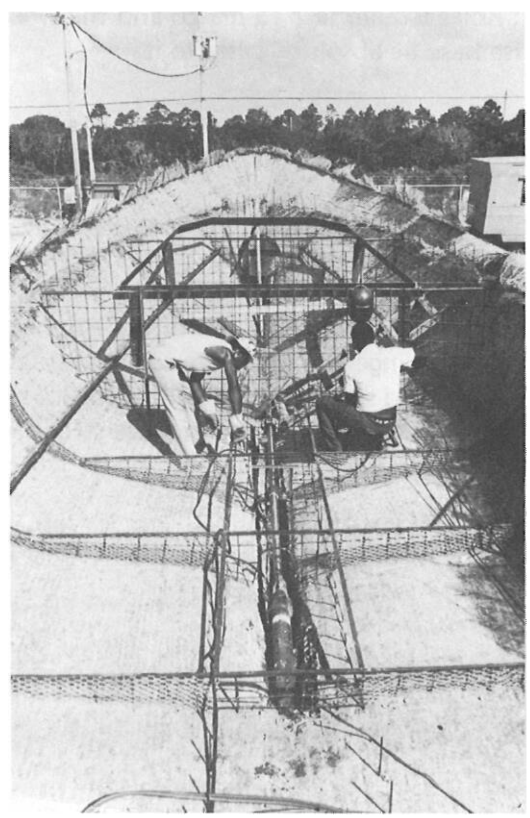
The rod reinforcing to the webs, bulkheads, and stringers were then meshed. Strips of eight-inch (203 mm) wide mesh were folded and used for all stringers and webs. (This mesh was purchased in eight-inch (203 mm) wide rolls.) The same three-feet wide mesh as was used on the hull was used on larger areas such as tanks and bulkheads. All the mesh was clipped onto the reinforcing rods using 3/4-inch (19 mm) hog rings. The mesh edges were neatly trimmed and tucked in.



Vertical rods in aft bulkhead welded to the wheelhouse base frame.

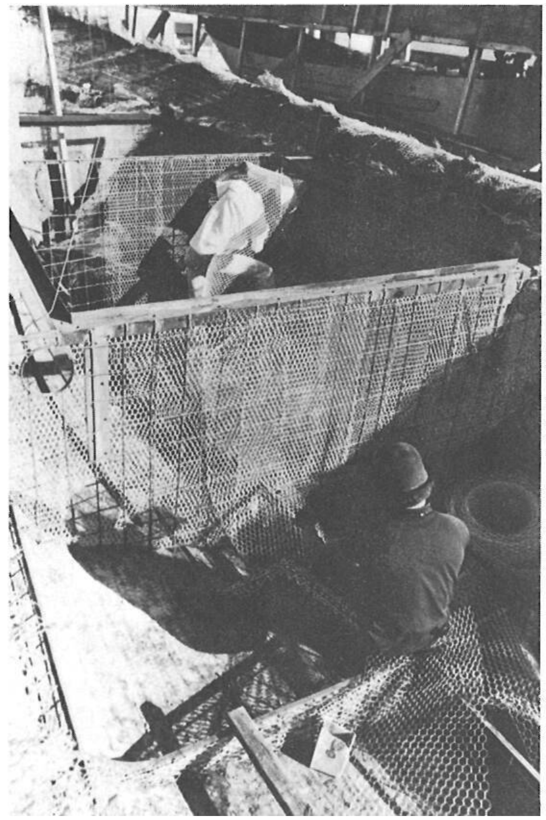


Stem head reinforcing being filled with foam insulation for lightness.



Propeller shaft in place for positioning pillow block bearing and bulkhead stuffing box.

Fastening mesh to webs and stringers with hog ring staples.



Fastening mesh to bulkheads.

TASK 8 — Preparing Apertures for Piping and Bilge Water

One and one-half inch (38 mm) galvanized thimbles were welded at all low spots on the stringers, webs, etc., as limber holes. Cut-outs were allowed in the mesh and rod reinforcing for stringing hydraulic lines and waterlines. Through-hull fittings were installed on the water-tight bulkheads. Outlets and vent holes were placed in the water tank bulkhead reinforcing.

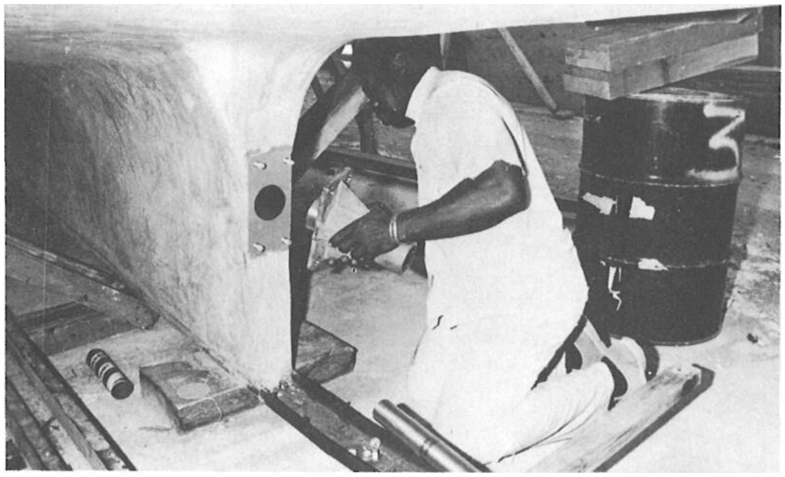
TASK 9 - The Deadwood Section

Two holes were punched through the concrete skin above the deadwood cavity. The bottom of the shaftlog had been poured prior to rolling. The top part of the deadwood was poured when the interior of the hull was plastered.

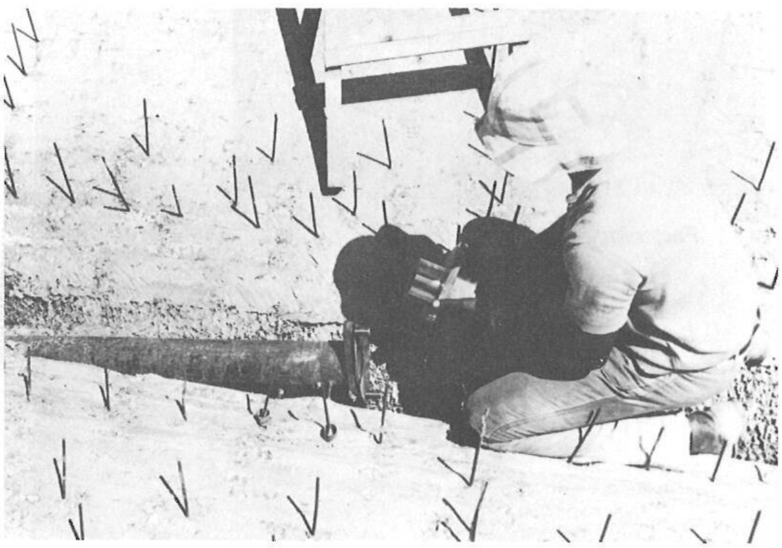
TASK 10 - Preparing Deck Starter Rods

The deck starter mesh and rods were bent upwards out of the way. Loose ends of mesh were trimmed.

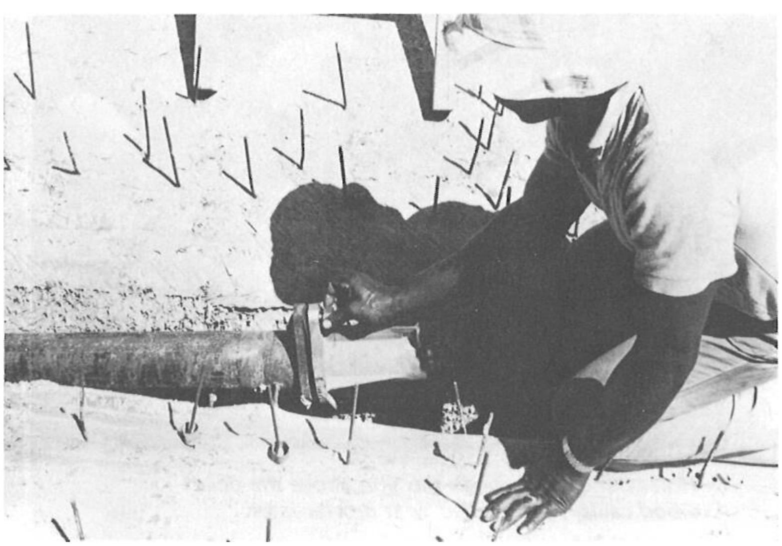
Holes punched through the skin above the deadwood cavity, to be filled with mortar later.



Stern cut/ass bearing goes on.



Stern stuffing box goes on.



Bolted to matching plate on the stern tube.

JOB 13 - MAIN SHAFT AND BEARING ALIGNMENT

TASK 1 — Affixing Stern Cutlass Bearing

The stern cutlass bearing was bolted to its matching plate on the outside of the steel stern tube. One and one-half inch (38 mm) stainless steel studs and nuts had been previously welded in place on the stern tube for this purpose. (Stage 1, Job 7) The nuts were peened over after being tightened.

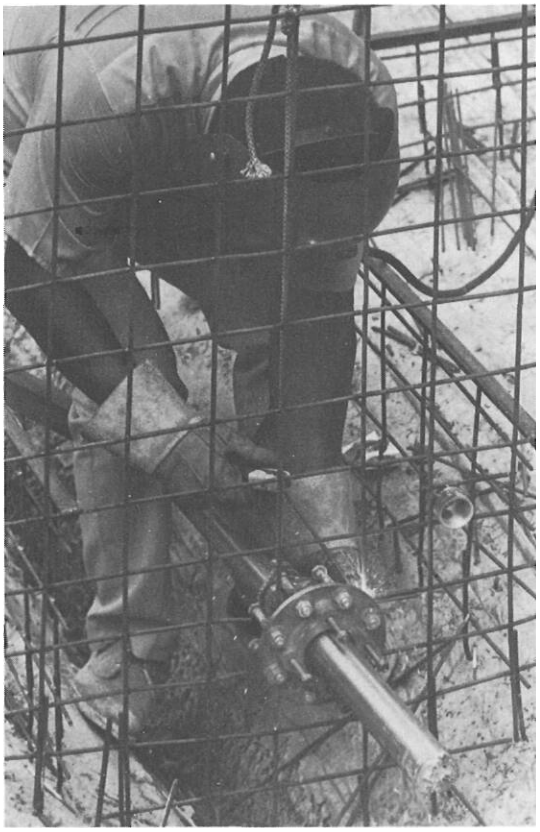
TASK 2 - Affixing Propeller Shaft Stuffing Box

The stuffing box was bolted to its matching plate on the hull interior side of the steel stern tube. A 1/4-inch (6.4 mm) neoprene gasket was placed between the stern tube plate and the stuffing box. Gasket compound was liberally smeared over both matching plates. The nuts here were not peened.

TASK 3 - Installing the Propeller Shaft

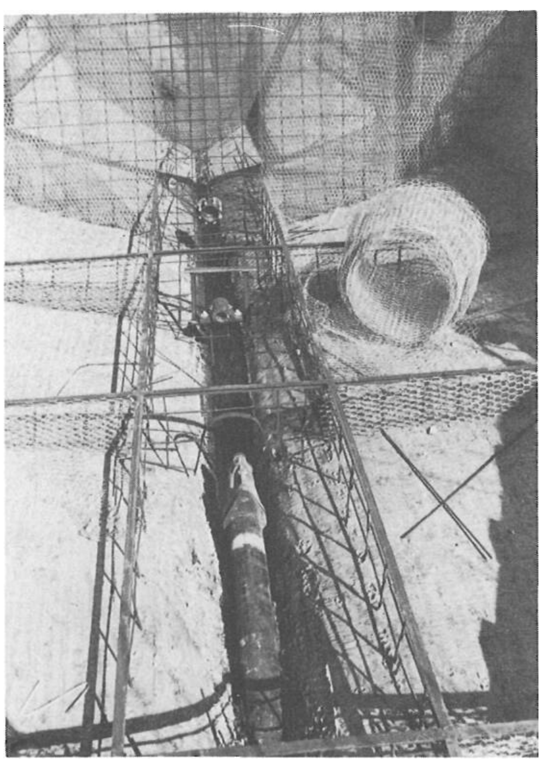
The 2 '' x 17' (57 mm x 5.3 m) long stainless steel shaft was lightly greased. It was then eased in through the stern bearing and the stuffing box. The intermediate pillow block bearing was then slide along the shaft from inside the hull, and the head of the shaft run through the aperture in the engine room bulkhead. The engine room bulkhead stuffing box was placed on the shaft within the bulkhead aperture. The shaft was carefully checked for alignment, then the bearing housing studs were welded in place.

Note: Pressure on the packing of the engine room stuffing box was later loosened as no means of water cooling the packing existed. In fact, it is not advisable that this type of bulkhead stuffing be installed in the future. Heat from the nearby reverse/reduction box was the main source of the problem. In the case of the stern stuffing box the flax packing was compressed only to the point of allowing a few drops of water to work through as the propeller shaft revolved.

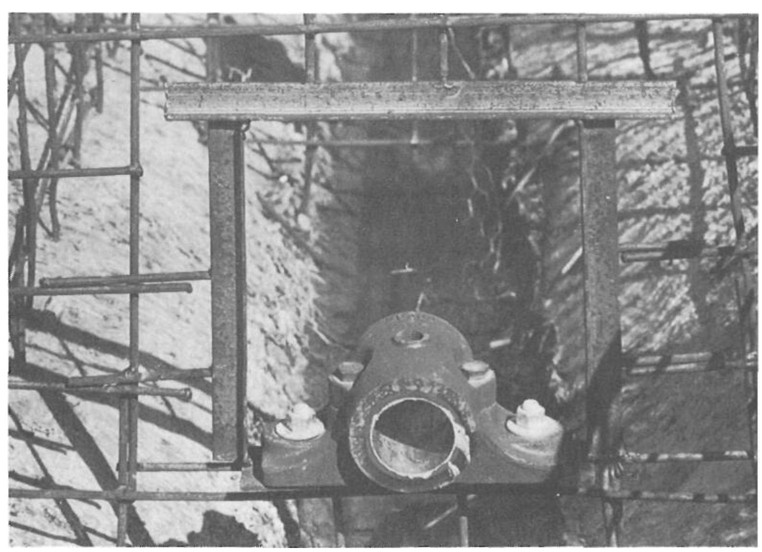


Welding aft engine room bulkhead reinforcing to the studs on the stuffing box housing.

The greased propeller shaft is eased in.



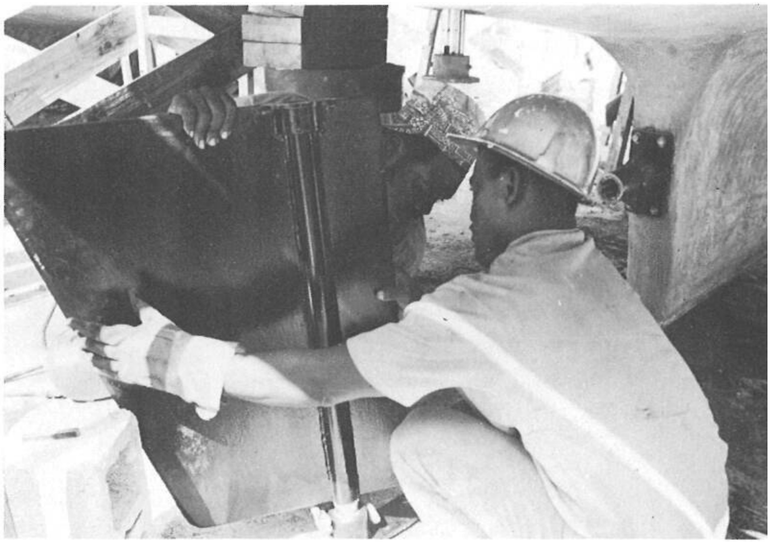
Propeller shaft removed after positioning the bearings.



The shaft pillow block bearing in place.

JOB 14 - INSTALLING RUDDER AND HYDRAULIC STEERING GEAR

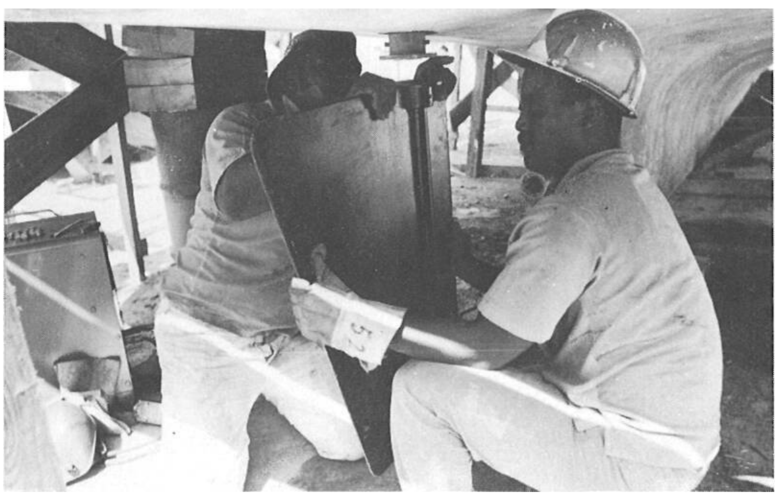
The rudder consisted of two detachable pieces. The rudder blade itself was of steel plate welded vertically to a length of 21/4-inch (57 *mm)* diameter stainless steel shafting. This was bolted by means of matching flanges to a second piece of 21/4-inch (57 mm) stainless steel shafting. This rudder stock, once assembled, ran through three bearings, one on the top of the skeg, one a stuffing box bearing against the bottom of the steering compartment and a third at the deck-head. The deck-head bearing was only installed when the deck reinforcing was laid-up.



Rudder stock slid into skeg bearing.

TASK 1 - Installing Rudder Assembly

First the rudder shoe cutlass bearing and rudder stuffing box housing were assembled in place, together with the rudder and rudder stock. Next, the rudder and rudder stock were lined up and their matching flanges bolted together. The rudder shoe bearing was then bolted to the steel keel skeg. When the rudder stock was standing perfectly plumb, the rudder stuffing box housing was welded to the starter rods as per illustration. Next, more 1/4-inch (6.4 mm) diameter rebar was welded in concentric rings to strengthen these starter rods. This was later formed into a cone shape when the interior of the hull was plastered.



Matching flange on two-piece rudder stock.

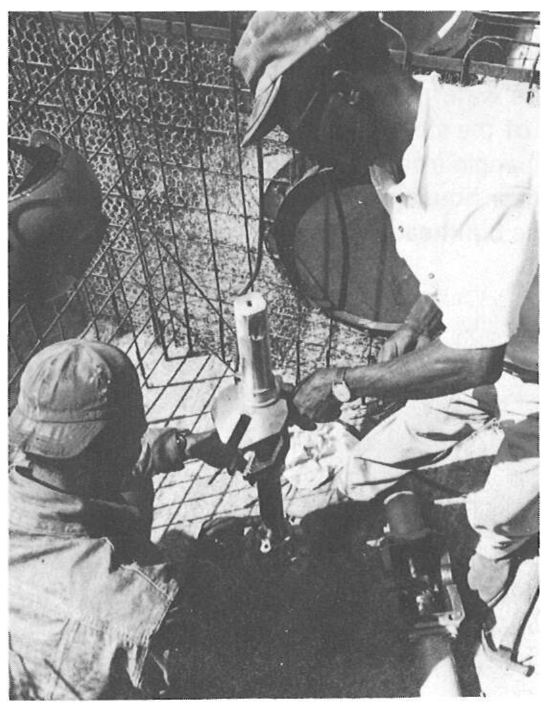
Two-piece rudder stock bolted together and the rudder assembly in place.

Stuffing box housing in the steering compartment.

TASK 2 — Installing Hydraulic Steering Gear

The hydraulic steering gear was attached to the rudder stock. The steering gear housing was disassembled, attached to the rudder stock, packed with grease, then all the bolts were fastened. Care was taken to use only clean grease. There was a lot of sand blowing around the job which required keeping away from exposed mechanical parts.

Fitting hydraulic steering gear.



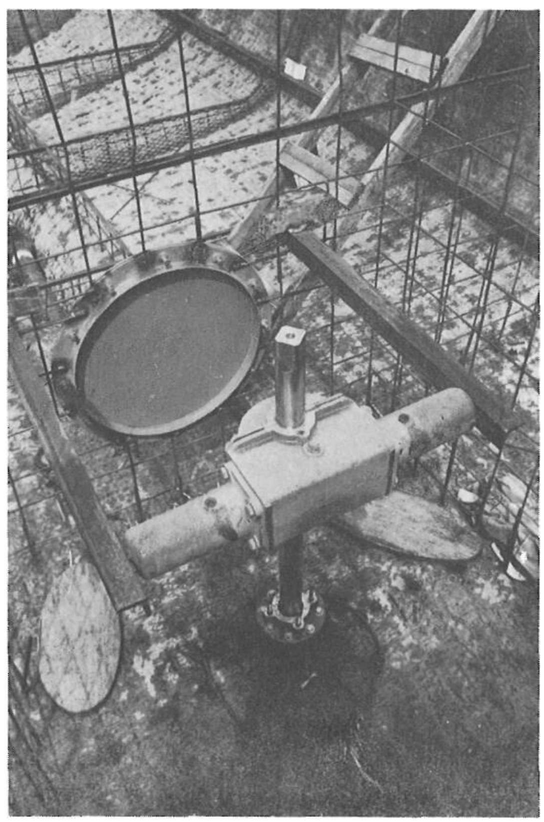
Hydraulic steering gear assembly.

Cone-shaped reinforcing to stuffing box housing.

Hydraulic steering mechanism packed with grease.

TASK 3 — Bracing the Hydraulic Steering Gear

Six-inch (152 mm) steel straps were welded to the watertight bulkhead forming the forward end of the steering compartment. Two-inch (51 mm) angle iron braces were bolted to the steering gear housing and welded to these brackets in the bulkhead steel reinforcing.



The steering gear assembled and braced.

JOB 15 - INSTALLING RUBBING STRAKES

The guards were made up from 2" x 10" (51 mm x 254 mm) pitch pine planks. Two 12-ft (3.7 m) pieces were scarfed together to form 22-ft (6.7 m) long planks. A pattern was made up from plywood and the guards were cut to this pattern. Each guard was beveled so that the face which fitted against the hull was larger than the outside face. This was done to stop the guards catching on pilings, etc., when tied alongside a wharf with a dropping tide. Further, the lower bevel would eliminate excessive pounding at the guard as the boat plunged through a head sea. The upper bevel would shed rain water which might otherwise lie against the hull and eventually rot the guard.

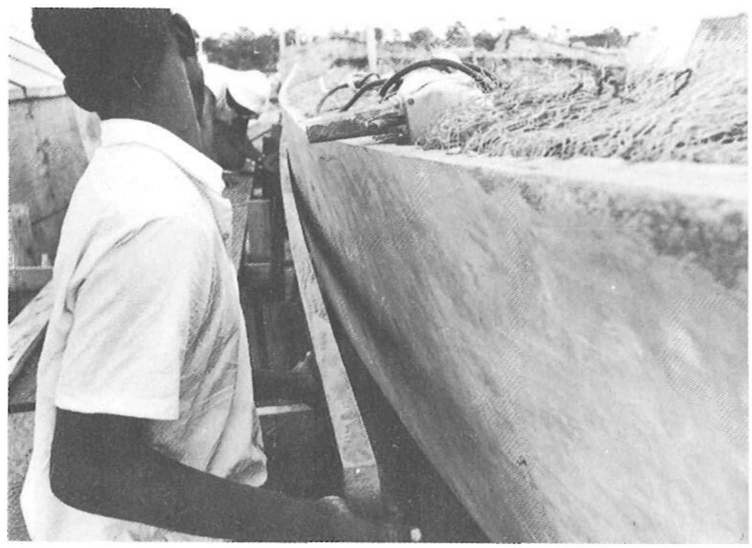
On completion, the guards were well bedded and bolted into place on the side of the hull. After the hull was painted a rubber cushioning strip was screwed onto the wooden rubbing strakes. Wide brass washers were used under the screw heads to give the screw a better holding head and to stop the rubber cushioning from tearing away on impact.

TASK 1 - Removing Temporary Bolts from the Hull

The 1/2-inch (12.7 mm) diameter greased guard bolts, which were driven into holes drilled in the wooden hull mold before plastering, were removed. These bolts were found to be deeply embedded in the concrete hull shell. A pneumatic wrench was used to remove the bolts. The vacant bolt holes were then cleaned with a masonry bit.

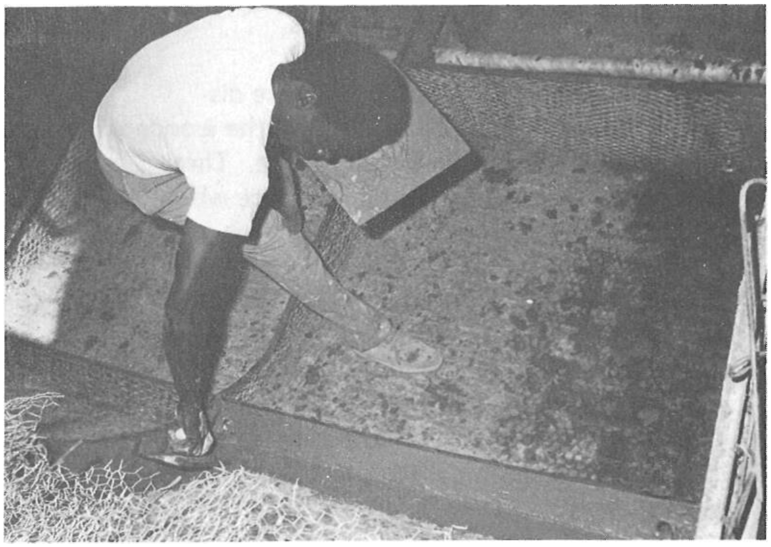
TASK 2 - Installing Rubbing Strakes

When all the vacant bolt holes were distinguishable on the outside of the hull, the wooden rubbing strake was positioned into place. Three bolts were used to hold the guard in place while all the bolt holes were drilled right through it. The guard was then removed and the bolt holes counter-sunk. The guard was primed with red lead sealer paint. Next, a thick coat of bedding compound was troweled onto the hull side of the guard. The guard was then firmly bolted in place. Bolts were staggered on nine-inch (229 mm) centers along the length of the rubbing strakes.



Fitting rubbing strakes.

Bolting down rubbing strakes.



Plastering webs and stringers.

JOB 16 - PLASTERING THE INTERIOR OF THE HULL

The same mortar mix was used for the interior of the hull as for the exterior. The interior plastering was a tedious job as there were many difficult corners to finish along webs and stringers. The plastering crew was divided into two crews, one crew working one day ahead of the other. The first crew plastered the bulkheads, webs and stringers. The second crew skin-coated the hull interior filling up any air pockets which had been left under the plastic sheeting and covering the ground-off staple ends.

TASK 1 - Cleaning and Wetting the Hull Interior

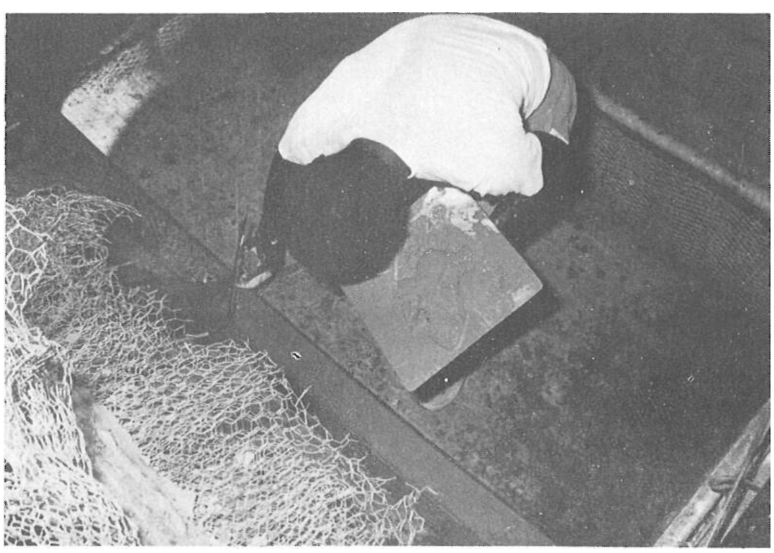
The inside of the hull was thoroughly cleaned. First a broom was used, then a vacuum cleaner, and finally the hull was washed out. The washing was done just prior to plastering. The old mortar required wetting in order to adhere better to the new.

TASK 2 - First Areas to Be Plastered

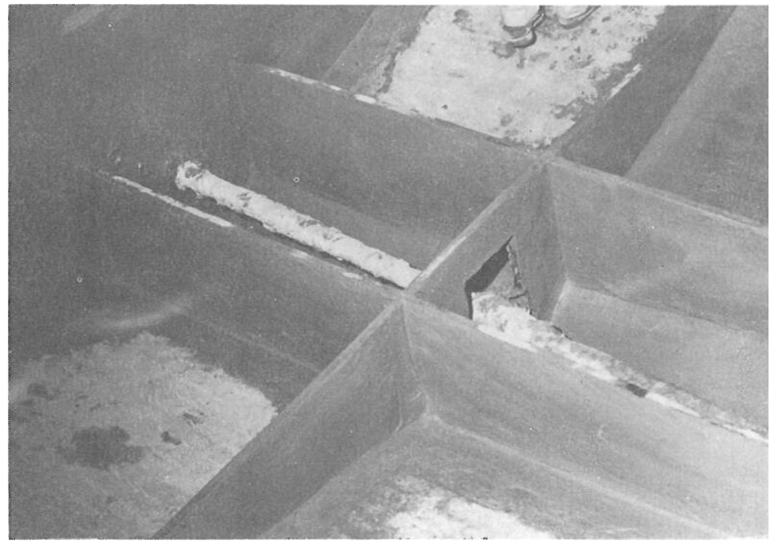
The deadwood area over the shaft-log was filled up and vibrated. The forward end of the hull above the keel was smoothed. The cone-shaped foundation for the rudder stock stuffing box housing was filled and shaped.

TASK 3 — Plastering Bulkheads and Webs

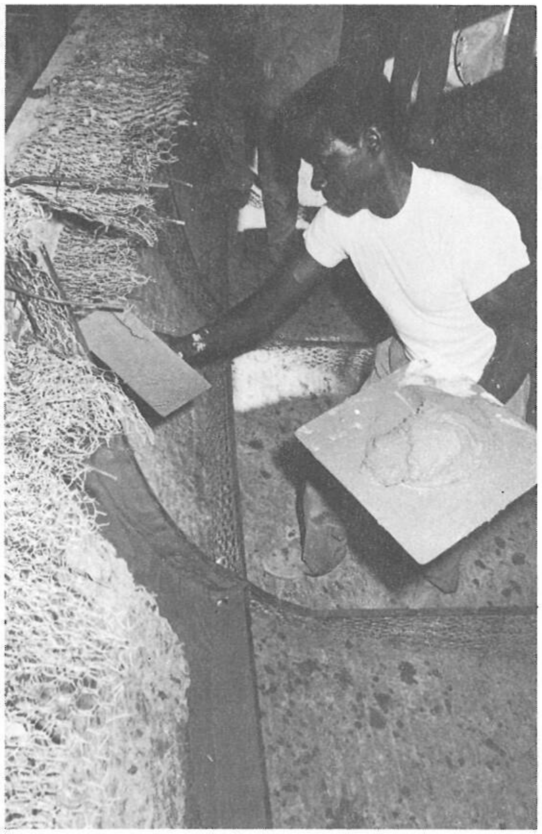
Each of the bulkheads, webs and stringers was plastered in turn. The mortar was forced through the mesh and rod reinforcing from both sides. Prior to plastering an area where new concrete joined the old, the plasterers used a water brush to sprinkle watery grout on the joints. The interior surfaces were steel troweled where convenient and just sponge troweled where the plasterers were unable to produce a good finish. Pointers and edgers were used to pack the mortar hard into areas difficult to penetrate.



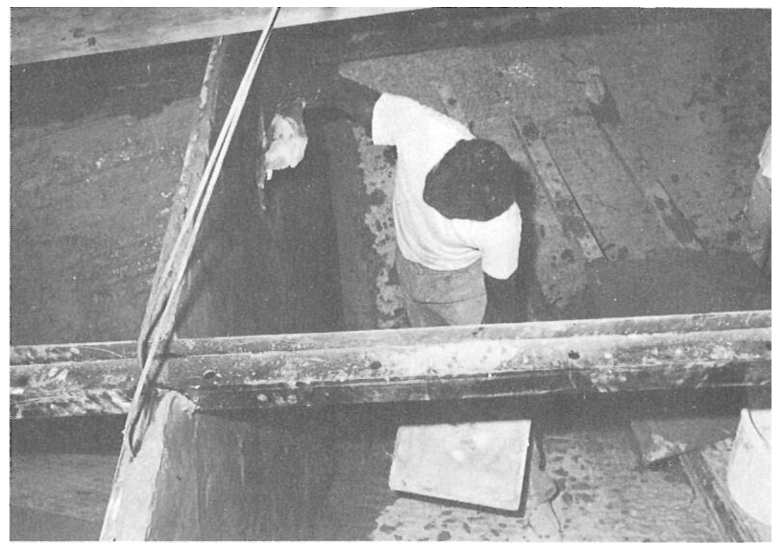
Drainage holes left free of mortar.



Shaft alley and webs; propeller shaft protectively wrapped.



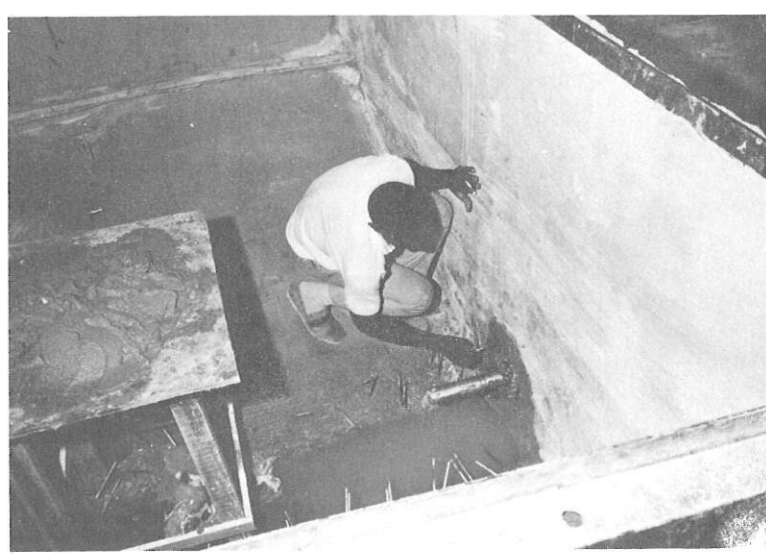
Mortar forced through from both sides of webs.



Plastering bulkheads.

TASK 4 — Apertures and Corners

Excess mortar in all limber holes and piping apertures was trimmed off and cleaned out. In those areas where a radius was required, the round bottom of a beer bottle was worked over the inside corners to give a regular shape to the finished concrete work.

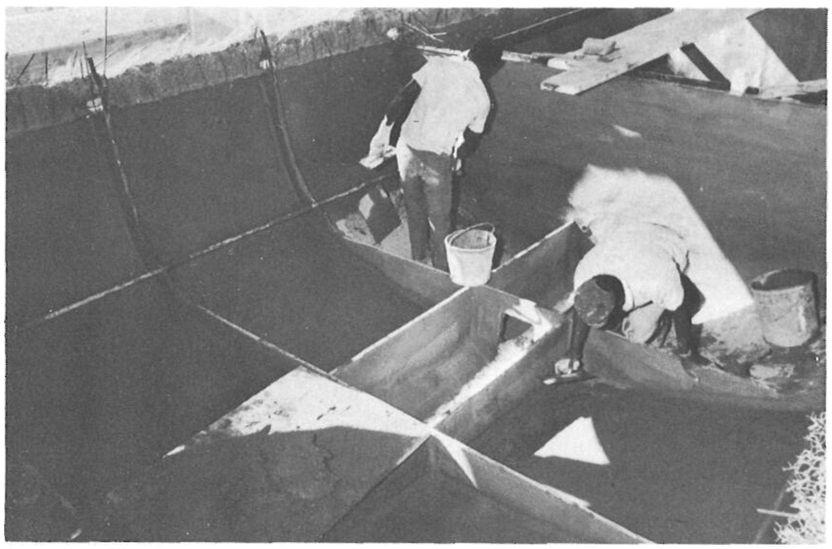


Cleaning out piping apertures.

At work on interior skim coat.

TASK 5 - Hull Interior Skim-Coat

The areas of the hull between the webs and stringers were plastered. Grout was splashed over these areas prior to troweling on a very thin skim-coat. The plasterers were careful not to build up excess concrete weight during interior finishing.

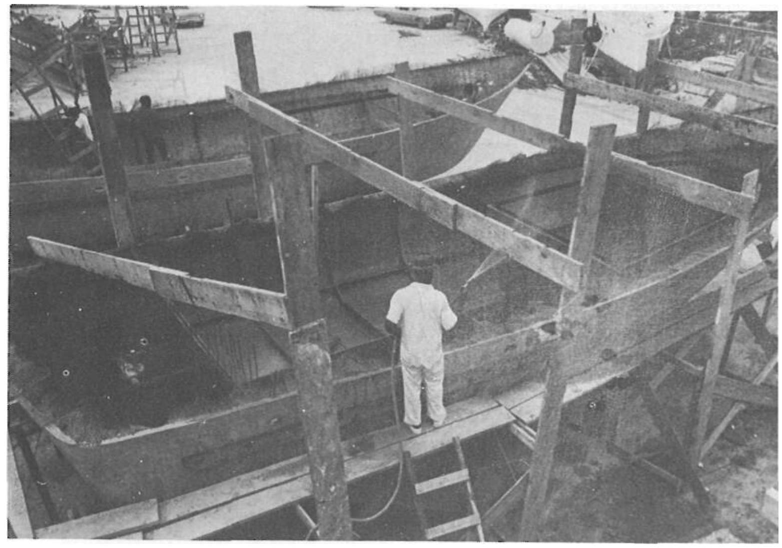


Final touches to the skim coat.

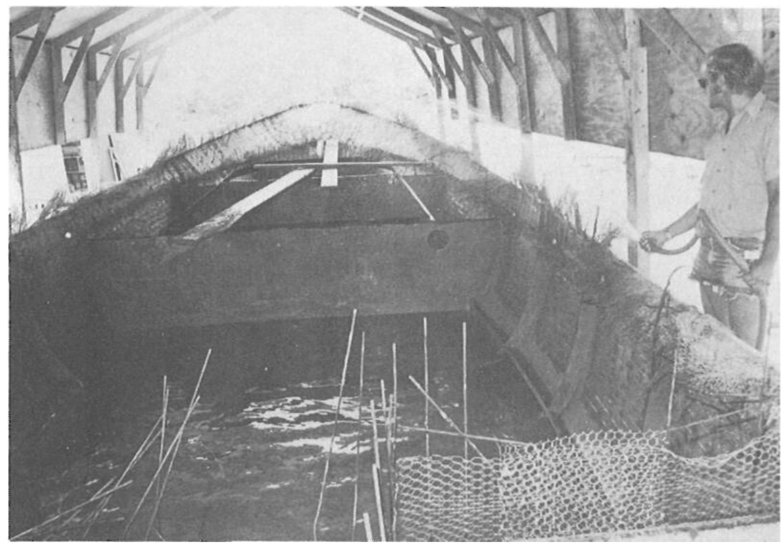
Note aperture in aft engine room bulkhead.

JOB 17 - WATER TESTING AND REPAIRING

All the vessels were submitted to a water test after the inside coat of concrete had been applied. Each hull was filled with fresh water to a level above the loaded waterline. The water was left in the hull for several days to a week depending on how long work could be effectively organized on other hulls without disturbing the hull under test. The testing accomplished two jobs. First, the new concrete work inside the hull was being wet cured. Secondly, any existing hairline cracks would show up as damp spots on the outside of the hull. These could all be quickly located and repaired. This was the assumption worked to–if a hull would hold water in, it would certainly hold water out. Approximately 25 tons of water were poured into each hull, and three hulls were kept full at all times during testing. Water was expensive in Freeport, so the water was pumped from one hull to the other as each test was completed. Five gallons of sodium silicate (waterglass) was stirred into the testing water in each hull. The chemical action of the sodium silicate served to fill minor cracks. Major cracks received from rough handling of the hulls–mostly during rolling–were repaired by chipping out a wide "V"-shaped groove along the crack and troweling in a mixture of Roplex (acrylic paint base) and water. The exact mixture used was, by volume, one part Roplex to one part water. Just enough of this liquid mixture is added to sand and cement, also mixed one part to one part, to form a workable paste. First pure Roplex was brushed into the groove, then the repair compound was troweled in. When this had set (about 1/2 hour) it was sponge troweled and then steel troweled smooth. After steel troweling, Roplex was painted over the surface. These repairs never leaked or gave further problems.

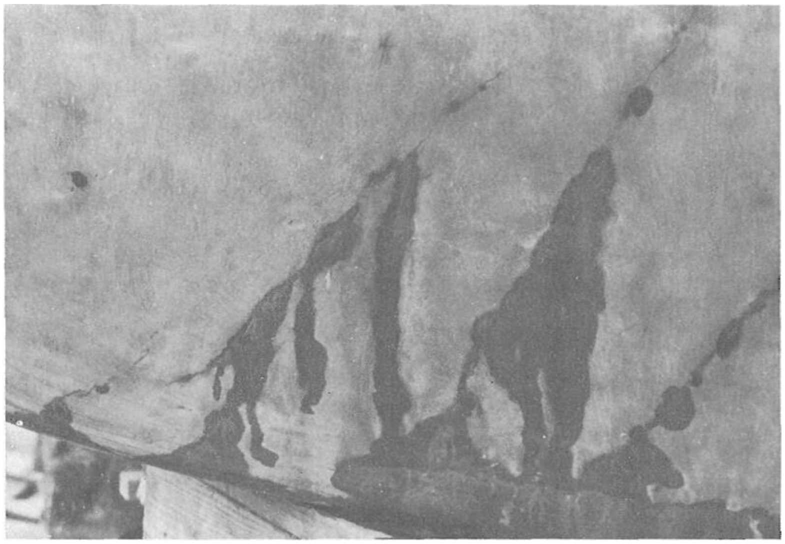


Filling the hull for the water test.

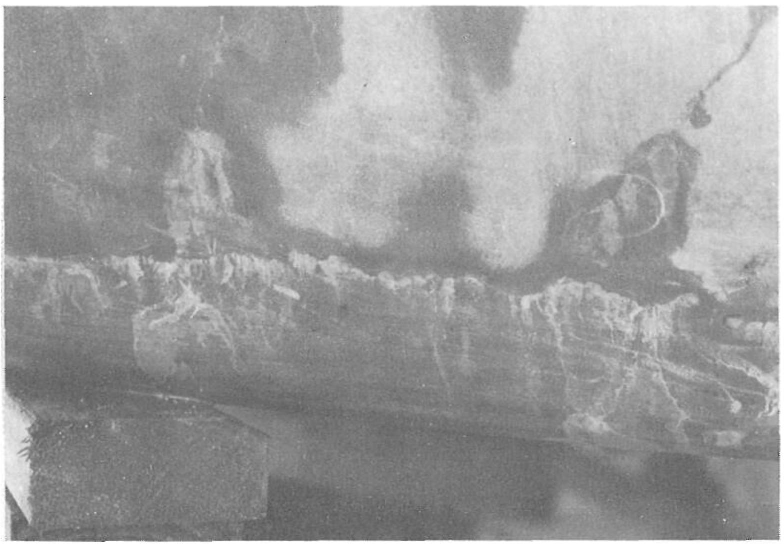


Water level is brought above load water line.

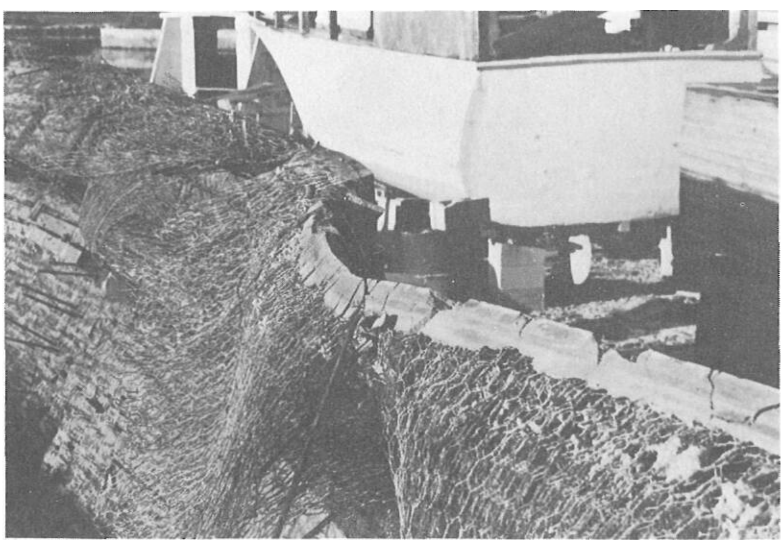
Stress cracks being sealed with the action of sodium silicate in the water.



Stress cracks radiating from the stem. This hull was dropped by the crane.



Sodium silicate forming a seal.



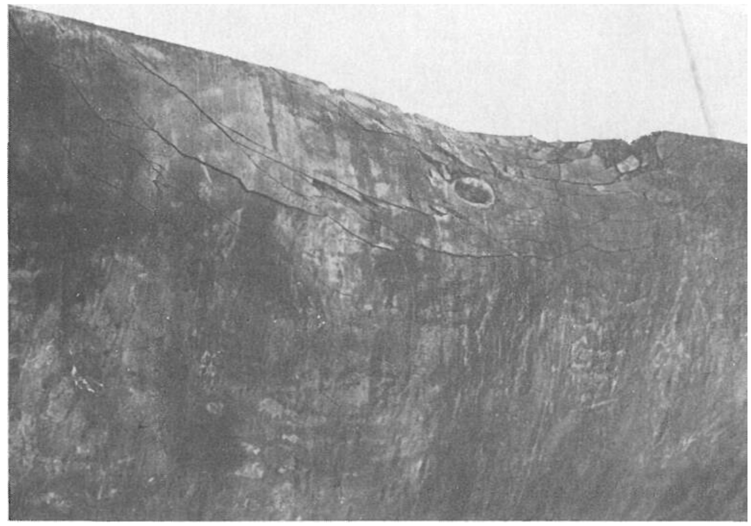
This hull dropped six feet (1.8 m) onto its side when rolled. It fell on blocks on the concrete pad.

Altogether, some 500 feet (152 m) of hair-line cracks were repaired on this project. But most of these cracks were confined to just four of the ten hulls. There were two reasons for these crack formations. First, the shut-downs in the steam curing cycle caused by the lime content in the Bahamian water. Although extra curing time was given in compensation, some of the cracks undoubtedly relate to the uneven temperature curve caused by these shut-downs. It was fortunate that ambient temperature was around 85° F in Freeport at the time, otherwise more extensive cracks might have occurred.

The second reason for hull cracks can be traced to the crane operator. He was new to his job and consequently nervous about rolling the hulls. Most crane operators work in straight lifting, moving and lowering sequences. This job required the hull to be lifted, held briefly at a height, then rolled 180°, simultaneously slacking off on one line and tightening up on the other. Two sets of controls and brakes had to be used with great skill at the same time. (It was a credit to the Bahamian crane driver that he learned as fast as he did, as he had nothing to practice with except our boats.) One boat was suddenly dropped from a height of over six feet (1.8 m) on its side when the crane operator's hands and feet became confused in the working of his lifting levers and holding foot-brakes. Three other boats received pretty heavy crane treatment, having their athwartship braces moved several times each time they were lifted and set down because they were not balancing horizontally on the lift. Other damage was caused by men who grew disenchanted stripping out the mold, and would sometimes hammer a crow bar through the hull before throwing down their tools and walking off the job.

TASK 1 - Shoring Up Hulls for Water Test

The hulls were well shored up for water testing. Dozens of 4" x 4" (102 mm x 102 mm) timbers were edged under the bilge to supply support for the 25 tons of water used in the test.



View from outside of the hull damaged when dropped on its side.

TASK 2 - Filling Hulls with Water

The water tanks were filled to the top. All through-hull holes were plugged and each section of the hull was filled in turn. All through-bulkhead accesses were blocked to check if each bulkhead was truly watertight. If not, they were repaired. Waterglass, or sodium silicate, was added to the water, approximately five gallons per boat, to seal hairline cracks.

TASK 3 - Repairing Leaks

Checks were made for leaks. Most of the hulls were totally watertight. Some hulls showed a few damp spots which disappeared after a couple of days. Where there were stress, shrinkage or damage cracks, they were repaired. If the damaged area was bad, it was tested once more with water after repair.

Damaged area pounded out for repair.

TASK 4 - Draining Hulls

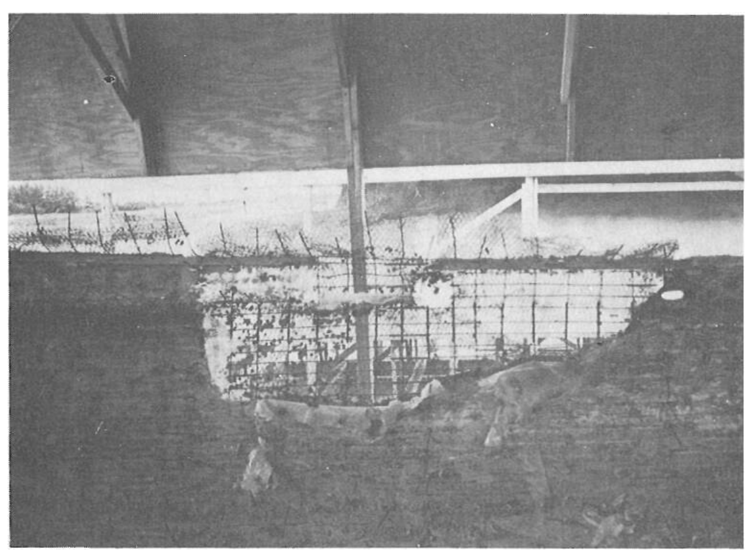
The hull was completely bailed out, all free water mopped up and left to dry.

