NAVSHIPS 0982-019-1010

U.S. NAVY

FERRO-CEMENT
BOAT BUILDING MANUAL

VOLUME I

NAVAL SHIP SYSTEMS COMMAND
WASHINGTON, D. C.

1972

FOREWORD

There has been a big increase in the use of cement for the construction of boat hulls. These hulls are commonly referred to as Ferro-Cement. They are constructed from a combination of fine wire, small diameter reinforcing bars and sand-cement mortar. The rapidly increasing popularity of these craft is deserved for the construction techniques used to build these vessels are simple and easily learned. The materials used to build the hulls are economical and readily available all over the world. Further, the hulls are practical, durable and easily maintained.

This series of manuals has been prepared specifically as a training aid and guide for ferro-cement construction. It covers the two basic construction methods currently in use – the upright welded cage and the inverted wood mold techniques. The "Upright Welded Cage Method" is described from lofting through launching in Volume I. The construction of a 65-foot Patrol Boat Hull is demonstrated. The "Inverted Wood Mold Method" is described in Volume III; a combination fishing boat is used to describe this method. This vessel is detailed from setting-up and outfitting through sea trials. Plastering, the use of plastering tools and hull repair are described in Volume II.

The instructions are in complete detail. The construction stages have been broken down into Jobs and Tasks. This has been done to enable the reader to absorb the information in each task before proceeding with the next. Each task is clarified with the use of photographs. Both English and Metric units have been used when describing weights, volumes and measurements.

The construction methods covered in this text series are visually demonstrated in Navy Training Aid Film Series No. 5862-1-72: Ferro-Cement Boat Building No. 1 through No. 18.

INTRODUCTION

This volume deals with the construction in ferro-cement of a 65-foot (19.5 m) power boat hull for twin engines. The construction method demonstrated is the upright, welded framework method in suspension from an overhead structure.

The contents of this volume treat in proper sequence with all the construction stages from lofting through to a hull ready to be plastered. Inevitably, for the purposes of illustrating the construction work in detail, one single design of hull had to be chosen. Prospective builders of other designs of boats within this category need not be deterred, however. The techniques demonstrated here may be safely imitated to produce other hulls of equal proven quality.

Construction Costs:

Costs of construction are what immediately interest the prospective builder. Following the reproduction of the set of drawings from which this hull was built, a comprehensive catalogue has been included. The catalogue lists all the equipment and materials used in the yard and in the construction of the demonstration hull. It will be noted that some of the equipment and most of the tools were purchased. In those instances where equipment was required only for a short period of time it was, where possible, rented. In cases of either rental or purchase the prices are recorded as they stood in Seattle, Washington, USA, in the spring of 1972.

The costs of overheads: management, yard material, electricity, insurance, social security, etc., have been omitted because of the wide differences in these costs from one place to another.

Labor Costs:

Labor costs also differ widely from one region to another. For this reason estimates are given of the number of man-hours required to perform a given task by a given trade classification. This information will be found in the Construction Schedule, a valuable guide which is placed immediately after the Catalogue in this Section. From these man-hour estimates (in fact, an actual record of man-hours utilized in the construction of the demonstration hull), the prospective builder can calculate total labor costs according to the rates prevailing in his area.

The Manager's Check-List:

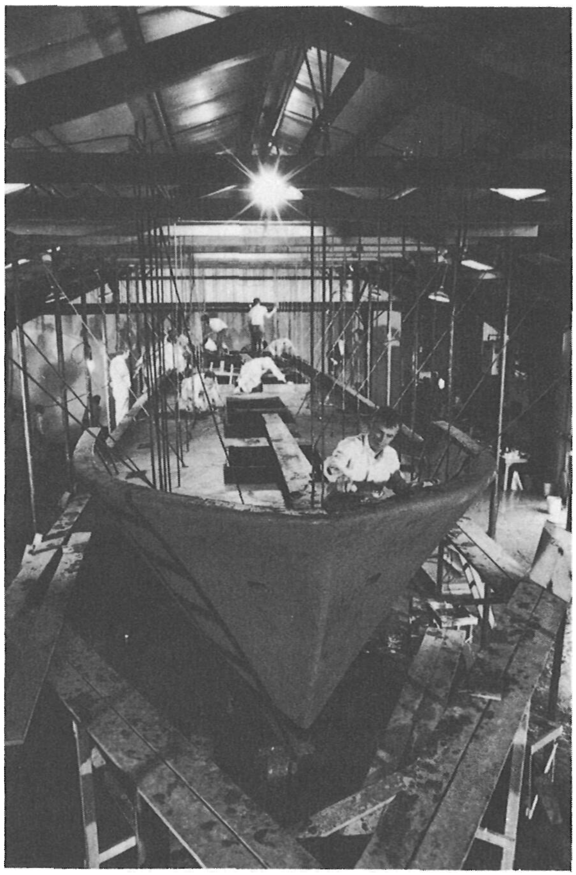
The Construction Schedule has purposes other than a guide to labor requirements and its principal function is to serve as a form of check-list for management. Here, in condensed form, the manager has set down before him all the essential information required for building the hull efficiently. For precise details on certain jobs the manager refers, by numbers of Stage, Job and Task, to the corresponding section in the text, for both text and Construction Schedule follow the same titles and sequence.

The Construction Schedule reminds the manager when to consult the Catalogue for deliveries of materials and equipment. It informs him, as has been mentioned, on what types of tradesmen will be required for a certain job, also, how long the job should take.

Because of printing space requirements only a skeleton Construction Schedule is included here but, in expanded form, more space would be given for the manager's own annotations. In the case of series production of one design of hull the Construction Schedule would be constantly revised according to the performance of the work force as it gained efficiency. The basic information contained in the Construction Schedule would be submitted to an over-all, Master Construction Schedule which would project, on one sheet of paper at any one time the varying stages of production of all the boats in the yard. This was the system employed in the Bahamas in 1971 when a new boat yard was developed, men trained and ten ferro-cement vessels of one design were successfully built and launched within a five-month period. (See Volume III.) If a crisis should arise where a fleet is required in a hurry, a production schedule of this type could be effectively used on a protected beach to produce one boat complete through trials every working day. Providing space, materials, labor and money were available. Details of the production method would alter but this tried and proven principle would remain the same.

The Illustrated Text:

The bulk of this section is taken up with precise descriptions of the two construction stages utilized in the building of the 65-foot (19.5 m) demonstration hull. The text has been profusely illustrated with photographs because it is felt that in the demonstration of construction techniques a picture can convey the information required so much more clearly and swiftly than words. The ordered series of illustrations with their accompanying captions show the construction sequence on its own. A reading of the text will give the prospective builder all the details he requires.



Final stages of plastering

INDEX

Page

FOREWORD. i

INTRODUCTION. ii

INTRODUCTION TO MATERIAL ORGANIZATION. 1

1. Preparatory Work to Establish a Boatyard Overseas. 1
2. Materials and Equipment Organization. 5
3. Organization of Tools in the Yard. 6
4. Drawing and Lines Plan. 10
5. Catalogue. 22
6. Construction Schedule for Vessel. 30
7. Production Planning Chart. 43

STAGE 1

JOB 1 - Making Hull Frames. 45

Task 1 Making the Lofting Floor. 45
Task 2 Sanding and Painting Lofting Floor. 46
Task 3 Layout the Lofting Grid. 46
Task 4 Lay Out Hull Profile. 49
Task 5 Lay Out Hull Sections. 50
Task 6 Lay Out Waterlines and Sheer in Plan View. 51
Task 7 Set Up Hull Frame Bending Bench. 52
Task 8 Drive Nails Along Lofting Floor Station Lines. 53
Task 9 Cut Rods for Hull Frames. 53
Task 10 Bend Hull Frames. 53
Task 11 Mark Reference Lines on Hull Frames. 54
Task 12 Store Hull Frames in Pairs. 54

JOB 2 - Making Up Deck Beams. 55

Task 1 Deck Beam Welding Jig 55
Task 2 Cut Flat Bar to Approximate Lengths. 56
Task 3 Weld Deck Beams in Jig. 56
Task 4 Master Pattern for Deck Beam Camber. 57
Task 5 Deck Beam Bending Jig. 57
Task 6 Check and Hammer Deck Beams to Master Camber Pattern. 57
Task 7 Cleaning and Priming Deck Beams. 60
Task 8 Mark Center Line and Buttock Lines on Deck Beams . 60

Page

JOB 3 — Assemble Frames, Deck Beams and Suspension Rods 61
Task 1 Lay Hull Frame Pairs in Place on Lofting Floor 61
Task 2 Lay Deck Beam onto Frame and Mark 61
Task 3 Cut and Weld Deck Beam in Place 61
Task 4 Make Deck Knee Bending Jig 62
Task 5 Weld in Deck Knee 63
Task 6 Weld Lower Suspension Rods to Hull Frame 65
Task 7 Weld Athwartship Braces 65
Task 8 Weld Bulwark Supports 66
Task 9 Weld Keel Sections 67
Task 10 Weld Rod Reinforcing to Solid Bulkheads 68
Task 11 Weld Webs to Hull Frames 68
Task 12 Fasten Mesh to Bulkheads, Bulwark Supports and Webs 69

JOB 4 — Erecting Overhead Supports 75
Task 1 Measure Off Base 75
Task 2 Layout and Fasten Wooden Base Plates 75
Task 3 Bolt Piping Base Plate to Wooden Base Plate 75
Task 4 Prepare Piping Supports and Braces 75
Task 5 Weld Overhead Support Frames 75
Task 6 Preparations for Erection of Support Frames 76
Task 7 Erect Overhead Support Structure 77
Task 8 Align and Weld Overhead Support Structure 77
Task 9 Weld Channel to Support Structure at Buttock No. 2 Lines 77

JOB 5 — Establish Base and Support Lines 79
Task 1 Make Center Line and Buttock No. 2 Lines 79
Task 2 Mark Water Lines 79
Task 3 String the Water Line Around the Four Corners of the Structure 79
Task 4 String Vertical Center Line and Buttock No. 2 Lines 80

JOB 6- Make Stem Piece 81
Task 1 Measure and Cut Stem Piece Rod 81
Task 2 Bend Rod to Shape of the Stem Piece 81

JOB 7 — Hanging Frames, Fairing Frames, Welding Stringers 82
Task 1 Cut Upper Suspension Rods to Size 82
Task 2 Weld Upper Suspension Rods to Hull Frames 82
Task 3 Mark Hull Frame Positions on Longitudinal Girders 82
Task 4 Weld First Hull Frame to Overhead Support Structure 83
Task 5 Weld Remaining Hull Frames to Overhead Support Structure 84
Task 6 Make Alignment Frames for Bow Hull Frames 85
Task 7 Plumb One Hull Frame and Brace 88

Page

Task 8 Plumb Remaining Hull Frames and Brace 88
Task 9 Temporarily Brace Hull Frames to Support Structure Sides 88
Task 10 Weld Stem-Piece to Bow Frames 90
Task 11 Erect Scaffolding to Support Structure 91

JOB 8 - Check Hull and Deck Exterior for Fairness 92
Task 1 Check Hull Exterior for Fairness 93
Task 2 Check Deck Exterior for Fairness 94
Task 3 Stem and Keel Reinforcing 95
Task 4 Keel Deadwood Reinforcing 98
Task 5 Weld Longitudinal Spacer Rods to Hull Frames 100
Task 6 Weld Transom in Place 101

STAGE 2

JOB 1 - Applying Rods and Mesh 102
Task 1 Make Mesh Folding and Cutting Bench 102
Task 2 Fold and Cut Mesh 102
Task 3 Applying First Four Layers of Mesh to the Hull 103
Task 4 Apply Mesh to Transom Interior 106
Task 5 Fasten Longitudinal Reinforcing Rods Above the Mesh 106
Task 6 Remove Underlying Spacer Rods, Replace with Longitudinal Reinforcing Rods Overlying the Mesh 109
Task 7 Weld Vertical Rod Reinforcing at Three-Inch Centers 110
Task 8 Make Starter Rod Jig 112
Task 9 Make Starter Rods 113
Task 10 Weld Starter Rods Along Diagonal "D" Line 114
Task 11 Weld Hull Reinforcing Rods at Stem, Keel and Transom 115
Task 12 Staple Interior Mesh to Longitudinal Rods 117

JOB 2 — Deckhead Lining Preparations 118
Task 1 Marking Deck Apertures 118
Task 2 Making Longitudinal Beams for Deck Apertures 118
Task 3 Weld Deck Aperture Beams in Place 119
Task 4 Make Deck Ventilator Coamings 121
Task 5 Weld Deckhead Lining Supports 122
Task 6 Clean and Prime Deck Steel Work 123

JOB 3 - Laying Deckhead Lining 123
Task 1 Fitting Wooden Deckhead Planks 123
Task 2 Installing Deck Ventilator Coamings 127
Task 3 Paint Deckhead Planking 128
Task 4 Fitting Insulation Material 128
Task 5 Laying Hardboard Panels Above Deckhead Insulation Material 130

Page

JOB 4 - Laying Mesh and Rods on Deck . . . 131
Task 1 Laying First Four Layers of Mesh on Deck . . . 132
Task 2 Weld Longitudinal Reinforcing Rods Over Deckbeams . . . 132
Task 3 Weld Athwartship Reinforcing Rods Above Deck Longitudinal Rods . . . 133

JOB 5 . . . 134
Task 1 Apply Bulwarks Screed . . . 134
Task 2 Weld Bulwarks Longitudinal Rods . . . 136
Task 3 Bend Bulwarks Sheer Rods . . . 136
Task 4 Fair Bulwarks and Weld Sheer Rods in Place . . . 137
Task 5 Fair Hull Steel Reinforcing . . . 139
Task 6 Weld Deck Steel Reinforcing to Hull Framework . . . 140

JOB 6 — Hatch Coaming and Scuppers . . . 141
Task 1 Fabricate Hatch Coaming Screeds . . . 141
Task 2 Weld Hatch Coaming Reinforcing in Place . . . 141
Task 3 Make Scuppers . . . 142
Task 4 Weld Scuppers in Place . . . 144

JOB 7 - Mesh Deck, Coaming and Bulwarks . . . 145
Task 1 Laying Four Layers of Mesh Above Deck Reinforcing Rods . . . 146
Task 2 Mesh Coaming and Bulwarks . . . 147

JOB 8 - Stringers and Sole Supports . . . 148
Task 1 Mark Sole Support Positions . . . 148
Task 2 Weld Sole Support Starter Rods . . . 148
Task 3 Weld Sole Support Screeds . . . 149
Task 4 Weld Diagonal "D" Stringer Screeds . . . 149
Task 5 Mesh Sole Supports and Diagonal "D" Stringers . . . 149

JOB 9 — Installation of Engine Beds and Stern Tubes . . . 150
Task 1 Mark Engine Bed Positions . . . 150
Task 2 Fabricate Engine Bed Screeds . . . 150
Task 3 Install Engine Bed Reinforcing . . . 151
Task 4 Fabricate Stern Tubes . . . 154
Task 5 Prepare Stern Tube Alignment Sights . . . 155
Task 6 Align and Weld Stern Tubes in Place . . . 156
Task 7 Mesh Engine Beds and Stern Tubes . . . 158

JOB 10 - Install Rudder Stuffing Box Supports . . . 158
Task 1 Prepare Rudder Stuffing Box Housings . . . 158
Task 2 Mark Rudder Stuffing Box Positions . . . 159
Task 3 Install Rudder Stuffing Box Housings and Fabricate Supports . . . 160
Task 4 Mesh Rudder Stuffing Box Supports . . . 161

Page

JOB 11 - Hull Exterior Mesh 162
Task 1 Modify Hull External Supports and Braces 162
Task 2 Apply Outer Layers of Mesh to Hull 162
Task 3 Fairing, Cleaning and Final Inspection of Mesh 165

- END OF VOLUME I -

INDEX OF TRAINING FILMS CORRESPONDING TO THIS TEXT AND THE PAGES THEY RELATE TO

TRAINING FILM SERIES NO. 5862-1-72

Film No.		Pages
(1)	Lofting	44- 51
(2)	Making Frames	52- 74
(3)	Erecting an Overhead Support Structure	75- 80
(4)	Erecting Frames	81- 91
(5)	Fairing Hulls	92- 101
(6)	Applying Mesh and Rods to the Hull	102- 111 & 115- 117
(7)	Deck Beams and Deckhead Lining	118- 130
(8)	Reinforcing Deck, Bulwarks and Coamings	131- 147
(9)	Webs, Engine Beds, Shaft Log, and Rudder Stuffing Box	112- 114& 148- 161
(10)	Meshing Hull Preparation for Plastering	162- 167

General Films

(17) Ferro-Cement Boat Building, the Upright Welded Cage Method

(18) Ferro-Cement Boat Building, the Inverted Wood Mold Method

PARTI - INTRODUCTION TO MATERIAL ORGANIZATION

1. PREPARATORY WORK TO ESTABLISH A BOATYARD OVERSEAS

This is a brief guide to the several factors which require examination before attempting to set up a ferro-cement boatyard on a foreign shore. A detailed appraisal is not possible here. If "foreign" implies shores beyond these of North America, then, as types of climate, geographical locations and societies, all so widely differ, only general guidelines can be offered.

Certain assumptions must be made, within this context and at this preparatory stage, before going any further:

1. It is assumed that a company is being formed and so structured as to conform to the laws of the land.

2. It is assumed that ferro-cement craft are to be produced in series of sufficient numbers to justify the capital outlay required for the boatyard.

3. It is assumed that an expanding sales market exists and that adequate financing is planned to carry the company into a future liquid operating position.

These assumptions will seem obvious but, with respect to the first-mentioned in the above list, it is surprising how many fair-minded investors are ill prepared to face what often appears to be quite illogical laws regulating foreign companies overseas.

The reason for these inhibiting laws, which may sometimes be profit-eliminating if taken to the letter, can usually be traced to national fears of economic domination from the more powerful, industrialized countries. It is significant that most nations on the UNCTAD "under-developed" list have strict regulations on the formation of companies with foreign capital and management. The assistance of an energetic and non-partisan local company lawyer will always be required when preparing to establish a company abroad.

A) The Design

The boatyard site cannot be fixed, nor equipment costs calculated until the first design, or designs, of the craft have been decided.

The first consideration in the design is size. The size of the craft to be built determines the following:

1) The Method of Construction

Craft under 50 feet in length can be more quickly and economically built on the inverted wooden mold method. Over 50 feet, the better method is upright open construction suspended from an overhead support structure.

2) Handling Equipment

For craft under 30 tons dead-weight (in the class of up to 50 feet), the most versatile piece of handling equipment is the self-propelled boat comporter which will lift, launch and carry craft. In addition to the comporter, lifting equipment for turning inverted concrete hulls will be required. As turning hulls is only an occasional two-hour operation in the boatyard, rental, rather than purchase, of a mobile crane is recommended.

3) Labor, Equipment and Materials

The division of boatyard requirements at the 30 to 50 feet design size is far-reaching in its effects on planning. Construction on the inverted wooden mold method makes greater demands on inventory. Quantities of the right kind of lumber at the right kind of price must be readily available. More woodworking equipment is needed, more carpenters will be hired, a different type of mesh-fastening staple is used with accompanying differences in air-stapling equipment. A greater variety of hand tools must be maintained on the yard. Yet this construction method remains the fastest and easiest, especially where low quality labor is being employed.

In construction requirements beyond the 30-ton, 50-foot design size, the emphasis changes to welders and welding equipment. More permanent boatyard facilities are needed, amongst which will be included a fixed overhead support structure for building the boats. Heavier boats, therefore, require heavier handling equipment all round. Fewer but more skilled men will be employed on the yard. Construction is slower, consequently the application of yard overhead charges is proportionately higher for each boat produced.

If the craft to be built at the yard are destined for the local market, some consideration should be made in the design to local preferences, at least in the accommodation, cooking and toilet facilities on board. The best and the very latest in design is not often good enough in some parts of the world. Traditional preferences, peculiar to the region or to religion, will often be demanded. The Arab seafarer is likely to prefer his transom-hung toilet; the Japanese fisherman may prefer to sleep on tatami. It is wise to give the customer what he wants.

One last point in regard to presenting a design overseas. Some countries only recognize the qualifications issued to architects by their own universities. They may legitimately demand that a set of designs be examined and certified by a locally qualified architect.

B) The Boatyard Site

The following factors should be considered when searching for an ideal site for the boatyard:

1. Reasonably close to a source of labor, of electric power, potable water and general hardware supply.

2. Sheltered access to a sea or waterway system which has sufficient depth, at least at high tide, for all drafts of vessels likely to be handled by the yard.

3. Reasonably close to a port of entry for ease of delivery of all shipped or imported equipment and materials. This question of ease of delivery refers to customs and banking facilities in addition to transportation and handling goods.

4. Reasonably close to rental accommodations for non-local employees, food and medical facilities, equipment rentals, if available.

5. If boats are to be built primarily for a fishing industry, then, clearly, the boatyard must be sited advantageously for the repair and maintenance of the fishing fleet and its base of operations.

6. Site should be in an area zoned by the local authorities for industry, an area where no impediments would be placed on future expansion of the yard.

C) Fishing Craft

In the event that a fleet of fishing vessels were to be built for the development of a local industry, the following factors should be considered:

1. Information should be gathered from the country's regional fisheries authorities on existing regulations, future plans and fish conservation policies.

2. Information should be gathered from the regional fishing communities on the species fished, the fishing grounds, the fishing methods used and methods of conservation of the catch on board.

3. A survey should be made of regional fish distribution systems and exports, if any.

The information collected from 1, 2 and 3 will influence the design of the fishing craft, consequently, the design and location of the boatyard. Types of fishing gear to be used, choice of refrigeration equipment on board, shore facilities in processing, exporting, off-loading and distribution will all be affected by these findings.

D) Layout and Costs of the Boatyard

At this stage, preparatory information will be coming together and an idea is being formed of what the boatyard will be required to produce and where it will be located. What will the boatyard cost, and how long will it take to start production are likely to be the next questions asked. The following factors will require preparation:

1) A Plan for the Boatyard

An architect's complete set of drawings will be required for the boatyard. This set of plans will cover specifically:

a) Location, water and land access to the yard.

b) Lay-out of the yard, plan view.

c) Wharf moorage, floats and anchorage plan.

d) Production time chart showing in-flow of materials, prefabricated parts and equipment.

e) Details of structures, handling and launching facilities, repair area.

f) Secondary buildings; stores, office, canteen,warehouse.

g) List of boat construction equipment for the yard.

h) List and quantities of building materials.

The set of plans will have to be copied and submitted for approval to the pertinent regional authorities whose responsibilities cover the various aspects of the future boatyard. The number of regional, even central, authorities who have some say in the establishing of an enterprise of this nature, and who issue the required permits and licenses, can be bewilderingly large and may sometimes be found to overlap. The fact that a boatyard is situated on the water, and produces boats, appears to have grave military implications in some countries. Indeed, the constitutions of certain Latin American countries have passed all coastal and waterway shoreland into the jurisdiction of the navy up to a certain distance above high water mark. This shoreland can never be bought outright, only leased and built upon with explicit permission from the navy high command.

2) Boatyard Construction Costs

Drawings pertaining to specific construction work will require submittance to local contractors for tender. Certain construction work–if drainage, dredging or pile-driving is required–will require offering to firms specializing in these fields. This will also hold true if a slipway or elevator launch platform is required. The mass pouring of concrete pads, leveling filling and electrical installation work is usually more economically and effectively carried out by contractors with the proper equipment and first-hand acquaintance with the local building codes.

Much of the second stage boatyard construction work can probably be managed by the future boatyard training instructors in charge of a local workforce of tradesmen and helpers. The first operations in construction in the locality will give the ferro-cement technicians a valuable grounding in instructing the men in the new surroundings and help to establish a working relationship with them. It will also give the instructors an opportunity to select a nucleus of tradesmen and workers for the time when actual boat construction begins.

If such a course should be contemplated an estimate of labor costs must be made. The information sought should specifically include the following:

a) Numbers of what types of tradesmen locally available and current rates of pay.

b) Regulations concerning hours of work, rest periods, medical, social, holiday and other benefits. The hiring and firing of labor in the construction industry. Whether the supply of transport and work clothing is mandatory or not.

c) Calendar of national and local holidays.

d) Local weather chart. Mean seasonal temperatures, periods when monsoons, typhoons or other natural impediments to construction are prevalent.

e) Local traditional methods of hiring labor. Whether direct, through a labor office or through a contractor.

f) Subcontractable services: Transport, cleaning, painting, sand-blasting, work clothing, glazing, etc.

All these factors, if not properly investigated beforehand, can play havoc with an estimate of labor costs in construction work in a new country. It is surprising that however experienced a person may be in running his own business in his own country, how often he will omit to investigate at least one of these factors mentioned here when setting up abroad. Obviously, construction work should never be programmed for an expected period of monsoon or heavy winds. It must be expected that all business activities will come to a standstill for a week in Latin America during Carnival and, in China and Japan, during the New Year festivities. It must be understood that the Mohammedan will take Friday as his day of rest and worship but that he is prepared to work on Sundays.

2. MATERIALS AND EQUIPMENT ORGANIZATION

No planning or ordering for the building of a given number of vessels of a given design can be started without a full set of drawings in conjunction with a construction schedule. These will determine which material and which equipment need to be in the yard at what time.

The second step is to calculate what lead time is required for ordering these goods, calculating transport, handling and customs' delays. Then add sufficient lead time to this total to estimate delivery of the goods, in the yard, 90 days ahead of when it will be needed.

This may seem like playing it too safe. Objections may be voiced from the financing side at having funds committed unnecessarily soon. But, experience has shown that overseas one is particularly at the mercy of events beyond one's control. Unexpected strikes, communal holidays which certain manufacturing firms take, goods mis-routed by rail or road, mistakes made by shipping departments of firms in packaging the wrong sizes, and import and export papers not conforming to local regulations. Unless a comfortable safety margin is built into delivery times, the boat-building project overseas may suddenly find itself brought to a standstill in mid-construction and forced to lay-off workers while overhead expenses continue.

If any subcontracted work is to be done the first work farmed out will generally be the stern tube. Often watertight hatches, fuel tanks and rudder assembly may be contracted out to firms with specialized equipment. In these instances, a comfortable lead time must be given. Delivery dates are never so critical to the subcontractor as they are to the firm which is awaiting the installation of the equipment so as to proceed to the next stage of construction.

The subcontractor will need complete blueprints for the section of work he is to carry out. Often the subcontractor will not have the necessary materials on hand to do the job and it may have to be ordered from overseas. If this is the case, it may be wiser to order the necessary materials directly and deliver to the subcontractor on arrival. It is also wise to check a subcontractor in progress to ensure that the blueprints and instructions are being followed correctly.

On delivery of materials and equipment to the yard a check should be made for damage or short-shipment against the packing lists. Fittings and equipment should be unpacked and preferably laid on shelves in a secure warehouse. Materials should be stacked and stowed according to their programmed order of use. If checking is carried out immediately on arrival the more lead time remains for making good any discrepancies in the shipment.

On the subject of packing lists, a word is in order here on shipping documents generally. A full set of shipping documents usually consists of the following:

A) **Commercial Invoice**

Usually an original and four to five copies. This document will state clearly that it is an "invoice." It will contain quantities, a concise description of the goods, a unit price figure and a quantity price figure. It will give the name and address of the vendor and the name and address of the purchaser. The customs authorities in some countries will not accept a commercial invoice if it shows that discounts have been given. The vendor is wise, therefore, to show only the negotiated prices in unit and total forms. Some countries also insist that an invoice be certified. The usual certification notice, either stamped, typed or written onto the invoice, will read: "This invoice certified true and correct," and it will be signed beneath by an accountant, cashier or manager of the vending company.

B) **Packing List**

If the goods shipped according to the invoice require to be stowed in more than one container, the packing list will enumerate what is packed into each container. Each container will be marked and numbered, the packing list will show these marks and numbers. Normally, the container will hold a copy of the packing list and another copy will be attached to the set of shipping documents.

C) Certificate of Origin, or **Consular Invoice**

Usually an original and one to two copies. Some countries insist on this document which provides certified proof of the country of origin of the goods. In many cases the consul of the country of destination will himself certify it and exact a small fee for doing so.

D) **Certificate of Insurance**

Most goods shipped overseas are insured as a matter of course under a general policy on the part of the shipper. Sometimes a certificate of insurance is called for as proof. When goods are shipped under the terms of a bank "Letter of Credit" a certificate of insurance will nearly always be demanded. In this case the certificate of insurance will cover the cost of the goods purchased plus the freight to the destination. Usually an original and one to three copies will be produced.

E) Bill of Lading, or Air Consignment Note

The bill of lading and the air consignment note, the first referring to goods shipped by sea and the second by air, are the most important documents in the set. It is the original of the bill of lading, endorsed by the consignee, which is the legal instrument giving the holder the right to possession of the goods shipped. The bill of lading will contain some general information: the number, markings, dimensions and weight of the goods shipped. It will state the names of the consignee and the name of the carrying vessel. There will be an original and several "non-negotiable" copies; sometimes as many as twenty will be issued by the shipping agency. The bill of lading will list freight charges plus extras such as dockage, insurance, documentation, etc., and the total amount shown is payable before the original bill of lading is handed to the consignee or his appointed agents. The same procedure applies for the air consignment note.

3. ORGANIZATION OF TOOLS IN THE YARD

A basic kit of tools should be issued to each man for him to maintain while in the employ of the company. A list of what each tradesman's kit should contain is given at the close of this section. Further, each employee should be given ten identical identification discs to be turned in to the person in charge of stores when a non-issue tool such as a power plane is to be drawn out.

From the very beginning of the project the attitude of management towards the employee's possession of the company tools must be one of absolute firmness. Each man must sign for his basic kit of tools, know the cost of each tool, and understand that if a tool is lost or misused to the point of inutility the tool will be paid for by the consignee. A tool genuinely worn out or defective will, of course, be replaced by the company. It is a good policy to deduct the value of the tools from the tradesmen's and laborers' wages. Refunding the full price when the tools are turned in at the end of the job or when an employee's service is terminated.

As an aid to individual conservation of the basic tool kits each man should possess a securable locker in an appropriate building, the owner alone to possess a key to the locker. On no account should tools be allowed to leave the confines of the boatyard. Tools should be issued to tradesmen and laborers alike. This will ensure that each man has good quality tools to perform his work. If a tradesman is left to supply his own tools he may only have an incomplete kit and be continually borrowing from other men with the result that both men are slowed down, making them unproductive. Periodical kit inspections should be carried out and new tools issued and charges made for tools lost. Replacement tools should be issued for those that are genuinely worn out.

Grinders and saw benches must also be set up on a job where men may sharpen their tools during break time. If not, the result will be men wandering over to the sharpening area at all times during the day with the excuse to hone a chisel, etc. The company should either sub-contract hand and power saw sharpening and setting or appoint one man to sharpen saws continually for all the tradesmen. A carpenter, for instance, will take twice as long and only do one-half as good a job if he is using poor or dull tools. The initial cost and maintenance of tools should be calculated when setting up a job. Money spent here will have a tremendous effect on the efficiency and quality of work being produced.

Power tools and more specialized hand tools and accessories should be maintained in a toolroom constantly watched over by an employee who devotes his time to tool maintenance. This man will be in charge of handing out and receiving tools and logging the employee's number when a tool has been withdrawn. To avoid delay in the morning and evenings, when tools are being withdrawn and returned in quantities, a second man should lend his assistance.

Without strict controls over tools, reinforced with a policy of obliging the tradesman to pay for loss or willful neglect, there would be no end to the company's continual replacement of tools abused or spirited away. A sound system of accounting for tools is a more reliable safeguard than a stout wire fence, padlocks and security guards.

Given below are the lists of tools which are suggested for issue to each tradesman before beginning work on the yard.

A) CARPENTERS - Basic Issue Tool Kit:

1 Smoothing plane
1 Block plane
1 Jack plane
1 10 Point handsaw, cross-cut
1 8 Point handsaw, cross-cut
1 Coping saw and blades
1 Compass saw and blades
1 Hacksaw and blades
1 16-oz. (1 kg.) clawhammer
1 Nail set — 3 sizes: small, medium, large
1 Set bashing chisels - 1/4",1/2", *3/4"*, 1" (6 mm, 13 mm, 20 mm, 25 mm)
1 Carpenter's apron
1 10' (3 m) steel tape measure
1 2' (600 mm) spirit level
1 Set compass
1 2' (600 mm) wrecking bar
Selection of sand papers
1 Ratchet brace and set of bits - 1/4" - 1" (6 mm — 25 mm)
1 Hand drill and set of drills - 1/32" to 1/4" (0.79 mm -6 mm)
1 Set screw countersink heads
1 Large ratchet screwdriver with selection of heads
1 Small screwdriver

B) PAINTERS - Basic Issue Tool Kit:

3 4" (100 mm) paint brushes
3 3" (76 mm) paint brushes
3 $1^1/_2$" (38 mm) paint brushes
1 Face mask with spare filters
1 Roller tray
1 Roller handle (with extensions)
4 9" (228 mm) paint rollers
1 Paint scraper
1 Putty knife
5 lbs. (2.5 kg) rags
1 Roll 1" (25 mm) masking tape
Selection of sand papers

C) WELDERS - Basic Issue Tool Kit:

1 Welder's hood
1 Pair dark cutting goggles
1 Pair leather gloves
1 Leather apron
1 Chipping hammer
1 2 lbs (1 kg) engineer's hammer
1 Pair 10" (254 mm) common pliers
1 Pair Vice-grip pliers
1 Magnetic spirit level
1 Flint lighter
1 Set tip cleaners
1 12" (300 mm) Coarse flat mill bastard file
1 12" (300 mm) Coarse half round bastard file
1 12" (300 mm) Coarse round bastard file
1 Leather electrode pouch
1 Soapstone (marking chalk) holder and spares

D) DRAFTSMEN/ENGINEERS - Basic Issue Yard Tool Kit:

1 16-oz. (1 kg) hammer
1 100' (30 m) Steel tape measure
1 10' (3 m) Steel tape measure
1 Chalk line plus chalk
1 Smoothing plane
1 10 Point handsaw
1 2' (600 mm) spirit level
1 Magnetic spirit level
1 Transit level with tripod

E) PLASTERERS - Basic Issue Tool Kit:

2 4" x 12" (100 mm x 300 mm) Stainless steel standard trowels
1 4" x 16" (100 mm x 400 mm) round-edge swimming pool trowel
1 Aluminum hawk
1 Coarse sponge float
1 Fine sponge float
1 Edger
1 3-gallon galvanized bucket
1 6" (152 mm) water brush
1 Pair waterproof work gloves

F) LABORERS - Basic Issue Tool Kit:

1 16-oz. (1 kg) Claw hammer
1 Carpenter's apron
1 2' (600 mm) wrecking bar
1 Pair 10" (254 mm) common pliers
1 Pair 1/2" (13 mm) Hog ring pliers
1 Pair 3/4" (20 mm) Hog ring pliers
1 Face mask with spare filters
1 Pair work gloves

A Final Word on Tools Issue:

It cannot be emphasized too strongly the importance of supplying good quality hand and power tools on a boat building job. If, for instance, a man is being paid $2.00 per hour and is working without proper tools he may well be producing less than $1.00 per hour in actual output and personally working harder to achieve it. Eight hours a day, forty hours a week, multiplies at an alarming rate on even a small job. An inexperienced man given proper tools will soon start turning out acceptable work. The best illustration for this is that of the company supplying a power cut-off saw (which will produce accurate square cuts every time) instead of a dull hand saw. Even a master craftsman will not be able to cut a board accurately using a dull hand saw with no set to it. If a man is supplied with good tools to do his job he will turn out good work and take increasing pride in his work. Good tools make the work easy. Poor tools make work hard and frustrating. Using improper tools is probably one of the major causes of a job failing to reach its projected target dates.

One of the first jobs to attend to when starting up a project is to have a carpenter construct tool boxes for every tradesman anticipated being employed on the job. As each tradesman is employed, his individual tool box should be issued with the required tools and a proper receipt signed.

CONSTRUCTION DRAWINGS

FOR A

65-FOOT PATROL BOAT HULL

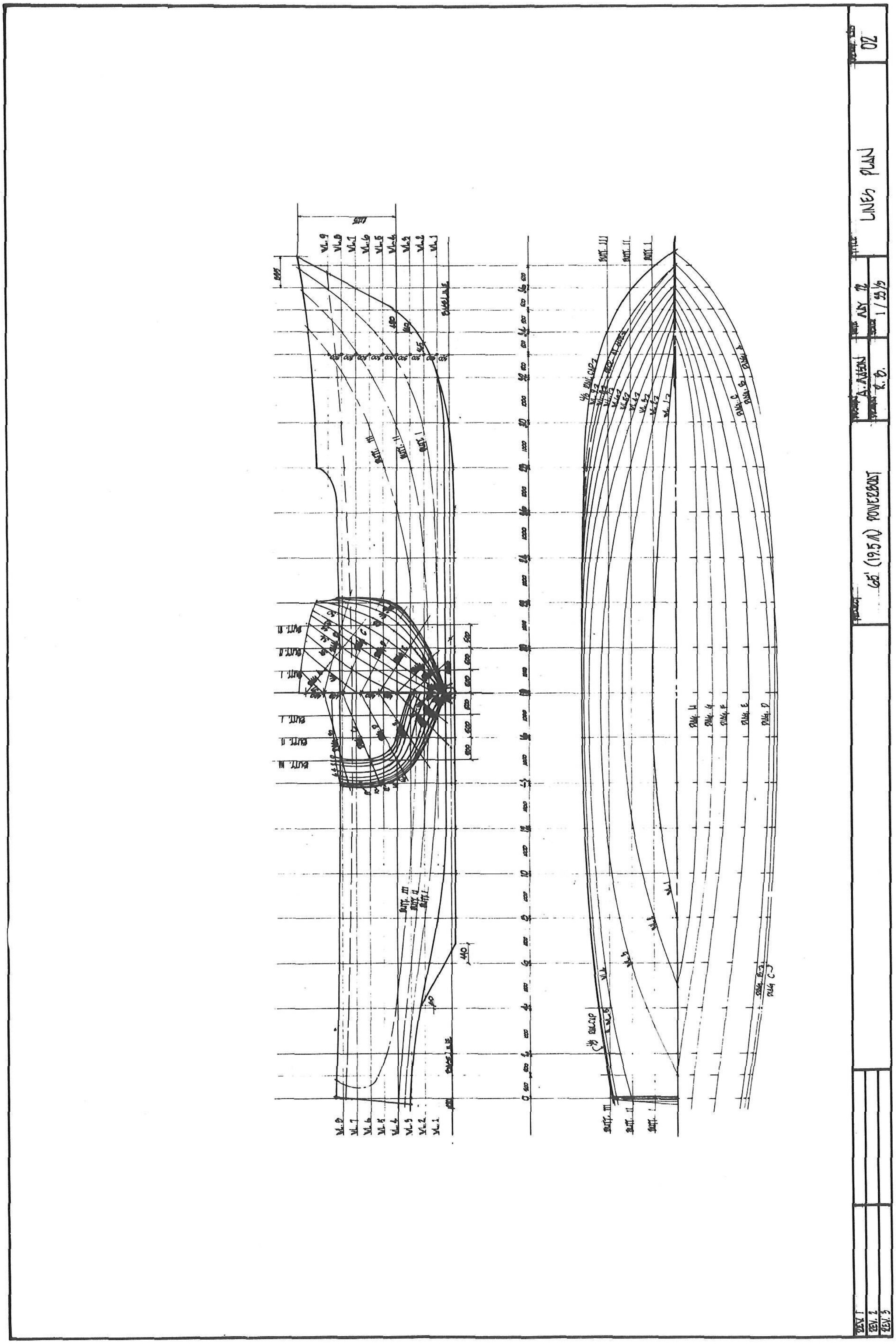


Figure 1. Lines Plan

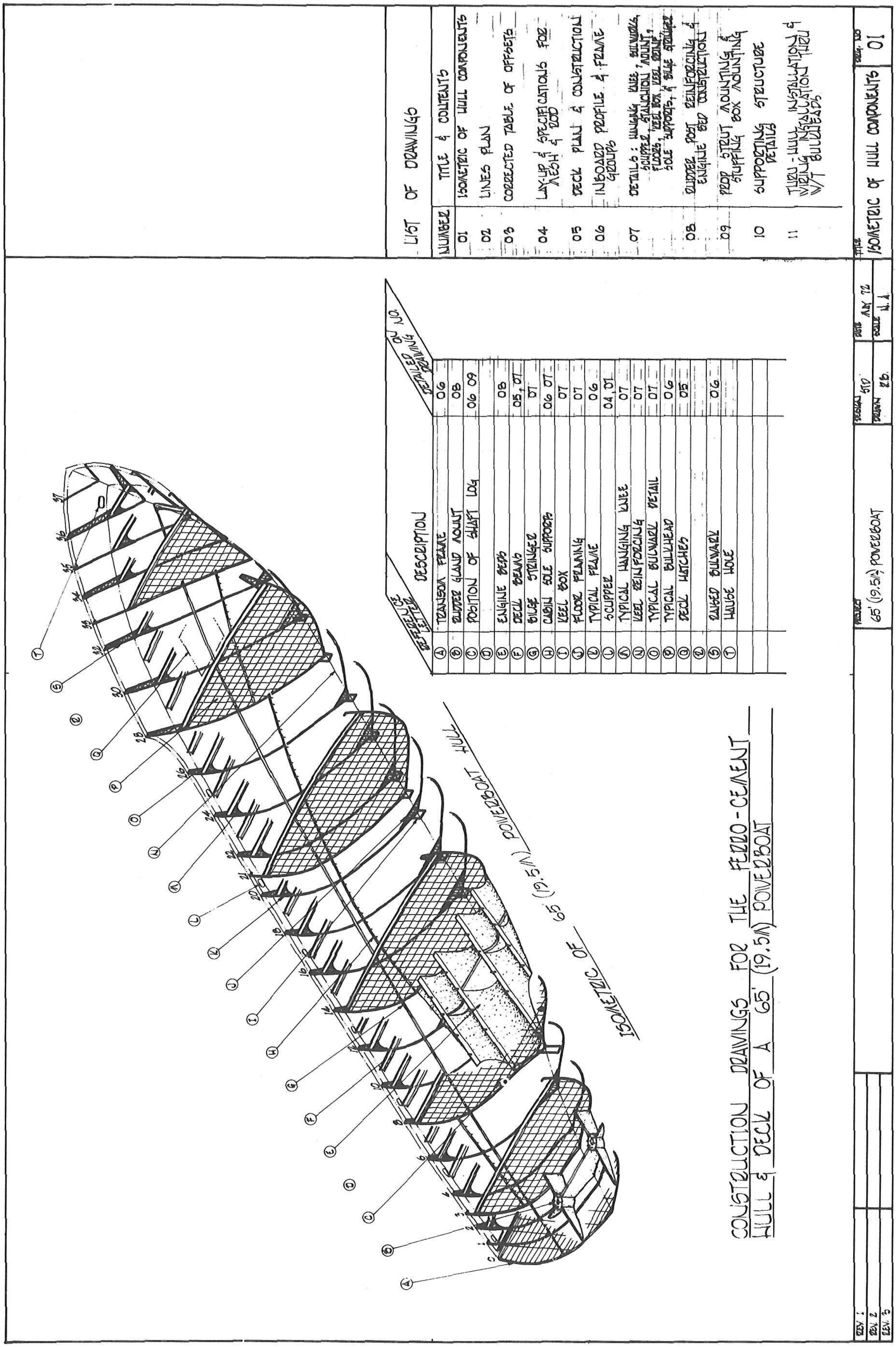


Figure 2. Isometric of Hull Components

CORRECTED TABLE OF OFFSETS IN METRIC MEASURE

FRAME NO.	0	1	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	33	34	35	36	37	BULKHEADS 3	BULKHEADS 21
HALF-BREADTHS FROM ℄ SHIP																									
U/S RAIL CAP	1427	1512	1595	1734	1841	1921	1982	2027	2055	2079	2092	2095	2091	2071	2031	2026	1965	1822	1697	1552	1290	945	455	1668	2118
TOP DECK AT SIDE	1459	1543	1624	1758	1862	1941	1999	2045	2076	2095	2103	2103	2093	2064	2006	1895	1732	1493	1327	1119	829	442		1694	2103
W.L. 9																1983	1862	1631	1453	1227	905	480			
W.L. 8	1450	1532	1613	1746	1849	1927	1985	2031	2057	2082	2092	2097	2092	2070	2018	1911	1730	1444	1249	1004	676	257		1684	2097
W.L. 7	1475	1558	1633	1765	1967	1947	2002	2043	2072	2098	2106	2105	2092	2051	1971	1815	1583	1255	1046	792	465	69		1703	2103
W.L. 6	1455	1537	1615	1750	1856	1936	1995	2040	2067	2089	2099	2096	2070	2006	1887	1693	1416	1062	845	590	278			1686	2091
W.L. 5	1360	1444	1524	1675	1790	1875	1943	1992	2025	2045	2052	2043	2000	1908	1760	1526	1221	858	643	401	122			1603	2029
W.L. 4	1022	1152	1279	1465	1602	1710	1797	1863	1910	1935	1935	1914	1855	1741	1559	1310	1005	652	452	239				1381	1894
W.L. 3			220	694	1061	1283	1446	1555	1627	1666	1675	1655	1584	1446	1255	1025	756	445	277					451	1633
W.L. 2					175	515	787	975	1105	1177	1205	1191	1124	1016	867	693	485	244							1160
W.L. 1						10	197	357	462	515	527	517	488	435	366	286									511
HEIGHTS ABOVE BASELINE																									
U/S RAIL CAP	2661	2549	2536	2510	2487	2465	2447	2437	2432	2430	2433	2444	2468	2474	2540	2914	2953	3011	3055	3103	3158	3215	3275	2522	2456
TOP DECK AT SIDE	2338	2321	2304	2275	2247	2225	2207	2192	2185	2179	2185	2195	2220	2253	2293	2343	2405	2477	2516	2557	2602	2651		2289	2208
BUTT. III		1625	1449	1234	1109	1015	932	860	810	779	770	784	833	946	1135	1461	1948	2490	2772	3067				1319	800
BUTT. II	1190	1128	1074	975	880	784	691	608	548	510	497	502	533	589	694	875	1197	1711	2031	2396	2820			1054	514
BUTT. I	1045	1002	956	856	731	590	464	368	313	290	285	290	301	326	370	446	615	976	1277	1660	2150	2725		910	294
PROFILE	923	898	858	711	492	289	157	115	115	115	115	115	115	115	115	115	130	245	410	692	1232	2015	2806	797	114
DIAGONALS																									
DIAG. A																			1554	1349	1086	752	349		
DIAG. B	1499	1589	1672	1814	1921	2004	2065	2111	2140	2165	2176	2178	2168	2138	2073	1949	1766	1505	1335	1126	843	480		1748	2178
DIAG. C	1571	1655	1733	1869	1977	2060	2123	2169	2199	2219	2228	2223	2186	2107	1980	1791	1543	1243	1062	846	568	221		1802	2211
DIAG. D	1403	1474	1546	1673	1772	1858	1929	1989	2029	2052	2056	2040	1988	1893	1748	1552	1299	998	819	617	343			1616	2022
DIAG. E	826	905	967	1090	1210	1320	1418	1498	1553	1586	1600	1588	1552	1482	1372	1222	1022	754	587	391	149			1029	1575
DIAG. F	315	355	407	536	675	815	933	1022	1080	1112	1125	1117	1100	1062	999	908	766	548	404	230				465	1111
DIAG. G			45	191	356	510	630	716	766	788	792	788	778	754	717	660	560	386	262	107				113	787
DIAG. H					089	258	371	433	456	461	458	457	455	448	439	423	377	264	146						457

CORRECTED TABLE OF OFFSETS IN BRITISH MEASURE

FRAME NO.	0	1	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	33	34	35	36	37	BULKHEADS 3	BULKHEADS 21
HALF-BREADTHS FROM ℄ OF SHIP																									
U/S RAIL CAP	56-1+	59-4+	62-6	68-2	72-4	75-5+	78-0	79-6+	80-7+	81-6+	82-3	82-4	82-2+	81-4+	79-7+	79-6	77-3	71-6	66-6	60-2+	50-6	37-1+	17-7	65-5+	82-3
TOP DECK AT SIDE	57-3	60-6	63-7	69-1+	73-2	76-3+	78-5+	80-4	81-4+	82-4	82-6+	82-6+	82-3+	81-2	78-7+	74-5	68-1+	58-6+	52-2	44-0+	32-5	17-3		66-5+	82-6+
W.L. 9																78-1	73-2+	64-2	57-2	48-2	35-5	18-7			
W.L. 8	57-0+	60-3	63-4	68-6	72-6+	75-7	78-1+	79-7+	81-0	81-7+	82-3+	82-4+	82-3	81-4	79-3+	75-2	68-1	56-7	49-1+	39-4	26-4+	10-0+		66-2+	82-4+
W.L. 7	58-0+	61-2+	64-2+	69-4	73-4	76-5+	78-6+	80-4+	81-4+	82-4+	82-7+	82-7	82-3	80-6	77-5	71-4	62-2+	49-3	41-1+	31-1+	18-2+	2-5+		67-0+	82-6+
W.L. 6	57-2+	60-4+	63-5	68-7	73-0+	76-2	78-4+	80-3	81-3	82-2	82-5	82-4	81-4	78-7+	74-2	66-5	55-5+	41-6+	33-2	23-1+	10-7+			66-3	82-2+
W.L. 5	53-4+	56-6+	60-0	65-7+	70-4	73-7	76-4	78-4	79-5+	80-4	80-6	80-3+	78-6	75-0+	69-2+	60-1	48-0+	33-6	25-2+	15-6	4-6+			63-1	79-7
W.L. 4	40-2	45-5+	50-3	57-5+	63-0+	67-3	70-6	73-3	75-1+	76-2	76-1+	75-3	73-0	68-4+	61-3	51-4	39-4+	25-5+	17-6+	9-3				54-3	74-4+
W.L. 3			8-5+	27-2+	41-6	50-4	56-7+	61-2	64-0+	65-4+	65-7+	65-1	62-3	56-7	49-3	40-3	29-6	17-4	10-7					17-6	64-2+
W.L. 2					6-7	20-2	30-7+	38-3	43-4	46-3	47-3+	46-7	44-2	40-0	34-1	27-2	19-0+	9-5							45-5+
W.L. 1						0-3	7-6	14-0+	18-1+	20-2+	20-5+	20-3	19-2	17-1	14-3	11-2									20-1
HEIGHTS ABOVE BASELINE																									
U/S RAIL CAP	100-7	100-3	99-7	98-6+	97-7	97-0+	96-3	95-7+	95-6	95-5	95-6+	96-1+	97-1	98-3	100-0	114-6	116-2	118-4+	120-2	122-1+	124-3	126-5	128-7+	99-2+	96-5+
TOP DECK AT SIDE	92-0+	91-3+	90-5+	89-4+	88-4	87-4+	86-7+	86-2+	86-0+	85-6	86-0+	86-3+	87-3	88-5+	90-2+	92-2	94-5+	97-4	99-0+	100-5+	102-3+	104-3		90-1	86-7+
BUTT. III		63-7+	57-0	48-4+	43-5+	39-7+	36-5+	33-6+	31-7	30-5+	30-2+	30-7	32-6+	37-2	44-5+	57-4+	76-5+	98-0+	109-1+	122-4				51-7+	31-4
BUTT. II	46-7	44-3	42-2+	38-3	34-5	30-6+	27-1+	23-7+	21-4+	20-0+	19-5	19-6	21-0	23-1+	27-2+	34-4	47-1+	67-3	80-0	94-2+	111-0+			41-4	20-2+
BUTT. I	41-1+	39-3+	37-5	33-4	28-6+	23-2	18-2	14-3+	12-2+	11-3	11-2	11-3+	11-7	12-6+	14-5	17-4+	24-1+	38-3	50-2+	65-3	84-5	107-2+		35-6+	11-4+
PROFILE	36-2+	35-2+	33-6	27-7+	19-3	11-3	6-1+	4-4	4-4	4-4	4-4	4-4	4-4	4-4	4-4	4-4	5-1	9-5	16-1	27-2	48-4+	79-3	109-3+	31-3	4-4
DIAGONALS																									
DIAG. A																			61-1+	53-1	42-6	29-5	13-6		
DIAG. B	59-0	62-4+	65-6+	71-3+	75-5	78-7	81-2+	83-1	84-2	85-1+	85-5+	85-6	85-3	84-1+	81-5	76-6	69-4	59-2	52-4+	44-2+	33-1+	18-7		68-6+	85-6
DIAG. C	61-6+	65-1	68-1+	73-5	77-1	81-0+	83-4+	85-3+	86-4+	87-3	87-5+	87-4	86-0+	82-7+	77-7+	70-4	60-6	48-7+	41-6+	33-2+	22-3	8-5+		70-7+	87-0+
DIAG. D	55-2+	[illegible]	60-7	65-7	69-6+	73-1+	75-7+	78-2+	79-6+	80-6+	80-7+	80-2+	78-2+	74-4	68-6+	61-0+	51-1	39-2+	32-2	23-7+	13-4			65-5	79-5
DIAG. E	33-0	35-5	38-0+	42-7+	47-6+	52-0	55-7	58-7+	61-1+	62-3+	63-0	62-4+	61-1	58-2+	54-1	48-1+	40-1+	29-5	23-0+	15-3	5-7+			40-4	62-0
DIAG. F	12-3+	14-0	16-0+	21-0+	26-4+	32-0+	36-6	40-2	42-4+	43-6+	44-2+	44-0	43-2	41-6+	39-2+	35-6	30-1+	21-4+	15-7+	9-0+				18-2+	43-6+
DIAG. G			1-6+	7-4+	14-0	20-1	24-6+	28-1+	30-1+	31-0+	31-1+	31-0	30-5	29-5+	28-1+	26-0	22-0+	15-1+	10-2+	4-2				4-3+	31-0
DIAG. H					3-4+	10-1+	14-5	17-1	18-0	18-1+	18-0+	18-0	17-7+	17-5	17-2+	16-5+	14-6+	10-3+	5-6						18-0

NOTE OFFSETS ARE GIVEN IN INCHES – EIGHTS. FOR + ADD 1/16"

REV 1		PROJECT: 65' (19,5M) POWERBOAT	DESIGN: STD	DATE: MAY 72	TITLE: CORRECTED TABLE OF OFFSETS	DWG. NO. 03
REV 2			DRAWN: R.B.	SCALE: N.A.		
REV 3						