TASK 5 — Repairing Damaged Hulls

The dropped hull needed some extensive repair on the top sides along the sheer, where it had suffered the most damage. This was done as follows:

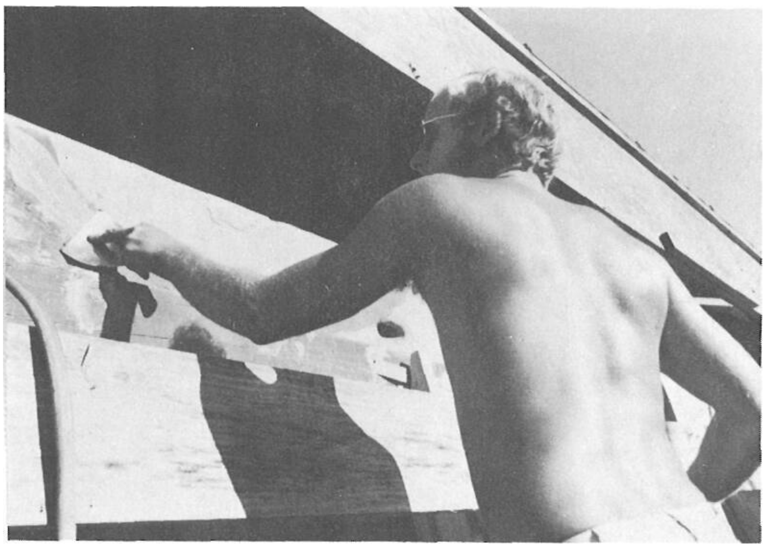
1. The damaged concrete areas were pulverized out.

2. The reinforcing rods were pounded back into shape and faired.

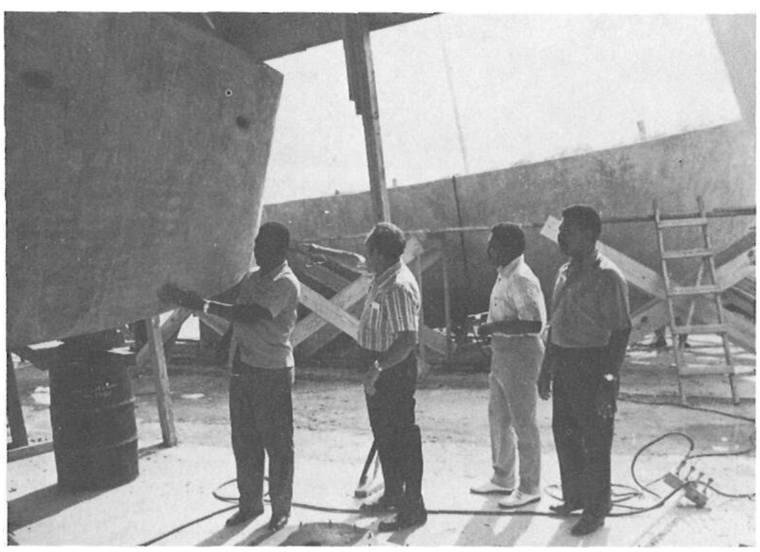


View of same damaged area from inside.

Cracks being chipped open for repair.



Filling the cracks.



Damage from a crow bar smoothly repaired.

The loose mesh was clipped tight and smooth with hog rings.

The area was plastered in the same way as the hull. A grout slurry coat was painted over the cleaned joint. Wet sacks were hung over this new concrete surface for a week. This repair was totally successful and the repaired portion could not be discerned after the hull was painted.

STAGE 2
FABRICATING COMPONENT PARTS

Work on Stage 1 and Stage 2, Job 1, was carried out simultaneously. The tradesmen had been assigned to building the hull as a first priority. When pressure slackened on hull building, they were given work fabricating component parts of the vessels.

Stage 2 is concerned with how the component parts of the vessel were prefabricated. In every possible case a part was fabricated in its required numbers ahead of the construction schedule. The project called for two prime principles from its management: economy and fast delivery. This entailed detailed planning from the start so that a smooth flow of materials would combine with a smooth deployment of the maximum number of men who could be effectively organized at any one time. It is calculable that a given boat will take a certain number of man-hours to bring it to completion. It might take, say, ten men working 100 days which, at first sight, may appear to be comparable to 100 men working ten days. The costs of overheads would be admirably reduced on this latter schedule if this were, in fact, possible in practice. But, large numbers of men working in one place at one time tend to limit their individual capacities in addition to imposing greater organizational difficulties. Management's aim is to work toward this maximum number without reducing overall efficiency.

An added factor to be calculated with the more general ones governing boat construction efficiency was that in the Bahamas all the men had to be trained in, what was to them, completely new boat-building techniques. Output was, therefore, frequently diminished by training demands.

A further consideration which was brought into the planning of the project was capital investment in boatyard equipment. Obviously, the machining and fabrication of certain parts would be more economically subcontracted to firms possessing specialized equipment. In particular, the machining of the propeller shaft and rudder assemblies, the fabrication of such items as the fuel tanks and inspection hatches. Given only one month to terminate the design of the boat, to plan the construction schedule and to attend to the host of supply and organizational details required to start production, the emphasis was on subcontracting wherever possible. Some of the work subcontracted was consequently expensive but, in most instances, was done better than the men could have been trained into turning out in so compressed a schedule. The aluminum fish-hold pen boards were prepared and cut to size, the hydraulic steering gear machined to fit, from as far away as Vancouver, Canada. It was fortunate the work was done well, otherwise the distance was just too great for the parts to be returned for correction.

JOB 1 - FABRICATE FISH-HOLD

The fish-holds were prefabricated at the same time as the hull molds were receiving their mesh and rod reinforcing. These holds were soundly insulated with 3½-inch (89 mm) polyurethane foam slabs. The insides of the fish-holds were then covered with treated 3/4-inch (19 mm) plywood. This later had tarpaper stapled over it, sealant applied to all joints, and two layers of mesh attached. After installation in the hull, a thin skin-coat of mortar was troweled onto the mesh inside the fish-hold to protect the wood from moisture and fish slime. Marine aluminum corrugated boards were used to make the fish pens in the hold. This is the sequence of construction prior to the installation of the fish-hold in the hull.

Series assembly of fish-hold frames.

All joints treated with waterproof compound.

The fish-hold was fabricated as follows:

1. 2" x 4" (51 mm x 102 mm) fir was cut to length for framing the hold.

2. 2" x 4" (51 mm x 102 mm) frames were made up for fore and aft bulkheads.

3. 2" x 4" (51 mm x 102 mm) frames were made up for side bulkheads.

4. The plywood was cut to size for sheathing.

5. The 3/4-inch (19 mm) inside plywood was nailed to the frames and the joints sealed with a waterproof compound.

6. 2" x 4" (51 mm x 102 mm) frames were made up for the fish-hold tops and bottoms.

7. All surfaces were primed with liquid asphalt cement to prevent rot.

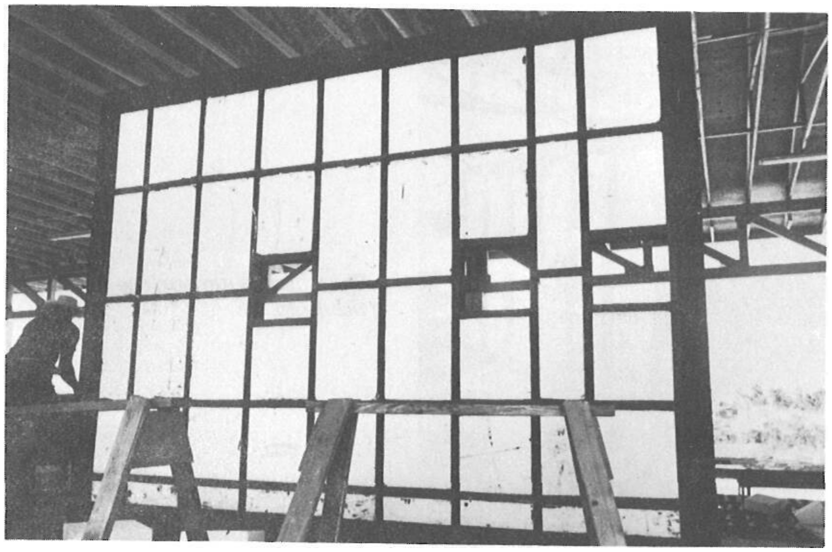
8. The polyurethane insulation slabs were cut to size and installed in the framework.

9. Ends, sides, tops and bottoms were assembled.

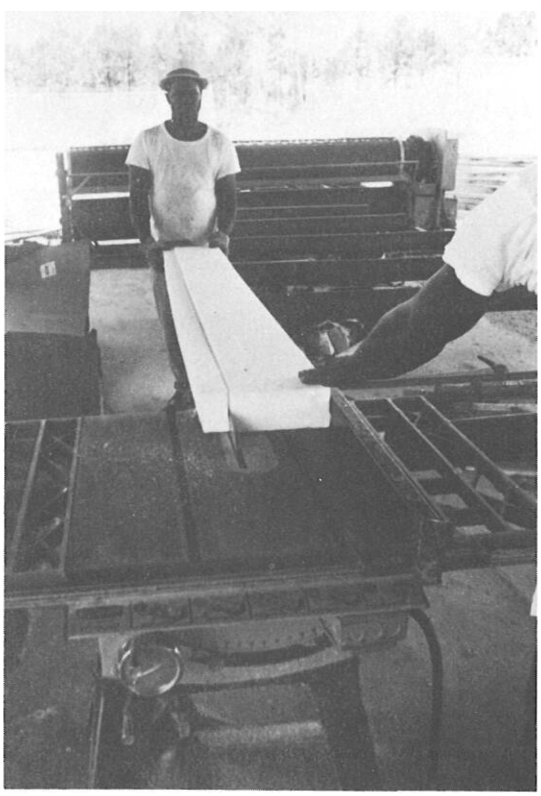
10. Exterior 5/16-inch (7.9 mm) plywood sheathing was cut to size, primed on its inner surface, and nailed to the outside of the fish-hold framework.

11. All exposed edges of the fish-hold were primed and stored until needed for installation in the hull.

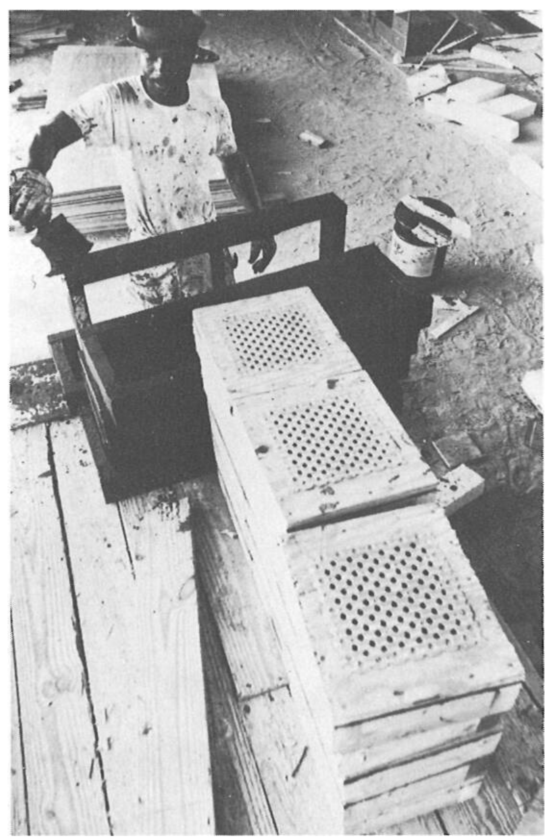
12. Combined access and drain hatches to the stuffing box, pillow block bearing and bulkhead stuffing box were fabricated for each fish-hold floor.



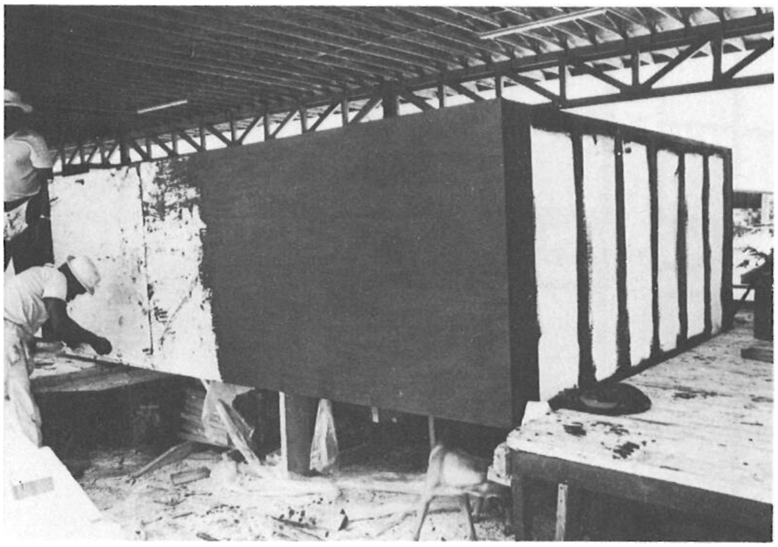
Foam insulation slabs installed.



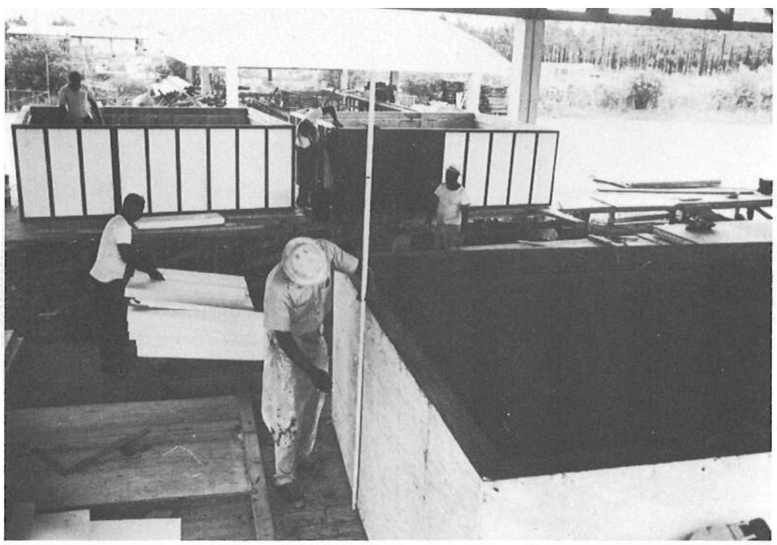
Sawing foam insulation slabs to size.



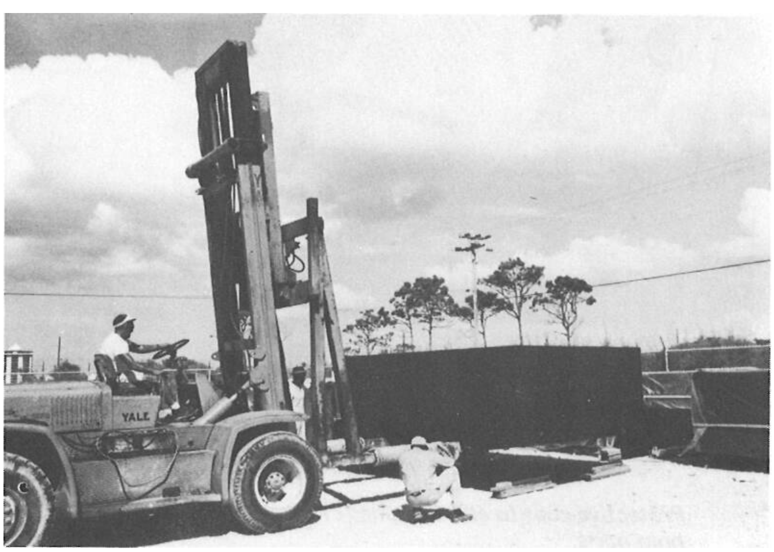
Protective coat to all component fish-hold parts.



Sheathing outer surface of prefabricated fish-hold.



Fish-holds awaiting tops.



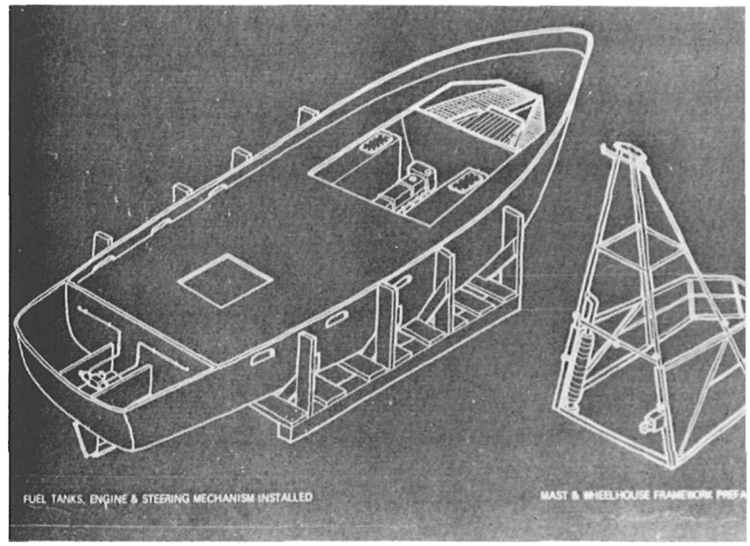
Storing completed fish-holds.

JOB 2 - THE ORIGINS OF THE SUPER-STRUCTURE FRAMEWORK

The design of the combined mast and wheelhouse structure owes its conception to experiences drawn from the spiny lobster fishing industry in Northeast Brazil. The time period this refers to was from 1959 to 1966 when the industry was in its early days.

Until 1959 almost all the Brazilian fishermen in this region were using catching methods and sailing craft which had remained virtually unchanged for centuries. But from 1959 to 1962 the advent of modern processing and exporting plants for lobster on this coast created a sudden and enormous demand for more efficient fishing vessels. Financing, boat-building materials, skills and equipment were hard to obtain in this region. Traditionally-built, local wooden sailing boats were imported from abroad and adapted to lobster fishing. The number of powered fishing craft grew, lobster was caught more efficiently, the numbers of sailing craft began to diminish. Inevitably, as the powered fleets expanded, catches of lobster per boat began to drop and a need to diversify the regional fishing came about.

In the late 1960's the first ferro-cement fishing boats appeared in North America. Ferro-cement had long been proclaimed by Professor Nervi and his followers, pioneers in ferro-cement, as the ideal material for building fishing boats. Some of the reasons for this claim appeared to be particularly fitting in the context of Northeast Brazil at this stage of its development. Ferro-cement boats required relatively unskilled labor, at least in the construction of the hull. No sophisticated equipment was needed, the construction materials were commonplace. That ferro-cement was not subject to deterioration and absolutely impervious to the attacks of the teredo worm was a factor which particularly favored its introduction to these tropical waters.



It can be argued that the techniques used in the construction of ferro-cement boats owe more to the lessons learned in boatyards using steel than to those building in wood or fiberglass. Steel was chosen for the combined mast and wheelhouse framework but this was not the principal reason. During the past forty years the basic equipment and skills employed in electric arc-welding have spread to almost every human settlement in the world big enough to support a gasoline pump. The underdeveloped Northeast of Brazil has arc-welding. It has had skills in wood-working for a longer time, but dimensional, finished lumber, plywood and marine fastenings are particularly hard to obtain. Common steel pipe, flat bar, plate and angle iron, the materials which comprise this superstructure frame are, on the other hand, relatively easy to find in the coastal towns. Above all, experience in the fitting out of fishing boats in this primitive region had shown that men who had acquired welding and mechanical skills in automotive repair could be more effectively employed for this work than the local builders of traditional sailing craft. And so the concept grew of a superstructure frame which would fulfill the following requirements:

a) One integral, steel welded structure: predrilled for bolt holes, shackles and all anticipated fishing gear and wheelhouse attachments. It would be sand-blasted and coated before installation. If need be it could be fabricated in any repair garage possessing welding and oxy-acetylene equipment in advance of the hull. Later it would be transported to the beach-head or creek where the hull was being built.

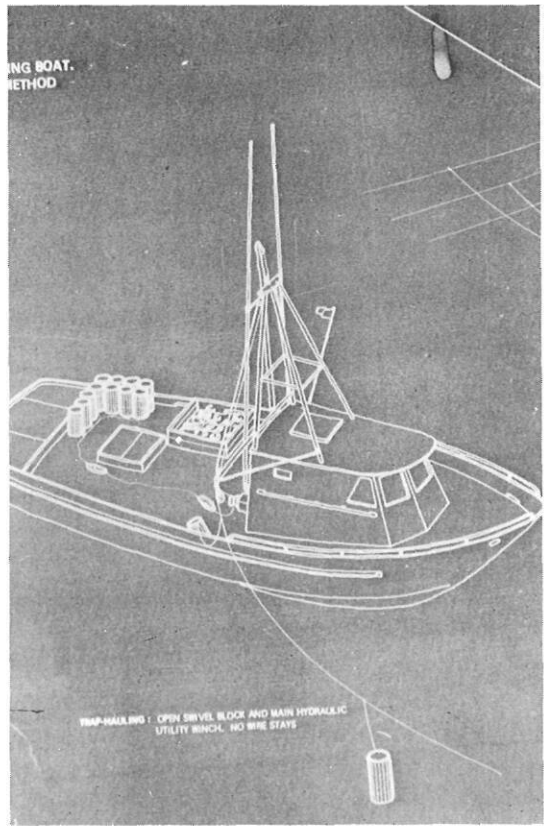
b) The double A-frame mast structure itself would support a number of types of fishing gear and largely eliminate the need for wire rope stays which tend to interfere with some types of fishing operations.

c) The wheelhouse could be sheathed with whatever material was found convenient according to the locality. The fitting-out of the wheelhouse could be varied according to the requirements of the owners.

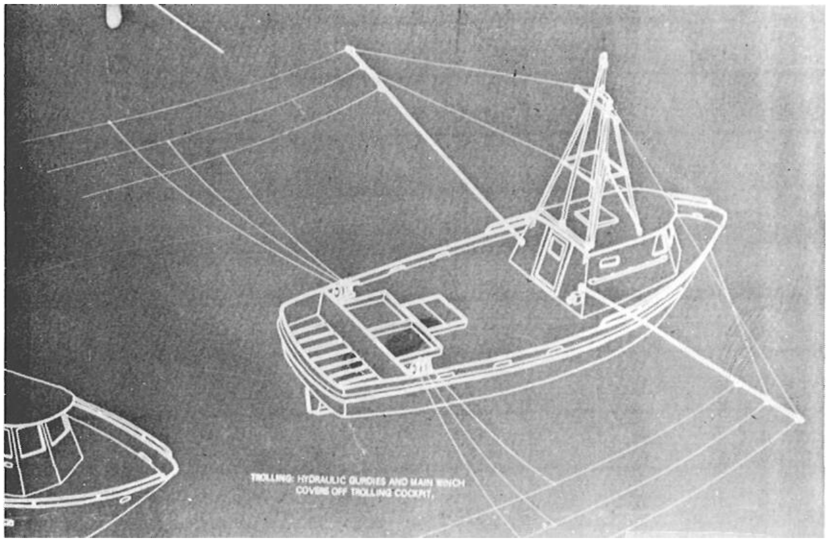
d) Engine removal for overhaul would be greatly facilitated in remote regions by suspending a chain hoist from the mast framework through the cabin roof hatch and unbolting removable hatches in the cabin floor, also a removable plate on the aft side of the wheelhouse. The unbolted engine could then be hoisted by the crew and skidded out on the deck in a matter of minutes.

The original plan was to weld the superstructure legs to a steel coaming which had already been welded to the reinforcing in the ferro-cement deck. The wheelhouse would then be sheathed and fitted-out. But, in the Bahamas, the call was for ten fishing boats in a hurry, not for just one boat on a beach. To meet this call the superstructure was completely prefabricated and fitted-out as one unit, down to cabin furnishings, engine and steering controls, plumbing and electrical wiring. It was then seen that the original concept of an integral steep superstructure framework, taken to this stage of completion, lends itself admirably to the requirements of series ferro-cement boat production.

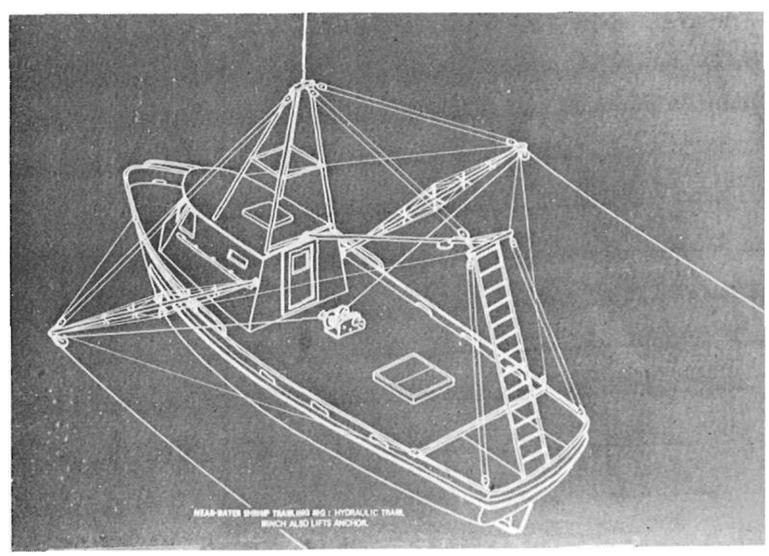
Illustrated here are a number of fishing gear rigs which can be applied to the basic mast structure and operated by hydraulic power taken off the main engine.



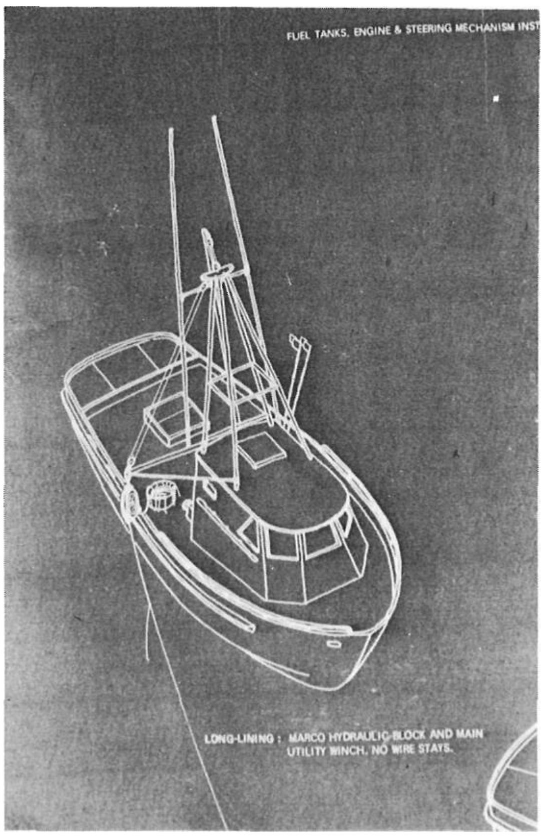
This installation shows a main hydraulic utility winch with a capstan head hauling lobster traps. The traps' mail line runs through an open swivel block swung down on a retractable boom. An anchor winch is not shown because it is possible to haul the anchor line on the main winch through snatch blocks shackled inside the starboard rail. Note that trolling poles are retracted upwards. The hydraulic gurdies for the trolling lines are not visible.



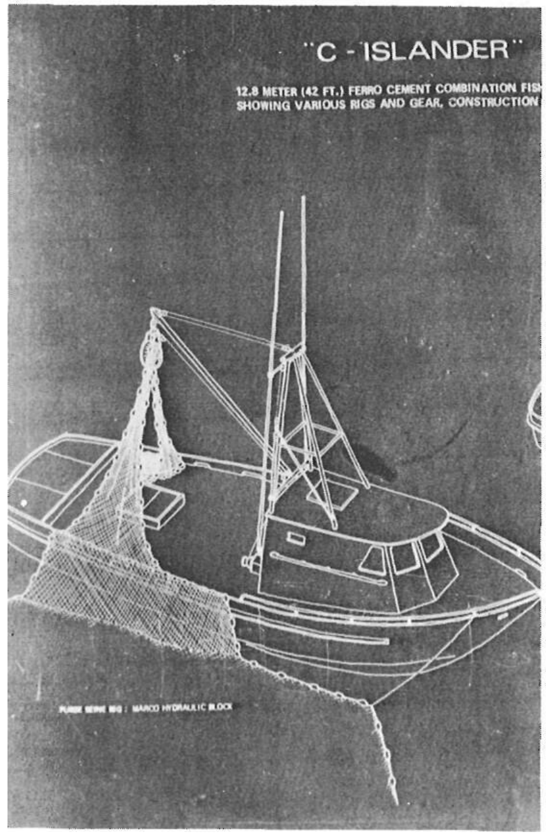
Trolling poles are out in this sketch, the covers are off the trolling cockpit, the gurdies are visible and the trap-hauling boom has been retracted into the mast structure. This combination of rigs is suitable for many warm latitudes where the fishing grounds for lobster and king mackerel, for instance, are not so far apart.



A possible, double-trawl, shrimp rig is shown here. The hydraulic crawl winch could also lift the anchor line by means of snatch blocks.

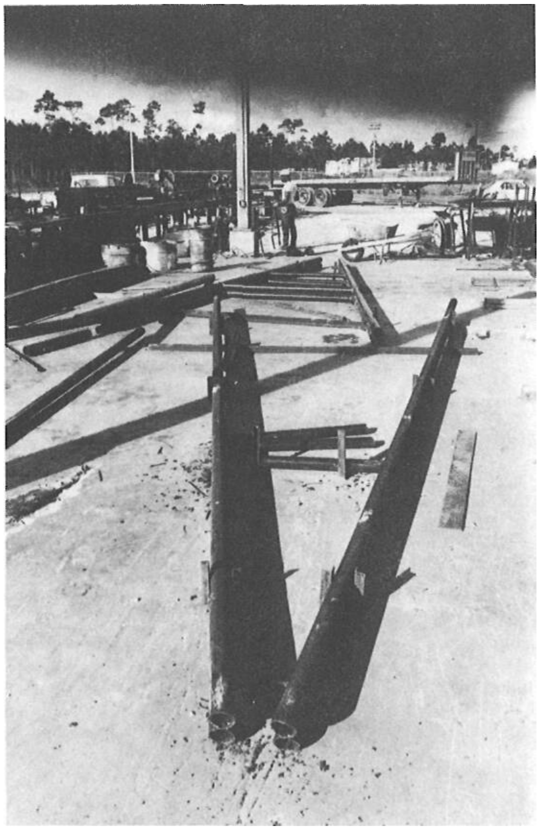


*The trap-hauling boom could also support a Marco **hydraulic** block for long-lining. This rig shows **trolling** poles retracted; the hydraulic trolling **gurdies** are not shown.*



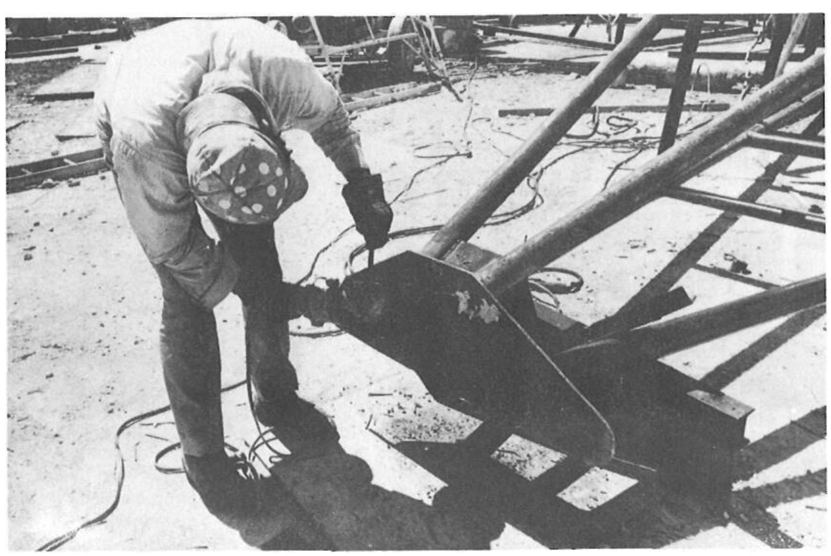
*A small, purse-seine could be operated by means of a Marco **hydraulic** purse-seine block and winch. The boom would require more halyard support than the artist has shown here.*

*The forward command, solid mast structure, and the spacious work deck aft make other permutations of fishing rigs possible. A gill-net reel could be easily **installed,** also a small stern-trawler rig, in combination with one or other of the rigs which have already been mentioned.*



A-frame mast structure laid out in jigs.

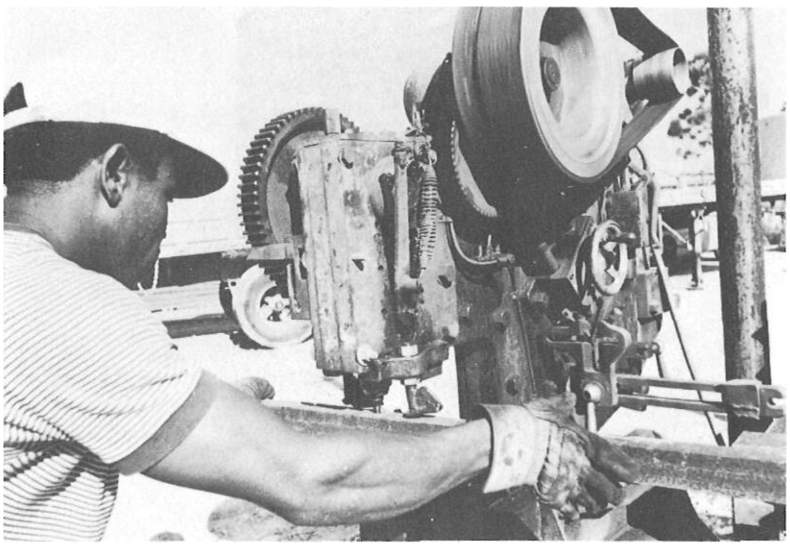
Bracing and assembling the two A-frames.



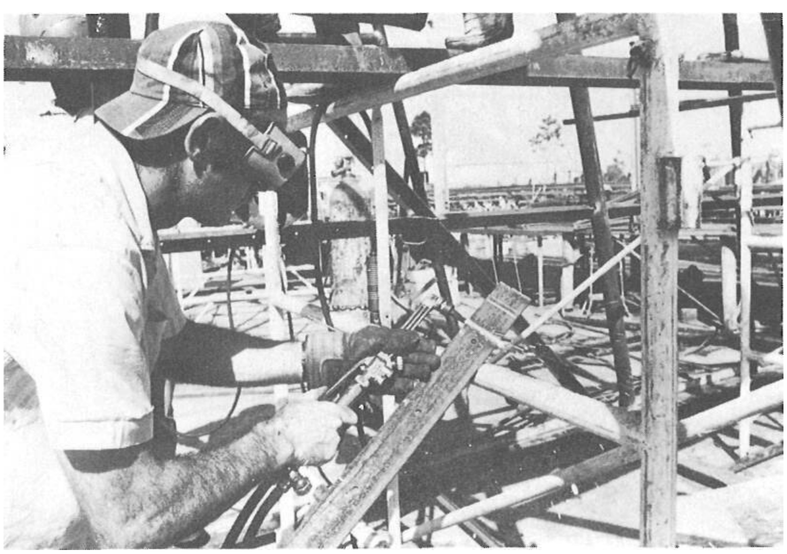
The mast-head plate.

Marking angle iron for bolt holes.

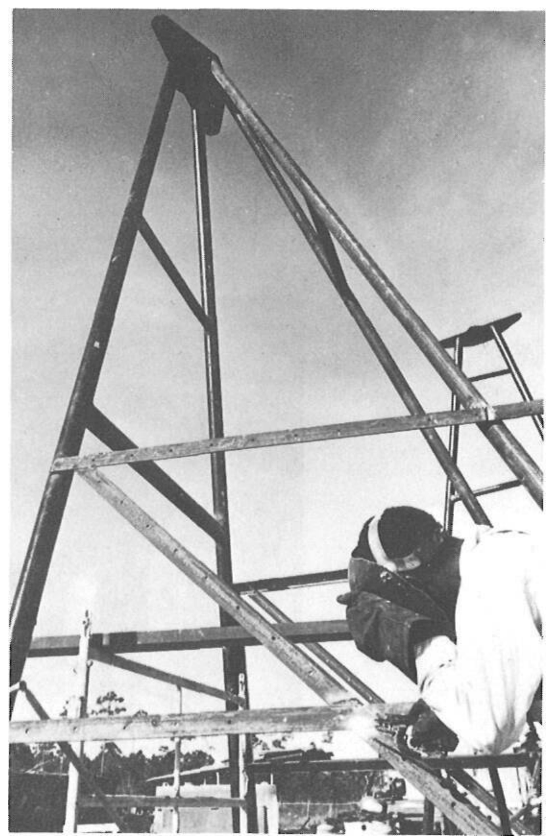
The wheelhouse frame takes shape.



Punching bolt holes.



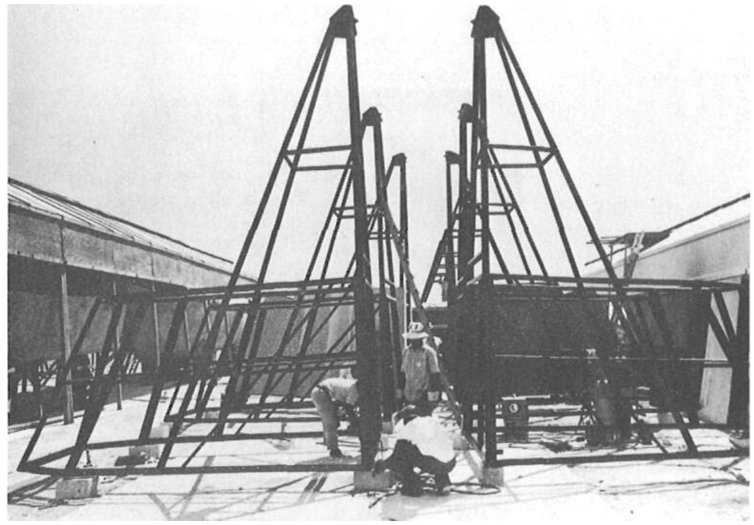
Cutting angle iron pieces.



Welding braces; note bolt holes.

JOB 3 - SHEATHING THE WHEELHOUSE

The wheel house sides were sheathed with 3/4-inch (19 mm) thick, good one side, exterior grade fir plywood. The roofs were made of two layers of 3/8-inch (9.5 mm) thick exterior grade fir plywood glued together and canvassed over. The sides received several coats of oil-based paint. All plywood joints were backed with butt blocks of the same plywood on the insides. Outside joints were covered with two-inch strips of 18 gauge copper set in bedding compound. Hatches and window apertures were cut out after sheathing.



Superstructure framework sand-blasted and painted.

TASK 1 — Leveling the Superstructure Framework

The superstructure framework was first blocked up on the concrete pad at the same angle it would eventually possess on board the hull when afloat. It was checked for plumb. Leveling the superstructure framework in this way very much eased the work of the carpenters who could thereafter use their spirit levels in the course of the fitting-out work.

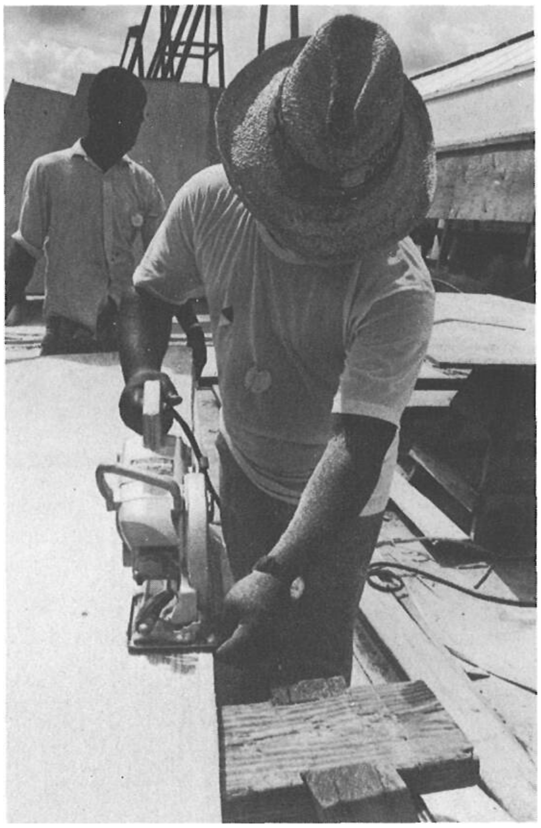
TASK 2 - Checking Welds and Bolt-Holes

Any welding jobs on the steel structure that were not up to par were strengthened. Any bolt-holes which had been overlooked in fabrication were drilled.

TASK 3 — Coating Superstructure Framework

The entire wheelhouse structure was given a second coat of black epoxy tar. Special care was taken to ensure that the steel was well protected where plywood would be bolted to it to ensure that no rusting would occur behind the plywood.

Touching up scratches with coal-tar epoxy.



Cutting wheelhouse sheathing.

TASK 4 - Sheathing Wheelhouse Sides

The sides were sheathed with sheets of 3/4-inch (19 mm) thick exterior grade plywood bolted to the steel framework. Working procedure was as follows:

1. One man was stationed at a bench cutting plywood sheets for the two carpenters who applied the sheathing.

2. The two carpenters would fit a panel on one side of the wheelhouse, then hand over the final fitting to the two laborers.

3. The two laborers removed the four bolts temporarily holding the panel in place.

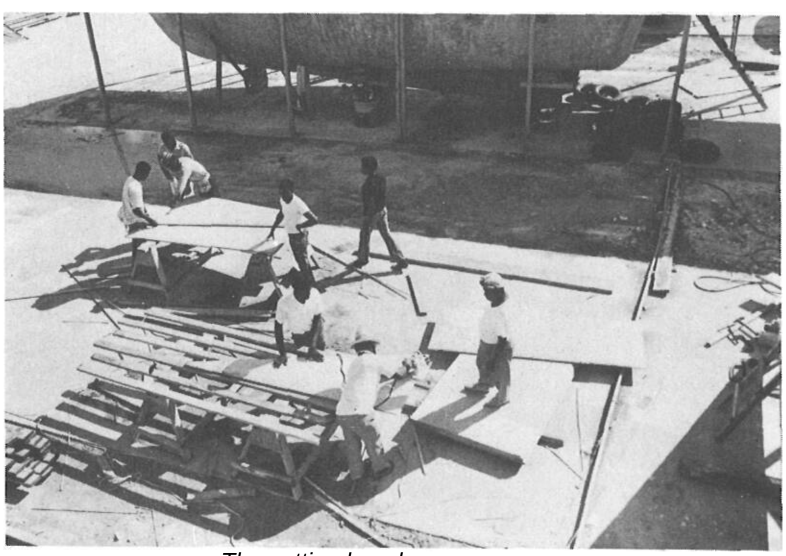
4. Bedding compound was applied liberally to the steel surfaces of the framework against which the panel was to be placed.

5. The panel was replaced. Remaining bolt holes were drilled through the plywood through the existing boltholes in the framework.

6. The panel was bolted down with 5/16" x1" (7.9 mm x 38 mm) galvanized bolts, the bolts and washers being smeared with bedding compound. An air-driven impact wrench was used to speed the bolting work.

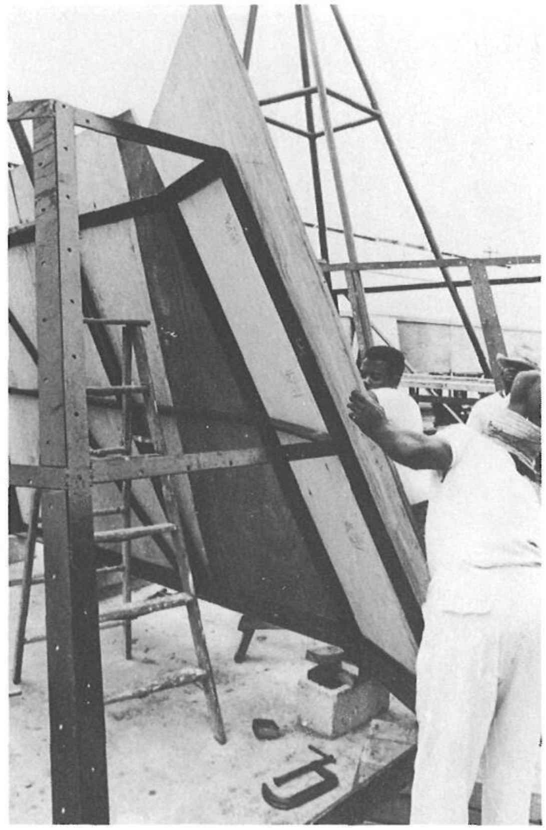
7. The laborers proceeded to the next panel, this time on the other side of the wheelhouse, which the carpenters had temporarily fitted into place.

The plywood was fitted to the steel deck plate so the plywood edge stopped 1/2" above the deck. In this way, the panels would avoid contact with water collected on deck and thus reduce the chances of rot spreading upwards. Two undercoats of red lead paint were given to all edges and surfaces of the plywood panels.

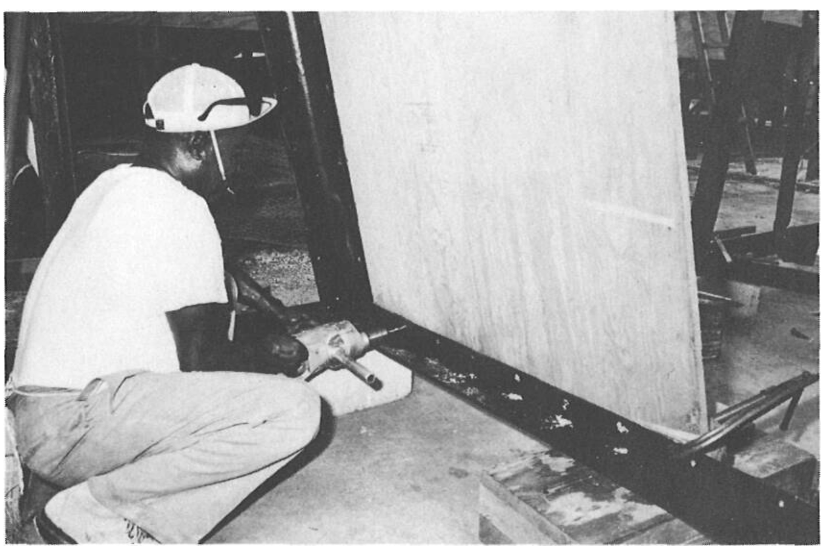


The cutting bench.

Drilling holes to secure the plywood for marking.



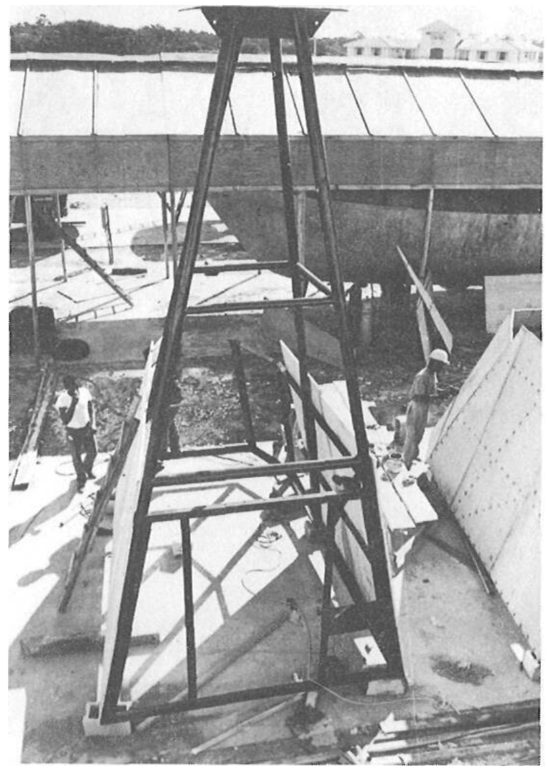
Marked and cut, the sheathing goes on.



Drilling the plywood through predrilled bolt holes in the frame.

Drilled from the inside, bolts knocked through from the outside.

Bottom round edge of plywood is raised above deck level.

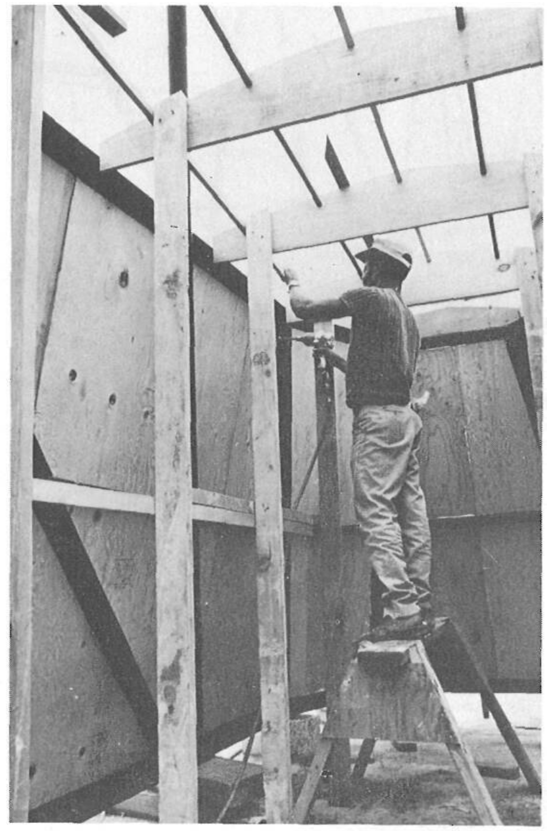


Plywood sheathing is left untrimmed at the top.