Figure 3. Corrected Table of Offsets

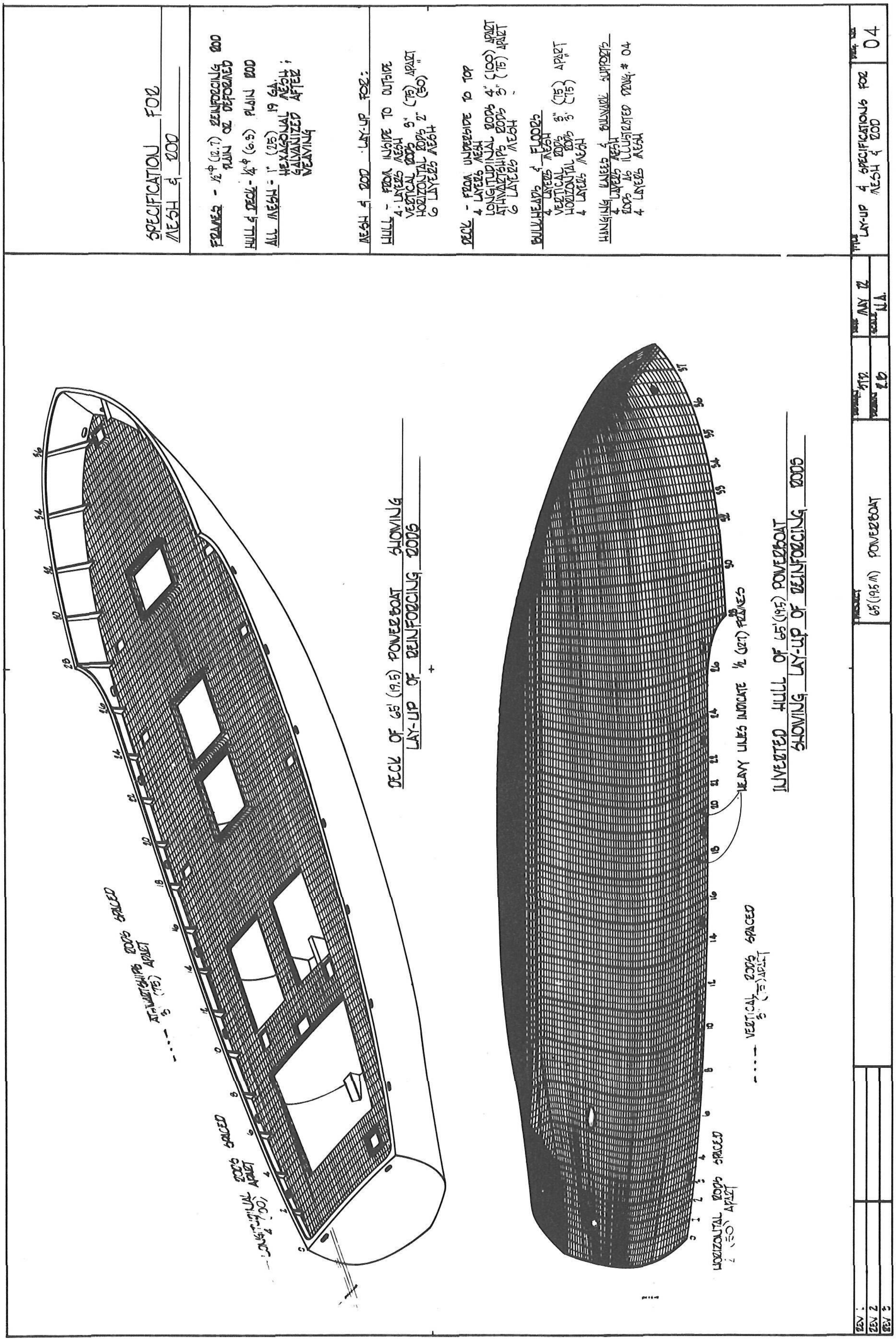


Figure 4. Layup for Rod and Mesh

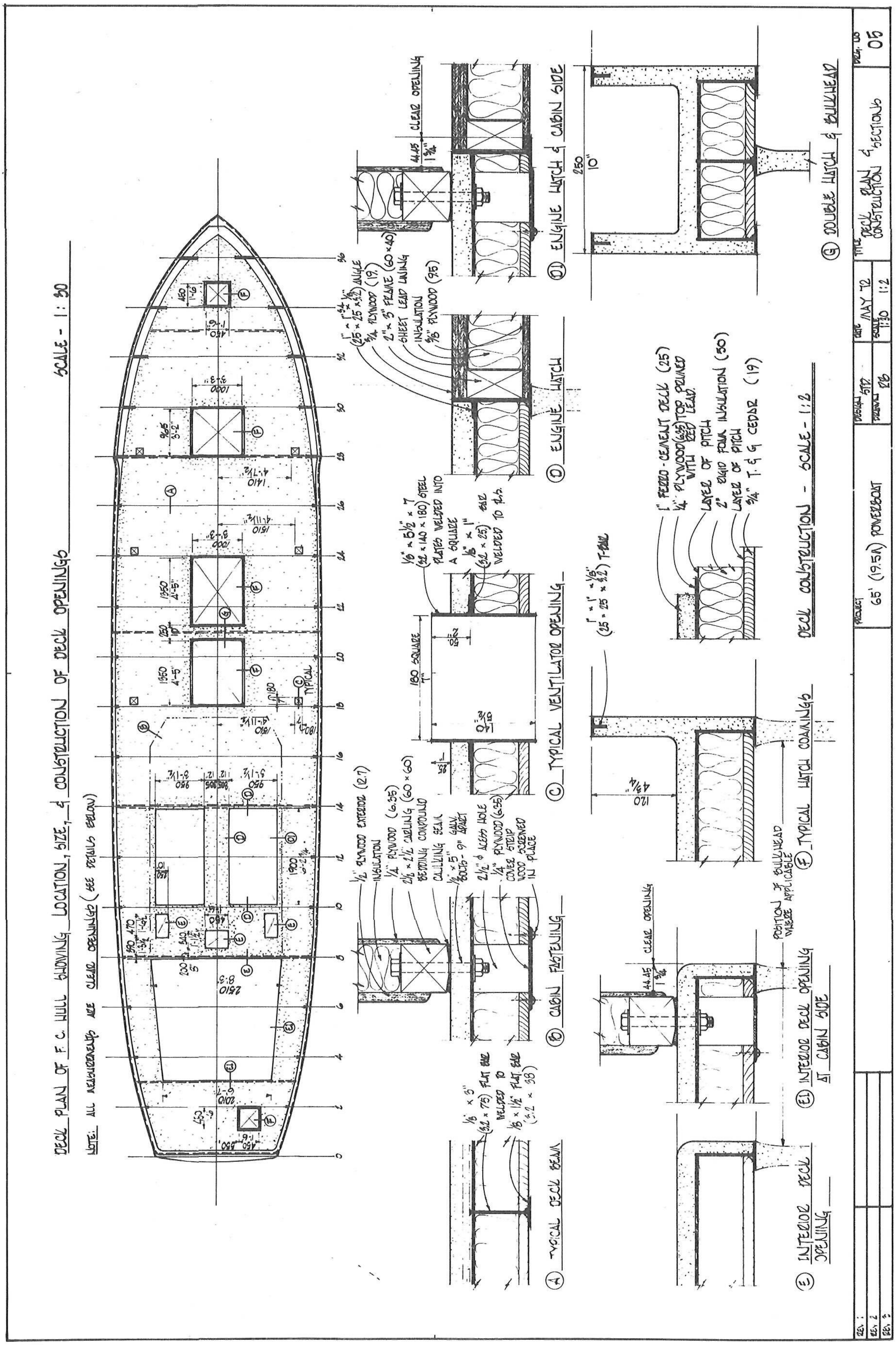


Figure 5. Deck Plan and Construction Details

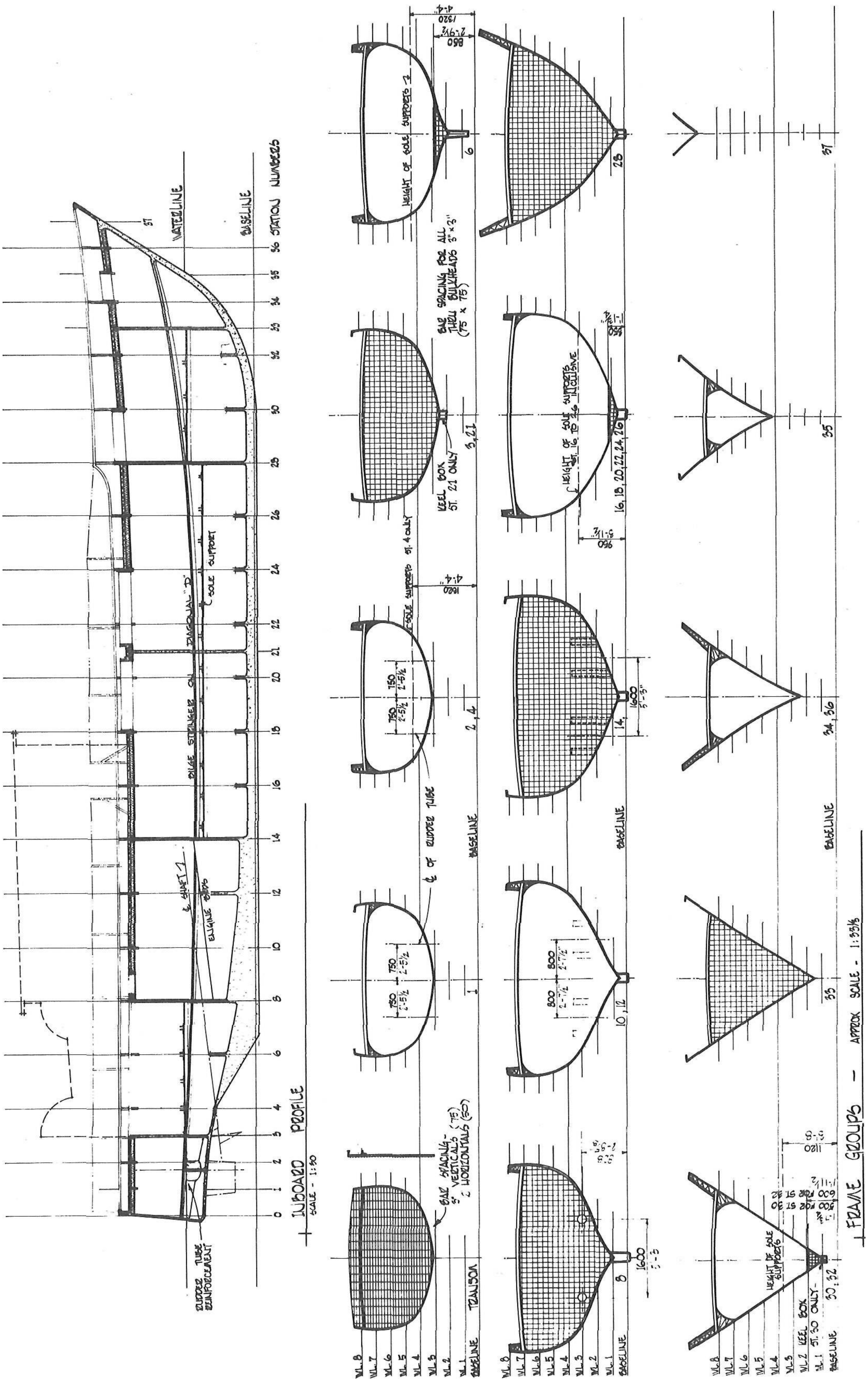


Figure 6. Inboard Profile and Frame Groups

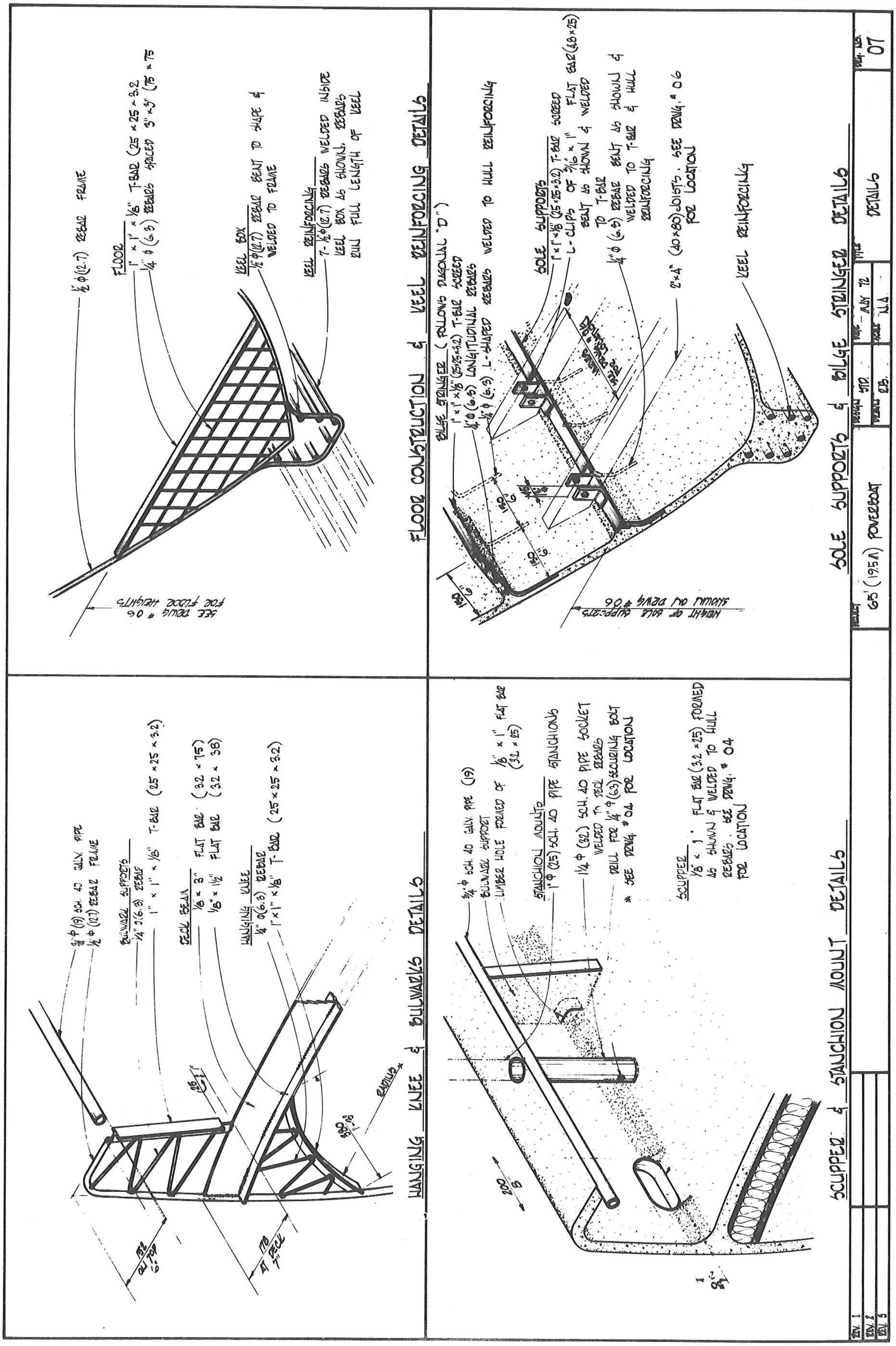


Figure 7. Construction Details

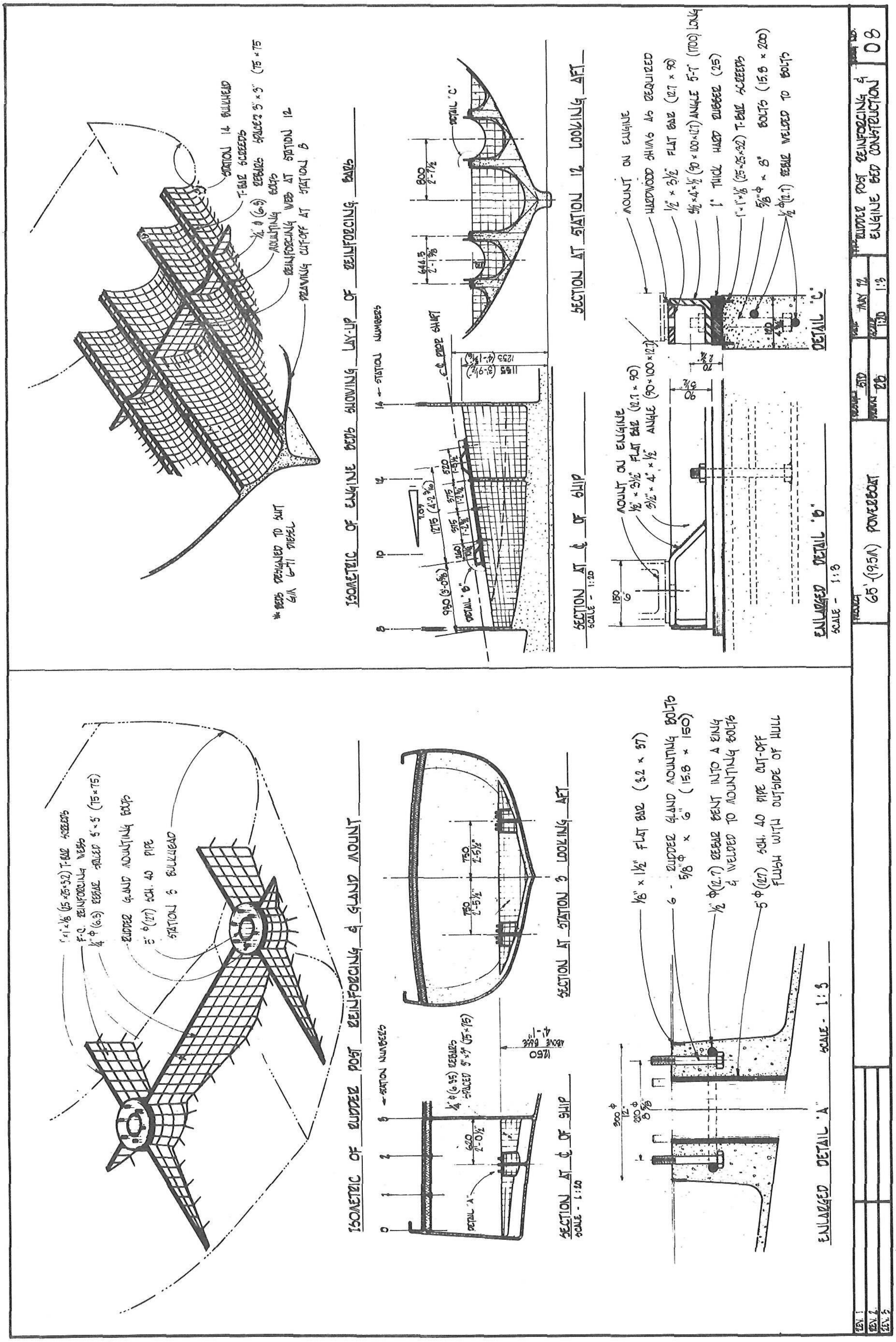


Figure 8. Construction Details — Rudder Post and Engine Bed

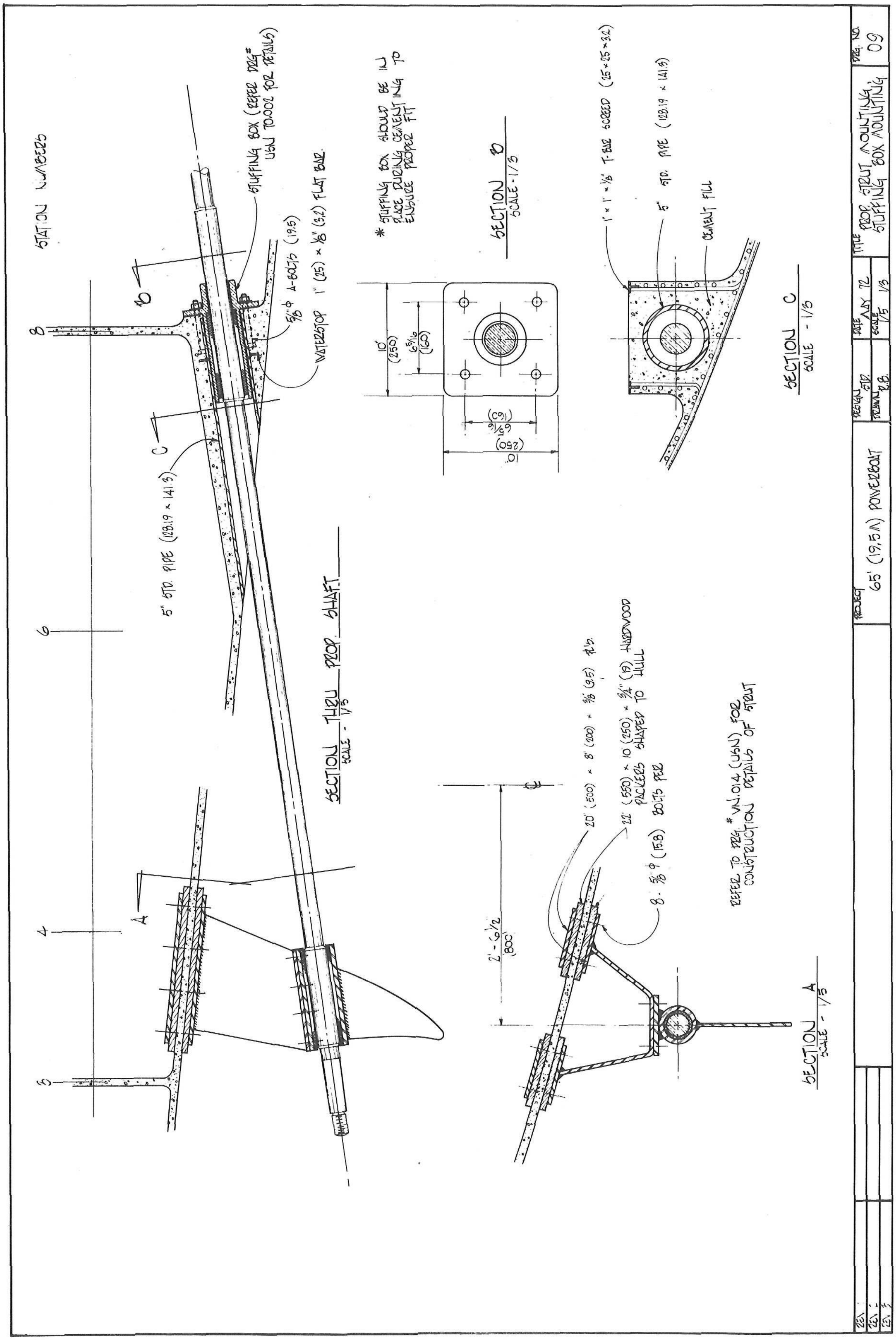


Figure 9. Construction Details - Strut and Stuffing Box

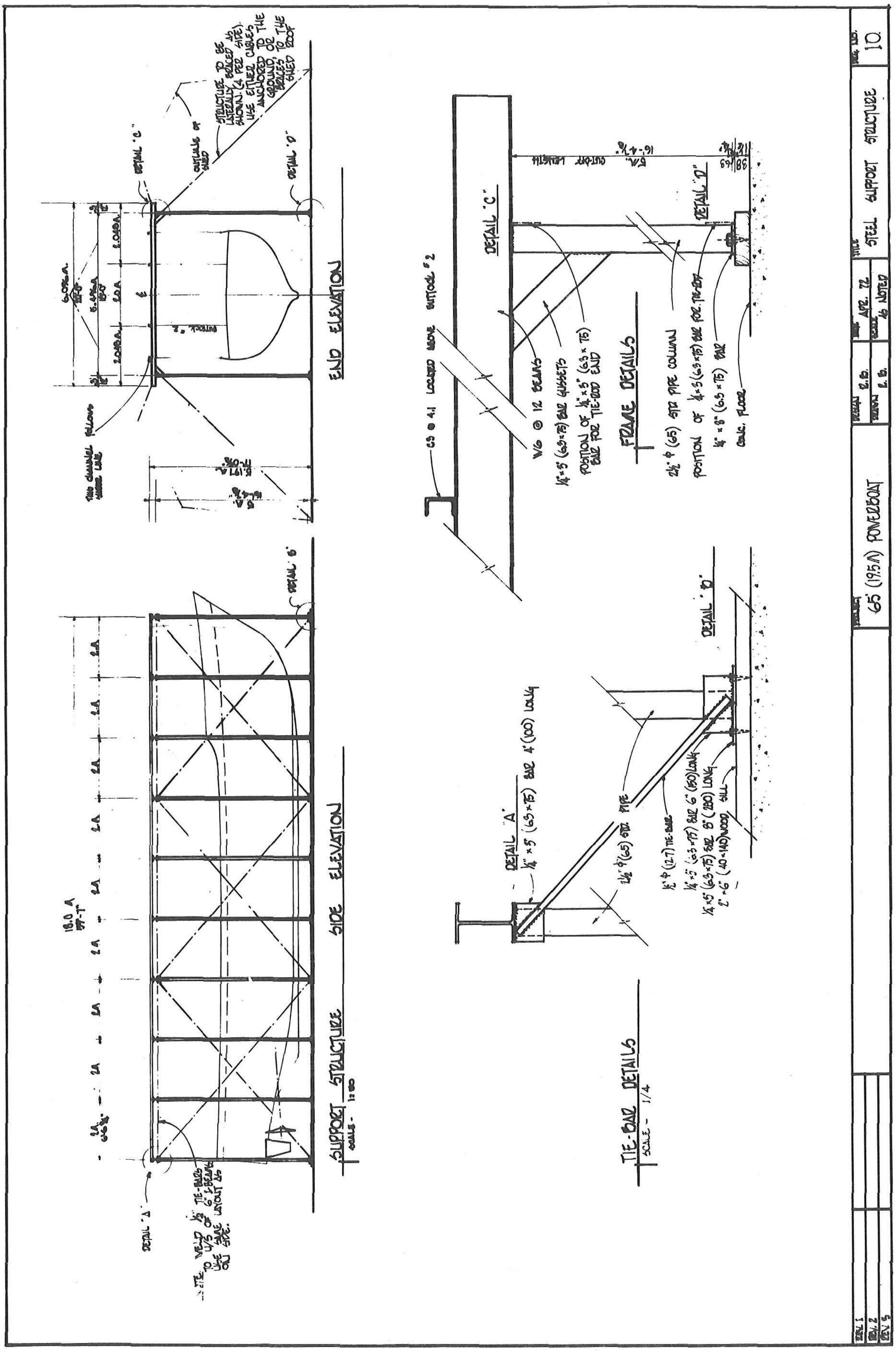


Figure 10. Hull Support Structure

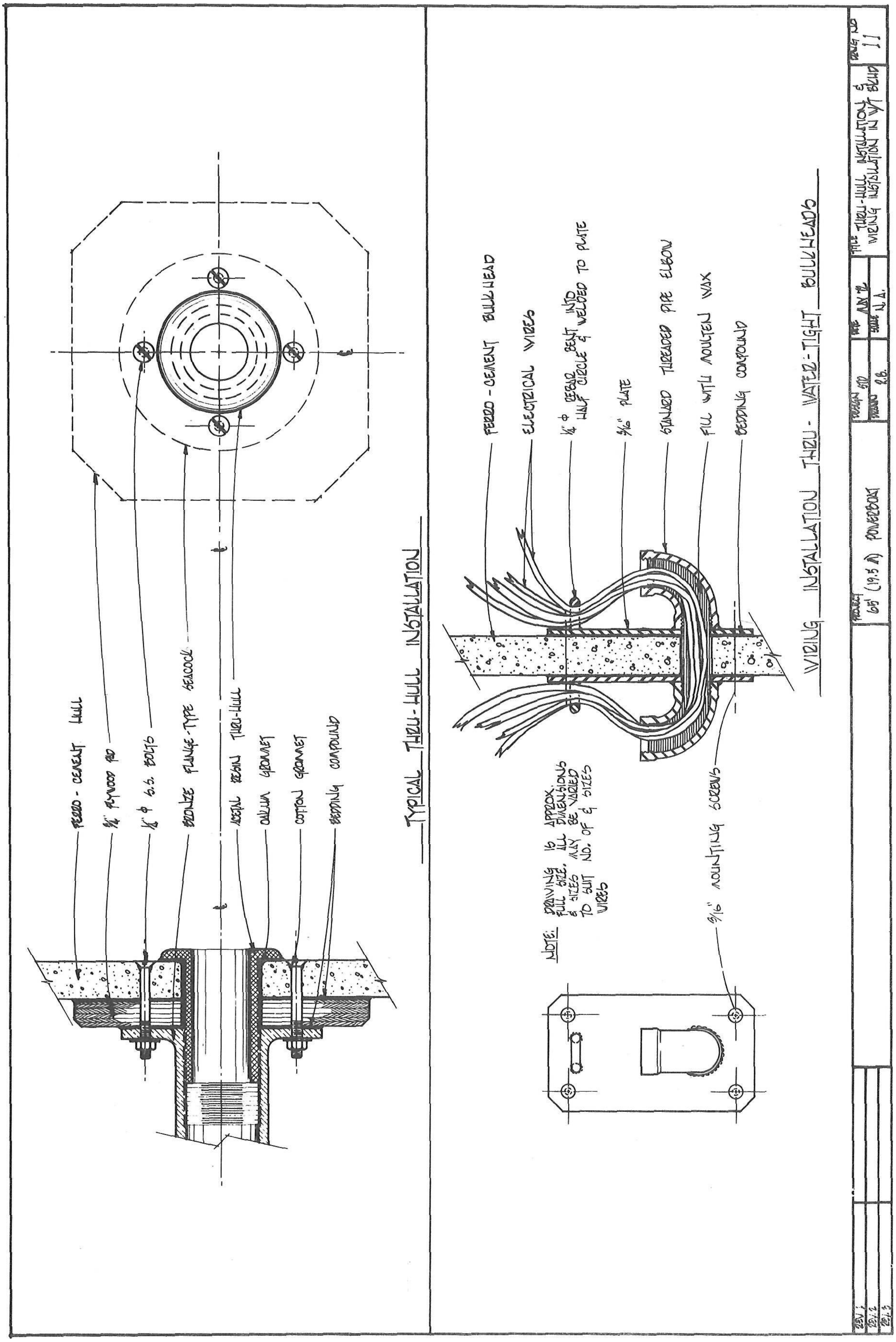


Figure 11. Thru Hull Installation and Wiring

MATERIAL LISTS AND CONSTRUCTION SCHEDULE

FOR A

65-FOOT PATROL BOAT HULL

YARD EQUIPMENT: HAND TOOLS & ACCESSORIES

(N.B. All prices quoted in U.S. Dollars, Seattle, Washington, 1972.)

1	Sledge-Hammer, 2 lbs. (1 kg)	$ 6.83
4	Hammer	11.40
1	Duo-fast Staple Hammer for 5/16" x 5/8" (8 mm x 16 mm) staples	16.85
1	Yard broom, stiff bristles	1.69
1	Floor broom, soft bristles, 24" (600 mm) wide	9.50
2	Shovels, square-ended	11.42
1	Bench Vise, 6" (150 mm)	36.74
1	Hacksaw, metal	4.15
24	Hacksaw blades	18.21
5	Tapes, pocket, retractable, 10' (3 m) in metric and inches	20.50
2	Refill tapes for above	3.00
1	Tape, 100' (30m)	45.36
1	Cat's Paw wreck bar, 12" (300 mm)	2.95
1	16" (400 mm) wreck bar	3.45
3	Centre punches	2.80
5	Electrical extension cords, 50' (15 m)	30.75
2	Electrical extension cords, 15' (4.5 m)	6.40
7	Trouble lights with 50' (15 m) extension cords	63.79
2	C-clamps, 4" (100mm)	5.50
1	G-clamp, large (for securing block and tackle to roof beams)	8.07
1	G-clamp, 8" (200 mm)	8.27
1	Rubber-tired, steel wheelbarrow	39.00
1	Set Allen wrenches, medium	3.36
1	Set Allen wrenches, small	2.40
1	Pipe wrench	4.12
1	1/16" (14 mm) masonry drill bit	2.63
9	1/4" (6 mm) masonry drill bits	15.07
4	5/16" (8 mm) jobber drills for drilling boat support structure foundations	6.84
1	7/16" (11 mm) drill bit	3.29
2	5/8" (16 mm) concrete drills	5.63
1	12" (300 mm) half-round bastard file	3.87
1	12" (300 mm) flat mill bastard file	2.35
1	12" (300 mm) flat bastard file	2.58
1	12" (300 mm) round bastard file	1.95
3	No. 4 wooden file handles	1.50
3	No. 3 wooden file handles	0.86
1	3/4" (22 mm) x 8" (200 mm) cold chisel	2.42
1	1/4" (6 mm) cold chisel	0.89
1	Set of wood speed bores	11.62
20	Pairs of 3/4" (20 mm) hog ring pliers	112.45
12	Pairs of common pliers	42.55
4	18'x 3/4" x 3/4" (6.4 m x 20 mm x 20 mm) spruce lofting battens	2.88
6	12' x 3/4" x 3/4" (3.6 m x 20 mm x 20 mm) spruce lofting battens	3.84
4	Pair of tin-snips	17.08
10	Carpenters' aprons	18.00
2	Mason's lines	1.00
1	Plumb bob	1.73
1	Step-ladder	17.84
1	5/8" (16 mm) I.D. water hose	10.38
	Carry Forward:	$ 655.76

YARD EQUIPMENT: HAND TOOLS & ACCESSORIES

	Carried Forward:	$ 655.76
2	5/8" x 75' (16 mm x 22.5 m) rubber hose (steam generator water)	21.51
1	Mechanic's dolly on casters (for lying on one's back, mobile)	14.64
1	4" (100 mm) knife	2.40
1	Edging trowel	1.05
2	Steel trowels	12.20
1	Fuel funnel for kerosene	0.52
1	1 1/2" (40 mm) derby brush	0.26
1	Hand-pump for kerosene (steam-curing)	7.47
4	4" (100 mm) brushes for painting "gluvit" sealant	16.74
8	100-watt lamp bulbs for trouble lights	1.85
6	Light bulbs	4.38
1	Plasterer'sedger	3.48
20	Galvanizedpails	51.60
10	Coarse sponge floats	27.00
1	Plasterer's hawk	4.30
6	Steel scraper blades (for removing excess mortar)	18.00
1	Spirit level	7.23
2	1/2" (13 mm) T-couplings for steam pipes	0.46
2	1/2" (13 mm) close nipples for steam pipes	0.30
1	80' x 1/2" (24 m x 13 mm) conduit for steam pipes	18.50
	TOTAL	$ 869.65

YARD EQUIPMENT: WELDING & GAS-CUTTING EQUIPMENT

3	Electric Welding Machines, "AIRCO"-make, A.C. 225 amp. 230 volt	$ 280.50
1	150' (45 m) welding cable	79.25
1	75' (25 m) No. 1 cable	48.75
1	100' (30 m) extension cable	83.00
1	Welder's Hood	8.10
1	Hood (hand-held)	8.50
3	Electrode holders	14.62
2	Welding rod pouches	1.25
3	Welding ground clamps	14.40
1	Spare welding tip	2.90
2	Spare cutting tips	9.00
4	No. 10 glasses for welders' masks	4.00
4	No. 10 plastics for welders' masks	0.80
3	Welders' chipping hammers	6.60
3	Steel wire brushes	2.40
1	Pair metal-working pliers	3.23
1	"Harris" oxy-acetylene torch	109.00
2	Oxy-acetylene cylinders' dolly	36.95
1	25' (10 m) extension to oxy-acetylene hose	14.00
2	Oxy-acetylene brass hose connectors	19.80
1	Wrench for oxy-acetylene cylinders	2.75
1	Burning tip	4.50
	Carry Forward:	$ 754.30

YARD EQUIPMENT: WELDING & GAS-CUTTING EQUIPMENT

	Carried Forward:	$ 754.30
1	Tip cleaner	1.95
2	Flint lighters for cutting torch	1.50
1	Pair tinted goggles	4.00
1	"Harris" circle-burner for cutting pipe	19.00
	TOTAL	$ 780.75

YARD EQUIPMENT: POWER TOOLS

1	Radial saw, 10" (254 mm) diameter, 3450 rpm (used)	$ 150.00
1	Electric drill, 3/8" (10 mm), pistol-type, 1/3 hp, 11/5.5 amp	39.49
1	Electric drill, 3/4" (20 mm), heavy duty	141.26
1	Electric hand-saw, 7 1/2" (190 mm) diameter, 2 hp and 4 blades	66.14
1	Bench grinder, electric	51.98
	TOTAL	$ 448.87

YARD EQUIPMENT: YARD EQUIPMENT RENTALS

1	Hydraulic Pipe Bender for 2" (50 mm) diameter pipe	$ 20.40
1	Hydraulic Pipe Bender for 3/4" (20 mm) pipe	3.68
1	Transit for setting up overhead support structure	3.68
4	Rolling scaffolding towers, tubular steel, 5' x 10' x 12' (1.5 m x 3 m x 3.6 m) high (75 days)	104.53
2	Gasoline-powered mortar mixers (2 days)	57.75
1	Gasoline-powered Lincoln Welding Machine with accessories (14 days) (Above accessories include 1 electric angle-grinder)	121.45
3	Electric vibrators, 1" (25 mm) heads, 7' (2.1 m) leads (2 days)	58.80
1	Fork-lift truck, 3000 lbs. (1000 kg) capacity,(2 days)	34.77
1	Fork-lift for 2 hours to unload cement and sand pallets	26.25
2	Malsbary Steam Generators @ 24 hours each	100.00
6	Temperature gauges for steam tent	30.00
	TOTAL	$ 561.39

YARD EXPENDABLE MATERIAL: LOFTING FLOOR CONSTRUCTION & LOFTING

6	Marking Pens for lofting	$ 5.30
1	Tube/Dispenser "Elmer's" White Wood Glue (for making battens)	1.00
1	Packet chalk-line chalk	0.23
1	Quart Spackle paste (wood-filler)	4.70
5	Gallons mineral spirits	3.85
1	Box rags	11.25
1	9" (228 mm) roller tray (paint)	3.75
1	9" (228 mm) extra handle	0.79
5	9" (228 mm) paint rollers	10.04
1	Paint roller extension handle	8.80
10	lbs. (5 kg) galvanized finishing nails, 3d	3.20
10	lbs. (5 kg) galvanized finishing nails, 6d	3.20
	TOTAL	$ 56.11

YARD EXPENDABLE MATERIAL: YARD EQUIPMENT INSTALLATION

10	lbs. (5 kg) 21/2"(63 mm) concrete nails	$ 3.40
8	1/4" x 1 1/2" (6 mm x 38 mm) square head anchor screws	0.40
44	1/4" x 1 3/4" (6 mm x 76 mm) square head anchor screws	7.48
3	3/8" x 3" (10 mm x 76 mm) hex. bolts (for securing vise)	0.30
40	1/4" x 3" (6 mm x 76 mm) anchor bolts	4.20
4	Anchor bolts	0.12
1	Pkt. of nuts and bolts	1.89
	TOTAL	$ 17.79

YARD EXPENDABLE MATERIAL: SUNDRIES

10	Pair of work gloves	$ 6.60
	First Aid supplies	3.53
10	Grinding wheels	15.93
1	Metal stone for angle grinder	4.93
	TOTAL	$ 30.99

YARD MATERIAL: DIMENSIONAL LUMBER

2888	Ft. (660 m) 2" x 4" (50 mm x 100 mm) construction grade fir	$ 462.08
100	Ft. (30 m) 1" x 4" (25 mm x 100 mm) construction grade fir	13.28
100	Ft. (30 m) 1" x 6" (25 mm x 150 mm) construction grade fir	13.28
120	Ft. (36 m) 2" x 6" (50 mm x 150 mm) construction grade fir for "support structure" base plate	23.94
3	18 Ft. (5.4 m) 2" x 12" (50 mm x .300 mm) construction grade fir for work bench	19.44
4	18 Ft. (5.4 m) 1" x 10" (25 mm x 254 mm) construction grade fir for work bench	14.40
	Carry Forward:	$ 546.42

YARD MATERIAL: DIMENSIONAL LUMBER

	Carried Forward:	$ 546.42
140	Ft. 3/4" x 3/4" (20 mm x 20 mm) clear fir battens	5.88
64	Sheets, 4' x 8' x 1/2" (600 mm x 2.4 m x 12 mm) A.C. exterior plywood for lofting floor and benches	501.76
	TOTAL	$1054.06

YARD MATERIAL: SUPPORT STRUCTURE STEEL

20	Ft. (6.3 m) lengths, $2^1/_2$" (63 mm) I.D. black steel pipe @ $0.72 per ft.	$ 302.40
10	Ft. (6 m) lengths, 6" (150 mm) I-beam (W6 @ 12) @ $13.00	314.40
13	20 Ft. (6 m) lengths 3" (76 mm) channel (C3 @ 4.1) @ $10.65	113.53
2	20 Ft. (6 m) lengths 1/4" (6 mm) x 3" (76 mm) flat bar @ $10.15	10.35
1	1/4" x 4' x 8" (6 mm x 1.2 m x 200 mm) steel plate	34.07
100	1/4" x 11/2"(6 mm x 38 mm) lag screws for bottom of support structure	4.25
4	20 Ft. (6 m) lengths 2" x 2" x 1/4" (50 mm x 50 mm x 6 mm) T-bar for scaffolding planks	89.60
6	20 Ft. (6 m) fairing battens 2" x 2" (50 mm x 50 mm)	12.00
72	Ft. (21.6 m) 1" x 3" (25 mm x 76 mm) lumber for ladders	6.05
	TOTAL	$ 917.00

YARD MATERIAL: OTHER MATERIALS

24	Hollow concrete blocks, 8" x 8" x 16" (200 mm x 200 mm x 400 mm) @ $0.45 (for chocking blocks)	$ 10.80
3	Rolls 16' (4.8 m) wide 4 mil plastic sheeting for steam tent	46.00
	TOTAL	$ 56.80

BOAT MATERIAL: HULL CONSTRUCTIONAL & REINFORCING STEEL

1600	20 Ft. x 1/4" (6 m x 6 mm) diameter smooth rebar (5.500 lbs) @ $13.80	$ 759.00
140	20 Ft. x 1/2" (6 m x 13 mm) diameter deformed rebar (1870 lbs.) @ $10.00	187.00
12	20 Ft. (6 m) lengths 1" x 1" x 1/8" (25 mm x 25 mm x 3 mm) T-bar (204 lbs.) @ $12.60	25.70
20	20 Ft. (6 m) lengths of 1" x 1" x 1/8" (25 mm x 25 mm x 3 mm) T-bar	35.36
30	20 Ft. (6 m) lengths 1/8" x 3" (3 mm x 76 mm) Flat bar (765 lbs.) @ $10.85	76.05
30	20 Ft. (6 m) lengths 1/8" x $1^1/_2$" (3 mm x 38 mm) Flat bar (378 lbs.) @ $11.75	46.28
	Carry Forward:	$1129.39

BOAT MATERIAL: HULL CONSTRUCTIONAL & REINFORCING STEEL

	Carried Forward:	$1129.39
1	20 Ft. (6 m) lengths 1/8" x 1/8" (3 mm x 32 mm) Flat bar (for scuppers) (11 lbs. @ $13.15)	1.45
4	20 Ft. (6 m) lengths, 1/8" x 1" x 1" (3 mm x 25 mm x 25 mm) angle iron (64 lbs.) @ $10.15	6.50
10	Ft. 5" (127 mm) I.D. Schedule 40 pipe (stern and rudder tubes) @ $2.3750 per ft. (and 2.50 cutting charge)	26.25
24	Pieces, per cut, No. 10 gauge sheet 6" x 8" (152 mm x 203 mm) for deck ventilator coamings	11.96
	TOTAL	$1175.55

BOAT MATERIAL: WELDING SUPPLIES

5	Cylinders of Oxygen	$ 43.00
5	Cylinders of Acetylene	45.10
100	lbs. (50 kg) No. 6011 1/8" (3 mm) welding rod	30.00
150	lbs. (75 kg) No. 70143/32" (2 mm) welding rod	45.30
50	lbs. (25 kg) No. 6011 5/32" (4 mm) welding rods for deck beams	17.06
100	lbs. (50 kg) No. 7014 1/8" (3 mm) welding rod	27.10
7	Pairs welders' long leather gloves	30.00
2	Soapstone holders	1.30
12	Boxes of soapstones	1.70
1	Set leather welding sleeves	9.15
1	Box renewal flints for oxy-acetylene torch	0.71
5	Gallons gasoline for rented welding machine	1.40
	TOTAL	$ 251,82

(N.B. A small portion of these welding supply costs are applicable to the creation of the over-head support structure.)

BOAT MATERIAL: STAPLES & TIE WIRE

10,000	3/4" (19 mm) galvanized hog ring staples (Power-Line Sales, Inc.)	$ 13.10
125	lbs. (63 kg) 1/2" (13 mm) galvanized hog ring staples (Fisheries Supply Company)	55.56
30,000	1/2" (13 mm) hog rings (Power-Line Sales, Inc.)	34.80
18	Rolls of tie wire @ $3.75	37.45
3	Boxes of 1000 5/16" x 5/8" (8 mm x 16 mm) staples	18.80
2	Boxes of 3/8" (9 mm) staples No. 5012	1.40
2	Boxes of 3/8" (9 mm) staples No. 5019	1.90
4	Boxes of 3/8" (9 mm) staples	3.30
1	Box of 8p. nails, galvanized, wide head (for screwing deck-head lining)	12.00
10	lbs. (5 kg) 16d. galvanized nails	3.40
	TOTAL	$ 181.71

BOAT MATERIAL: MESH

60	Rolls 1" x 20" (25 mm x 500 mm) gauge galvanized hexagonal mesh (galvanized after weave) @ $20.52	$1231.20

BOAT MATERIAL: DECKHEAD LINING MATERIALS

686	Ft. (205 m) of 1" x 10" (25 mm x 250 mm) @ $0.20 dressed cedar tongue and groove planking @ $0.20	$ 137.20
15	Sheets of 2" x 48" x 144" (50 mm x 1.2 m x 3.6 m) Polyurethane foam insulation material	345.60
1	Roll 16' (4.8 m) wide 4 mil plastic sheeting	13.30
	TOTAL	$ 496.10

BOAT MATERIAL: SAND

280	Bags, 100 (50 kg) No. 1 fine graded sand	$ 356.00
42	Bags, 100 (50 kg) No. E1-70 Del Monte extra fine sand	64.70
	TOTAL	$ 420.70

BOAT MATERIAL: CEMENT

170	Bags, 94 lbs. (47 kg) Lone Star, Type I Cement	$ 387.00

BOAT MATERIAL: PLASTERING SERVICES

For services of 16 professional plasterers, total 144 hours, including taxes, mixers, wheelbarrow and equipment rental	$1673.55

BOAT MATERIAL: BOAT FITTINGS & FASTENINGS

8	12" (300 mm) galvanized deck cleats	$ 24.00
20	2 1/2" x 3/8" (63 mm x 10 mm) galvanized eye bolts	10.56
16	4 1/2" x 3/8" (114 mm x 10mm) galvanized bolts for cleats	2.02
12	5/8" x 6" (16 mm x 152 mm) galvanized bolts - rudder stock housing	5.21
28	5/8" x 8" (16 mm x 203 mm) galvanized bolts-engine beds	17.12
40	5/8" 916 mm) galvanized washers	1.56
50	3/8" (10 mm) galvanized washers	0.42
	2 Ft. (600 mm) gasket material for plates above rudder stock housings	1.58
	Galvanizing charge on scupper screeds	3.50
	TOTAL	$ 65.97

BOAT MATERIAL: KEROSENE

220	Gallons of Kerosene used for steam curing	$ 77.00

BOAT MATERIAL: MESH

60	Rolls 1" x 20" (25 mm x 500 mm) gauge galvanized hexagonal mesh (galvanized after weave) @ $20.52	$1231.20

BOAT MATERIAL: DECKHEAD LINING MATERIALS

686	Ft. (205 m) of 1" x 10" (25 mm x 250 mm) @ $0.20 dressed cedar tongue and groove planking @ $0.20	$ 137.20
15	Sheets of 2" x 48" x 144" (50 mm x 1.2 m x 3.6 m) Polyurethane foam insulation material	345.60
1	Roll 16' (4.8 m) wide 4 mil plastic sheeting	13.30
	TOTAL	$ 496.10

BOAT MATERIAL: SAND

280	Bags, 100 (50 kg) No. 1 fine graded sand	$ 356.00
42	Bags, 100 (50 kg) No. E1-70 Del Monte extra fine sand	64.70
	TOTAL	$ 420.70

BOAT MATERIAL: CEMENT

170	Bags, 94 Ibs. (47 kg) Lone Star, Type I Cement	$ 387.00

BOAT MATERIAL: PLASTERING SERVICES

For services of 16 professional plasterers, total 144 hours, including taxes, mixers, wheelbarrow and equipment rental	$1673.55

BOAT MATERIAL: BOAT FITTINGS & FASTENINGS

8	12" (300 mm) galvanized deck cleats	$ 24.00
20	$2\frac{1}{2}$" x 3/8" (63 mm x 10 mm) galvanized eye bolts	10.56
16	$4\frac{1}{2}$" x 3/8" (114 mm x 10mm) galvanized bolts for cleats	2.02
12	5/8" x 6" (16 mm x 152 mm) galvanized bolts - rudder stock housing	5.21
28	5/8" x 8" (16 mm x 203 mm) galvanized bolts-engine beds	17.12
40	5/8" 916 mm) galvanized washers	1.56
50	3/8" (10 mm) galvanized washers	0.42
	2 Ft. (600 mm) gasket material for plates above rudder stock housings	1.58
	Galvanizing charge on scupper screeds	3.50
	TOTAL	$ 65.97

BOAT MATERIAL: KEROSENE

220	Gallons of Kerosene used for steam curing	$ 77.00

BOAT MATERIAL: PAINTS & COMPOUNDS

1	Gallon Red Lead Paint (DeckBeams)	$ 7.17
5	Gallons Red Lead Paint (Deck Beams & Deckhead)	35.05
5	Gallons Thinner for above	4.45
2	Quarts Weldwood White Glue	3.07
2	Cartridges of Thiokol Compound	6.60
1	Bundle of Oakum	3.45
10	Gallons "Gluvit" Epoxy Sealant	117.00
	TOTAL	$ 176.79

SUMMARY OF CATALOGUE

YARD EQUIPMENT

Hand Tools and Accessories	$ 869.65	
Welding and Gas-Cutting Equipment	780.75	
Power Tools	448.87	
Yard Equipment Rentals	561.39	
		$2660.66

YARD EXPENDABLE MATERIAL

Lofting Floor Construction and Lofting	$ 56.11	
Yard Equipment Installation	17.79	
Sundries	30.99	
		$ 104.89

YARD MATERIAL

Dimensional Lumber	$1054.06	
Support Structure Steel	917.00	
Other Materials	56.80	
		$2027.86

BOAT MATERIAL

Hull Constructional and Reinforcing Steel	$1175.55	
Welding Supplies	251.82	
Staples and Tie Wire	181.71	
Mesh	1231.20	
Deckhead Lining Materials	496.10	
Sand	420.70	
Cement	387.00	
Plastering Services	1673.55	
Boat Fittings and Fastenings	65.97	
Kerosene	77.00	
Paints and Compounds	176.79	
		$6137.39

Current Prices - Seattle, Washington, USA (1972) TOTAL $10930.80

CONSTRUCTION SCHEDULE for vessel:	65-ft. Power Boat				STAGE	1
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compi.
JOB NO. 1 - Making Hull Frames						
1	Construct Lofting Floor	7L 7C	14		Catalogue: Lofting Floor Construction and lofting.	
2	Sand and Paint Lofting Floor Surface	4P	4		Dimensional lumber, Power tools, Hand tools & accessories	
3	Lay Out Lofting Grid	See below	See below			
4	Lay Out Hull Profile	See below	See below			
5	Lay Out Hull Sections	See below	See below			
6	Lay Out Water Lines & Sheering Plan View	33D 33C	66			
7	Set Up Hull Frame Frame Bending Bench	6C	6			
8	Drive Nails Along Lofting Floor Station Lines	10C	10			
9	Cut Rods for Hull Frames	4W	4		Catalogue: Hull Con-structional & Reinforc-ing Steel	
10	Bend Hull Frames in Pairs	47W	47		Welding & Gas Cutting equipment Welding Supplies	
11	Mark Reference Lines on Hull Frames	5L	5		Yard Equipment Installation & Over-head Support	
12	Store Hull Frames	1L	1			

NOTE: For manpower classification see page 42.

CONSTRUCTfON SCHEDULE for vessel: 65-ft. Power Boat						STAGE 1
Task	Description	Manpower Class.	Estimated Man- Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 2 - Making Deck Beams						
1	Make Deck Beam Welding Jig	2W	2			
2	Cut Flat Bar of Deck Beams	3W	3			
3	Welding Deck Beams in Jig	22W	22			
4	Cut Master Pattern for Deck Beam	1C	1			
5	Make Deck Beam Bending Jig	1W	1			
6	Shaping Deck Beams	12L	12			
7	Clean and Prime Deck Beams	8L 7P	13			
8	Mark Center and Buttock Lines on Beams	4D	4			
JOB NO. 3 — Assemble Frames, Deck Beams and Suspension Rods						
1	Welding Hull Frames in place	12W	12		Catalogue: Mesh Staples & Tie Wire	
2	Mark Off Deck Beams	4D	4			
3	Cut & Weld Deck Beam in place	18W	18			

CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 1
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
4	Make Deck Knee Bending Jig	3W	3			
5	Weld Deck Knee in place	16W	16			
6	Weld Suspension Rods to Hull Frames	12W	12			
7	Weld Athwartship Braces	12W	12			
8	Weld Bulwark Supports	20W	20			
9	Weld Keel Sections	16W	16			
10	Weld Rod Reinforcing to Bulkheads	24W	24			
11	Weld Webs to Hull Frames	8W	8			
12	Fasten Mesh to Bulkheads Webs and Bulwarks	42L	42			
JOB NO. 4 - Erect Overhead Support Structure						
1	Measure Off Base	2D	2		Catalogue: Support Structure Steel	
2	Layout and Fasten Wooden Base Plates	18C8L	16		Yard Equipment Rentals	
3	Bolt Piping Base Plate to Wooden Base Plate	6L	6			

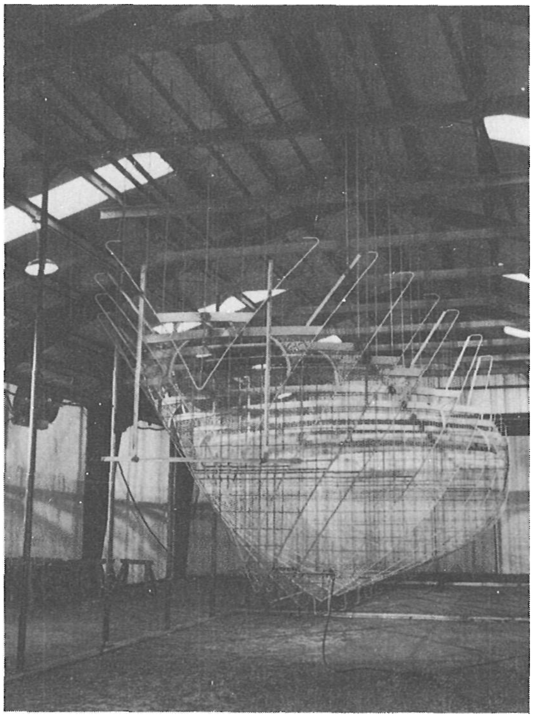
CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 1
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
4	Prepare Piping Supports and Braces	5W	5			
5	Weld Overhead Support Frames	16W	16			
6	Preparations for Erection of Support Frames	3W	3			
7	Erect Overhead Support Structure	8D 22L	30			
8	Align and Weld Over-head Structure	16W	16			
9	Weld Channel to Support Structure at Buttock No. 2 Lines	6W	6			
JOB NO. 5 — Establish Base Lines and Support Lines						
1	Mark Center Line and Buttock No. 2 Lines	1/2 D	0.50			
2	Mark Water Line	3D	3			
3	String Water Line Around 4 Corners of Structure	1/2 D	0.50			
4	String Vertical Center Line and Buttocks No. 2 Lines	1/2 D	0.50			
JOB NO. 6 - Make Stem Piece						
1	Measure and Cut Stem Piece Rod	1/2 W	0.50			

CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 1
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compi.
2	Bend Rod to Shape of Stem Piece	3W	3			
JOB NO. 7 - Suspend Frames						
1	Cut Upper Suspension Rods to Size	2W	2			
2	Weld Upper Suspension Rods to Hull Frames	16W	16			
3	Mark Hull Frame Position on Longitudi-nal Girders	1D	1			
4	Weld First Hull Frame to Support Structure	1W	1			
5	Weld Remaining Hull Frames to Support Structure	8D 16L 26W	50			
6	Make Alignment Frame for Bow Hull Frames	8W	8			
7	Plumb One Hull Frame and Brace	1W	1			
8	Plumb Remaining Hull Frames and Brace	8D 10W	18			
9	Temporarily Brace Hull Frames to Support Structure Sides	12W	12			
10	Weld Stem-Piece to Bow Frames	4W	4			
11	Erect Scaffolding Around Hull	12W	12			

CONSTRUCTION SCHEDULE for vessel:			65-ft. Power Boat		STAGE	2
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 2 - Prepare Deckhead Lining						
1	Mark Deck Apertures	4D	4		Catalogue: Deckhead ining materials	
2	Making Longitudinal Beam for Deck Apertures	4W	4			
3	Weld Deck Aperture Beams in Place	12W	12			
4	Make Deck Ventilator Coamings	4W	4			
5	Weld Deckhead Lining Supports	6W	6			
6	Clean and Prime Deck Steelwork	4P	4			
JOB NO. 3 - Lay Deckhead Linings						
1	Fitting Wooden DeckheadPlanks	30C	30			
2	Installing Deck Ventilator	2C	2			
3	Paint Deckhead Planking	5P	5			
4	Fitting Insulation Material	22C	22			
5	Laying Hardboard Panels Above Deckhead Insulation Material	30C	30			

CONSTRUCTION SCHEDULE for vessel:	65-ft. Power Boat				STAGE 2	
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 4 - Lay Mesh and Rods on Deck						
1	Laying First Four Layers of Mesh on Deck	50L	50			
2	Weld Longitudinal Reinforcing Rods over Deck Beams	36W	36			
3	Weld Athwartship Reinforcing Rods Above	3OW	30			
JOB NO. 5 - Fair Bulwarks and Hull						
1	Apply Bulwarks Screed	16W 4D	20		Catalogue: Yard Equipment Rental	
2	Weld Bulwarks Longitudinal Rod	6W	6			
3	Bend Bulwarks Sheer Rods	8W	8			
4	Fair Bulwarks and Weld Sheer Rods in Place	45W	45			
5	Fair Hull Steel Reinforcing	8W 3OL 16D	54			
6	Weld Deck Steel Reinforcing to Hull Framework	26W	26			
JOB NO. 6 — Hatch Coaming and Scuppers						
1	Fabricate Hatch Coaming Screeds	7W	7			

CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 1
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 8 - Check Hull and Deck Exterior for Fairness						
1	Check Hull Exterior for Fairness	8W 8D 4L	20			
2	Check Deck Exterior for Fairness	3W 3D	6			
3	Stem and Keel Reinforcing	18W	18			
4	Keel Deadwood Reinforcing	10W	10			
5	Weld Longitudinal Spacer Rods to Hull Frames	28W	28			
6	Weld Transom in Place	6W	6			



Frames suspended in preparation for fairing

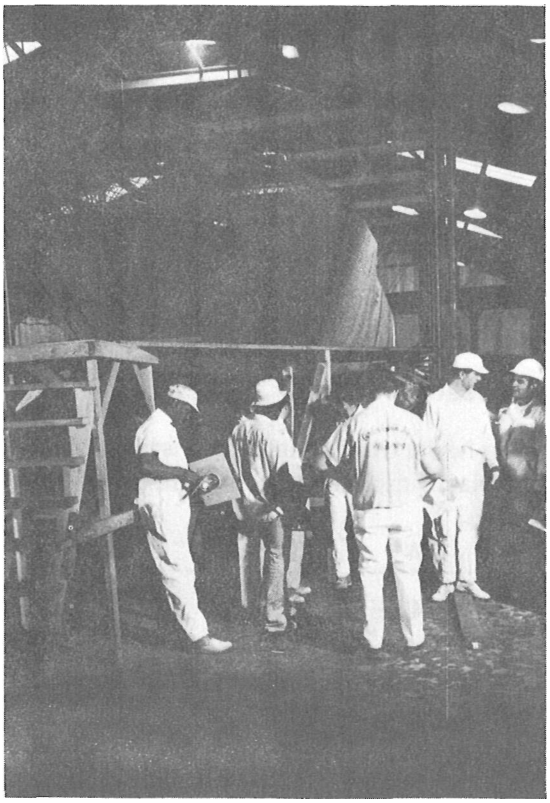
CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 2
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 1 - Apply Rods and Mesh						
1	Make Mesh Folding and Cutting Bends	5C	5			
2	Fold and Cut Mesh	28L	28			
3	Apply First Four Layers of Mesh to Hull	96L	96			
4	Apply Mesh to Transom	7L	7			
5	Fasten Longitudinal Reinforcing Rods Above the Mesh	100L	100			
6	Remove Underlying Spacer Rods and Replace with Longitudinal Rods Overlying the Mesh	3OL	30			
7	Weld Vertical Rod Reinforcing 23" Centers	180W	180			
8	Make Starter Rod Jig	2W	2			
9	Make Starter Rods	2L	2			
10	Weld Starter Rods Along Diagonal "D" Line	16W	16			
11	Weld Hull Reinforcing Rods at Stern, Keel and Transom	25W	25			
12	Staple Interior Mesh to Longitudinal Rods	10L	10			

CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 2
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
2	Weld Hatch Coaming Reinforcings in Place	3OW	30			
3	Make Scuppers	6W	6			
4	Weld Scuppers in Place	6W	6			
JOB NO. 7 - Mesh Deck, Coamings and Bulwarks						
1	Laying Four Layers of Mesh Above Deck Rein-forcing Rods	70L	70			
2	Mesh Coaming and Bulwarks	60L	60			
JOB NO. 8 - Stringers and Sole Supports						
1	Mark Sole Support Positions	5D	5			
2	Weld Sole Support Starter Rods	8W	8			
3	Weld Sole Support Screeds	16W	16			
4	Weld Diagonal "D" Stringer	18W	18			
5	Mesh Sole Supports and Diagonal "D" Stringers	26L	26			
JOB NO. 9 - Engine Beds and Stern Tubes						
1	Mark Engine Bed Positions	6D	6			

CONSTRUCTION SCHEDULE for vessel: 65-ft. Power Boat						STAGE 2
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
2	Fabricate Engine Bed Screeds	6W	6			
3	Install Engine Bed Reinforcing	40W	40			
4	Fabricate Stern Tubes	6W	6			
5	Prepare Stern Tube Alignment Sights	6D	6			
6	Align and Weld Stern Tubes in Place	8W	8			
7	Mesh Engine Beds and Stern Tubes	28L	28			
JOB NO. 10 - Install Rudder Stuffing Box Supports						
1	Prepare Rudder Stuffing Box Housings	10W	10			
2	Mark Rudder Stuffing Box Positions	4D	4			
3	Install Rudder Stuffing Box Housings and Fabricate Supports	14W	14			
4	Mesh Rudder Stuffing Box Supports	20L	20			
JOB NO. 11 - Apply Hull Exterior Mesh						
1	Modify Hull External Supports and Braces	8W	8			

CONSTRUCTION SCHEDULE for vessel:			65-ft. Power Boat		STAGE 2	
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
2	Apply Outer Layers of Mesh to Hull	240L	240			
3	Fairing, Cleaning and Final Inspection of Mesh	8D 42L	50			

Crew assembled in preparation for plastering



CONSTRUCTION SCHEDULE for vessel:		65-ft. Power Boat			STAGE 3	
Task	Description	Manpower Class.	Estimated Man-Hours	Actual Man-Hours	NOTES	Date Compl.
JOB NO. 1 - Plastering and Steam Curing						
1	Preparations for Plastering	18C	18		Catalogue: Sand and Cement	
2	Plastering Day	144 PA 288 L	375		Plastering Services	
3	Preparations for Steam Curing	15C 15L	30		Kerosene—Yard Equipment Rentals	
4	Steam Curing	24L	24			
5	Second Phase Plastering	20PA 40L	60		Plastering Services	

NOTE: For Stage 3, see Volume II.