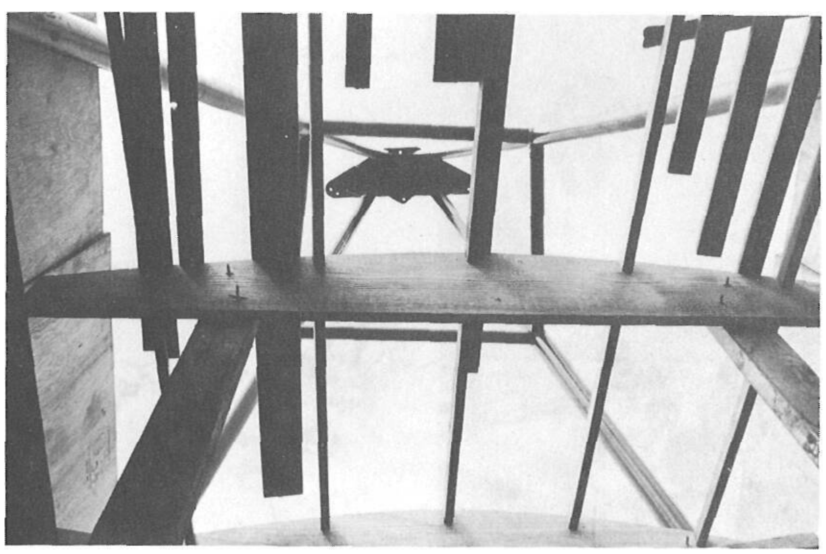
TASK 5 - Wheelhouse Roof Jig

One carpenter made up three laminating jigs for the wheelhouse roofs. These were made up so that they would fit loosely inside the wheelhouse roof, as per illustration. They were positioned and braced firmly. Packing strips for the top edge of the wheelhouse were made up from shaped 2" x 4"s (51 mm x 102 mm). They were well bolted to the angle-iron framework at the top. The outside plywood sheathing was well screwed to these packing strips. Then the plywood sheathing was trimmed and faired into the wheelhouse roof jig.

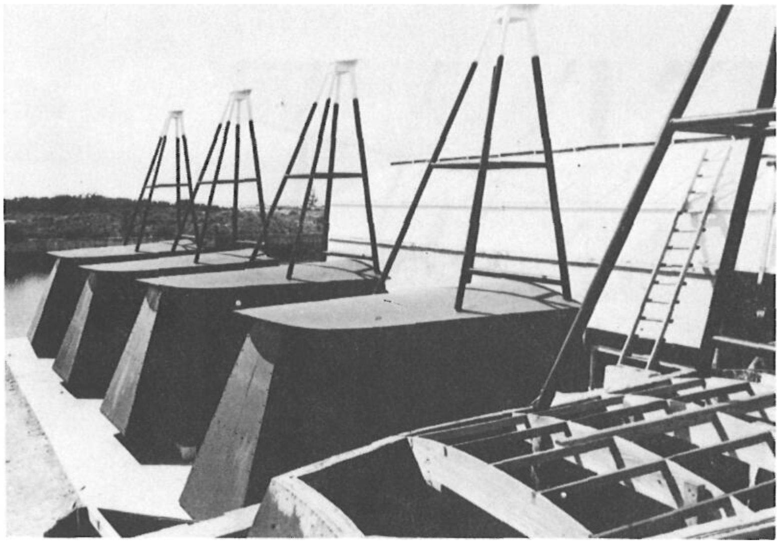
A jig is necessary to do this job for the men are working with both angles (wheelhouse sides slope) and curves (crown in the top of the wheelhouse roof). Without a jig it would be almost impossible to keep the crown in the wheelhouse top fair, and also to fit all the framing pieces accurately. Unless this joint fits well it has little strength and there would be a greater danger of the roof being washed off if the top of a wave broke over the side of the boat and washed up the cabin side.



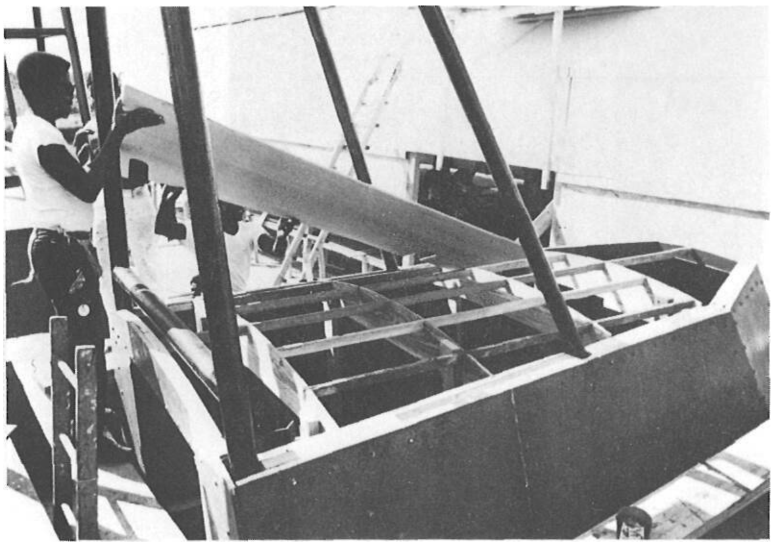
Jigs for laminating plywood roofs.



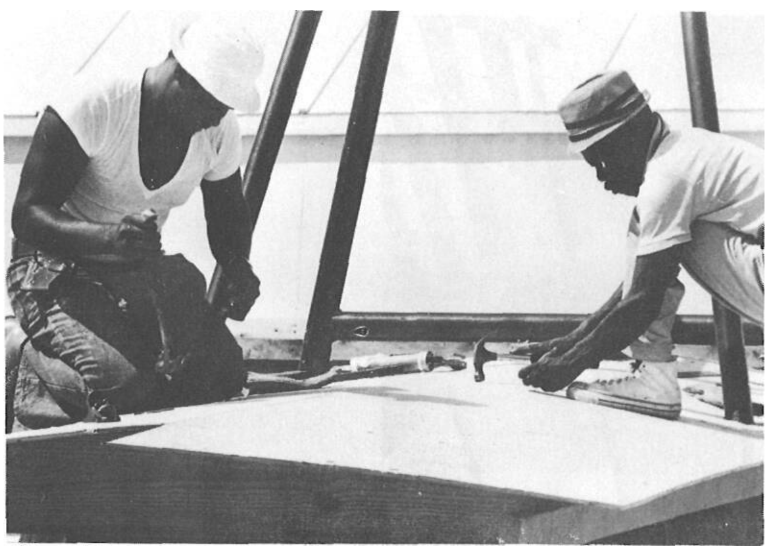
Roof jig viewed from below.



Four roofs complete.



The roof jig in place; the topside packing faired to receive plywood covering.

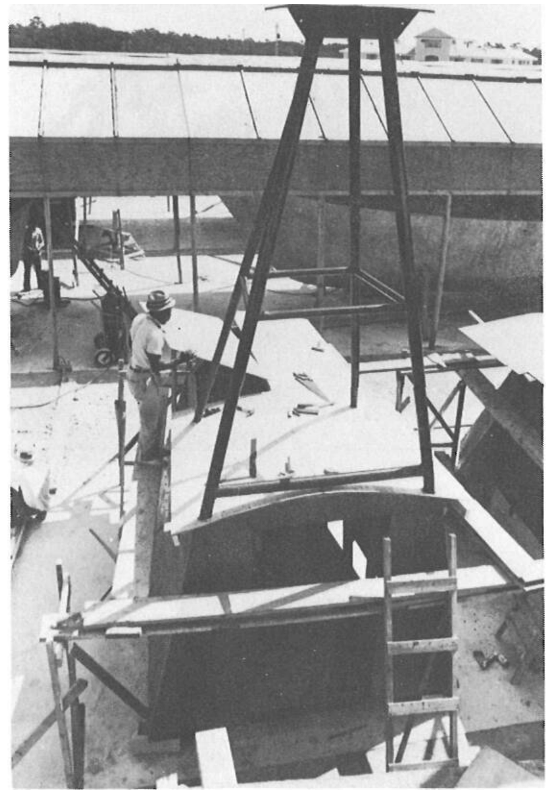


First layer of 3/8-inch (9.5 mm) plywood nailed to jig.

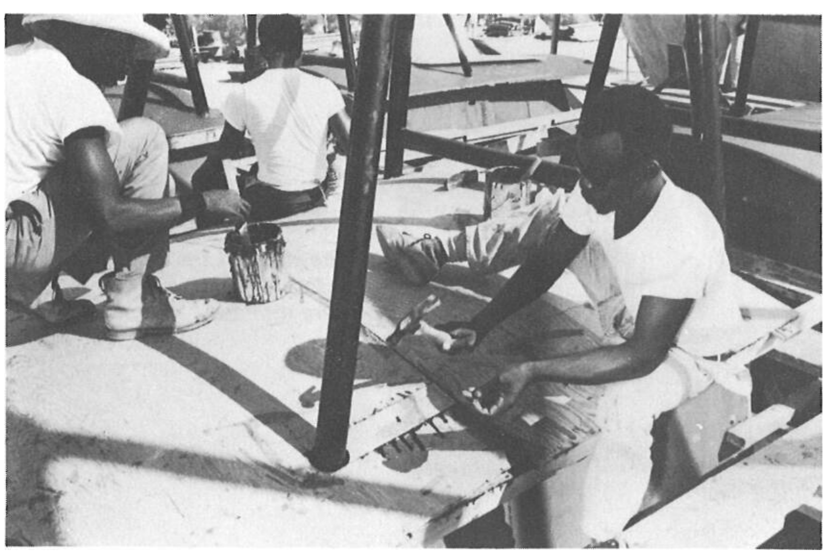
TASK 6 - Fitting Wheelhouse Roof

The wheelhouse top was laminated up over the jig. 3/8-inch (9.5 mm) good one side plywood was used for both layers of the wheelhouse roof. The good face was left showing on both sheets. The first layer was fitted and nailed lightly in place to the jig using finishing nails which could later be drawn right through the plywood when the jig was removed. Where the bottom layer met the packing strips at the side it was glued and screwed in place. After the first layer was fastened the second layer was fitted. The sheets of the second layer ran in opposite directions to the bottom layer so that all joints were staggered. After the top layer had been fitted, large amounts of glue were mixed. The top layer was then removed. Glue was spread liberally over the top of the bottom layer. The top layer was then replaced and clenched nailed on six-inch centers to the bottom. One man inside bent over the nails to clench them. He then held a sledge hammer face to the clenched nails while a man on top of the roof set them.

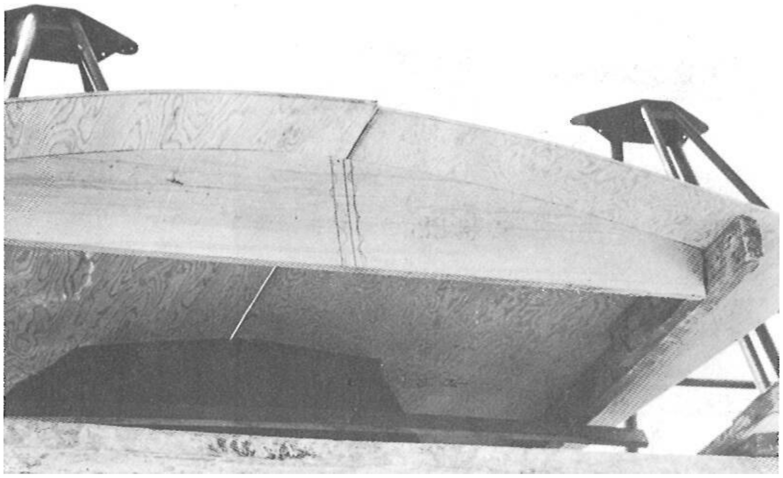
Bedding compound spread over topside packing.



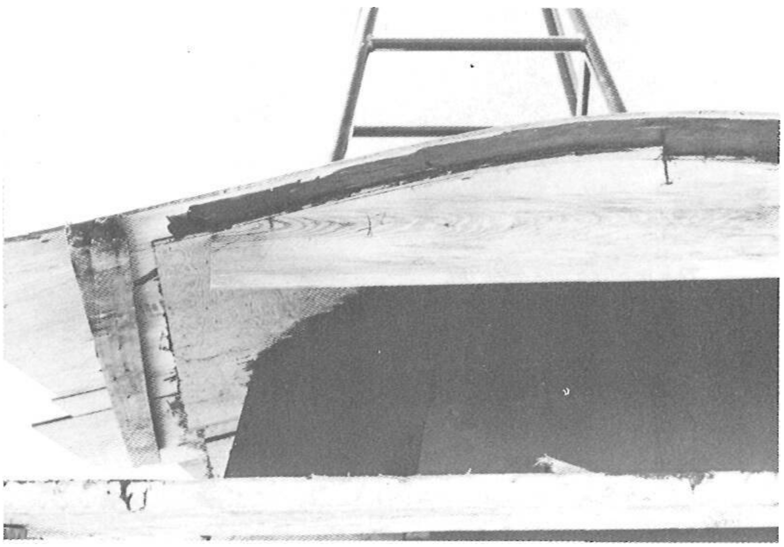
The roofing ply goes on.



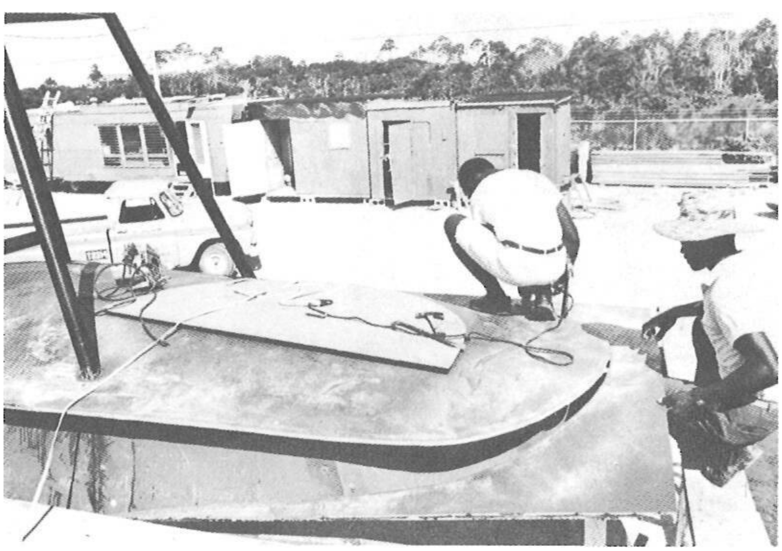
Fitting around the mast legs.



A separate curved jig was used on the forward overhang of the wheelhouse top to stop this portion of the roof from drooping. This was made from a piece of 1" x 12" (2.5 mm x 305 mm) dimensional lumber cut to the same shape as the inside jig.



The glue was left to set for two days. Then the jig was removed.

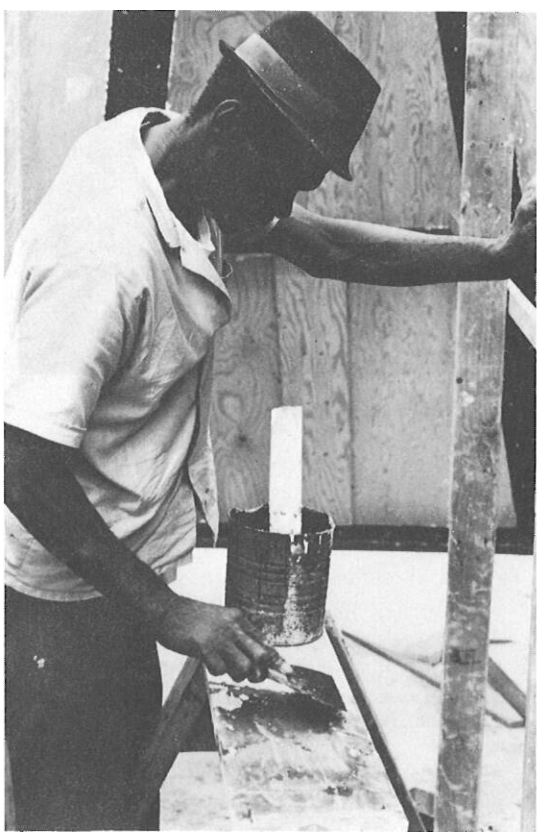


The edges of the wheelhouse roof were trimmed with a hand power saw. The trimmed edges were rounded.

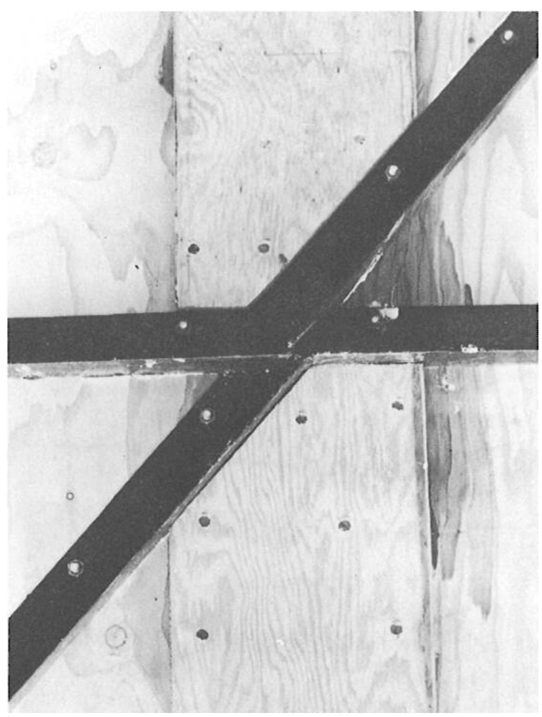
TASK 7 - Fitting Butt Blocks

Plywood butt blocks, 3/4" x 8" (19 mm x 203 mm) wide, were screwed and glued on the inside wherever plywood sheets joined. The plywood joints were made clear of the steel framing for ease of construction. 3/8" x 8" (9.5 mm x 203 mm) butt blocks were used on the deckhead joints.

Preparing plywood butt blocks.



Applying marine glue to the butt blocks.

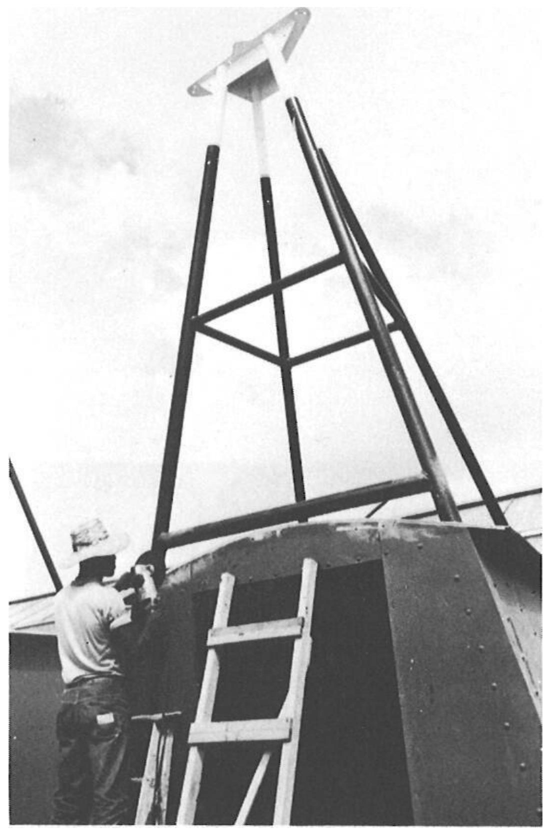


The butt blocks screwed into place inside the framework.

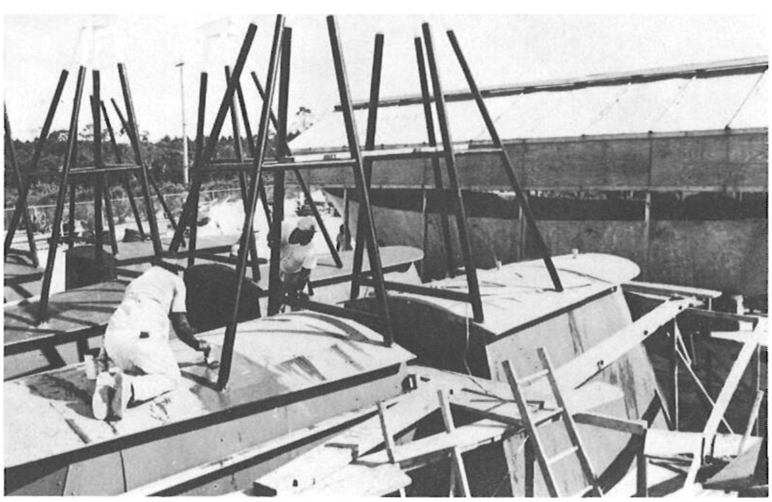
TASK 8 - Priming Plywood Sheathing

All plywood sheathing was primed and sealed inside and out with red lead paint. This job was done as soon as possible as the wheel-houses were sheathed in the open. The sun and rain quickly warped unpainted wood.

Butt blocks glued and screwed to the roof interior.



Sanding roof edge flush.



Priming roofs with red lead paint.

JOB 4 - FITTING OUT THE WHEELHOUSE: JOINERY

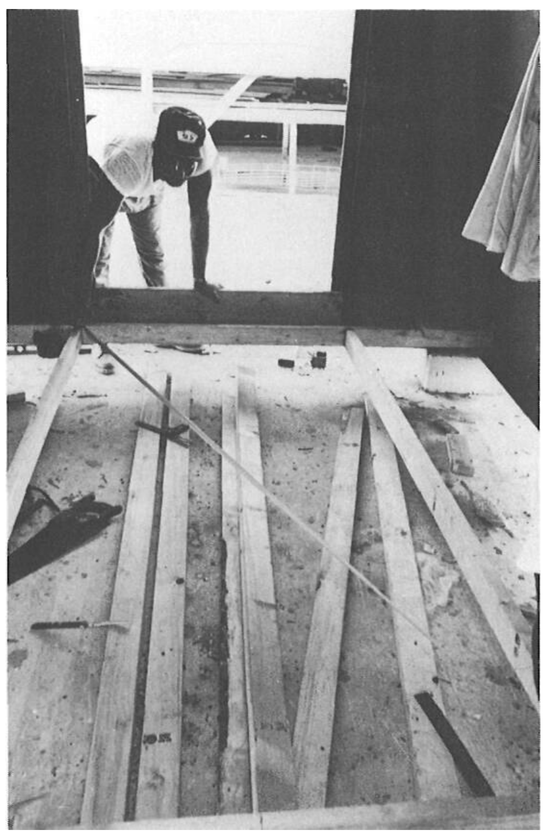
Fitting out the wheelhouse was a project in itself. There were many construction details to be attended to in a proper sequence. First, the wheelhouse floor was framed out and covered. Bunks, bulkheads and cupboards were built in. Finally, the wheelhouse roof was canvassed, hatches and windows fitted and the aft cabin door installed.

The temporary boatyard established at Freeport was not equipped with a good joinery shop. This would have proved an enormous asset in fitting out the wheelhouse but, as the yard was not permanent, the investment in proper joinery shop equipment could not be justified.

When fishermen at sea are not actually working the wheelhouse is where they spend most of their time. For the reason the wheelhouse interior should possess some measure of comfort. The design and finish should be aesthetically pleasing for this is the fisherman's home on the high seas.

An alternative method of wheelhouse construction is suggested here. The mast pipe structure could be made independent of a wholly wooden wheelhouse and bolted down outside it to the deck and interior bulkheads. The wheelhouse would then be framed in wood and sheathed in plywood in a professional joinery shop. With no integral high mast structure to pass through doorways, the wheelhouse could be completely fitted out under cover. Fitting out in a shop usually results in less wastage of material than in the open.

In this alternative method of wheelhouse construction a jig would be set up to establish the shape of the wheelhouse. All interior bulkheads and cross members would be set up in the jig. Work on the wheelhouse would then proceed outwards starting with the interior lining. Insulation material would be applied between the frames and the exterior plywood sheathing, glued and screwed into place. The interior fittings to the wheelhouse would be carried out in much the same way as with the steel framework construction. The result would be a lighter, more economical and more smoothly finished wheelhouse. It would be insulated against tropical weather and less prone to leakage over the years. Packing out the steel framework wheelhouse for insulation and interior lining would prove difficult if a neat, high quality finish were sought.



Floor framing.

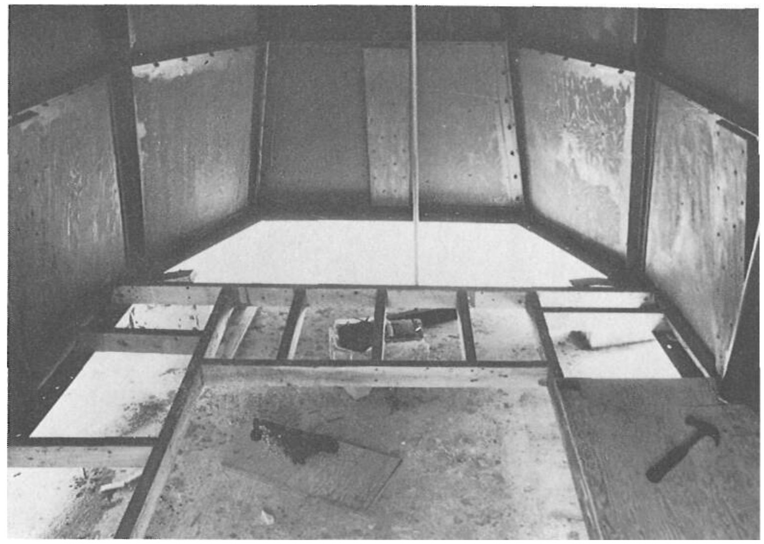
Engine room hatchway is framed first.

3/4-inch (19 mm) plywood flooring.

Sawing packing for outside edges of floor.

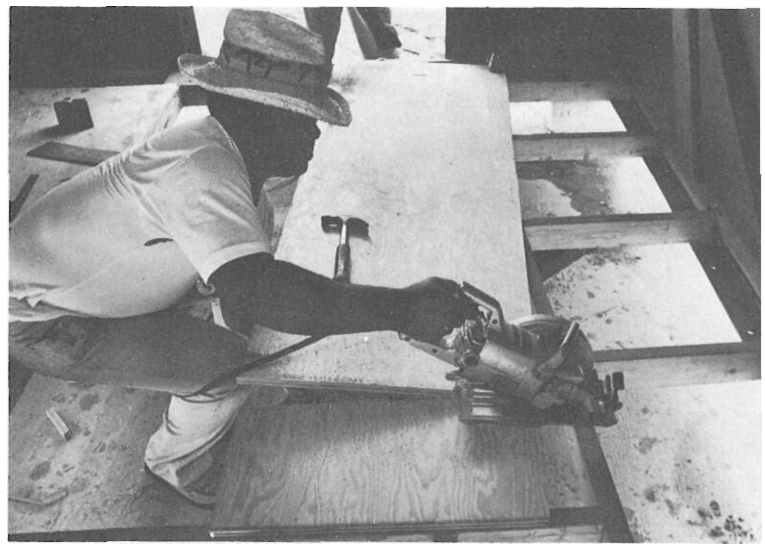
TASK 1 — Framing and Covering the Wheelhouse Floor

Floor framework was made from dressed 2" x 4" (51 mm x 102 mm) fir. The ends of the floor joists rested on the base flange of the steel framework. This base flange contained the pre-drilled bolt-holes for the bolts which would later be used for fastening the superstructure down through the concrete deck. Consequently, these bolt-holes had to remain free for access. Packing was screwed to the wheelhouse interior sides above the base flange to give additional support to the edges of the floor covering. The floor was covered with 3/4-inch (19 mm) thick plywood, glued and screwed into place. Once the floor was down the bulkheads were fitted. These were made of 3/4-inch (19 mm) plywood with framing of 1" x 2" (25 mm x 51 mm) fir glued and screwed to the wheelhouse floor, sides and deckhead.

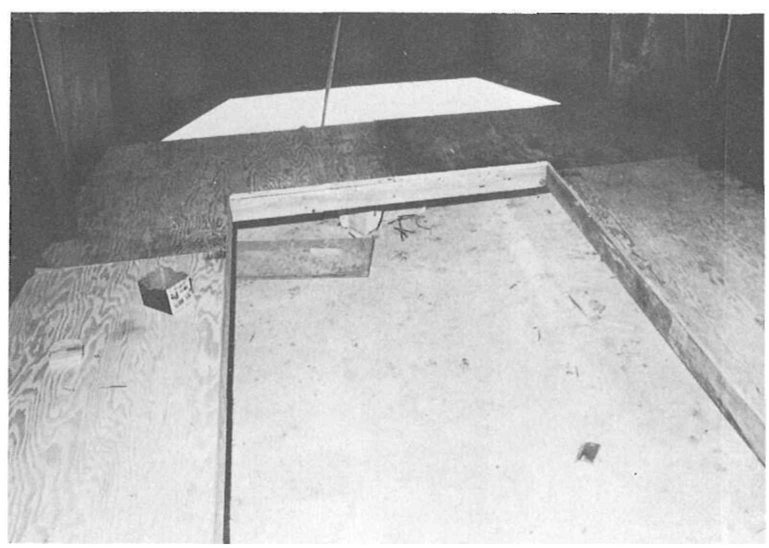


Floor partially covered.

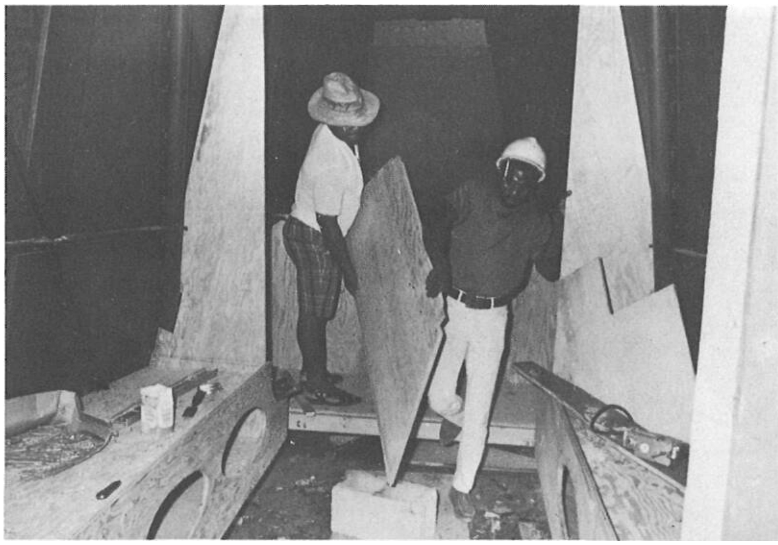
A large part of the wheelhouse floor was left open for access hatches to the engine room. To give the wheelhouse floor additional support in this area, the longitudinal plywood bunk faces were attached to the edge of the hatch aperture. These bunk faces lent the floor adequate support. More 2" x 4"s (51 mm x 102 mm) were glued and bolted onto the hatch sides of the bunk faces to form the framing for securing the engine room hatch hinges.



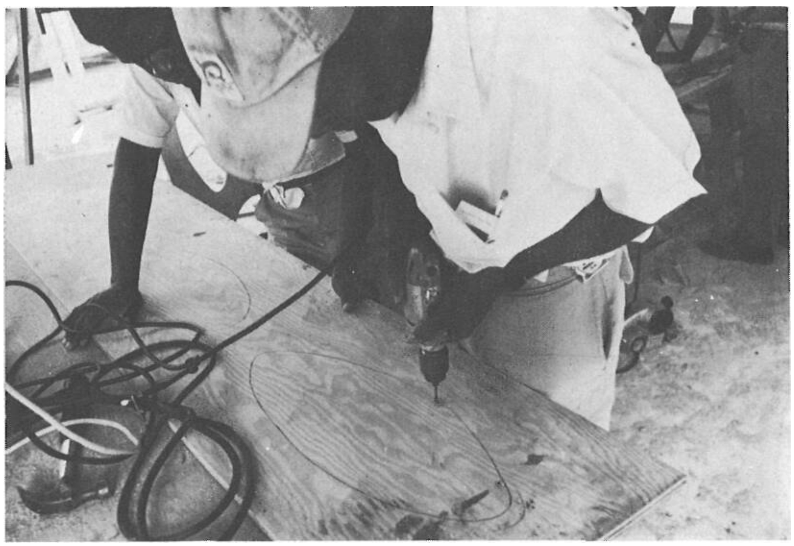
Cutting the flooring.



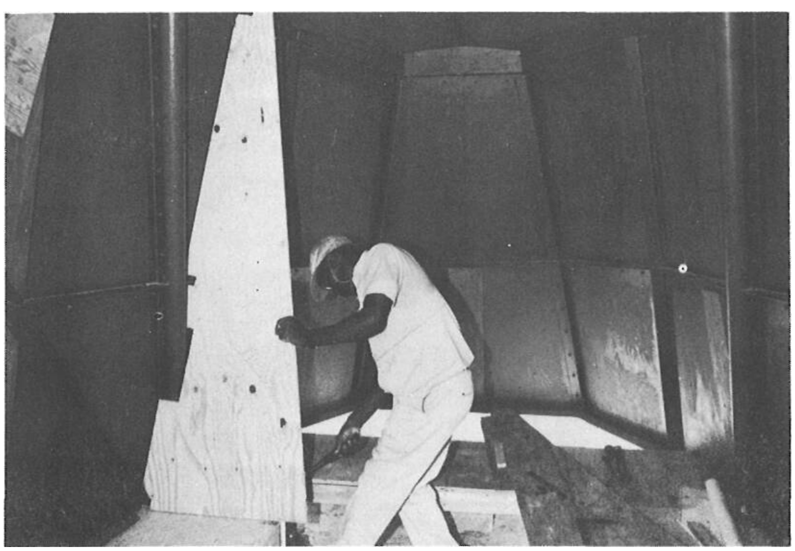
Flooring complete, engine room and foc's'le access open.



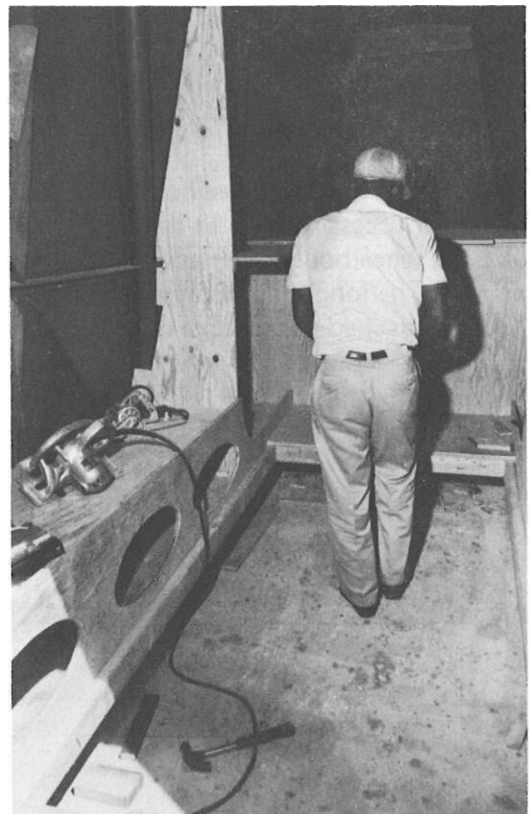
Fitting the helmsman's counter.



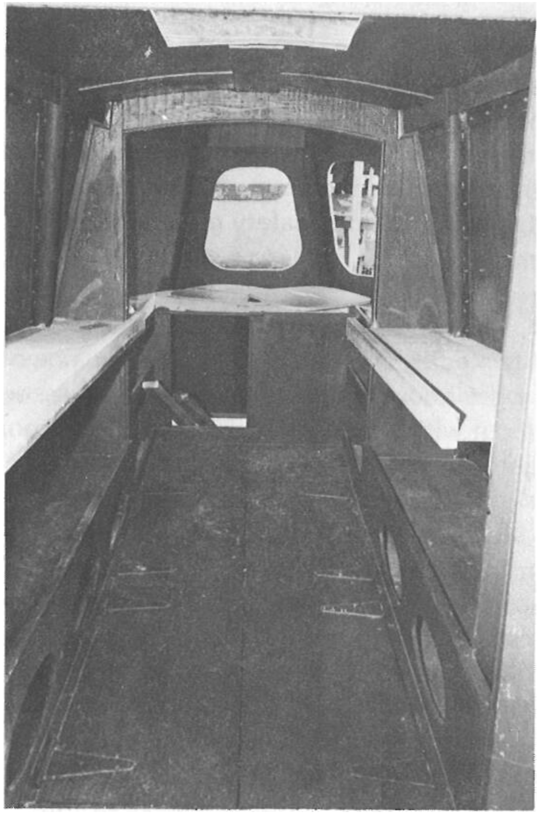
Bunk panels.



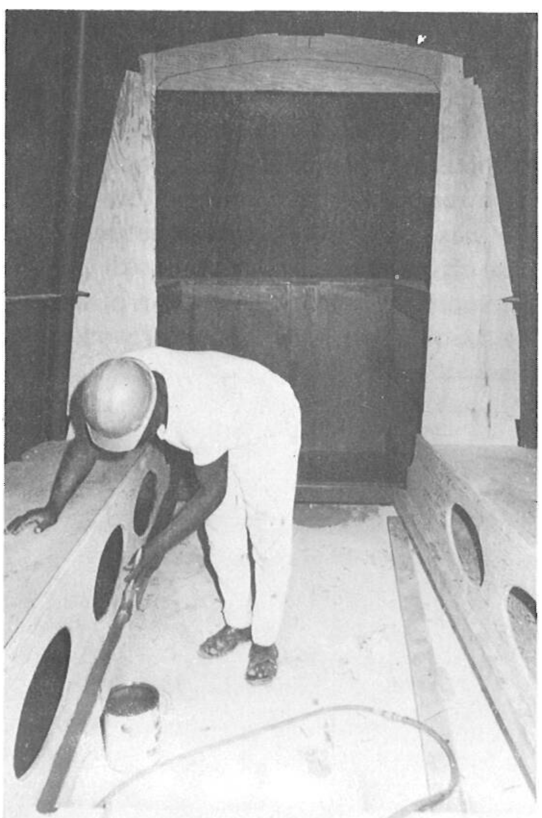
Cabin bulkhead.



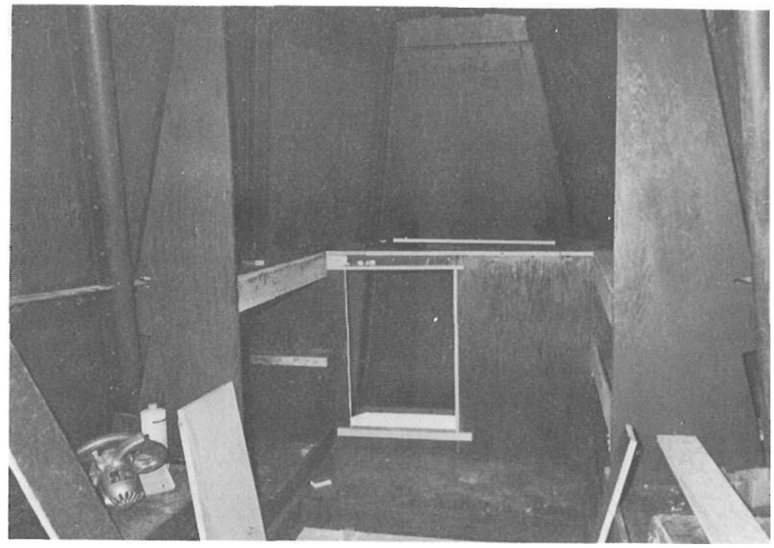
Counter, bulkhead and bunk fitted.



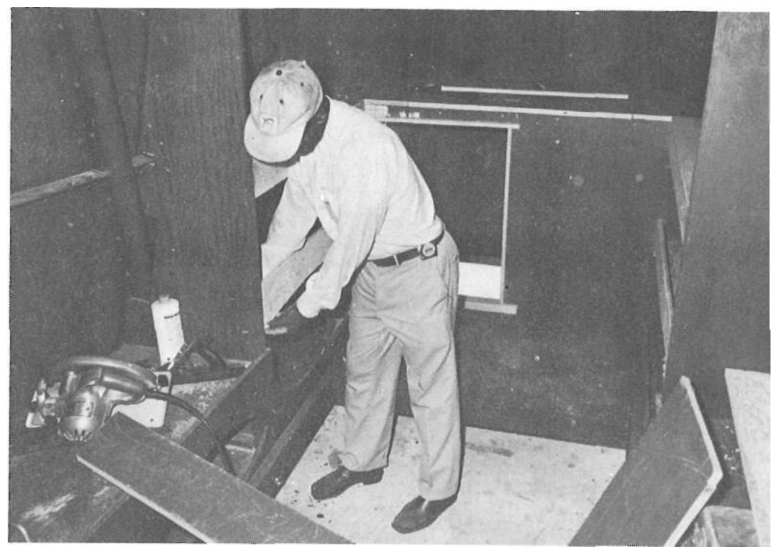
Hinged upper bunks.



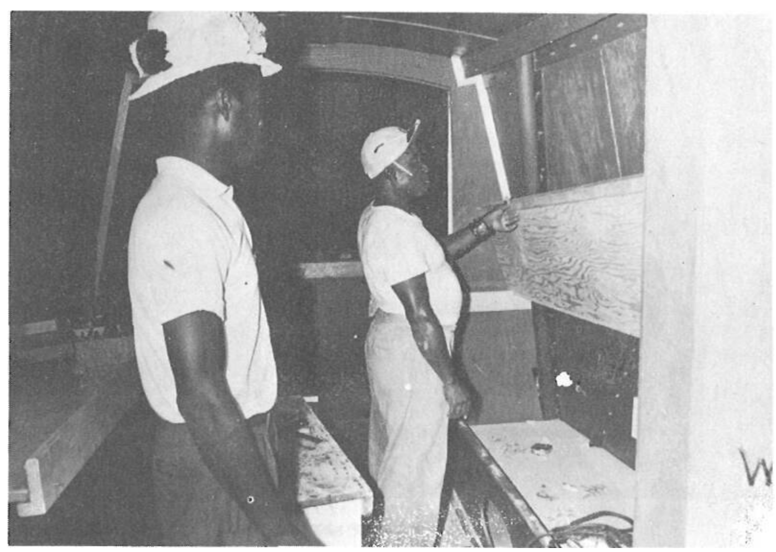
***Priming** engine hatch frame.*



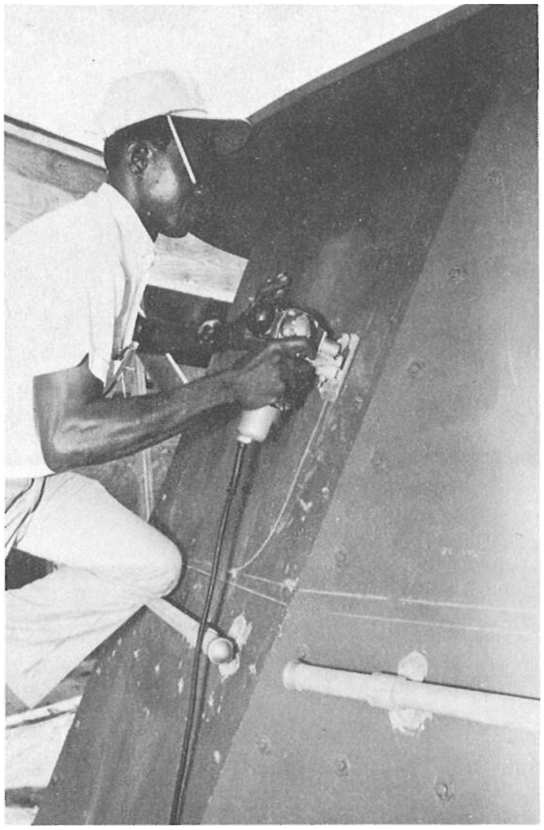
Access to foc's'le.



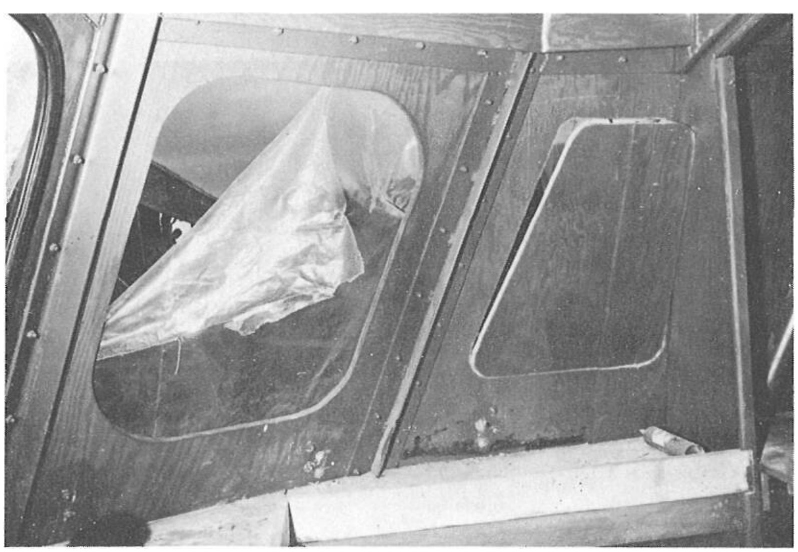
Fitting shelves.



Checking hinges.



Cutting out window apertures.



Window corners are well rounded for the fitting of rubber molding.

TASK 2 - Installing Wheelhouse Windows

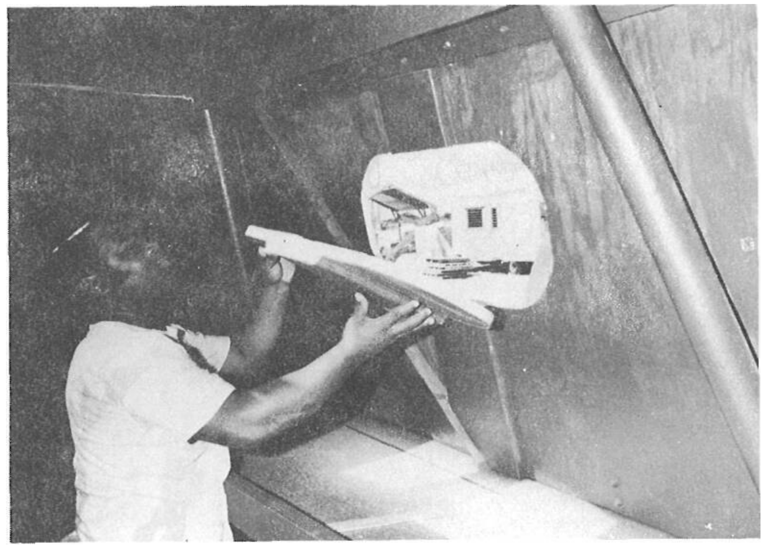
Patterns were made in the shape of the window apertures. Separate patterns were cut in hardboard to the shape of the window glass. The window glass patterns were 1/4-inch (6.4 mm) smaller all around than the aperture patterns. The window glass patterns were sent to the glass manufacturers who cut the ten sets of 1/4-inch (6.4 mm) safety glass windows from them.

The window aperture patterns were aligned and tacked lightly into place on the outside of the wheelhouse for marking. The apertures were then cut with a saber saw, the edges being sanded smooth. If butt blocks intruded upon an area where a window aperture was being cut out, the butt block was trimmed back 3/4-inch (19 mm) so that it would not interfere with the laying of the window rubber molding. The plywood edges of the window apertures were then painted with two coats of red lead paint to prevent rot.

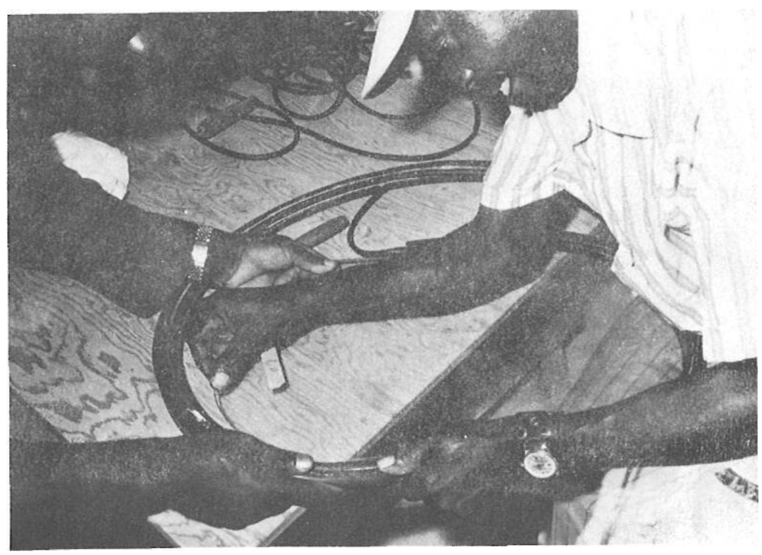
A special black rubber molding was used to install the glass window in the 3/4-inch (19 mm) thick plywood. The molding had three grooves. One groove was 3/4-inch (19 mm) wide and 1/2-inch (13 mm) deep; this fitted over the plywood edge. A second groove was 1/4-inch (6.4 mm) wide and 1/2-inch (13 mm) deep; this held the glass in place. The third groove was a locking groove on the wheelhouse interior side. After installing the window glass and its molding into the aperture, a triangular-sectioned strip of rubber was forced into this third groove. This had the effect of expanding the molding and thus compressing the glass firmly in place against the plywood edge. All windows proved to be watertight.