SUMMARY OF LABOR

Key to "Manpower Classification" in the Construction Schedule:

"C" - Carpenter
"W" - Welder
"D" — Draftsman/Engineer
"L" — Laborer (or helper)
"P" - Painter
"PA" - Plasterer

Note, therefore, that an entry in the "Manpower Class." column of the Construction Schedule shown, for example, as "18 C" signifies an estimate of 18 hours of carpentry work. This could also be interpreted as 6 hours work by 3 carpenters, depending, of course, upon the manpower resources which the yard manager has at his disposal and how he wishes to apply it.

Man-Hours Utilized by Job Classification:

The following is a summary of man-hours utilized in the construction of the 65-ft. (19.5 m) power boat hull. The summary is by job classification and covers Stages 1, 2 and 3 of construction

		"W	"D"	"L"	"P"	"PA"
Man-Hours:	197	1041.5	99.5	1337	20	164

Total man-hours utilized in the construction of the hull through to completion of Stage 3: 2,859

MASTER CONSTRUCTION SCHEDULE

Production Line Planning for Fleet Production:

As was mentioned in the introduction to this section, the construction schedule contains the necessary elements from which to compile a Master Construction Schedule which could project, at any given time, the varying stages of construction of a fleet of one-design vessels.

The Master Construction Schedule would be compiled in advance of production. It would project labor and equipment costs and program the flow of construction materials and boat equipment into the yard. Although this schedule would provide an overall program for the series production of a fleet of vessels, yet, for a realistic day-to-day interpretation by the men of the yard, a more flexible instrument is needed, its component information constantly revised and its projections brought up-to-date.

For this purpose a five-day projection would be compiled at the end of each week. A sample sheet of this five-day projection on a ten-vessel production line entitled "Production Planning Chart" is included on this page. Essential information is, of course, drawn from the Master Construction Schedule and from progress reports to date. The value of this up-to-the-minute information is that an extremely realistic projection can be made for the five working days ahead.

Latest copies of the "Production Planning Chart" would be circulated among the foreman on the yard, purchasing department, stores, and the tool room.

		Day No. 5		Day No. 4		Day No. 3		Day No. 2		Day No. 1	
											No. 1 Stage
											Labor
											No. 2 Stage
											Labor
											No. 3 Stage
											Labor
											No. 4 Stage
											Labor
											No. 5 Stage
											Labor
											No. 6 Stage
											Labor
											No. 7 Stage
											Labor
											No. 8 Stage
											Labor
											No. 9 Stage
											Labor
											No. 10 Stage
											Labor
											New Yard Work
											Labor
											Repair and Maintenance
											Labor
											C — Carpenter
											W — Welder
											P — Painter
											L — Laborer
											D — Draftsman
											PA — Plasterer
	Surplus	Required	Surplus	Required	Surplus	Required	Surplus	Required	Surplus	Required	

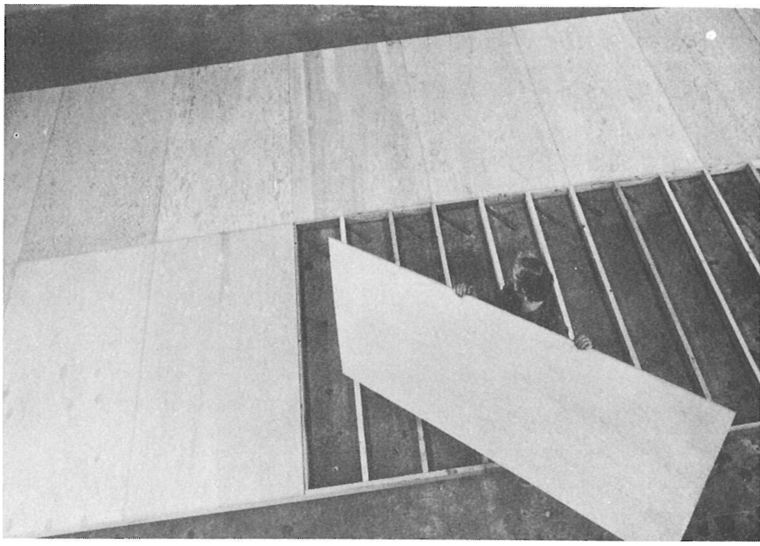
DETAILS OF CONSTRUCTING

A 65-FOOT POWER BOAT HULL

STAGE 1 - JOB 1
MAKING HULL FRAMES

The hull of the vessel is drawn to full size, in plan section and in profile, on the lofting floor. For economy of space the hull body lines, which are symmetrical, are shown only in half-section. It is from these body lines, called "stations," that the shape of the hull frames is obtained.

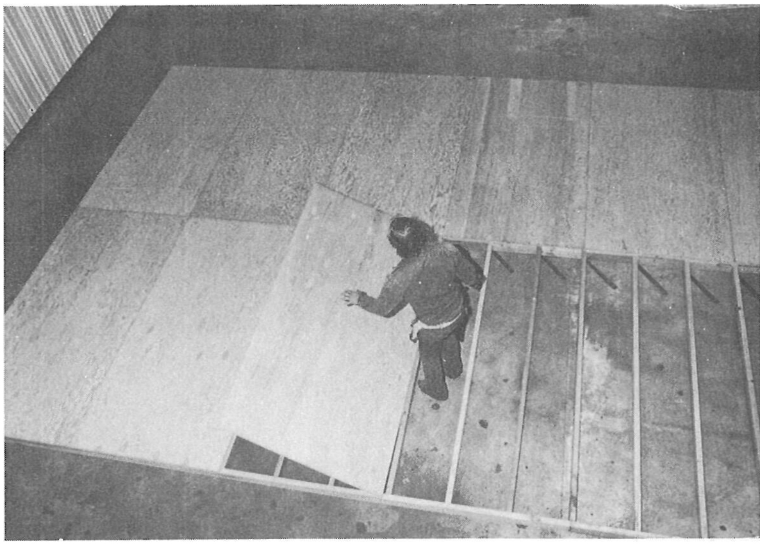
The material the hull frames are made of is 1/2-inch (13 mm) diameter "deformed," mild steel reinforcing rod. It is a relatively soft rod, easy to curve into the shapes shown by the stations on the lofting floor. As only one half-section of a station is drawn, it is convenient to curve two lengths of rod during the same operation. This pair of curved rods forms one complete hull frame.



Four supports to each sheet

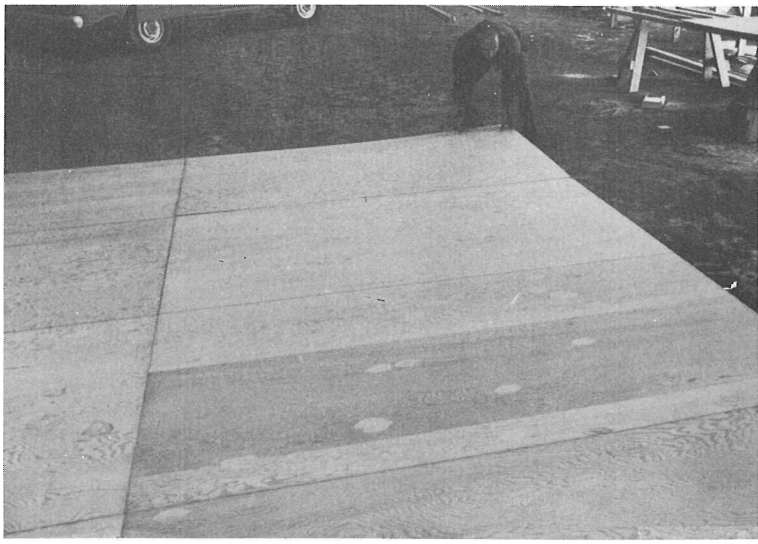
TASK 1 - Constructing the Loft Floor

The materials to be used are 2" x 4" (45 mm x 90 mm) construction grade timbers and 1/2-inch (13 mm) 4' x 8' (1,220 mm x 2,440 mm) plywood sheets of the type termed "good one side." A rectangular 2" x 4" (45 mm x 90 mm) framing is made for the floor, 68 feet (20.6 m) long and 16 feet (4.5 m) wide. Within this framing 2" x 4" (45 mm x 90 mm) floor supports are required for taking the weight of personnel using the floor. Plywood 1/2 inch (13 mm) thick is necessary for the flooring as plywood thinner than 1/2 inch (13 mm) will not provide an adequate foundation for the frame-shaping nails which will be driven into it later.



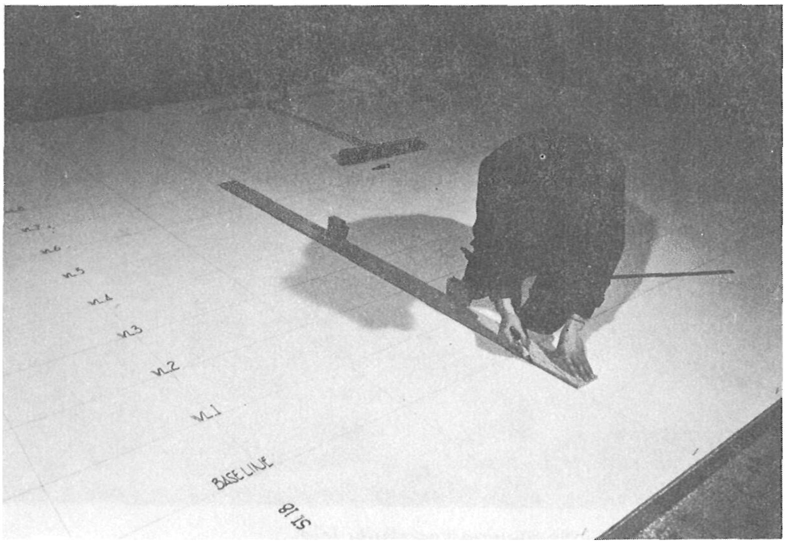
One-half inch plywood carefully laid

Care must be taken to see that the floor framing is kept level and absolutely rectangular. The 4' x 8' (1,220 mm x 2,440 mm) plywood sheets are nailed down to this framing. A total of 34 sheets are required to cover the framing. The points to observe here are that the good side of the plywood sheets is nailed uppermost, and that all edges match exactly to form one, smooth level floor.



All plywood edges match exactly

A non-gloss paint for the lofting floor



Laying out the lofting grid

TASK 2 — Sanding and Painting Lofting Floor

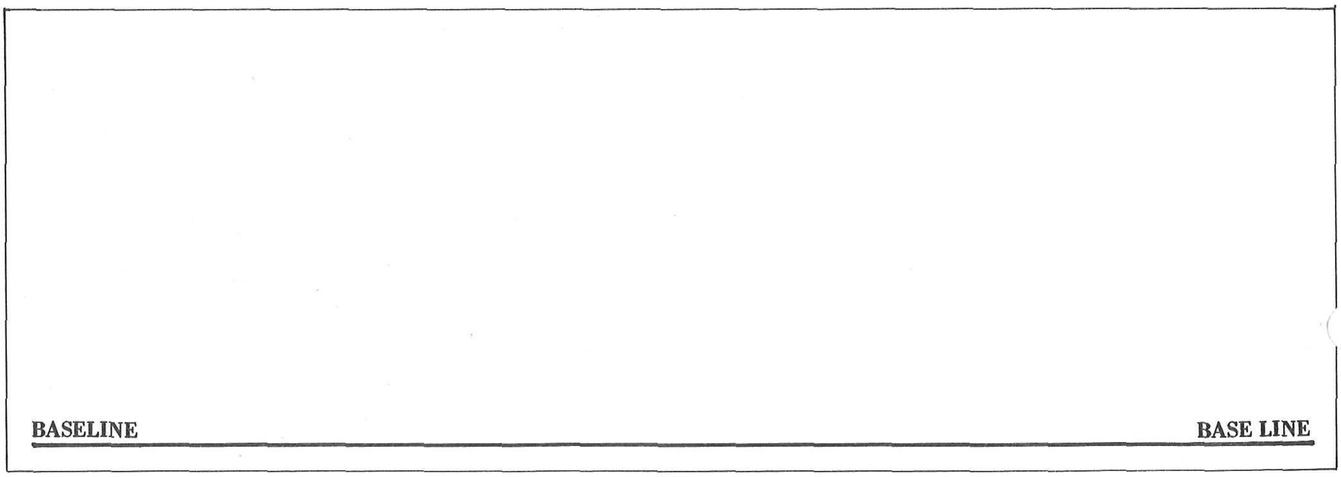
Sand down any imperfections on the plywood surface or edges. Use a long-handled paint roller. Paint the lofting floor with a non-gloss white acrylic paint. Four gallons (15.16 I) will be needed.

TASK 3 - Layout the Lofting Grid

Two drawings need to be spread out close by for frequent consultation. One is entitled, *Lines & Offsets,* the other, *Corrected Table of Offsets.* A reel-type chalk-line and a set of good, smooth, flexible wooden battens are required for this work. The recommended batten sizes are as follows:

2 1" x 1" x 70' (25.4 mm x 25.4 mm x 21.2 m)
2 1" x 1" x35''(25.4 mm x 25.4 mm x 10.6 m)
2 1/2" x 1/2" x16''(12.7 mm x 12.7 mm x 4.5 m)
2 1/4" x 1/2" x 16' (6.3 mm x 12.7 mm x 4.5 m)
2 1/4" x 1/4" x 8'(6.3 mm x 6.3 mm x 2.25 m)

The following numbered series of figures illustrates how to proceed with laying out the lofting grid.



LOFT FLOOR

BASE LINE

Draw the base line first. Start by measuring 20" (508.0 mm) up from the bottom edge of of the lofting floor on both sides of the frame and drive nails in at these two points. Stretch a chalk-line taut between two nails. At the center point of the chalk-line take it carefully between forefinger and thumb, lift it about six inches (152 mm) off the lofting floor, then allow it to snap down smartly. The chalk-line will leave a perfectly straight line across the floor, providing a base line for all remaining measurements. Using a straight batten and a waterproof felt pen, ink in the base line for permanence. Write "BASE LINE" beneath it. Remove the nails.

FIGURE 13-Waterlines

The waterlines are shown as the horizontal lines extending across the drawing *Lines and Offsets* (refer to Figure 1). The drawing states that these lines are 300 mm (11.81 in.) apart. Starting at the base line measure up every 300 mm (11.81 in.) on both sides of the lofting floor and drive in nails at these points. In the same way as the base line was marked out, proceed with the waterlines. Check that each waterline runs perfectly parallel with the base line before inking. Mark each waterline at both ends with its appropriate number as shown on the *Lines Drawing* (Figure 1).

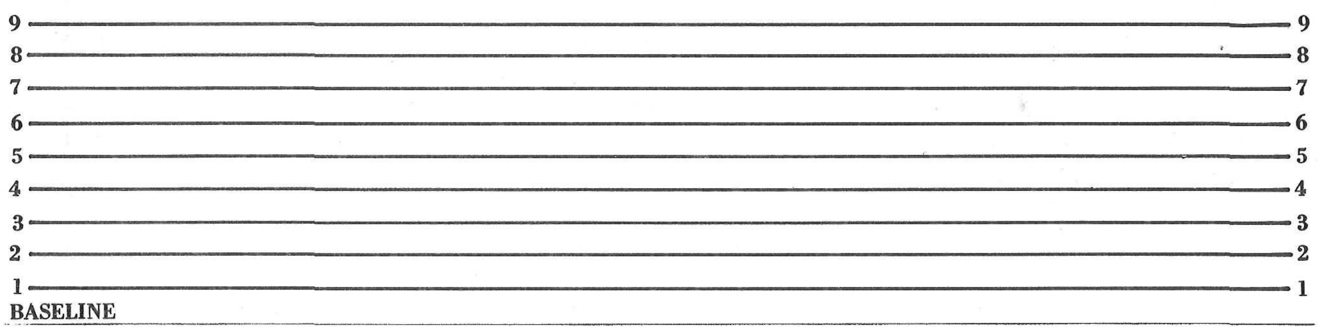


Figure 13. WATERLINES. All run parallel with the BASE LINE

FIGURE 14 - Station Lines

The station lines run vertically over the Lines Drawing. The drawing states that these station lines are to be one meter apart. These station lines will often represent the position of an actual hull frame but not necessarily so. In this case the bow and stern sections of the hull require the frames to be closer together than in the midships section in order to achieve more accurate faring. Consequently, the distance between stations is halved at the bow and stern of the coastal raider.

The first step is to establish an exact perpendicular line at the center of the base line. This perpendicular must be cross-checked for exactitude as the vertical station lines will lead off parallel to it on both sides (fore and aft) at one meter spacings.

The *Lines Drawing* will show which station lines require to be spaced at 50 cms (19.59 in.) in order to conform to the positions of the future bow and stern hull frames. Mark the station lines into the lofting floor in the same way as the preceding lines and number them as shown in the *Lines Drawing* (Figure 1).

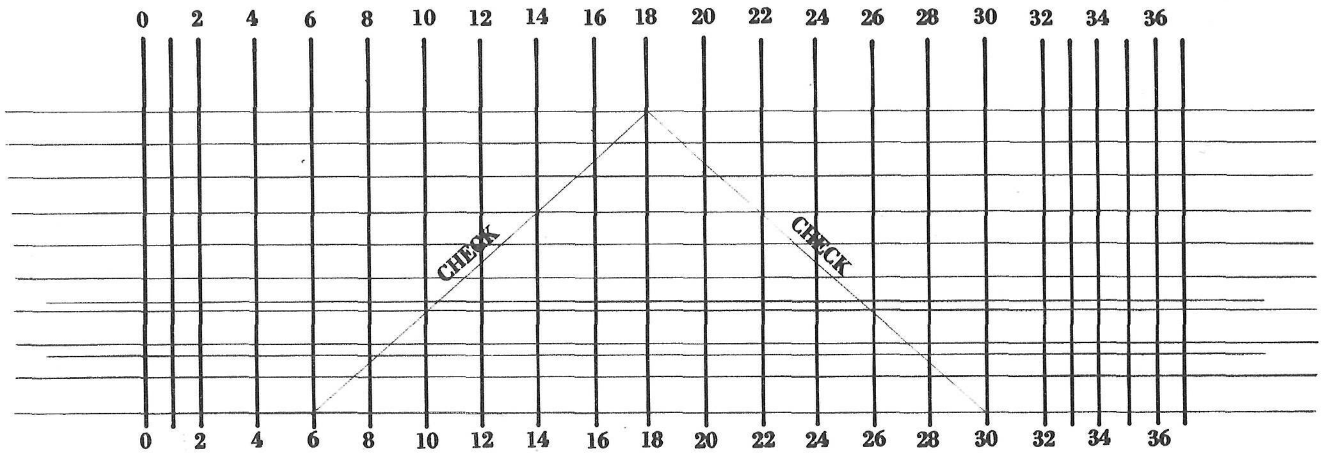


Figure 14. STATION LINES. Perpendicular to the BASE and WATER LINES

FIGURE 15 - Buttock Lines

If a hull could be cut in neat parallel slices right down its full length, the Buttock Lines on the drawing would represent these cuts. With the hull viewed in section, the Buttock Lines are shown running parallel to the vertical Center Line. Mark out and number the Buttock Lines using the measurements shown on the *Lines Drawings* (Figure 1) outwards from the Center Line. Complete in the same way as the preceding lines.

With the hull viewed full length, use the base line as hull center line. Mark out and number at both ends the buttock lines using the same measurements as were used for buttock lines measured from vertical center line.

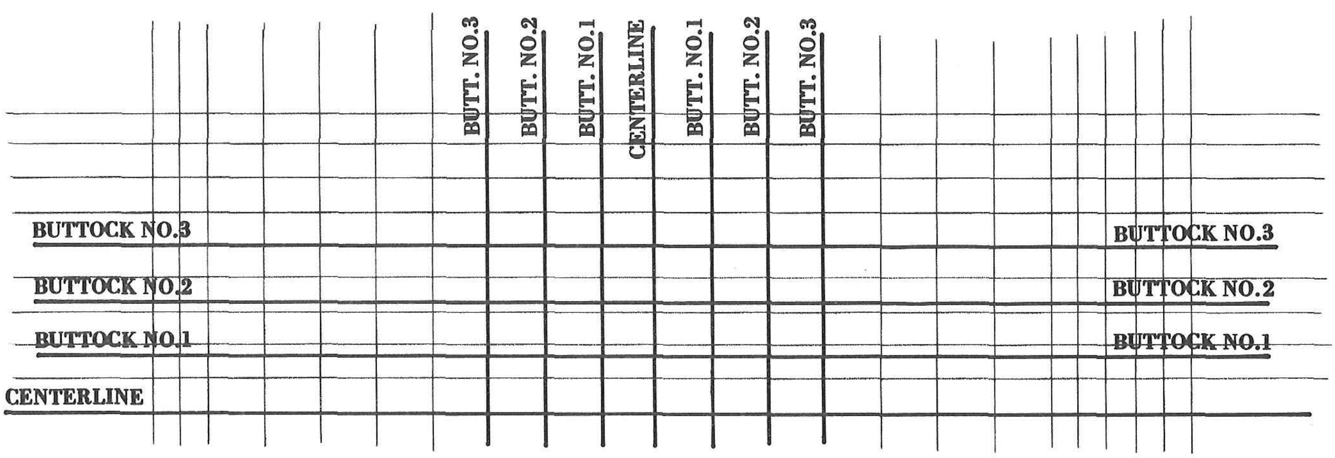


Figure 15. BUTTOCK LINES. Measure off from the LINES DRAWINGS

FIGURE 16- Diagonal Lines

Like the Water Lines and the Buttock Lines the Diagonal Lines serve to represent the shape of the hull transferred to two-dimensional view. Whereas the *Lines Drawing* also shows the Diagonal Lines in plan view, the lofting floor will only show the diagonals running through the hull section, or "body plan" as it is sometimes called. Draw out the Diagonals on the lofting floor. Number the Diagonals to port and starboard as shown in the *Lines Drawing* (Figure 1).

The lofting grid is now ready for marking in the shape of the hull itself.

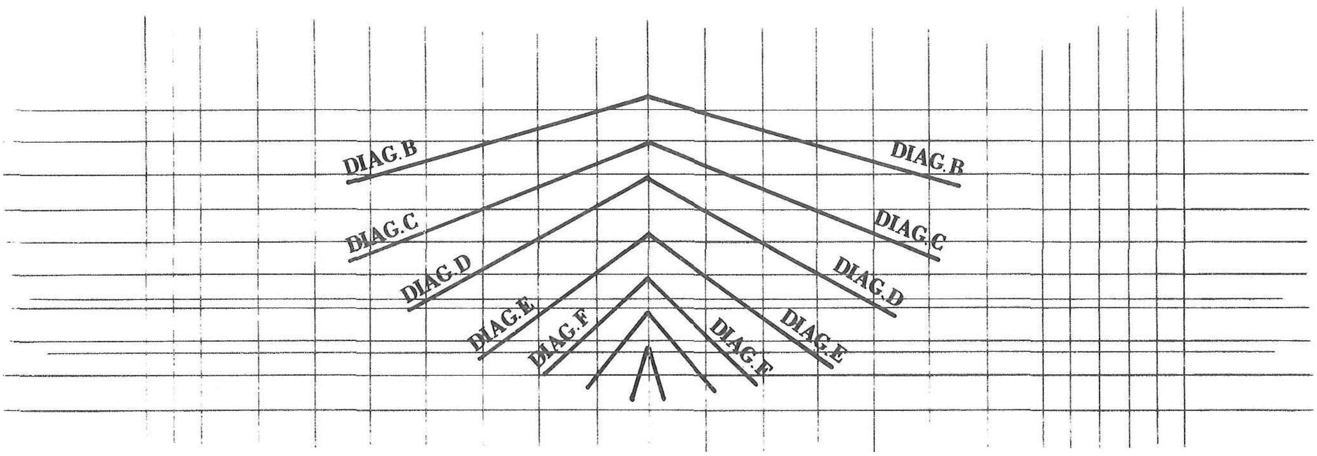


Figure 16. DIAGONAL LINES. Final stage in the preparation of the LOFTING GRID

TASK 4 - Lay Out Hull Profile

FIGURE 17

The profile of the hull can now be marked out. The essential measurements for taking off the profile from the *Lines Drawing* and transferring it to full size on the lofting floor can be read in the *Corrected Table of Offsets* (see Figure 2). Start with the rail cap height measurements from the Base Line, proceed to the Sheer Line marking the deck height from Base Line, and then mark the keel, stem and transom profiles. Where measured off and marked — drive in a nail. Inevitably, as the batten is laid along the nails, some discrepancies in the nail positions will be found. This is where the skill of the loftsman comes into play. Some nails will require further positioning, and the resulting curve drawn along the batten will be slightly modified. But profile modifications (indeed, any line modifications throughout the whole lofting job) must never be allowed to "push out" complementary dimensional measurements in the lofting. That is to say, if the rail cap sheer appears too exaggerated amidships to the eye, be careful not to adjust the midship section station rail cap heights correspondingly high. The skilled loftsman always works towards the happy median between the two conflicting measurements as they appear to him on the floor.

The loftsman using the *Corrected Table of Offsets* (Figure 2) which accompanies this program should encounter little discrepancy in his lofting as the corrections to this table were made from a full-size lofting.

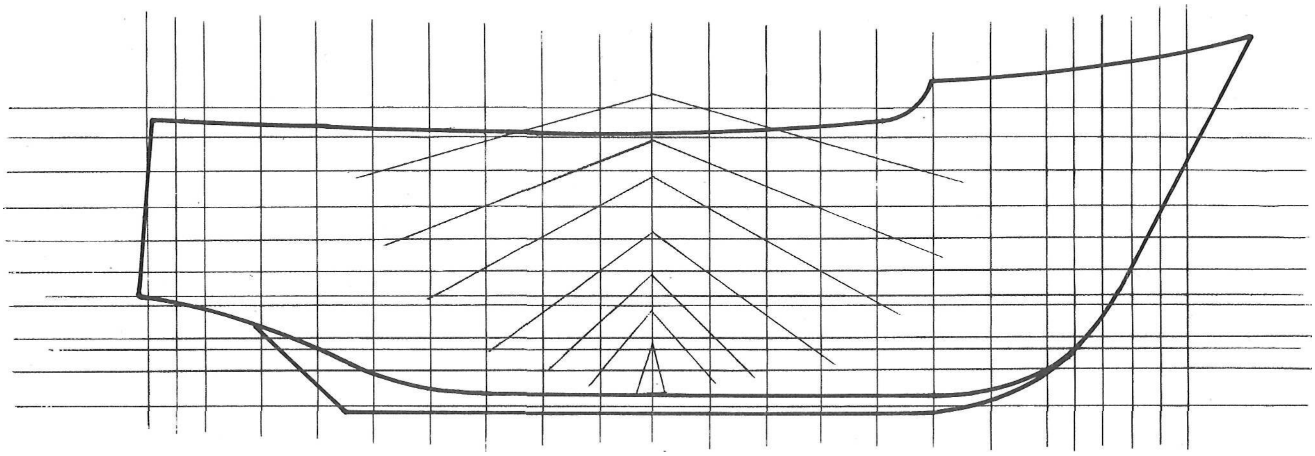


Figure 17. HULL PROFILE. Here a "foreshortened" profile has been drawn by reducing full-size station spacings by half

TASK 5 - Lay Out Hull Sections

FIGURE 18

The *Lines Drawing* shows the hull sections in half-breadths. For the sake of economy, the forward hull half-sections are shown portside view on the righthand side of the center line, and aft hull half-sections are shown portside view on the lefthand side of the center line. Which, essentially, is all that is required for our purpose.

At this stage of the laying out it is wise to follow a skilled loftsman's procedure. Viewed in section, this hull contains 38 stations, the lines of their individual curves lying closely together on the *Lines Drawing.* Therefore, take every alternate station in the midship section (but not at bow and stern) in this order: Station No. 0, No. 2, No. 4, No. 6, No. 10, No. 14, to No. 18 (which is the full midship section) and draw these out on the lofting floor in the same manner prescribed for the hull profiles in Task 4.

Proceed next to Task No. 6, the laying down of water lines in plan view but, in this case, measure off half of the total number of the water lines as they strike at the hull sections for Station Nos. 0, 2, 4, 6, 8, 12, 16 and 18. By establishing a smooth curve on these water lines, an accurate job can be made with correcting the stations already drawn out on the floor.

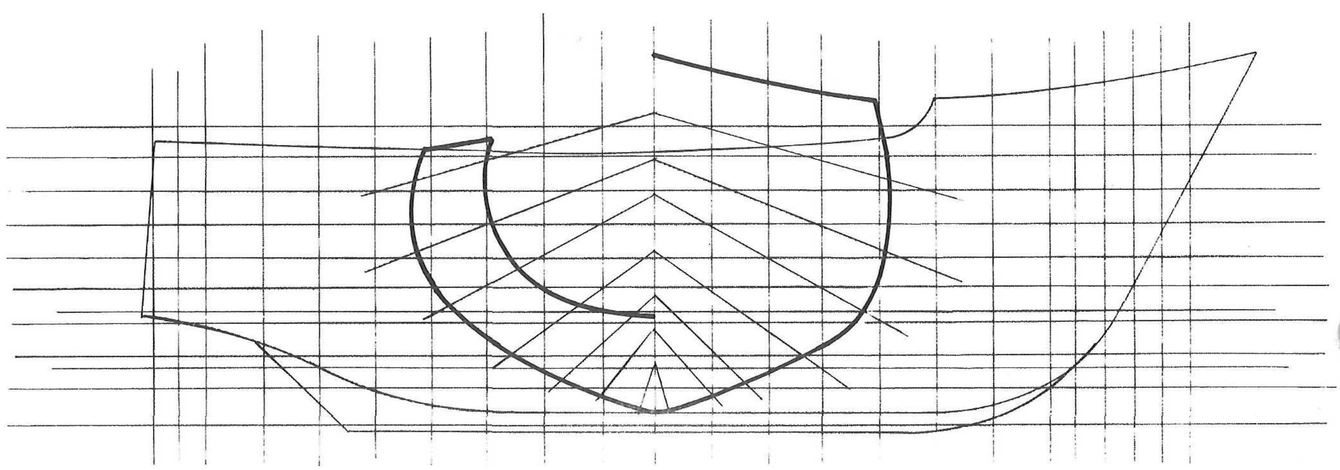


Figure 18. HULL SECTIONS. Drawn to full-size on the lofting floor.

TASK 6 - Lay Out Water Lines and Sheer in Plan View

FIGURE 19

As explained, Task No. 5 has already intruded on this operation. Complete the laying out of the remaining hull sections of Task 5 and complete the remaining water lines in plan view correcting both water line, sheer and hull stations in the process. Finally, ink the lines and number them, removing all nails as before. This completes the lofting operation.

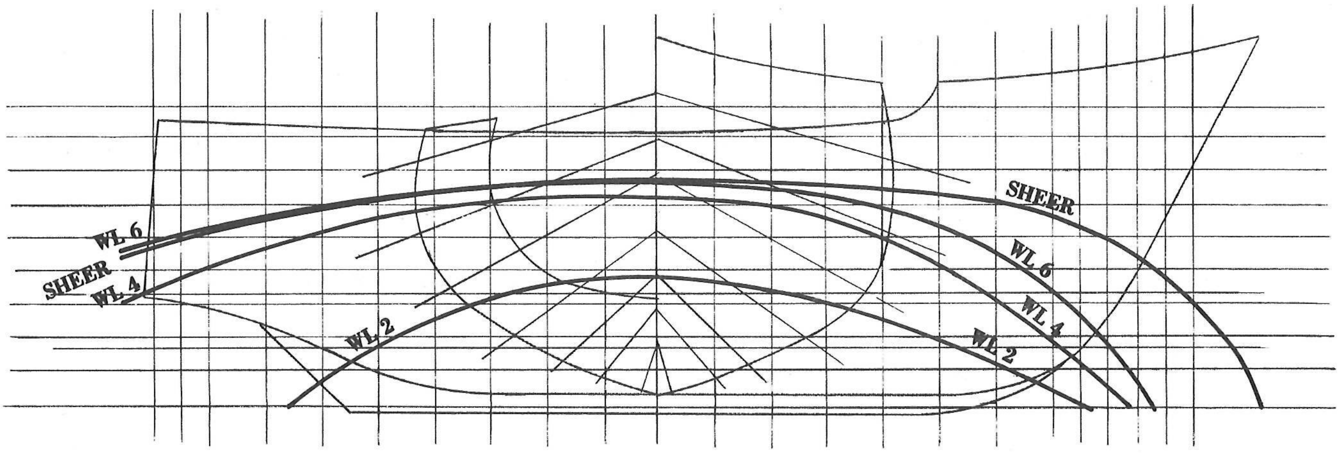
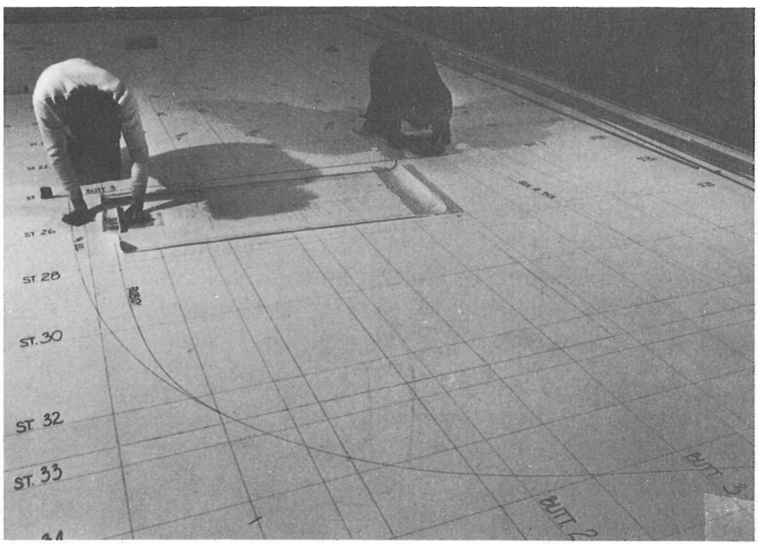
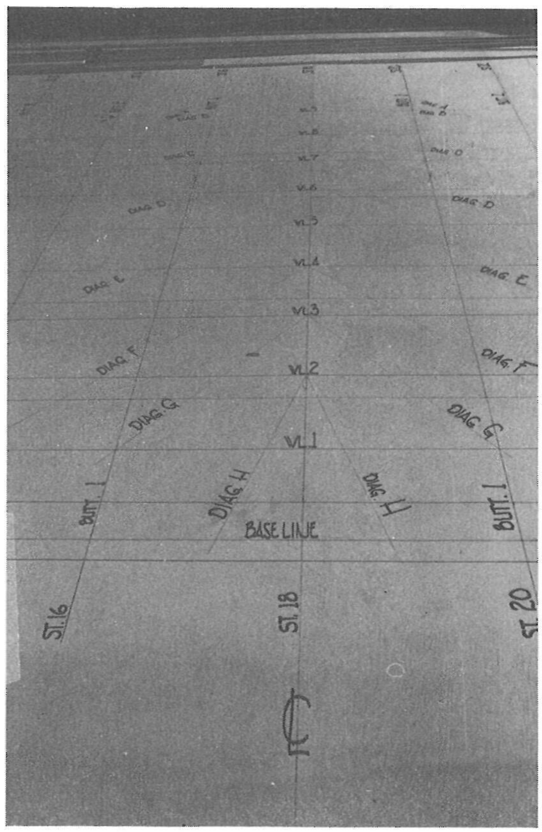


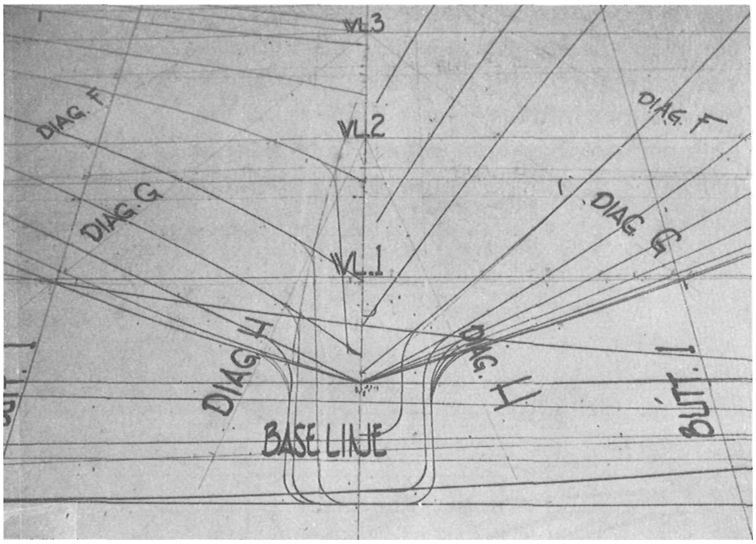
Figure 19. WATER LINES AND SHEER IN PLAN VIEW. Here drawn foreshortened on the Lofting Floor



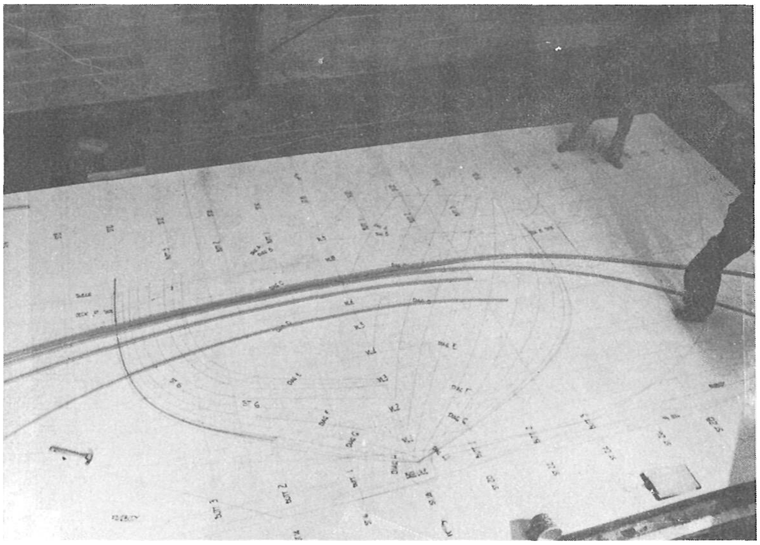
(Above) Hull Profile being lofted from the Lines Drawing and the Table of Offsets

(Right) The center of the Lofting Floor showing the lofting grid prepared

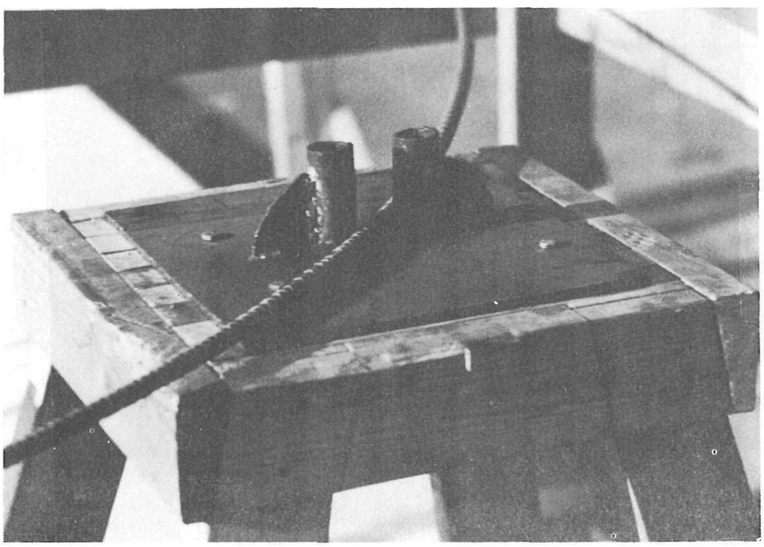




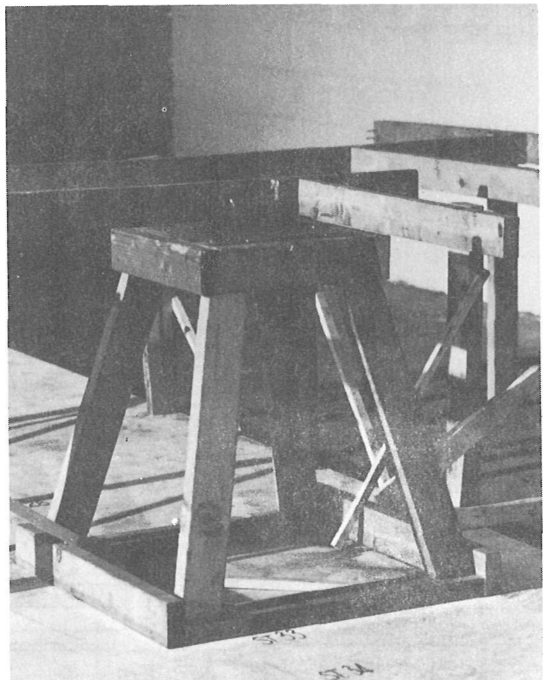
Lofting floor close-up with lines inked in.



Lofting floor long shot. Note battens.



Hull frame bending jig in use.



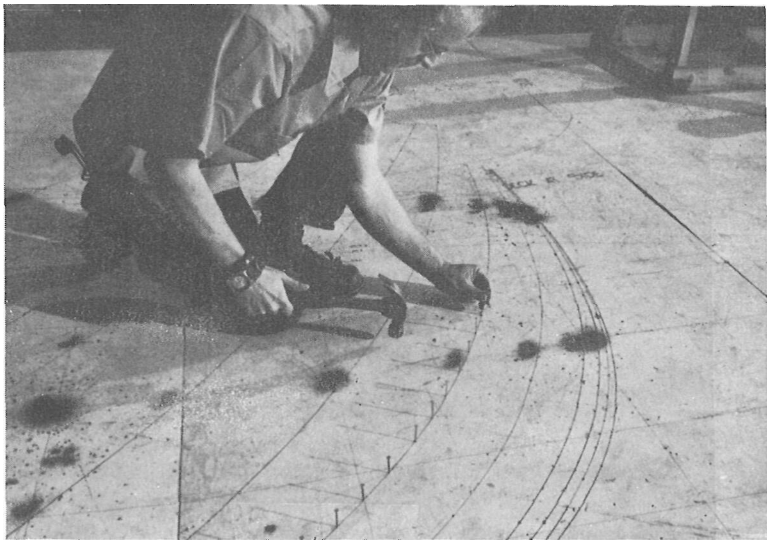
Hull frame bending jig showing outer supports for the rod.

TASK 7 - Set Up Hull Frame Bending Bench

The hull frame bending bench is set up close to the lofting floor. It is made as follows: Cut a piece six inches square (152.4 mm) of 1/4-inch (6.35 mm) mild steel plate. Weld two three-inch lengths (76.2 mm) of 1/2-inch (12.7 mm) diameter rod upright to the center of the plate, spaced one inch (25.4 mm) apart. Drill 3/8-inch (9.53 mm) diameter bolt holes at each corner of the plate.

Construct from 2" x 4" (45 mm x 90 mm) timbers a stoutly braced bench; 36 inches (914.4 mm) high, with a top 12 inches (304.8 mm) square. Bolt the prepared steel plate securely to the bench top. (Refer to Figure 20.)

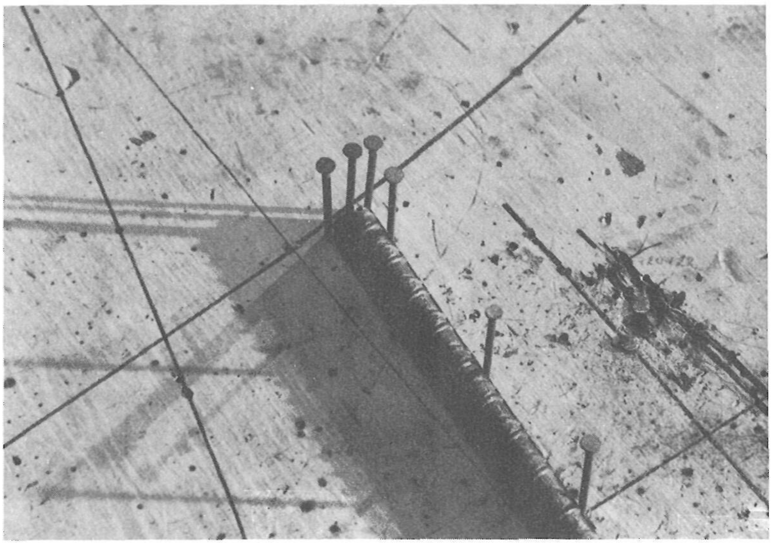
This bench will be found to be at a convenient height for handling the 1/2-inch (12.7 mm) diameter rod which is to be used for making the hull frames. The rod will be pushed between the two upright pieces of rod welded to the plate and, every two inches (50.8 mm) along its length, pressure will be applied so as to induce a gentle lateral curve to the rod. It is important that the rod maintains a true, lateral curve. That it will lie flat when placed on the floor. To facilitate this operation construct additional supports to the same height as the bending bench. The accompanying photographs best illustrate how this is done.



Driving nails along station lines on lofting floor.

TASK 8 - Drive Nails Along Lofting Floor Station Lines

Select an easy curve station to begin working with. Drive 21/2-inch(63.5 mm) common nails at two-inch (50.8 mm) centers for the full length of the lofting floor station line. Leave the nails standing upright at least two inches (50.8 mm) above the lofting floor. Place these nails at the cap rail mark in such a way as to form a dead stop "pocket" for the 1/2-inch (12.7 mm) diameter rod to run into.



Nail "pocket" for making a dead stop for the hull frame rod on the lofting floor.

TASK 9 - Cut Rods for Hull Frames

Take a flexible batten and bend it hard against the rails describing the station shape on the lofting floor. Mark the batten with the correct length of the station. Transfer this measurement to the 1/2-inch (12.7 mm) diameter steel rod and add six (152.4 mm) inches excess. Place the rod in a pipe vise. Cut with bolt cutters or an oxy-acetylene torch. Cut a second length of rod for the matching hull frame.

TASK 10- Bend Hull Frames

The cut length of rod may now be worked through the jig on the hull frame bending bench. Remove the rod after every 12 inches (304.8 mm) or 18 inches (457.2 mm) length of bending and place it hard against the nails at the cap rail mark and against those describing the station curve on the lofting floor. Rectify the curve again in the jig. Proceed in this way throughout the complete length of the rod, right down to the keel, until it is shaped exactly as the station inked on the lofting floor. Remember that the hull frame must lie perfectly flat when its shaping is completed. On the final check for shape and flatness mark the correct length of the hull frame at the point it strikes the center line at the keel. Cut off the excess rod.

Proceed with bending the matching hull frame in the same manner. Cut off excess rod at the keel.

TASK 11 - Mark Reference Lines on Hull Frame

Lay each frame in turn against the nails on the lofting floor and carefully mark the required references onto the steel rod with a hack-saw. The required reference marks are:

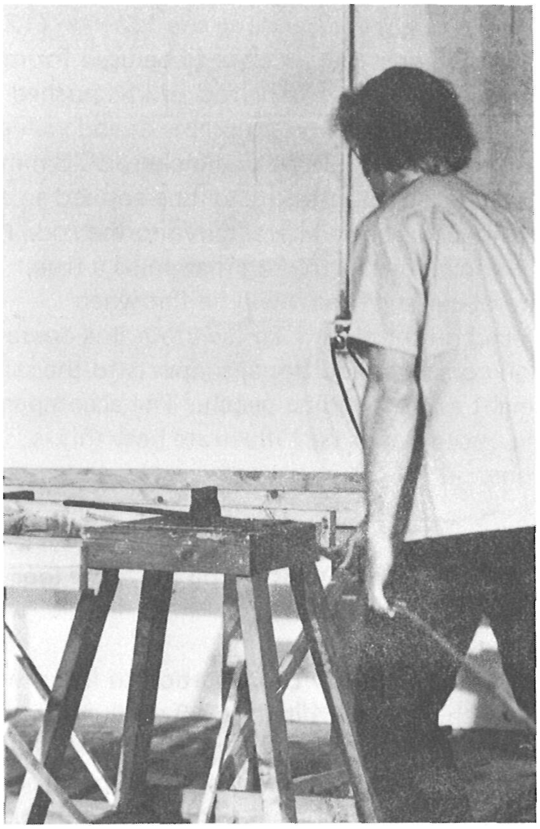
1. All Water Lines
2. Diagonal "D"
3. Buttock Line No. 2
4. Deck Sheer Line

Note that these lightly sawn marks must accompany the "run" of the lines as drawn on the lofting floor.

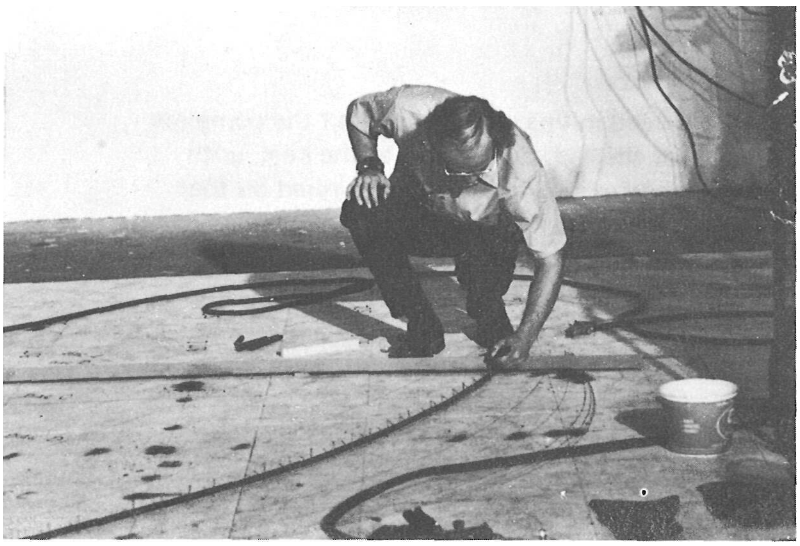
TASK 12 - Store Hull Frames in Pairs

Lay the marked pair of hull frames together on a flat surface in an area where they will not be disturbed until required. Succeeding pairs of hull frames should be arranged in the proper sequence to the first pair so as to avoid confusion later.

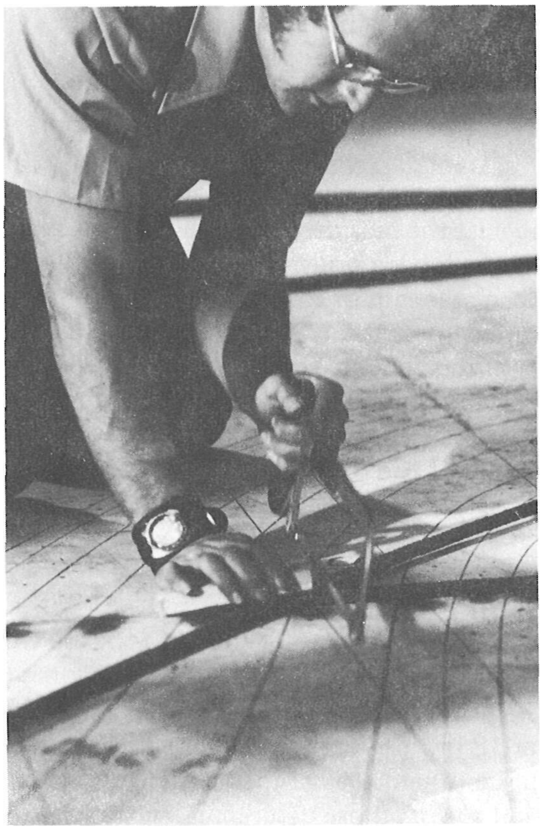
Remove the nails from the completed station on the lofting floor and drive them along the next station lines as described in Task 8. Proceed through Tasks 9, 10, 11 and 12 until all the hull frame pairs are prepared.



Bending the hull frame rods.



Check hull frame shape in lofting floor nail pattern.

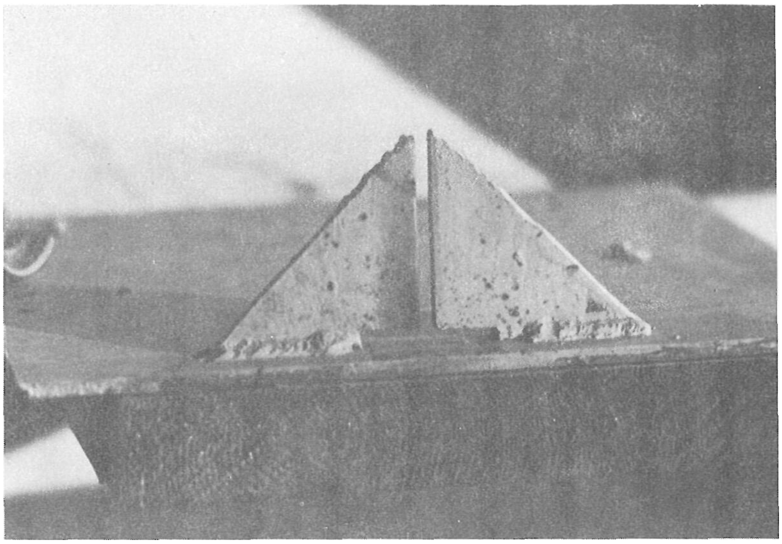


Hack-saw cuts the reference marks.

JOB 2 - MAKING UP DECK BEAMS

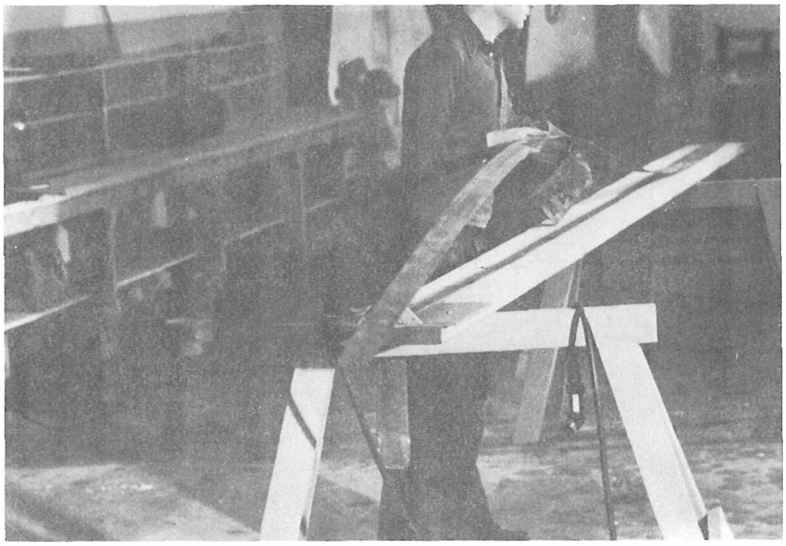
TASK 1 - Deck Beam Welding Jig

The deck beams are made from two pieces of steel flat bar, welded lengthwise to each other in the sectional form of a "T." The inverted "T"-shaped deck beam serves additional purposes to its principal ones of supporting the deck and stiffening the hull at the beam. The bottom lip of the inverted "T" provides a secure ledge for supporting a wood deckhead lining. This lining, in turn, supports the polyurethane insulation material which lies sandwiched beneath the ferro-cement deck. To facilitate the welding of these two flat bars, a simple jig is to be made in the following manner:



Simple inverted "T" jig for deck beams.

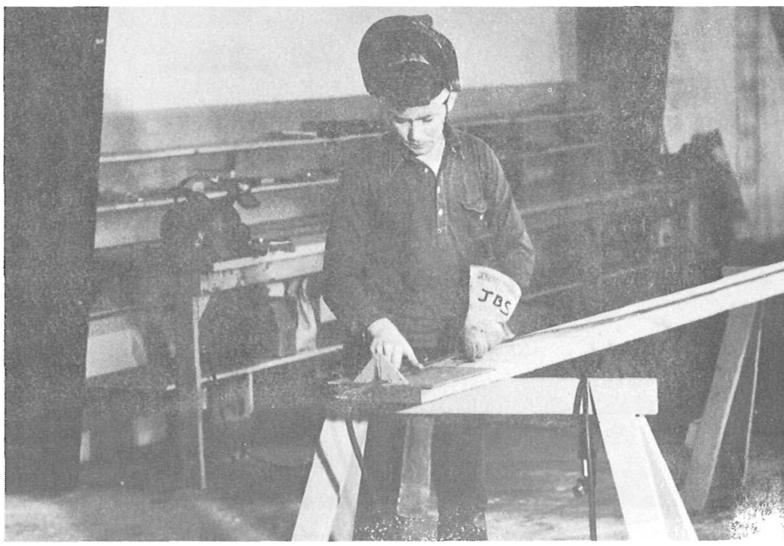
Cut a 1/4-inch (6.3 mm) thick base plate, 6" x 12" (152.4 mm x 304.8 mm). Drill 3/8-inch (9.5 mm) diameter bolt holes at the four corners. Cut two right-angle triangle pieces of 1/4-inch (6.3 mm) plate, 3" x 3" (76.2 mm x 76.2 mm). Weld the two triangles upright to one side of the base plate as shown in the upper right-hand photo. (Refer to Figure 21.)



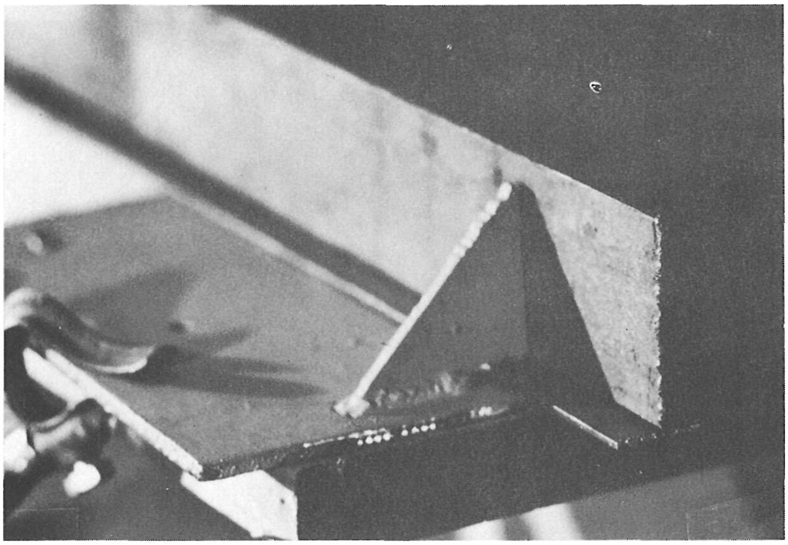
Laying out flat bar for deck beams.

A gap of 3/16 inch (4.7 mm) is left between and below the two opposing triangular pieces forming an inverted "T" shape. The two pieces of 3/16-inch (4.7 mm) steel flat bar which form the deck beam are fed through this inverted "T" aperture in the jig and welded at three-inch centers on alternate sides.

Bolt the completed jig to the end of a 36-inch (914.4 mm) high workbench long enough to support the 20-ft. (5.7 m) lengths of flat bar. Leave sufficient space clear at the end of the bench for the welded "T" beam to be fed outwards from the jig.



Inserting flat bar Into the jig.



Deck beam flat bar in the jig.

Welding deck beam in the jig.

Checking deck beam curve against the wooden pattern.

TASK 2 - Cut Flat Bar to Approximate Lengths of Deck Beam

Measure and mark the 1/8" x 1-1/2" (3.17 mm x 38.1 mm) and 1/8" x 3" (3.17 mm x 76.2 mm) steel flat bar to the approximate lengths of the deck beams. Cut with oxy-acetylene torch. Note that all deck beams must be measured completely athwartships with about four inches (101.6 mm) excess on either side. Do not consider hatch openings and other apertures in your measurements at this stage. Place the two pieces of flat bar side by side on the welding bench. With chalk, mark off weld positions every six inches (152.4 mm) for the entire length of one piece of flat bar. Start at three inches 76.2 mm) from one end of the second piece of flat bar and then mark off every six inches (152.4 mm) for the entire length.

TASK 3 - Weld Deck Beams in Jig

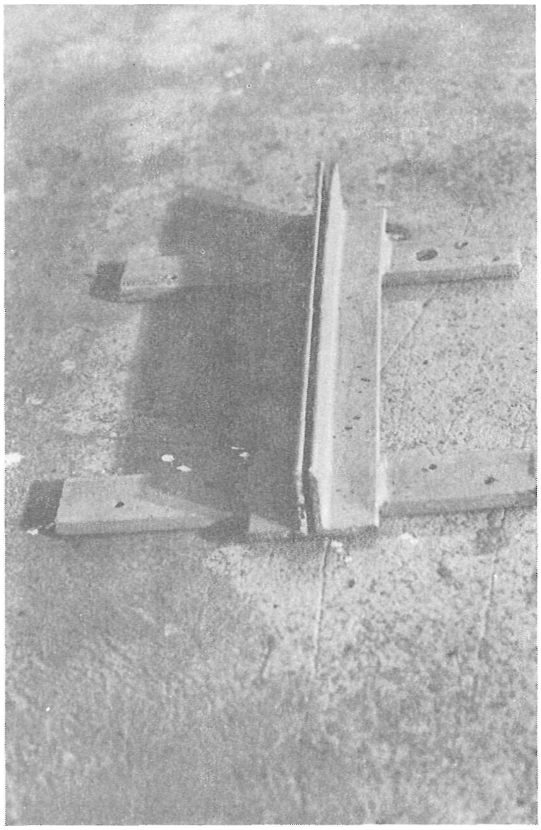
Insert 1/8" x 1-1/2" (3.17 mm x 38.1 mm) flat bar into horizontal aperture of the jig, eight inches (203.2 mm) protruding outwards. Insert 1/8" x 3" (3.17 mm x 76.2 mm) flat bar into the vertical slot of the jig, eight inches (203.2 mm) protruding outwards. Weld flat bars together with a bead one inch (25.4 mm) long starting at the three-inch (76.2 mm) weld mark on one of the flat bars. On the other side of this weld the chalk line marking the next position is at six inches (152.4 mm) from the end. Weld a one-inch (25.4 mm) bead at this position and proceed in this manner, welding alternate sides, pushing the flat bars through the jig as required.

It will be observed that as the welded deck beam advances through the jig and overhangs the bench, the weight of it, plus the contraction caused at the weld points, gradually imparts a curve to the beam in the desired direction.

Weld up all the deck beams and store.

TASK 4 - Master **Pattern for Deck Beam Camber**

Select a good piece of 2" x 12" x 16' (50.8 mm x 304.8 mm x 4.5 m) clear cedar for the deck beam camber master pattern. Mark a center line, buttock lines, and a base line on the plank and from the Table of Offsets on the Lines Drawing read off the required measurements to describe the deck camber. With nails, a batten and a felt pen, ink the curve in the same way as used on the lofting floor. Cut carefully along the curve with a band or saber saw. Both sections of the sawn cedar plank may now be used as a deck beam camber pattern but the "male" pattern which fits beneath the deck beam, is the better one as this makes contact with the horizontal section of the inverted "T."



Simple deck beam bending jig.

TASK 5 - Deck Beam Bending Jig

To make this jig cut two pieces three feet (914.4 mm) long of 3" x 3" x 1/4" (76.2 mm x 76.2 mm x 6.3 mm) angle iron. Weld the angle iron pieces back to back but with a 3/16-inch (4.7 mm) gap between them, to two flat bar base plates. Place the completed jig on a concrete floor with the deck beam master camber pattern close to hand. (Refer to Figure 22.)

TASK 6 — Check and Hammer Deck Beams to Master **Camber Pattern**

Place the welded deck beam upside down into the bending jig, that is to say, with the 1/8" x 3" (3.17 mm x 76.2 mm) flat bar section of the deck beam inserted into the slot between the angle iron of the jig. Take a short-handled 20 pound (9 kg) sledge hammer and pound the 1/8" x 1-1/2" (3.17 mm x 38.1 mm) flat bar section of the underside of the deck beam at select spots to induce the correct camber. Check constantly by laying against the camber pattern.

Pounding a curve into the deck beam.

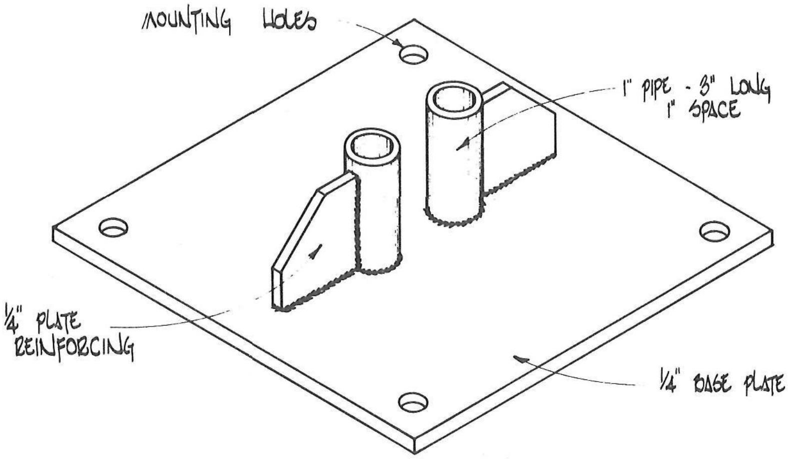


Figure 20. Jig for bending 1/2" rod frames

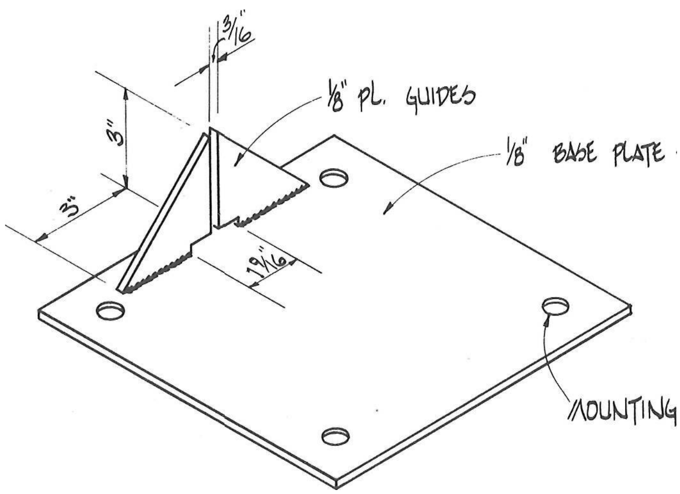


Figure 21. Welding jig for deck beams.

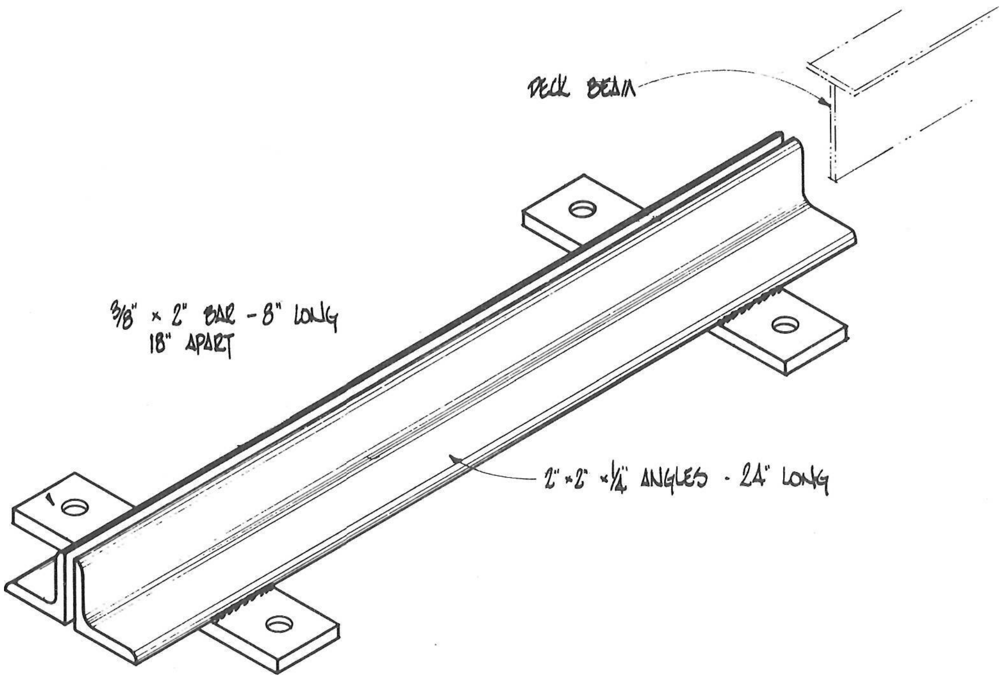


Figure 22. Jig for fairing deck beams.

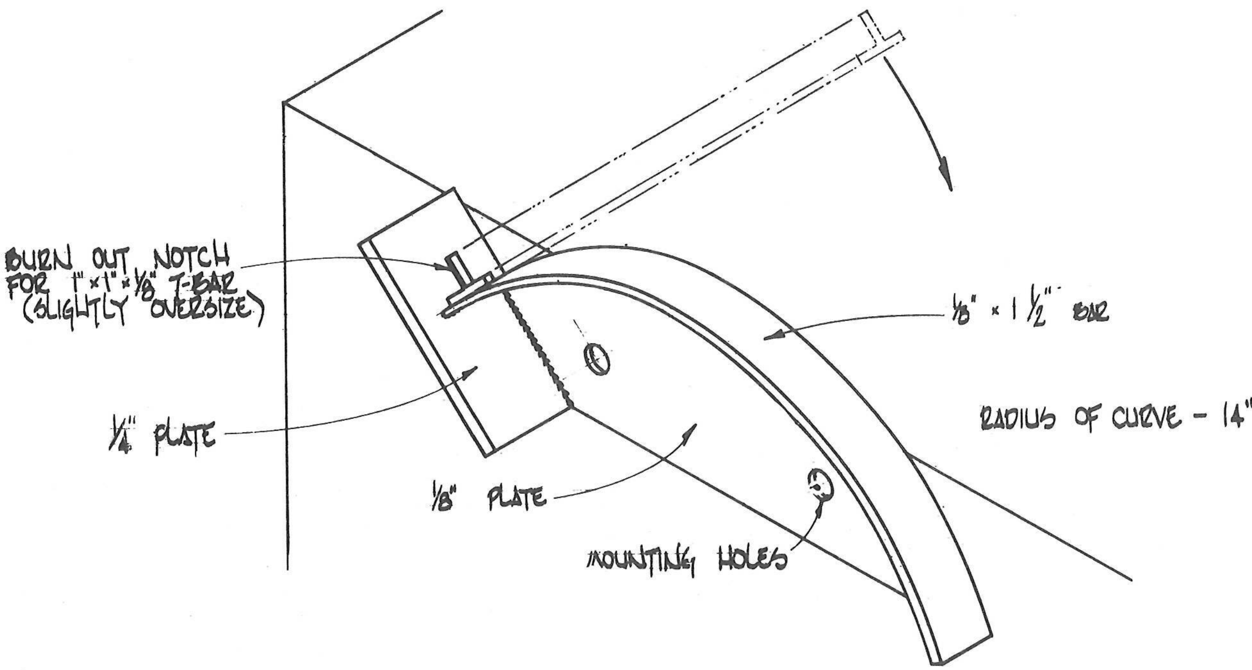


Figure 23. Jig for bending T-bar hanging knees.

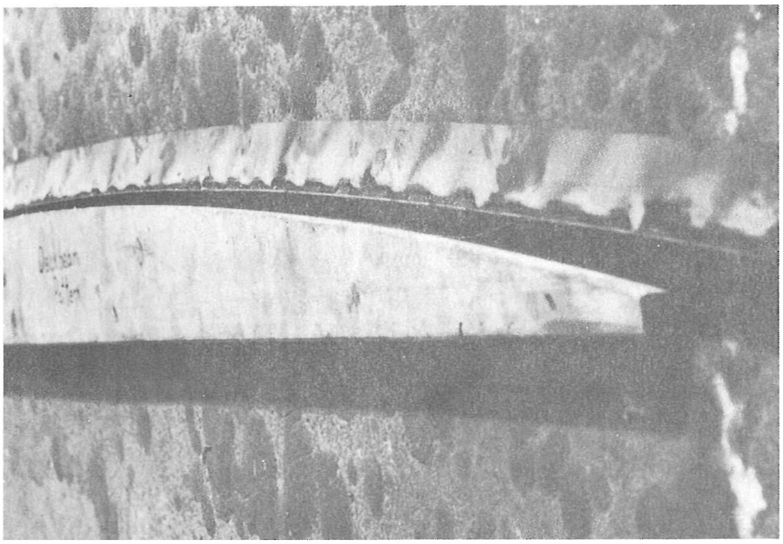
TASK 7 — Cleaning and Priming Deck Beams

Take a steel scraper and wire brush and clean off all welding scale and rust from the deck beams. If the rust is advanced on the deck beams, use a disc sander and rotary wire brush. Prime with red lead paint.

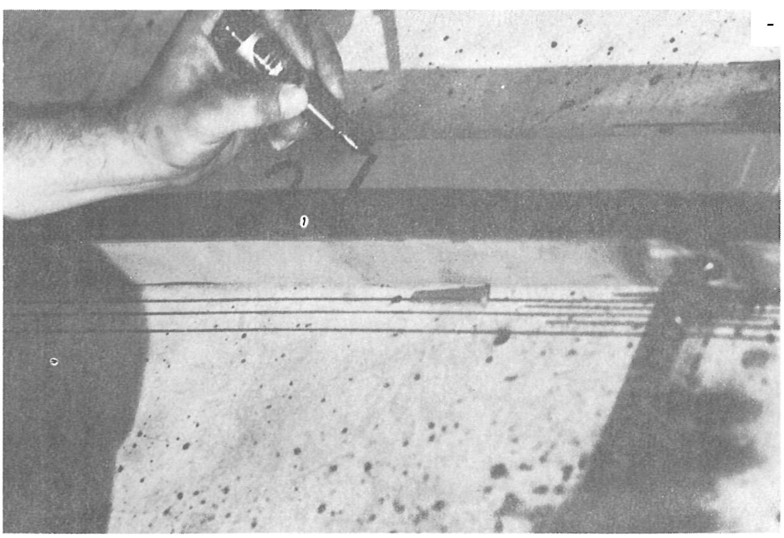
TASK 8 — Mark **Center Line and Buttock Lines on Deck Beams**

When the red lead paint is dry mark the center line and buttock lines neatly onto the deck beams, using the master deck beam pattern as a reference.

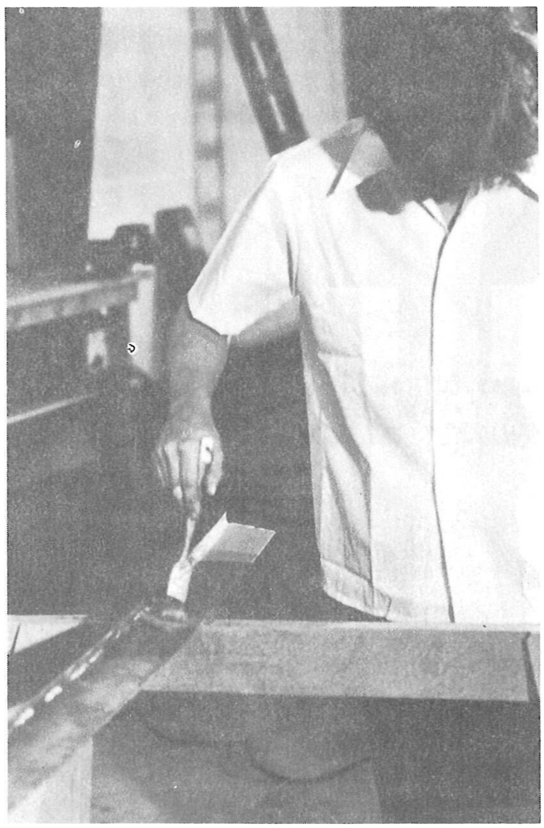
Cleaning off welding slag.



Further shaping required on this deck beam.



Marking the station number.



Painting with red lead.

JOB 3 - ASSEMBLE FRAMES, DECK BEAMS AND SUSPENSION RODS

TASK 1 - Lay Hull Frame Pairs in Place on Lofting Floor and Tack Temporarily Together

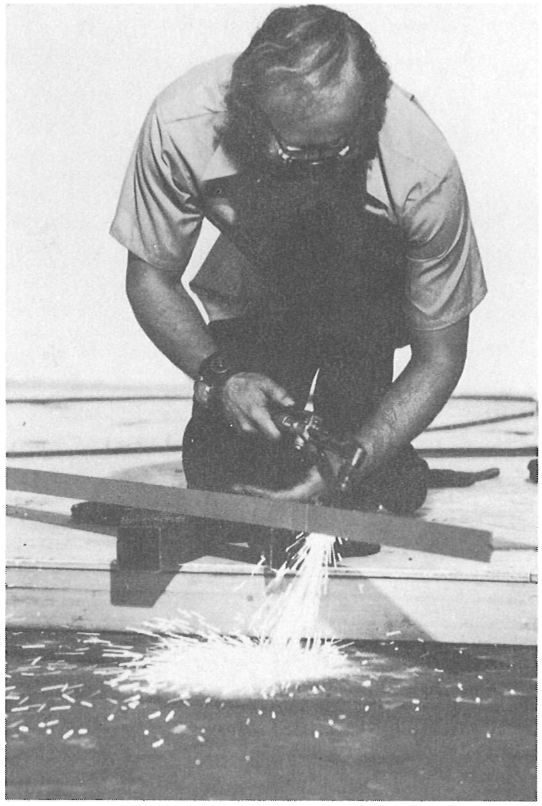
Lay the pair of frames selected in place on the lofting floor. Drive nails at six-inch (152.4 mm) centers along the station lines to hold the frames securely in place. Ensure that the two rods meet exactly at the keel center line. Tack temporarily in place.

TASK 2 — Lay Deck Beam onto Frame and Mark

Lay the deck beam on center into its required position on the frames and mark off the excess ends. Mark in such a way as to allow the frames to pass outside the beam and run free up to the height of the rail cap.

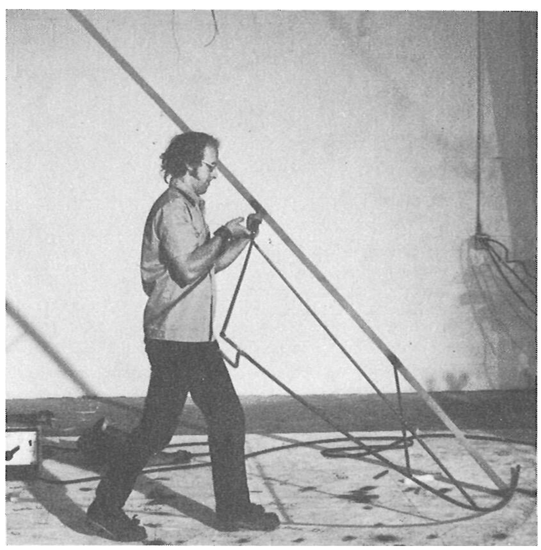
TASK 3 - Cut and Weld Deck Beam in Place

Cut off the excess length at both ends of the deck beam. Lay back in place on the lofting floor. Weld to the hull frames.

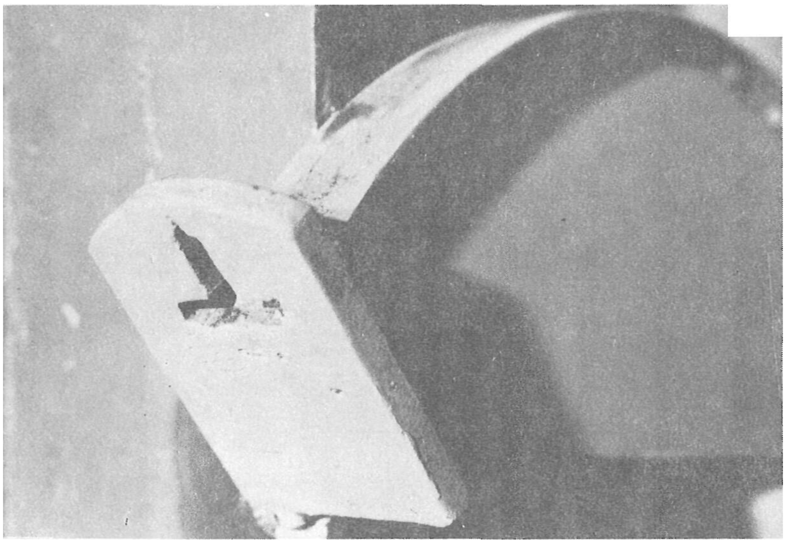


Cutting excess ends off deck beam.

Welding deck beam to hull frame.



Turning hull frame over to weld the other side.

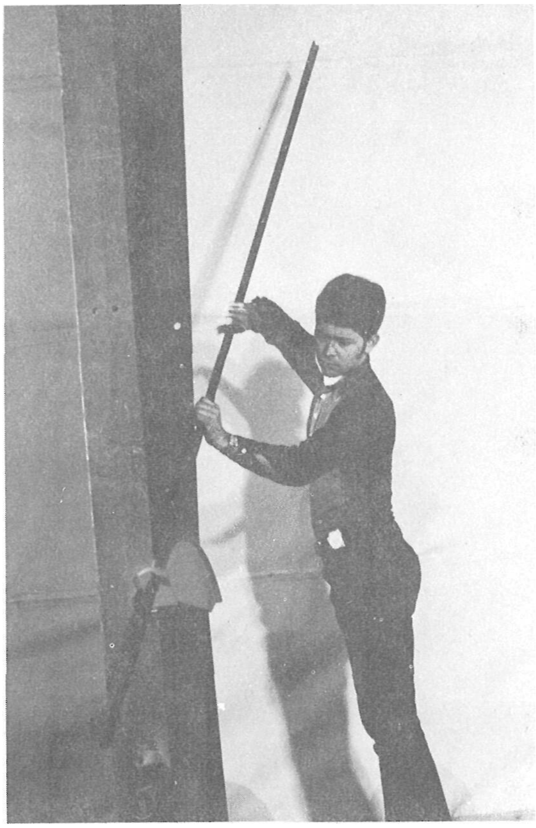


The deck knee bending jig.

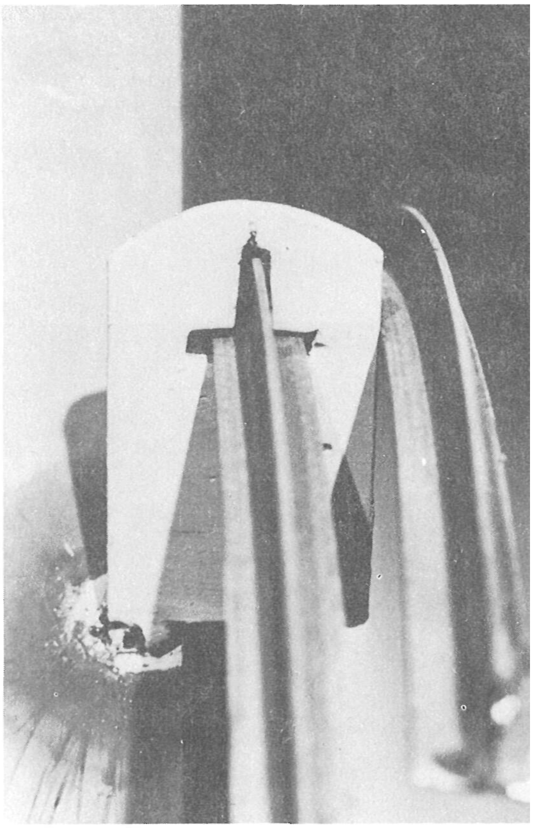
TASK 4 - Make Deck Knee Bending Jig

The accompanying photo illustrates the deck knee bending jig. Also refer to Figure 23. The plate used is 1/8 inch (6.35 mm) cut on a 14-inch (355.6 mm) radius. A piece of 1/8" x 1-1/2" (3.17 mm x 38.1 mm) flat bar is welded to the circumference of the plate. Height from base to the crown is 7 inches (177.8 mm). At one end a piece of 1/4-inch (6.3 mm) plate has been welded with an aperture cut into it in the exact shape of an inverted "T." This is for inserting the 1/8" x 1" x 1" (3.17 mm x 25.4 mm x 25.4 mm) T-bar.

The T-bar is then bent cold over the "back" of the jig to form one continuous circle of T-bar. The T-bar circle is then marked to length and cut into deck knees. Make up 32 deck knees.

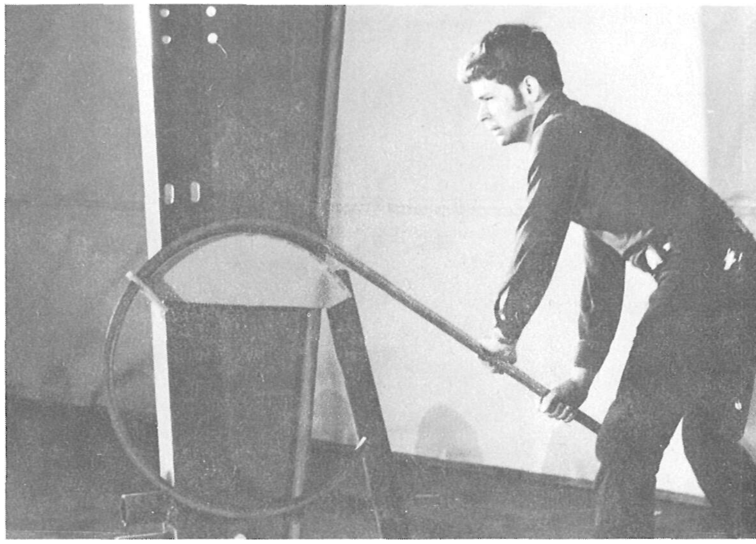


Inserting T-bar into the jig.



Bending T-bar into full circle.

Cutting out deck knee.



Side view of the jig.

Marking to prescribed length.

Fitting the deck knee in place.

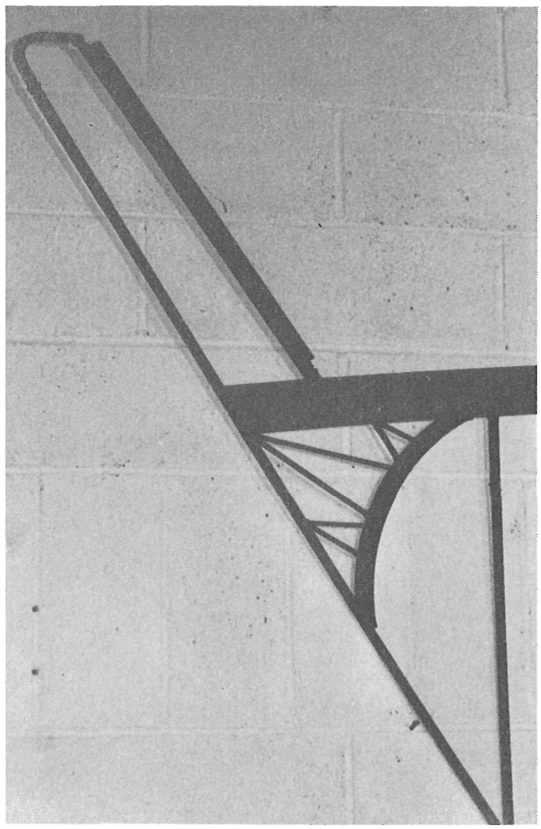
TASK 5 - Weld in Deck Knee

With the hull frame and deck beam still lying tacked together on the lofting floor as in Task 3, proceed to mark with chalk the ends of the T-bar knee which requires shaping to form a snug fit between hull frame and deck beam. Cut off the marked surplus ends with the oxy-acetylene torch. Now weld the deck knee so that it braces the angle between the hull frame and the underneath of the deck beam. Weld in the 1/4-inch (6.3 mm) diameter rod deck knee reinforcing to the pattern as shown on the drawing. Note that not all the hull frames require deck knees. Consult the drawing.

Tapering ends to fit.

Cutting deck knee reinforcing bars.

Welding reinforcing bars.

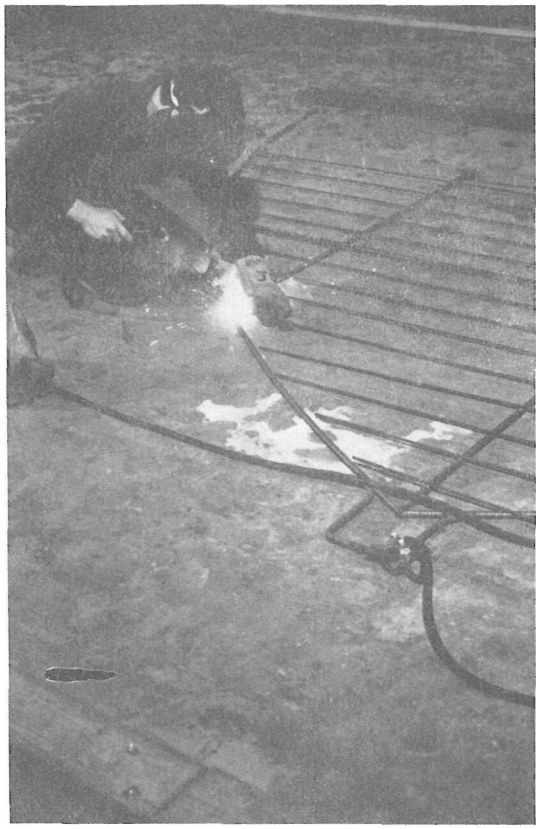


Reinforced deck knee in place.

TASK 6 — Weld Lower Suspension Rods to Hull Frame

In this method of hull construction, the hull frames require to be suspended from an overhead support structure. The suspension rods hang in a straight line from longitudinal girders on the support structure down to the hull frame at the deck beam. At the deck beam the rod is interrupted. Below the deck beam the suspension rod continues to the lower part of the hull frame. The rod used is 1/2-inch (12.7 mm) diameter deformed mild steel rod. The line the suspension rod follows is Buttock No. 2 which is already marked on the Deck and Beam and on the lower hull frame. This task only concerns the lower part of the suspension rod, from beneath the deck beam to the lower hull frame.

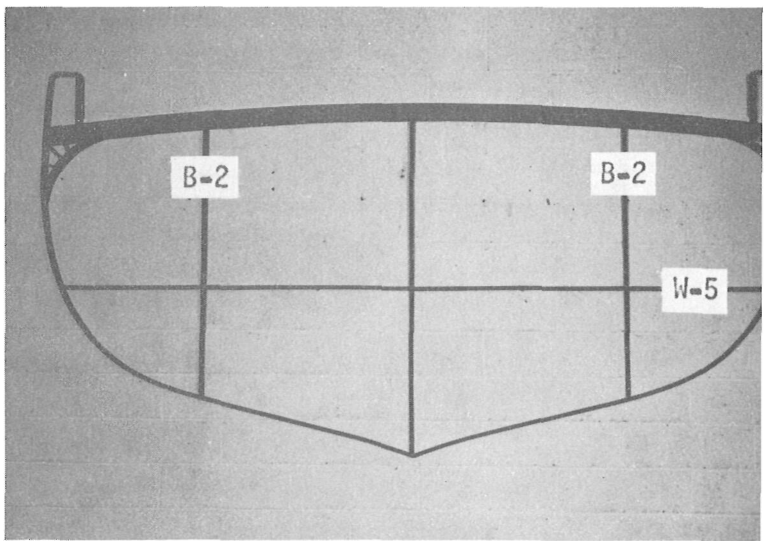
Measure and cut two lengths of 1/2-inch (12.7 mm) diameter rod to fit between the upper part of the lower hull frame and the underside of the deck beam in the line of Buttock No. 2. Weld into place.



Welding lower suspension rods in place at Buttocks No. 2. (Thinner horizontal rods shown are bulkhead reinforcing rods.)

TASK 7 - Weld Athwartship Braces

An athwartship brace of 1/2-inch (12.7 mm) diameter rod is welded across the hull frame on the line of Water Line No. 5. The brace lies inside the vertical suspension rods at Buttock No. 2 and on the center line. The hull frame is now adequately braced for erection.

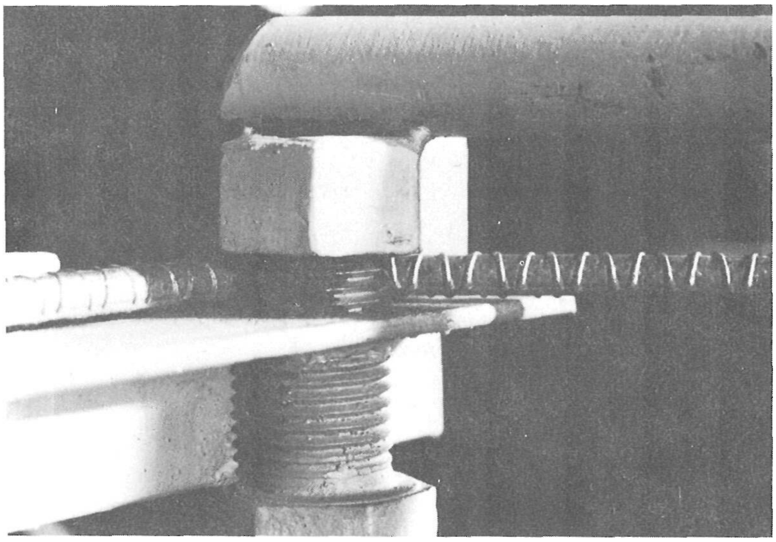


Completed hull frame showing vertically placed lower suspension rods at Buttock No. 2, a/so athwartship brace at Water Line No. 5.

TASK 8 - Weld Bulwark Supports

It is important that the rail cap lies flat in section as it accompanies the curve of the sheer line around the hull. To achieve this required flat section the bulwark support is made up while the frame lies in place on the lofting floor.

The outer edge of the rail cap is particularly vulnerable to chipping on a ferro-cement hull. To reduce damage, this outer edge is gently rounded. It is at this stage of construction that this rounded edge is initially attended to.



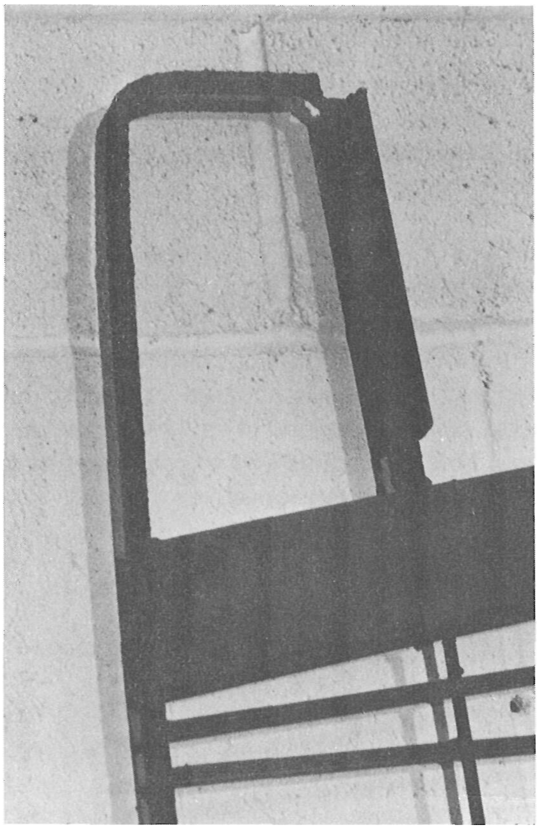
Rod bend at right angles in pivotal jig.

Prepared rail cap piece butted to hull frame rod, prior to welding together.

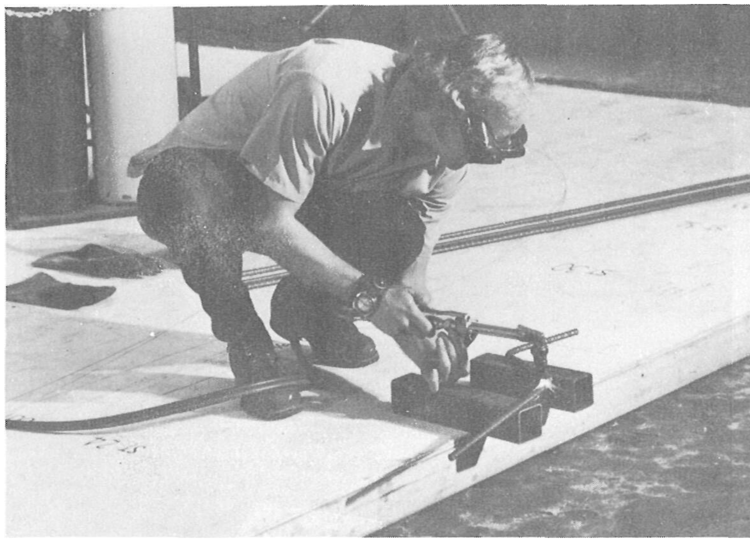
Take scrap lengths of 1/2-inch (12.7 mm) diameter rod and bend them over sharply at right angles in a pivotal jig or a bench vise. The rod forms a tight little curve where it has been bent over. This will later give the outer edge of the rail cap the desired rounded section. The rod is then cut short immediately below the bend and is cut to a length of five inches (127.0 mm), this measurement including that absorbed by the right-angled bend. Prepare 46 of these pieces.

Select *a* straight-edged length of lumber and lay it on the concrete floor butted to the rail cap at the top of the hull frame. Lay the long part of the rail cap piece of rod up against the straight-edged lumber and mark the hull frame rod at the point where the downward end of the bent rail cap piece meets it. Cut the hull frame rod at this mark. Butt weld the rail cap piece to the hull frame, the straight-edge lumber ensures that the rail cap section will lie flat. Proceed with the opposing rail cap on the hull frame in the same manner.

A length of 1/8" x 1" x 1" (3.17 mm x 25.4 mm x 25.4 mm) T-bar is used as a bulwark support. It is prepared and welded to the tip of the rail cap piece and to the upper side of the deck beam as the next step in this sequence of construction. But first, a cut-back is required on the horizontal top section of the "T" to the height of one inch (25.4 mm) at the foot where it is welded to the deck beam. The purpose of this cut-back is to improve concrete penetration into the deck reinforcing material at the time of plastering. The bulwark support is welded into place on the lofting floor; the distance from the outside of the hull frame to the outside of the T-bar support at deck level is maintained at seven inches (177.8 mm) throughout. The bulwark support is now ready to receive the 1/4-inch (6.3 mm) diameter rod reinforcing. Cut the rod with bolt-cutters and weld in place to conform to the pattern shown on the drawing.



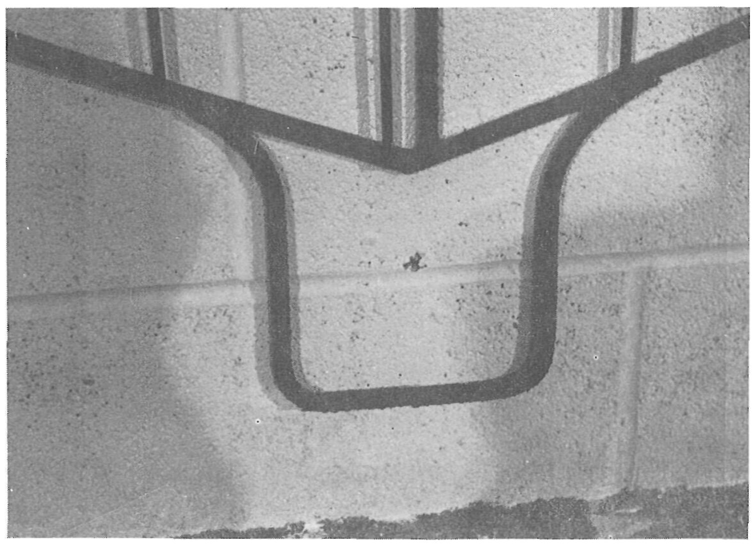
The bulwark support shown without reinforcing. Note that the tip of the rod is welded to the tip of the T-bar vertical screed. The longitudinal piping screed for the rail cap will later be welded into this prepared support.



Pre-bent keel section rod being cut on the lofting floor.

TASK 9 - Weld Keel Sections

The keel sections are made from pieces of 1/2-inch (12.7 mm) diameter rod bent to conform to the keel section lines as inscribed on the lofting floor at every station. For ease of bending, each keel section is made from two separate pieces of rod. The rod shape is checked on the lofting floor and cut directly on the center line. The two separate rod pieces are welded to the underside of the frames and butt-welded together at the bottom of the keel.



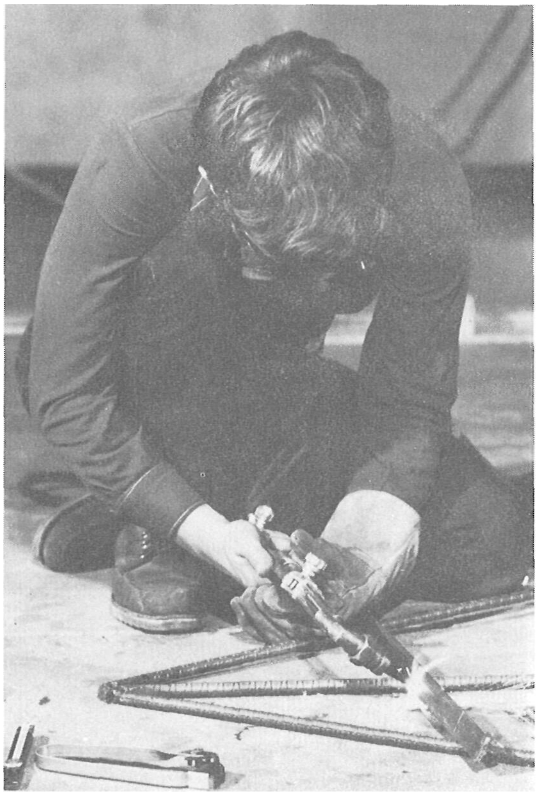
Keel section complete.

Welding bulkhead reinforcing rods.

TASK 10 - Weld Rod Reinforcing to Solid Bulkheads

There are seven solid bulkheads to this hull (if the transom is to be included in this count). These bulkheads receive 1/4-inch (6.3 mm) diameter rod reinforcing throughout their full section.

The 1/4-inch (6.3 mm) diameter rod reinforcing is welded vertically between the frames and the underside of the deck beam at three-inch (76.2 mm) centers. The horizontal rods are welded in the same way at three-inch (76.2 mm) centers. All intersections of rod are tacked together. This reinforcing grid of rods must lie flat square and be well tensioned.



Cutting T-bar screeds for hull webs.

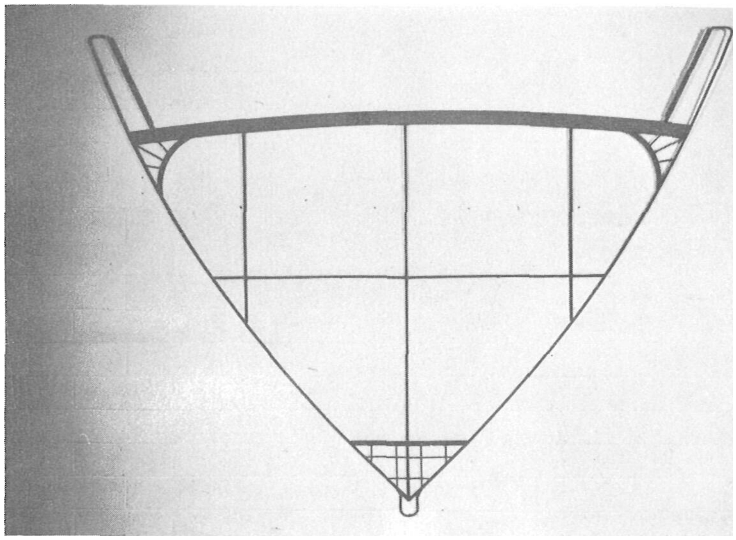
TASK 11 - Weld Webs to Hull Frames

Nine of the open hull frames take a reinforcing web at their base center situated immediately above the keel. The web is topped with a length of 1/8" x 1" x 1" (3.17 mm x 25.4 mm x 25.4 mm) T-bar. The T-bar serves as a screed for the plasterers and as a foundation for the 1/4-inch (6.3 mm) diameter rod which reinforces the web. This rod reinforcing is laid out in the form of a grid at three-inch (76.2 mm) centers and welded at all intersections.

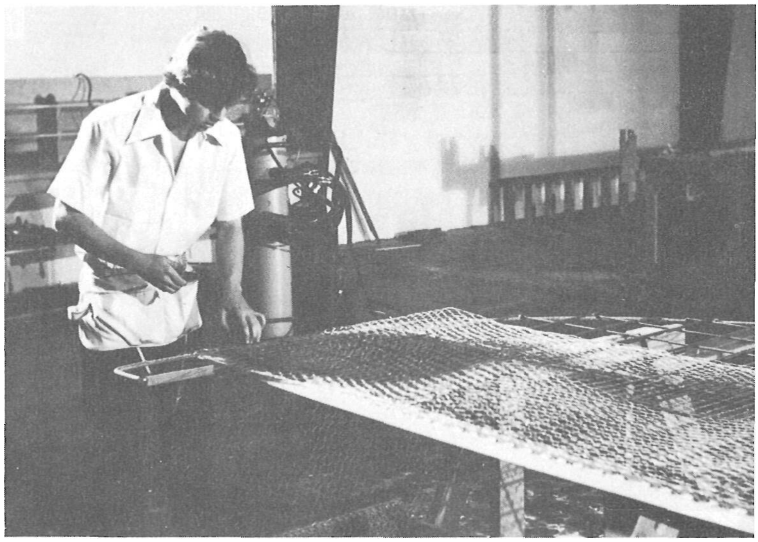
TASK 12 - Fasten Mesh to Bulkheads, Bulwark Supports and Webs

The hull frames, completed to this stage, are taken one by one, laid over sawhorses, and galvanized wire mesh is fastened to them in the required areas. One inch by 20 gauge hexagonal mesh, galvanized after weaving, is used. Two layers are fastened to each side of the bulkheads, the bulwark supports and the webs. Three-quarter inch (19.0 mm) hog ring staples are used as fasteners to the 1/4-inch (6.3 mm) and 1/2-inch (12.7 mm) diameter rod reinforcing. These staples are applied with hog ring pliers. Around the outside edges of the 1/2-inch (12.7 mm) diameter rod hull frames the mesh is laced down tightly with tie wires. It makes a neater finish to the curved outer surface of the hull frame and more tension can be imparted to the mesh layers. On long, straight edges garden shears are used to cut the mesh; on curved or awkward edges tin snips are handier.

It is important to keep the mesh flat and well tensioned on the webs, bulkheads and bulwark supports. Care must be taken to ensure that no areas are omitted, unreinforced with mesh, and that no loose ends of wire are left protruding. Loose ends of wire and mesh later interfere seriously with the plasterers' efforts to produce a smooth finish. In the same way, the hog ring staples must always be crimped tightly to the reinforcing rods.

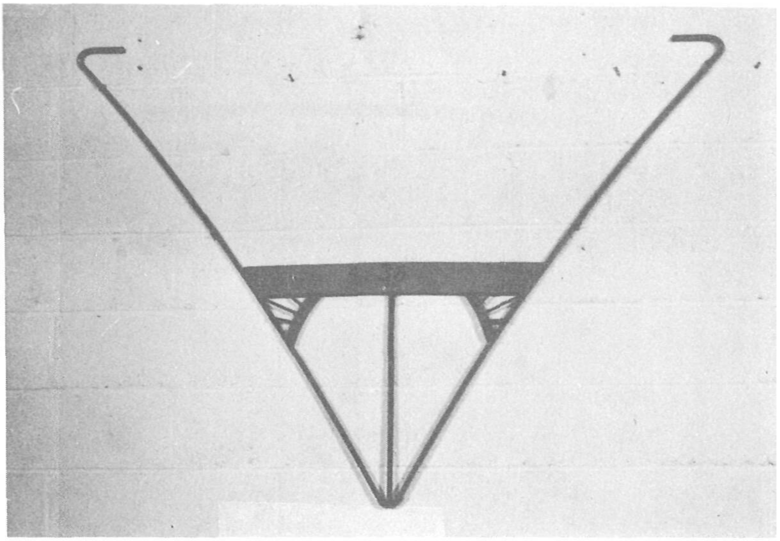


Web and deck knees ready for mesh.

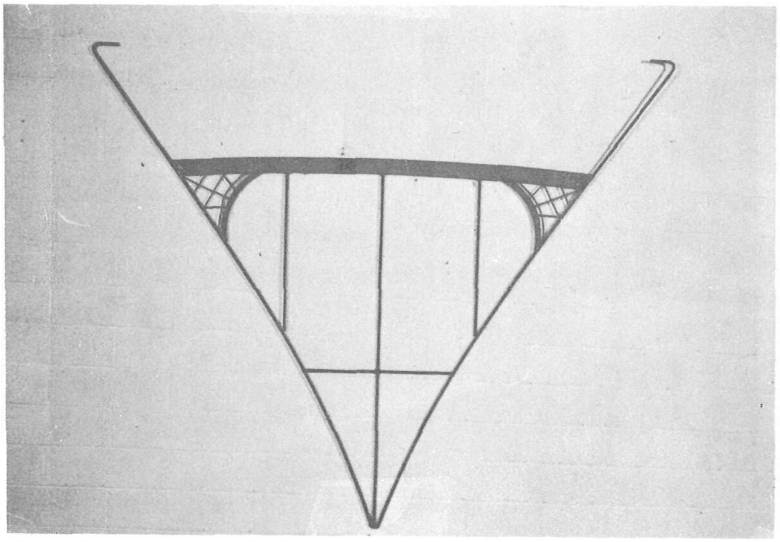


Applying mesh to bulkheads.

The hog ring pliers.

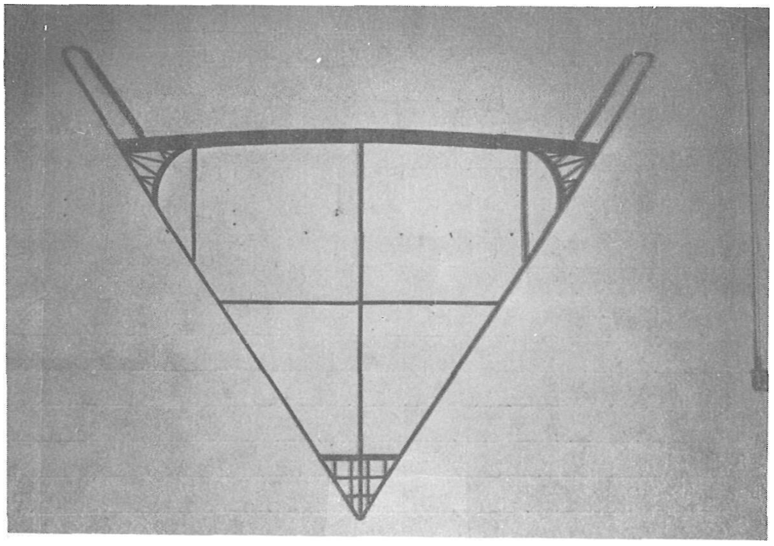


Hull frame No. 36.