PROCEDURE:

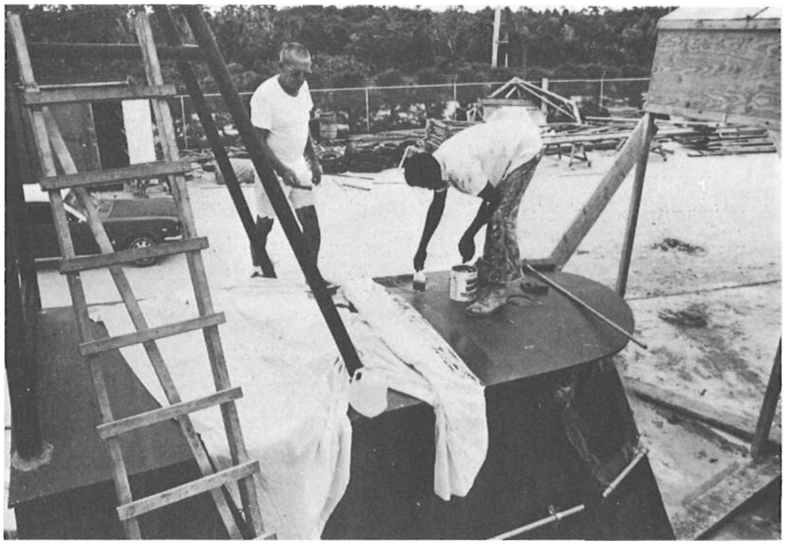
The glass, with molding strip attached, was then inserted into the window aperture from the outside of the wheelhouse. The molding strip was folded back over the plywood and the whole window assembly was eased into place. Two men did this job; one working inside and the other working outside of the wheelhouse. The men were careful not to twist or force the glass which might cause it to break.



Side window cut out

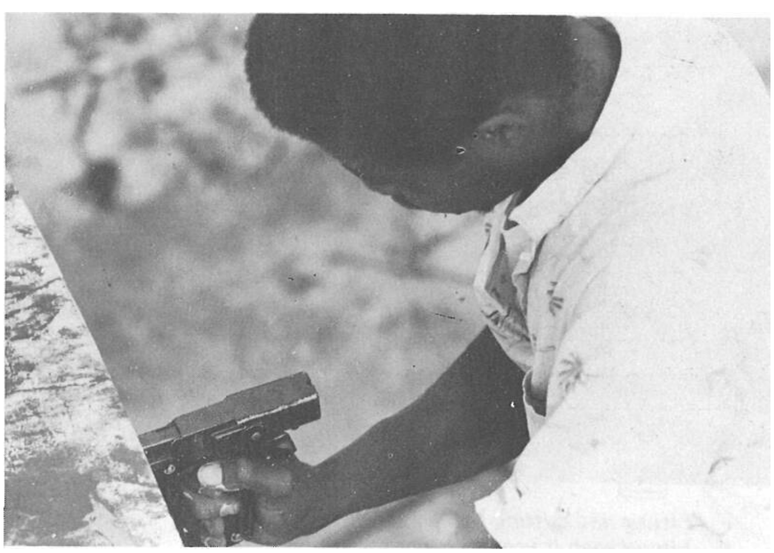


Fitting and cutting the rubber molding. Liquid soap is used to make the rubber pliable.



Sealing the roof with second coat of red lead paint.

Stretching the cloth over fresh paint.

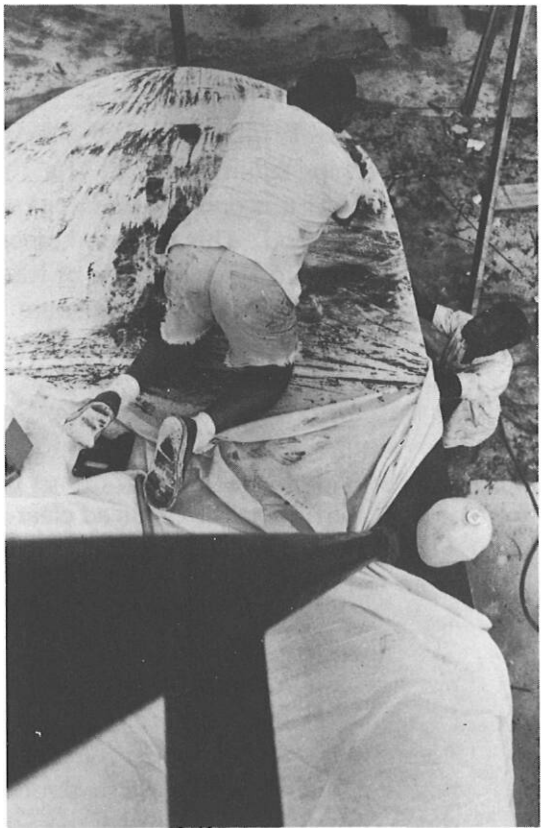


Fastening down with bronze staples.

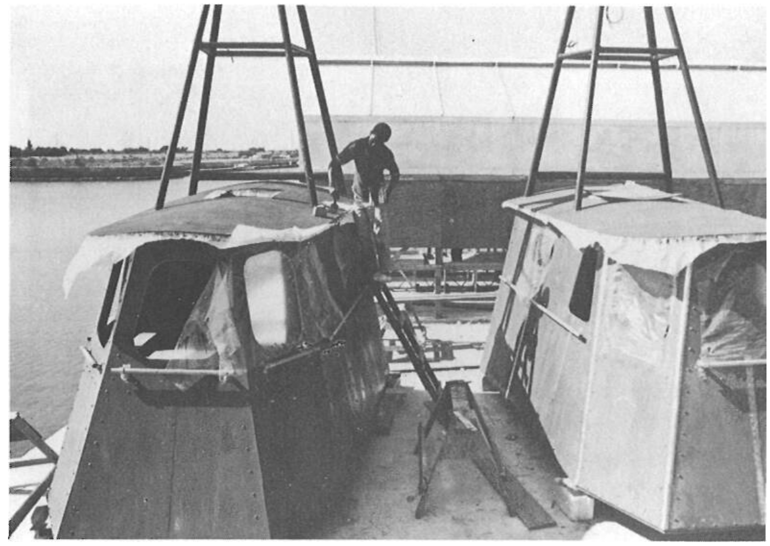
TASK 3 — Canvas Covering for Wheelhouse

The wheelhouse roofs were covered with a very light grade canvas. Even a muslin fabric is adequate for this purpose. Often in boatbuilding a canvas is used for covering cabin roofs which is too heavy for the job and the paint will not penetrate it thoroughly.

First, a liberal coat of red lead primer sealer was painted over the plywood roof. The canvas was stretched tightly over the painted surface. Bronze Bostitch staples were used to hold the canvas in place. Once the canvas had been stapled down it was dampened with a wet sponge. Then it was given a coat of aluminum paint to stop the canvas from rotting. The aluminum paint was applied while the canvas was still wet and taut. The edges of the roof were later trimmed with 3/4-inch (19 mm) half-round wooden molding. Bedding compound was applied around the pipe superstructure where it passed through the wheelhouse roof.



The cloth is stretched taut.

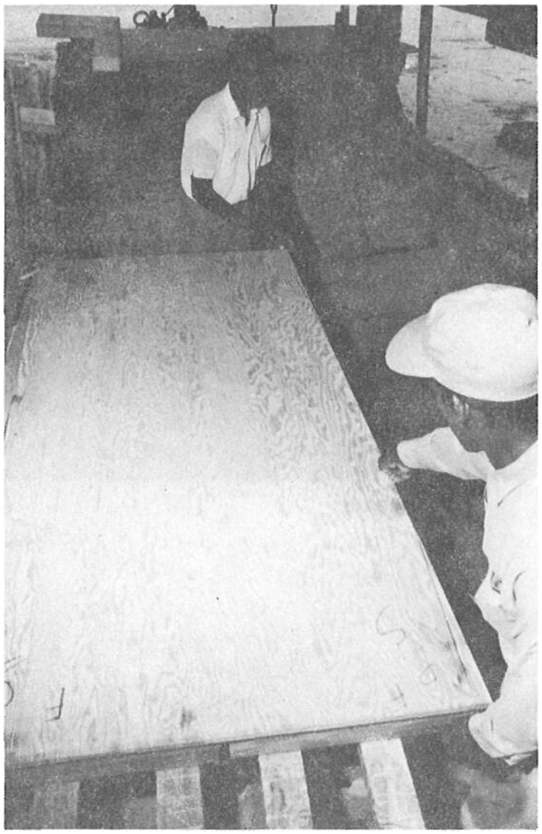


Painting over.

Fastening wooden molding.

Priming the molding.

TASK 4 - Engine Room Hatches



Engine room access hatches measured as one unit.

The engine room hatches were made as follows:

1. A 4′ x 8′ (1.2 m x 2.4 m) sheet of plywood was held up under the framing of the engine room opening. The exact size of this opening was marked on the plywood. This plywood piece was destined to form the tops of four separate hatches. The hatches were not constructed individually as they would then become too difficult to fit into the engine room opening. So they were all made up in one unit, then cut into four pieces. The width of the saw cut furnished the required clearance between the hatches, allowing them to open and close freely.

2. The frames for the four individual hatches were made up separately. They were glued and screwed to the plywood. The frames were made slightly smaller than the hatch they were to support. Again, this was done to allow the hatches to open freely.

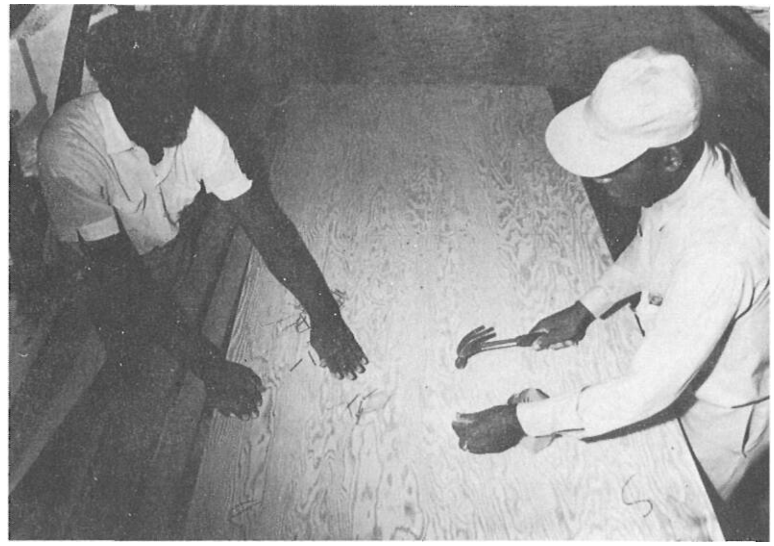
3. Butt blocks were fitted inside each hatch where the hinges were to be fastened. There would be a lot of strain on these hinges, so long screws were required to ensure that the hinges would not pull out from the hatches.

4. Insulation was fitted inside the 2" x 4" (51 mm x 102 mm) hatch frameworks.

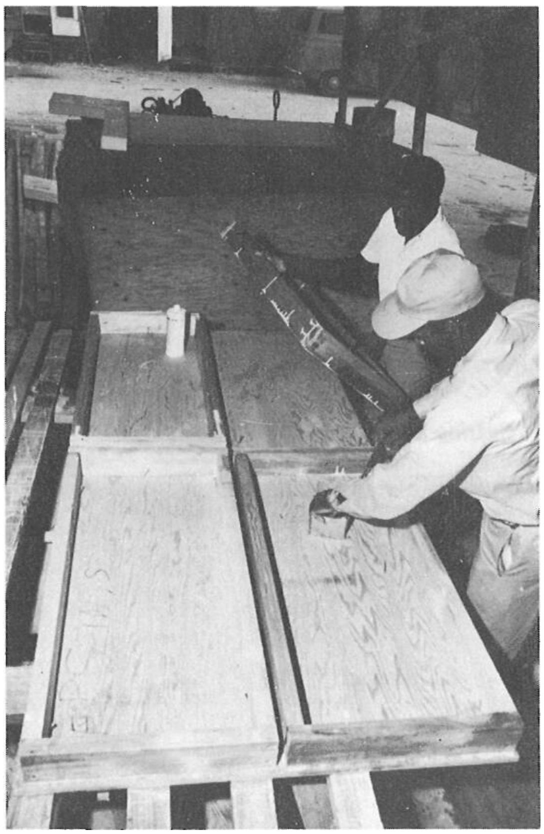
5. Three-eighths-inch (9.5 mm) plywood hatch bottoms were fitted over the 2" x 4" (51 mm x 102 mm) hatch frameworks.

6. The whole hatch unit was moved into the wheelhouse and the hinges were temporarily screwed into place. This was done before cutting out the four individual hatch sections. The screws were then removed. The single top plywood lid was cut into four separate hatches. The hinges were then screwed back in place and the hatches all fitted perfectly.

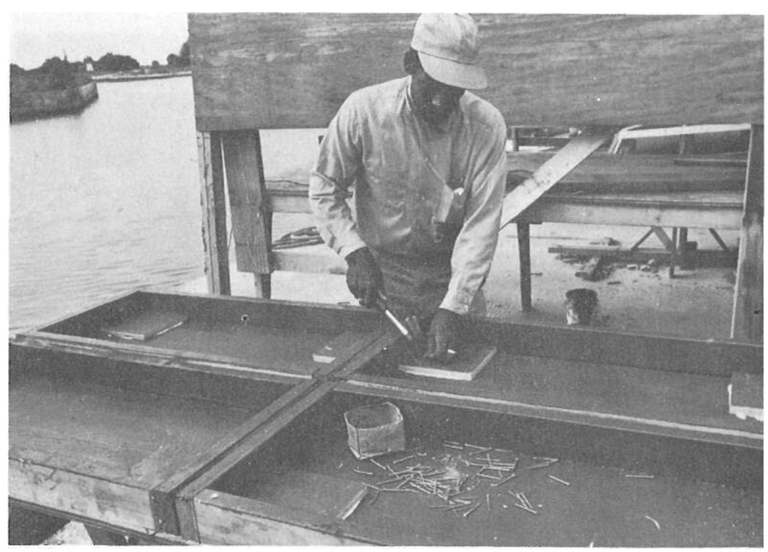
Frames for four separate hatches.



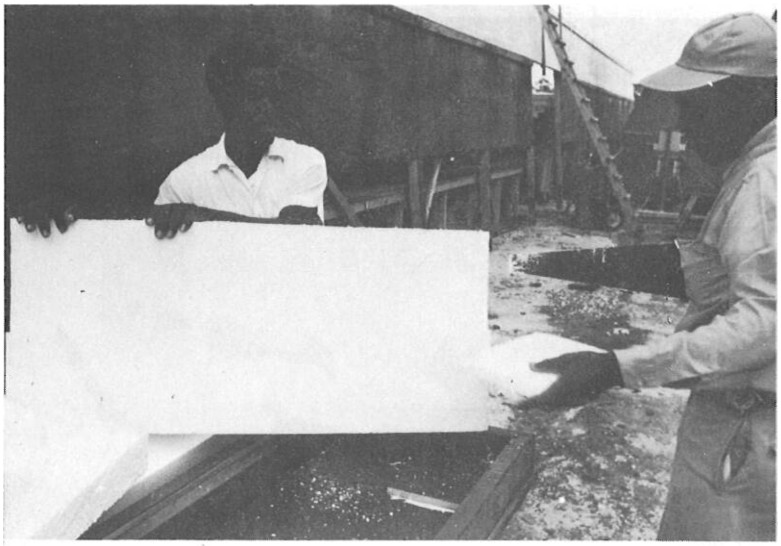
Nailing the frames down.



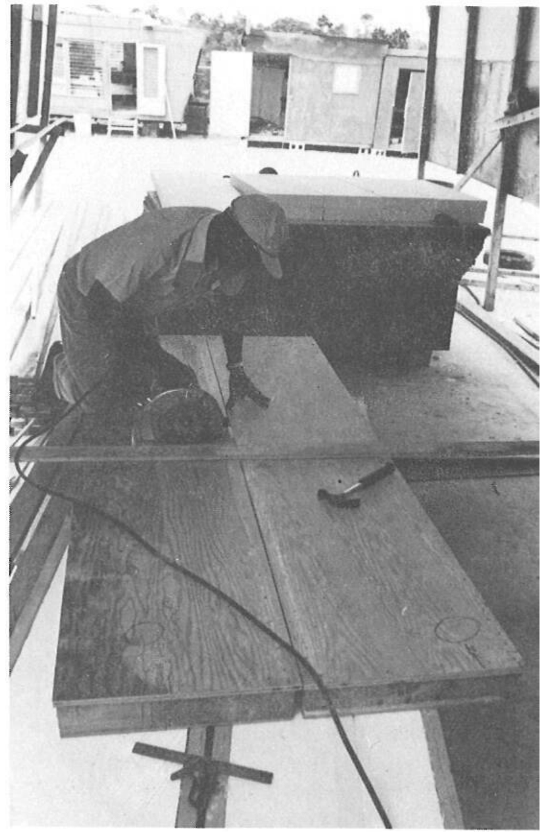
Four separate hatch frames glued to single cover.



Hatch interior primed; hinge butt blocks fastened.

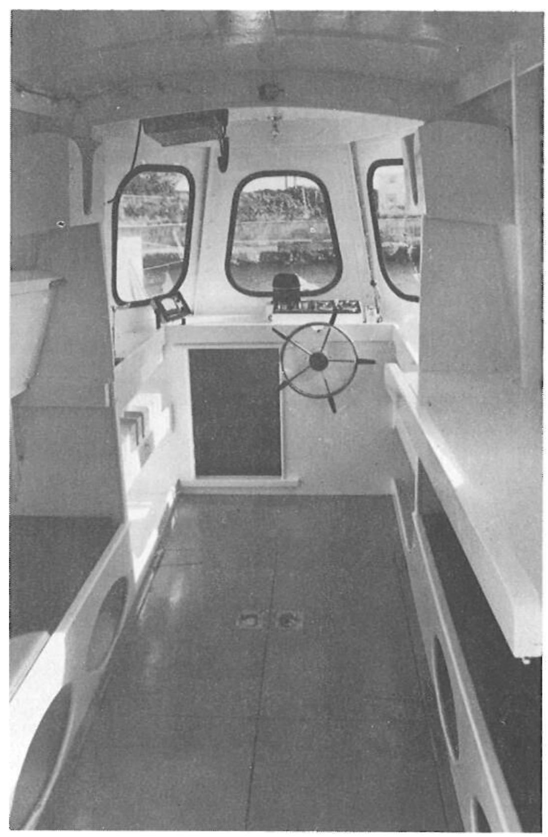


Insulation for engine room hatches.



Cutting the cover into four hatches.

Underside to the hatches.



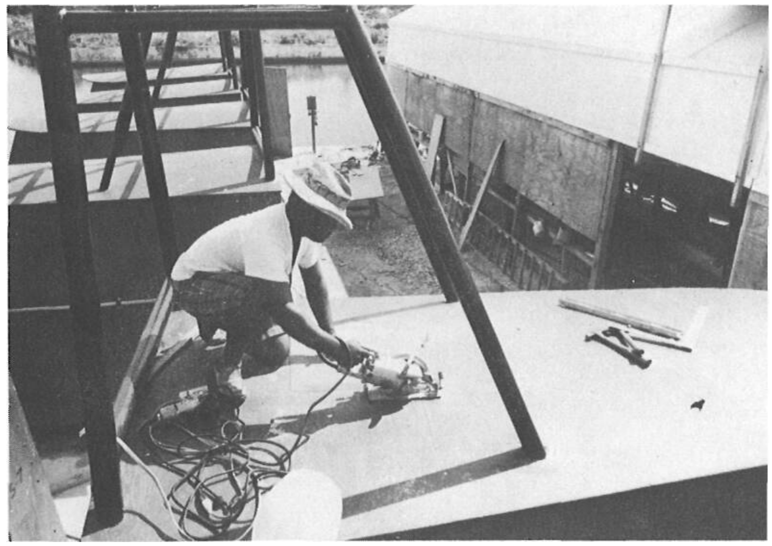
Engine room hatches complete.

TASK 5 - Wheelhouse Roof Hatch

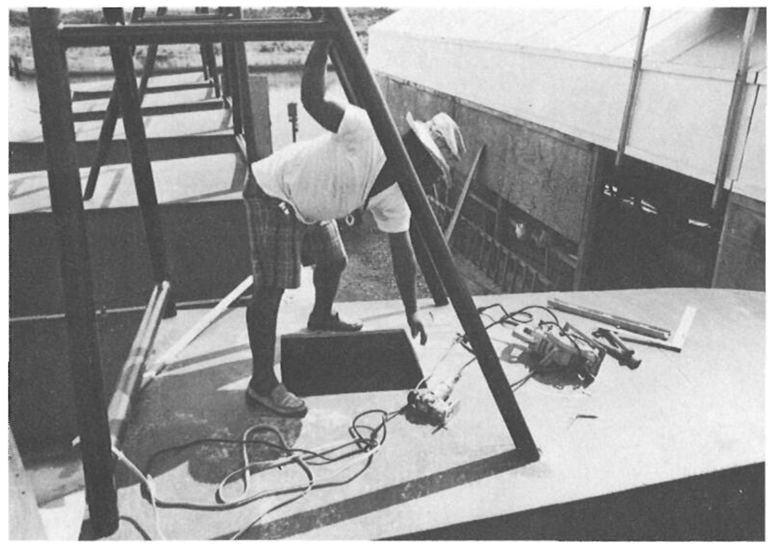
1. The hatch opening was two feet (610 mm) square. A 1" x 6" (25 mm x 152 mm) hatch framework was glued and nailed together. This was braced square.

2. A pattern was made to the shape of the outside edges of the 1" x 6" (25 mm x 152 mm) hatch framework. This was laid out in place on the top of the wheelhouse roof and the hatch opening was cut out to this size.

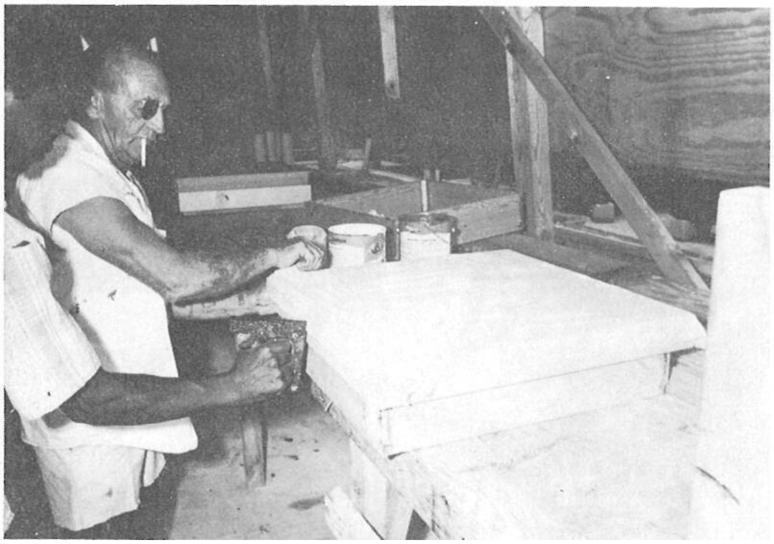
3. The hatch framework was inserted into the opening. The bottom edges of the framework were left flush with the inside surface of the wheelhouse roof. Fairing blocks were then scribed to the crown of the wheelhouse roof. These were glued and screwed to the framework. The framework was then removed from the opening and taken back to the workbench. A hatch lid was made to match the framework. The lid was covered with canvas and painted. Four-inch (102 mm) butt hinges were screwed onto the back face of the hatch. The whole hatch assembly was then bedded down and screwed to the wheelhouse roof.



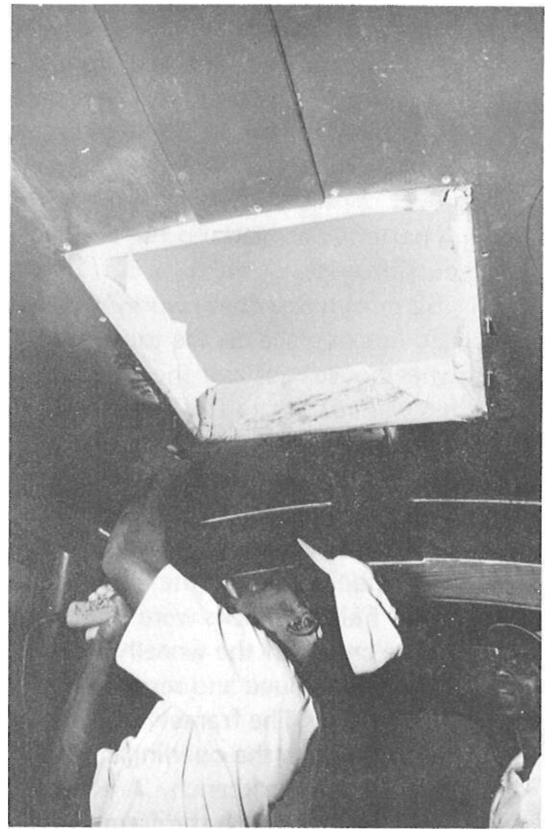
Cutting the hatch aperture.



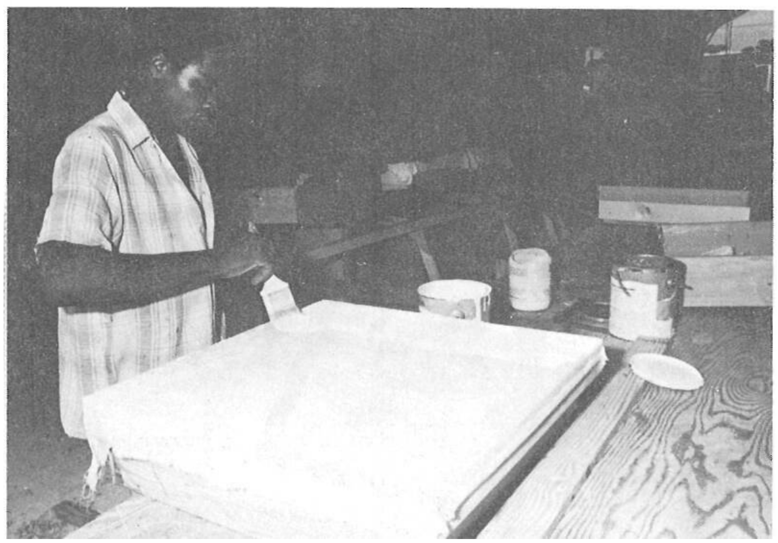
The hatch framework.



Hatch cover clothed over.

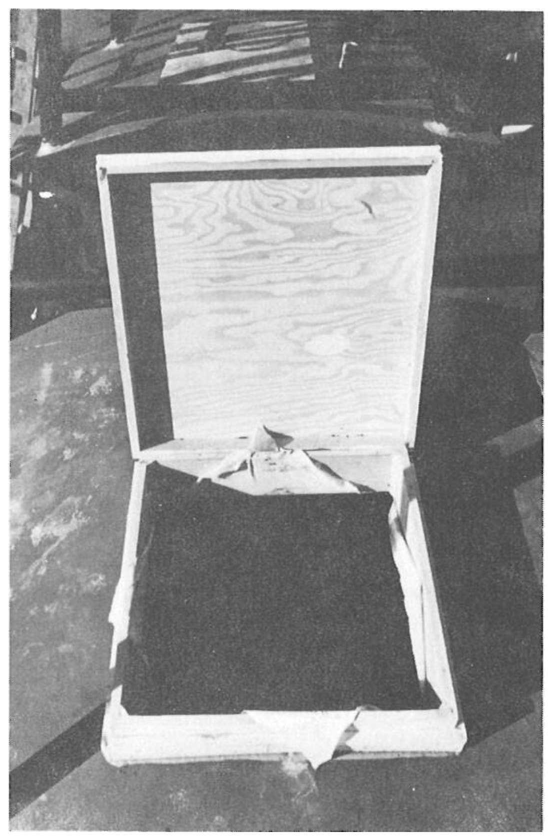


Screwing down the hatch frame.



Painting the cloth after shrinking.

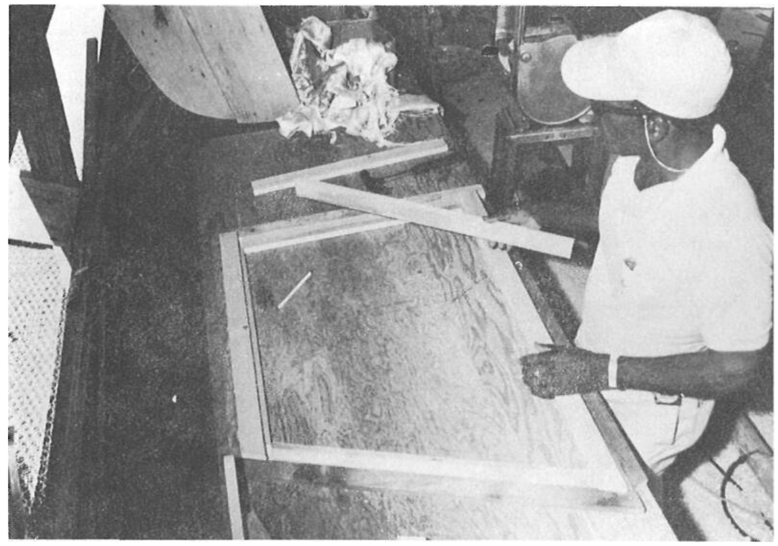
Fitting the hatch cover.



Bedding compound forced out after fastening down.

TASK 6 - Sliding Window Frames

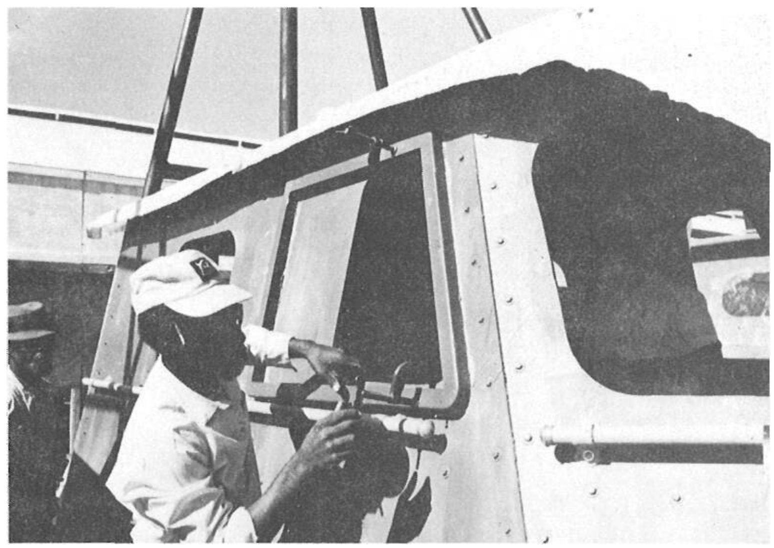
Frames for the sliding windows were made up in a jig. Two layers of 3/4-inch (19 mm) fir were laminated to form the frame. The joints were lapped. Plastic channel was inserted into the frame for the glass to slide into. Drain holes were cut in the bottom of the frame to allow water to escape. The frame was sealed with two coats of red lead to protect it from rot. The glass was installed in the frame from the back. The frame was screwed to the plywood wheelhouse side.



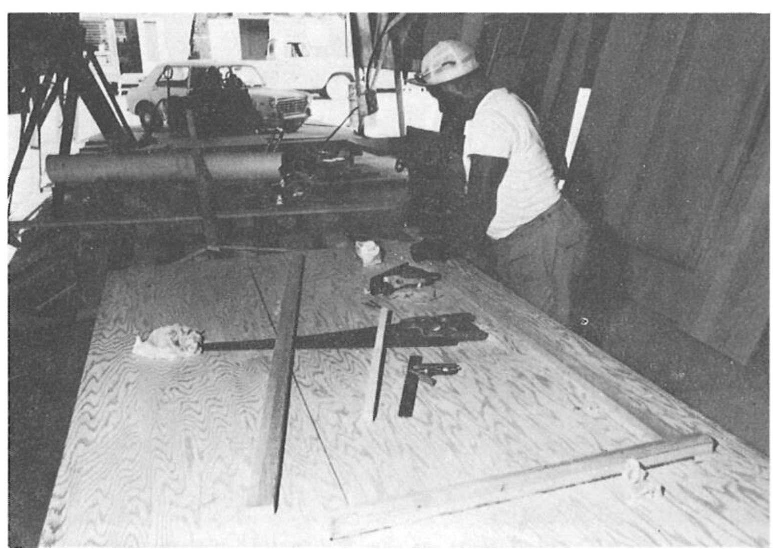
Sliding window frames in the jig.

TASK 7 - Removable Aft Panel and Door Assembly

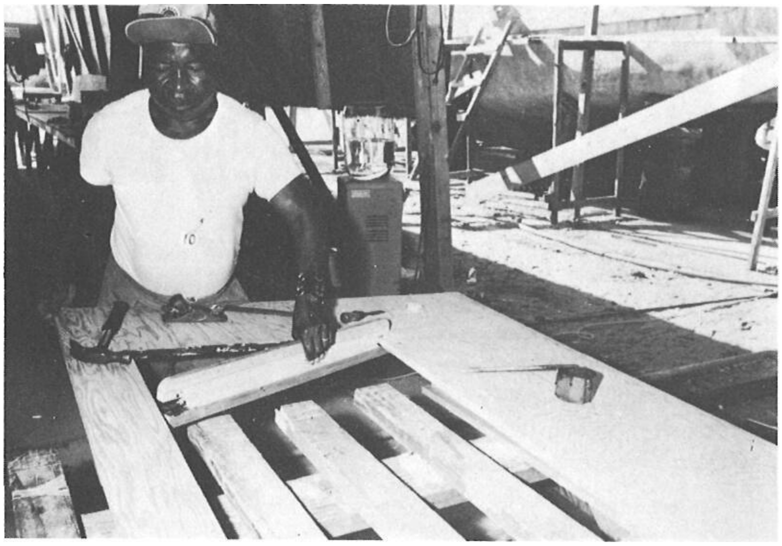
The removable panel on the aft bulkhead of the wheelhouse was made from 3/4-inch (19 mm) plywood. It was made up on a work bench. First a door aperture was cut out in the panel. One inch by two inch framing was glued and screwed to the panel to form a recess for the door to sit into. A door sill was made out of 2" x 4" (51 mm x 102 mm) fir and fitted. The piece cut out from the panel was framed with 1" x 3" (25 mm x 76 mm) fir and thus formed the door. The hinges and door hardware were attached to the door and its frame prior to bolting the complete removable panel into place on the back of the wheelhouse. This removable panel was bedded down with compound and through-bolted to the angle-iron framework on the steel wheelhouse structure which had been predrilled for this job. A copper drip strip was bedded down to the plywood of the wheelhouse aft side above the removable panel to stop water leaking in from the top.



Installing window frames.

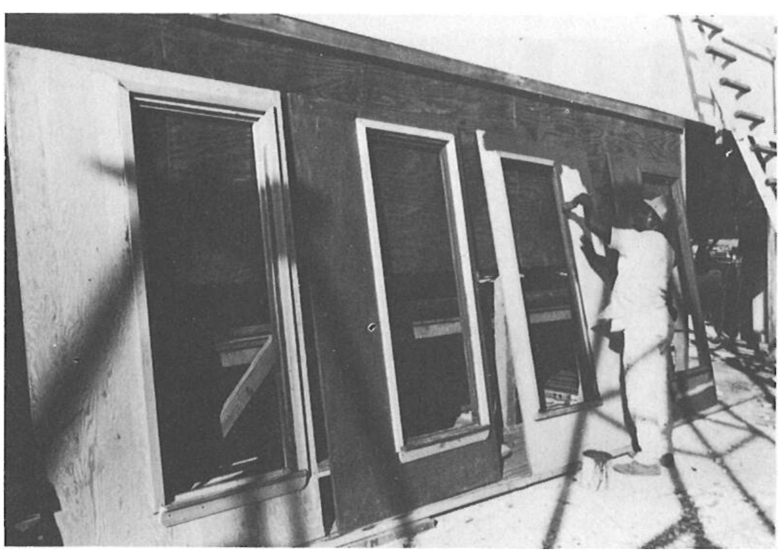


Removable aft panel and door.



Door aperture cut out; still being filled.

Applying bedding compound to inside face of the panel.

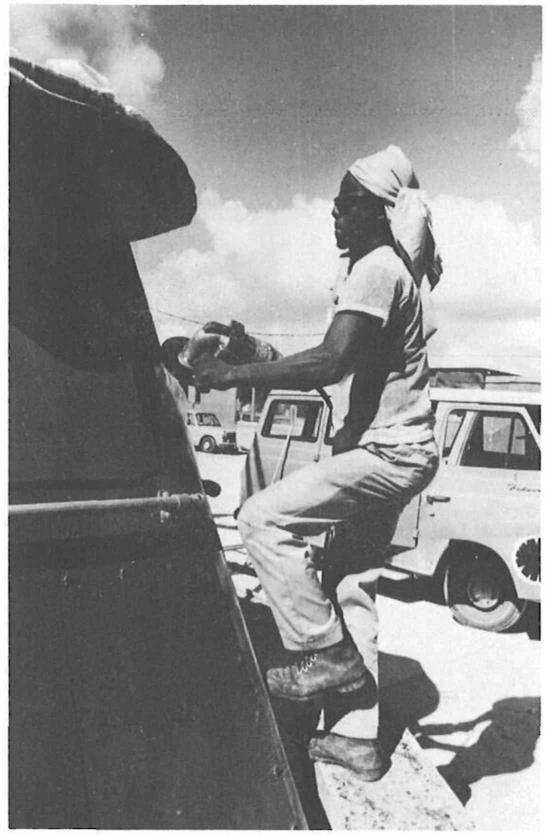


Removable aft panels with door frames fitted.

Removable aft panel tacked into position prior to bolting.

TASK 8 — Waterproofing Plywood Joints in Wheelhouse Sheathing

Two-inch (51 mm) wide strips of copper sheathing were applied over all the exterior plywood side joints of the wheelhouse. These joints were first sanded smooth. They were then liberally spread with a coat of bedding compound. The copper strips were nailed on two-inch centers over the joints, using 3/4-inch (19 mm) copper ring nails. The corner joints were done in the same way except that copper strips 21/2inches (64 mm) wide were used. These strips were bent to the correct angle on a workbench before installing.

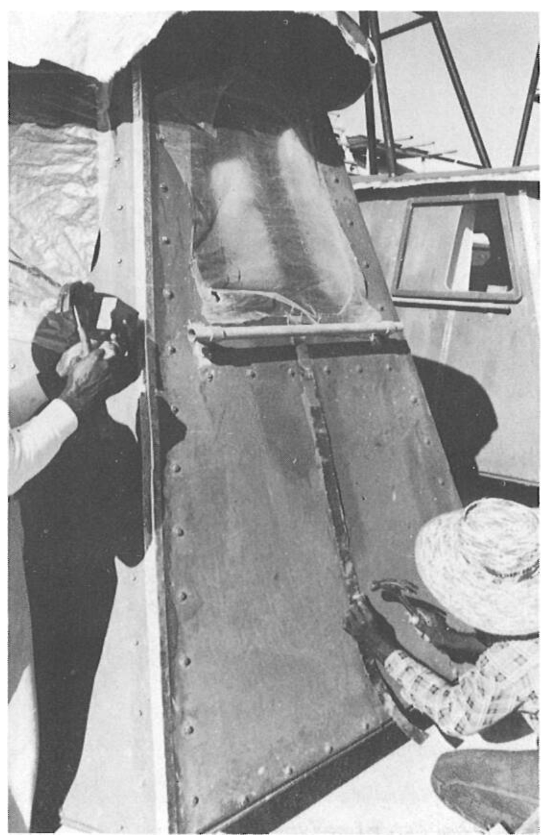


Sanding edges smooth.

TASK 9 - Radio Antennas and Masthead Light Assembly

Brackets for the radio antenna and masthead light assemblies were made up and welded to the five-foot (1.5 m) length of two-inch (51 mm) I.D. pipe which formed the top of the mast structure. Holes were drilled near the top of both the aft mast pipes directly beneath the covering top plate. Radio antenna and electrical wires were led down to the cabin inside the mast pipes. The wires were run through these holes and afterwards plugged watertight.

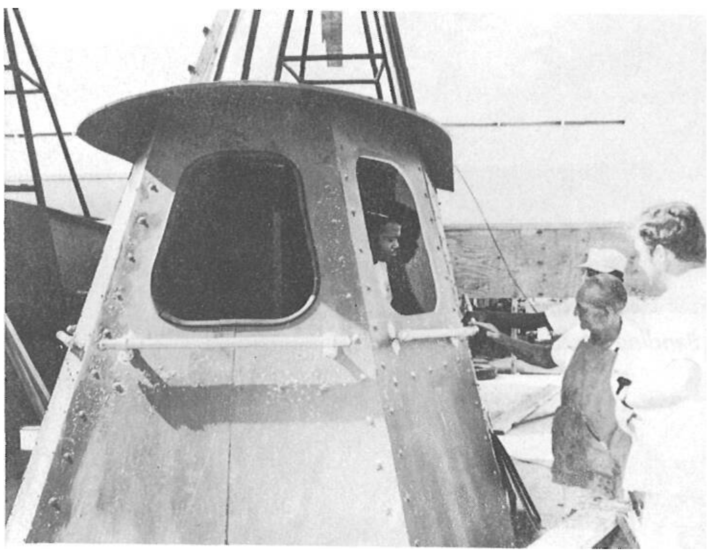
Masthead assemblies welded into place.



Nailing protective copper strips over joints.

TASK 10 – Installing Handrail

Handrails were bolted onto the outside of the wheelhouse. They were made from one-inch (25 mm) galvanized fencing pipe. Special caps, as used for wire fencing, were rammed into the ends. The rails were secured with steel brackets which were through-bolted to the wheelhouse sheathing. Care was taken to ensure that the front and side rails were properly aligned.



Aligning galvanized handrails.

Bolting handrails from inside.

TASK 11 - Electrical Wiring

The electrical wiring for the wheelhouse interior lights, the navigational lights and the fo'c'sle lights, was strapped in place. Size Number 10, double strand, rubber-cased electrical cable was used for all the twelve-volt wiring other than for the cables running from the engine to the batteries. The wiring was strapped in place with brass clips.

TASK 12 – Air Ducts

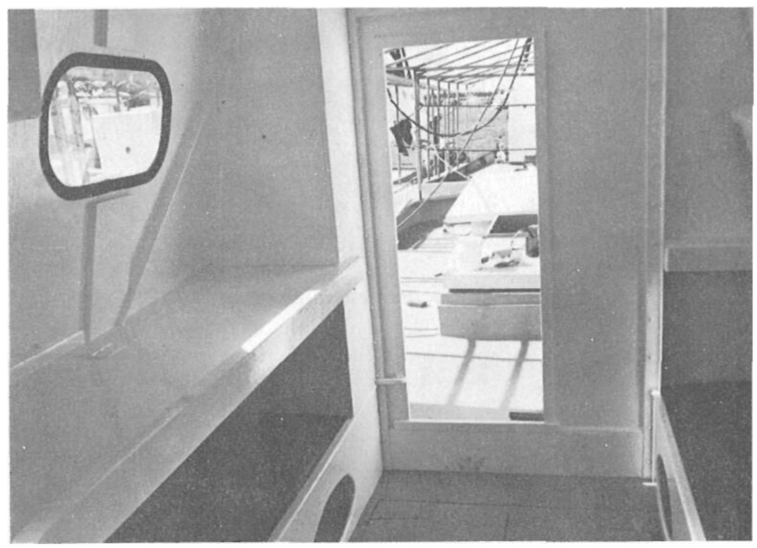
Air ducts were installed in the back of the wheelhouses. They were first prefabricated on a workbench. A vent hole was cut into the aft side of the wheelhouse. A section under the port bunk was blocked off to allow a free flow of fresh air from outside down into the engine room compartment.

White enamel spray paint finish for the interior.

TASK 13 - Exhaust Compartment Duct

An eighteen-inch (457 mm) wide duct was left at the aft starboard end of the wheelhouse. A removable plywood panel was fitted over this. A sheet-metal louvered ductwork was made and installed where the main engine exhaust pipe passed through the wheelhouse roof. A 12" x 12" (305 mm x 305 mm) sheet-metal louvered duct was screwed onto the back of the wheelhouse to assist in drawing hot air from the engine compartment. Light gauge sheet-metal "stand-offs" were screwed to the inside face of the plywood in the duct compartment. These "stand-offs" were made merely of flat sheets of galvanized iron held 3/8-inch (9.5 mm) off the plywood with short pieces of copper tubing spacers. The screw holding the sheet-metal to the plywood ran inside the copper tubing. As the "stand-offs" became hot from the exhaust pipe, air would flow vertically between the sheet metal and the plywood, keeping the plywood reasonably cool.

The wheelhouse facing forward.



Facing aft Upper bunks' cushions stowed.

TASK 14 - Painting the Wheelhouse

The wheelhouse was spackled and sanded inside and out. It was given three coats of white gloss paint with a spray gun.

TASK 15 – Interior Fixtures

The radio, sink, hydraulic steering head, compass, depth sounder, spotlight, cup-racks and all other miscellaneous fixtures were then fastened in place.

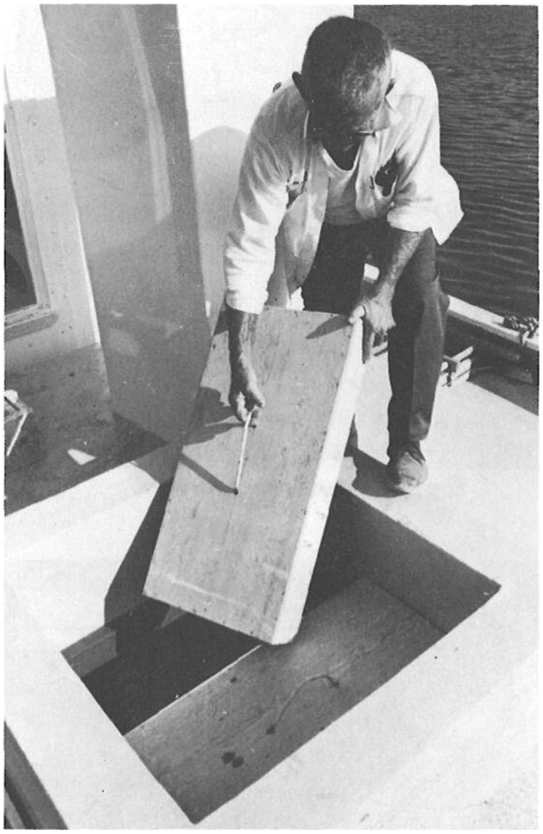
The wheelhouse structures were now complete and ready to be attached to the deck.

The helmsman's station.

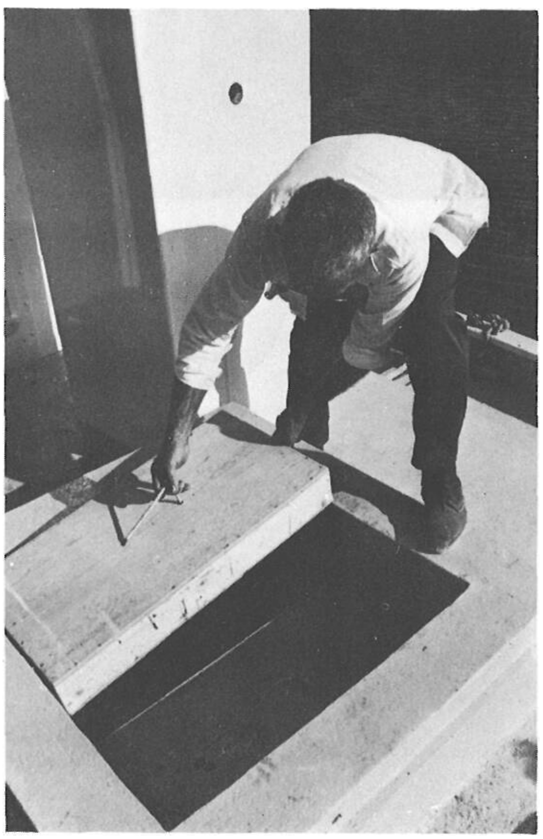
JOB 5 - FABRICATE HATCHES: FISH-HOLD AND LAZARETTE

These hatches were made with 3/4-inch (19 mm) plywood tops and 2" x 4" (51 mm x 102 mm) sides. They fitted neatly over the concrete hatch coamings. The corners of these hatches were reinforced with galvanized iron corner straps. A hatch was made to fit each individual hatch coaming once it had been completed.

The fish-hold insulated hatch plugs were made to fit beneath the outer hatch cover. These were made by first constructing a 1" x 4" (25 mm x 102 mm) framework. Next a 3/8-inch (9.5 mm) plywood top was fitted. Two 1/2-inch (13 mm) holes were drilled in this plywood top. A rope was passed through the holes and fitted as a handle. Insulation was placed inside the frame. The bottom was nailed on, the edges rounded. The hatch plugs were made 3/4-inch (19 mm) smaller than the inside of the concrete hatch coamings so that they would not bind. After checking for fit, the hatch plugs were painted.



Insulated secondary hatch cover.



Checking for fit. Note rope handles.

JOB 6 - RUDDER ASSEMBLY

The rudder assembly was subcontracted for fabrication. The rudder stock was constructed from 2 1/4-inch (51 mm) stainless steel shafting, the same material as the propeller shaft. The 17-ft. (5.3 m) propeller shaft was cut from stainless steel round stock twenty feet (6.1 m) long which is the standard size of shafting as supplied by the mill. The surplus piece was utilized for the rudder stock.

A deck bearing housing for the rudder stock was fabricated by the same yard. This housing bolted into the concrete deck. The top of the rudder stock protruded through it. The top of the rudder stock was squared to receive an emergency tiller head. A bronze bushing fitted under the deck housing to stop the rudder from riding up. A key way was cut into the rudder stock to receive the hydraulic steering head mechanism. The rudder stock passed through a vertically placed stuffing box of the same style as the propeller shaft, at the spot where it entered through the hull in the steering compartment. On the bottom of the rudder stock was a five-inch (127 mm) diameter welded flange. This flange was for bolting on the removable rudder blade assembly. The rudder blade was fabricated with a matching flange on top to connect it to the rudder stock. The main stock of the rudder blade was also 21/4-inch(57 mm) diameter stainless steel shafting. The rudder blades and flange were of mild steel. Stainless steel bolts were used to bolt the matching flanges together. A mild steel rudder shoe was fabricated for the bottom of the rudder blade shaft. This bottom bearing assembly had a bronze bushing set into it and a round steel bearing at the bottom. The bearing assembly was designed so that it would bolt onto the keel channel.