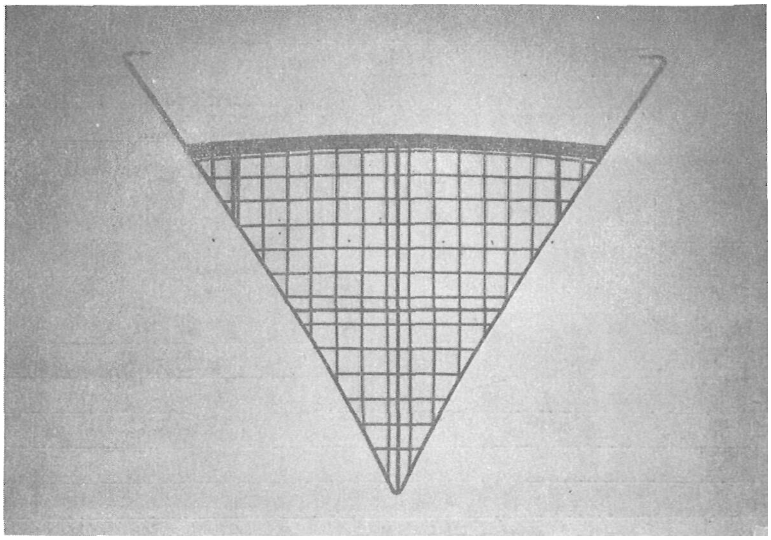
Hull frame No. 34.

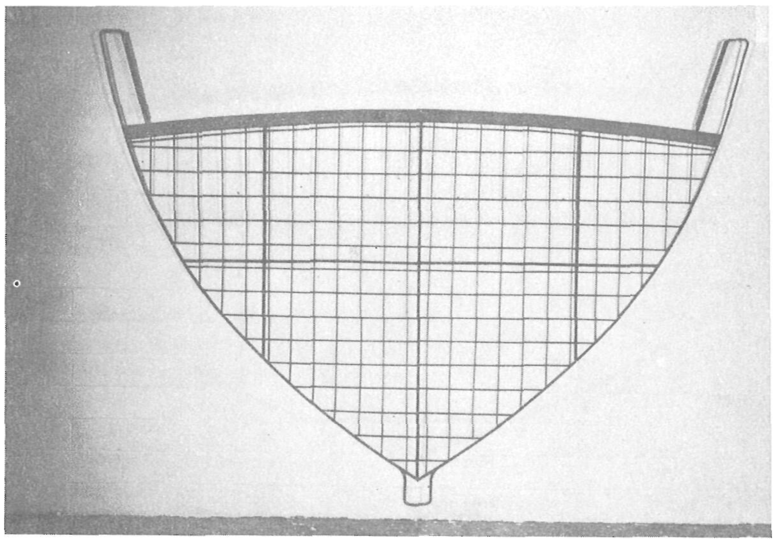
TYPICAL HULL FRAME CONSTRUCTION

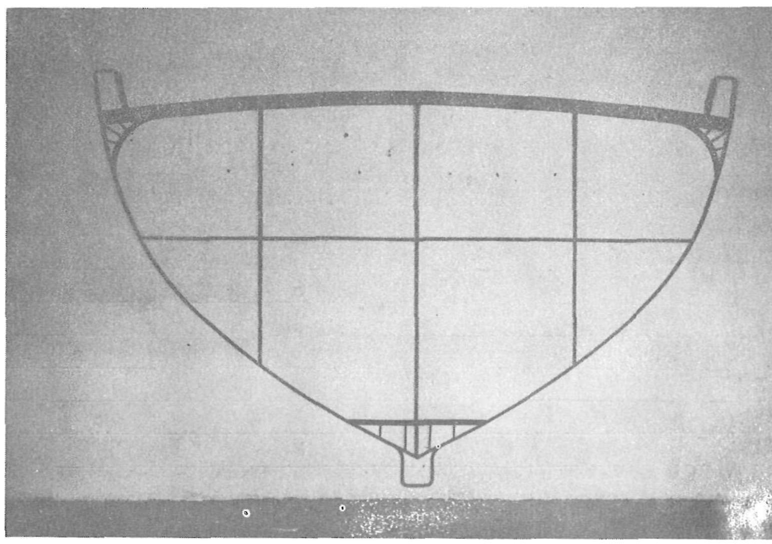


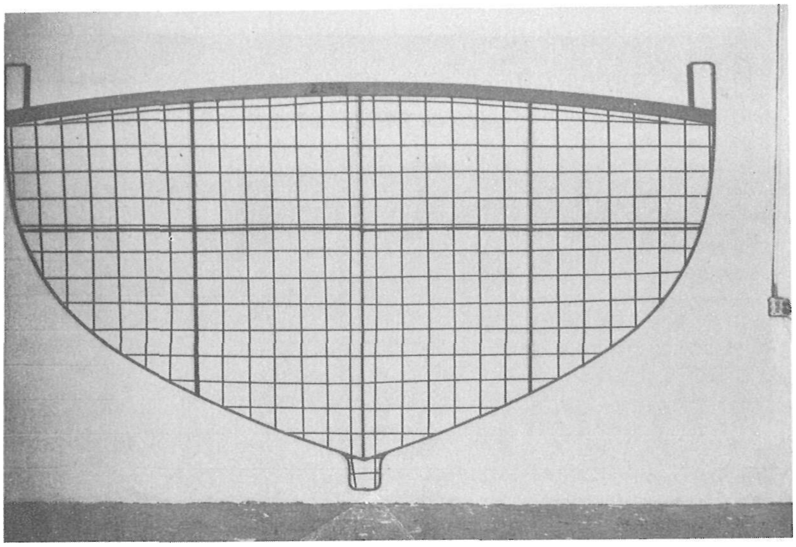
Hull frame No. 32.

TYPICAL
HULL FRAME
CONSTRUCTION

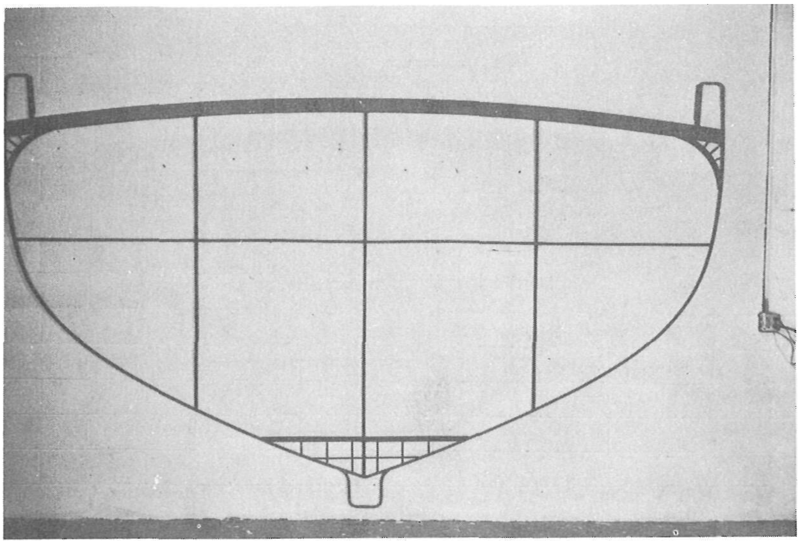

Bulkhead No. 33.


Bulkhead No. 28.


Hull Frame No. 26.

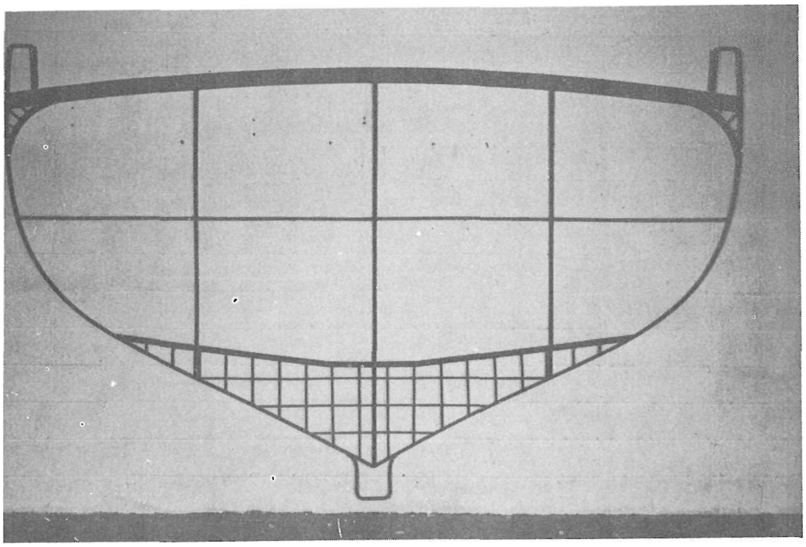


Bulkhead No. 21.



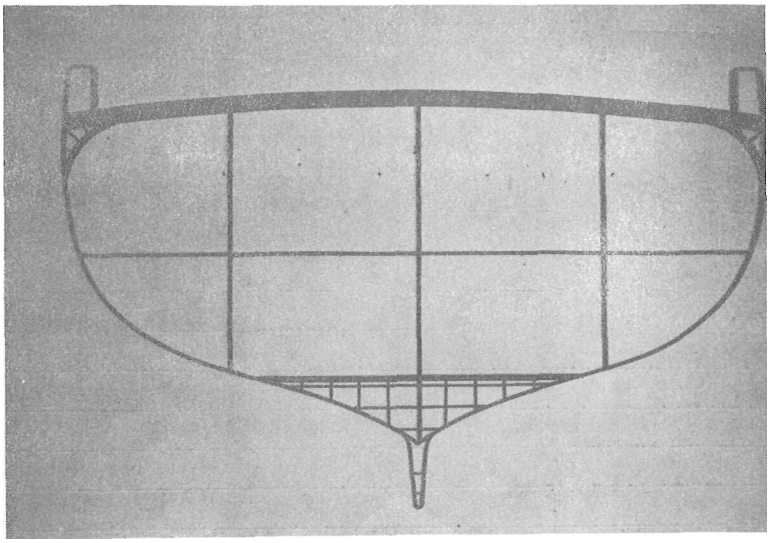
Hull Frame No. 16.

TYPICAL HULL FRAME CONSTRUCTION

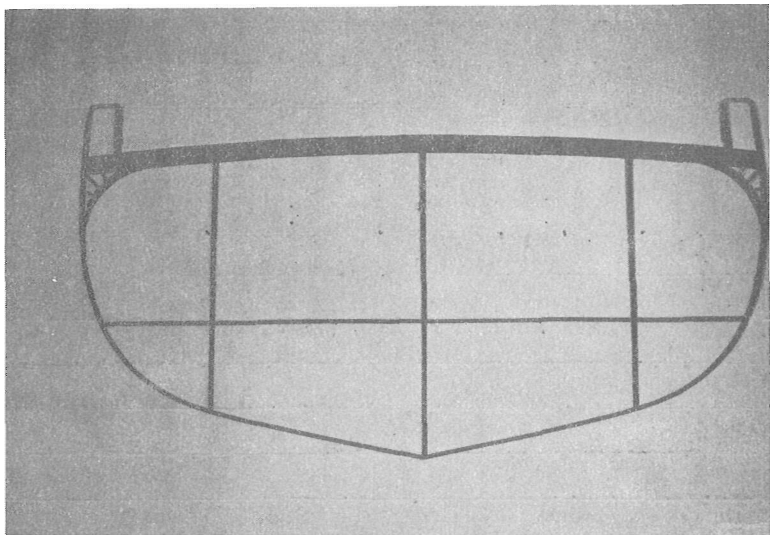


Hull Frame No. 12.

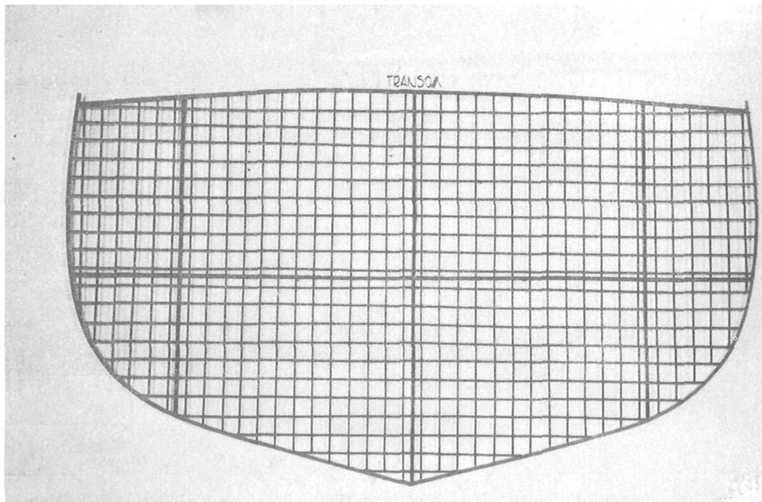
TYPICAL
HULL FRAME
CONSTRUCTION



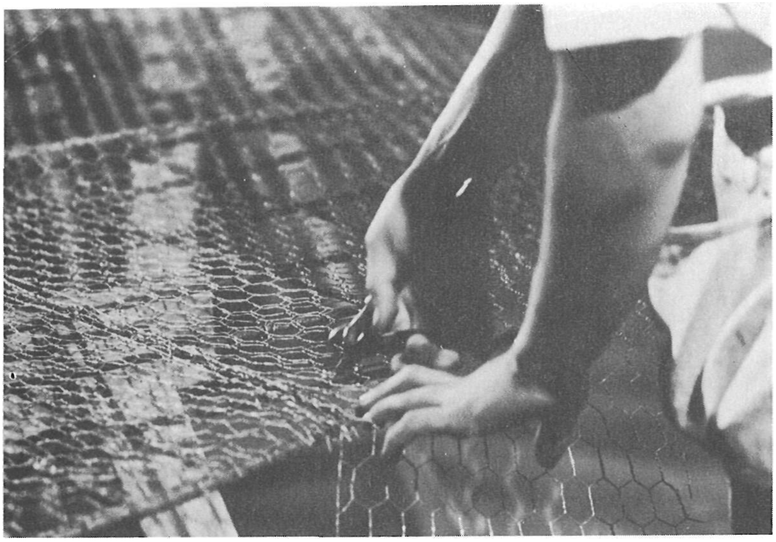
Hull Frame No. 6.



Hull Frame No. 2.

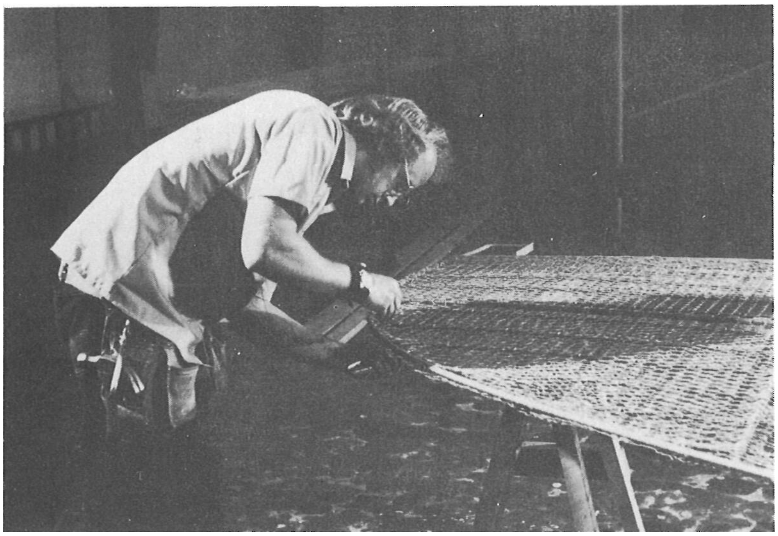


The Transom.

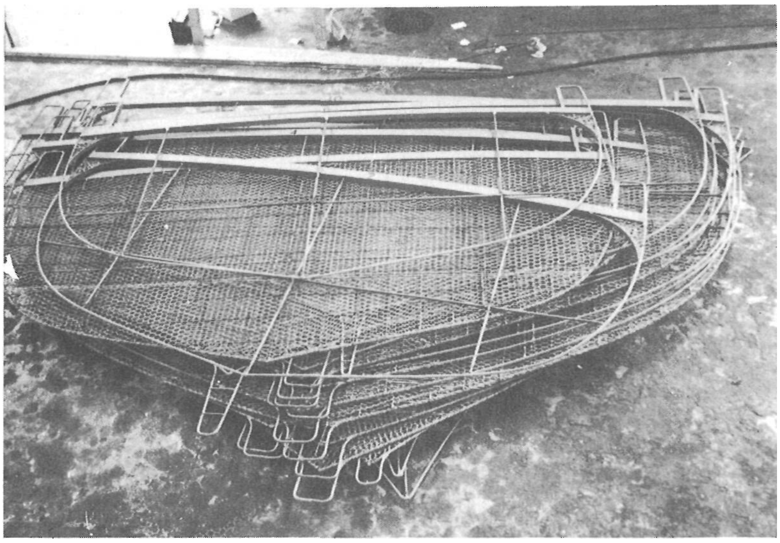


Fastening mesh with hog ring staples.

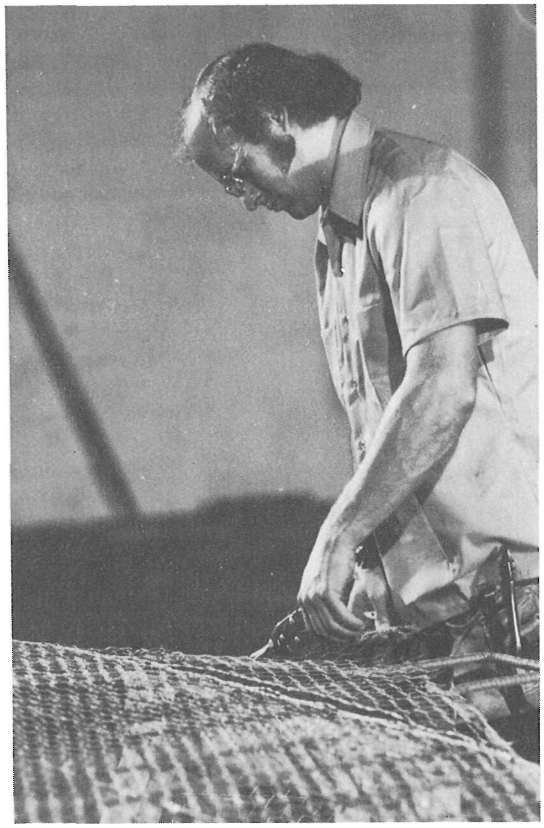
Cutting mesh with shears.



Lacing mesh to bulkhead edges.



Stack of frames and meshed bulkheads.



Trimming awkward edges with snips.

JOB 4 - ERECTING OVERHEAD SUPPORTS

TASK 1 - Measure Off Base

A rectangular area, 65' x 18' (19 m x 5.4 m) is measured off on the concrete building pad, or floor, and diagonally checked for accuracy. A chalk-line is used to mark out the area which represents the base for the overhead support steel structure.

TASK 2 — Layout and Fasten Wooden Base Plates

Lengths of 2" x 8" (50.8 mm x 203.2 mm) construction grade fir, butted end to end, are used for the base plate. Two base plates, each 65 feet (19 m) long, are laid down following the chalk-lines already marked on the concrete floor. The wooden base plate and underlying concrete is drilled with 1/4-inch (6.3 mm) masonry drills and the plate fastened down with 21/2-inch(63.5 mm) concrete nails.

TASK 3 - Bolt Piping Base Plate to Wooden Base Plate

Twenty plates of nine-inch lengths of 1/4" x 3" (6.3 mm x 76.2 mm) steel flat bar are cut and 1/4-inch (6.3 mm) holes drilled at each end. These pieces are to serve as individual base plates for the piping supports to the overhead structure. The longitudinal centerline is marked with chalk-line on the top of the wooden base plate. The position of the piping supports is marked off at two-meter (6.56 ft.) centers onto the longitudinal center line. The individual steel base plates for the piping supports are then laid in place on the 2" x 8" (50.8 mm x 203.2 mm) wooden base plate and fastened securely with two lag screws, size 1/4" x 1-3/4" (6.3 mm x 44.4 mm).

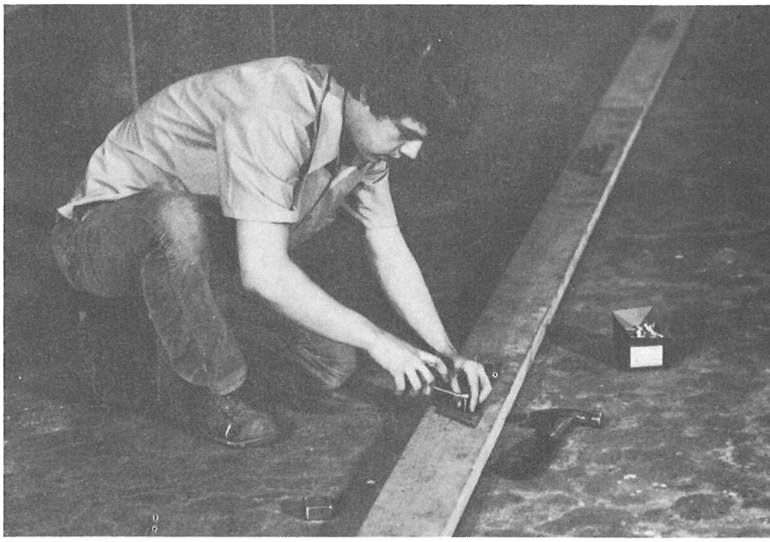
TASK 4 — Prepare Piping Supports and Braces

The piping used is black steel construction pipe 2 1/2-inch (63.5 mm) I.D. It is cut to the required height of 18 feet (5.5 m) using a pipe cutting attachment on the oxy-acetylene torch. The braces are made from 1/4" x 3" (6.3 mm x 76.2 mm) flat bar and cut to fit the 45-degree angle between the vertical piping support and the overhead, horizontal "I" beam.

N.B. Height of the piping supports may be reduced from 18 feet (5.5 m) down to 15 feet (4.6 m) if builders feel they can work with less than standing clearance on the deck.

TASK 5 - Weld Overhead Support Frames

Each support frame for the overhead support steel structure is comprised of two vertical pieces of 21/2-inch(63.5 mm) I.D. pipe and one horizontal 20-ft. (6.1 m) "I" beam, 6" x 6" x 1/4" (152.4 mm x 152.4 mm x 6.3 m). As the width of the support structure is 18 feet (5.5 m), the 20-ft. (6.1 m) long "I" beam is marked for the piping support weld at one foot (304.8 mm) from each end. For convenience, the support frame is welded up on the floor, carefully chocked for level and diagonally measured for accuracy. The two braces are welded into place and the frame is laid flat to await erection. All ten support frames are prepared.

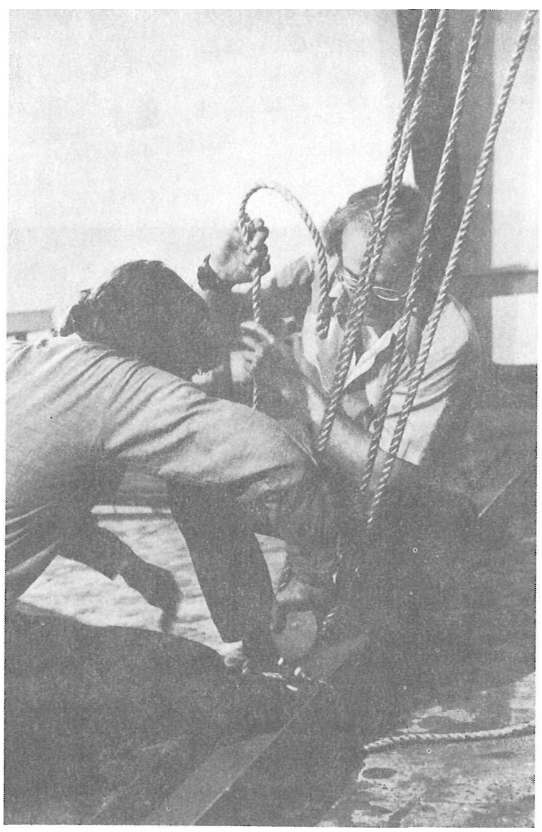


Bolting pipe base plates to wooden base plate.

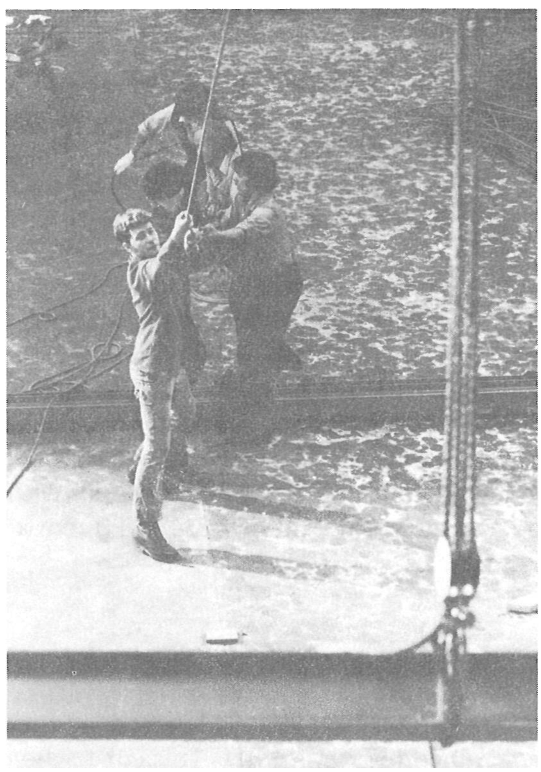
Spacer for use in erection.

TASK 6 — Preparations for Erection of Support Frames

Two "spacers" are made to secure the horizontal "I" beams on the frames temporarily in place when hoisted erect. The spacers are made from lengths of 2" x 4" (50.8 mm x 101.6 mm) lumber with arms nailed to them to hold the "I" beams apart at two-meter (78.6 in.) centers. Other equipment required: block and tackle for hoisting the frames, two-stage mobile scaffolding with locking wheels.



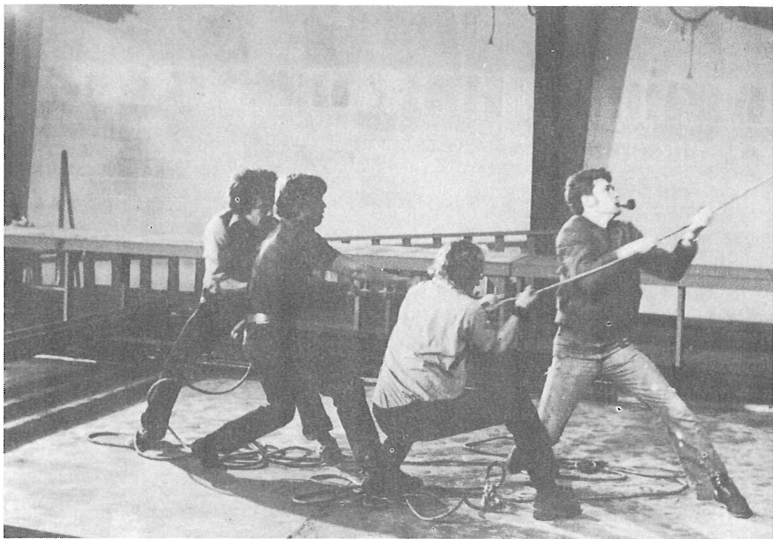
Block and tackle hoist.



A support frame starts to rise.

TASK 7 — Erect Overhead Support Structure

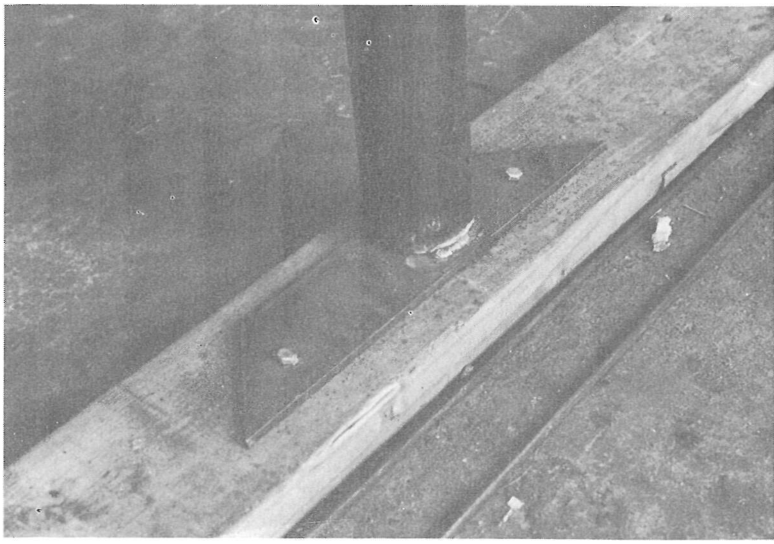
Starting at one end, the support frames are hoisted erect with the block and tackle. The piping supports are not welded to the base plates at this stage, the frame being temporarily braced with 1/2-inch (12.7 mm) diameter rod to the closest external steel structure. The second support frame is then hoisted, temporarily secured with the 2" x 4" (50.8 mm x 101.6 mm) spacers, and braced with 1/2-inch (12.7 mm) diameter rod tacked to the "I" beams and piping. All ten frames are erected and temporarily braced in this manner.



A last heave to bring the frame upright.

TASK 8 - Align and Weld Overhead Support Structure

The support structure is then aligned with string, the flexibility of the 1/2-inch (12.7 mm) diameter rod bracing allowing sufficient measure of lateral movement for adjustment. The two end frames are checked for vertical accuracy with the use of spirit levels and the vertical piping welded to the base plates. The intervening frames are then welded to the base plates after aligning with string and plumbing with a spirit level.



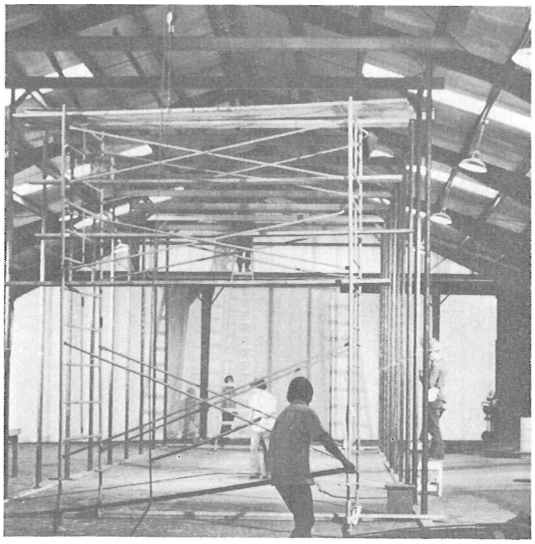
Piping support welded to base plate.

TASK 9 - Weld Channel to Support Structure at Buttock No. 2 Lines

Using a chalk-line, measure and mark a center line running over the top of the overhead support frames.

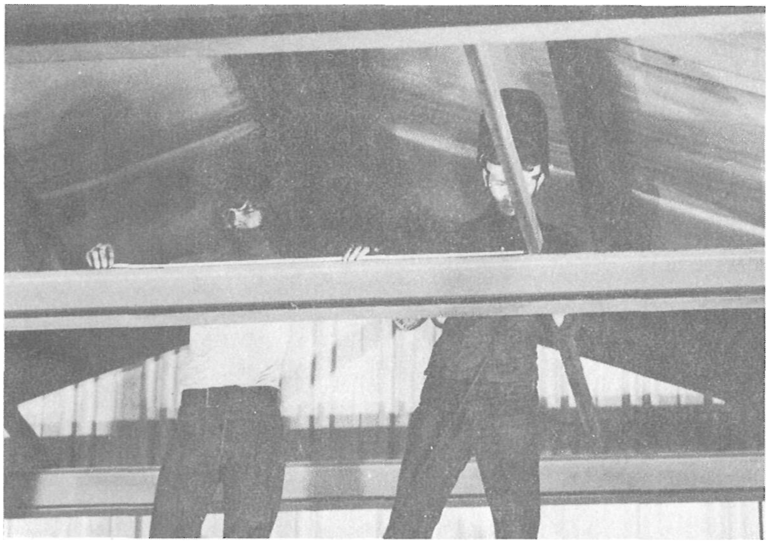
Measure and mark the positions, outwards from the center line of the Buttock No. 2 Lines. Run the chalk-line over the top of the overhead support frames at these two lines.

Lay lengths of three-inch (76.2 mm) "U" channel on the inside edges of both Buttock No. 2 Lines. Butt weld together. Weld to the overhead support frames.

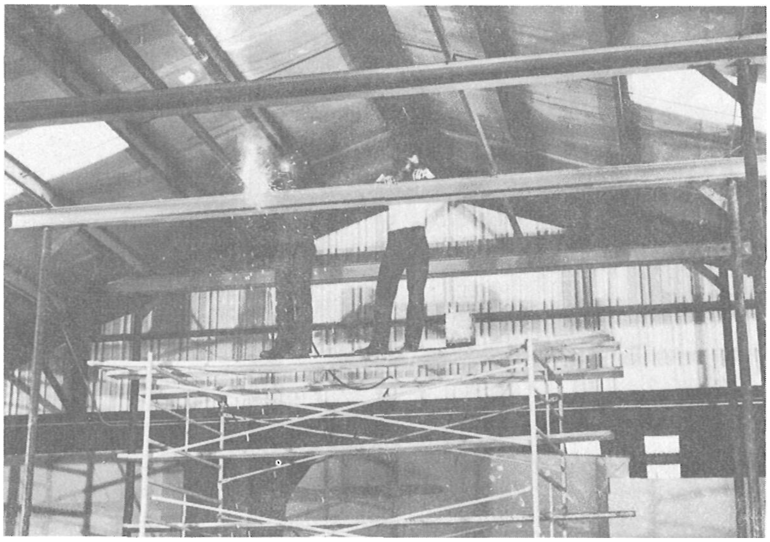


Overhead support frames erected.

Longitudinal girder being laid over the support frame.



Measuring from center to Buttock No. 2.



Welding longitudinal girders to support frames.

Longitudinal channel girder being hoisted.

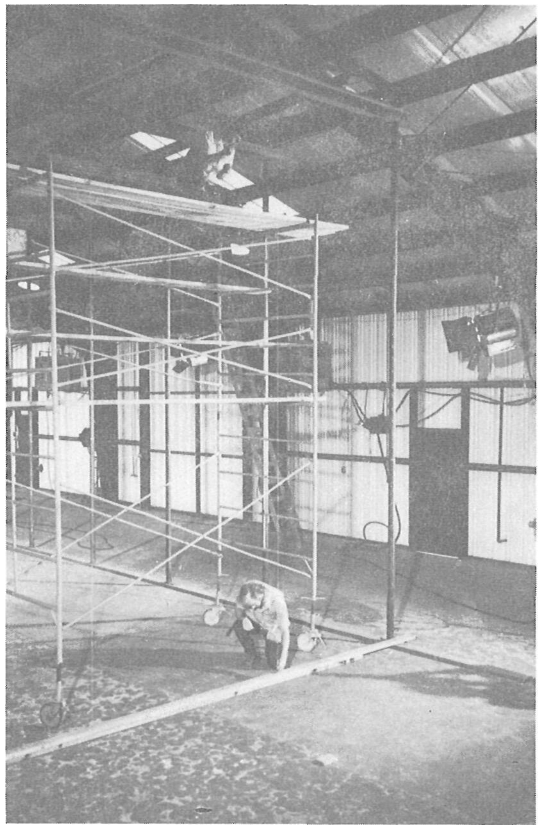
JOB 5 - ESTABLISH BASE AND SUPPORT LINES

TASK 1 - Make Center Line and Buttock No. 2 Lines

These three lines have already been marked at the top of the overhead support structure. (See Job 9, Task 9.)

Nail a length of 2" x 4" (50.8 mm x 101.6 mm) lumber connecting the wooden base plates of the overhead support structure at both ends.

Using a plumb bob, transfer the Center Line and Buttocks No. 2 Lines from the top of the support structure to the 2" x 4" (50.8 mm x 101.6 mm). Mark the wood clearly and title the marks.



Plumbing Buttocks No. 2 Line from overhead support.

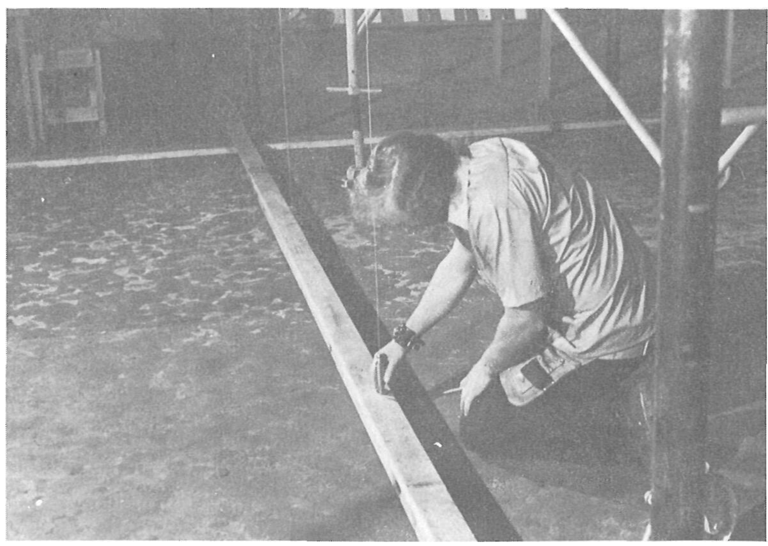
TASK 2 - Mark Water Lines

The use of a transit is essential for marking the water line onto the support structure. A height of 80 inches (2032 mm) from the floor is marked on the closest corner post of the structure, and this same level, whatever the irregularities of the concrete floor, is then transferred to all remaining pipe supports. This line now represents Water Line No. 5 on the lofting floor, the same line on which the athwartship braces run in the welded hull frames. (See Job 3, Task 7.)

Placing Water Line No. 5 at a height of 80 inches (2032 mm) from the floor will give 18 inches (457.2 mm) clearance beneath the keel when the hull hangs in the support structure.

TASK 3 - String the Water Line Around the Four Corners of the Structure

Starting at one corner of the structure, tie a builder's line to the steel piping at the mark of Water Line No. 5 and extend around all four sides following the level marks.

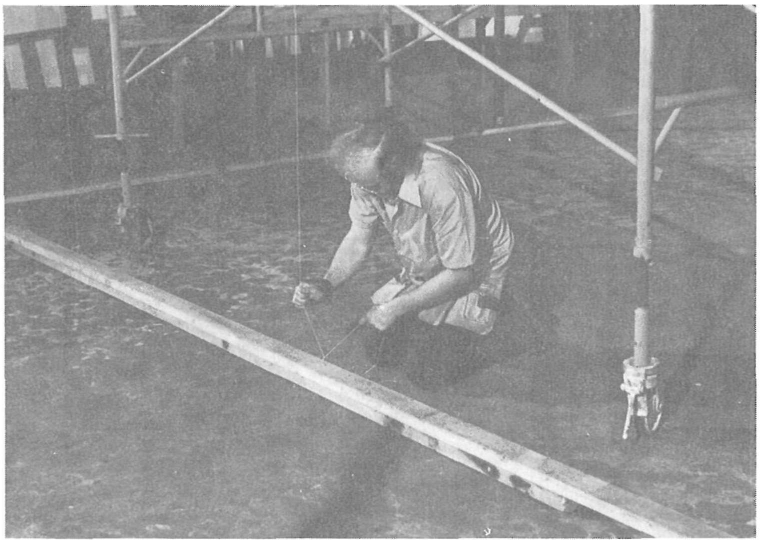


Plumbing center line from overhead support.

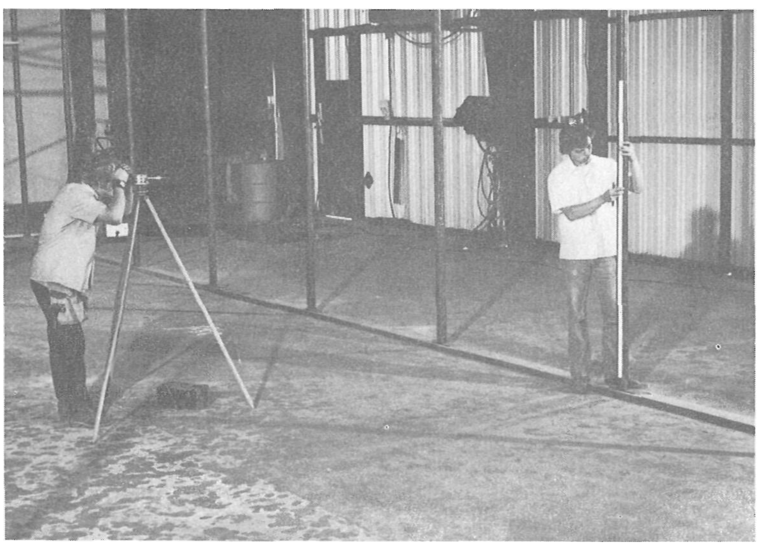
TASK 4 - String Vertical Center Line and Buttock No. 2 Lines

String builder's lines from the Center Line and Buttocks No. 2 Line marks on the floor level 2" x 4" (50.8 x 101.6 m). Run them to the corresponding marks on the top of the overhead support structure at both ends.

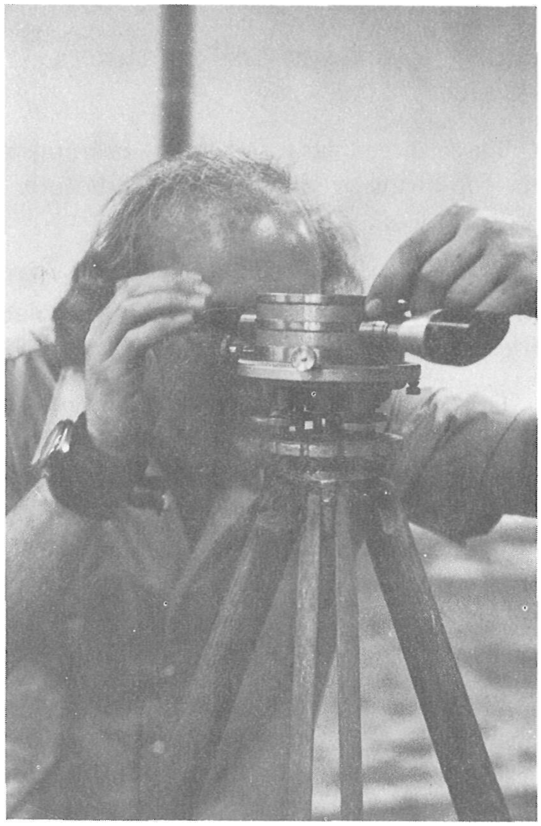
The support structure is now accurately marked to receive the hanging of the hull frames.



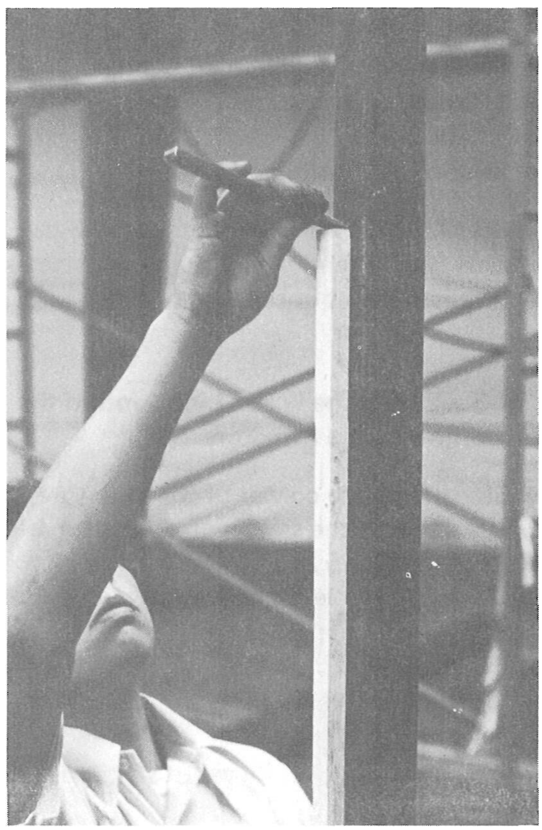
Stringing the Buttock and Center Lines.



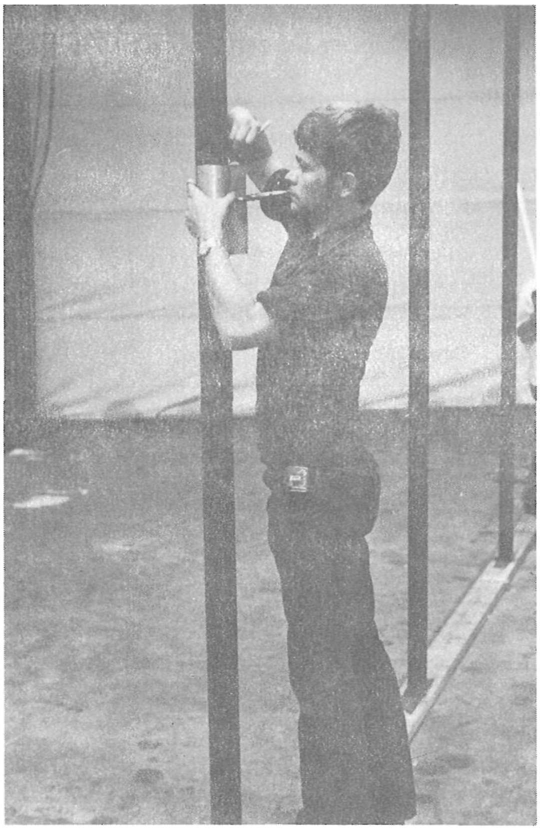
Marking Water Line No. 5 with the use of a transit.



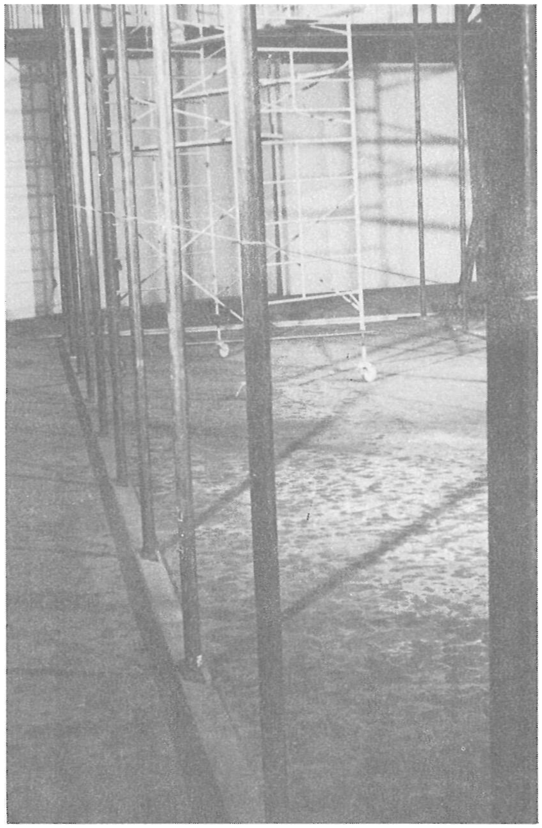
A transit is essential for accuracy.



Piping support is marked.



Water Line No. 5 mark is taken all round with the use of a pattern.



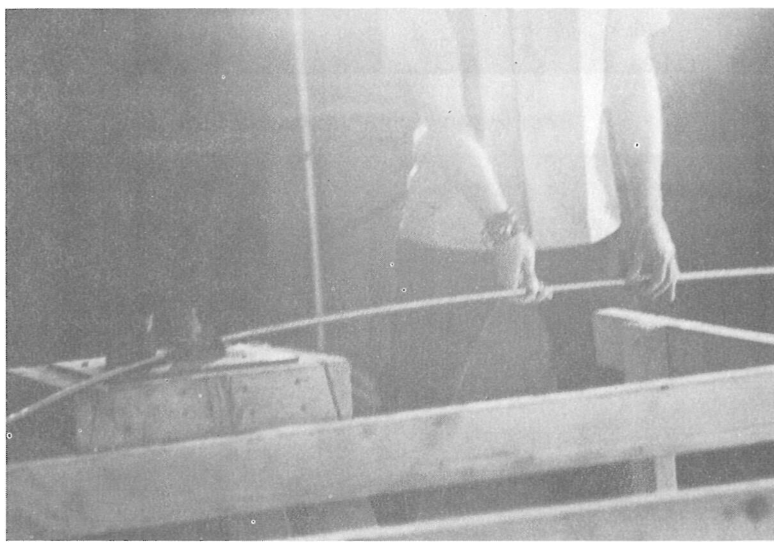
Stringing Water Line No. 5.

JOB 6 - MAKE STEM PIECE

The profile of the vessel was drawn on the lofting floor in Job 1, Task 4. Outlined are the profiles of the stem, the keel and the deadwood section. The same 1/2-inch (12.7 mm) diameter rod is used to obtain these curved shapes as was used on the hull frames. The rod is bent exactly the same way.

TASK 1 - Measure and Cut Stem Piece Rod

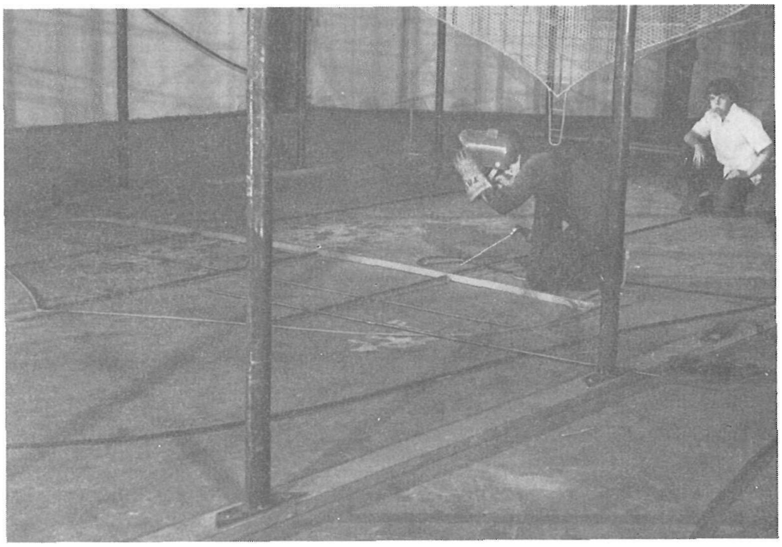
Hammer 21/2-inch(63.5 mm) nails lightly along the line of the stem profile at two-inch (50.8 mm) centers. Measure the length of the stem profile, taking it from rail cap height at the center of the bow down to the straight part of the keel. Cut 1/2-inch (12.7 mm) diameter rod to this required length.



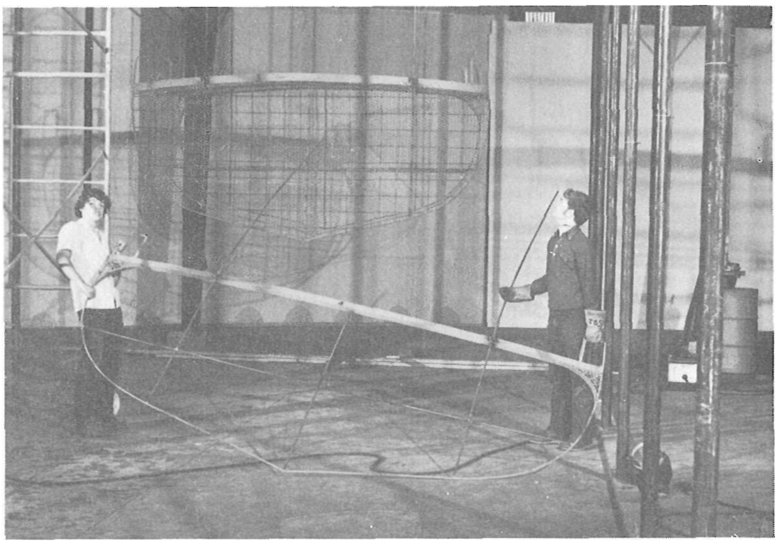
Bending rod for the stem piece.

TASK 2 - Bend Rod to Shape of the Stem Piece

Bend the rod in the jig, in the same way as described in Job 1, Task 10. Check the formation of the curve constantly by laying the rod against the nail pattern on the lofting floor. Ensure that the curved rod lies flat.



Welding upper suspension rods to the deck beam.



Both suspension rods at Buttocks No, 2.

Marking frame positions on the longitudinal girders.

JOB 7 - HANGING FRAMES, FAIRING FRAMES, WELDING STRINGERS

TASK 1 — Cut Upper Suspension Rods to Size

Calculate the height from the deck beam of the midship section to the top edge of the longitudinal channel at Buttock No. 2 Lines on the top of the overhead support structure.

Select straight pieces of 1/2-inch (12.7 mm) diameter rod and cut 48 pieces to size. These rods will be used to hang the hull frames from the longitudinal channel girders on the support structure.

TASK 2 - Weld Upper Suspension Rods to Hull Frames

This task is the conclusion of Job 3, Task 6, where the suspension rods were welded from the lower hull frame to the underside of the deck beam.

The hull frame is now placed on the floor. The end of an upper suspension rod is placed on the deck beam at the Buttock No. 2 mark. The tip of the rod touches the horizontal flat bar section of the deck beam and lies against the vertical section. One man sights down the rod to ensure that it is aligned with the lower suspension rod. The welder welds it in place to the deck beam. Weld all upper suspension rods to the hull frames in this way.

TASK 3 - Mark Hull Frame Positions on Longitudinal Girders

Check with the drawings to establish the spacing of the hull frames, fore and aft. Some are one meter (39.3 in.) apart, others, at the bow and stern, are only 50 cms (19.95 in.) apart.

The spacing of the overhead support frames is set at two meters (78.6 in.). It is important to mark the transom position away from the first transverse "I" beam so that the suspension rods of all subsequent hull frames will not be intercepted by "I" beams. Proceed to mark both longitudinal girders at Buttock No. 2 with the spacings of the hull frames.

Two welders overhead ready for welding the suspension rods to the support structure.

TASK 4 - Weld First Hull Frame to Overhead Support Structure

Two welders and three men are required to carry out this job efficiently.

The two welders station themselves on the top of the overhead support structure. Two men hold the hull frame upright in place, bringing the suspension rods within grasp of the welders overhead. The third man aligns the frames in relation to the reference marks on the support structure.

As has been explained, the following points of reference are already prepared:

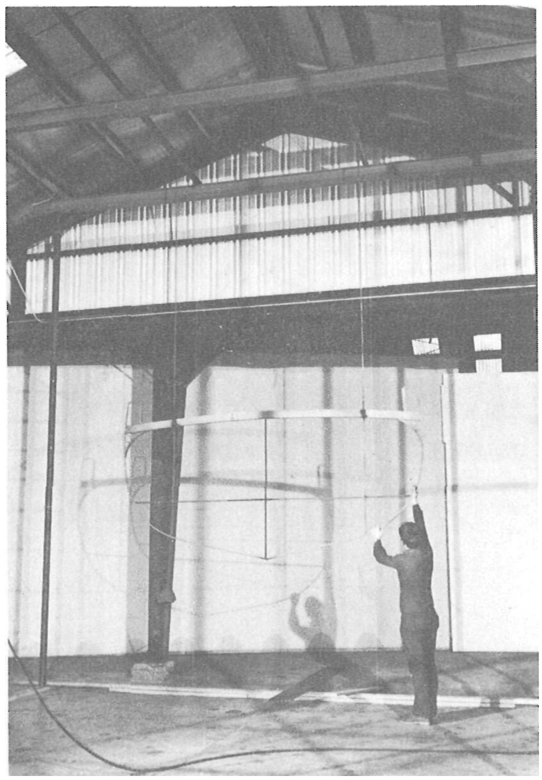
a) The center line is strung at both ends of the structure.

b) The Buttock No. 2 Lines are strung at both ends of the structure.

c) The Water Line No. 5 mark is strung all around the structure.

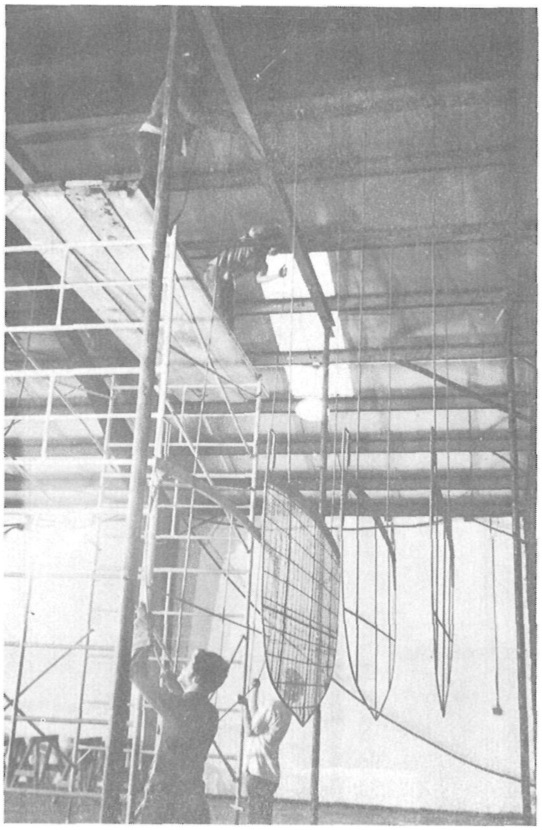
d) The spacings between the hull frames are marked on the overhead longitudinal girders along the lines of Buttock No. 2.

e) Each hull frame carries all the above-mentioned points of reference.



The first frame suspended in place.

Welding the suspension rods to the longitudinal girders.



The fourth frame hung into place.

Two men hold the hull frame in place, the two welders, overhead, secure the suspension rods, the fifth man carefully sights along all four points of reference. As soon as the hull frame is absolutely in line with the reference marks on the structure the order is given for the suspension rods to be welded in place.

The hull frame at Station No. 1 is the first to be welded into position. The transom is to be left until after the hull has been faired.

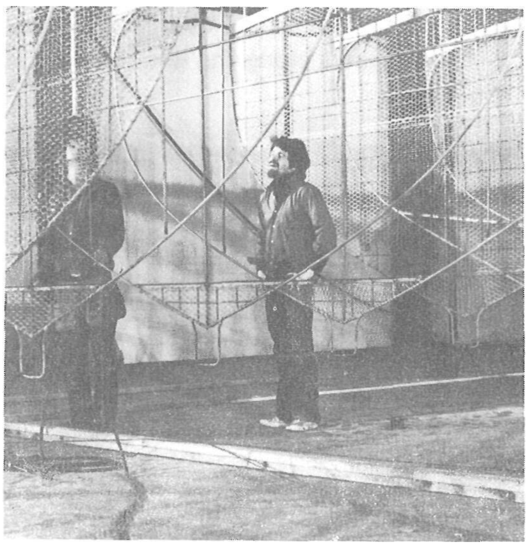
TASK 5 — Weld Remaining Hull Frames to Overhead Support Structure

Proceed forward from Station No. 1 and weld the remaining hull frames in place in the same manner.

At the bow, Station No. 35, 36 and 37 are not wide enough to take the pair of suspension rods at the Buttock No. 2 lines.

For Station No. 35 suspend the hull frame from the bulwark supports.

For Stations No. 36 and 37 suspend the hull frame from a single rod at the Center Line.



Checking alignment.

TASK 6 — Make Alignment Frames for Bow Hull Frames

The hull frames at the peak of the bow, Nos. 37 and 36, are situated above the level of Water Line No. 5. All the remaining hull frames have been sited level in erection using this water line. To ensure that these two small hull frames will be aligned with equal precision as the remainder, a temporary alignment frame is constructed.

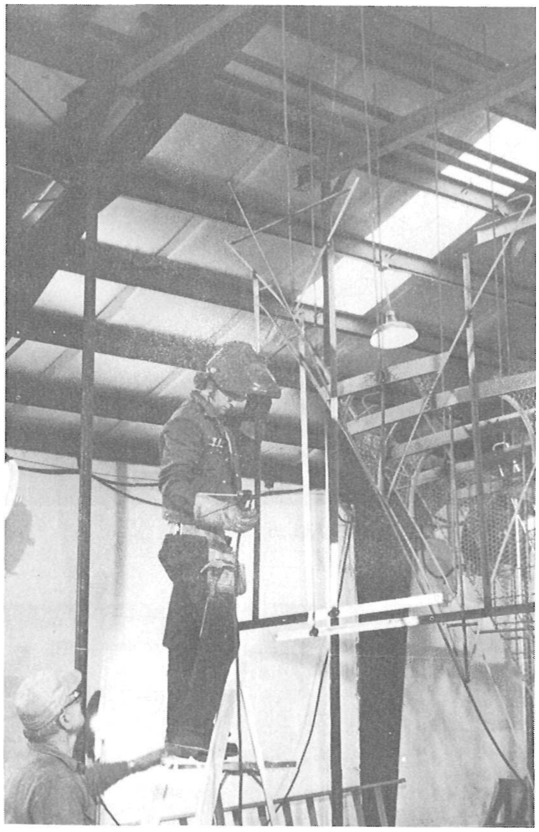
The alignment frames are constructed as follows:

A horizontal piece of flat bar, 1/8" x $1^1/_2$" x 4 ft. (3.1 mm x 38.1 mm x 1.2 m), is used to represent Water Line No. 5. Two identical vertical pieces are welded to the horizontal at a measurement equal to half the beam of the hull frame.

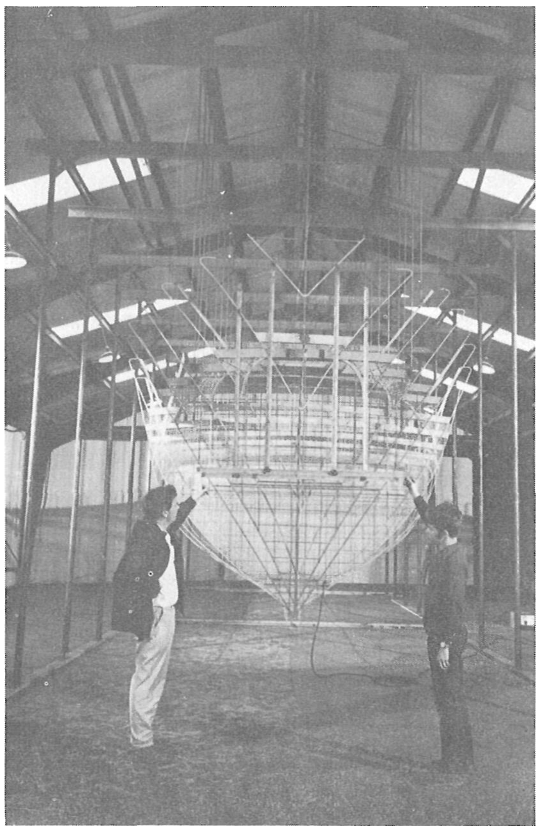
The complete alignment frame is placed flat on the lofting floor, the horizontal arm aligned to Water Line No. 5. The hull frame is placed over the alignment frame, into correct position as shown on the lofting floor, and welded temporarily.

Suspension rods are welded to the vertical arms of the alignment frame and the unit welded to the overhead longitudinal girders in the same way as the remaining hull frames.

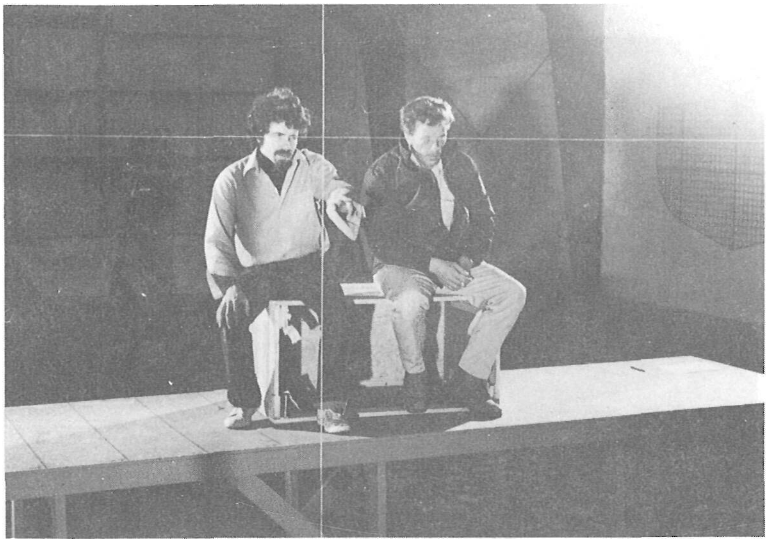
The alignment frames will be cut away once the hull has been faired and the bow adequately braced.



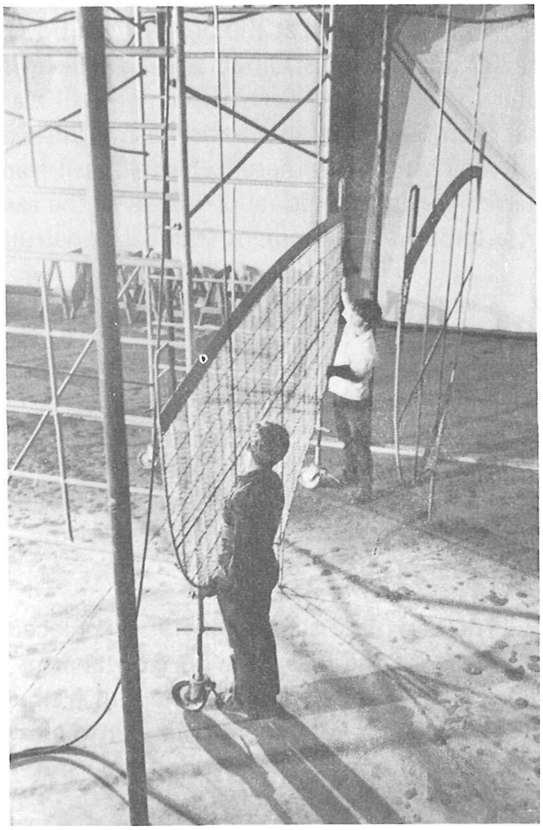
Bow alignment frames welded into place.



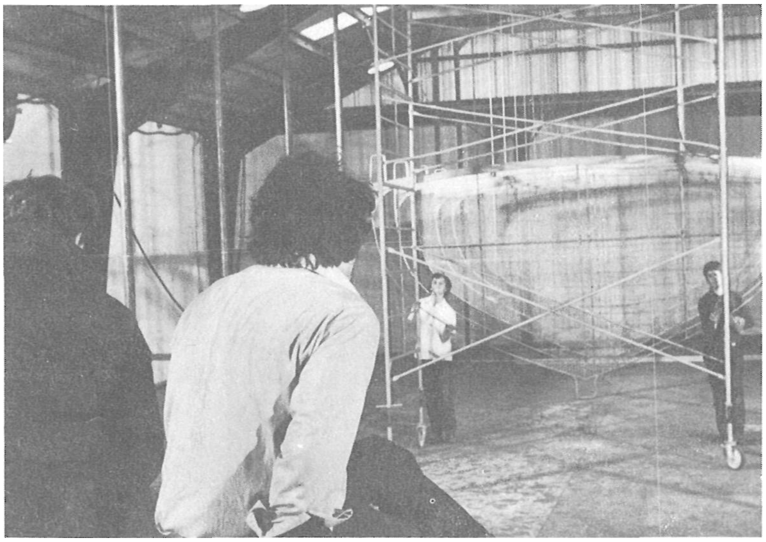
Horizontal arm aligned with Water Line No. 5.



Eyes on Water Line No. 5.



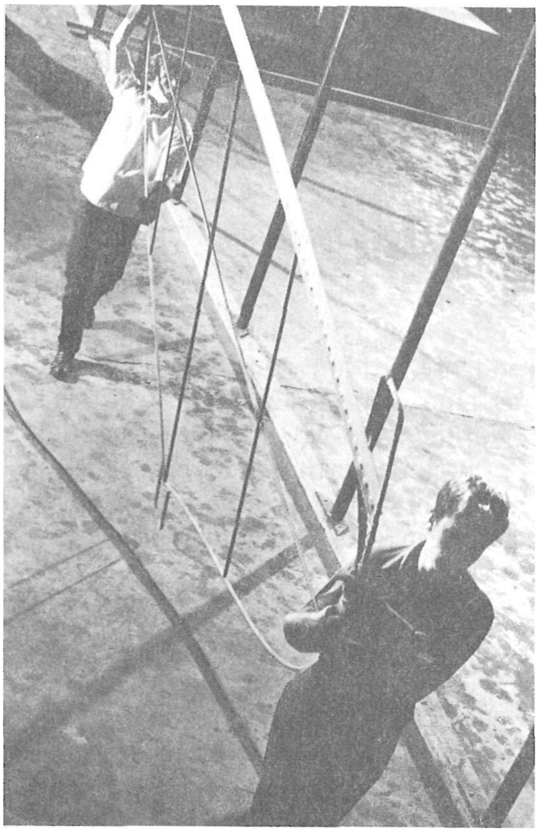
Positioning the hull frame for the men aligning.



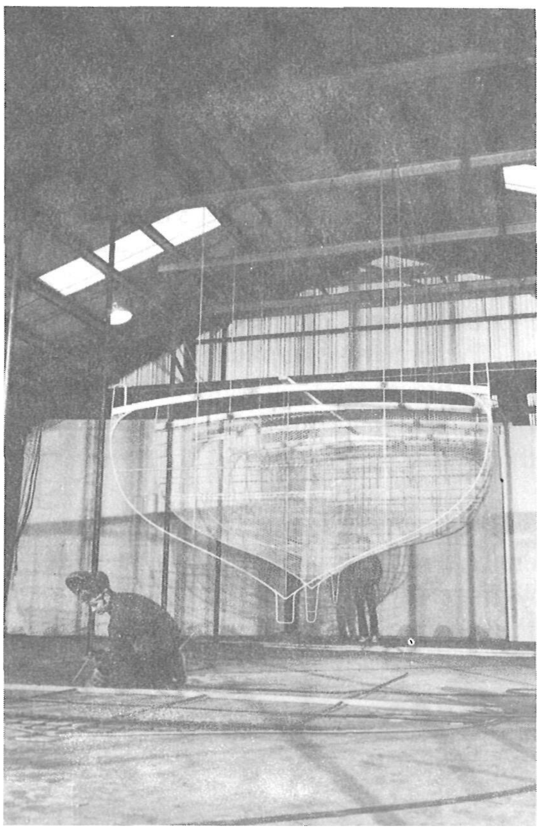
Moving scaffolding forward for the overhead welders.

Checking center line.

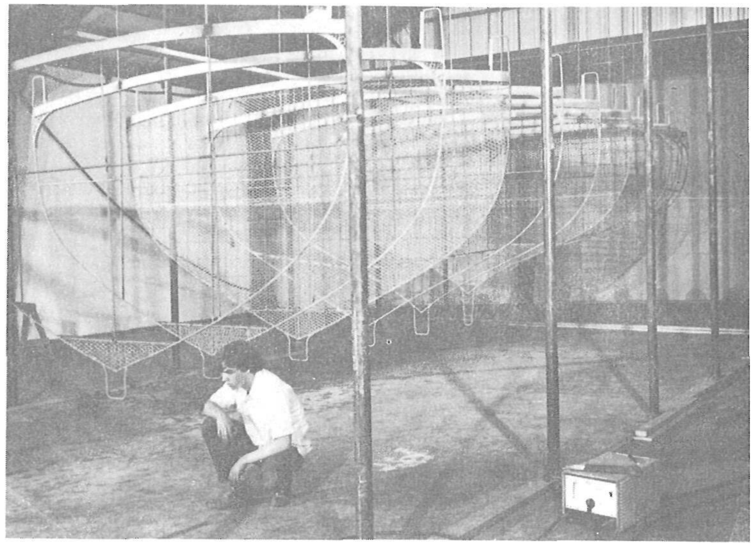
Hull Frame No. 14 is moved up.



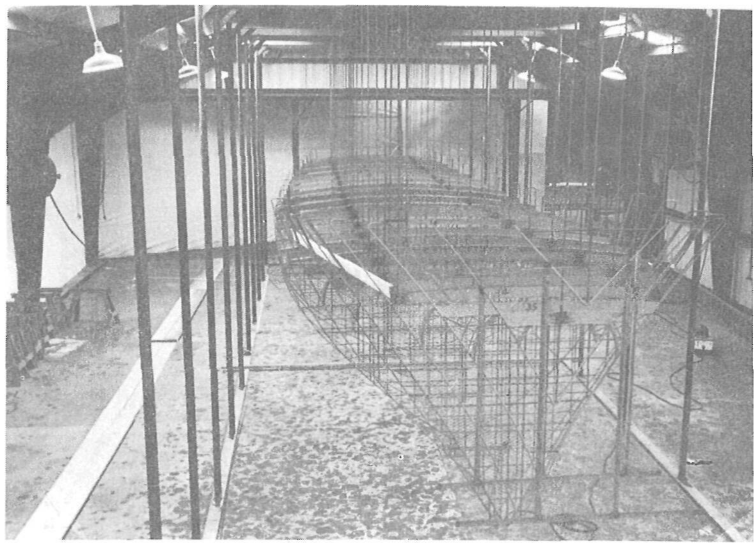
Bringing up another frame.



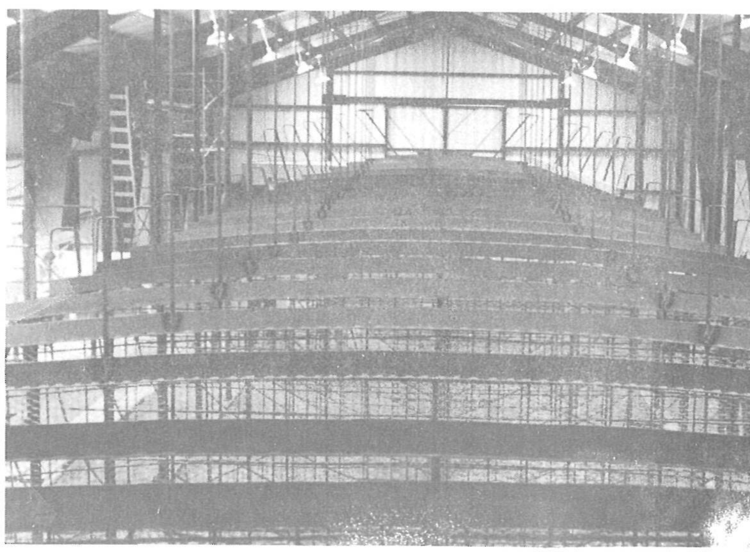
Adjustment to a suspension rod.



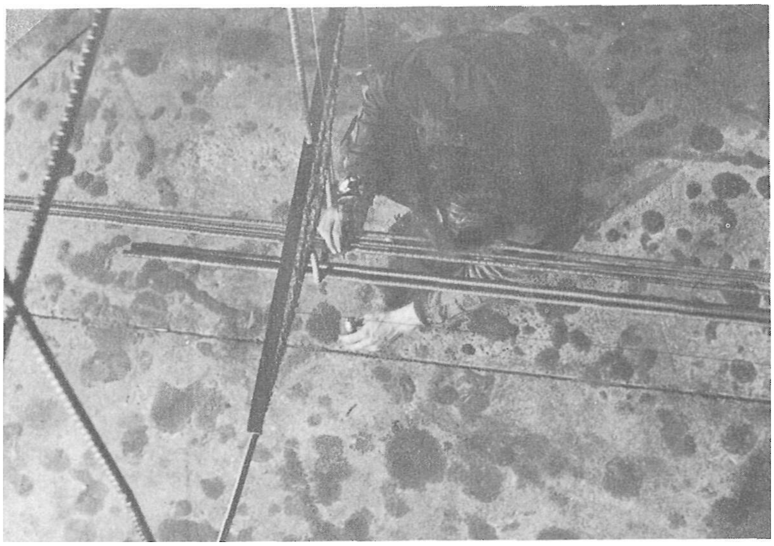
Hull shape begins to emerge.



All frames hanging free.

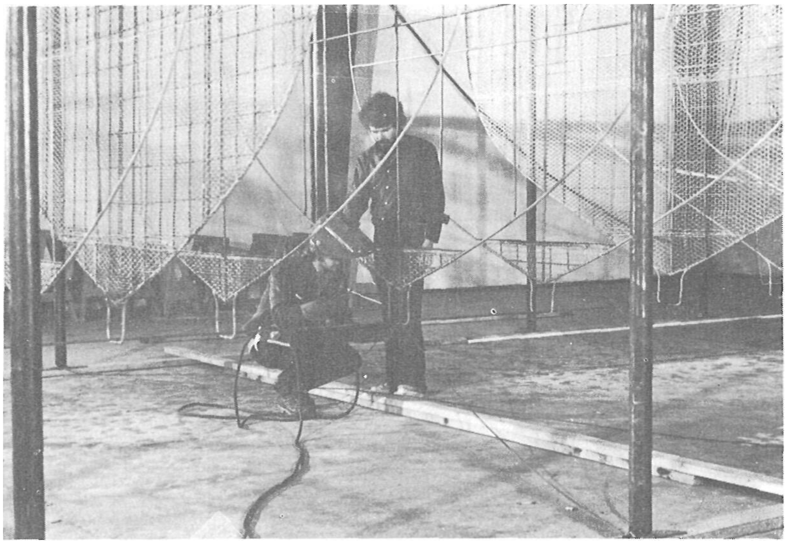


Sighting forward over the deck beams.



Plumbing a hull frame.

Measuring correct spacing between frames.



Temporary bracing to support structure.

TASK 7 - Plumb One Hull Frame and Brace

Suspend a plumb bob down the center line of one hull frame and brace it plumb. With this hull frame secure, other hull frames may be plumbed and braced to it.

TASK 8 — Plumb Remaining Hull Frames and Brace

Cut a length of 1/4-inch (6.3 mm) diameter rod and insert it through the hull frames at the Center Line, just above the keel. Starting at the first hull frame braced, plumb the next hull frame to it. Check by measuring the space between the frames. Spot weld the rod to the frames. Plumb and brace the remaining frames in this manner.

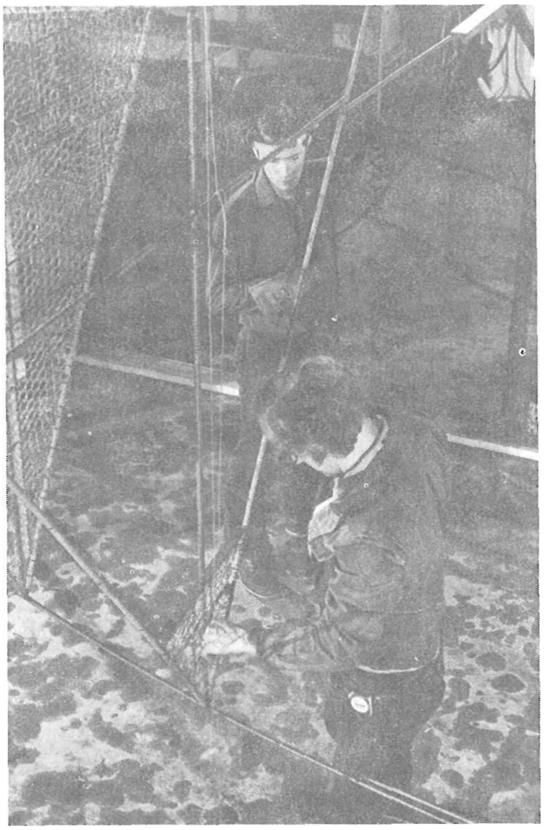
TASK 9 — Temporarily Brace Hull Frames to Support Structure Sides

All the hull frames have been suspended, plumbed and braced fore and aft. The bow, amidships section and stern now require lateral bracing to the support structure. This will give many of the hull frames extra firmness and true alignment before welding on stringers and the keel and the bow reinforcing.

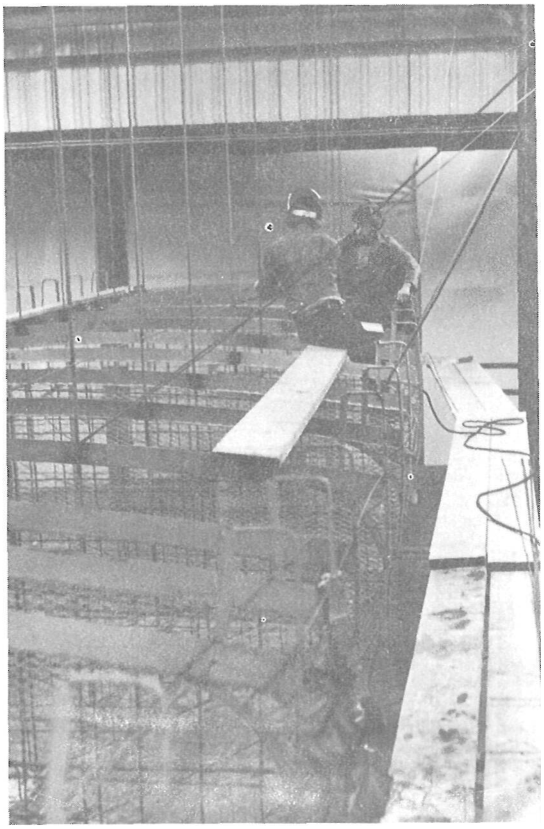
First, a builder's line is strung on the Center Line, a few inches below the keel.

The midships hull frame is held absolutely on center at the keel while diagonal braces of 1/4-inch (6.3 mm) diameter rod are welded from it to the feet of the vertical piping of the support structure. This bracing is duplicated on the other side. Diagonal braces are then welded from the hull frame at rail cap height to the support piping on both sides.

The bow hull frame, No. 37, is then braced laterally, also hull frame No. 1 at the stern, in the same manner. Every hull frame is temporarily braced to the support structure with a single piece of rod at Water Line No. 5.



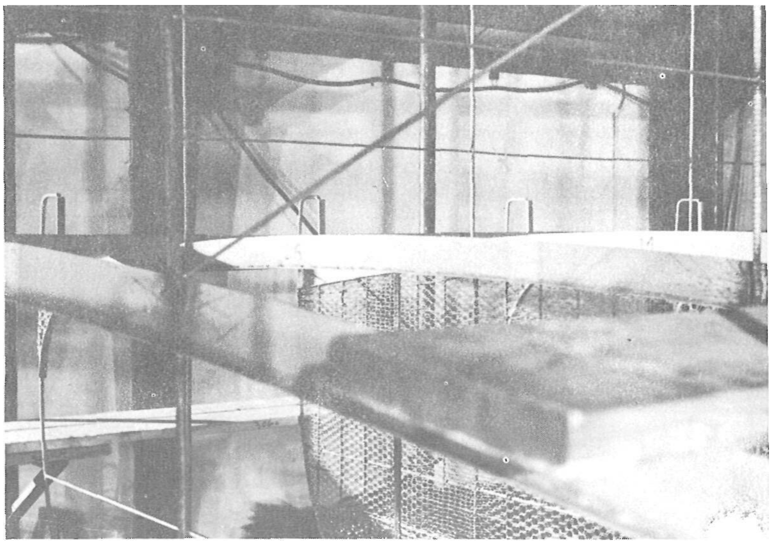
Checking alignment at the bow.



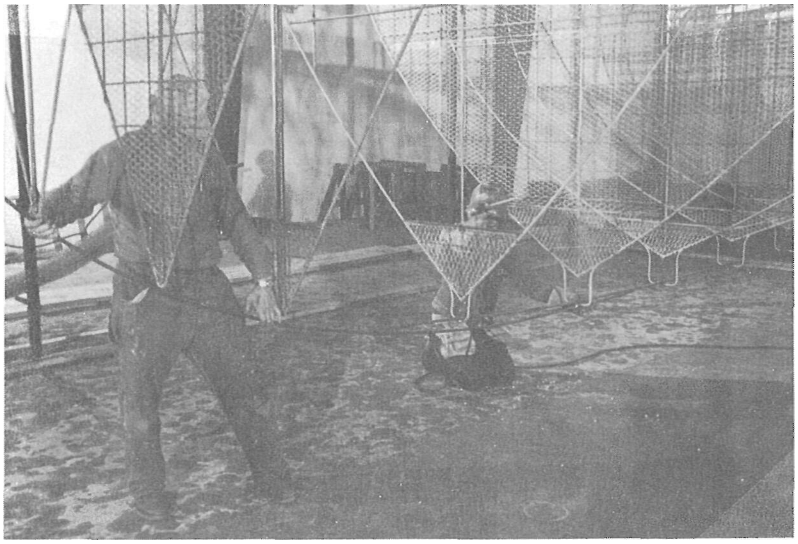
Midships bracing to support structure.

Stringing the keel center line.

Bracing frames at correct spacings.



Temporary bracing at deck beam.

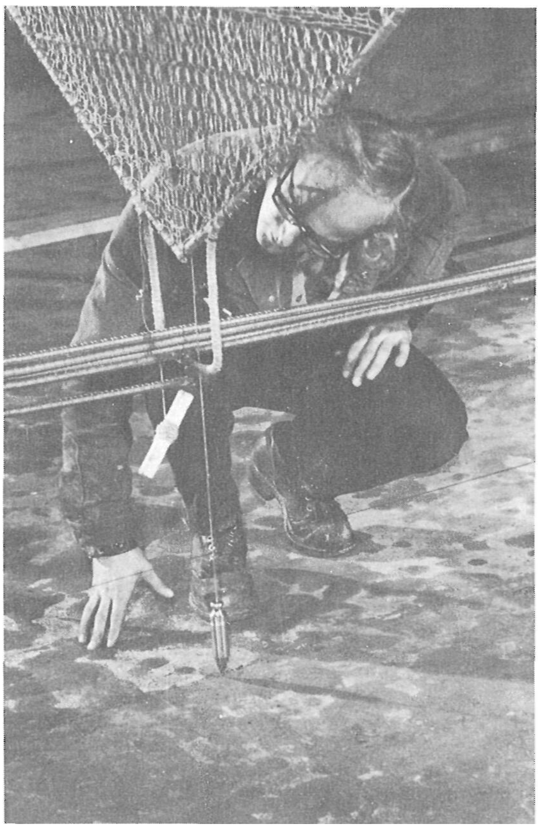


Welding stem-piece rod in place at the forefoot

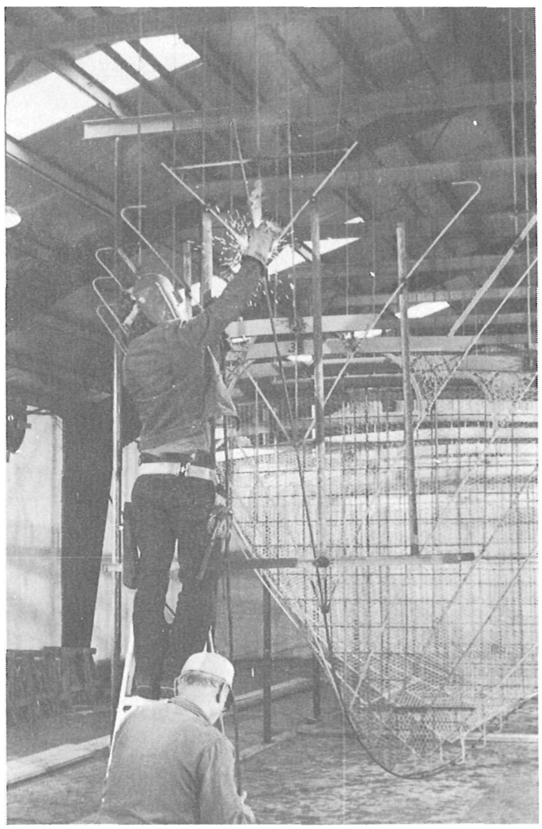
TASK 10 - Weld Stem-Piece to Bow Frames

The cutting and bending of the stem-piece rod was described in Job 6, Tasks 1 and 2. The hull frames, now aligned and braced, are ready to receive the stem-piece. Beginning at Hull Frame No. 37, weld the stem-piece rod to the outside of the lower center points of the forward hull frames. Note that the position of these hull frames have been previously marked on the stem-piece. By sighting with the vertical center line string on the support structure, ensure that the upper part of the stem-piece is being welded plumb.

By sighting along the center line string beneath the keel ensure that the lower part of the stem-piece is aligned.



Aft end of stem-piece rod is plumb on center.

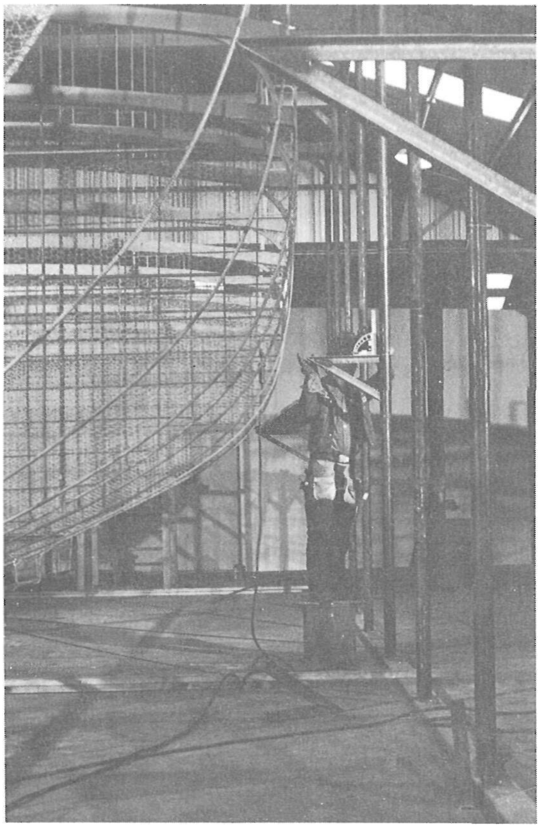


Welding stem-piece to the tip of the bow.

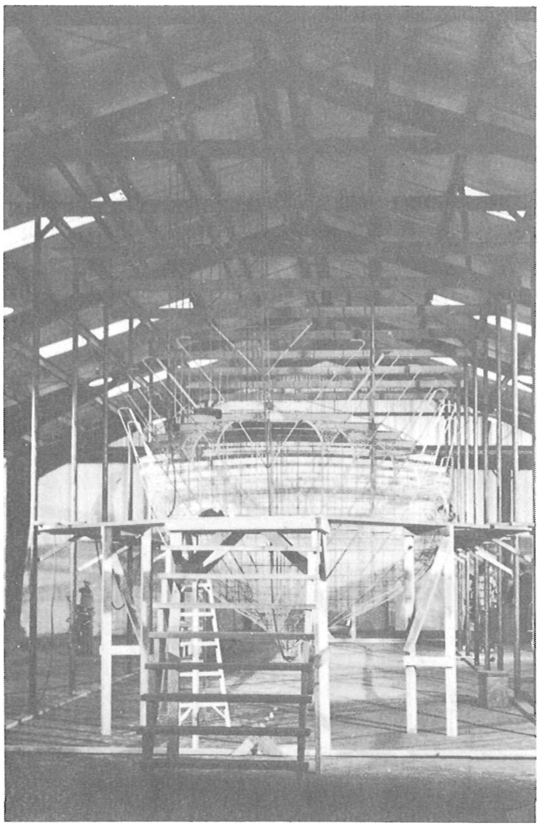
TASK 11 Erect Scaffolding to Support Structure

Scaffolding supports made from 2" x 2" x 1/4" (50.8 mm x 50.8 mm x 6.3 mm) angle iron are welded to the vertical piping of the support structure at the height of Water Line No. 5. This mark was previously made on the support structure in Job 5, Task 2.

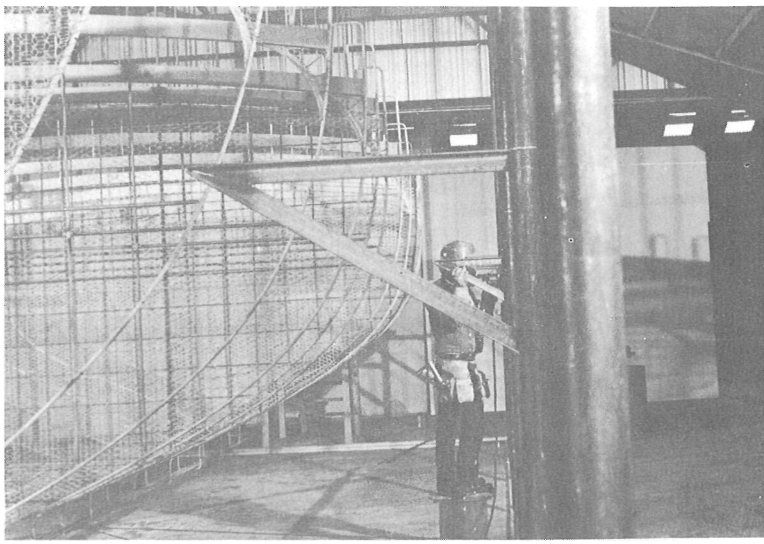
Around the midships section of the hull, the angle iron scaffolding support consists of an horizontal arm, 20 inches (508 mm) long, projecting inwards from the vertical piping. It is supported at its tip with a brace of the same angle iron descending at 30 degrees to the vertical piping. As the hull tapers at bow and stern, the horizontal arm of the support is made longer to bring the scaffolding planks within one foot (304 mm) of the hull. Fourteen feet (4.2 m) scaffolding boards of construction grade fir, 2" x 10" (50.8 mm x 254 mm) in section, are laid in pairs over the angle iron supports completely around the hull. Stout wooden steps are placed at both ends of the scaffolding walk, at bow and stern. There is standing height beneath the scaffolding.



Leveling scaffolding supports.

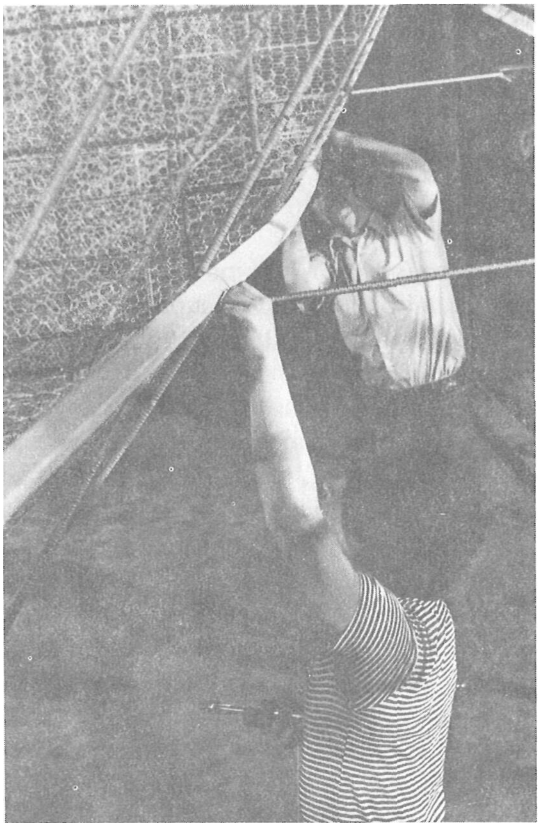


Scaffolding complete with steps at both ends.



Scaffold supports project further at the bow and stern.

JOB 8 - CHECK HULL AND DECK EXTERIOR FOR FAIRNESS



Tying on fairing battens. (Note braces to scaffold supports.)

This is the most critical stage of the construction of a fair hull. It is the hour of proof on the quality of the work which has preceded it. On the lofting first of all; whether the work on the lofting floor has been accurately carried out. Whether the hull frame rods were bent faithfully to the curves described on the lofting floor. Whether any distortion to the hull frames passed unnoticed when the bracing and bulkhead reinforcing was welded into place. Finally, whether the support structure has been welded up true and square and the hull frames suspended in proper alignment.

In Job 7, Task 8, every second hull frame was aligned and laterally braced to stiffen the hull framework in preparation to fairing. If the hull framework is too flexible, the bending of battens to the hull exterior to check fairness becomes an object-defeating exercise. The batten will force a series of hull frames into fair on one side of the hull and exaggerate the situation on the other side. So the hull framework must be braced firmly and, if the batten does reveal a hull frame out of alignment or out of shape, the hull frame brace must be broken and the frame attended to until it comes into fair.

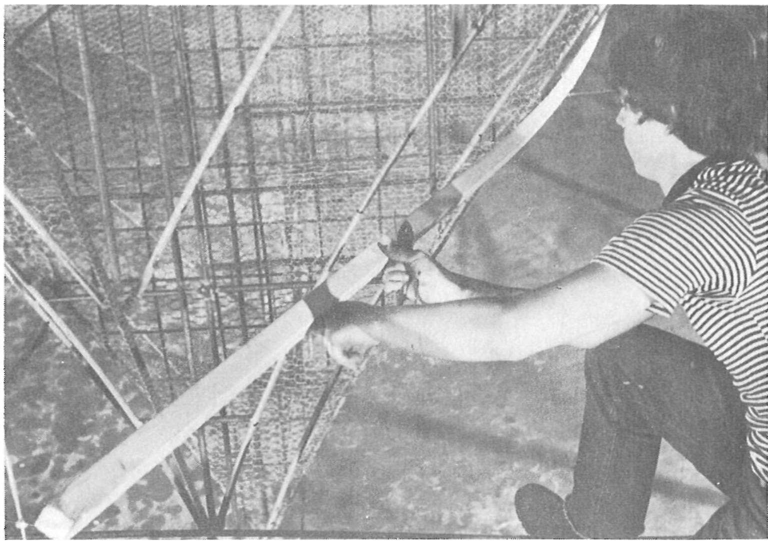
It is worthwhile exercising every ounce of patience and care in eliminating any unfair contours which may appear in the hull frames at this time. Ahead of this stage of construction it becomes too late for correction. Any defect in the lines of the hull will become built in, ultimately cemented in, for all time.

Every frame is tied to the battens.

TASK 1 — Check Hull Exterior for Fairness

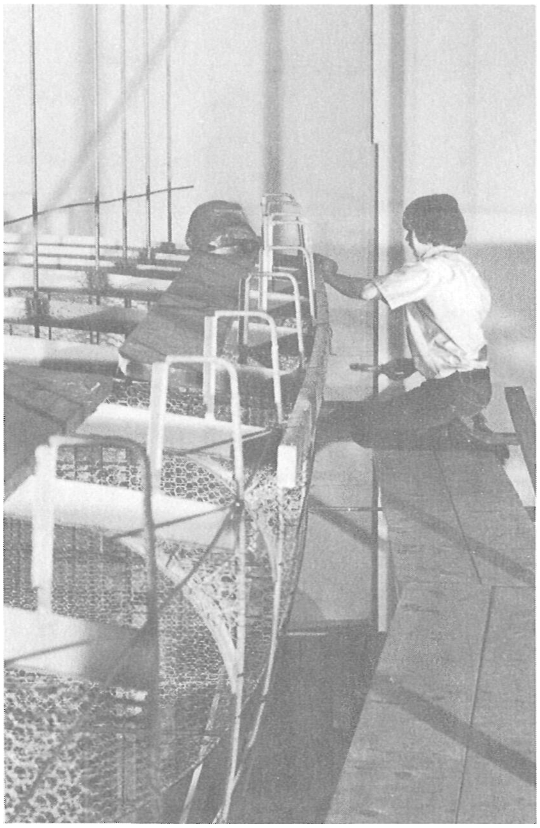
Two men hold up a 20-ft. (6.1 m) fir batten, 1" x 2" (25.4 mm x 50.8 mm) in section, placing its narrow surface against the outside of the hull frames, and sight along the batten to check if any hull frame is slightly out of fair. If out of fair, the hull frame must be broken free from its bracing and either realigned or reshaped, depending upon what is required to bring the hull frame into fair. It is then replaced and braced.

The whole exterior of the hull framework is painstakingly worked over with the batten and all necessary adjustments to the hull frames made. The finer the tolerances worked to, the fairer the hull will eventually be.

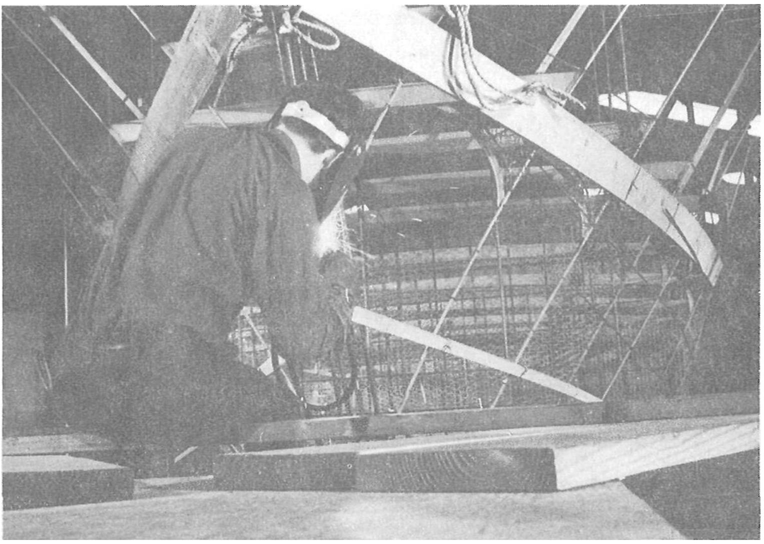


A fair shape at the bow.

Fairing and bracing.



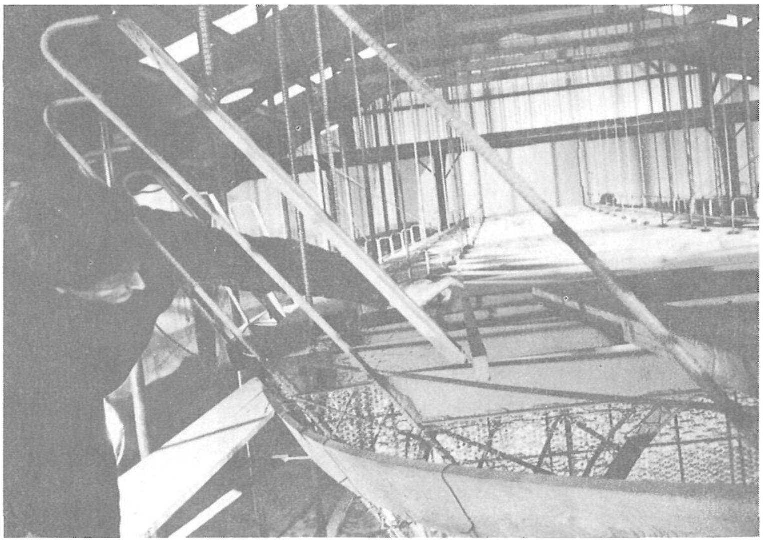
Heavy battens used at the sheer.



Adjustment at the bow.

Sighting down the fairing batten.

Checking the deck shape with boards.



Checking deck camber at the bow.

TASK 2 — Check Deck Exterior for Fairness

The 20-ft. (6.1 m) batten is laid over the deck beams. The deck sheer and camber is checked for fairness. Any deck beams which appear out of alignment are cut from the hull frames and welded into place. Equal care is taken with fairing the deck as with the hull.

TASK 3 - Stem and Keel Reinforcing

Seven reinforcing bars of 1/2-inch (12.7 mm) diameter rod are welded inside the keel sections as longitudinal reinforcing.

Six similar reinforcing bars follow the descending profile of the bow and forefoot to join with the keel reinforcing. (This makes seven stem reinforcing rods altogether, if the stem-piece rod, welded in Job 7, Task 10, is included.)

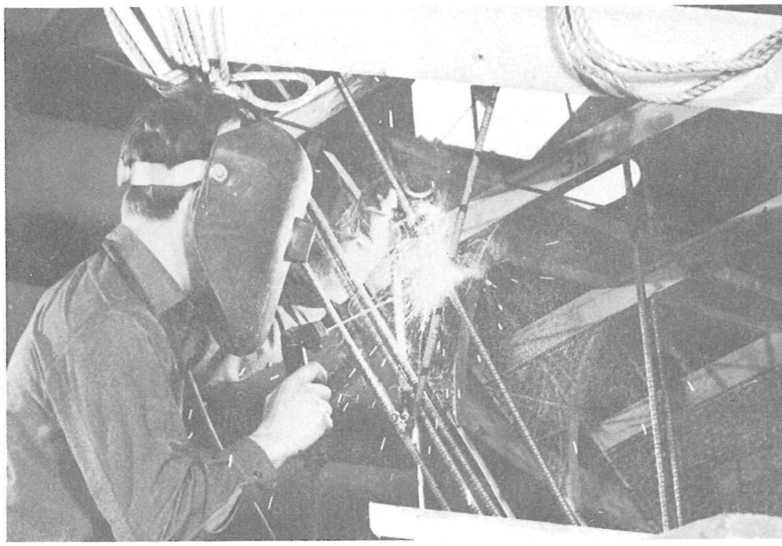
This is the procedure to follow:

1. Lay a length of 1/2-inch (12.7 mm) diameter rod inside the keel section along the center line at the bottom. Align carefully. Lap-weld this length of rod to the aft end of the stem-piece rod. Weld in place to the keel sections and terminate the rod aft at Station No. 10 keel section.

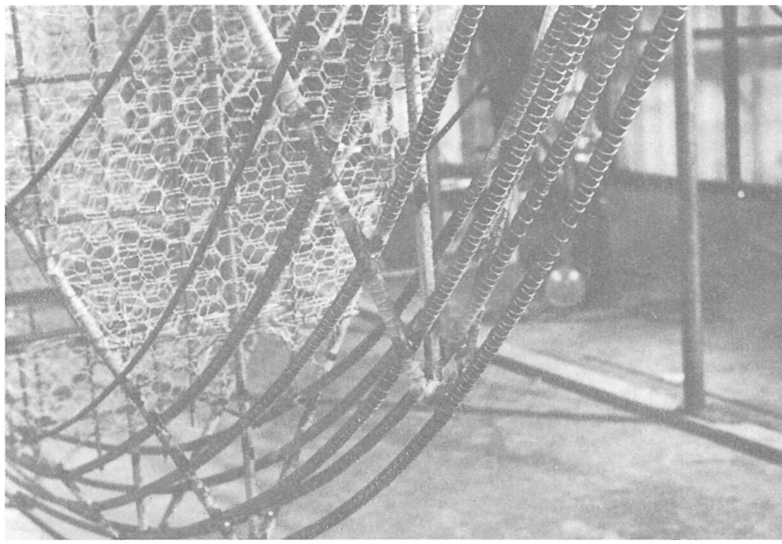
2. Weld a rod at Hull Frame No. 37 at a distance of three inches (76.2 mm) from the stem-piece rod. Allow the start of the rod to exceed the height of the rail cap at the bow. (It will be trimmed later.) Follow the descending profile of the stem-piece rod at a distance of three inches (76.2 mm). Weld to the inside of the bow hull frames. As the reinforcing rod approaches the first of the keel sections it passes inside it to the second keel section. The rod is welded to the interior side of the keel sections at the point immediately above bottom side corner.

   Weld a reinforcing rod in exactly the same way on the other side of the stem-piece rod.

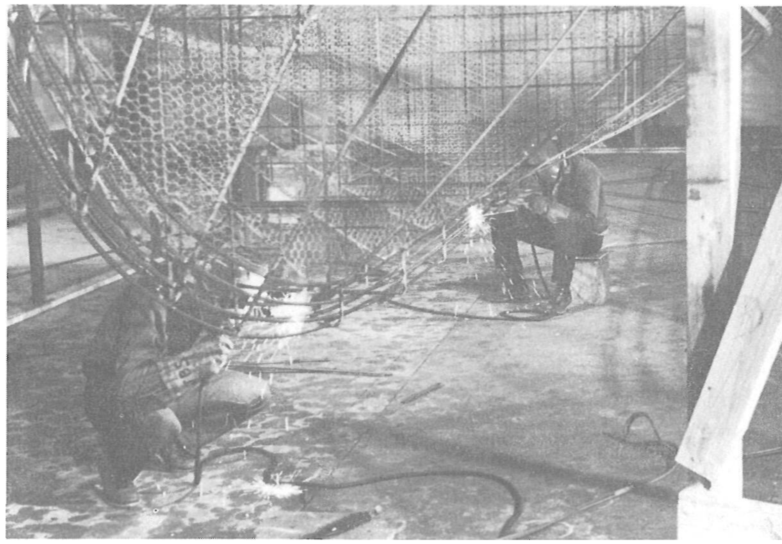
3. An extension is lap-welded to the rod at (par 2) to serve as keel longitudinal reinforcing. The rod is welded to the same places inside the keel sections as described at (par 2). It is allowed to extend for three feet (914.4 mm), unsupported, beyond the keel section at Section No. 8. This process is repeated on the other side.



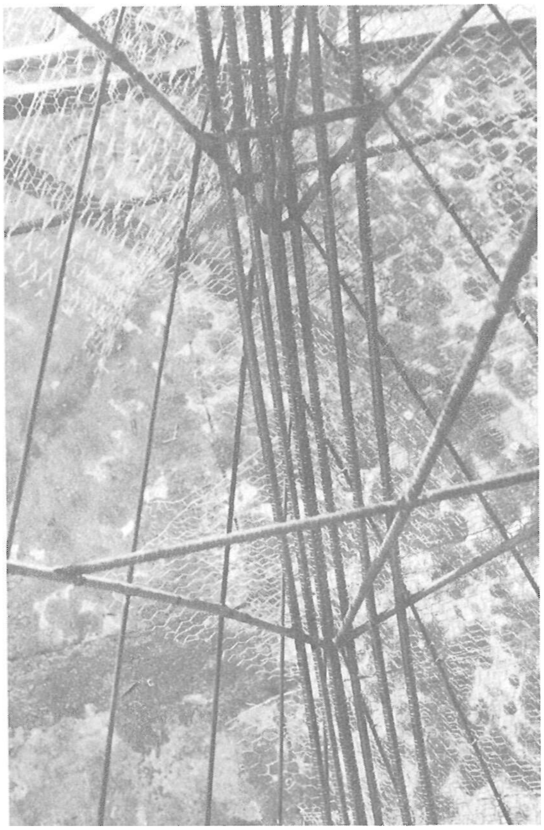
Stem reinforcing rods being welded in place.



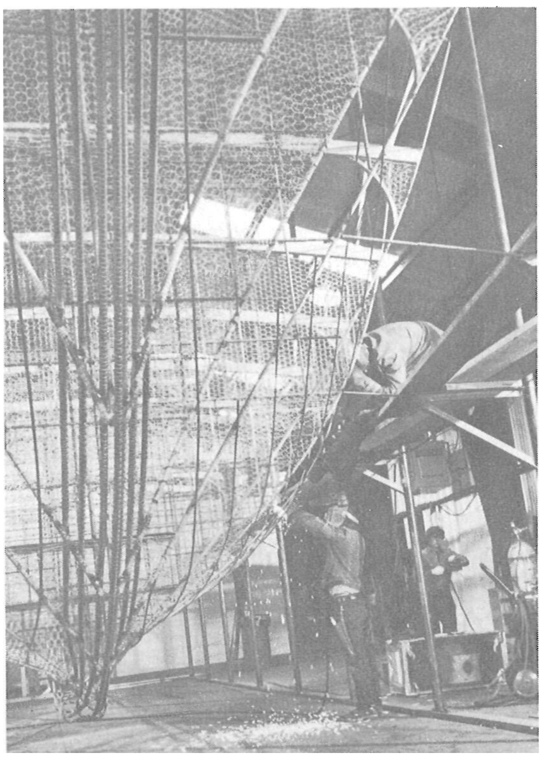
The reinforcing rods follow the profile of the stem-piece rod.



AC work on stem and keel reinforcing.



Stem reinforcing viewed from inside.



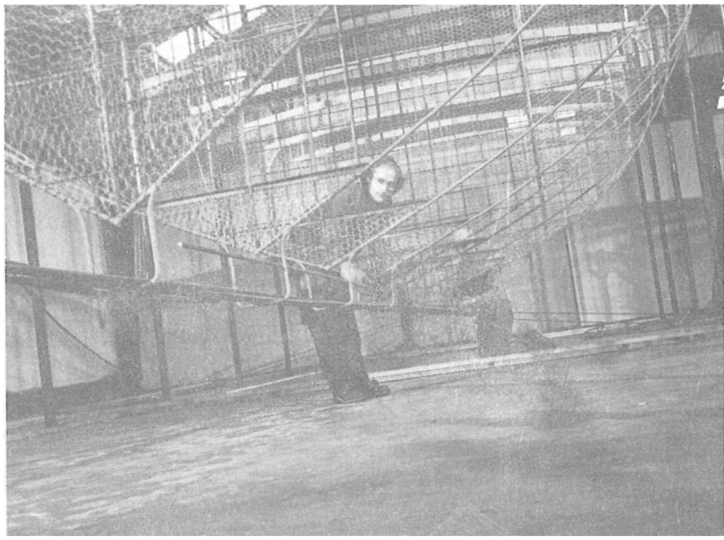
Stem reinforcing from the outside.

Three inches (76.2 mm) aft from the stem reinforcing rod described at (par 2), another rod is welded in the same manner. At a distance of three inches (76.2 mm) it follows the profile of this first stem reinforcing rod. As the rod enters the first two keel sections it is welded at the point: interior side, center.

A keel longitudinal rod is lap-welded to it, following the same weld attachment points inside the keel sections. At Section No. 8 it projects, unsupported, for three feet (914.4 mm). This reinforcing process is repeated on the other side of the hull.

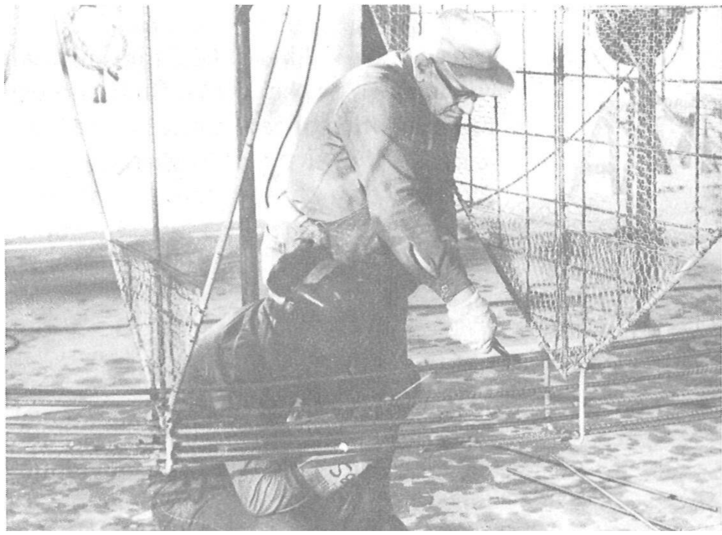
Three inches (76.2 mm) aft from the second stem reinforcing rod described at (par 4) a third rod is welded in place in exactly the same manner. At three inches (76.2 mm) distance it follows the profile of the preceding rod (par 4) to the inside of the first two keel sections. This rod is welded at the point: keel section interior, topside corner. A keel longitudinal rod is lap-welded to it, following the same weld attachment points inside the keel sections. At Station No. 8 it projects, unsupported, for three feet (914.4 mm). This reinforcing process is repeated on the other side of the hull.

In review, it will be seen that seven pieces of 1/2-inch (12.7 mm) diameter rod, three inches (76.2 mm) apart, form the bow and fore-foot reinforcing. The keel longitudinal reinforcing consists of seven pieces of rod as far aft as Station No. 10 where the keel bottom center rod (par 1) terminated. Six reinforcing rods continue, temporarily unsupported, for three feet (914.4 mm) beyond Station No. 8.