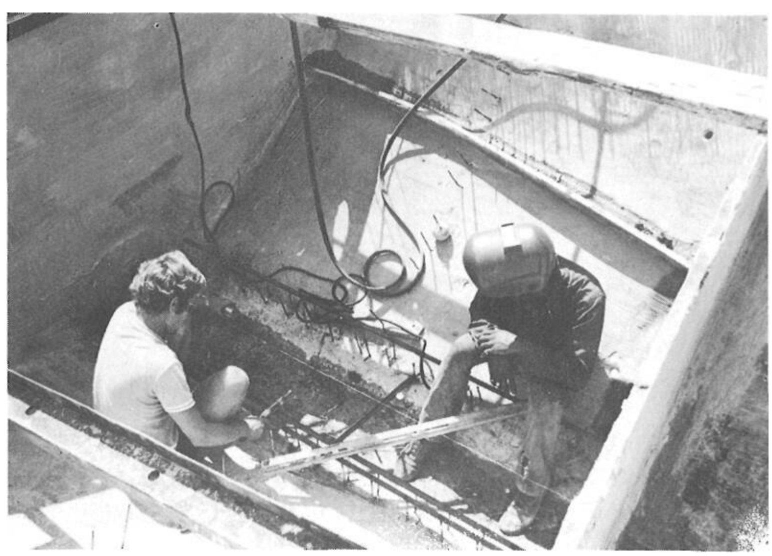
STAGE 3
INSTALLATION OF PREFABRICATED COMPONENT PARTS

Stage 3 consists of installing all prefabricated component parts in the vessel. Stage 1 was concerned with building the hull, Stage 2 with fabricating these component parts. The deck mold was not prepared until the rudder, the fuel tanks and the fish-hold had been installed. The mesh and rod reinforcing was then applied over the wooden deck mold and the deck plastered.

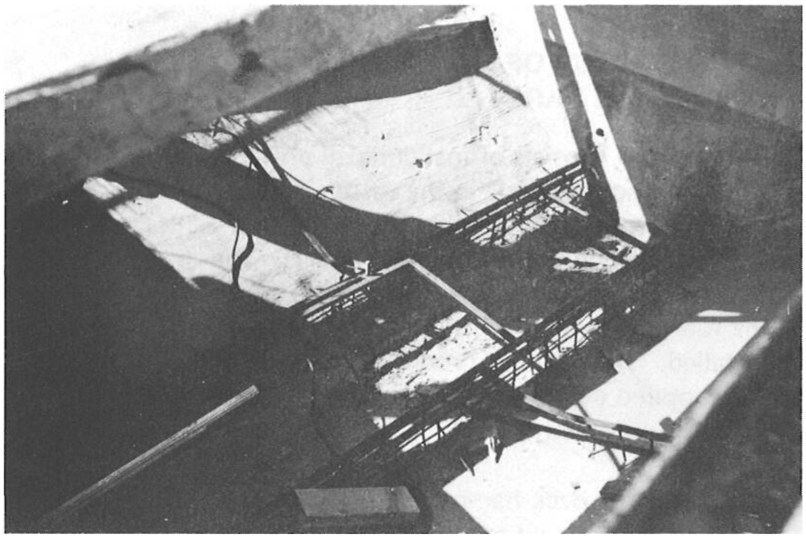
Once the deck had been plastered the boatyard crew could set to work on the installation and finalizing of the vessel's engine and equipment. This involved the main engine cooling, exhaust and fuel system, the complete bilge system, the hydraulic steering gear, the superstructure with its electrical and plumbing systems, the ice machine and diesel generator unit, the water tanks and the foc's'le accommodations.

JOB 1 - INSTALLING ENGINE ROOM WEBS AND ENGINE BEDS

The engine beds were not completed until after the propeller shaft was installed. The propeller shaft was required to be in position in order to align the engine beds properly.



Making the engine beds.



Engine bed steel reinforcing.

TASK 1 — Engine Base and Web Reinforcing

First the engine bed starter rods and the web starter rods were straightened and clipped to length. Measurements were then taken from the propeller shaft in order to locate the height of the engine beds properly. T-bar screeds were welded onto the engine bed starter rods from these measurements, parallel to the propeller shaft center line. Two T-bars were welded on each engine bed at the outside top edges. Longitudinal reinforcing rods were then welded to the starter rods of each engine bed. Engine base bolts were welded in place. The threaded top of each bolt protruded from between the T-bar screeds to two inches above the top surface of the engine beds.

TASK 2 - Webs and Stringers

The engine room webs and stringers were fabricated next. Care was taken to ensure that these were accurately measured. The main engine fuel tanks were to be fitted between the central web and the aft bulkhead. T-bar screeds were welded to the webs and they were reinforced in the same way as were the other webs in the hull. The webs joined into the engine bed at the bottom and were terminated three inches (76 mm) short of the deck at the top.

TASK 3 — Engine Bed Mesh Reinforcing

The engine bed had two layers of mesh clipped onto the outside surface with hog rings. Care was taken not to place too much mesh into the engine beds as this would make mortar penetration difficult.

Vibrating mortar into engine beds.

TASK 4 - Plastering the Engine Beds

The engine beds were plastered. The same mix was used as for the hull. The mortar was faired out on the sides to avoid stress points at the edge of the engine beds. The area between the engine beds was troweled smooth to form an oil sump. (Although an oil sump pump was fitted later to avoid fouling the engine room bilge.) The engine compartment was then filled with water to a height above the engine beds. The water remained for one week while the engine beds cured.

The engine beds plastered.

JOB 2 - PAINTING THE HULL INTERIOR

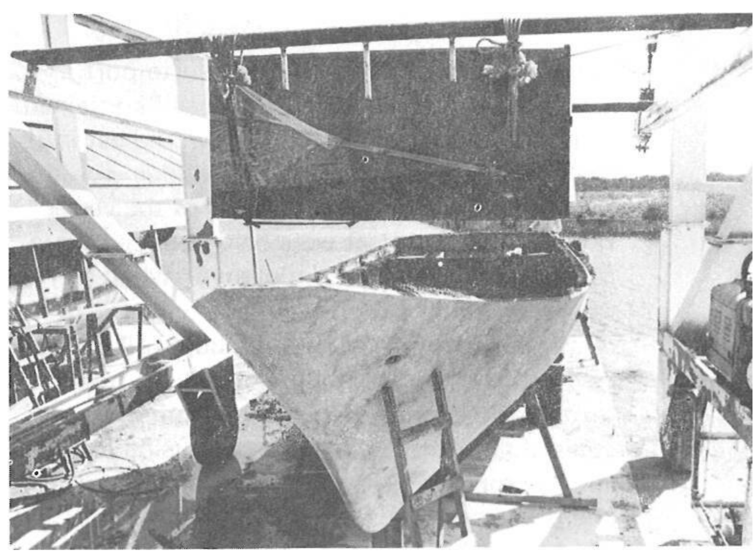
The interior of the hull was thoroughly cleaned. After cleaning, the interior received two coats of red lead primer. The first coat of red lead primer was brushed on. The second coat was applied with a spray gun. The purpose of painting at this time was to seal the inside of the concrete hull thoroughly and to prime all exposed steel screeds, etc. Just prior to turning the fishing boats over to their owners, a touch-up coat of paint was given to the accessible interior areas. Many parts of the hull interior later became inaccessible to the painters when items such as the fuel tanks and fish-hold had been installed.

JOB 3 - INSTALLING THE FISH-HOLD

The prefabricated fish-holds were lowered into the hulls with the use of the comporter. Special slings were rigged to lift the holds. These slings were so designed that they could be easily removed once the fish-hold was in place.

TASK 1 - Preparing Wooden Base

First, beds were prepared in the hull for the fish-hold to lie on. The beds consisted of 2" x 6" (51 mm x 152 mm) planking set on top of the midships concrete webs. Once these beds were accurately leveled, they were removed and primed with red lead paint.

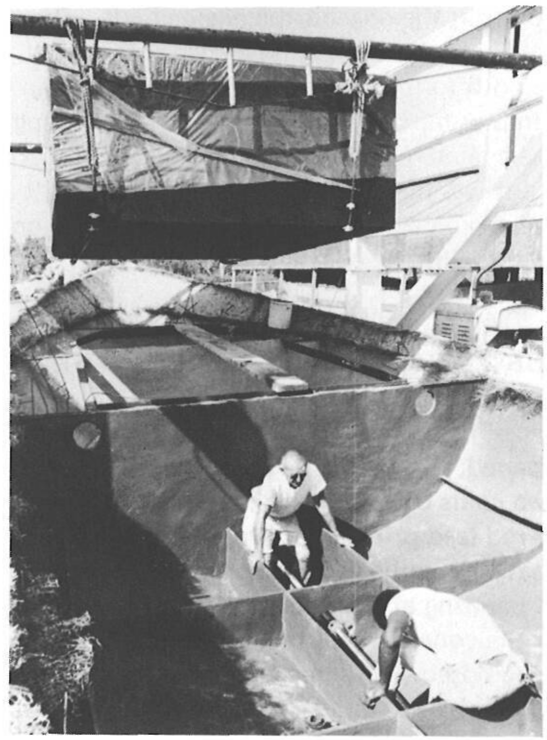


Comporter lowers prefabricated fish-hold into place.

TASK 2 - Installing the Fish-Hold

The fish-hold was then dropped gently into the hull. Once in place on the beds it was carefully checked for proper positioning in relation to the hull. The hold had *a* capacity of 1,400 cubic feet (40 cu m). By constructing it in the shape of a rectangular box, there was still access remaining all around it once in place and the decks were attached. This was particularly handy for future cleaning and maintenance, also installing plumbing, wiring and hydraulic lines. Further, it gave the hold itself far better insulating qualities than it otherwise would have possessed had it come into direct contact with the hull shell. Two one-foot (610 mm) diameter air vent holes were left at the top of the aft engine room bulkhead. This was done so that when the main engine was running a certain amount of fresh air would be drawn into the engine room from the area around the fish-hold box. This fresh air circulation would help keep dry rot in check.

The rectangular shape of the fish-hold made installing the fish pens an easy task. The main aluminum pen boards were made a standard size and were interchangeable.



Hull interior was painted prior to installing the prefabricated fish-hold.

AIM IDEA FOR THE FUTURE

A new concept of containerized fish-holds might be developed from this innovation. The idea being to create a rectangular steel box into which a portable fish-hold could be dropped. This would allow the entire fish-hold to be hoisted out when the vessel came into port. The fish-hold would have its own self-contained sump so that no melted hold ice would get into the bilges and its attendant fish residue would thus not contaminate other parts of the vessel. If a standardized fleet were being utilized extra fish-holds could be held in reserve. When a vessel came into port it would be only a matter of a few minutes to hoist out a hold full of iced fish and replace it with a sterilized hold ready packed with ice. The hold full of fish could then be rolled into the processing plant and the top removed. The fish would be sorted and processed directly out of the box. The box would then be sterilized and repacked with ice for the next vessel. A tremendous amount of time and money could be saved in this way in the fishing boat turn-around in port as well as in the packing plant. By sterilizing the hold after every trip, seafood would be delivered in better condition to the plant.

TASK 3 - Deck Mold Supports

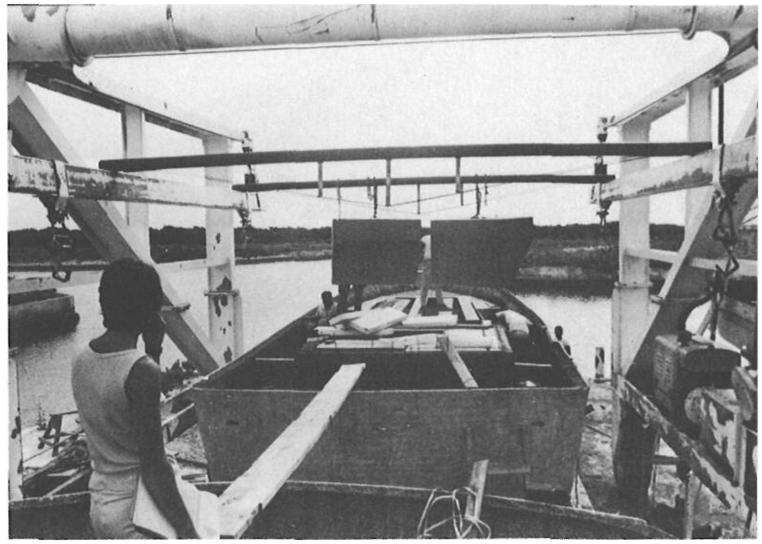
Once the wooden fish-hold box was in place 2" x 4" (51 mm x 102 mm) timbers were spiked to the sides. The 2" x 4" (51 mm x 102 mm) timbers were spiked on at the same level as the side deck joint. They were used to brace the permanent wooden deck mold.

TASK 4 - Installing the Fish-Hold Hatch Coaming

Next, the raised hatch coaming was installed. The coaming had been constructed and insulated in the same way as the fish-hold itself.

JOB 4 - INSTALLING THE FUEL TANKS

The port and starboard engine room fuel tanks were constructed of 3/16-inch (4.8 mm) plate steel, each with a capacity of 178 U. S. gallons (47 liters). They were air-tested for leakage. Prior to installation they were given two coats of zinc epoxy primer.



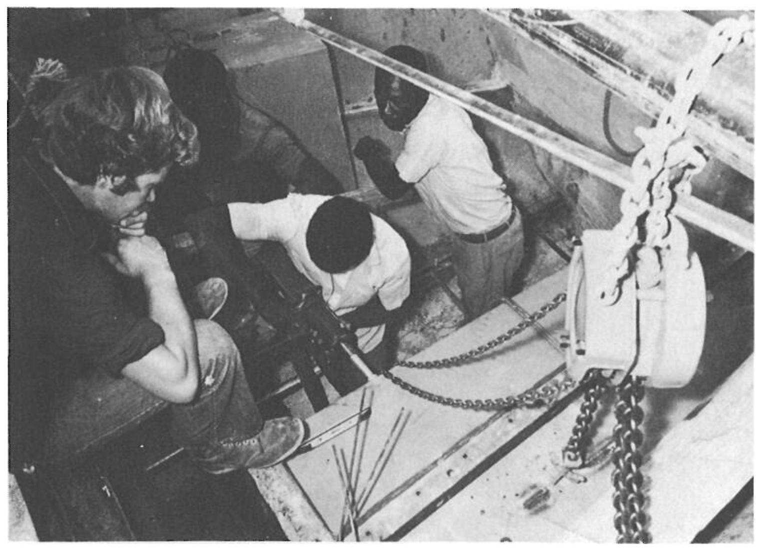
Comporter carries the fuel tanks.

TASK 1 — Placing Tanks in Position

The fuel tanks were lifted with the comporter and placed on planks spanning the hull sheer. The tanks were then lowered into place, one at a time. They were temporarily wedged into place in each corner of the engine room.

TASK 2 - Installation of Fuel Tanks

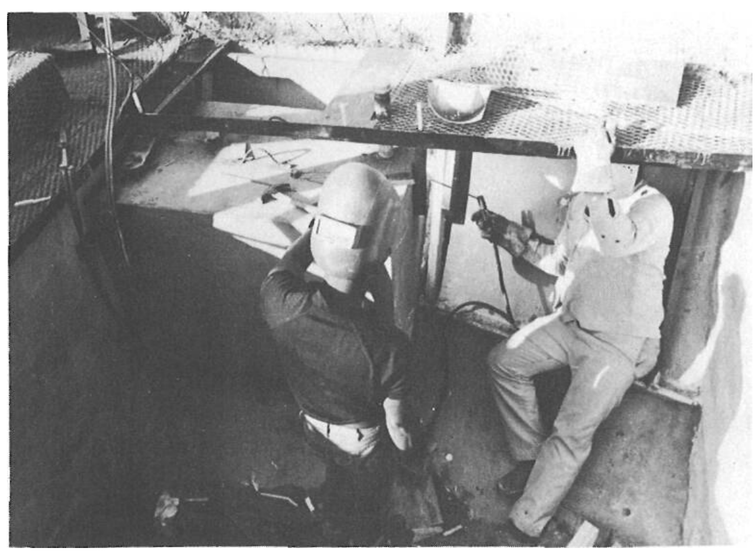
Two flanges were welded to the tank and bolted to the aft engine room bulkhead. The tanks were further braced to the wheelhouse steel base framework and to the hull webs. 2" x 4" (51 mm x 102 mm) wooden pads were wedged between the tanks and the hull.



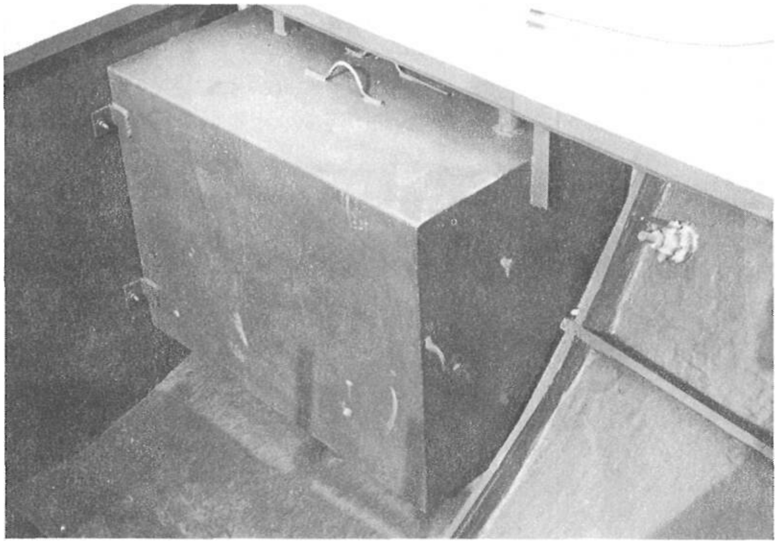
Lowering and jacking into place.

TASK 3 - Filler Pipes and Vents

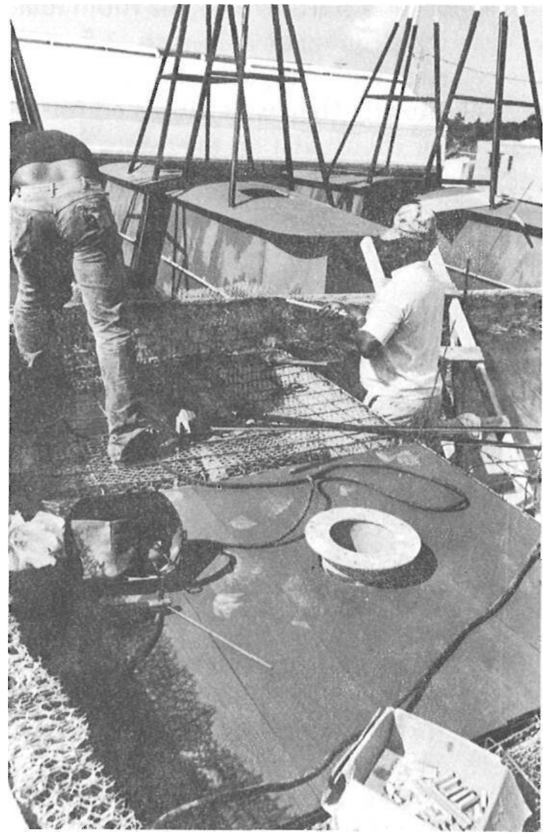
The two-inch (51 mm) diameter deck filler pipe was then welded in place running through the deck. Air vents and drain plugs were prepared. All tank openings were plugged to prevent dirt from getting into the tanks during the remainder of construction work.



Securing the fuel tanks.

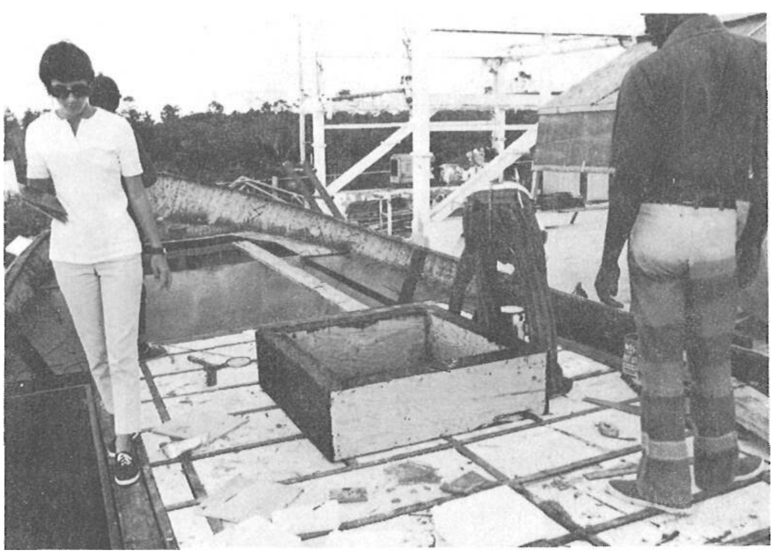


Portside fuel tank in place.

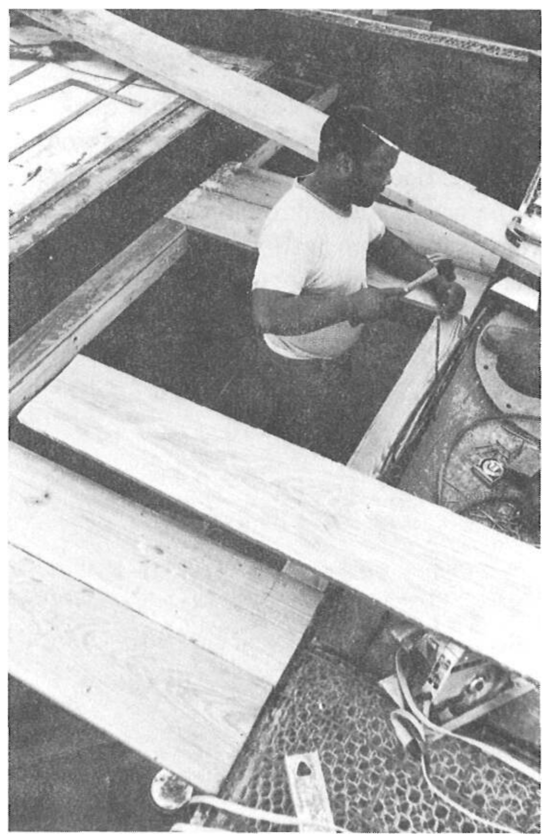


Deck mold over steering compartment.

Plywood deck mold forward.



Deck mold supports alongside fish-hold.



Deck mold over lazarette.

JOB 5 – DECK MOLD

The deck was constructed over a permanent wooden mold. The only deck area where a mold was not used was over the water tanks. How this area was fabricated is covered in the water tank section (Job 6, Task 1).

TASK 1 - Deck Mold Over Steering Compartment

The first section of deck mold constructed was that covering the steering compartment which is situated between the two water tanks aft. When the bulkheads were constructed a special screed was employed which enabled the bulkhead vertical rods to be tied into the deck reinforcing. This screed also formed a foundation for the deck mold. The special screed consisted of a one-inch (25 mm) T-bar, with the top of the "T" placed downwards, welded to the upper edge of the bulkhead reinforcing. This left a lip recess for holding the 1" x 10" (25 mm x 254 mm) planks of the deck mold. The bulkheads were plastered to the edge of the T-bar screed, which later allowed the excess lengths of vertical rods to be bent over and formed into the deck reinforcing. The first step was to lay red lead primed 1" x 10" (25 mm x 254 mm) deck mold planks between the water tank bulkhead screeds. Then a hole was cut in the mold to receive the deckhead bearing for the rudder shaft. A circular, one-inch (25 mm) strap iron screed was welded to the deck reinforcing where the deckhead bearing was to be finally attached.

TASK 2 - Deck Mold Over Foc's'le

A 2" x 4" (51 mm x 102 mm) framework was fabricated in the bow which supported a 3/4-inch (19 mm) plywood mold. The plywood mold was wedged up under the deck edge mesh around the bow and after the concrete deck was cured the 2" x 4" (51 mm x 102 mm) framework was removed. The staples used to attach the deck reinforcing later supported the mold over the foc's'le and bow.

TASK 3 - The Remainder of the Deck Mold

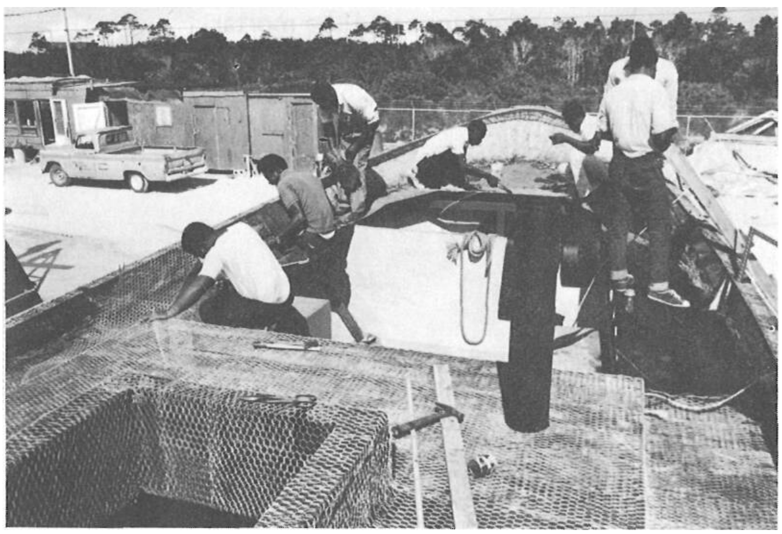
The remainder of the deck mold was fabricated in the same manner as the foc's'le. Three-quarter inch plywood was used from the bow to the aft engine room bulkhead. 1" x 10" primed fir was used for the rest of the deck mold. In all cases the deck mold was fitted neatly against the hull to avoid mortar dropping through this joint when the deck was being plastered and vibrated.

TASK 4 - Tarpaper Over the Deck Mold

Tarpaper was laid over the wooden mold. It was stapled in place. Tarpaper was also carried over the top of the prefabricated fish-hold which did not have a wooden mold laid over it. The insulation material supported the mortar being poured over the fish-hold when the deck was plastered. The deck reinforcing rods were stapled to the fish-hold wooden frames.

Tarpaper being stapled over deck mold.

Water tank top reinforcing.



Mesh laid over deck and into fish-hold.

Stapling deck reinforcing rods athwartships.

JOB 6 - MESH AND ROD REINFORCING: DECK

TASK 1 — Reinforcing Water Tank Tops

The first job was to complete the framing for the top of the water tank. First, the T-bar screed which had been tacked to the bulkhead starter rod around the top edge of the water tank was removed. This left a ledge which later served as a good key for the mortar at this joint.

The starter rods for the water tank bulkheads were bent over horizontally. Rods were welded to them and to the deck starter rods to form a grid. An inspection hatch frame was welded into the center of the grid reinforcing of each water tank top. The frame also served as a screed. Four layers of mesh were then clipped to the inside top of the water tank.

TASK 2 — Reinforcing Rods and Mesh to the Deck and Fish-Hold

Four layers of mesh were then laid over the entire deck and stapled to the wooden mold. The mesh was carried over the fish-hold to form a reinforcing for an interior cement skin coat. After the bottom layer of mesh had been applied along the deck, the athwartship rods were stapled to the mold. These rods were welded to the reinforcing rods on the top of the water tank and the starter rods protruding from the hull at the deck line. Deck rods were solidly welded to the wheelhouse base frame. The vertical starter rods which protruded from the top of the bulkheads were bent over and welded to the deck rods. The deck rods were spot welded at approximately every second intersection. The rods were placed two inches (51 mm) apart along the deck and six inches (152 mm) apart athwart the deck. Four layers of mesh were stapled to the top of the deck reinforcing rods. This mesh was clipped to the deck rods with hog rings.

TASK 3 - Lazarette Hatch Coaming

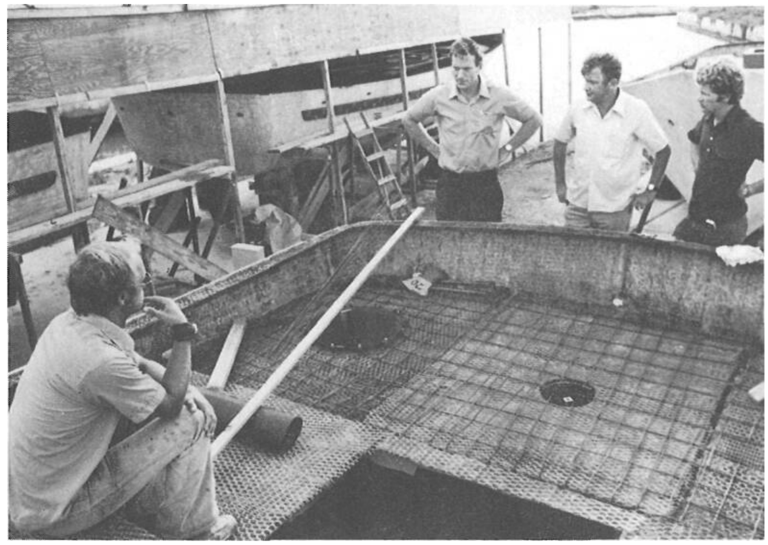
A coaming was framed of reinforcing rod at the hatch to the lazarette. The upper edge was finished with a one-inch (25 mm) T-bar screed. Four layers of mesh were fastened to the inside of the coaming and four to the outside. A wooden screed was fastened around the lower inside edge of the coaming to facilitate the plasterers' work.

TASK 4 - Plug Wheelhouse Base Frame Bolt-Holes

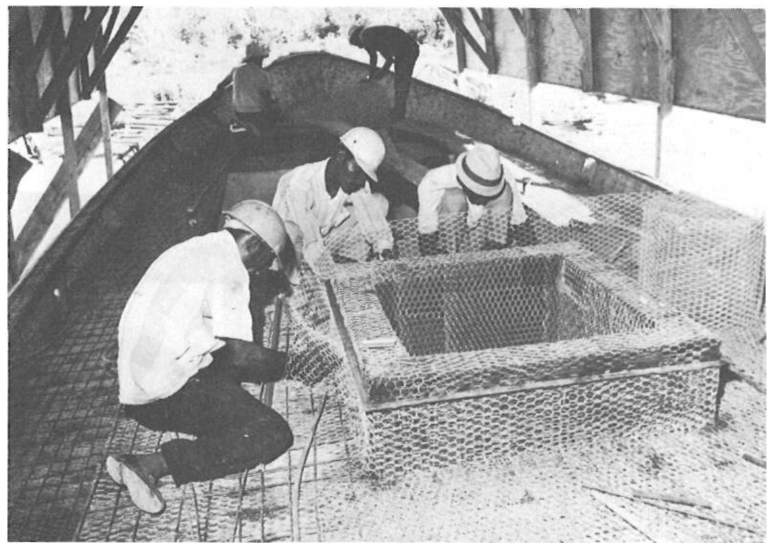
Using the existing bolt-holes in the wheelhouse steel base frame as a guide, the holes were drilled and extended upwards through the wooden deck mold. These bolt-holes were then plugged with wooden doweling to the height of the deck screed. After the deck was plastered and cured, the dowels were knocked out and the bolt-holes cleaned out with a drill.

TASK 5 — Install Ice-Machine Chute and Base

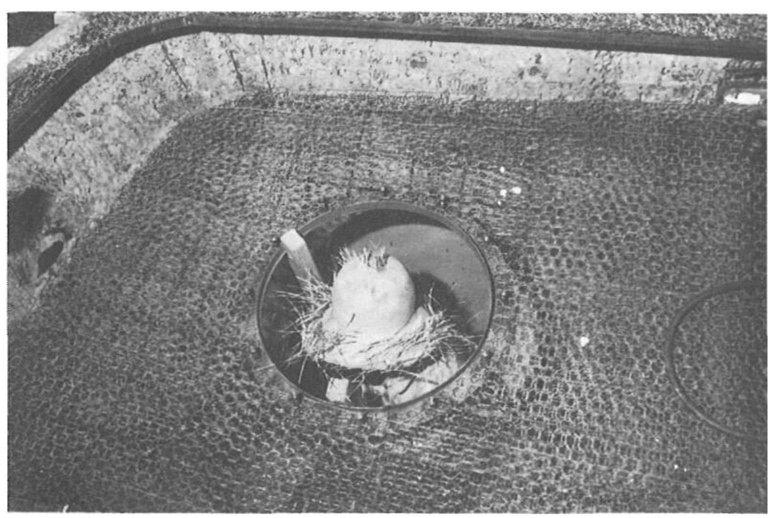
A circular aperture of 61/2inches (165 mm) diameter was cut through the top of the fish-hold at its portside forward corner. Into this aperture was inserted an 18-inch (457 mm) length of six-inch (152 mm) I.D. P.V.C. pipe. It was secured and bedded watertight, four inches (102 mm) left standing above finished deck level. This short piece of pipe served as the chute into the hold for the ice-machine. A base frame for the ice-machine, of 2" x 2" x 1/4" (51 mm x 51 mm x 6.4 mm) angle iron, 26" x 24" (660 mm x 610 mm), was fabricated and welded to the deck reinforcing on short, two-inch (51 mm) legs.



Reinforcing over water tanks and steering compartment.



Applying mesh to insulated fish-hold hatch coaming.



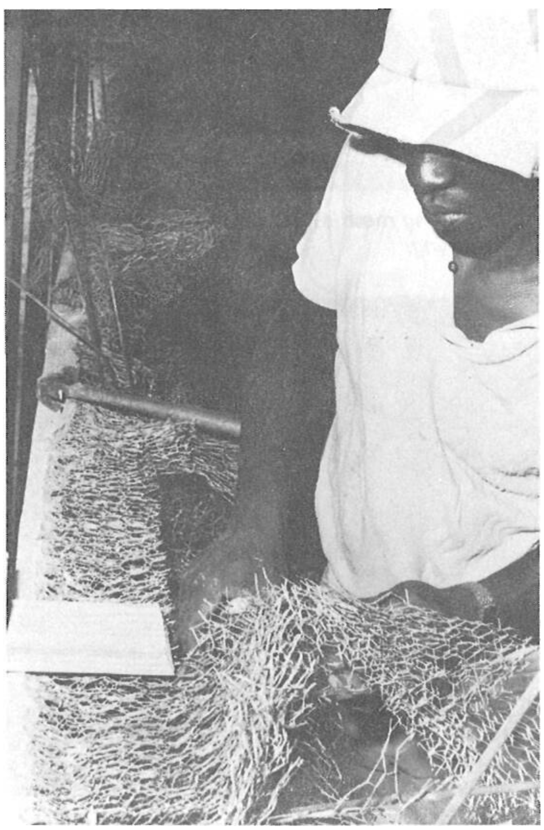
Worker installs temporary supports to tank tops.

JOB 7 - MAKING THE RAIL CAP

A one-inch (25 mm) T-bar screed was welded to the tips of the hull starter rods where they had been bent over at the sheer to form a rail cap.


Cutting rail cap rods to length.

First, any lumps of mortar which had been spilled on the rail cap mesh during plastering were pounded and cleaned out. The mesh was trimmed to an even six inches (152 mm) and folded back. The starter rods were cut off at six inches (152 mm) length and the T-bar screed was welded in place. Great care was taken in welding the rail cap screed to ensure that a fair pleasing curve was formed longitudinally. Also that the rail cap lay flat as it accompanied the sheer of the hull. Two 1/4-inch (6.4 mm) reinforcing bars were welded to the starter rods longitudinally to reinforce this area further. One-and-one-quarter inch (32 mm) galvanized pipe was cut into one-inch (25 mm) rings. These rings were welded in place between the reinforcing bars of the rail cap. These galvanized rings, or collars, served for holding removable pipe stanchions in the rail cap. They were welded flush with the top of the rail cap. The mesh was then folded onto the reinforcing bars and clipped firmly in place with hog ring staples.

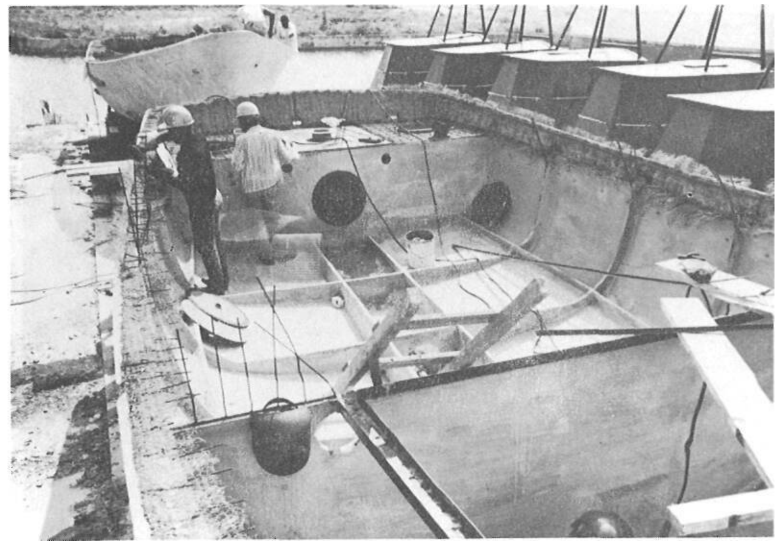

Trimming rail cap mesh. Note wooden guide.

TASK 1 — Prepare and Trim Reinforcing

The mesh and rod at the sheer was trimmed to a uniform six inches (152 mm) length. Any loose mortar that had been caught in the mesh was pounded out. The layers of mesh were separated by bending the top six layers upwards and the bottom four layers downwards. The starter rods were then bent inwards at right angles to the hull sheer. They were leveled to ensure that the rail cap would lie flat.

TASK 2 — Completing the Reinforcing

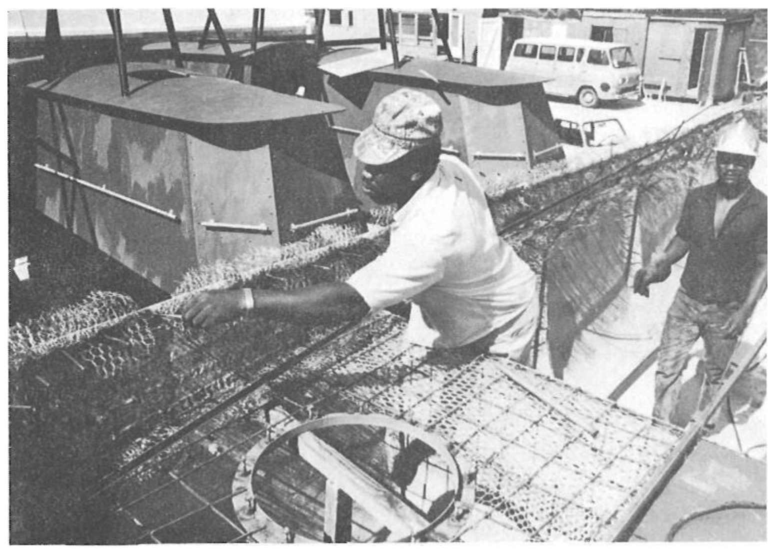
T-bar was welded to the tips of the starter rods around the inside of the sheer to form a screed for the rail cap. Care was taken to ensure that the curve of the sheer was followed neatly. Two lines of 1/4-inch (6.4 mm) diameter rebar were then welded to the starter rods, lying parallel to the sheer and the rail cap T-bar screed. The layers of separated mesh were fastened back to the rod reinforcing and screed with hog ring staples. Wherever gaps existed in the rail cap mesh, patches of mesh were inserted and fastened,



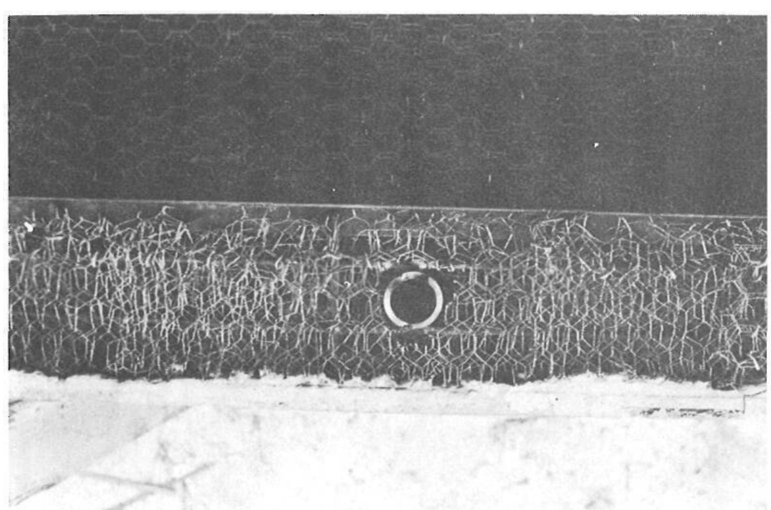
Folding back mesh before welding.

TASK 3 — Installing Stanchion Sockets

From the midships to the transom at a distance of six inches (152 mm) abaft every station, a removable stanchion was planned to be fitted into sockets cut from 1 1/4-inch (32 mm) diameter pipe, welded into the rail cap and deck reinforcing. First, one inch (25mm) deep rings, or collars, were cut from 1¼-inch (32 mm) diameter galvanized pipe, plus an accompanying two inches (51 mm) deep collar to form a socket base at the deck. The one-inch (25 mm) deep collars were welded into the rail cap reinforcing, the two inches (51 mm) deep collars to the deck. To position these collars correctly, a stanchion was slipped through them and a vertically placed spirit level used for accuracy. Patches of mesh were fastened around the collars in the rail cap and deck.

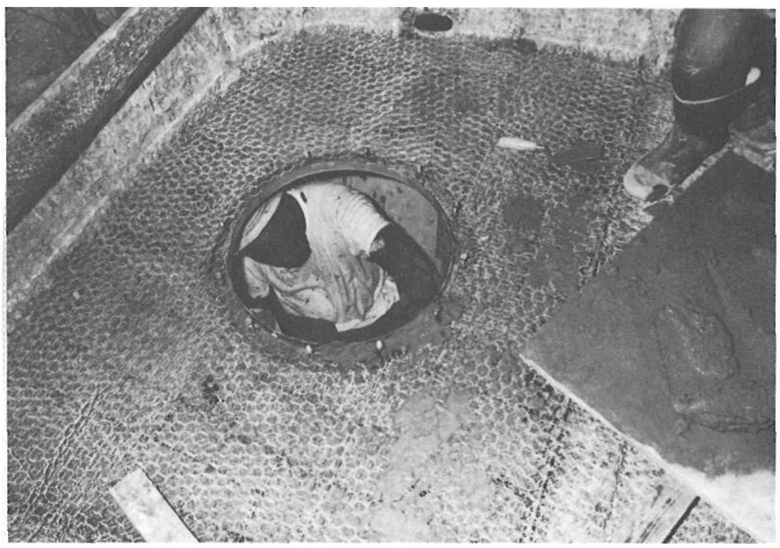


Rail cap rods leveled, screed goes on.

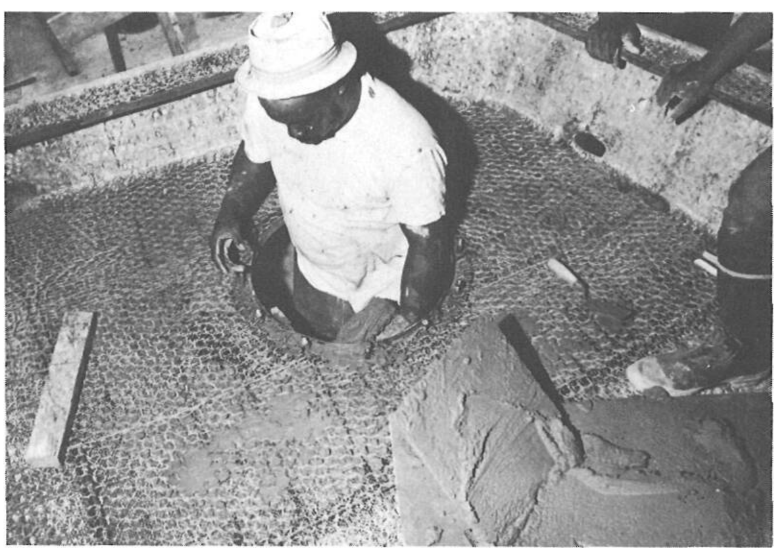


Stanchion socket in place (bird's eye view).

Supplying plasterer inside water tank.



Plastering water tank interior top.



Working inwards towards the hatch.

JOB 8 - SKIN PLASTERING WATER TANK TOPS AND INSIDE FISH-HOLD.

TASK 1 - Water Tank

The water tank required four separate plastering stages:

Stage 1 — When the hull and transom were formed, this molded the back, bottom and one side of the tank.

Stage 2 — When the bulkheads and webs were constructed, this molded the front and the midships side panel.

Stage 3 — A skin coat was required to do the following:

1. Ensure all joints were watertight so that fresh water would not leak out of the tanks and that contaminated bilge or salt water would not leak in.

2. A wood deck mold could not be used as this would have been difficult to fit and make watertight with the sides of the tank and the hull.

3. There was a two-foot (610 mm) diameter access hatch welded into the top of each tank. This left the tank top without adequate framing support before plastering.

The joints around the access hatch screed and the tank top and sides had to be completely watertight. To ensure that this would be so, a skin coat was applied completely over the interior surface of the tank. The top surface formed a deck mold once it had set. When the whole deck was plastered we were careful to ensure that mortar was vibrated well into the joints around the top of the tank.

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TASK 2 - Fish-Hold

A seafood container in use creates several problems:

1. The seafood which is stored in it leaves slime and residue upon which bacteria thrive. The surface of the container must be easily cleaned and contain a minimum of sharp corners and difficult crevices.

   If the hold cannot be cleaned easily the bacteria will soon become such a problem that no seafood can be placed in it without it becoming contaminated.

2. Wooden fish-holds soon rot because they are continuously damp. At times there is ice in the holds keeping them cool, while at other times the molds are left empty and as warm as the ambient air. Ideal conditions for stimulating dry rot. Spongy rotten wood collects and holds bacteria as well as structurally weakening the entire hold framing.

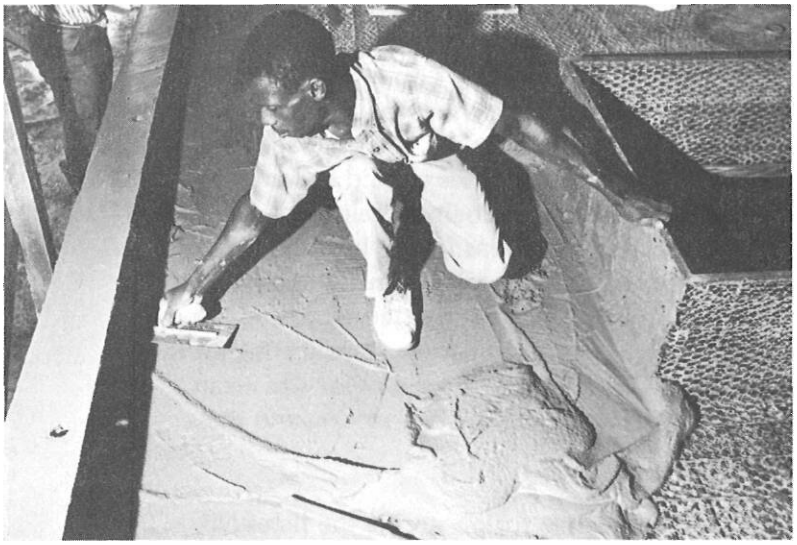
3. A fish-hold must store seafood for long periods of time without the cooling ice melting too rapidly. Direct metal ties between the inside of the fish-hold and the outside of the vessel must therefore be eliminated. These ties form hot spots in the hold. They transfer heat from the outside to the inside, thereby rotting seafood stored against them and generally making the insulation properties of the hold less effective.

The fish-holds were constructed using 2" x 4" (51 mm x 102 mm) wooden framing with plywood on both sides. Polyurethane foam insulation was packed between the framing. None of the nail heads attaching the plywood on the inside of the hold were in contact with the outside of the hold as the nails terminated one-half way through the 2" x 4" (51 mm x 102 mm) frame. Preventive measures were taken to inhibit rot forming in the fish-hold at some future date. All wood surfaces and joints were coated with pitch.

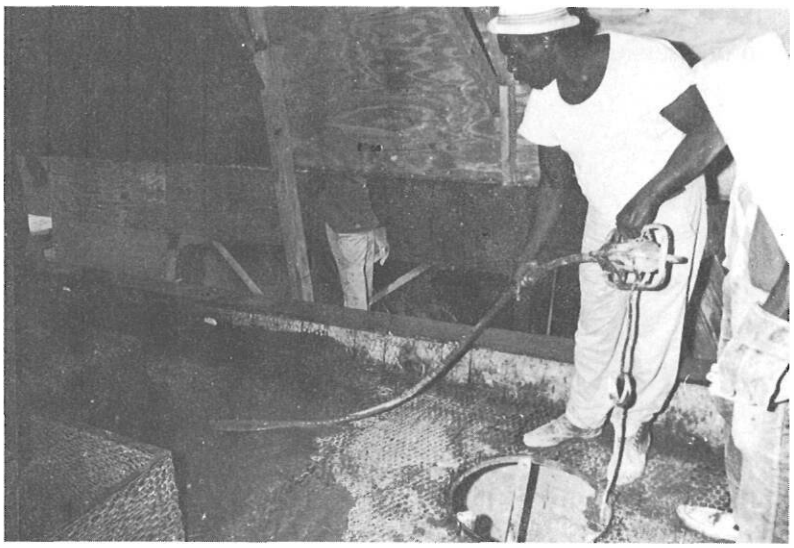
Inside the hold a layer of tarpaper was stapled over all surfaces. Two layers of mesh were then stapled over the tarpaper. The mesh was carried downwards into the drainage and inspection hatches. It was carried upwards to merge with the hatch coaming reinforcing. A thin layer of mortar was forced into the mesh and troweled to a smooth finish. All corners were rounded to prevent matter collecting. The result was a watertight hard surface throughout the entire hold. The surface was easy to clean and not easily damaged when storing and shoveling ice.

The schedule for plastering the fish-hold interior and the water tanks was one day ahead of plastering the deck. In this way the fish-hold, tanks and deck were steam-cured in one session.

Plastering inside the fish-hold.



Rail cap plastered, the deck follows.



Every square inch vibrated.

John Samson demonstrates use of vibrator on the deck.

JOB 9 - PLASTERING THE DECK

The mortar mix used for the deck was the same as for the hull. Particular attention was paid to the following:

1. Good overall penetration of the mortar through the deck mesh.

2. The edge of the deck where it met the hull was well vibrated to ensure that there would be no future leaks in this area.

3. The mortar was faired to give free flow to the scuppers.

4. The inside of the bulwarks were dampened as this section was receiving only a skin coat at this time. The skin coat here was applied and finished in the same way as the skin coat inside the hull.

5. The edge of the rail cap was rounded to eliminate future chipping.

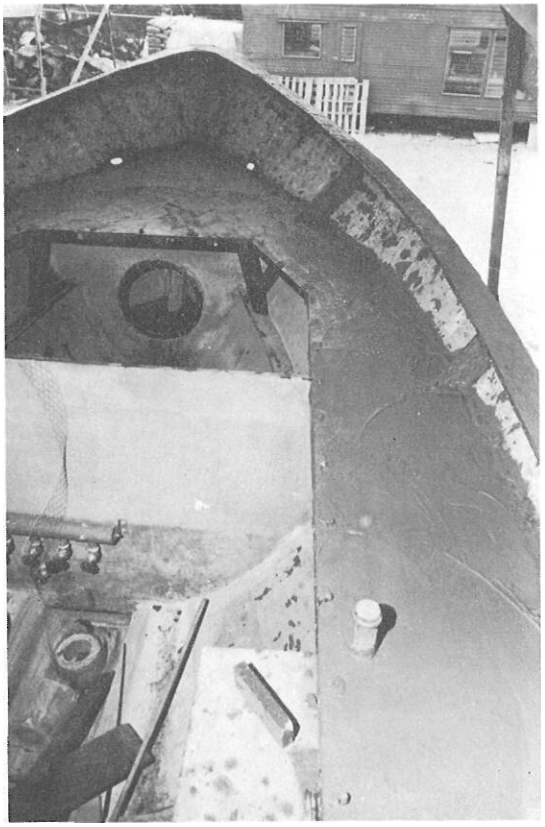
6. The hatch coamings were square to make fitting the hatch covers easier. The corners themselves were rounded to prevent chipping.

7. The deck area where the wheelhouse was to be later bolted down was leveled and smoothed to facilitate watertightness at this joint.

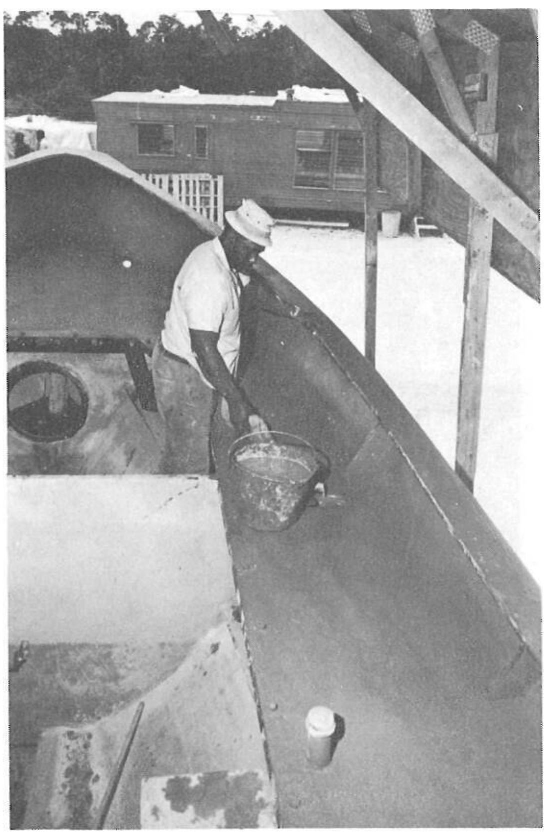
8. The deck over the water tanks was well vibrated. The mortar around the screeds forming the inspection cover frames was smoothed so that the covers could be easily bedded in place later.

9. A sponge trowel finish was given to the entire deck and bulwark surface except for the following areas:

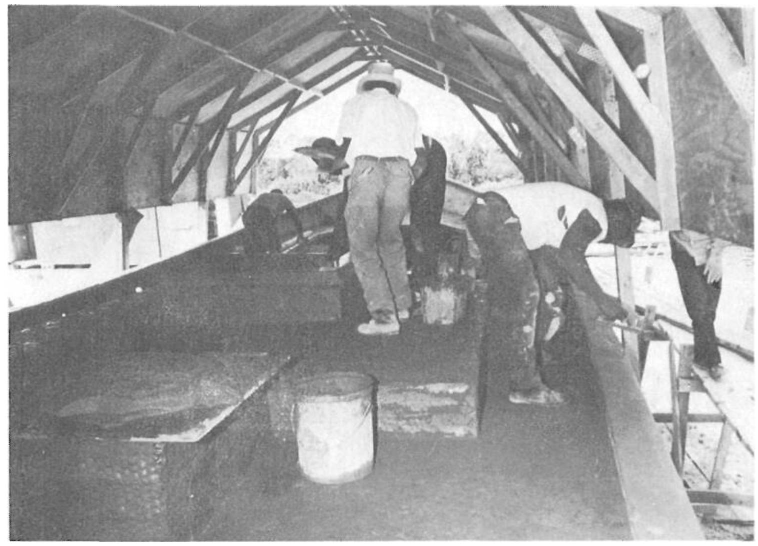
   A. Hatch Coamings
   B. Rail Caps
   C. Areas surrounding water tank inspection access and the wheelhousebase.



Note wooden plugs to superstructure bolt-holes, fuel tank filler cap.

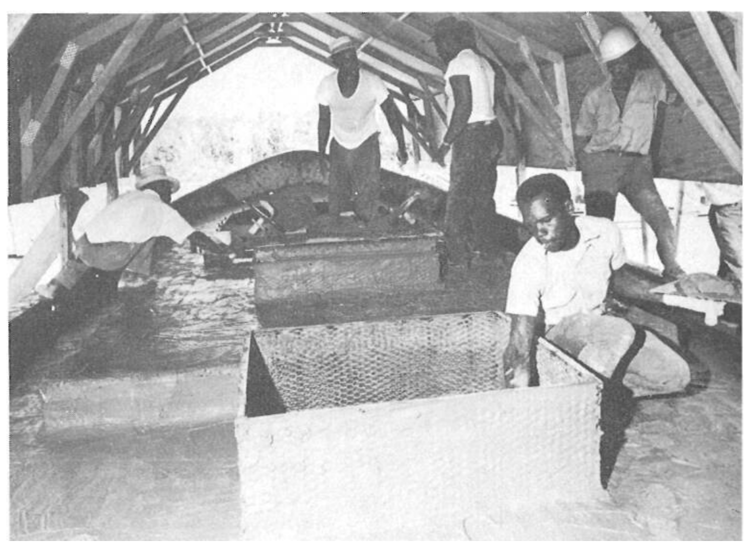


Final smoothing.

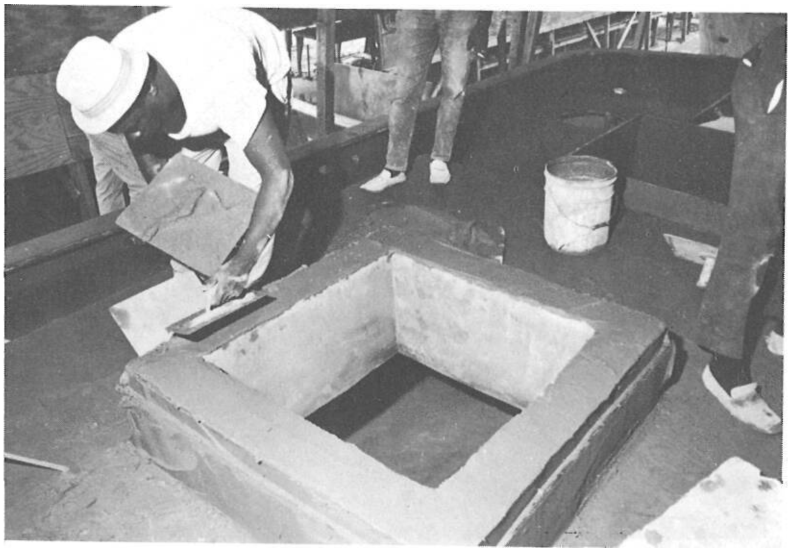


Finish off rail cap and coaming.

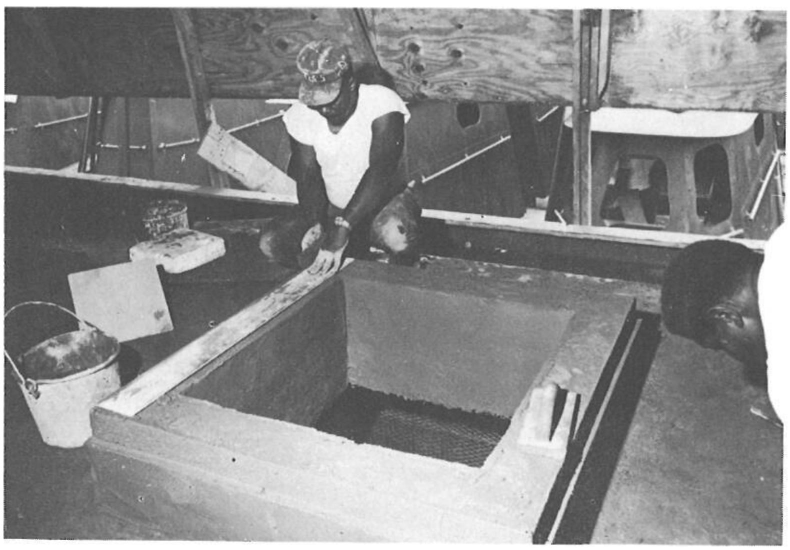
Plastering lazarette hatch coaming.



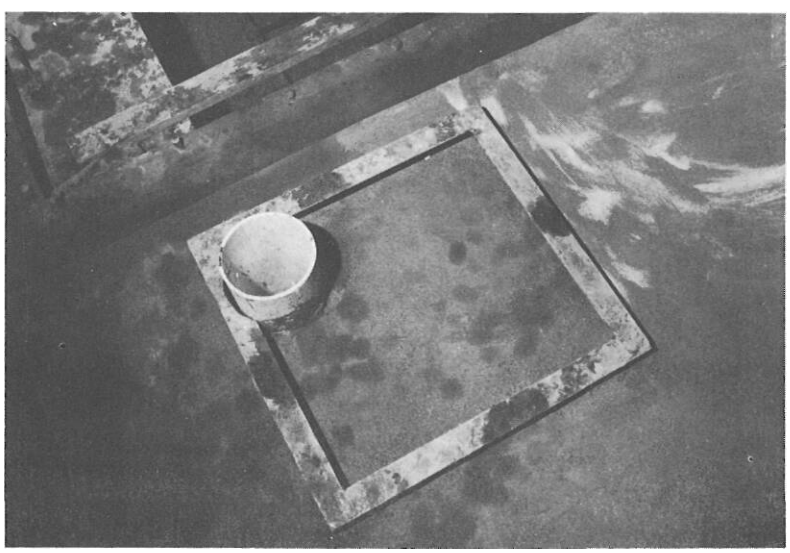
Plastering coaming from inside.



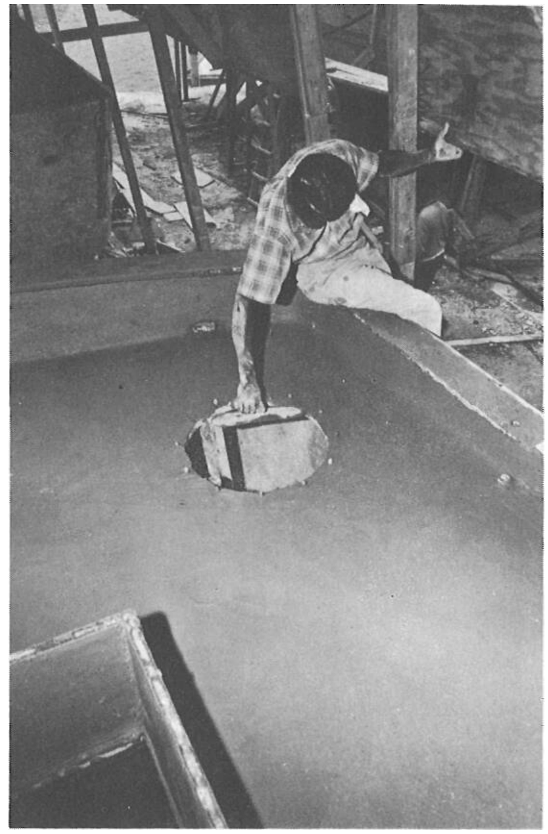
The fish-hold hatch coaming.



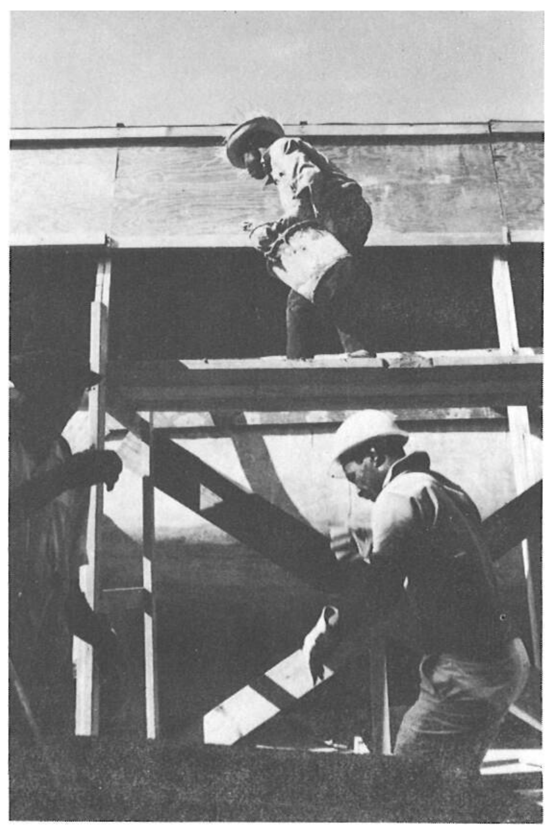
Squaring hatch coaming edges.



Ice machine chute and base frame cemented in.



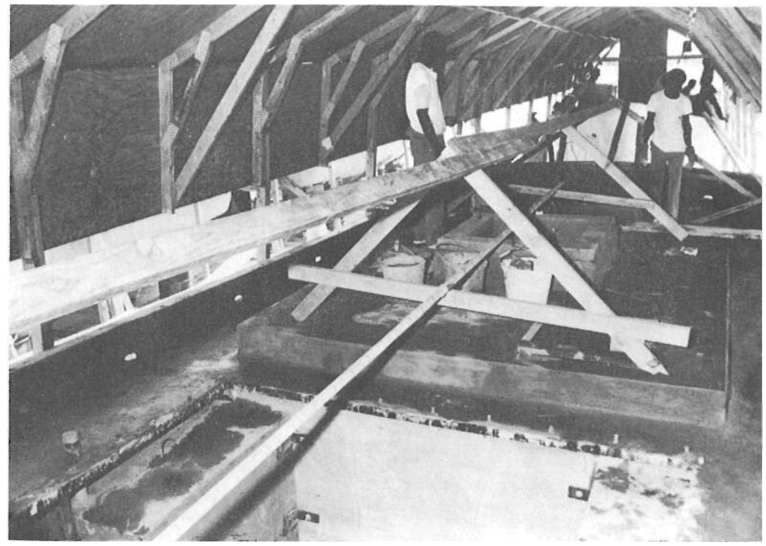
Smoothing surface for water tank cover plate.



Continuing mortar supply.

JOB 10 – STEAM CURING

The decks and fish-hold were steam-cured in the same manner and to the same temperature as the hull had been. A steam distribution pipe was set up on the deck. A temporary framework was constructed for the steam tent. The tent was dragged over the framework and the decks cured for 24 hours at 150° F (66° C).

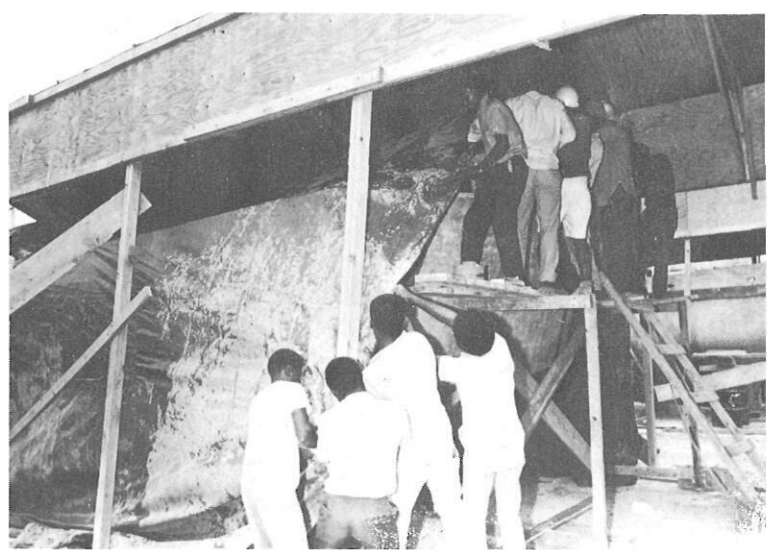


Ridge support for steam tent.

The steam tent.

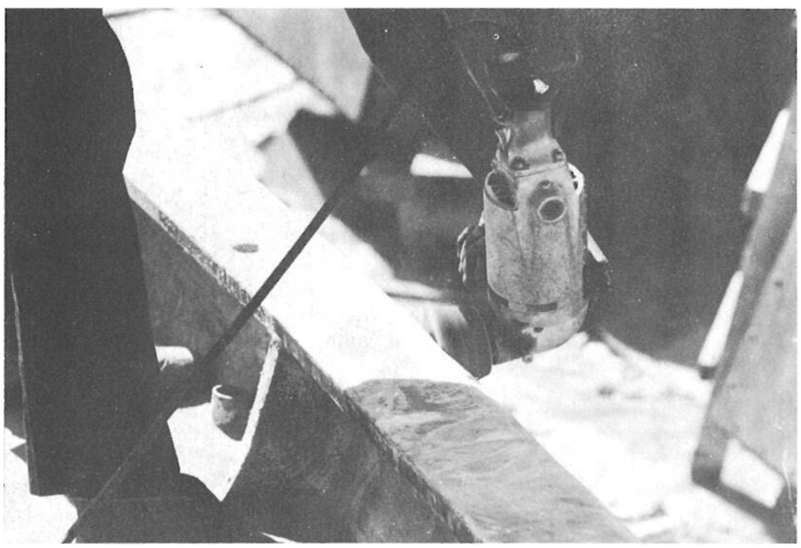
The perforated steam pipe in place.

The steam generator.



Steam tent hauled over.

Grinding rail cap smooth.

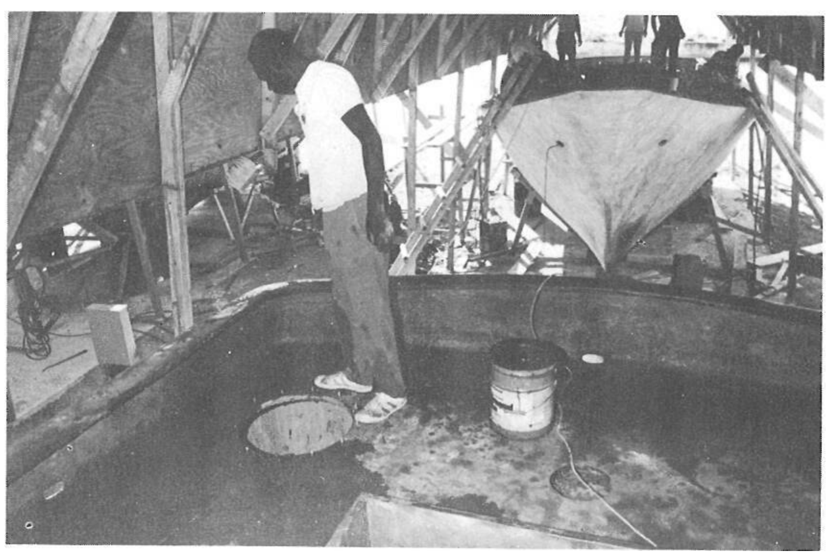


Rounding rail cap edge.

JOB 11 - TESTING THE WATER TANKS, GRINDING AND CLEAN-UP

The concrete work on the vessel was now complete. The tanks were again filled with water to check their watertightness a second time. All the steam condensation water which had gathered in the various compartments of the hull was mopped up.

The edges around the water tank inspection cover frames were ground smooth. The doweling forming the bolt-holes in the concrete deck, which would later be used to fasten the wheelhouse down, were knocked out and the holes cleaned with a carbide drill. These edges were also ground smooth. The rail cap outside edge was rounded. A special masonry grinding wheel was used for this purpose, the wheel mounted in an angle grinder. After grinding, the hulls were cleaned once more.



Filling water tanks for testing.

JOB 12 - INSTALLING THROUGH-HULL FITTINGS

Bronze through-hull fittings were used for the following systems:

Main engine cooling water intake and outlet.

Deck wash-down system intake.

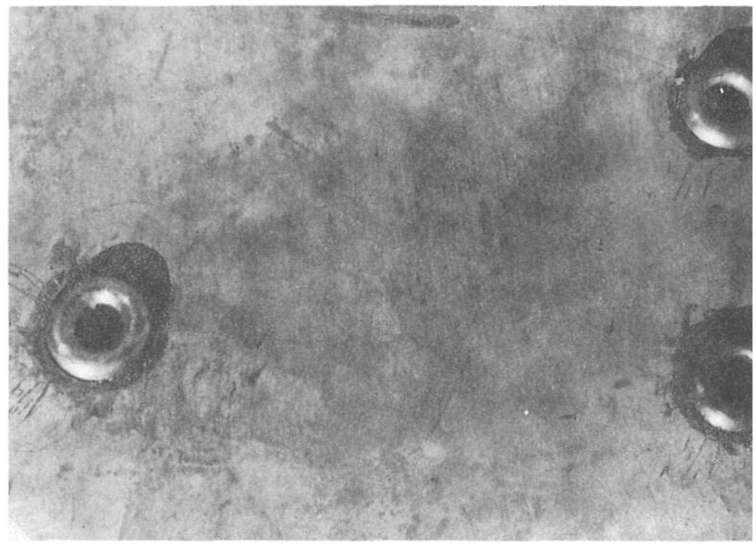
Ice machine intake.

Galley sink drain.

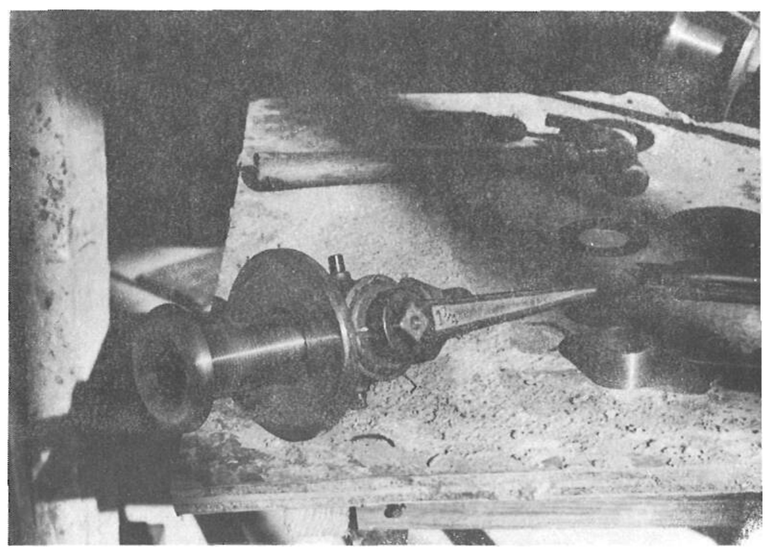
Cooling water intake for diesel generator unit and wet exhaust outlet.

All through-hull fittings had bronze, tapered-plug sea-cocks attached. The through-hull fittings had cottom grommets wrapped around the inside of the outside flange and were then bedded down in silicon sealant. Once all the through-hull fittings were installed they were joined together and grounded to the webs with No. 8 copper wire. The object of this was to reduce electrolytic action.

Inserting through-hull fitting.



Through-hull finings installed.

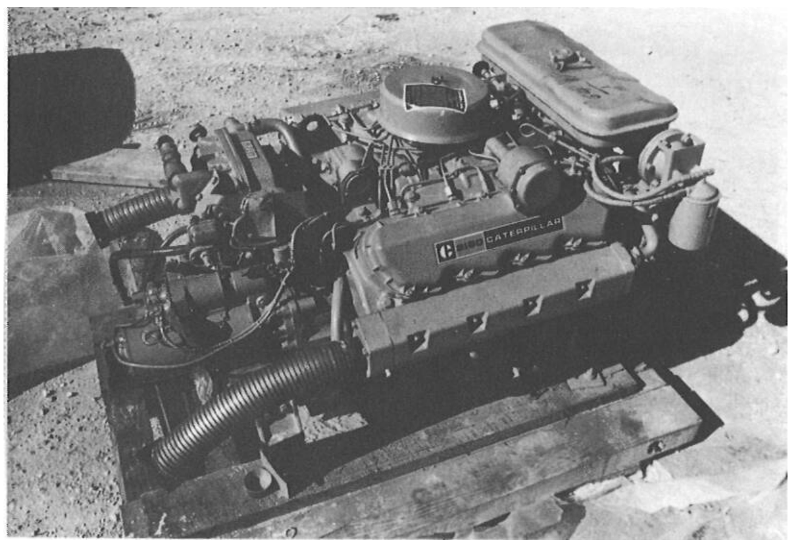


Bronze through-hull fitting with sea-cock attached.

STAGE 4
JOB 1 - INSTALLING MAIN ENGINE

TASK 1 - Align Pillow Block Bearing

The initial alignment of the propeller shaft pillow block bearing and aft engine room bulkhead stuffing box has been described in Stage 1, Jobs 7 and 12. At this stage the propeller shaft was installed and the pillow block bearing finally checked for alignment on its already prepared foundation in the shaft alley. The bulkhead stuffing box was not fastened until the engine had been aligned.



Caterpillar Model 3160 V-8 Marine diesel engine with twin-disc reverse/reduction gear.

Fitting propeller shaft half coupling.

TASK 2 - Fit Propeller Shaft Half Coupling

The propeller shaft half coupling was supplied with the Caterpillar Model 3160 engine. It was temporarily bolted to its matching flange on the reverse/reduction gear. The coupling required machining out to fit the 21/4-inch (165 mm) diameter propeller shaft. It also required a 9/16-inch (14.3 mm) keyway cut into it to match the keyway on the shaft. This work was undertaken by an outside machine shop. Tolerances were fine in this machine work as the fit of the propeller shaft half coupling is a critical one. The face of the flange must lie absolutely at right angles to the shaft center line at all points of its circumference. For it is from the siting of this face with the matching face of the reverse/reduction gear coupling that the engine is ultimately aligned.

As machine tolerances were fine, the fit of the half coupling to the shaft was tight. To avoid damaging the critically machined surface of the flange, a heavy lead buffer was placed over it while being pounded on. In addition to the key securing the coupling to the shaft, holes were drilled through the coupling and into the surface of the shaft which were tapped for 1/4-inch (6.4 mm) diameter set screws.

TASK 3 - Aligning Shaft End

With the half coupling fitted, the length of the shaft drooped slightly from its last point of support—the pillow block bearing. Experienced fitters can lift the drooping end of a propeller shaft and, by feeling it and rotating it, establish its true aligned position with their sense of touch. The use of a load indiator suspended from the deckhead is an exact way of establishing the shaft end alignment. A bottle screw is hooked onto the load indicator hook, and from the bottle screw a light wire rope sling is passed around the shaft at the middle of the half coupling. It is important that this gear is suspended directly overhead and that there is no lateral pull. A formula is now employed; the weight of the shaft from the pillow block support is calculated and divided by half. The total weight of the half shaft coupling is added to this calculation, less the weight of the bottle screw and sling. The bottle screw is shortened until the load indicator registers a pull equal in weight to that calculated in the formula. This will place the shaft end in its true aligned position. The ultimate check is to verify if the shaft is rotating as freely as it should be in this position.

TASK 4 — Engine Bed Preparations

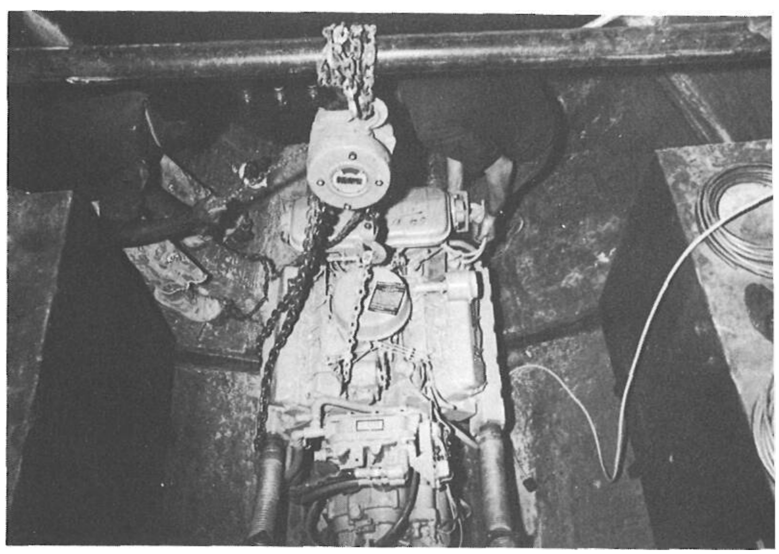
The engine bed steel reinforcing had been capped on its upper edge with two parallel lengths of T-bar screed. The two lengths of T-bar were welded five-eighths of an inch (16 mm) apart. Into this gap were placed 5/8-inch (16 mm) bolts, their heads downward, their threaded section projecting two inches above the T-bar. The bolts were welded to both T-bars and the heads welded to starter rods emanating from the hull reinforcing. The engine beds were meshed and plastered in the same way and at the same time as the webs, bulkheads and stringers.

Two lengths of 5/8" x 3" (16 mm x 76 mm) steel flat bar were cut and drilled to fit and to be bolted down to the upper surface of the engine beds by means of the embedded 5/8-inch (16 mm) bolts. Into the flat bar, first drilled and countersunk on both sides to ensure a solid weld, were welded the 3/4-inch (19 mm) engine mount bolts of specially hardened steel. After the flat bar had been securely bolted to the reinforced concrete engine beds, four hardwood pads of Bahamian madeira were drilled for the 3/4-inch (19 mm) engine mount bolts and placed on the engine beds. The engine was suspended by chain hoist from the superstructure framework and lowered and lifted to enable adjustment to be made to the hardwood pads as the alignment work progressed.

TASK 5 — Aligning the Engine

This is always a job demanding great patience and determination. For an engine, even when suspended on a chain hoist, is awkward to handle and will often require many tries at shim ming, shifting and bolting down before it becomes aligned within the manufacturer's recommended tolerances. The guide to engine alignment is the fit of the opposing faces of the matching half-couplings fitted to the propeller shaft and to the reverse/reduction gear. The propeller shaft half coupling has been aligned. It is the half-coupling on the reverse/reduction gear which has to be brought up to it.

Misalignment occurs in two ways. Parallel misalignment is apparent when the propeller shaft center line and the reverse/reduction gear output center line are parallel but are not in the same place. Angular misalignment is apparent when the face on the propeller shaft half-coupling, and the face on the reverse/reduction gear coupling, are not parallel.



Lowering engine onto bed.

The first aim in alignment is to reach the point where the male flange on the reverse/reduction gear half-coupling fits into the female flange on the propeller shaft half-coupling. Having achieved this, there remains to bring the two opposing faces of the flanges together, absolutely parallel. A set of feeler gauges must be used at this point to slip between the opposing faces. The feeler gauges must be checked regularly, all around the flanges, as the alignment work of adjusting the hardwood pads beneath the engine supports proceeds. If, for the purposes of this description, the faces of the opposing flanges can be regarded as clockfaces, then the feeler gauges must be inserted at the positions of 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock.

The engine and its sterngear can only be said to be secure and truly aligned when the following points have been carried out to perfection.

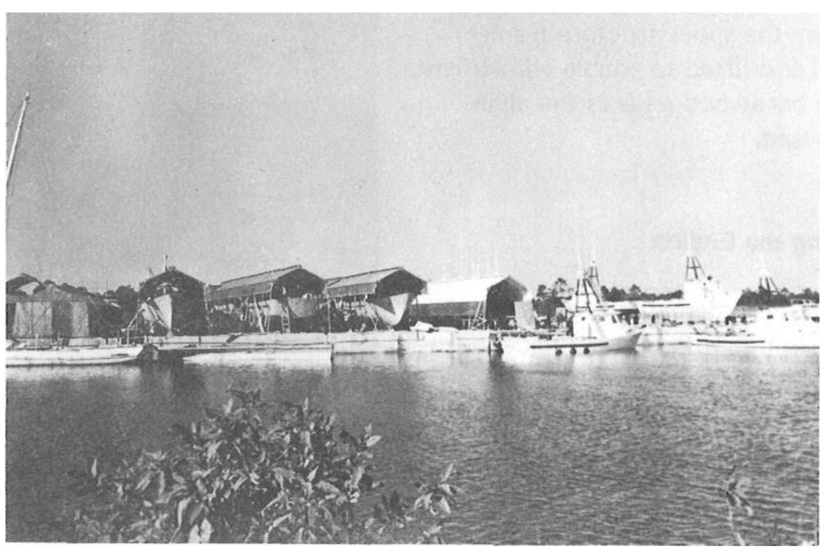
1. With the engine securely bolted to its bed the male and female flanges on the coupling fit smoothly into each other.

2. With the flanges smoothly rested into each other the distance measured between them with the feeler gauges, at all circumferential points, is constant.

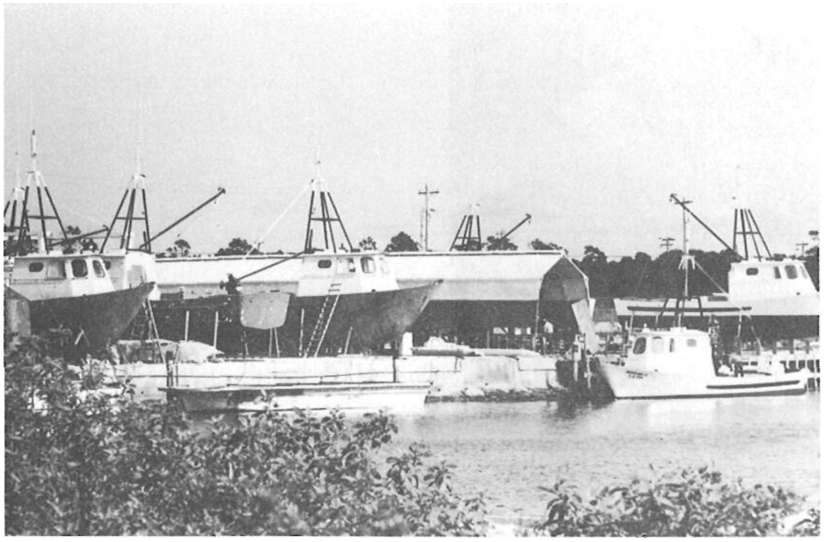
3. With the flanges nestled together and freely rotated by hand to the four opposing clockface positions, the distance apart registered with the feeler gauges still remains constant.

Twenty-four hours after launching the alignment must be checked again and further adjustments made if necessary. If the boats suffer a severe grounding or some other form of shock during service the alignment should be rechecked. As a matter of routine, alignment should be checked once a year.

Too much emphasis cannot be placed on the importance of secure and proper alignment. Endless mechanical trouble will occur, primarily to the shaft-bearings and ultimately to the reverse/reduction gear box if this work is not correctly carried out.

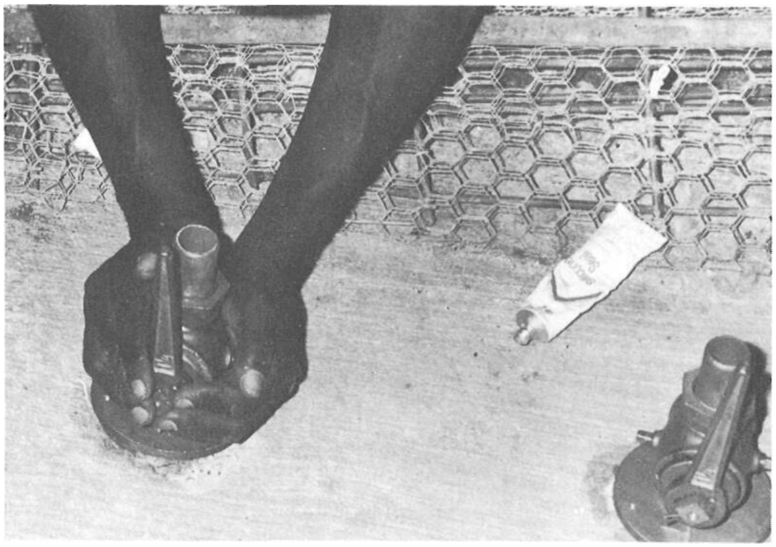


The boatyard at Freeport - November, 1971.

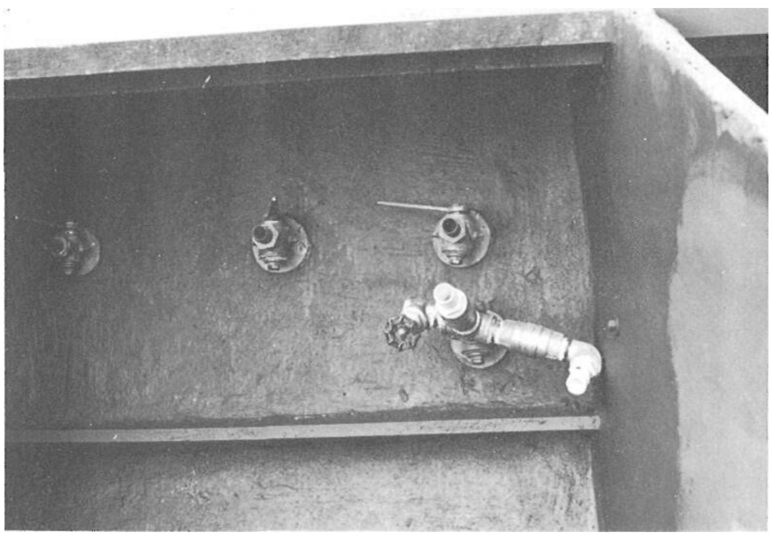


The superstructures are installed.

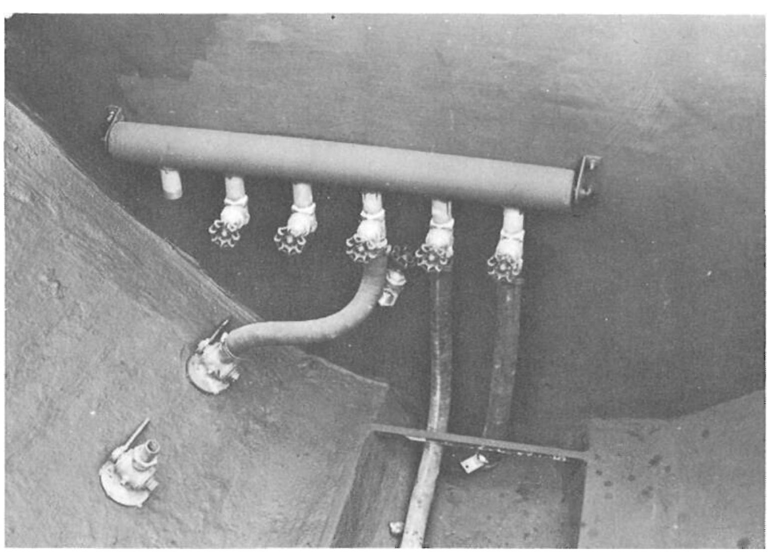
Final commissioning afloat.



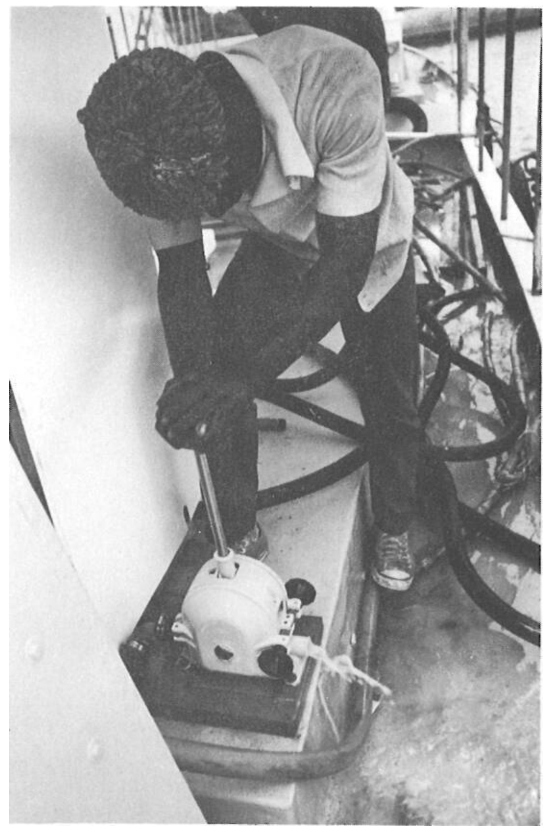
Threading sea-cocks to through-hull fittings.



Outlet sea-cocks fined above the waterline.



The bilge manifold. Note low-sited intake sea-cock.



The emergency hand bilge pump on deck.

JOB 2 - BILGE MANIFOLD INSTALLATION

The bilge manifolds were made from four-inch (102 mm) I.D. steel pipe 1½ feet (761 mm) long. Six 1%-inch (32 mm) pipe nipples, three inches (76 mm) long, were welded on at equal centers in a straight line. Both ends of the four-inch (102 mm) I.D. were then closed by welding on a round piece of %-inch (6.4 mm) plate. A 3/8-inch (9.5 mm) bolt was welded onto the center of both end-pieces. A pair of steel brackets were made to secure to the 3/8-inch (9.5 mm) bolt on the end-pieces. The brackets were then through-bolted to the forward bulkhead of the engine room. Five bronze gate valves were screwed into the pipe nipples and sealed with teflon tape. One nipple was reserved as a spare and temporarily capped off.

Gate Valve Functions: From Left to Right on the Bilge Manifold

No. 1 valve was connected to the suction side of the emergency hand bilge pump on deck.

No. 2 valve to the suction side of the main bilge pump driven off the main engine.

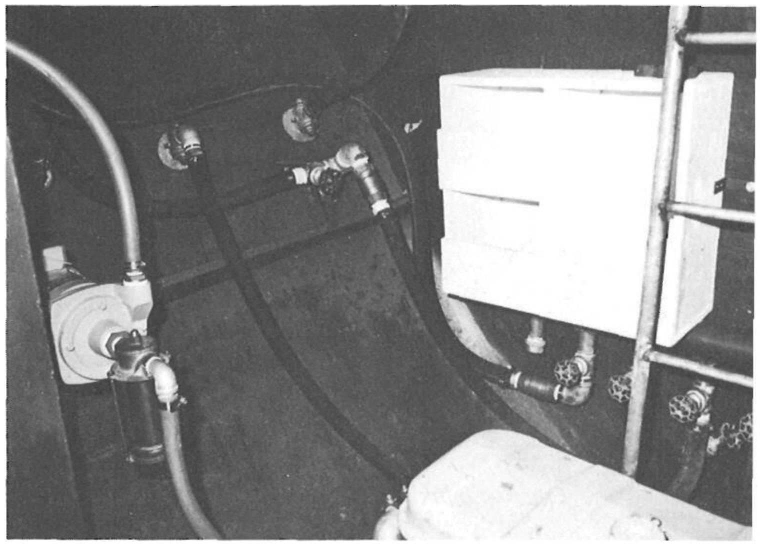
No. 3 valve to an inlet sea-cock.

No. 4 valve to the bilge strainer in the fish-hold. A check valve was screwed into the fish-hold strainer with flow directed to the manifold.

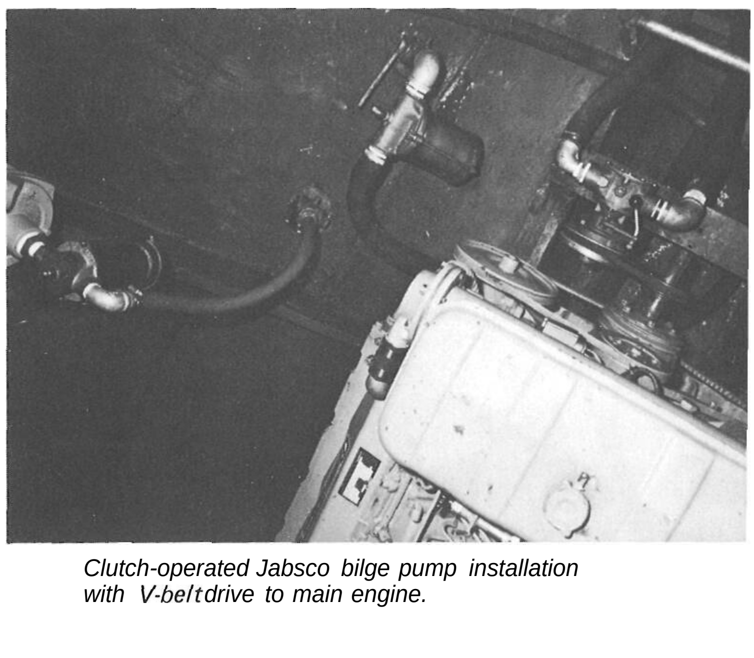
No. 5 valve went straight down into the engine room bilge with a combination strainer and check valve clamped to the end.

All the hoses going to and from the bilge manifold were 1%-inch (32 mm) suction lines and were, therefore, made of steel-reinforced, oil and saltwater-proof, rubber. A normal type radiator hose would collapse under suction. The outlet from the main bilge pump was through a check-valve screwed onto a "Tee," one end going to an outlet sea-cock, the other end through a valve leading on deck to the wash-down hose. All discharge hoses used were 1%-inch (32 mm) rubber radiator hose.

The bilge pump base was made from 3/8" x 4" (9.5 mm x 102 mm) flat bar welded across the engine bed. Four long sliding holes were cut in the flat bar, 7/16" x 2" (11 mm x 52 mm) long, to allow adjustment tension to the "V" belts on the bilge pump.



Bilge manifold system connected. Note sea-water transfer pump for ice machine installed on left.



Clutch-operated Jabsco bilge pump installation with V-belt drive to main engine.

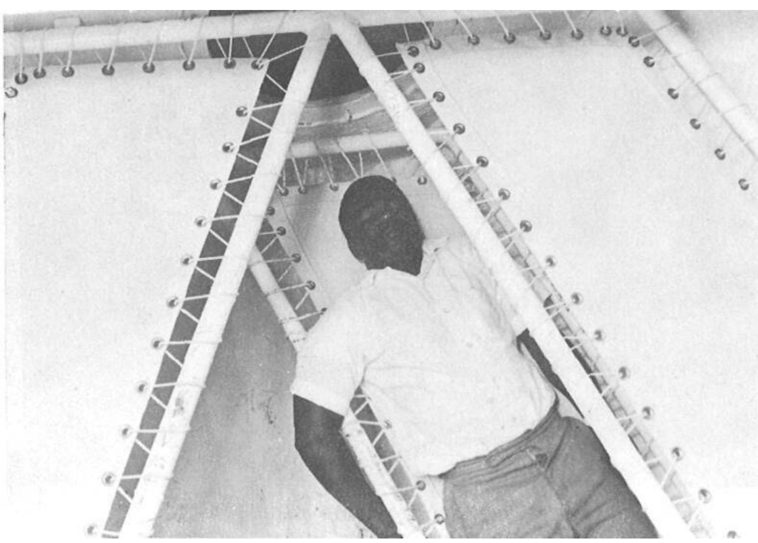
JOB 3 - INSTALL FORECASTLE BUNKS

Erecting bunk supports.

The bulkhead supports for the pipe frame bunks were made as follows:

Eight three-inch (76 mm) pieces of 3" x 3" (76 mm x 76 mm) angle-iron were cut and drilled with a 9/16-inch (14 mm) hole through the middle of one of the angle faces. The top bunks were designed to lie 1½ feet (761 mm) below deck level, the single bottom bunk at two feet (609 mm) below the top bunk. At these required levels the eight angle-iron supports were through-bolted in the fore and aft foc's'le bulkheads with -inch (12.7 mm) bolts. The 1¼-inch (32 mm) galvanized pipes were kept as long as possible, placed athwartships on top of the angle-iron supports and welded on at a two inches (51 mm) spacing away from the bulkheads. Three longitudinal pipes were then welded onto the pipes already fixed to the bulkheads. Two on the top level and one at the bottom, kept as close to the hull-side as possible. Pipes were then welded parallel at a space of two feet from the pipes accompanying the hull sides (thus giving the bunks a width of two feet). The two pipes bolted athwartships to the engine room bulkhead were used as steps. All welds were cleaned off and painted with zinc epoxy primer.

After the foc's'le had been painted white a stout marine canvas was laced to the pipe framework. Nylon cord,1/4-inch(6.4 mm) diameter, was laced through brass grommets set at four-inch (102 mm) centers. Though simple and somewhat austere, the canvas bunks were found to be cool and comfortable in the Bahamian climate.