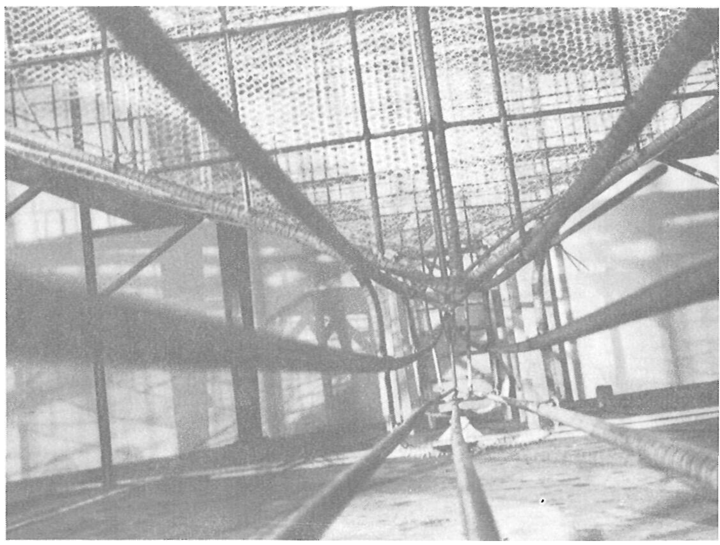
Placing keel reinforcing rods.

Keel section checked for alignment.



Lap-welding stem and keel reinforcing rods.

We/ding rods to inside of keel sections.



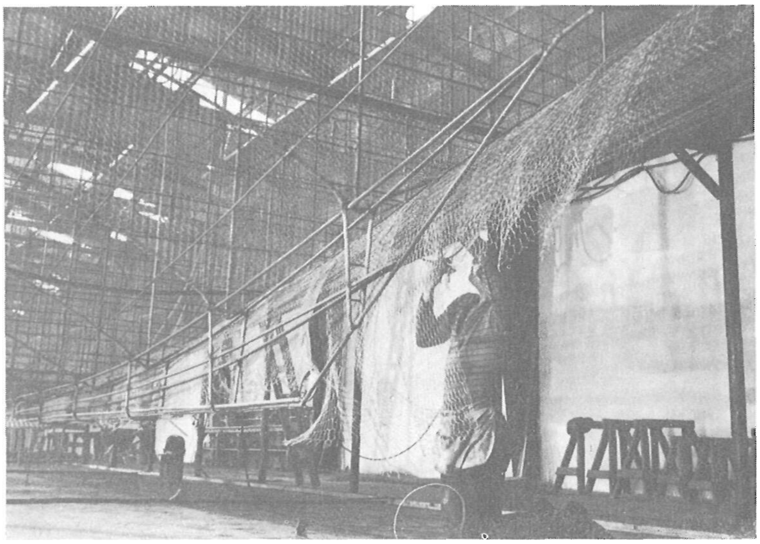
Looking forward through the keel section.

TASK 4 — Keel Deadwood Reinforcing

The six lengths of keel reinforcing which were left projecting from the inside of the keel section at Station No. 8 are now attended to. The object is to shape the deadwood section of the keel. The dimensions are taken from the hull profile lines drawn on the lofting floor. It will be noted from the drawings that this deadwood section is streamlined to a fine trailing edge, a design factor which will lend directional stability to this twin-engined craft when underway. Great care must be taken in construction at this point to ensure that this deadwood reinforcing runs perfectly true. Any deflection built in at this stage will give the boat a tendency to veer.

The following steps describe the construction procedure:

1. A length of 1/2-inch (12.7 mm) diameter rod is taken to the lofting floor and bent to the gentle concave shape of the hull lower profile at the part where it runs forward from beneath the transom to the point where the deadwood section meets.



The keel deadwood reinforcing.

2. The position of the stations is marked on the rod. The rod is cut exactly to the point just forward of Station No. 4 where the deadwood section meets. The aft end of the rod is cut at the point where it will later support the transom.

3. The rod is welded to the bottom center points of the aft hull frames, ensuring that it is in perfect alignment fore and aft.

4. The two uppermost lengths of keel reinforcing rod which were left projecting parallel from the inside of the keel section at Station No. 8 are now brought together at the forward tip of the rod which was welded in Step 3. These two rods are marked and cut, welded together at their ends, and welded also to the bottom of the hull frame at Station No. 6. The welded ends are welded to the tip of the rod welded forward from Station No. 4 in Step 3, the rods so welded forming a narrow "Y" pattern trailing aft when seen in plan view.

5. The distance aft from the keel section at Station No. 8 to the point where the deadwood section rises is measured on the lofting floor. This measurement is transferred to a batten. The batten is held on the keel section bottom center line with the required measurement projecting aft.

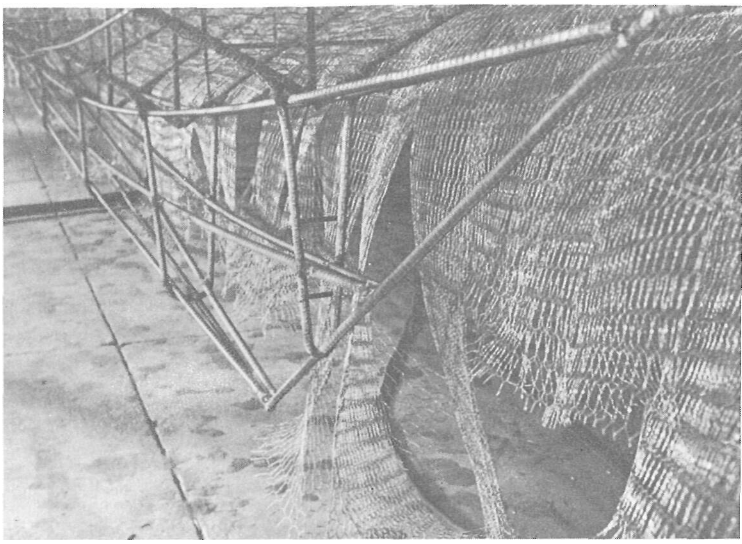
6. The two lowermost keel reinforcing rods which were left projecting parallel from inside the keel section at Station No. 8 are brought together at the measurement marked on the batten. The two rods are marked and cut.

7. The tips of the two rods are welded together exactly on the center line.

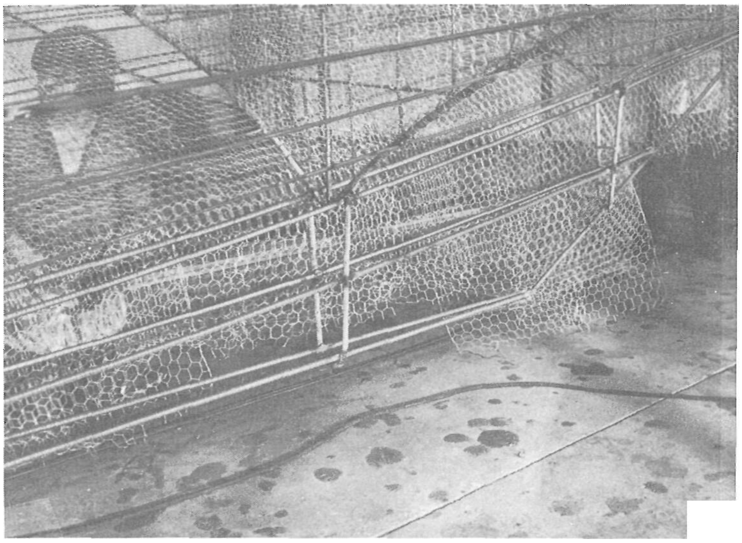
8. A straight piece of rod is marked and cut to form the trailing edge of the deadwood section. This single rod connects the tips of the joined rods described in Step 7 to those described in Step 4. The angle is shown on the lofting floor.

9. The two middle keel reinforcing rods left projecting parallel from the inside of the keel section at Station No. 8 will now be brought together at the single rod forming the trailing edge of the deadwood section. The point of meeting chosen is that which divides the deadwood area in half. Consequently, the two rods describe a curve upwards from the keel towards the hull, to the point where their tips are welded together at the trailing edge rod.

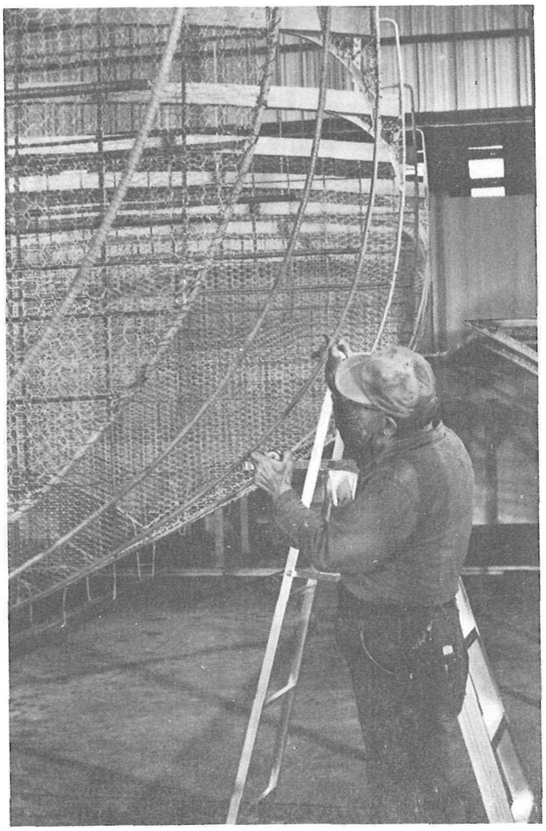
The hull framework, faired, braced and complete with spacer rods and transom, is now ready to receive the first four layers of mesh.



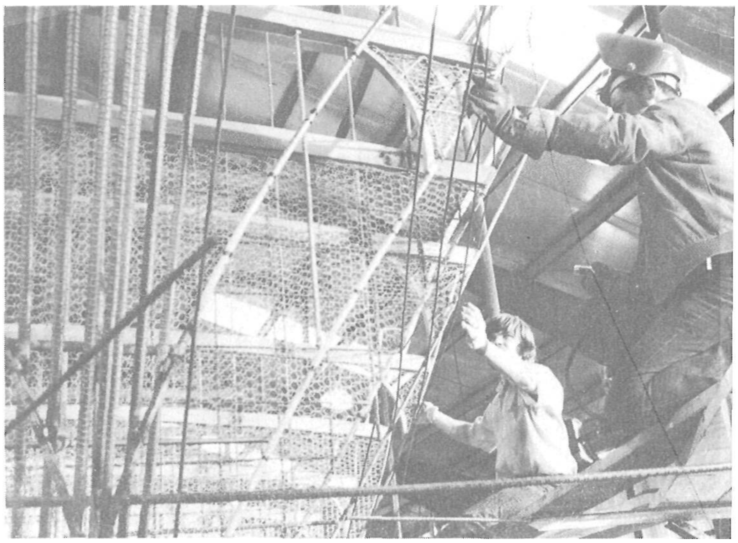
The fine trailing edge of the deadwood reinforcing.



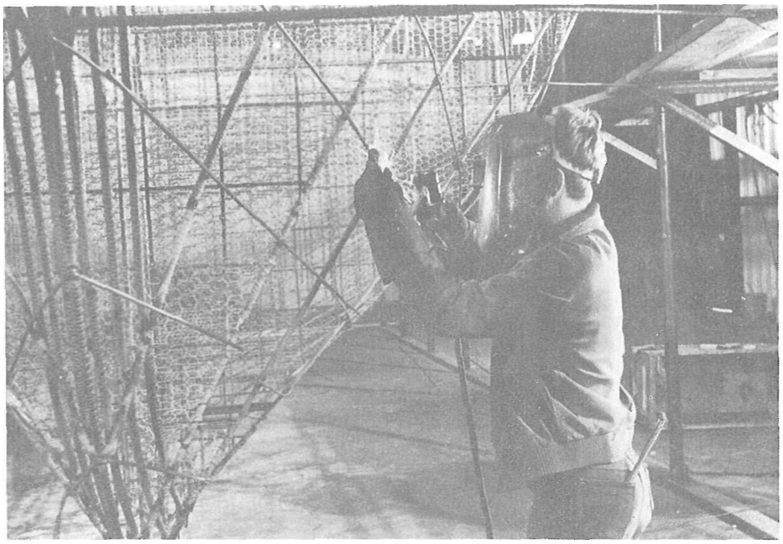
Note tapering and upward sweep of the reinforcing rods.



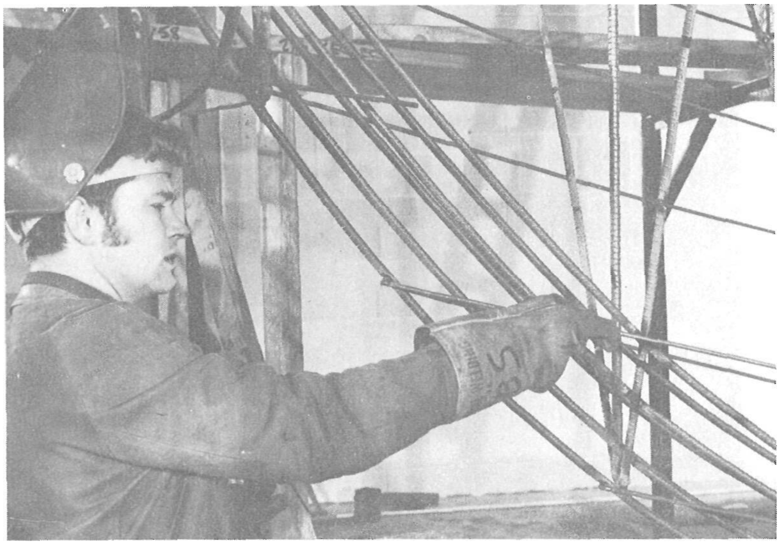
Measuring spacer rod positions.



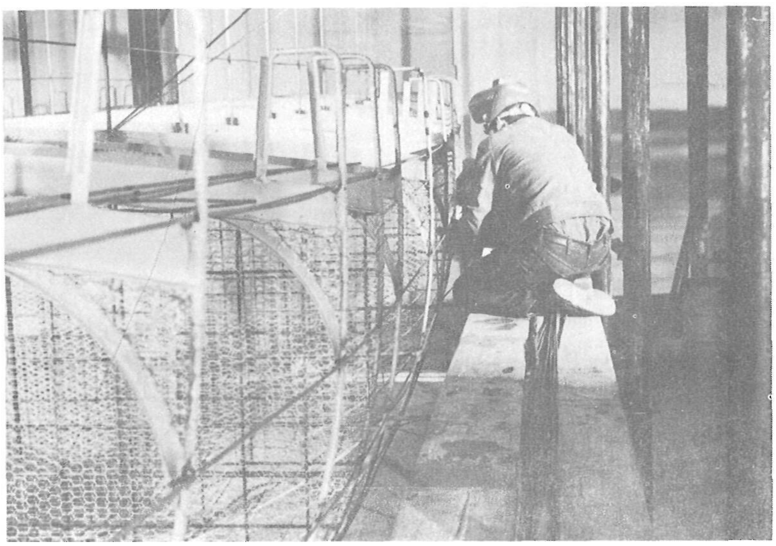
Welding spacer rods in place.



Spacing between the longitudinal rods narrows at the bow.



Spacer rods terminating at the forefoot.



Welding spacer rods amidships.

TASK 5 - Weld Longitudinal Spacer Rods to Hull Frames

Straight 20-ft. (6.1 m) lengths of 1/4-inch (6.3 mm) diameter rod are provisionally wired, then welded, longitudinally, to the outside of the hull frames. Rod joints are lap-welded. The first rod is welded at the deck sheerline. The procedure is then as follows:

1. At the amidships section hull frame a measuring tape is run over the outside of the hull frame from the rod running at the deck sheerline to the uppermost longitudinal keel reinforcing rod. [See Stage 2, Job 1, Task 3, (5).] This distance is then divided equally into ten parts and each division marked with chalk onto the frame. Working fore and aft from this amidship hull frame the remaining hull frames are divided and marked into ten divisions with the exception of the bow hull frames Nos. 34 to 37 which are too small for this purpose.

2. Starting at the amidships section hull frame, 1/4-inch (6.3 mm) diameter rods are welded to the hull frames at the marked spacings as described in (par 1). Because of the hull taper at the bow the spacings of the rods at Hull Frames Nos. 34 to 37 are narrowed. Some of the lower spacer rods terminate at the curved forefoot of the bow.

Note that the spacer rods are left to run wild at hull frame No. 1 to provide support for the transom. The full purpose of these preliminary spacer rods will become apparent on progressing to the fastening of the first four layers of mesh and the application of the longitudinal reinforcing rods.

TASK 6 - Weld Transom in Place

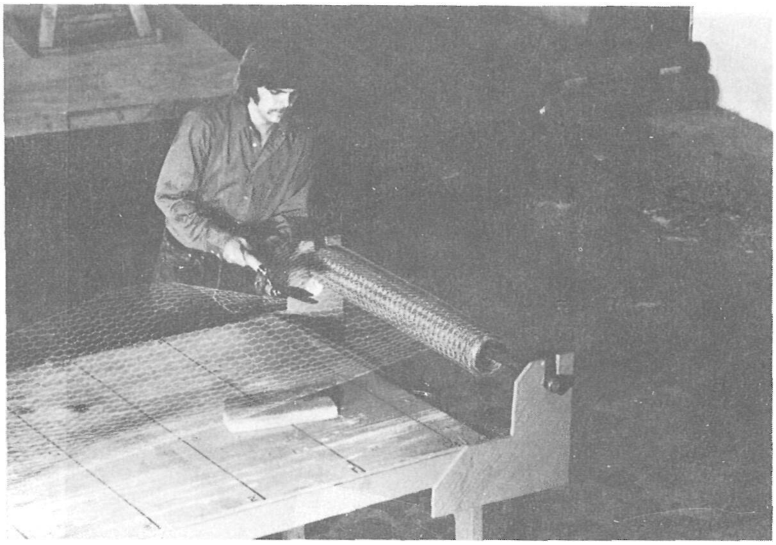
The forward-inclined transom is welded to the hull framework. The transom received its reinforcing grid of 1/4-inch (6.3 mm) diameter rods in Job 3, Task 10. Unlike the bulkheads it has not been meshed in advance.

The measurements for the exact siting of the transom are taken from the lofting floor. The transom is held in place and welded into position with a temporary bracing of 1/2-inch (12.7 mm) diameter rod. The fairing of the transom is checked with the use of battens. Once correctly aligned and faired, the transom is welded to the hull framework by means of the hull spacer rods and the 1/2-inch (12.7 mm) diameter rod running aft from the base center point of Station No. 4.

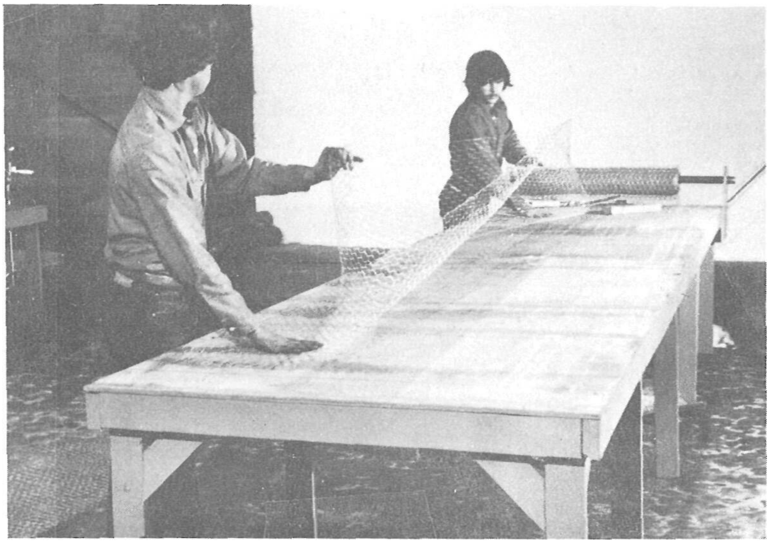
Fairing battens used to align position of transom.

Note concave shape of hull beneath the stern.

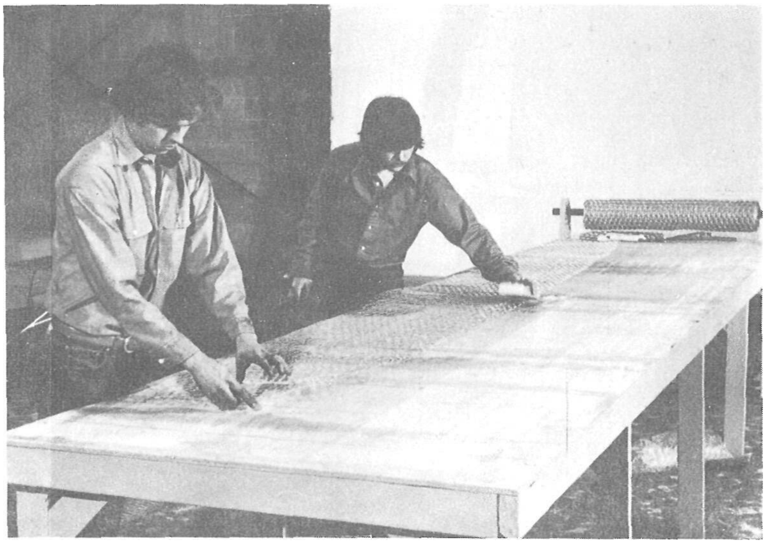
The transom temporarily braced in place.



The mesh is pulled out from the roll to the required length and cut with shears.



The strip of mesh is folded double.



777e fold in the mesh is pounded flat.

STAGE 2 - JOB 1
APPLYING RODS AND MESH

TASK 1 - Make Mesh Folding and Cutting Bench

A bench is made up for folding and cutting mesh. The bench surface is comprised of two sheets of 1/2-inch (13 mm) plywood, 4' x 8' (1,220 mm x 2,440 mm) giving the bench an overall length of 16 feet (4,880 mm). The bench supports are made from 2" x 4" (45 mm x 90 mm) lumber.

The surface of the bench is marked at every foot (300 mm) of its length with a straight line inked across it. The distance of each line from the end of the bench where the roll of mesh is to stand is marked clearly in feet. This will enable the mesh folders to cut the strips of folded mesh at whatever length they need at a glance.

The rolls of mesh are rotated on a length of pipe supported at one end of the bench and the mesh drawn out over the bench top as required. For convenient working the bench height is placed at three feet (915 mm).

TASK 2 - Fold and Cut Mesh

Two men work at the bench, one on each side, one man withdrawing the mesh to the required length marked on the bench top, the second man cutting the mesh with garden shears. The length of cut mesh is then simply folded double lengthwise, the fold being flattened with a piece of wood or pipe. Some quantities of folded mesh strips may be prepared in advance. The mesh used is 1" (25 mm) by 20 gauge hexagonal mesh, galvanized after weaving. The roll is 36 inches (915 mm) wide and 150 feet (45 m) long. When folded, the mesh strips are 18 inches (457 mm) wide.

TASK 3 — Applying First Four Layers of Mesh to the Hull

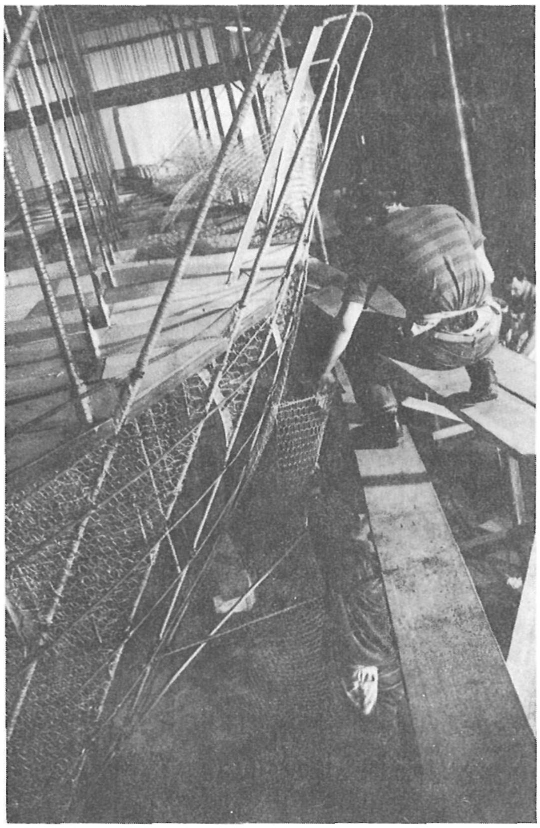
Beginning at the midships hull frame, a length of folded mesh is hung perpendicularly and clipped with hog ring staples to the spacer rod running at the deck sheer. Six inches (153 mm) of surplus mesh are allowed to run over at the deck sheer. (Later, this six inches (153 mm) of mesh will be folded over to merge with the deck mesh reinforcing.) This folded strip of mesh, secured at the deck sheer spacer rod, is then grasped firmly but without excessive tension and is laid over the hull spacer rods down to the keel. The hull frame rod is used as a center line guide for the 18 inches (457 mm) wide folded strip of mesh. The mesh is fastened with hog ring staples to the hull spacer rods only at those points where gravity tends to pull the mesh away from the rods, the idea being to use the staples as economically as possible at this stage. At the keel the mesh is trimmed away following the line of the lower reinforcing bar in the keel section.

The second folded strip of mesh is fastened in the same way to the deck sheer spacer rod leaving a six-inch (153 mm) surplus above. This time, however, the folded strip of mesh is laid over half the width of the first strip of mesh. The same hull frame rod which was used previously as a center line guide, now being used as a guide for the edge of this second strip of mesh. It is fastened lightly with hog ring staples and trimmed at the keel in the same manner as the first strip of mesh applied.

Strips of folded mesh are applied leading forward in this same way, each 18 inches (457 mm) wide strip lapping a nine-inch (229 mm) width of the preceding strip. In this way, as the strips of mesh are double and fully lapped, four layers of mesh are applied. At the same time, strips of mesh may be applied leading aft, over-lapping the first laid strip of mesh by nine inches (229 mm) as has been described.

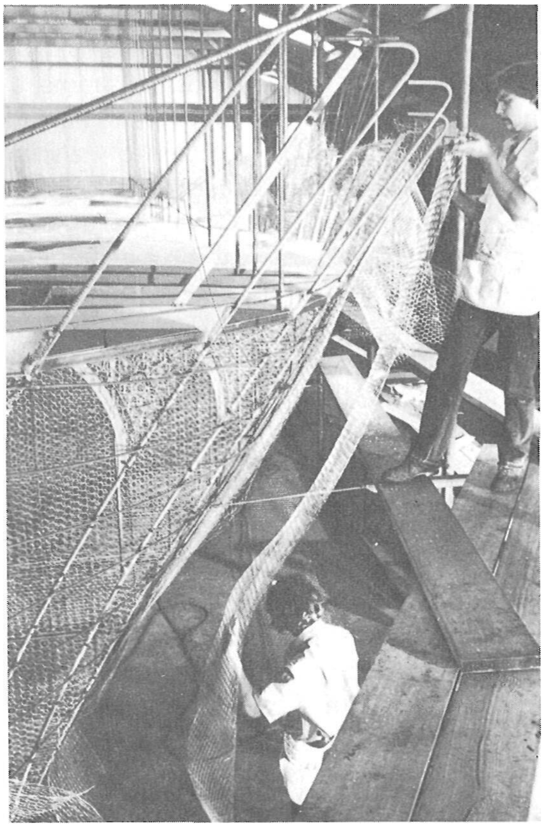
A second team of meshers may start work on the opposite side of the hull following the same procedure.

Care must be taken to ensure that not too much tension is pulled on the strips of mesh, especially in the one-meter wide spaces between the hull frames. Here the 1/4-inch (6.4 mm) diameter spacer rods tend to be forced inwards, imparting an undesirable hollow in the hull surface areas between the well-faired frames.

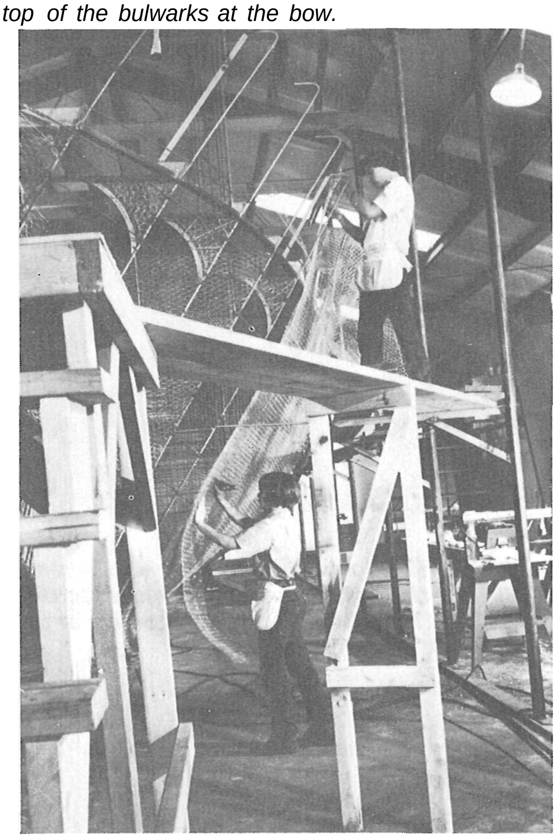


Working forward from the amidships section the first strips of mesh are fastened to the hull framework. Note surplus mesh at the deck sheer line.

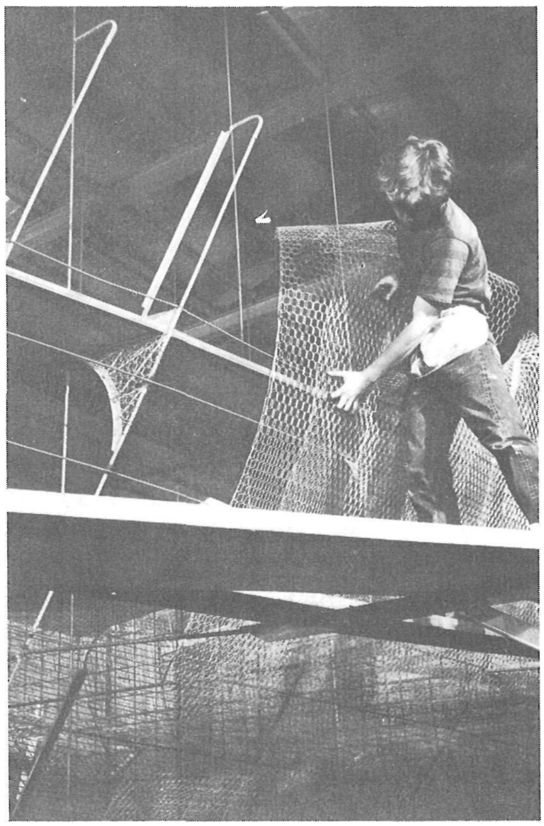
The mesh is cut long enough to reach the top of the bulwarks at the bow.



The mesh fasteners work in pairs.

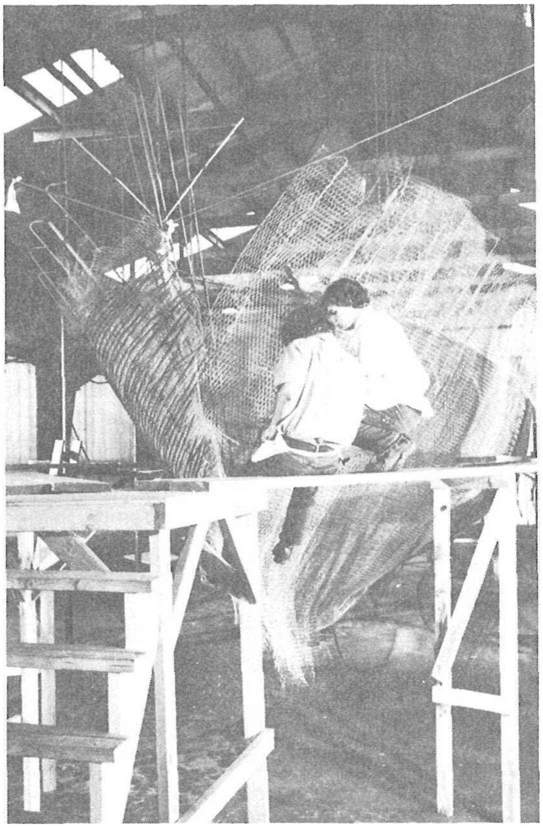


The man at ground level first fastens the mesh at his own height, then works downwards.

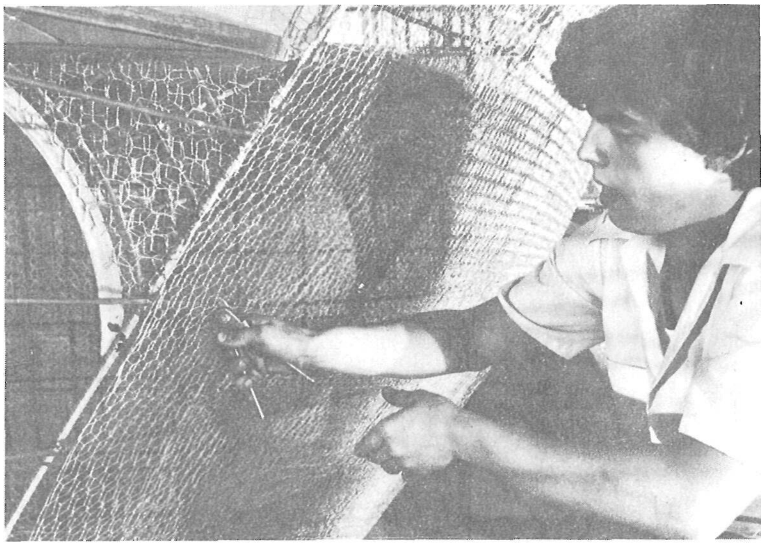


Butting the folded strip of mesh to the previously overlaid strip.

Inserting the open-jawed staples into the hog ring pliers.



The mesh fasteners close in at the stem.



The open jaws of the staple are thrust through the mesh and are closed tightly around the spacer rod with the pliers.

Mesh is left untrimmed at the stem.

Mesh is fastened to the inside of the transom before the hull mesh encloses this section.

TASK 4 — Apply Mesh to Transom Interior

At the same time as the mesh is being fastened to the hull, mesh should be applied to the inside of the transom. Access is easier to this area before the hull mesh encloses it and creates corners which are awkward to work to.

TASK 5 — Fasten Longitudinal Reinforcing Rods Above the Mesh

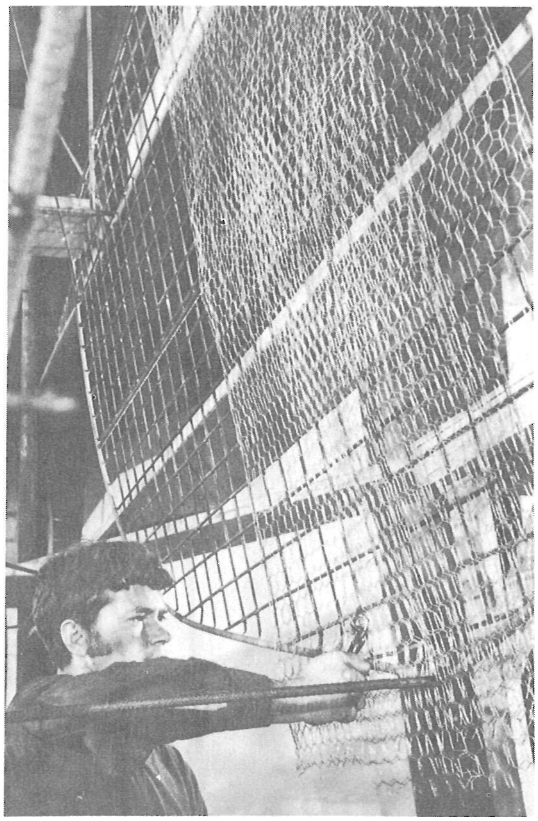
As soon as the hull is covered with its first four layers of mesh as described in Task 3, longitudinal reinforcing rods of 1/4-inch (6.4 mm) diameter mild steel are fastened above the mesh for the entire length of the hull.

These longitudinal rods accompany the lines of the spacer rods, lying under the mesh, which were welded in place in Stage 1, Job 8, Task 5. Five longitudinal rods are fastened between each pair of spacer rods. An equal distance is maintained between the spacer and all longitudinal rods. The procedure is as follows:

1. The distance between all spacer rods on the hull is equal as has been described in Stage 1, Job 8, Task 5. A chalk mark is now made on the hull frames at the center point between each pair of spacer rods.

2. A longitudinal reinforcing rod is fastened with tie wire to the hull frames at these center marks. This is laid first in the midships part of the hull, above the mesh.

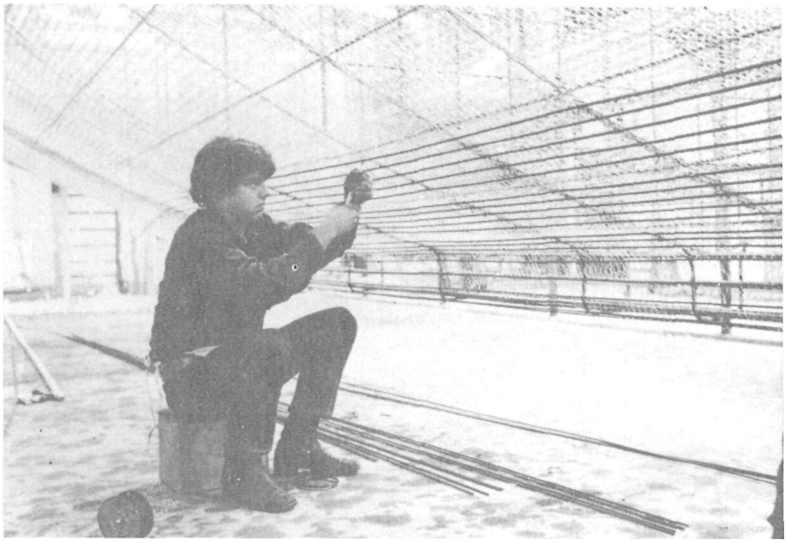
3. Two longitudinal reinforcing rods are laid and fastened between this center rod fastened in (2) and the spacer rod. Two longitudinal rods are laid in exactly the same way on the other side of the center rod. Five longitudinal reinforcing rods now lie fastened at equal spacings between the one pair of spacer rods.



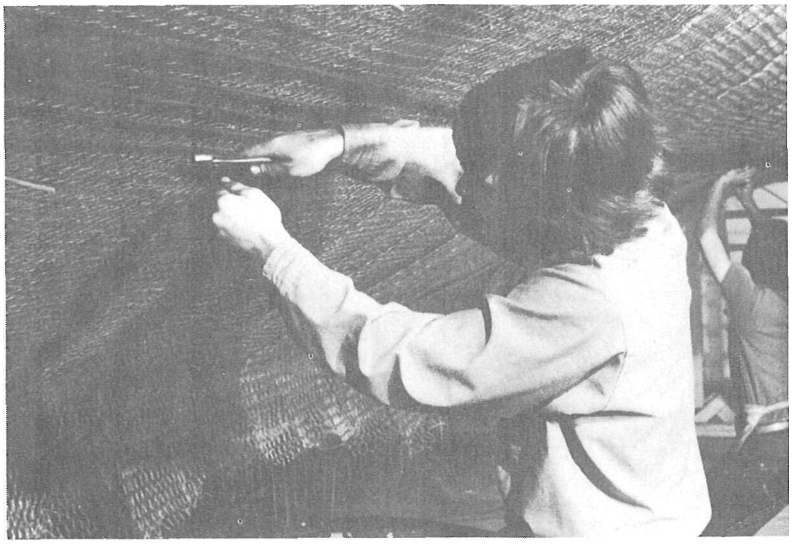
Interior meshwork becomes difficult and slow if the hull is meshed beforehand.

Working from midships, the entire hull is covered with longitudinal reinforcing rods in this way. Note that as the rod laying and fastening approaches the stern and the bow the distance between rods diminishes to conform to the tapering of the hull shape. Lap the reinforcing rods six inches (152 mm) and stagger the joints.

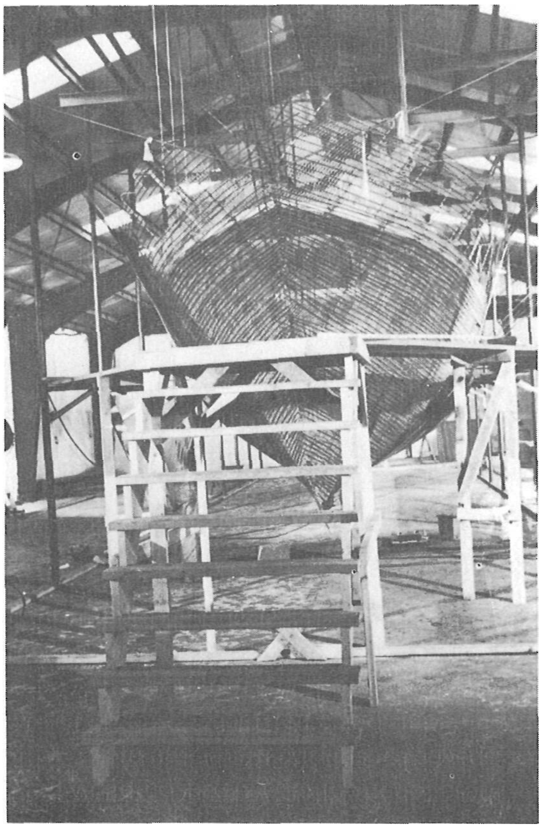
Do not lap-weld extensions to the longitudinal reinforcing rods at this stage. Only lap-joint the extensions of rod and fasten with tie wire. The reason for this will become apparent on reaching Task 7.



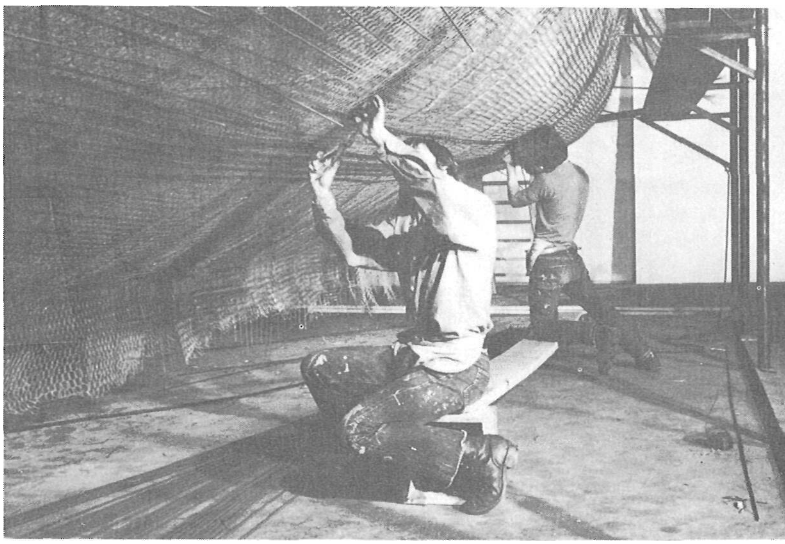
Fastening longitudinal rods on the outside of the mesh. Underlying spacer rods used as guides.



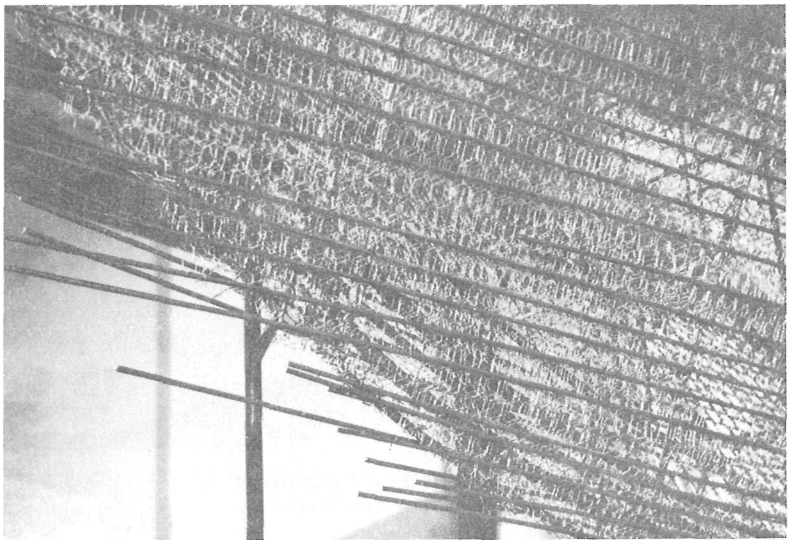
The rods are fastened to the hull frames with tie wire.



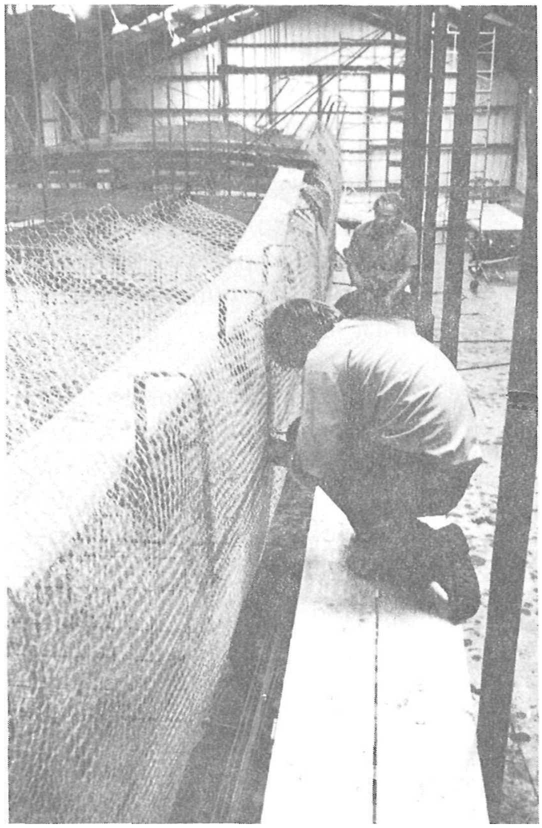
Spacing between the longitudinal reinforcing rods diminishes at the bow.



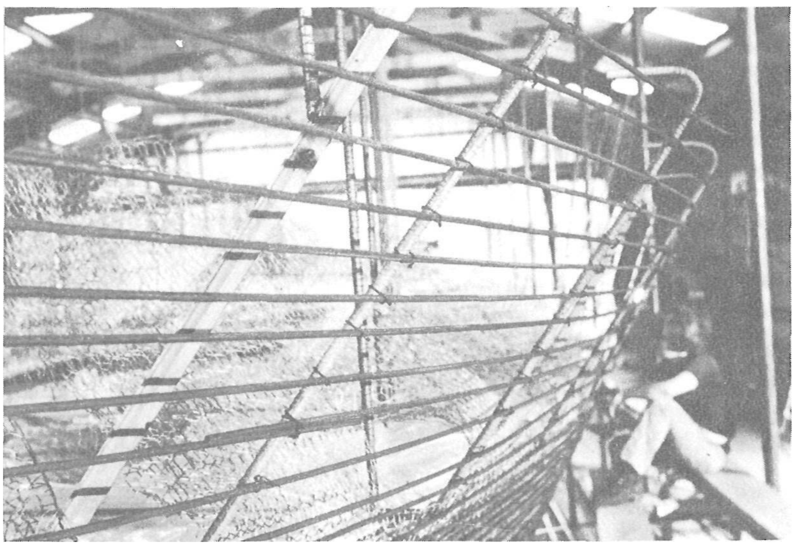
Successive lengths of rods are lap-fastened, one to the other.



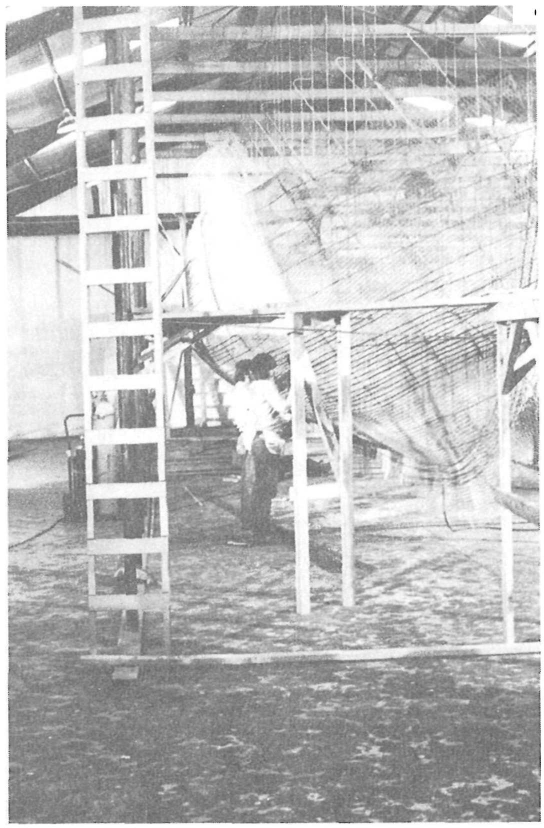
Longitudinal rods are left projecting at the stem.



Fastening rods along the hull sides.



At the raised bulwarks to the bow the unsupported mesh falls inwards, the rods are tied firmly to the bulwark supports (upper hull frames).



This view shows clearly the system of laying the reinforcing rods to conform to the underlying spacer rods.

TASK 6 — Remove Underlying Spacer Rods, Replace With Longitudinal Reinforcing Rods Overlying the Mesh

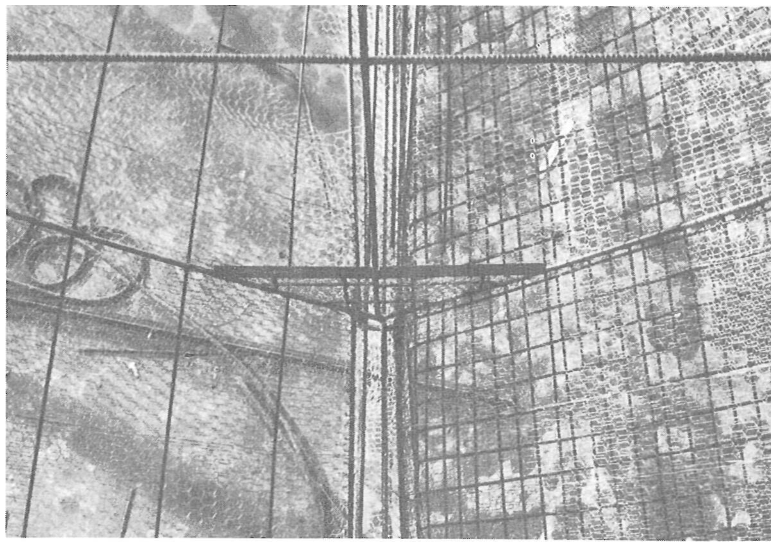
The first set of spacer rods, carefully measured and laid over the hull frames as described in Stage 1, Job 8, Task 5, have now performed their purpose. They have served as a structure to fasten from the *outside* of the hull what will now be the first four *inner* layers of mesh to the hull reinforcing.

Fastening mesh from the outside of the hull is a much easier and speedier operation than fastening mesh on the inside. The hull exterior is one smooth, convex surface. The mesh strips can be laid over this surface easily and tensioned without excessive use of staples.

The hull interior is partitioned with bulkheads, frames and webs. This creates a series of awkward corners. Fastening the mesh to the hull inner concave surface requires careful measuring, cutting, darting and trimming and a greater use of fasteners. Fastening mesh is a laborious business even on the hull exterior; fastening from the interior increases the work ten-fold.

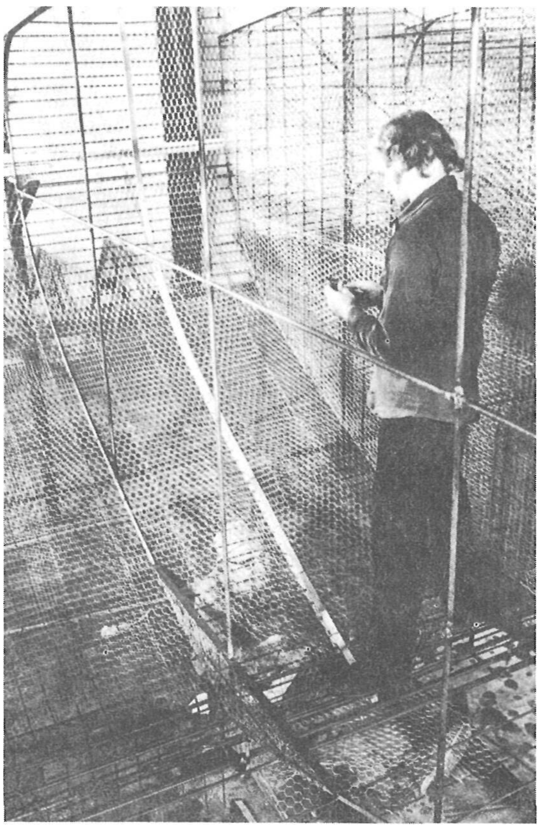
The spacer rods have served their purpose and will be cut out of the hull from the inside with bolt cutters. As each spacer rod is removed from beneath the mesh it is replaced over the mesh with a corresponding longitudinal reinforcing rod. This is tied with wire to the hull frame rod as described in Task 5. Note that care should be taken not to tread on the longitudinal reinforcing rods when cutting out the spacer rods from inside the hull. Planks should be laid across the inside of the hull frames for this purpose.

The entire hull is now covered with 1/4-inch (6.4 mm) diameter longitudinal reinforcing rods. They will be found to lie at approximately two-inch (51 mm) centers amidships, gradually diminishing this spacing as they approach the bow and stern.



On the left of the keel, spacer rods. On the right vertical reinforcing rods have already been welded to the longitudinal rods and the spacer rods removed.

Welding vertical reinforcing rod, the fairing batten fastened in place.



An inner and outer fairing batten being fastened together.

TASK 7 - Weld Vertical Rod Reinforcing at Three-Inch (76 mm) Centers

It was mentioned in Task 3 that if excessive tension was applied while fastening the first four layers of mesh an undesirable hollow could appear in the one-meter wide spaces between the hull frames. To bring the hull shape back into fair between the hull frames a limber fairing batten is temporarily tied perpendicularly to the mesh and rod reinforcing at center point between the hull frames. One batten is placed outside the reinforcing at this point, the other inside, and the two fastened firmly together with tie wire. This does not apply to those sections at bow and stern where the spacing between the hull frames is only 50 cms.

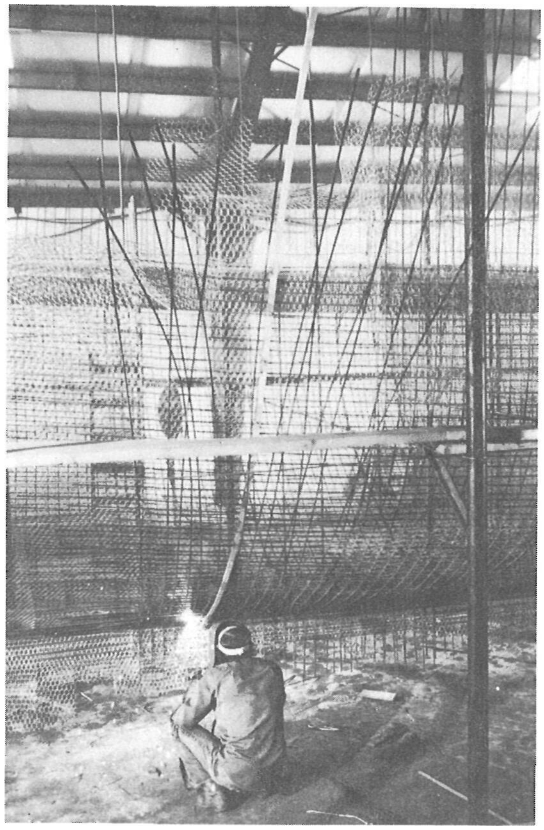
Once the inner and outer battens have been fastened together in place, the mesh and rod reinforcing faired, vertical reinforcing rods of 1/4-inch (6.4 mm) diameter are welded to the longitudinal rods on three-inch (76 mm) centers. The procedure is as follows:

1. Two fairing battens are made up from two-inch (51 mm) wide strips cut from 3/16-inch (4.8 mm) plywood. The battens are made 14 feet (4.3 m) long, each comprised of three layers of plywood strips nailed together, the joints staggered. The battens are temporarily fastened together in place to the rod and mesh at the center measurement between the hull frames, one inside and one outside. The rod and mesh reinforcing sandwiched between these battens is faired into the hull shape.

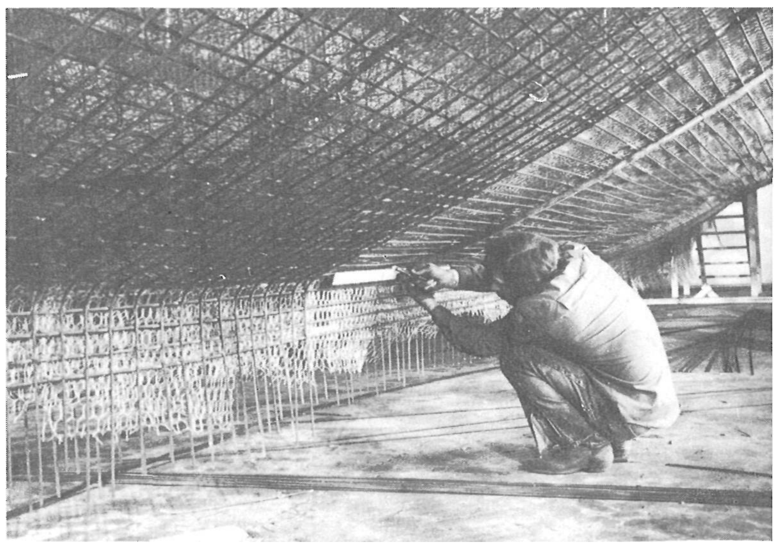
2. A vertical reinforcing rod of 1/4-inch (6.4 mm) diameter mild steel is welded to the lowermost of the longitudinal reinforcing rods lying on the side of the keel. Its start-end is allowed to project below untrimmed for three or four inches. The position of welding is close to the fairing batten. The rod is pre-shaped around the turn of the keel with the hull (where the garboard would be on a wooden vessel) and allowed to run over the longitudinal rods up beyond the rail cap height by about twelve inches (305 mm).