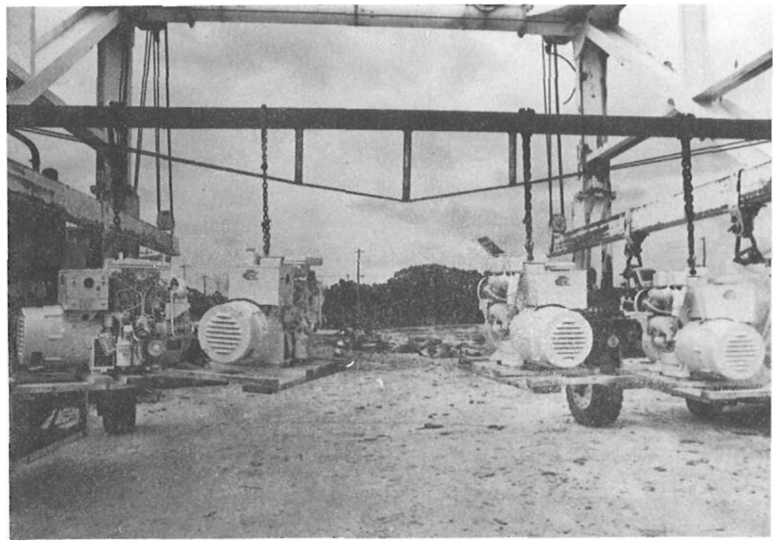


The bunks comfortably complete.

JOB 4 - DIESEL GENERATOR UNIT INSTALLATION

The 7.5 k.w. Onan diesel generator unit was supplied with its own, vibration-free, mounting plate, oil pan and two mounting brackets, each drilled with three 7/16-inch (11 mm) holes. It was installed in the lazarette, abaft the fish-hold. The complete unit was mounted on two 3" x 3" (76 mm x 76 mm) angle-iron supports welded athwartships onto the bilge stringers. Bolt holes were marked on the supports from the mounting brackets (drilled 7/16", or 11 mm) and then the unit fastened down with 3/8-inch (9.5 mm) bolts.

The sea-water cooling intake to the engine heat exchanger was connected to the bronze through-hull fitting and its accompanying water strainer by means of a short section of pressure hose.

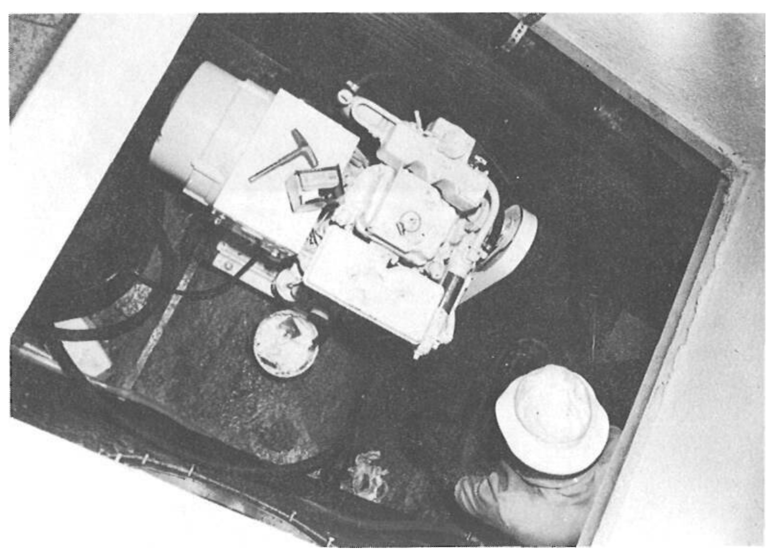


The diesel generator units being transported to the boats.

JOB 5 - INSTALLING OF HYDRAULIC STEERING GEAR LINES

Soft copper tubing, ½-inch (12.7 mm) diameter, as recommended by the manufacturers, was used for connecting the Wagner Hydraulic Steering Gear to the helm control in the wheelhouse.

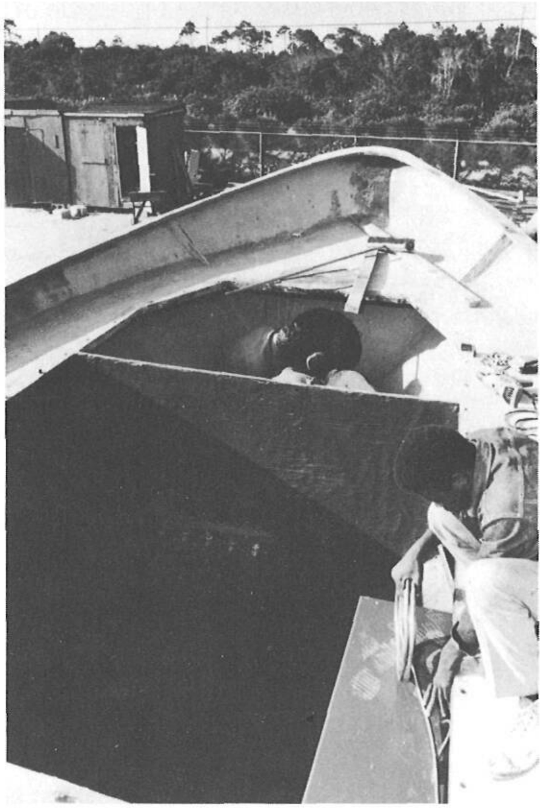
On top of the steering gear cylinder, and as close to and as high up as possible, a by-pass valve interconnecting the two hydraulic lines was inserted. This was for use in event of an hydraulic breakdown. The hydraulic lines running to the helm control could then be by-passed by closing the valve, and the emergency tiller taken out and fitted over the top squared section of the rudder post. All hydraulic lines were securely fastened with copper clamps at every two feet of length. The connections were double flared and sealed with gasket compound.



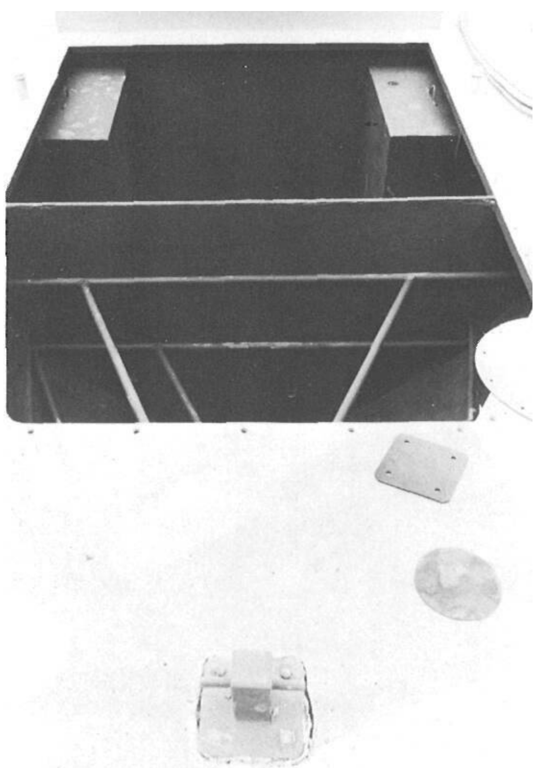
Installing the diesel generator unit in the lazarette.

These are the instructions issued to the crew for filling up the hydraulic system:

"Fill up the helm pump by hanging a one-gallon can above it. Connect a clear plastic hose from the outlet on the bottom of the can to the filling tube of the helm pump. Fill the can with hydraulic oil, open the by-pass valve on top of the steering cylinder. Turn the wheel continuously in one direction and keep filling the can as needed until no air bubbles are seen coming up from the helm pump. Close the by-pass valve and open the flared nuts on the steering cylinders juas a little. Turn the wheel from port to starboard slowly, a half turn in each direction. When no air bubbles are to be seen coming out around the flared nuts, but a solid flow of oil, tighten up the nuts. The hydraulic system is full and operative."



Installing hydraulic lines.



Samson Post installed.

JOB 6 - FASTENING CLEATS AND SAMSON POST TO DECK

The samson post at the bow is, at times, submitted to considerable pulls and strains. It has more height than the fairleads and cleats, consequently, it is often subject to greater leverage. To prevent the bolts which fasten the samson post to the deck from being wrenched out under strain, a steel plate, of the same dimensions as the samson post base, was placed beneath the deck. The bolts pass from the samson post base, through the deck, and through the deckhead plate. Cotton caulking was wound around the bolt heads to prevent leakage, and a neoprene gasket, coated both sides with silicon sealant, was placed between the samson post base and the deck.

STAGE 5
JOB 1 - INSTALLING THE SUPER-STRUCTURE

The superstructure framework had been built with a steel matching base frame. Both had been given the same number, both had all bolt holes predrilled. The base frame had been welded into the deck steel reinforcing, the bolt holes plugged with wooden doweling at the time the deck was concreted.

The superstructures were fitted to the hulls, either afloat or on the hard, according to convenience. The joint between the deck and superstructure was soundly caulked, and the unit bolted down with ½-inch (12.7 mm) diameter galvanized bolts at six-inch (152 mm) centers. The electrical, hydraulic and plumbing systems were then interconnected, the joint between the deck and superstructure cemented, and deck and wheelhouse to the height of the handrails, painted with epoxy deck paint.

TASK 1 — Applying Caulking Compound

Marine caulking compound was applied liberally to the concrete deck in the area of the joint of the superstructure base to the deck. A continuous "rope" of naval oakum was rolled by hand into roughly the thickness of a thumb, smeared with caulking compound, and laid along the joint on the inside of the line of bolt holes. A second continuous rope of oakum was laid on the outside of the line of bolt holes.

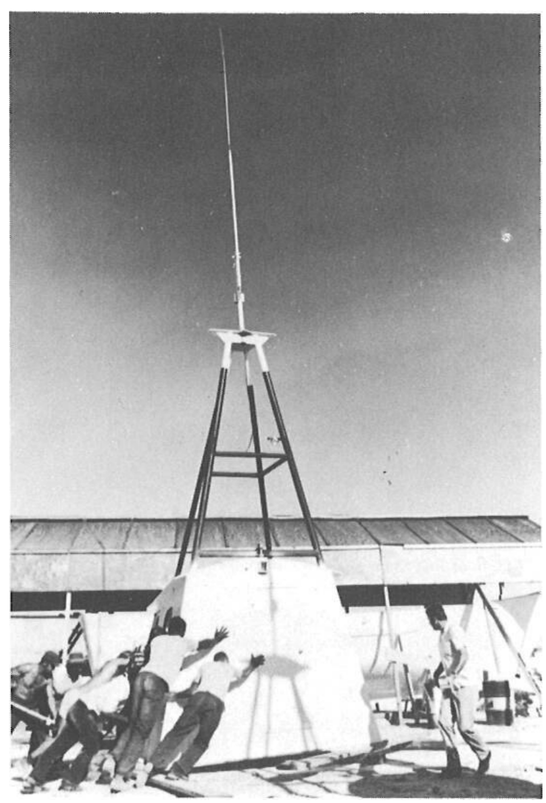
TASK 2 — Hoisting the Superstructure on Deck

The prefabricated superstructure, already completely outfitted and painted, was hoisted by a mobile crane. To facilitate the slinging of the superstructure, lugs had been welded to the legs of the forward A-frame mast piping at a height of three inches (76 mm) above the wheelhouse roof. A single wire rope sling was shackled to the two lugs. It was all that was needed; the superstructure balanced perfectly at this point.

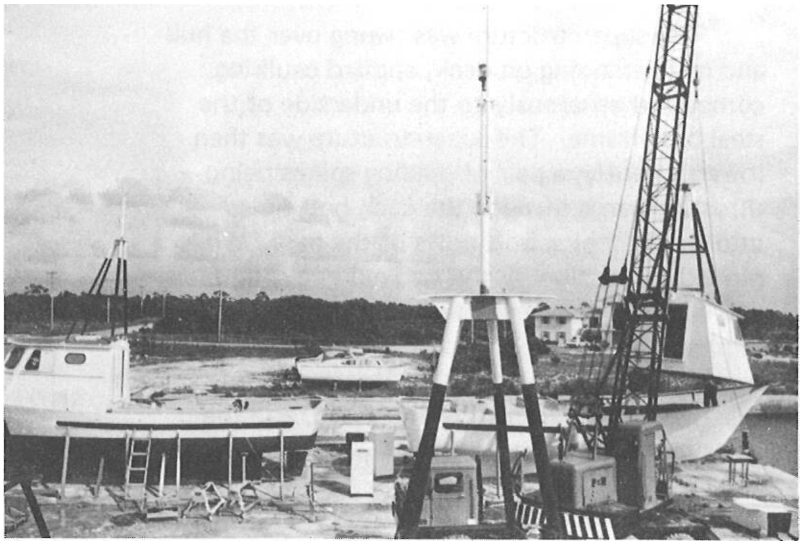
The superstructure was swung over the hull and men, standing on deck, applied caulking compound generously to the underside of the steel base frame. The superstructure was then lowered gently, a pair of guiding spikes being thrust upwards through the deck bolt holes into the matching bolt holes of the base. While pinned in position by the two guiding spikes, and while still suspended some two inches (51 mm) above the deck, the majority of the bolts were slipped into place. The superstructure was then lowered, the crane released, and the bolts fastened.

TASK 3 — Completing Superstructure Installation

Electrical, hydraulic and plumbing systems were connected from hull to superstructure. Excess caulking compound was cleaned off around the deck joint and the seam cemented from the outside. The deck and wheelhouse were afterwards given their final coat of pale turquoise epoxy paint, the wheelhouse taking this deck paint up to the level of the handrails.



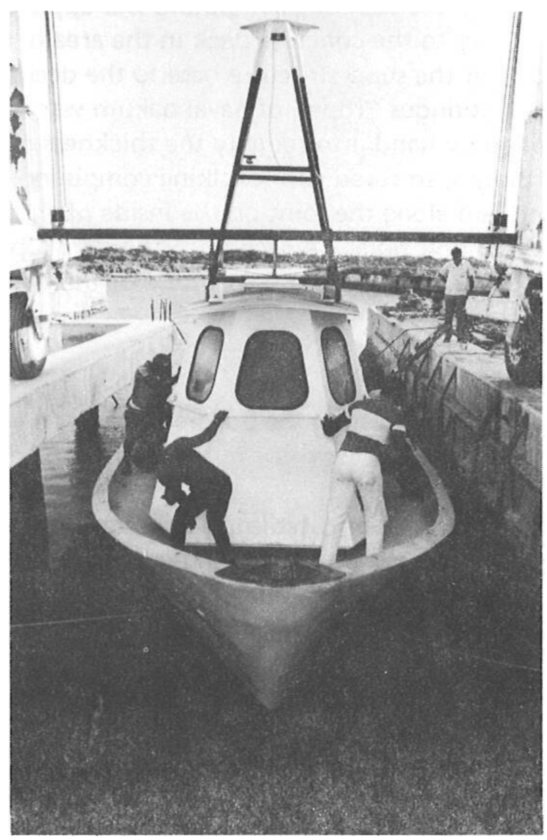
A completed superstructure being moved into position for lifting.



Mobile crane lifting superstructure onto a hull on the hard.

Comporterlowering superstructure onto a hull afloat.

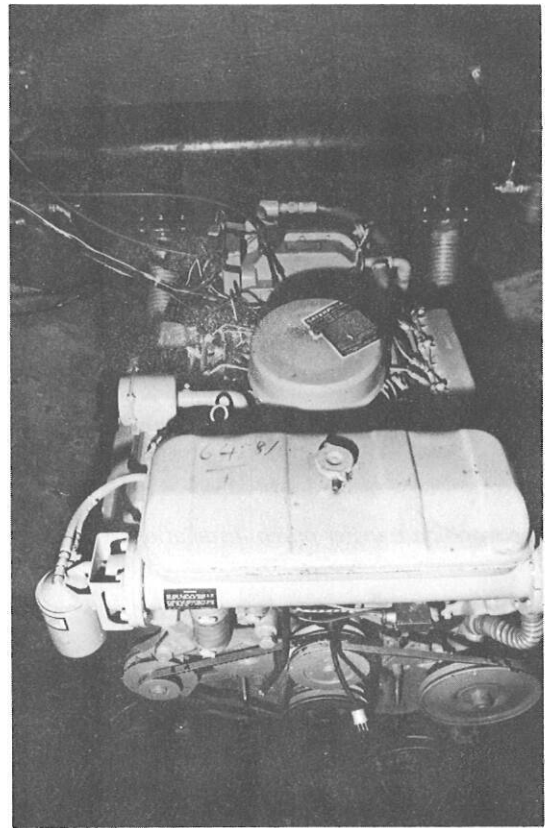
Crane released, superstructure being bolted down.



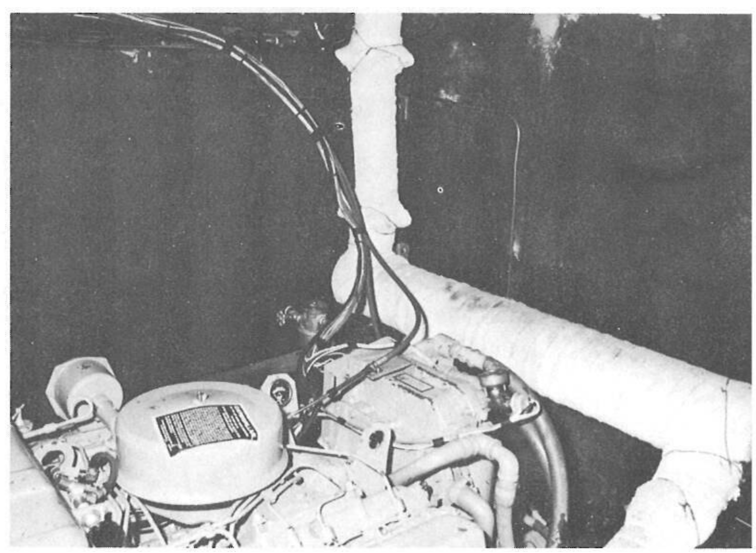
Guiding into position and slipping the bolts into place.

JOB 2 - INSTALL EXHAUST SYSTEM

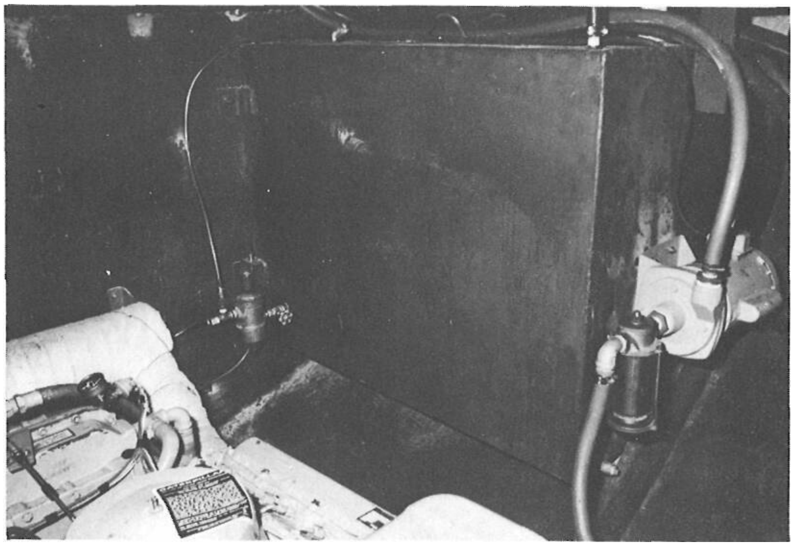
The main engine, a Caterpillar Model 3160, is a V-8 diesel possessing two exhaust outlets. An exhaust manifold was made up from six-inch (152 mm) I.D. schedule 40 steel pipe to receive these two exhaust outlets through three-inch (76.2 mm) pipe intakes with flanges. A four-inch (101.6 mm) pipe outlet with flange led upwards out of the manifold to the vertical exhaust pipe. The two engine exhaust outlets were connected to the manifold intakes by means of three-inch (76.2 mm) diameter flexible steel exhaust holes with matching flanges to the intakes. A section of four-inch (101.6 mm) flexible steel exhaust hose connected the manifold to the four-inch (101.6 mm) I.D. exhaust pipe. Stainless steel bolts were used for all matching flanges, also heavy duty asbestos gaskets and sealant. The exhaust manifold brackets were through-bolted to the aft engine room bulkhead. After bolting the complete exhaust assembly into position, the piping was wrapped first with soft asbestos rope and then outer wrapped with thick asbestos tape. The wrapping terminated at the base of the exhaust pipe in the ventilator shaft.



Exhaust manifold, showing dual flexible steel hose connection.



The exhaust manifold wrapped with asbestos tape.



Ice machine transfer pump installation.

JOB 3 — Install Sea-Water Ice Machine

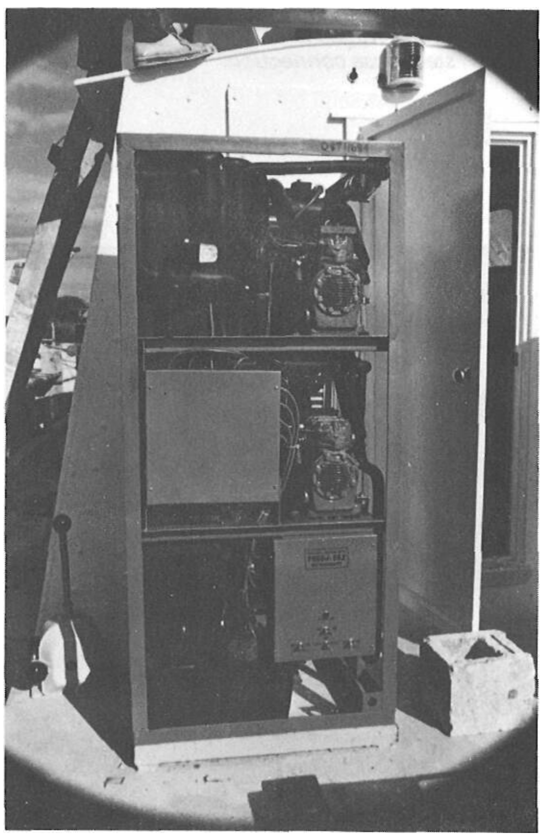
The transfer pump, which supplies sea-water for ice and for cooling the ice machine, was mounted on the port side fuel tank. (On the same side as the through-hull fittings.) It was important that the transfer pump be mounted below the waterline because, being of the centrifugal type, it possessed no intake lifting suction.

The pump intake was through a one-inch (25.4 mm) sea-cock with a water strainer mounted directly on the pump. The intake hose was one-inch (25.4 mm) steel-braided rubber hose. The discharge hose between the transfer pump and the water inlet on the ice machine was 3/4-inch (19 mm) diameter radiator hose. Over-flow hose from the ice machine was of the same kind, returning to the engine room and out through a sea-cock.

The ice machine was bolted onto a 2" x 2" x 1/4" (51 mm x 51 mm x 6.4 mm) angle iron frame. The frame possessed feet in each corner which were welded to the deck steel reinforcing before plastering.

On the back top part of the ice machine a support frame of two-inch channel iron was bolted onto the wheelhouse aft bulkhead. Rubber shock mounts were placed between the ice machine and this support, also on the base for the machine.

The ice chute down to the fish-hold was a six-inch (152 mm) PVC pipe passing through the deck. It was inserted before the deck was plastered. The stainless steel ice chute on the machine fitted inside the mouth of the PVC pipe. The joint was wrapped with neoprene sheeting and clamped watertight.



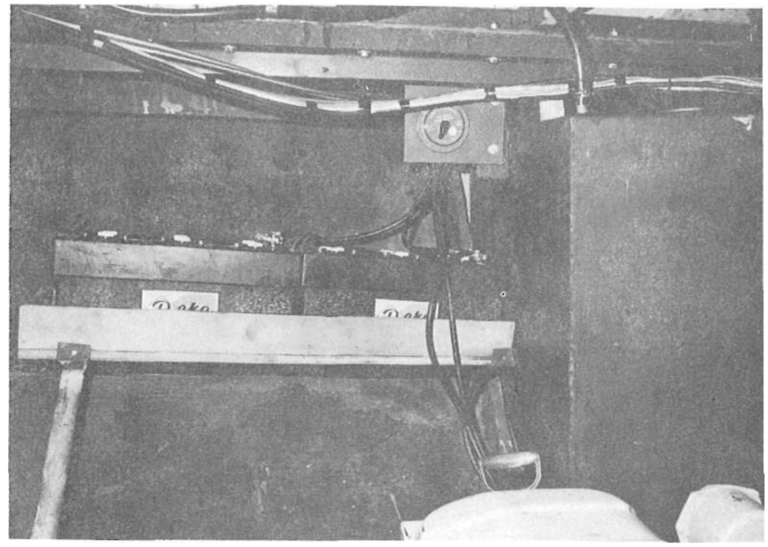
The "SEAFARER" ice machine, a successful sea water ice machine for commercial use afloat. (Environmental Controls, Inc., Longwood, Florida)

JOB 4 - INSTALL BATTERIES

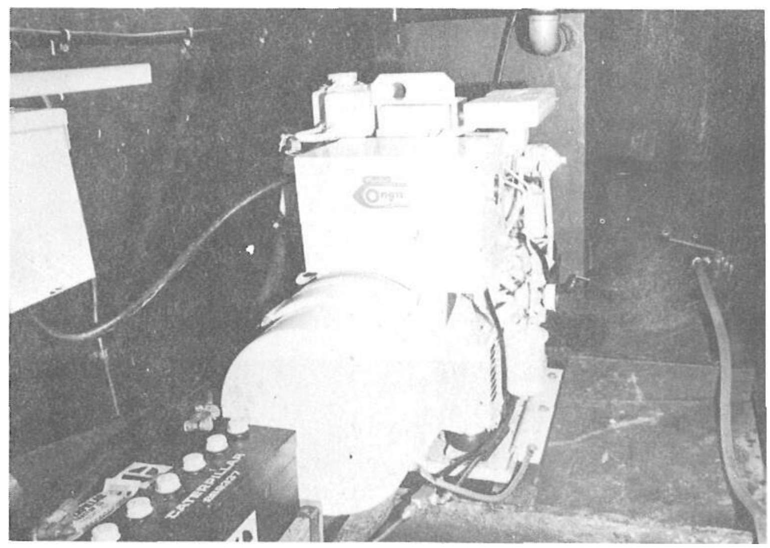
Two 210 amp. H.D. batteries were installed in the engine room for starting the main engine, for providing power for the radio and illumination of the boat. The batteries were connected to a four-position marine safety switch (Battery No. 1, Battery No. 2, Both On, Off). Battery charging was by means of the alternator on the Caterpillar main engine. It was planned to install later a battery charger in the engine-room powered by the Onan diesel generator, for use in emergencies.

The battery boxes were made out of 1" x 4" (25 mm x 102 mm) lumber with a 3/4-inch (19 mm) plywood bottom, fiberglassed inside. The generator battery was a 105 amp. H.D. type, the battery box made in the same way.

The batteries were mounted away from the heat generated by the main engine.

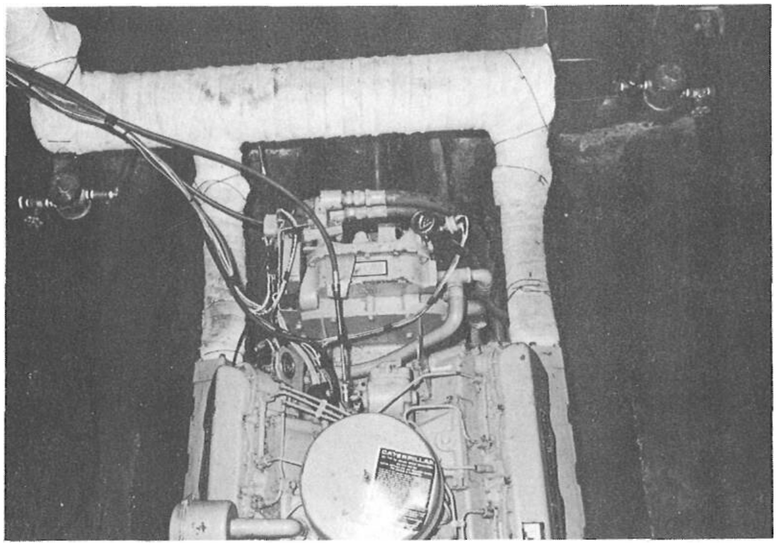


Twin batteries in the engine room.



Battery installation for the diesel generator unit.

"Seafarer" ice machine installed with fiberglass cover.



Fuel line connections to engine, showing valves and filters.

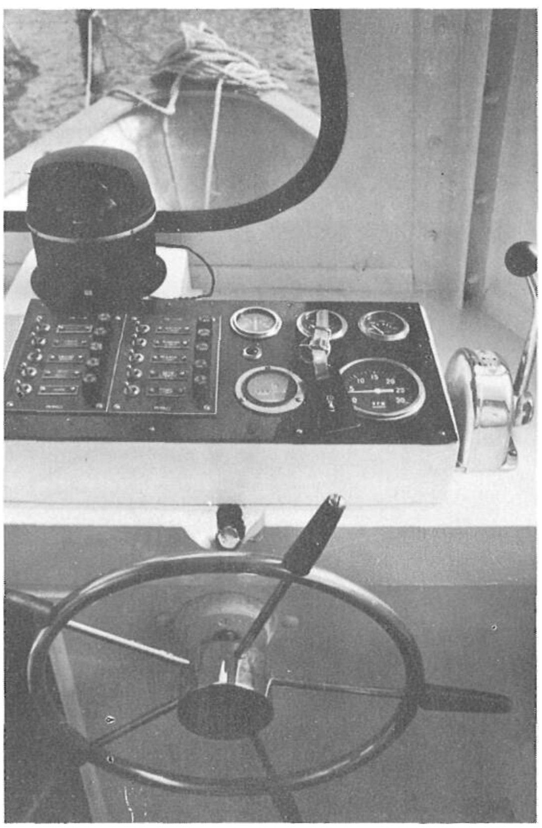
JOB 5 - CONNECTING FUEL LINES TO ENGINE

Two 178-gallon fuel tanks were installed; one port and one starboard of the engine room against the hull sides.

Each tank had a 2½-inch (63.5 mm) diameter filling pipe, 3/4-inch (19 mm) diameter vent, 3/8-inch (9.5 mm) diameter fuel return lines, ½-inch (12.7 mm) diameter outlet with a 1/2" x 3/8" (12 mm x 9.5 mm) fuel needle-valve. A 3/8-inch brass fuel filter was screwed directly onto the 3/8-inch (9.5 mm) fuel valve. The two tanks were connected with 3/8-inch (9.5 mm) soft copper tubing merging into a T-joint. From the T-joint to the engine flexible fuel hoses were used. The fuel return line was connected into both tanks with 3/8-inch (9.5 mm) copper tubing. There were no valves on the fuel return lines.

JOB 6 - CONNECTING THE ENGINE CONTROLS

Morse one-lever controls were installed for simultaneously shifting gear and for moving the engine throttle. If the engine required to be "revved" in the neutral position a knob situated at the axis of the control lever could be pulled out, disconnecting the forward/reverse control cable. Two Morse "push-pull" cables were installed; one 17 feet (5.3 m) long for the throttle, one 18 feet (5.5 m) long for the forward/reverse control. Adaptors were supplied with the cables to suit the Caterpillar Model 3160 control connections. A bracket was made and fastened to the engine air intake to secure the throttle cable. Before testing the Morse controls the cables were checked to ensure that full operational movement was obtained at the throttle and at the reverse gear.

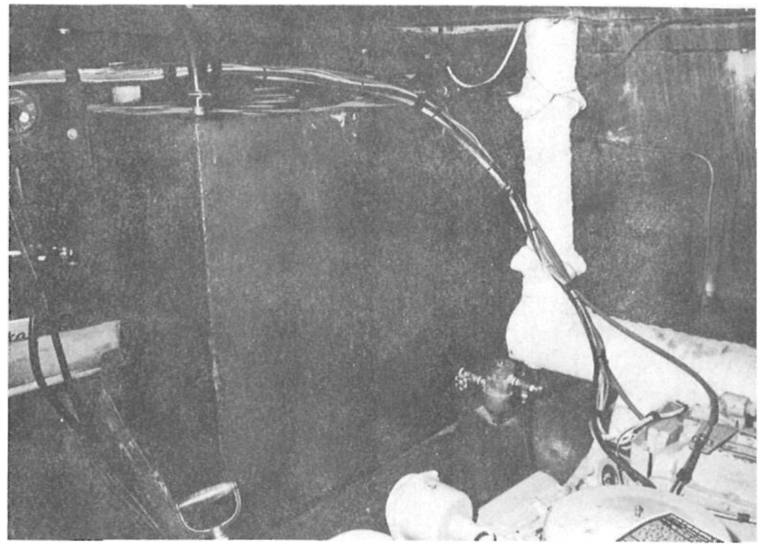


The Morse, one-lever engine control.

JOB 7 - CONNECT WIRING TO ENGINE

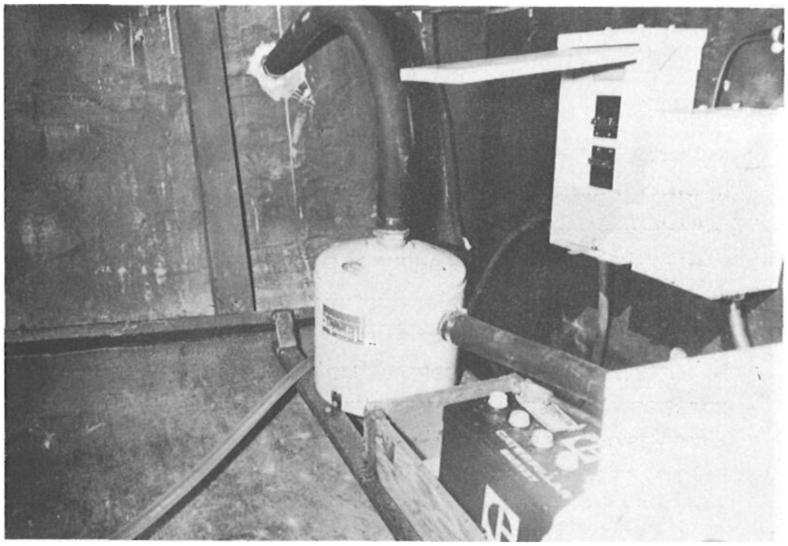
The Caterpillar Model 3160 engine was delivered already wired and complete with its alternator, electric starter and transistorized voltage regulator. Twin battery cables, size 1/0, were connected from the two 12-volt, 205 amp. batteries to the main engine electric starter motor. A third cable was connected to the safety switch. The engine was grounded to hull steel reinforcing. Following the directions shown in the Caterpillar wiring diagram, the engine wiring system was connected to the instrument panel in the wheelhouse. The electrical cables accompanied the stiffer Morse control cable sheathing and was bound to it at six-inch (152 mm) intervals with adhesive tape.

All terminals were soldered and afterwards coated with a high-voltage varnish spray to prevent mold and corrosion. Electrical cables were secured wherever possible with bronze clamps and maintained well away from sources of heat.



Engine wiring cables accompany the Morse engine control cables to the instrument panel.

Another boat is launched and warped alongside for final out-fitting.



Water-cooled exhaust system for diesel generator unit. The two breaker boxes on the bulkhead lead to the ice machine and its transfer pump.

JOB 8 - INSTALL GENERATOR UNIT MUFFLER

The type of muffler used was an "Aqualift" water-cooled muffler. Special' 1/2-inch (38 mm) marine rubber exhaust hose was connected between the exhaust elbow on the engine to the side intake on the muffler cylinder. From the outlet on the muffler the exhaust hose described a loop above the waterline height and connected to a bronze through-hull fitting. The muffler cylinder was bolted down to the steel base, running athwartships in the lazarette, which also supported the Onan diesel generator unit and the battery box.

JOB 9 - DIESEL GENERATOR UNIT FUEL TANK AND CONNECTIONS

The fuel tank for the diesel generator unit was made from 1/8-inch (3.1 mm) steel plate and its dimensions allowed it to be passed through the hatch into the lazarette. Capacity of the fuel tank was 100 gallons. It was secured with bolted brackets to the aft bulkhead of the fish-hold and with welded brackets to the bilge stringers. The filler cap was made from three-inch galvanized pipe fitting and was accessible through the lazarette hatch.

The tank possessed a drain cock at the bottom. The 3/8-inch (9.5 mm) needle-type fuel valve was sited four inches (102 mm) from the bottom to prevent scale and other foreign matter from passing into the fuel lines. A brass fuel filter intercepted the 3/8-inch (9.5 mm) copper tubing fuel line between the valve on the tank and a "tee" coupling which connected to both the diesel generator unit and also to the main engine fuel lines in case of an emergency.

Soft 3/8-inch (9.5 mm) diameter copper tubing was used for all fuel lines, the fittings double flared and sealed with gasket compound.

JOB 10 - CONNECT ICE MACHINE WIRING

The electrical cable used to connect the sea-water ice machine to the diesel generator unit was a No. 8 waterproof cable. The cable ran from the lazarette to the engine room and up to the ice machine. It was secured in position with copper clamps. Two breaker boxes were installed in the lazarette on the fish-hold aft bulkhead, close to the diesel generator unit. One breaker was connected to the transfer pump in the engine room, the other to the ice machine. The connections were made in such a way that it was mandatory to switch on the transfer pump first, ensuring that water would always be circulating through the ice machine before it could be switched on.

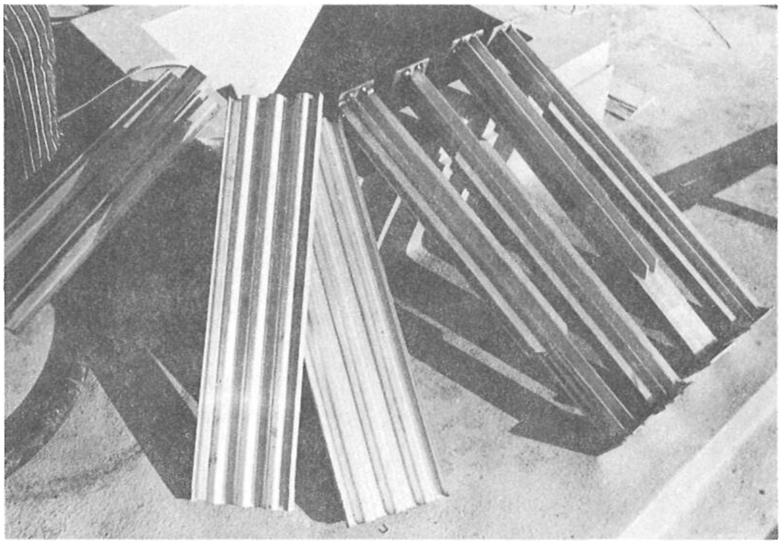
Checking the seawater ice machine installation. The first nickel-plated evaporator cylinder has just harvested its ice, the second is following.

JOB 11 - RADIO INSTALLATION

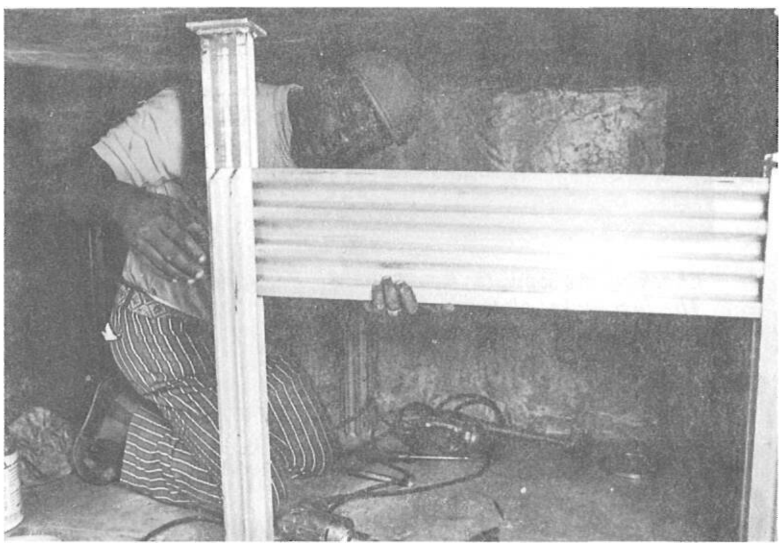
A Simpson 85-watt radio-telephone was fastened to the wheelhouse deckhead, portside, at a spot where it could be easily reached by the helmsman without releasing hold of the wheel. The radio was connected directly to the 12-volt batteries in the engine room; it was separately grounded, and the radio antenna cable ran down through one of the hollow forward mast legs to a point inside the cabin close to the radio. The radio antenna cable used was type GTO-15 as recommended by the equipment manufacturers. With the alternator running on the main engine, interference was experienced on the radio. A noise suppressor was consequently installed in the engine electrical circuit close to the input to the transistorized voltage regulator.

The 18-foot (5.6 m) fiberglass radio antenna, comprised of two connecting sections, was fitted to the topmast, leaving it completely free of all figging.

Fiberglass radio antennas fitted to topmasts.



Marine aluminum pen boards and slotted pillars.



Pen boards fit easily into the channels.

Fitting out the fish-hold.

JOB 12 - INSTALLING THE ALUMINUM FISH-HOLD PEN BOARDS

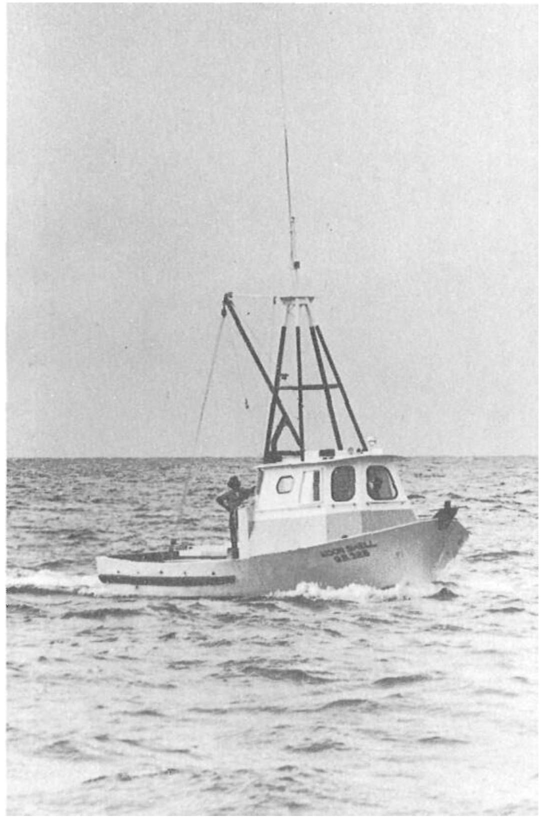
The fish-hold pen boards were made from corrugated, marine aluminum extrusion, especially designed for fish-holds. Lengths of this aluminum extrusion were purchased for this job. The pen boards were cut to size using a band saw. The slotted pen corner supports were made from the same type of salt-water resistant aluminum. Square brackets, at both top and bottom, were welded onto the middle rows of vertical supports. The fish-hold was carefully measured and divided and the pen boards cut to a standard length, making them fully interchangeable. The vertical supports were packed out where required with treated wood packing, then fastened through the cement skin lining of the hold to the 3/4-inch (19 mm) plywood lining with stainless steel screws.

JOB 13 - INSTALLING BOOMS

TRANSFER AND FISHING GEAR BOOM

A 16-foot (4.9 m) boom was made and fitted to the boats but later was unshipped to make way for the pipe framework supporting the aft deck awning. The boom was for off-loading or transferring the catch; with additional halyards it would support a purse-seine hydraulic power block. It was made from 3½-inch (89 mm) I.D. steel tubing. The boom swiveled on a gooseneck fitting welded to the lateral brace on the aft A-frame mast, just above the wheelhouse roof.

The boom halyard was of 1/2-inch (12.7 mm) diameter polypropylene rope running through double blocks. Guide halyards were rigged from 14-inch (6.4 mm) diameter stainless steel cable and were worked with 3/8-inch (9.5 mm) diameter polypropylene rope running through single sheaves. Galvanized halyard cleats were through-bolted to the aft bulkheads on the wheelhouse.

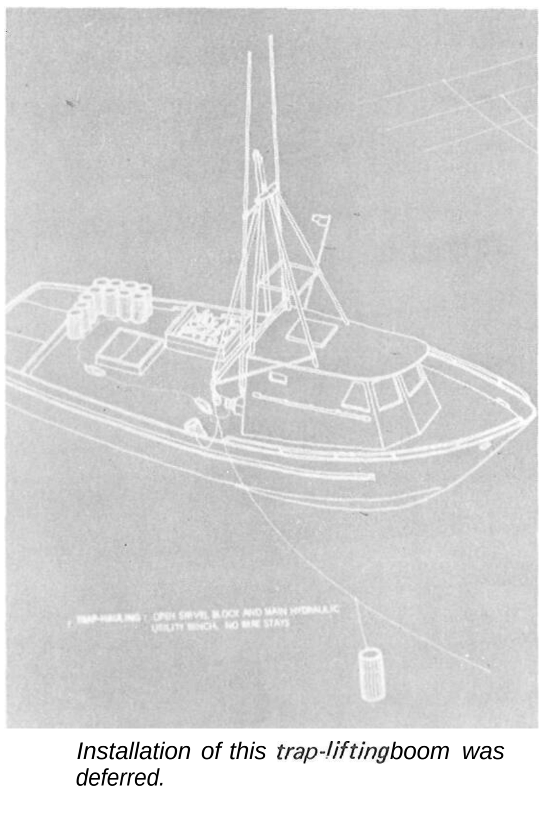


The boom installed.

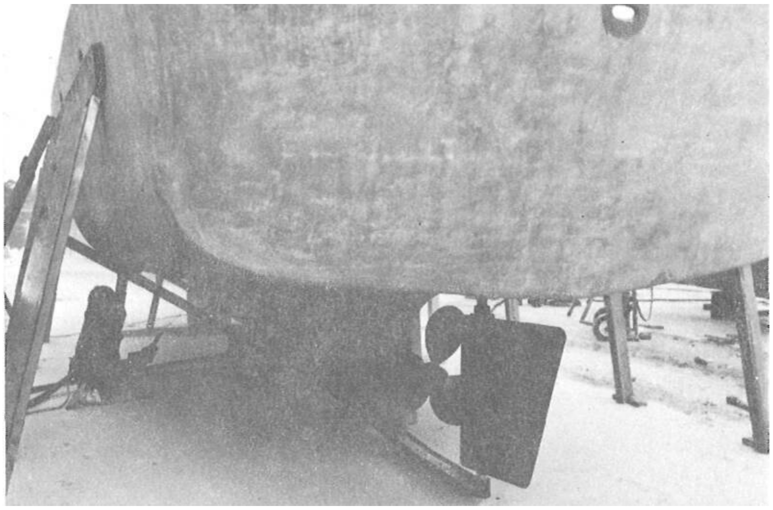
TRAP-LIFTING BOOM

Installation of the trap-lifting boom was temporarily deferred, together with the installation of the trap-hauling winch. This equipment was to be installed later.

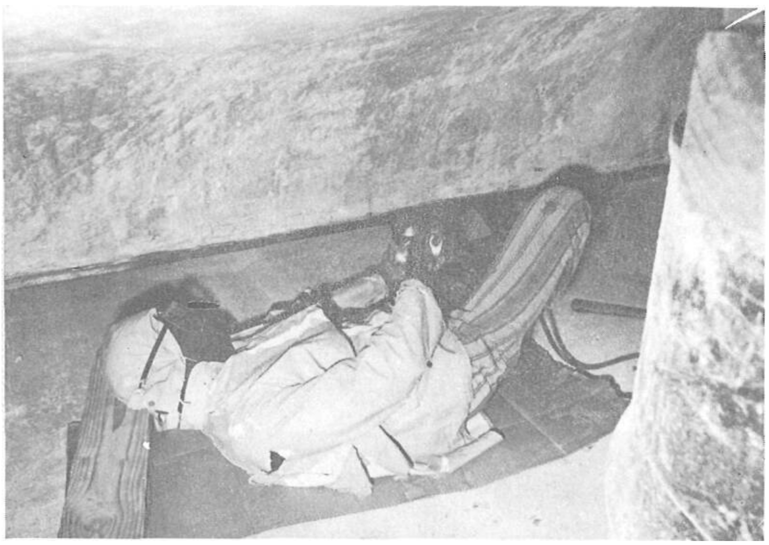
The trap-lifting boom is only long enough to overhang the midships rail by some eighteen inches (457 mm). It is designed to be swung upwards into the mast structure when not in use. A halyard running through a block at the mast cross-tree hoists and lowers the boom. At the extremity of the boom is hung an open swivel block. The trap-hauling line, when picked up at the flag buoy, is passed over the open sheave of the swivel block, given two or three turns around the capstan head of the winch, and the line is hauled.



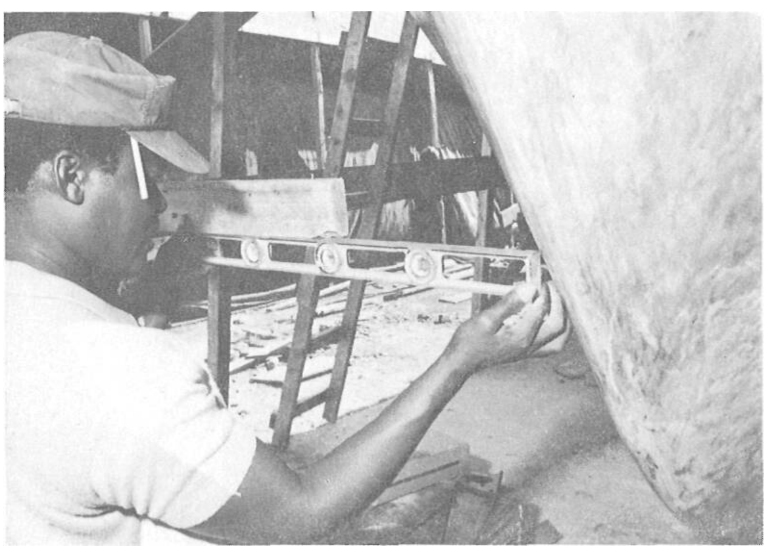
Installation of this trap-lifting boom was deferred.



A light sand-blasting given to the hull surface.



Buffing the steel keel shoe.



Transferring waterline marks from the shelter lace to the hull.

JOB 14 - INSPECTION PLATES

The circular inspection plates for both the deck and the bulkheads were prefabricated early in the course of the job. When they were being made, stainless steel studs for securing the covers were welded to the flanges. The flanges were in turn welded to the deck and bulkhead steel reinforcing and then embedded into the concrete. These studs protruded 3/4-inch (19 mm) above the mortar. Inspection covers were made of 3/16-inch (4.7 mm) mild steel plate. The stud holes for each inspection cover were drilled at the same time as the studs were welded in place.

When the inspection covers were finally installed they were bedded down as follows:

A. One-quarter inch (6.4 mm) neoprene gaskets were cut to fit around the circumference of the hatch opening. The rubber strips were 1½ inches (38 mm) wide. The stud holes were then punched out.

B. The hatch lids were sand-blasted and primed with two coats of zinc epoxy paint.

C. Silicon sealant was smeared on both sides of the neoprene gasket.

D. Tanks and compartments were thoroughly cleaned out and the inspection covers bolted in place.

JOB 15 - PAINTING THE DECK

The deck was first thoroughly cleaned. One coat of zinc epoxy primer was brushed and rollered onto the deck. After this had set, two coats of pale turquoise epoxy deck paint were applied. The last coat was applied after trials so that the vessels were turned over to the owners in mint condition. The deck paint was carried up the sides of the wheelhouse to a height immediately below the handrails.

JOB 16 - PREPARING AND PAINTING THE HULL

The hull surface was first sand-blasted. The hull was just lightly sprayed with sharp silica sand to remove the slick finish on the surface of the concrete and so provide a good bond for the paint.

The keel shoe was buffed with a rotary wire brush. The scuppers were well sand-blasted as were any other exposed steel pieces of the hull.

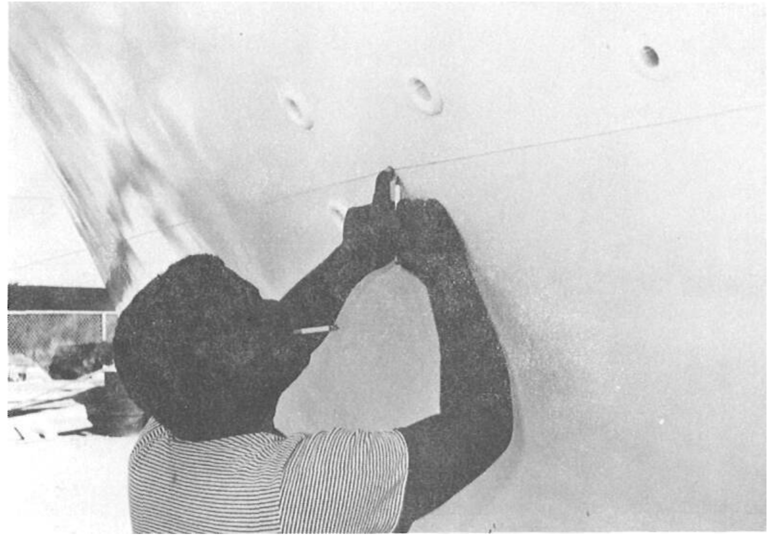
The waterline marks had been previously transferred to the sun shelter legs so that these marks would not be lost when the hull was painted.

The hull was then given a thick coat of zinc epoxy primer. This is a paint mixed in three parts. One part is zinc powder, one part is epoxy base and the other part epoxy catalyst. At times the painters became confused with the varying instructions on mixing different types of epoxy base paints. On several occasions surplus cans of one of the component mixes were found even though much care was exercised to ensure that the painters followed the manufacturers' instructions.

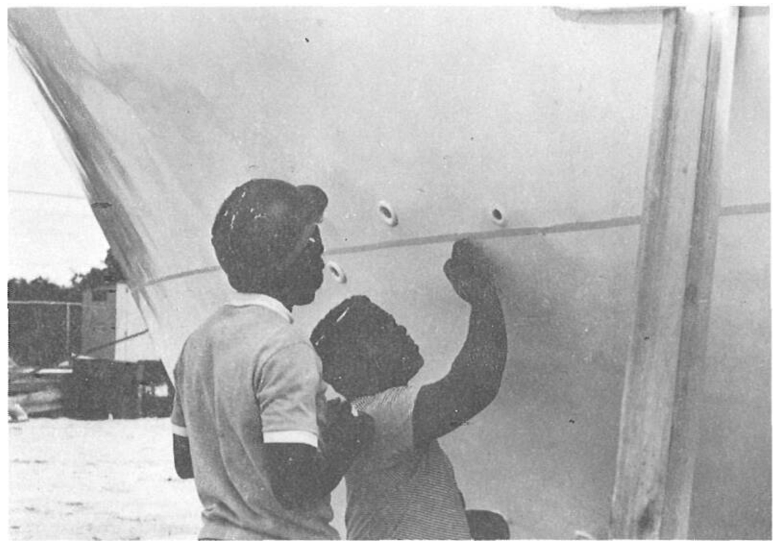
After the epoxy primer paint had dried, three coats of white epoxy top coat were applied to the hull. Rollers were used for the broad areas of the hull, brushes for trimming.

The waterline marks were then transferred back to the hull from the sun shelter legs. These marks were faired up and masking tape was taped to the hull above the waterline mark. The bottom of the boat was then painted with red vinyl anti-fouling.

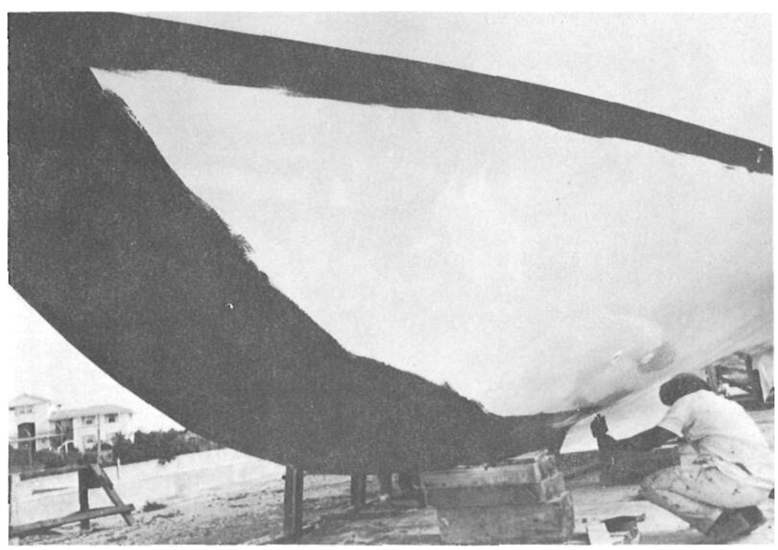
Finally, the boat's name and number were painted on by professional sign painters.



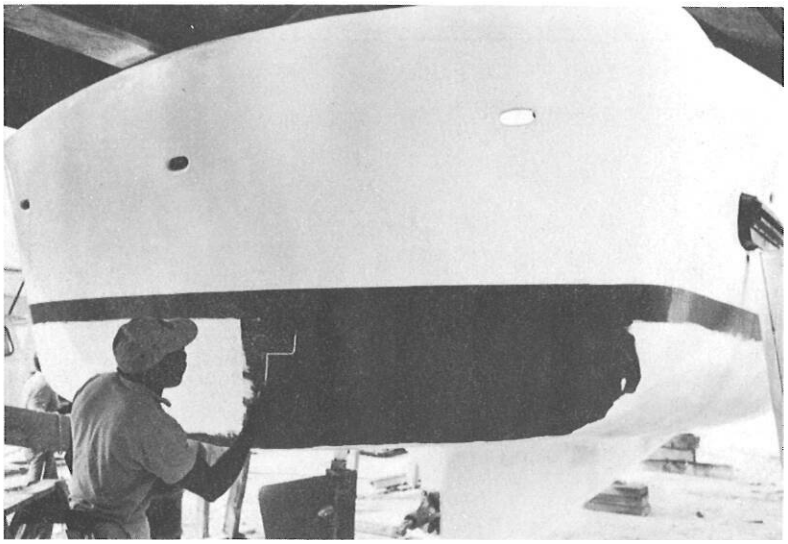
Marking and fairing the waterline.



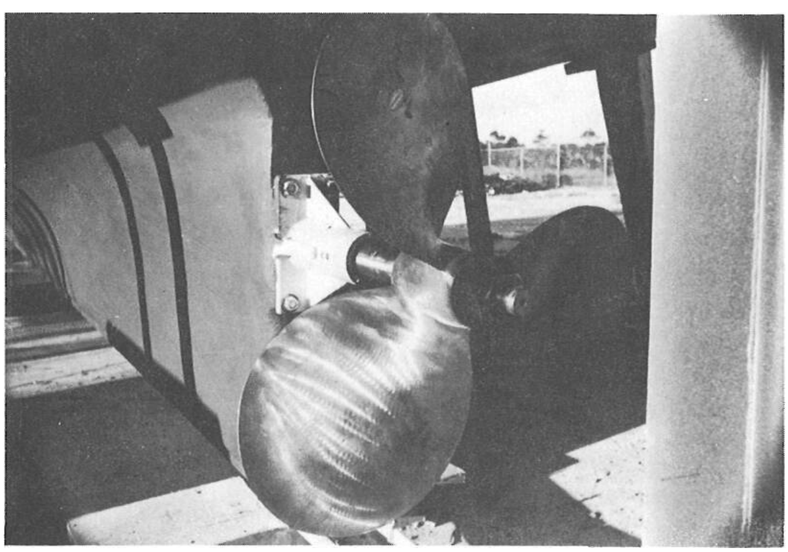
Masking tape laid above the waterline.



Anti-fouling bottom paint goes on.



A paint roller is used for the broader surfaces of the hull.



The 32-inch diameter bronze propeller.

JOB 17 - INSTALL PROPELLER

The standard-type bronze, three-bladed propeller was 32 inches (812 mm) in diameter with a pitch of 16 degrees. The propeller fitted to a coned section of the 2%-inch (57 mm) diameter stainless steel propeller shaft. It was keyed and secured to the shaft with two stainless steel nuts.

Power to the propeller was transmitted through a Twin-Disc hydraulic reverse gearbox with a reduction ratio of 3:1. At a comfortable engine running speed of 2,250 rpm, the shaft turned at 750 rpm, giving the boat a speed of 8.5 knots. The engine was designed to run continuously at 2,600 rpm, giving the boat a cruising speed of 10 knots with a half-load capacity in fuel, water and ice. The Caterpillar Model 3160 engine has an intermittent capability of 3,000 rpm. At this power output hull speed was assessed at 12 to 13 knots.

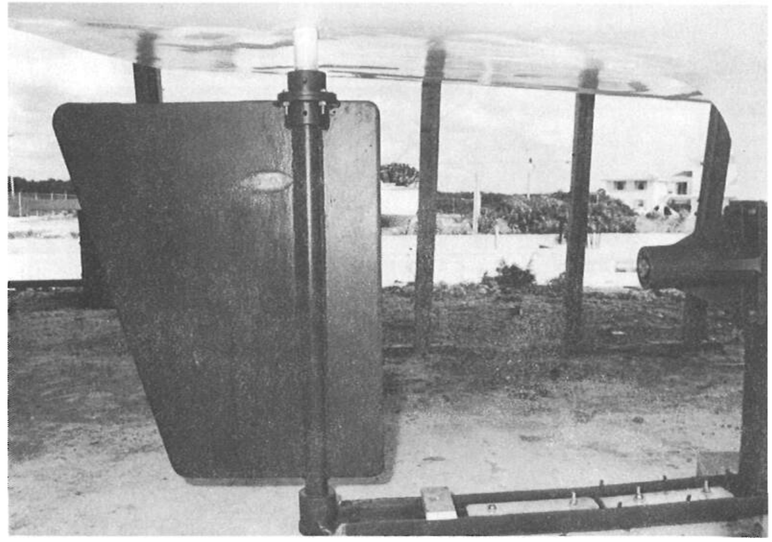
JOB 18 - INSTALL ZINC ANODES

To counter underwater electrolytic action approximately 20 pounds of zinc anodes were installed on each vessel. Two streamlined, one-pound zinc anodes were mounted on the rudder plate, one on each side. The remainder of the anodes, in block form, were bolted to the keel channel below the propeller. As the keel channel was welded throughout its length to the hull reinforcing, this was an ideal place to have them situated. Annular zinc anodes to the propeller shaft were not fitted as they could not be located at the time.

Three-eighths inch (9.5 mm) mild steel studs were welded upright to the inside of the keel shoe channel. The zinc blocks were drilled and bolted down to these studs. The rudder anodes were attached in the same way.

The rate of zinc anode consumption on ferro-cement boats appears to be about the same as with wooden and steel vessels generally. Ferro-cement vessels in service have been watched for a number of years for signs of deterioration to the reinforcing steel in the concrete. To date, no significant deterioration has been observed.

In the Bahamas, a considerable zinc loss was noted on some of the boats one month after launching. This was attributed to the extensive welding work which was carried out on the awning framework as the boats lay alongside the dock.



Location of the zinc anodes. Note the streamline anode on rudder.

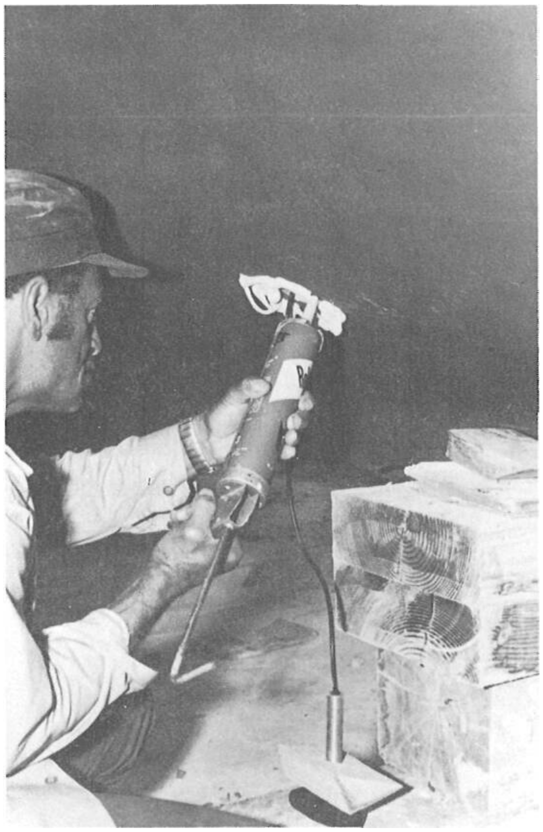
JOB 19 - RUBBER FENDER ON RUBBING STRAKES

Just prior to launching, double rubber, cushion-type fenders were screwed onto the wood guards. The double rubber fenders were supplied in single 25-foot (7.6 m) lengths and cut to 22 feet (6.7 m), the length of the wooden guards which had been previously bolted to the hull sides (Stage 1, Job 16).

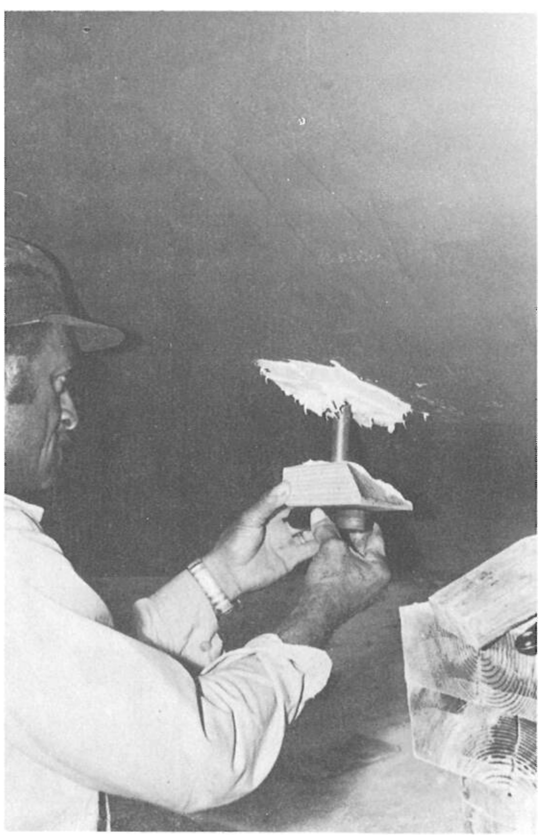
The fender rubber was screwed onto the wooden guards using´ 1/2-inch (38 mm) No. 12 bronze screws on six-inch (152 mm) centers. Extra wide diameter brass washers were used to give the screw heads a larger bearing surface for the rubber fender tended to tear from small washers if the vessel rubbed up and down against a dock with any force. The guards and fenders were later painted black.

Fastening rubber fenders to the rubbing strakes.

JOB 20 - INSTALL DEPTH INDICATOR



Sealant for the transducer base.



The wooden base for the transducer allows it to lie in a horizontal plane.

A small, battery-operated transistor depth indicator was installed as a temporary measure on the recommendation of the owners. The "Ray Jefferson" Model 400 was chosen. Depth is indicated in two ranges. For shallow water operation the zero feet to 12 feet (0 m to 3.6 m) range can be switched on. For deeper water the indicator can be switched to the 10 to 120 feet (3 m to 37 m) range. Owners intended to install more sophisticated fish-finding equipment later, once the Bahamian crews had become proficient in handling the boats.

TASK 1 - Drill Through Hull

First a one-inch (25.4 mm) hole was drilled vertically through the concrete shell, 24 inches (610 mm) from the keel on the starboard side, forward of the engine.

TASK 2 - Make Fairing Block

A wedge-shaped wooden fairing block was made for bedding the transducer. One edge of the wedge fitted snugly to the hull. The other face held the depth indicator transducer level to the waterline.

TASK 3 - Install Transducer

A second wood packing wedge was made up to fit inside the hull shell in the engine room. Cotton grommets were attached around the transducer stock against the concrete hull shell both inside and out. Bedding compound was applied generously on all matching surfaces before bolting the transducer in place. The transducer head was left bare of paint.

TASK 4 - Install Depth Indicator

The depth indicator was mounted in the wheelhouse, to port of the compass and instrument panel, and angled so that the helmsman could read it effortlessly while at the wheel. A single electrical lead ran from the indicator down to the transducer.

STAGE 6

JOB 1 - STARTING UP MAIN ENGINE AND RUNNING IN

The engine crankcase and reverse/reduction gear were filled with oil to the required levels as recommended by the manufacturer. Engine coolant system and heat exchanger were filled with fresh water and one pint of rust inhibitor. The sea water input sea-cock was opened full, also the sea water outlet. The valve on the input sea-cock was opened full, also on the sea water outlet. The fuel pump bleeder valve was opened and the pump hand-primed until a solid stream of fuel emerged from the bleeder valve. The valve was then closed, leaving the engine prepared to start. The marine safety switch was turned to "All" batteries position, the knob at the base of the Morse control lever was pulled out sideways momentarily, disconnecting the forward/reverse gear and giving one-third throttle position. The starter key was turned on at the instrument panel and the engine came to life. Water cooling discharge was immediately checked.

When the engine had run for one minute at one-third throttle the revolutions were cut back to "idle" and the fuel nuts were opened and closed on the injectors, one by one, to ensure that all air had been bled from the fuel system.

The oil pressure gauge was checked, also the ammeter to ensure that the alternator was charging the batteries. The engine was then stopped and the oil and water systems were checked for level. The engine was then started again and run for thirty minutes at 2,000 rpm. All systems were again checked.

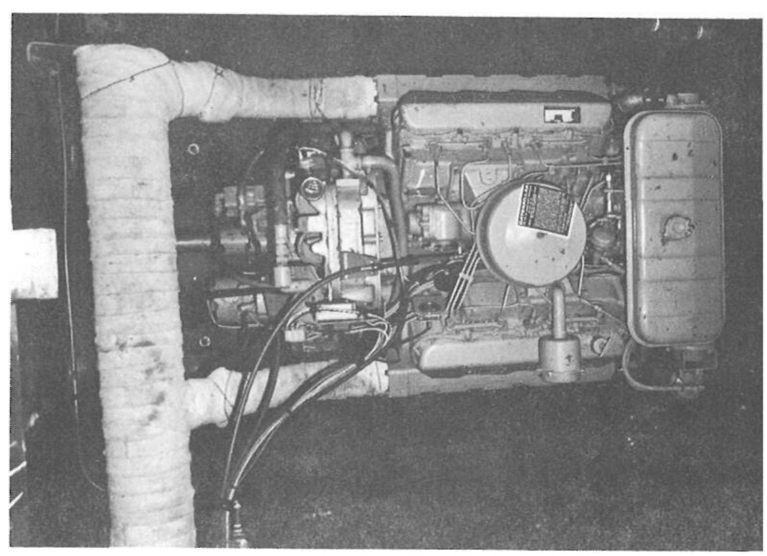
On sea trials the engine was run for 50 hours at revolutions between 1,750 and 2,250 before attempting intermittent runs up to 2,800 rpm After the first five hours of engine running the crankcase oil was drained and replaced with new lubrication oil as per the manufacturer's instructions.

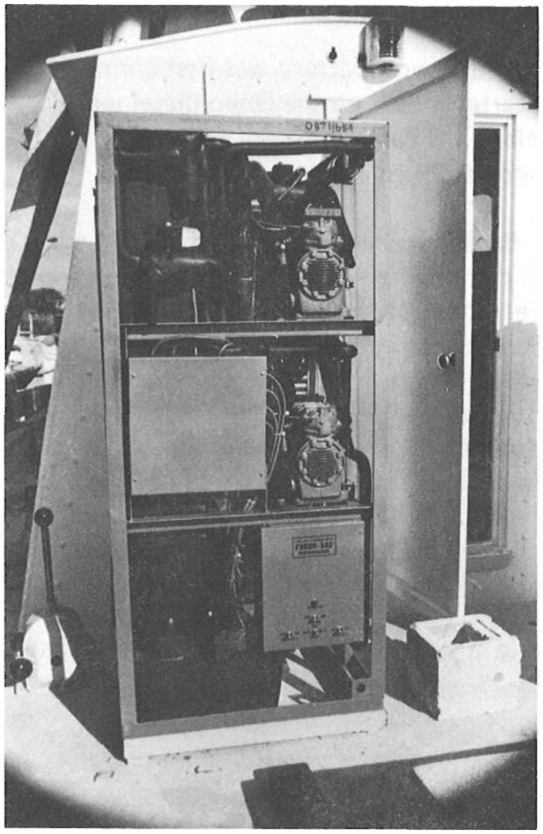
JOB 2 – STARTING UP DIESEL GENERATOR UNIT

The 12-volt battery was first connected to the starter motor on the Onan diesel with standard /0 battery cable. The unit was grounded.

Engine coolant fresh water system was filled and one-half pint of rust inhibitor added. The engine crank case was filled to the required level with the running-in type of lubricating oil specified by the manufacturer. The valve on the fuel tank in the lazarette was opened and the fuel line bled of air at the injector pump. The sea water inlet sea-cock was opened full. The two ice machine breaker switches were checked in the "Off" position to ensure that there would be no load on the generator when the engine fired. The combustion chamber preheating coil was switched on. When fully red, the starter switch was turned on until the engine fired. The oil pressure gauge was checked. The wet exhaust system outlet was checked to see if water was discharging satisfactorily with the diesel exhaust.

After running for two minutes the engine was stopped and the oil and water systems checked. The engine was then restarted and the ice machine breakers turned on to impose a load on the diesel generator unit. After five hours running the oil in the crankcase was drained and replaced as per manufacturer's instructions.





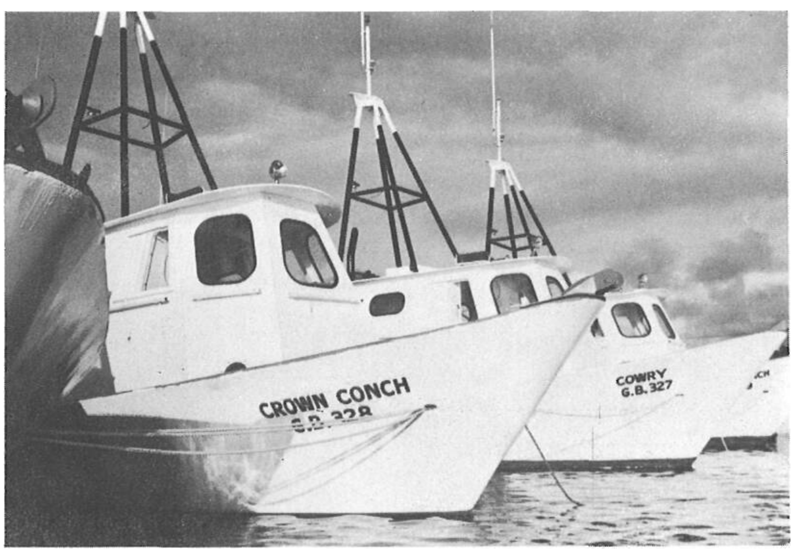
Ice machine control panel with "Manual' and "Auto" switches.

JOB 3 - STARTING UP THE ICE MACHINE

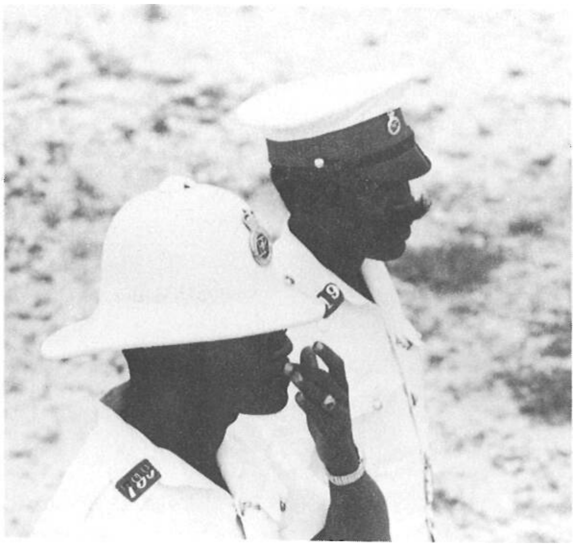
The sea water inlet sea-cock to the ice machine transfer pump in the engine room was opened fully. The sea-cock outlet on the return line was opened fully. With both breakers in the "Off" position, the diesel generator unit was started in the lazarette. Voltage and cycles were checked. The breaker for the transfer pump was then switched on and the sump in the ice machine was allowed to fill up with water. The breaker to the ice machine was switched and the "Power On" lamp glowed red on the machine.

The switch on the machine itself was put to the "Manual" position. With the sea water beginning to flow over the ice-making cylinder the switch was transferred to the "Auto" position and compressors 1 and 2 switched on. After some minutes water was observed beginning to freeze on the surface of the cylinders. Then the first harvesting cycle began, the ice sleeves slipping down the cylinders, churned up in the worm gear, and dropping into the fish-hold below.

Once the ice machine has been found to function well the ice machine switches may be left in the "Auto" position and the machine switched on and off at the breaker in the lazarette. The machine will give excellent service as long as ice is cleared regularly from beneath the chute in the fish-hold. If the machine should freeze up through neglect it must be allowed to thaw. Tools or sharp instruments should not be used to speed the cleaning of ice from the cylinders as these smooth surfaces may suffer damage or deformation



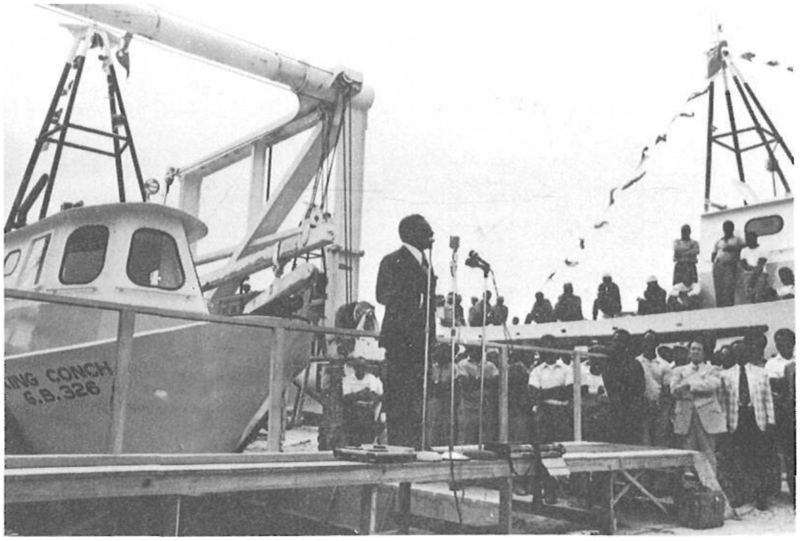
Bow anchor rollers are fitted.



Official Launching Day at Freeport, Grand Bahama.

Launching with champagne.

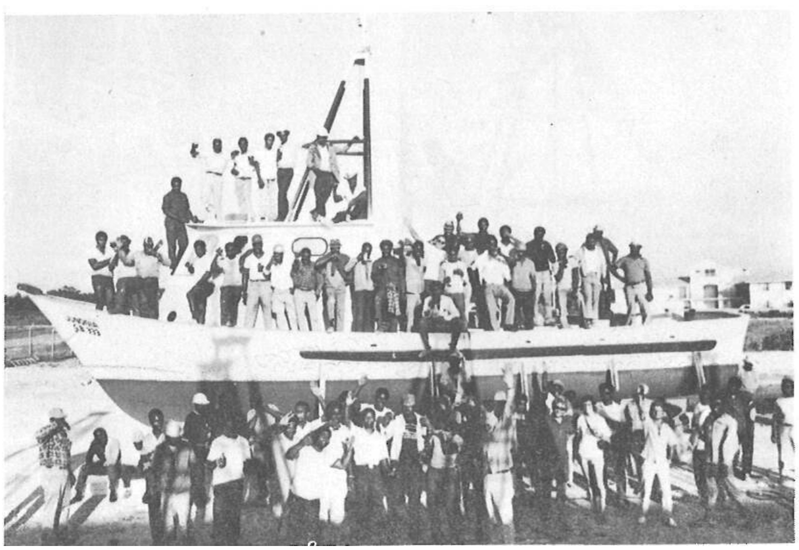
The launching party inspects.



The Prime Minister gives the launching address.

Later on Launching Day.

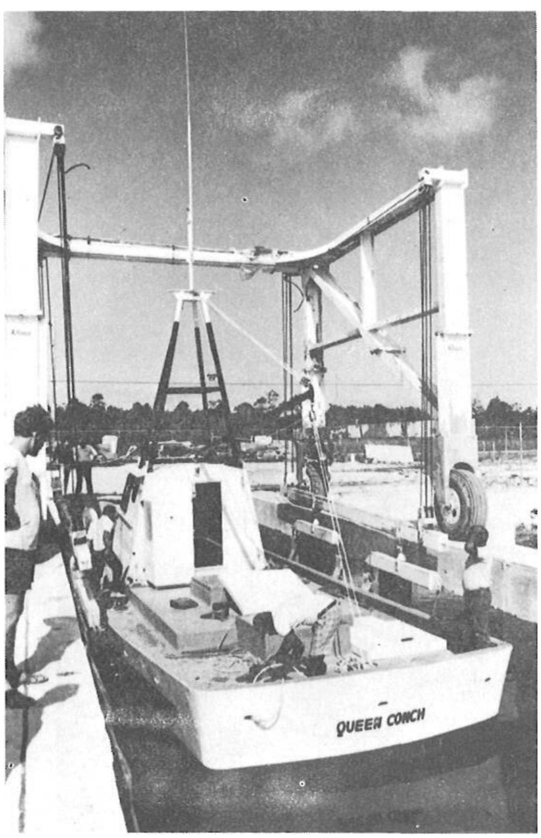
The launching party beer keeps cold on seawater.

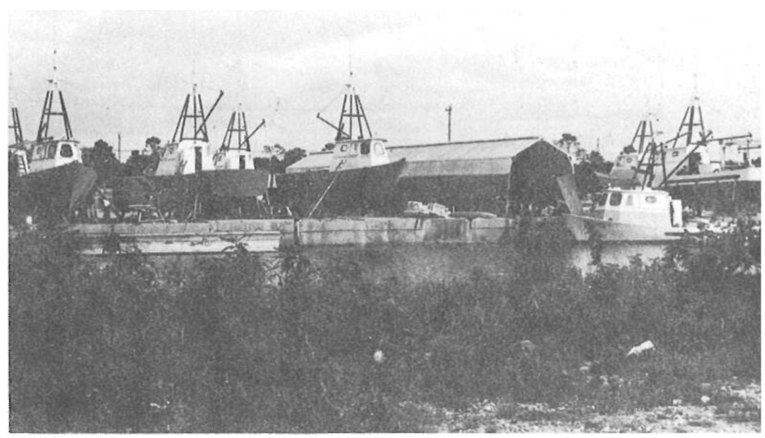


The men who built the boats.

"Queen Conch "is launched.


A view of the boatyard at an early stage.

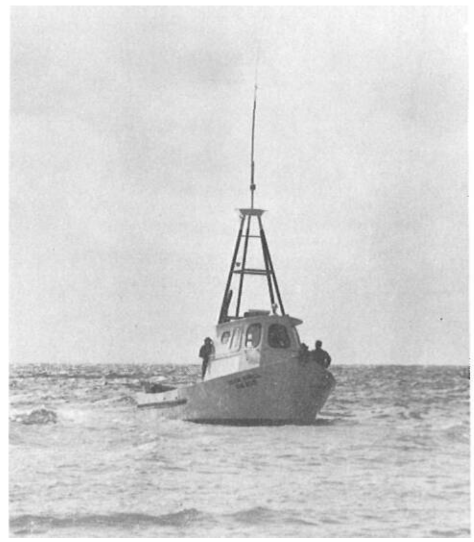



The boatyard at a later stage.

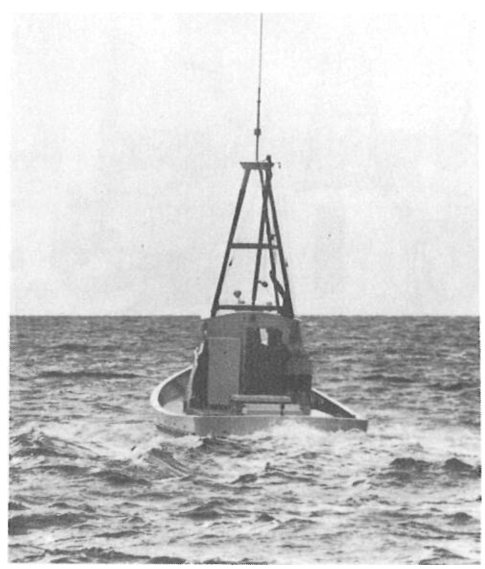
The first two launched are readied for trials.

The fleet prepares to depart.

Return from 300-mile trials' trip.

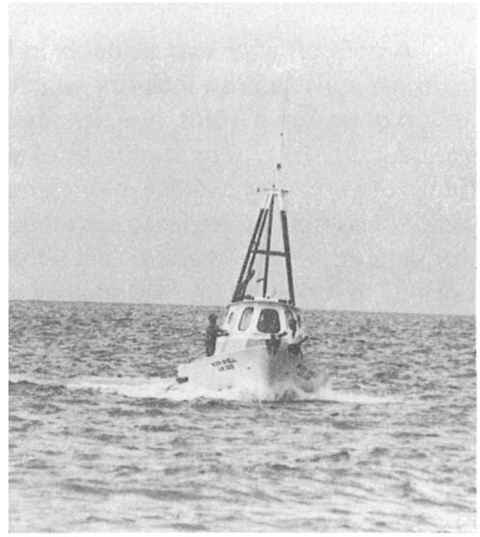


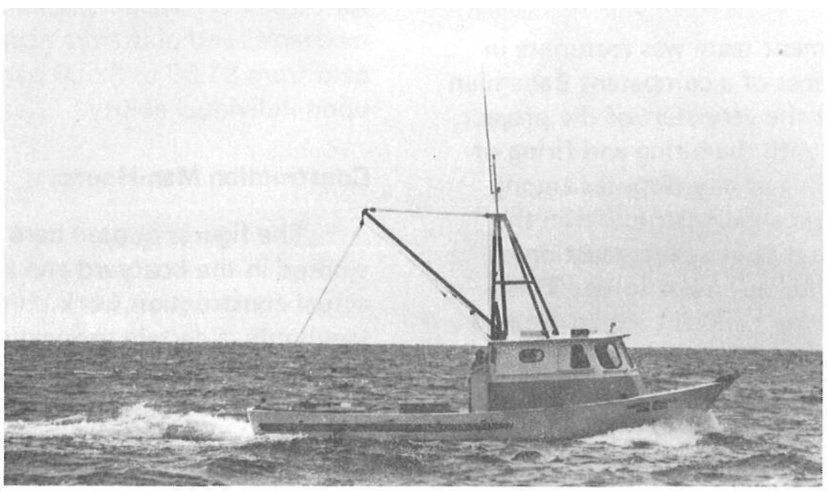
First engine trials.

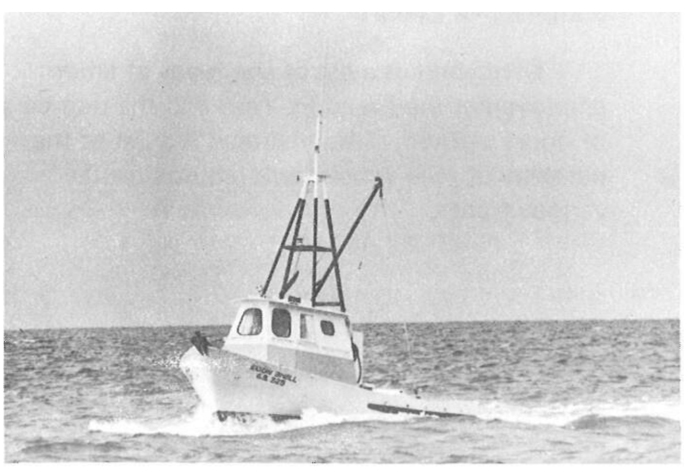


A low, beamy work deck.

"Moon Shell" shows her paces







. . . . and sails for the fishing grounds.

SUMMARY OF LABOR, EQUIPMENT AND MATERIALS USED AT THE FREEPORT YARD – 1971

A pool of labor was available in Freeport from the construction industry which, from a period of boom in 1968, had been brought to a standstill in 1971. The standards of skills in trades of carpenter, welder, plumber and plasterer were not as high as are to be found generally throughout North America. Nevertheless, if it was felt that certain professionalism was sometimes lacking among the workers, it was amply compensated by the enthusiasm which the Bahamians displayed toward learning the new art of ferro-cement boat-building. They turned out ten boats in five months.

It is significant that, of a total of 104 men employed at the boatyard at one time, only two possessed any previous experience of boat-building.

The management team was fortunate in acquiring the services of a competent Bahamian Labor Foreman at the very start of the project. He was entrusted with the hiring and firing of men, and the settling of any disputes among them. His experience in construction in the Bahamas was a great asset in the selection of tradesmen from the local labor force. This arrangement with the Labor Foreman led to a high standard of morale among the Bahamians and a good relationship with the management team.

The hiring and laying-off of labor in the yard was carefully regulated according to the type of work on hand at any given construction stage. At the same time, every effort was made to create a smooth flow of labor throughout the yard, avoiding abrupt lay-offs of certain trades and sudden mass hirings of others. The carpenters, for example, were hard at work early in Stage 1. They cut the hull mold frames, then assembled and planked the molds. As the unskilled workers took over the work, applying mesh, the carpenters then turned to making the prefabricated fish-holds.

At one point a snag occurred in the projected production timing on the yard. As the mesh was fastened to the ten hulls increasing numbers of welders were required for welding the reinforcing rod framework. There was some reluctance felt in purchasing additional welding equipment (no rentals were available) for this increased requirement in welders. The boatyard, after all, was destined to be only a temporary one. In consequence, it was decided to contract out the fabrication work of the steel superstructure framework. Out of the yard management's direct control, the delivery of the superstructure framework, ready sand-blasted and painted, did not coincide with the completion of the carpenters' work on the fish-holds as had been originally planned. The carpenters, therefore, suffered a two-week lay-off until the superstructure frameworks arrived and work could begin on their out-fitting.

Labor Rates:

In 1971 labor rates paid in the Bahamas were scaled from U.S. $3.50 to $4.00 per hour for carpenters, welders, plumbers, riggers, mechanics and plasterers. Unskilled men were paid from $1.50 to $2.00 per hour depending upon individual ability.

Construction Man-Hours:

The figures quoted here refer to total hours worked in the boatyard and are not restricted to actual construction work on the boats alone. Inevitably, a certain proportion of these hours was spent on the erection of sun shelters, work benches, scaffolding, off-loading and stacking materials, cleaning the yard and the like. Altogether, a round figure of 5,750 man-hours can be attributed to each boat.

Summary of Labor:

Given here is a list of the types of labor employed at the Freeport Yard and the numbers of hours worked. Also included is a list of the numbers of men which were required in the various trades.

Job Classification	Numbers of Men	Hours Worked
Labor Foreman	1	1,056
Carpenters	2 to 14	8,290
Welders	2 to 16	4,415
Plasterers	1 to 11	2,451
Mechanics/Riggers	2 to 4	1,878
Plumbers	1 to 4	771
Painters	2 to 8	2,243
Laborers	11 to 74	34,538
Yard Watchman	1	1,946
Ten Vessels — Total Man-Hours:		57,588

Management and Instruction Team:

In addition to this work force the management team was comprised of five men. The responsibilities of over-all supervision plus final planning and construction decisions were assumed by the leader of the team. A second man was entrusted with the ordering of equipment and materials and the general administration of the project. The three remaining technicians undertook the execution of the actual construction of the boats by working exclusively through the offices of the Labor Foreman. As has been explained, the Labor Foreman was a local man in charge of hiring and firing the labor. As a consequence of this responsibility, implementation of discipline on the yard never became a problem. All demonstrations of construction techniques by the instructors were carried out in his presence in order to give additional impetus to his personal authority.

Summary of Equipment and Materials Costs:

Given below is a summary of all equipment and materials costs incurred in the establishing of the temporary boatyard at Freeport, Grand Bahama, in 1971, and in the construction of the ten 42-foot ferro-cement fishing vessels. Prices refer to Miami, Florida, and Freeport, as current in 1971.

YARD EQUIPMENT		
Air Stapling Machines	$ 1,370.00	
Air Hose and Fittings	496.76	
Carpenters' Clamps	325.48	
Copper Tubing Tools	11.63	
Equipment Rentals (table saws, fork-lifts, cranes)	3,261.75	
Rope-Working Tools	7.54	
Carborundum Grinding Discs	1,054.30	
Sodium Silicate	44.10	
Steam-Curing Equipment	2,180.00	
Filtered Water Supplies	165.00	
Kerosene	225.42	
Welding Machines	1,189.38	
Welding Supplies	936.13	
Wood-Working Tools	1,654.81	
Other Power Tools	1,315.76	
Plasterers' Tools	885.84	
Other Hand Tools and Accessories	2,931.70	
Yard Lifting and Rolling Tackle	1,013.47	
		$ 19,069.07
FREIGHT COSTS		
Sea Freight	$ 6,264.40	
Air Freight	1,087.75	
		$ 7,352.15
BOAT MATERIALS		
Dimensional Lumber	$ 7,487.87	
Plywood	5,278.55	
		$ 12,766.42
Carry forward:		$ 39,187.64

BOAT MATERIALS (continued)

Brought forward:	$ 12,766.42	$ 39,187.64
Nails, Galvanized and Common	518.90	
Visqueen and Felt Paper	500.50	
Hull Steel Reinforcing and Other Steel	2,552.85	
Superstructure Frame	9,760.56	
Wire Mesh Reinforcing	7,579.26	
Staples, Galvanized	1,373.50	
Staples, Bronze	54.75	
Staples, Hog Ring	590.00	
Keel Pieces (Steel)	428.40	
Cement Type II	1,938.23	
Sand, Silica (Fine, Medium and Coarse Grades)	1,140.00	
Bolts, Nuts and Washers, Stainless Steel	86.23	
Bolts, Nuts and Washers, Galvanized	1,033.44	
Wood Screws, Silicon Bronze and Brass	826.72	
Nails, Bronze	86.00	
Styrofoam Insulation, Slabs	2,400.00	
Glue, Marine, Wood	632.68	
Sandblasting and Coating	1,790.00	
Caulking Compounds	1,009.50	
Fibreglass and Muslin Coverings	265.83	
Copper Strip	169.00	
		$ 47,502.42

ENGINE AND PROPULSION

Engine, Caterpillar Model 3160	$50,000.00	
Diesel Generator Set, Onan 7.5 kva	22,500.00	
Lubricants	199.60	
Propulsion System (Shaft, Propeller, Bearings)	12,936.94	
Flax Packing	74.70	
Rudder Assembly	6,363.50	
Hydraulic Steering System, Wagner	5,258.76	
Copper Tubing	247.10	
Exhaust Manifold Assembly	1,740.50	
Asbestos, Rope, Tape and Cement	676.95	
		$ 99,998.05
Carry forward:		$173,921.69

ENGINE AND PROPULSION (continued)

Brought forward:	$ 99,998.05	$173,921.69
Exhaust Ventilator	385.00	
Fuel Tanks	4,750.00	
Fuel Strainers	696.60	
Fuel Line Hose	84.64	
Miscellaneous Brass Pipe Fittings and Valves	1,134.94	
Fuel Tank Vents	44.46	
Crank Case Pump	99.00	
Engine Controls (Morse)	710.70	
Exhaust Hose	298.50	
Bilge Pump	1,604.00	
Through-Hull Threaded Hose Fittings	85.50	
Galvanized Pipe and Fittings	1,384.45	
PVC Bilge Fittings	401.69	
Bilge Hose, Suction Side	1,315.00	
Bilge Hose, Discharge Side	954.04	
Hose Clamps	184.30	
Sea Cocks	1,922.14	
Gate Valves	588.15	
Check Valves	139.26	
Water Strainers	660.30	
Zinc Anodes	140.57	
		$117,681.29

PAINTS AND COMPOUNDS

Coal-Tar Epoxy	69.50	
Gluvit Epoxy Sealer	234.00	
Zinc Epoxy Primer Paint	304.11	
White Epoxy Paint, Topcoat	888.90	
Red Lead Primer Paint	716.60	
Epoxy Deck Paint	1,106.44	
Anti-Fouling Bottom Paint, Red Vinyl	1,217.25	
White Gloss Oil Paint and Undercoating	509.20	
Thinners and Painting Accessories	1,128.08	
Painting Services	603.00	
		$ 6,777.08
Carry forward:		$198,382.01

RADIO AND ELECTRICAL EQUIPMENT

Brought forward:		$198,382.01
Radio, Simpson, 85-watt, antenna	$ 3,000.00	
Seawater Ice Machine, Seafarer	42,666.00	
Depth Indicator, Ray Jefferson	1,101.00	
Searchlight	348.40	
Navigational Lights	363.01	
Spreader Floodlight	78.75	
Horn, Electric	165.36	
Horn Pushbutton	6.98	
Cabin Light Fixture	30.78	
Instrument Panel	180.00	
Switch Panel and Nameplates	240.30	
Battery, Battery Cable and Terminals	2,418.60	
Safety Marine Switch	254.25	
Starter Switch	27.00	
Vapor-Proof Lamp	367.50	
Light Bulbs and Sockets	115.50	
Pilot Light	18.00	
Electrical Cable	894.00	
Electrical Cable Support Clips	76.00	
Antenna Wire	65.00	
Watertight Deck Connection	25.20	
Trouble Lights	374.20	
Electrical Services	5,200.00	
		$ 58,015.83

BOAT FITTINGS

Rubber Guard (Hull)	$ 930.00	
Sundry Fabricated Fittings	1,204.00	
Inspection Hatches, Circular, Steel	1,841.84	
Boat Joinery Fittings	630.43	
Wheelhouse Handrails	400.00	
Portlight	360.00	
		$ 5,366.27
Carry forward:		$261,764.11

BOAT FITTINGS (continued)

Brought forward:	$ 5,366.27	$261,764.11
Windows	1,087.20	
Window Fixtures	329.00	
Casement Adjuster (Skylight)	125.14	
Pipe Deck Plates and Keys	158.27	
Aluminum Penboards (Fish-Hold)	4,930.00	
Door Locks	87.00	
Sink, Pump and Fittings	371.75	
Anchor, Anchor Chain and Bow Rollers	911.00	
Snatch Block (Anchor Line)	613.20	
Compass	693.00	
Compass Adjustment Service	574.00	
Eye Bolts, Galvanized	48.91	
Deck Cleats, Galvanized	227.10	
Deck Hose	218.20	
Gooseneck and Boom	1,488.40	
Tackle Blocks	435.80	
Rigging Blocks	49.80	
Shackles, Galvanized	180.20	
Thimbles, Galvanized	3.60	
Rigging Cable	172.00	
Polypropylene Rope	1,161.21	
Primus Stoves	297.00	
Canvas Bunks	405.00	
Cabin Mattresses	825.00	
Flags (Bahamas)	80.00	
Weight Scales, Chatillon 7290	2,215.57	
Deck Awnings (Dinghy Fishing Only)	5,665.89	
		$ 28,719.51
		US $285,117.35

N.B. Each section shows its correct total, allowance has been made in the final column of additions for the "over-page" continuation of the summing of sections.

- ENDOF VOLUME III -

INDEX OF TRAINING FILMS CORRESPONDING TO THIS TEXT

TRAINING FILM SERIES NO. 5862-1-73

Film No.	Title
(13)	Multi-Stage Plastering Mold
(14)	Steam Curing
(15)	Water Testing and Repair
(16)	Moving and Rolling Hulls

General Films

(17)	Ferro-Cement Boat Building, the Upright Welded Cage Method
(18)	Ferro-Cement Boat Building, the Inverted Wood Mold Method