3. Six vertical rods are started at the same time, three on each side of the fairing battens. Note that not all intersections of vertical with longitudinal rods are welded. Welding starts at the lowest intersection on the first of the vertical rods and is carried up diagonally to the intersection of the third vertical with the third longitudinal rods. The idea being that welding at every intersection will cause considerable shrinkage of the rod reinforcing grid, imparting a flattened section to the hull shape between hull frames. Welding at every third intersection on the diagonal in this way will give sufficient strength to the rod reinforcing grid. The purpose of the welding of the rods together is primarily to prevent the rods drawing through the concrete should the hull ever suffer a severe impact in service.

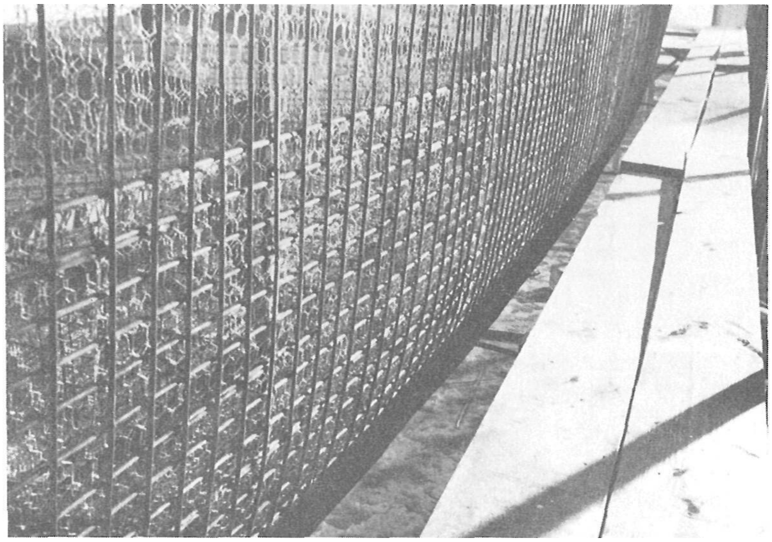
4. It was mentioned in the description of Task 5 that the longitudinal reinforcing rod should not be lap-welded at this stage, merely fastened together at the lap-joints and fastened to the hull frames with tie wire. Here, again, the purpose is to allow the longitudinal rods to contract freely as the welding of the vertical rods proceeds. Longitudinal rods may be lap-welded as soon as the welding of the vertical rods passes beyond the lap-joint.



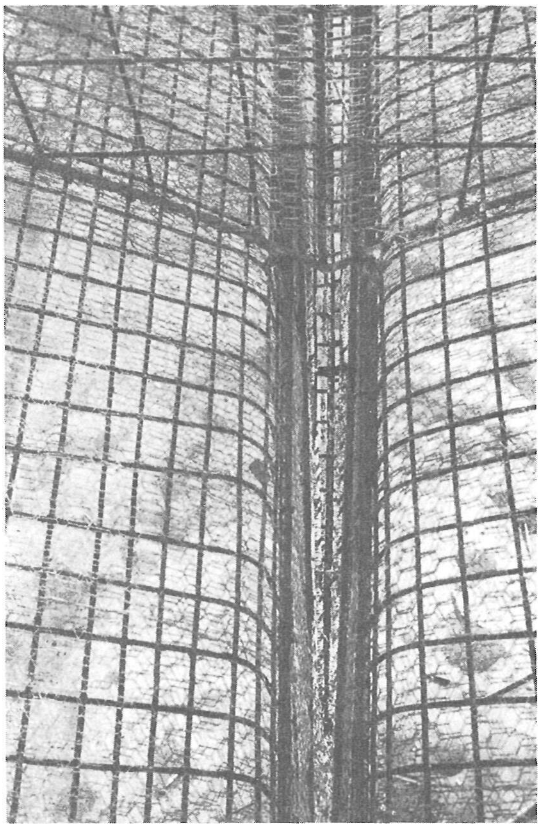
The welder starts at the keel and works upwards using the batten as a guide.



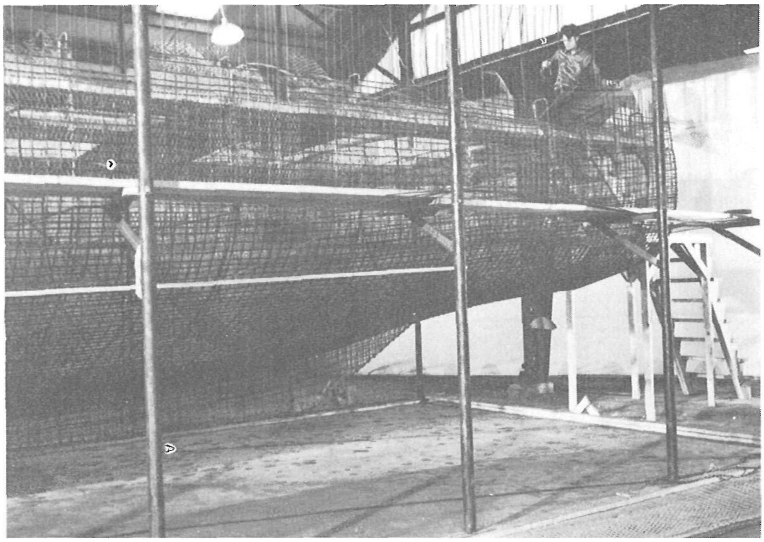
Marking the spacings between vertical rods at the garboard.



Vertical rods welded neatly in place along the hull sides.



View into the deadwood area.



Stern section completed, vertical rods untrimmed at the bulwarks.

TASK 8 - Make Starter Rod Jig

As their name implies, starter rods are used to start off reinforcing in those places which are planned to be completed only at a later stage of construction. The engine bed starter rods, as a particular example, are welded to the hull reinforcing rods before the application of mesh is completed. The engine-bed reinforcing rods will generally be lap-welded to these starter rods after the hull has been concreted.

The starter rods are simply pieces of 1/4-inch (6.4 mm) diameter mild steel reinforcing rod bent over at half their length into right angles. They are cut 12 inches (305 mm) long. One six-inch (152 mm) arm is welded to the existing hull reinforcing rods, the other is left to project six inches (152 mm) inside the hull. It will be appreciated that as starter rods lead into other construction work they must be positioned accurately.

When many starter rods are required a simple jig can be made to speed the work of measuring, bending and cutting. The jig should be mounted on the end of a bench at a comfortable working height of 36 inches (914 mm). The bench should be long enough to support the standard 20-ft. (6.1 m) lengths of 1/4-inch (6.4 mm) diameter rod. The accompanying diagram shows how this jig is made.

TASK 9 - Make Starter Rods

A length of 1/4-inch (6.4 mm) diameter reinforcing rod is laid on the bench and one end of the rod pushed hard against the "stop" on the jig. The lever is worked which bends a six-inch (6.4 mm) length of the rod at right angles. The rod is cut with bolt cutters at the prescribed mark on the jig. The desired quantity of starter rods is prepared in this way.

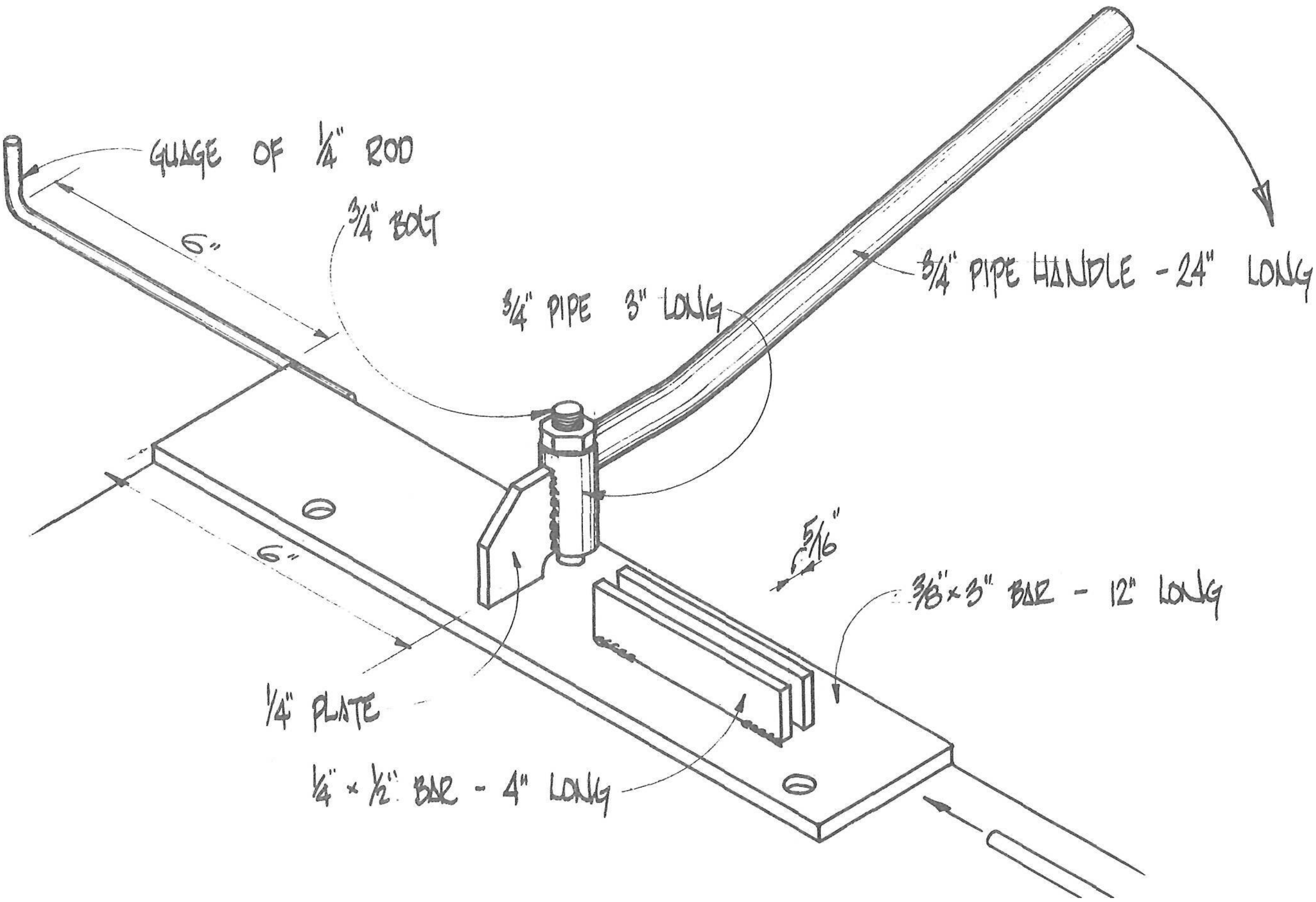
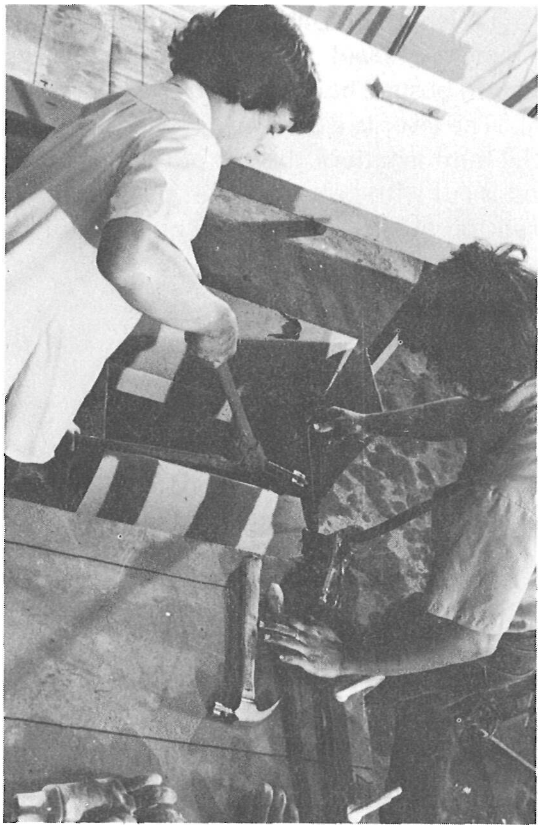


Figure 24. Bending Jig for Starter Rods.

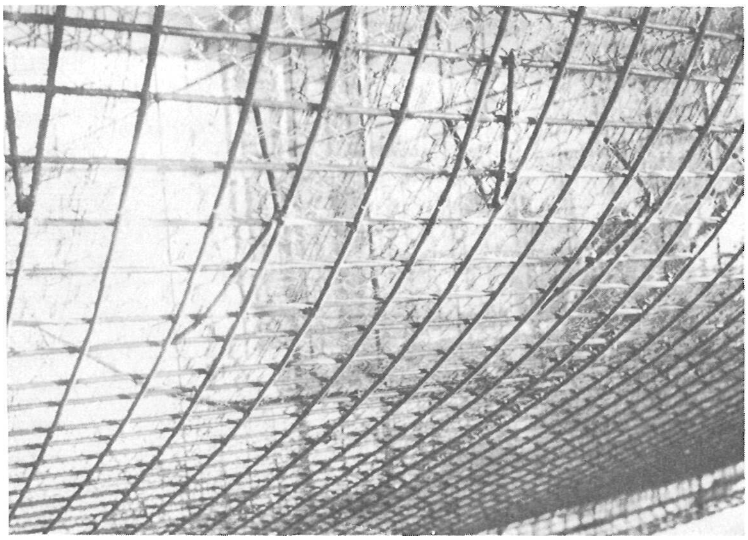


Bending and cutting starter rods.

TASK 10 - Weld Starter Rods Along Diagonal "D" Line

Wooden battens, butted end to end, are temporarily fastened to the outside of the hull rod reinforcing along the line of diagonal "D." The mark of diagonal "D" has been lightly sawn onto the hull frames in Stage 1, Job 1, Task 11. The procedure is as follows:

1. A chalk mark is made on all vertical and longitudinal reinforcing rods where they bisect the line of diagonal "D."
2. The battens on the diagonal "D" line are removed.
3. Starter rods are pushed through the hull reinforcing at the chalk marks, from the outside inwards. Starter rods are normally placed six inches (152 mm) apart.
4. The starter rods are welded to the hull rod reinforcing. The six-inch (152 mm) outer arm of the starter rod is welded to the vertical and longitudinal reinforcing rods on the diagonal. (The idea being that a concentration of reinforcing rod will not be built up and so make penetration of the concrete difficult.) Alternate the direction of every second starter rod where it is welded to the hull, one up and one down.
5. Repeat this procedure on the other side of the hull.



Starter rods welded at the line of the diagonal "D"stringer. Note one-up/one-down diagonal welding to avoid concentrations of rod.

The inner arm of the starter rods at diagonal "D" will later form part of the reinforcing of a stringer which will run the entire length of the inside of the hull. The line of diagonal "D" was chosen for this stringer as it intercepts the future waterline of the boat in two places. In so doing, it will afford valuable reinforcing to the hull at an area which is vulnerable on collision or if left high and dry on its side.

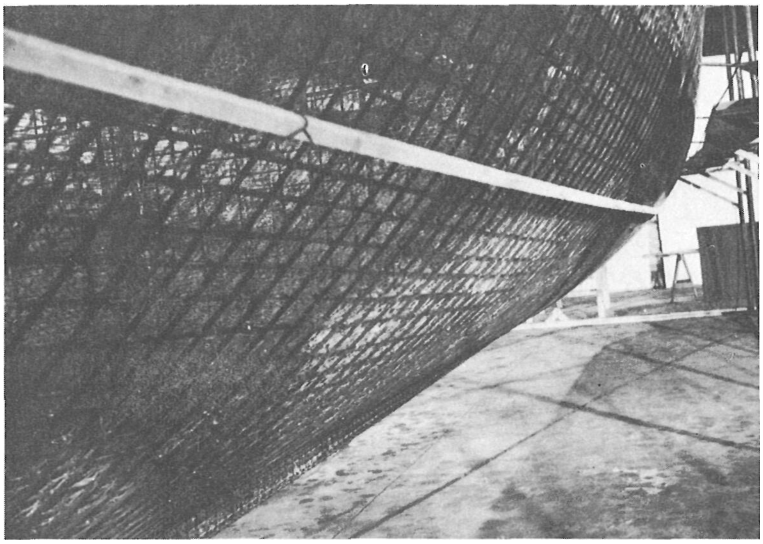
TASK 11 - Weld Hull Reinforcing Rods at Stem, Keel and Transom

The hull reinforcing rods have been left untrimmed at the stem, below the keel, and at the transom. (The vertical rods untrimmed at the rail cap will be attended to in Task 14.) The procedure is as follows:

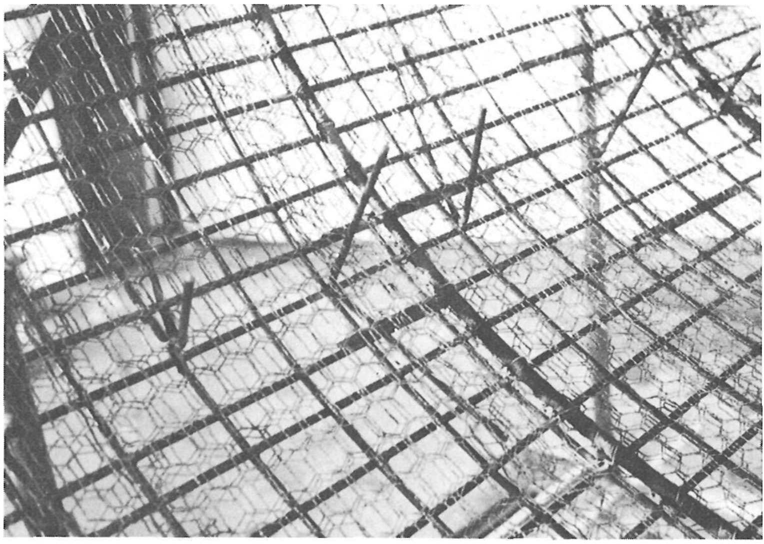
Stem: The longitudinal reinforcing rods are cut off at the stem-piece rod. The rods from port and starboard are welded to the stem-piece 1/2-inch (12.7 mm) diameter rod, their ends hammered round the front of the stem-piece and welded together. At the fore-foot twelve-inch (305 mm) long rods are pre-bent in a "U" shape. The arms of the "U" are welded to the reinforcing rods to port and starboard of the forefoot. As the forefoot widens vertically placed rods are bent around to the opposite side and upwards then welded to the longitudinal reinforcing.

Keel: Four longitudinal 1/4-inch (6.4 mm) diameter reinforcing rods are fastened over the mesh at the bottom of the keel for its entire length. The vertical untrimmed rods are bent round to the bottom of the keel, corresponding port and starboard rods are lap-welded together and then welded to the longitudinal rods. Be careful to keep a fair line on the bottom edge of the keel where the rods bend around.

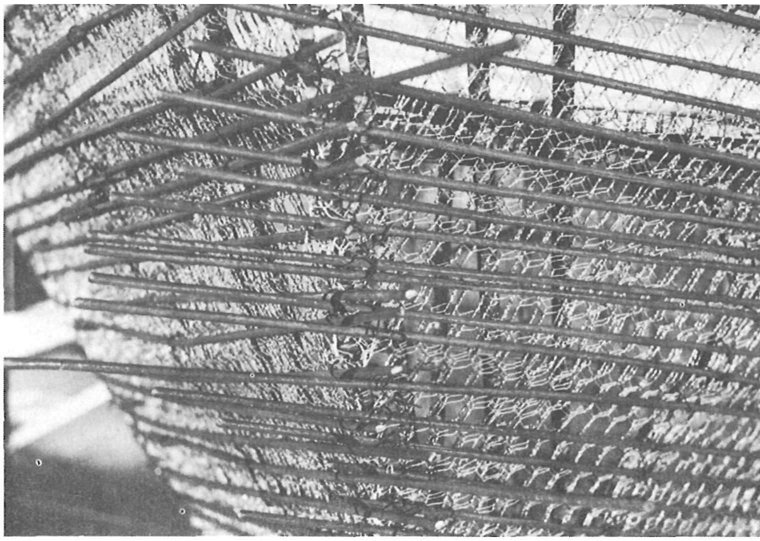
Transom: Hull longitudinal rods are trimmed off at three inches beyond the transom. These are welded to the transom frame of 1/2-inch (12.7 mm) diameter rod and hammered round into the transom reinforcing. Where the ends of these rods make contact with the transom reinforcing grid they are welded down. Be sure to be neat as this is a finished corner. If the rods are not bent carefully a bumpy edge will result.



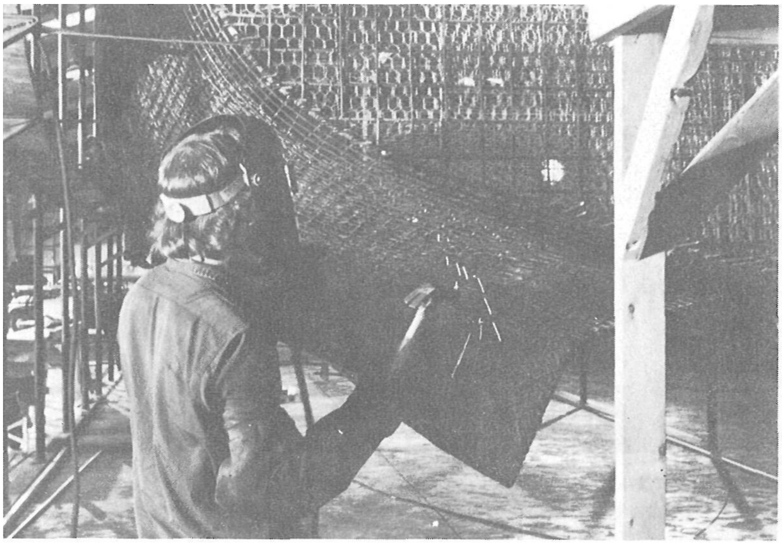
Batten fastened at the line of diagonal "D" for marking position of the stringer starter rods.



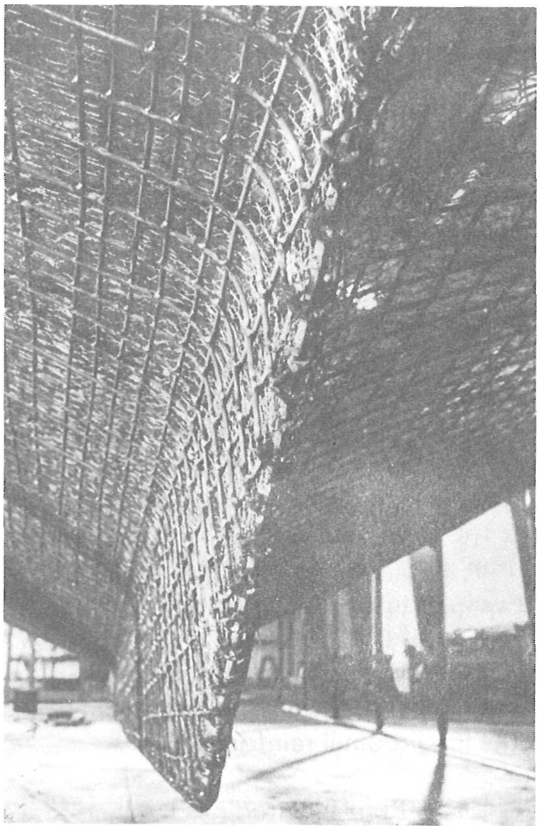
Stringer starter rods from the inside.



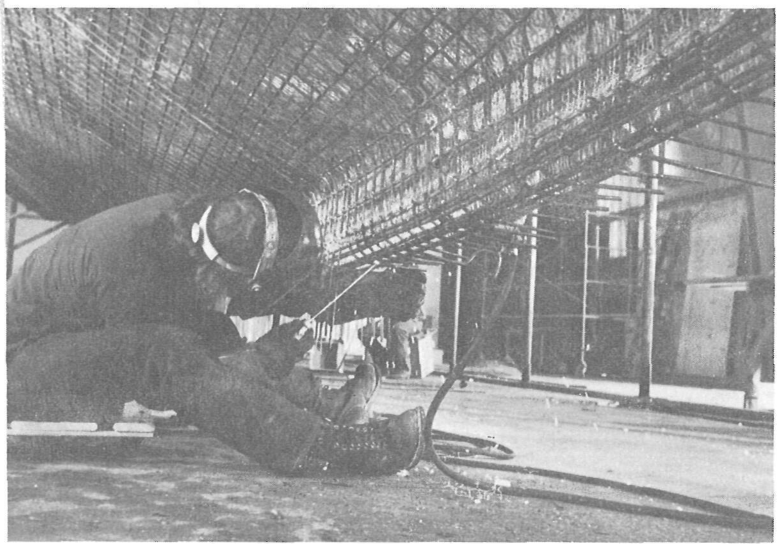
Longitudinal rods fastened at the stem prior to trimming and welding.



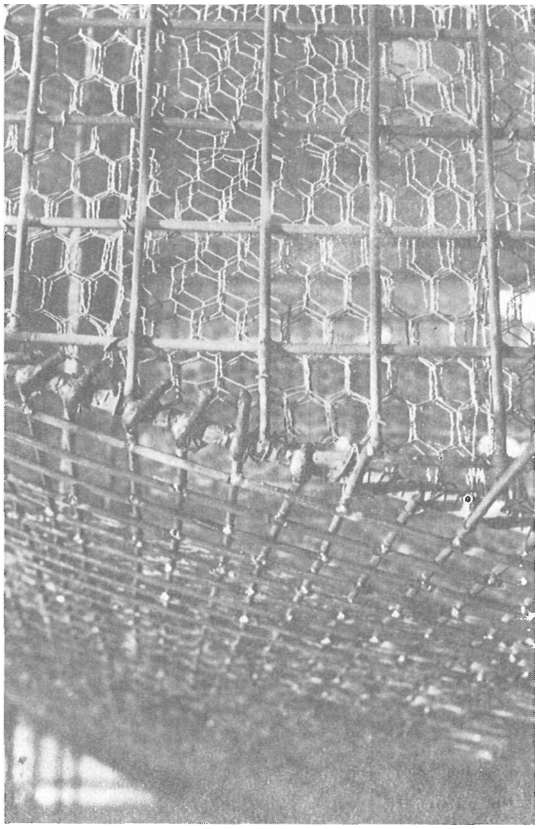
At the transom the longitudinal rods are welded and their ends hammered around the frame.



The rounded ends of vertical rods butt-welded at the trailing edge of the deadwood.



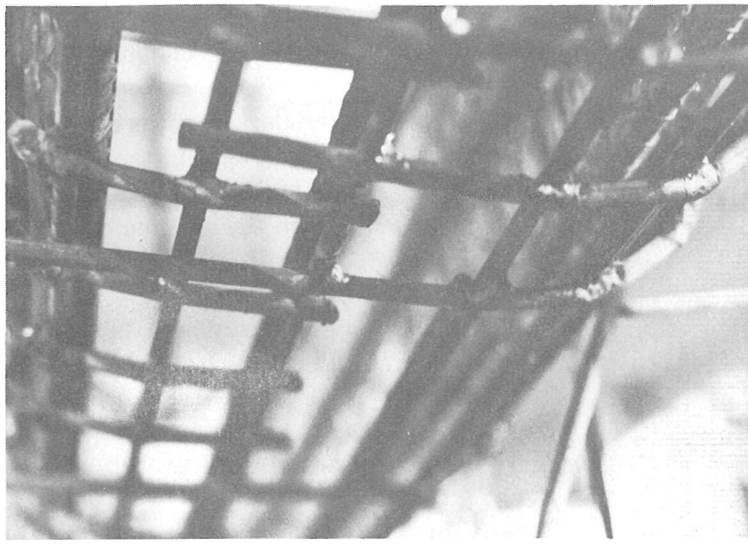
Welding the ends of the vertical rods to the underside of the keel reinforcing.



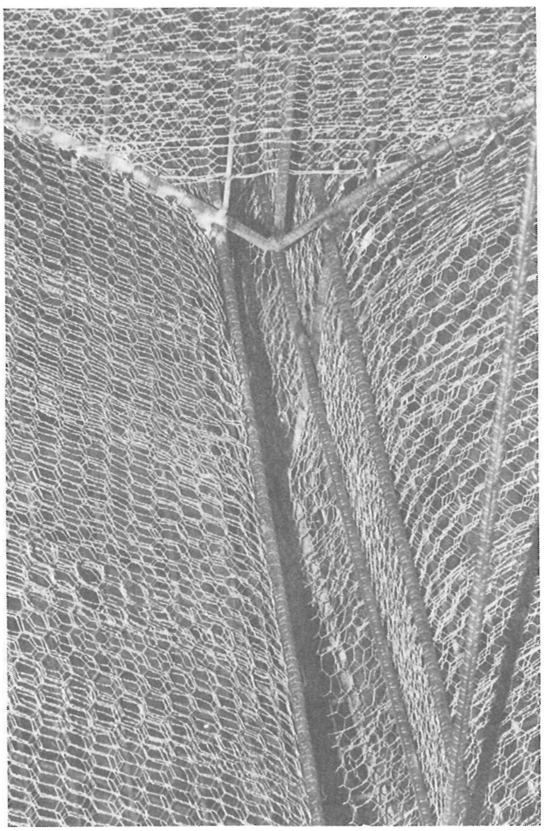
Detail at the transom edge. Longitudinal rods to the right await welding, trimming and bending over.

TASK 12 - Staple Interior Mesh to Longitudinal Rods

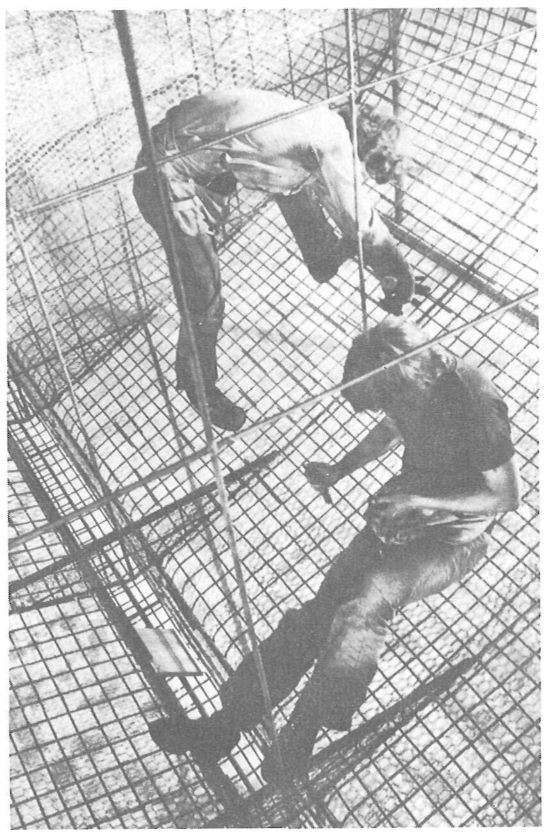
Working from inside the hull, the first four layers of mesh are checked for tautness and additional hog ring staples applied where necessary. Fastening is made to the longitudinal reinforcing rods. The complete interior of the hull is checked in this way.



Detail at the underside of the keel.



The interior mesh now requires fastening to the exterior rod framework.



Fastening the interior mesh with hog ring staples.

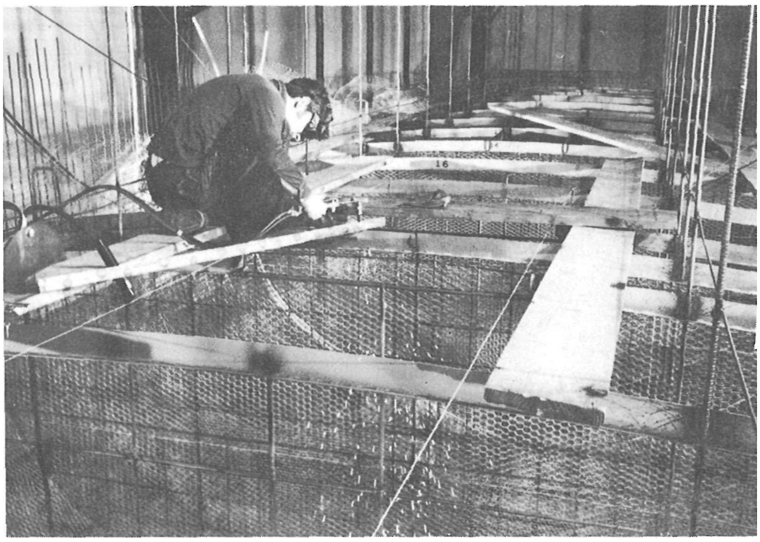
STAGE 2-JOB 2
DECKHEAD LINING PREPARATIONS

Up to this stage the deck consists only of the deckbeams, painted and faired, standing at every hull frame for the entire length of the hull. As work proceeds on the welding of vertical reinforcing rods to the longitudinal, preparations may now be made for lining the deckhead. The first preparation is to establish where all apertures in the deck are sited.

TASK 1 - Marking Deck Apertures

There are several apertures to be marked out on deck. They represent the engine removal hatches, deck hatches, companionway, aft cabin opening and ventilation ducts. The exact positions of these apertures and their dimensions are shown on Figure 5.

The center line has been previously marked on all deckbeams but it is advisable to string a line once more over the beams to verify that all center line markings remain aligned. From the center line read off the measurements of the apertures, to port and starboard, as noted in Figure 5. At the same time take measurements and note the lengths of longitudinal beams which are required to form, in conjunction with the athwartship beams, the rectangular hatch openings.



Positions of deck apertures strung out over deck beams.

TASK 2 — Making Longitudinal Beams for Deck Apertures

The longitudinal beams are made of the same flat bar material and welded together in the same jig as the deck beams. (See Stage 1, Job 2, Tasks 1, 2 and 3.)

The longitudinal beams are made to a length of one meter (the measurement between deck beams) except in the case of the twin hatches amidships, labeled Nos. F and G on Figure 5. Here the center sections of the deck beams at Station Nos. 20 and 22 will be cut out where the longitudinal beams intersect them. The longitudinal beams which form the sides of Hatches Nos. F and G will therefore be made to the length of one and one-half meters. The purpose in keeping most of the longitudinal beams as short as one meter is twofold:

1. The existing deck beams remain in place to lend the hull framework structural strength until the time that the concrete has cured. (These deck beams in the hatch openings will then be cut away.)

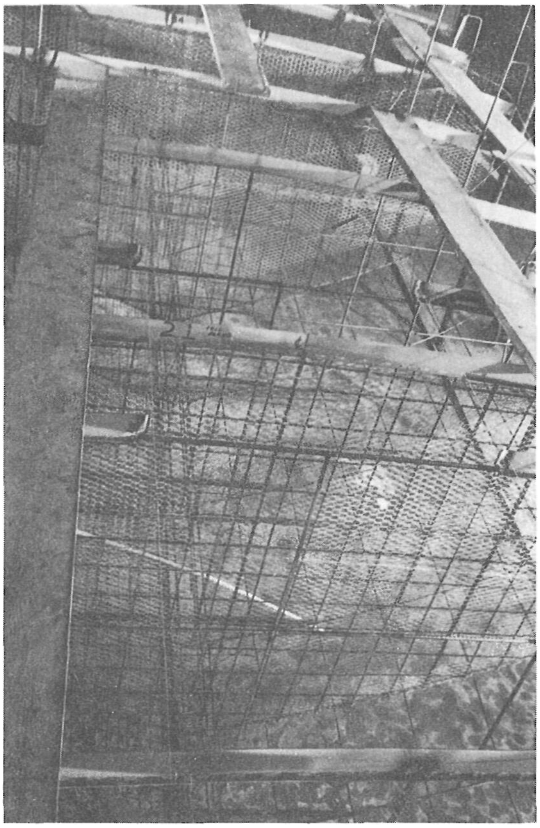
2. As has been explained earlier, the contraction caused by the welding of the beams in the deck beam jig imparts a convex curve. This aids in the formation of the deck beam camber but, in the case of the longitudinal beams, this curve has to be pounded out. Consequently, these beams are kept short in length and only spot-welded together. Note that six one-meter lengths of longitudinal beam will also be required to form the fore and aft sides of the engine room ventilator ducts between Stations 8 and 10.

TASK 3 - Weld Deck Aperture Beams in Place

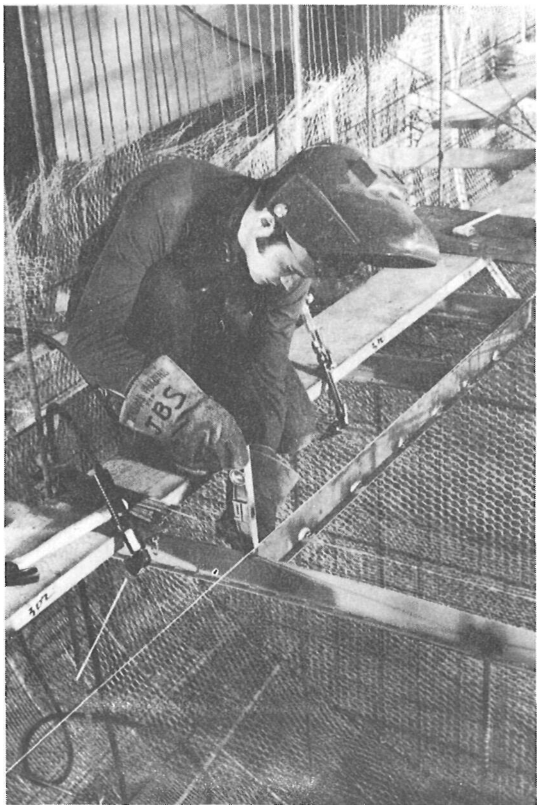
The prepared longitudinal beams are welded to the deck beams at the markings made in Task 1. As an aid to alignment, a line is strung over the marks in those cases where two or more longitudinal beams are welded to intervening deck beams to form one continuous beam.

At the twin midships hatches Nos. F and G the center sections of the deck beams at Station Nos. 20 and **22** are cut out where the one and one-half meters longitudinal beams intersect. The two cut-out center sections are then welded in place to the longitudinal beams at the measurements as shown on Figure 5.

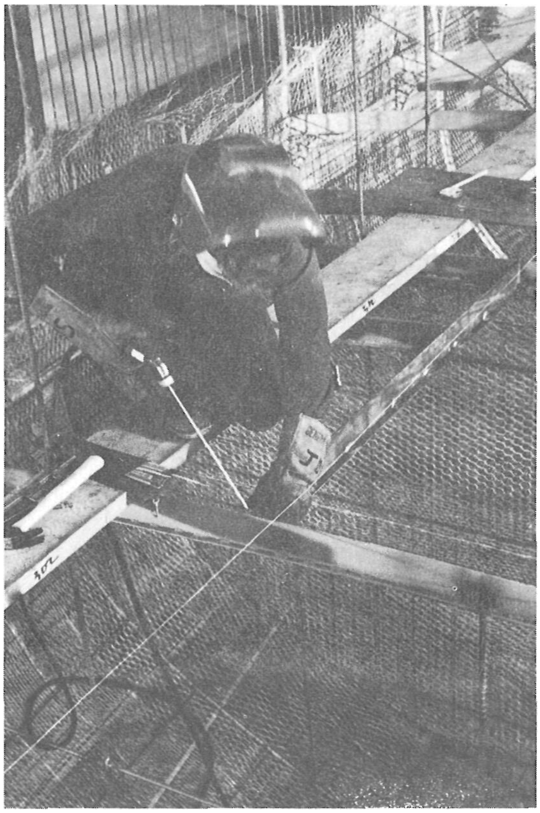
Short lengths of beam are welded athwartships to the longitudinal beams between Stations 8 and 10 to complete the openings for the engine room ventilators.



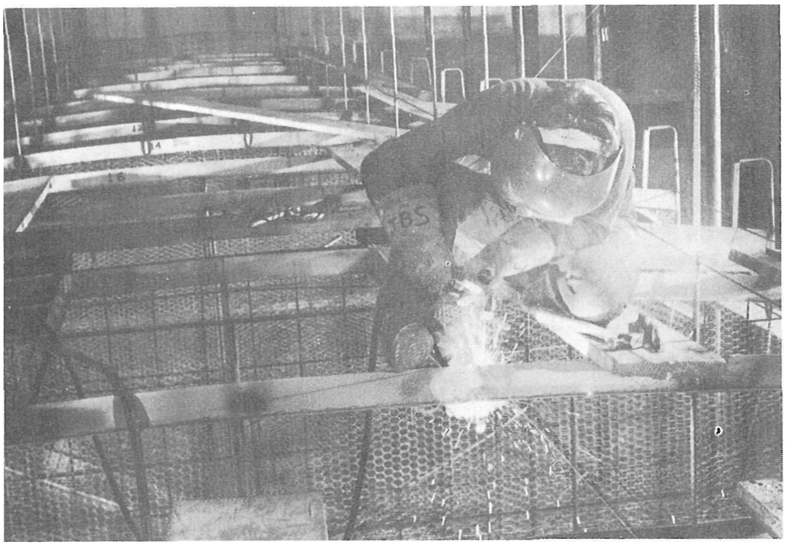
*Center sections of deck beams at Stations 20 and **22** cut away for hatches.*



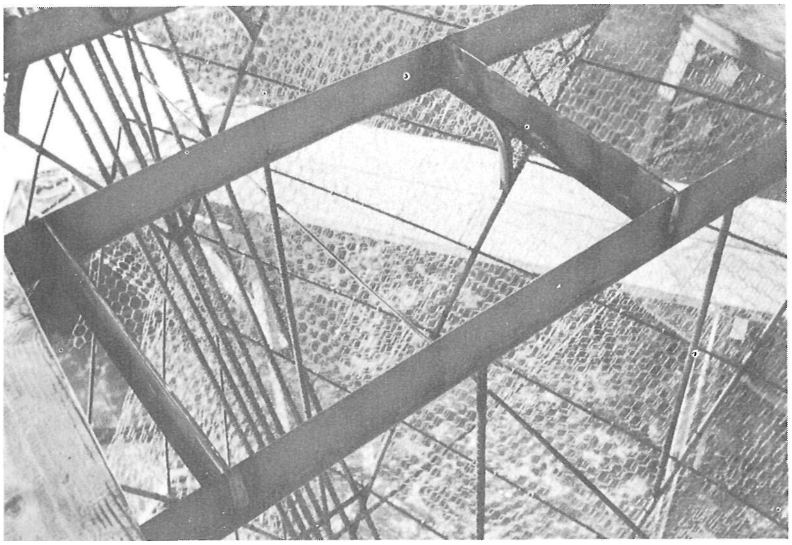
Longitudinal deck beam will form side of hatch.



Welder pushes string aside to weld beam in place.



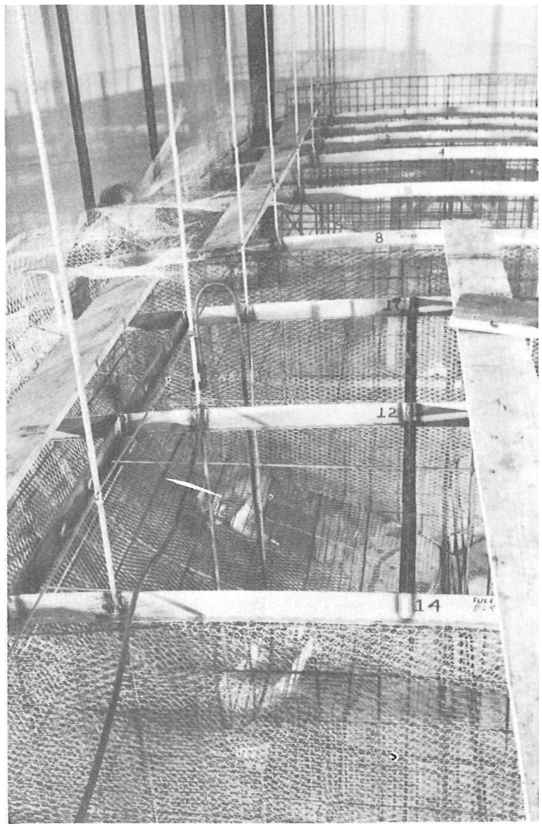
Hatch openings take shape.



Hatch to the forepeak.

Underside view of hatch opening.

Welding longitudinal beam in place.

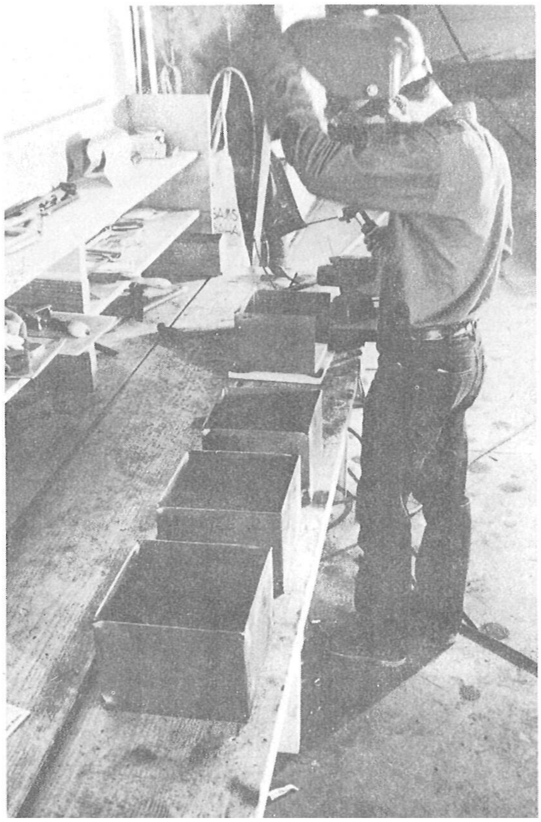


Engine hatch will retain its center deck beam (No. 12) until after plastering.

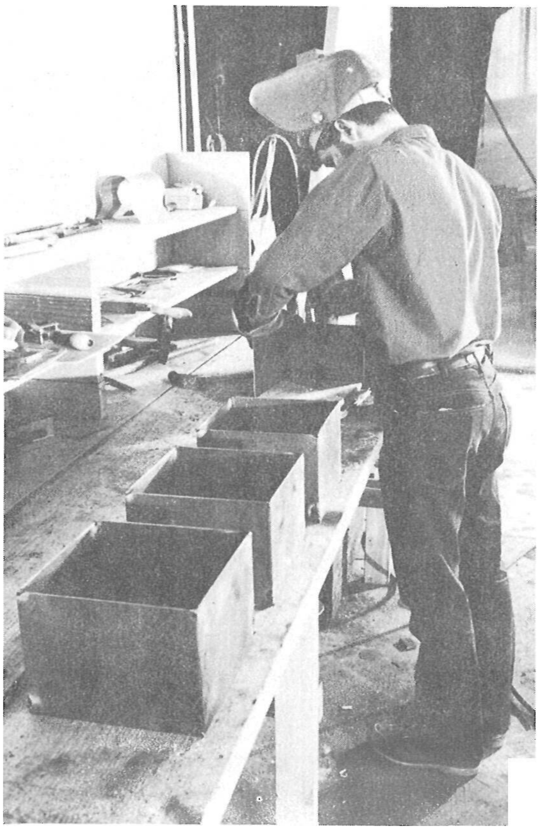
TASK 4 - Make **Deck Ventilator Coamings**

Six coamings are made for deck ventilators. The position and the dimensions of these coamings are shown on Figure 5. Mild steel plate, 1/8-inch (3.2 mm) thick, is cut into four pieces 6" x 8" (152 mm x 203 mm) and welded into a coaming.

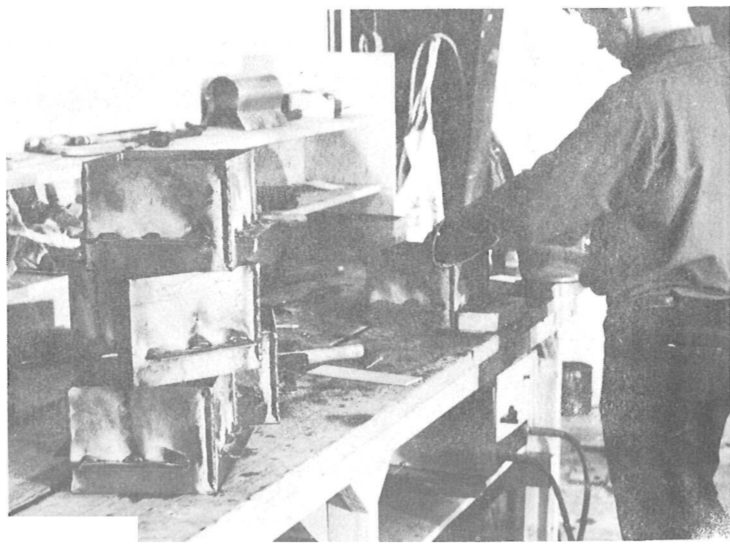
On two opposite sides of the coaming, at a height of two inches (51 mm) from the bottom outside edge, a piece of flat bar, 4" x 1" x 1/8" (102 mm x 25 mm x 3.2 mm), is welded on horizontally as a support for the coaming. The coaming will later rest on the supports in a cut-out made in the wooden deck lining. The bottom edge of the coaming will project for one inch (25 mm) through the wooden deck-head. In this way, by leaving the steel coaming projecting above the deck and below the deckhead lining, ventilation ducting may be welded to it later.



Fabricating deck ventilator coamings.



Welder uses a wooden pattern to keep the coamings square.

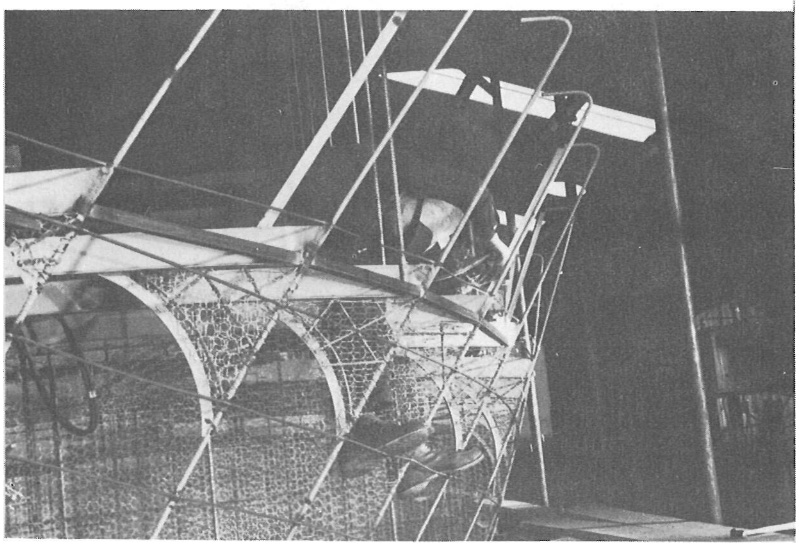


Horizontal supports to the coamings welded in place.

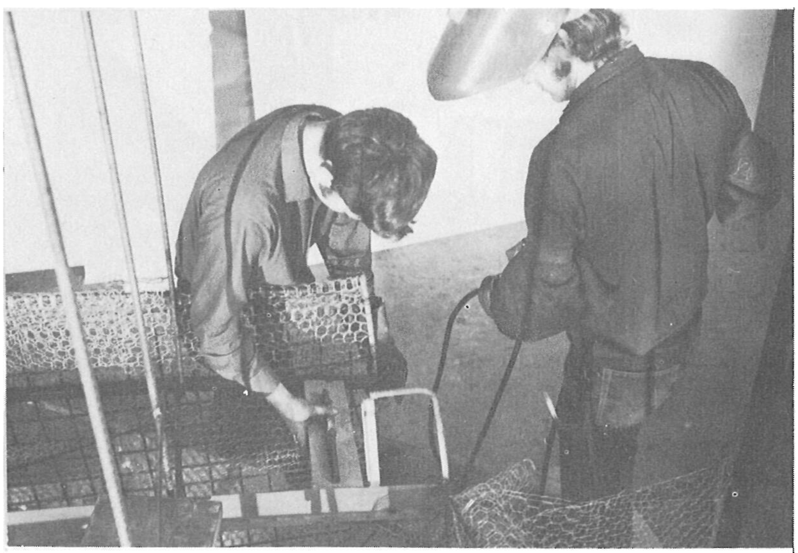
TASK 5 — Weld Deckhead Lining Supports

In the following places 1" x 1" x 1/8" (25 mm x 25 mm x 3.2 mm) angle iron is to be used as a support for the wooden deckhead lining. One is at the inside of the transom athwartships. It is also required forward of Station No. 28 at the deck sheer line running to the bow. In the midships section the lip on the deck beams supply all the support required for the wooden deckhead lining. Where the sheer line at the bow tapers inward the tongue-and-groove wooden deck lining planks require lateral support in addition to support fore and aft. The angle iron is welded to the hull frame rods at the deck sheer line. The inward facing lip of the angle iron maintained at the same level as the deck beam lip. The same procedure is followed at the transom.

Angle iron supports for the deckhead linings at the bow.



The angle iron is welded between hull frames at the deck sheer line.



Angle iron support across the transom.

The angle iron is welded exactly at the deck sheer line marked on the hull frame.

TASK 6 - Clean and Prime Deck Steel Work

The deck longitudinal beams require cleaning and priming with red lead paint. Also the deckhead support angle iron and the prepared deck ventilator coamings. All welds and weld burns on the previously painted deck beams require cleaning and painting. Once all the deck steel work has been touched-up and coated with red lead paint, preparations may be made for applying the deckhead lining and insulation material.

STAGE 2-JOB 3
LAYING DECKHEAD LINING

Preparations are now complete for the laying of the deckhead lining. The linings are simply cut and laid in from the top of the deck to rest on the projecting lips afforded by the deck beams and the angle-iron supports at transom and bow. The lining materials in the order of installation are as follows:

1. Red cedar tongue-and-groove planking, 1" x 10" (20 mm x 240 mm), dressed.

2. Two inches (50 mm) thick polyurethane foam insulation slabs wrapped in 4-mil vinyl sheeting.

3. Compressed hardboard panels, 1/8-inch (3 mm) thick.

TASK 1 - Fitting Wooden Deckhead Planks

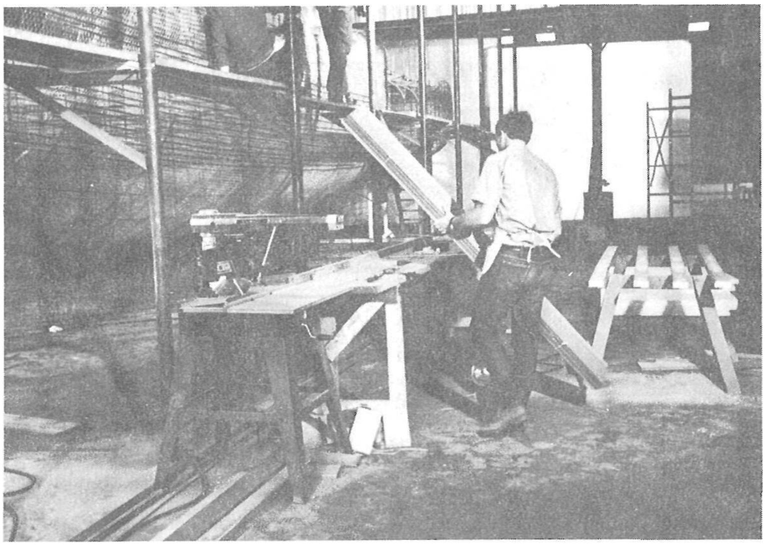
The red cedar tongue-and-groove planking is best supplied in length multiples of one meter (the measurement between the supporting deck beams) in order to reduce wastage. Note that the dimensions of the planking, 1" x 10" (25 mm x 250 mm) are reduced to 3/4" x $9^1/_2$" (20 mm x 240 mm) when dressed to the tongue-and-groove form.

Red cedar tongue-and-groove planking has certain advantages over plywood when used as a deckhead lining.

A protective coat of red lead for the angle iron supports.

a. All the grains of the red cedar planks run in one direction, consequently these planks will span a larger gap unsupported than would plywood of the same thickness. Plywood has only one-half of its wood grains lying in any one direction. The interlocking tongues and grooves of the cedar planks help support one plank to the other longitudinally. The entire width of the deck may be covered with interlocking planks which, when installed, become as one integral unit. If plywood sheets were used, wooden butt joints would be required between each sheet.

b. Plywood will not stand up to the wood dry rot conditions which have to be allowed for in this type of deckhead lining. Red cedar is excellent rot-resisting wood. Plywood, in this application as a deckhead lining, does not have the rot-resistant qualities for which red cedar is noted.



Work bench with power saw is placed close to the hull.

c. Red cedar is lighter than plywood and weight is always a factor when considering decking materials.

d. Red cedar is a reasonably stable wood. The tongues and grooves in the planking will accommodate any expansion or contraction which might occur in the surrounding hull materials better than plywood.

e. If laid with care, the edges of the grooves well aligned, the good side of the planking downwards, the red cedar gives a visually attractive deckhead lining which can be painted or clear varnished. Electrical fittings and cable can be attached to it easily.

Two men may be effectively assigned to fitting the deckhead lining. One man stationed on deck measures and calls the measurements out to a second man working a power saw below. The board is sawn and the edge beveled, then passed up to the man on deck. He checks the fit of the board, primes all edges with red lead paint, then fits the board in its final position between the deck beams.

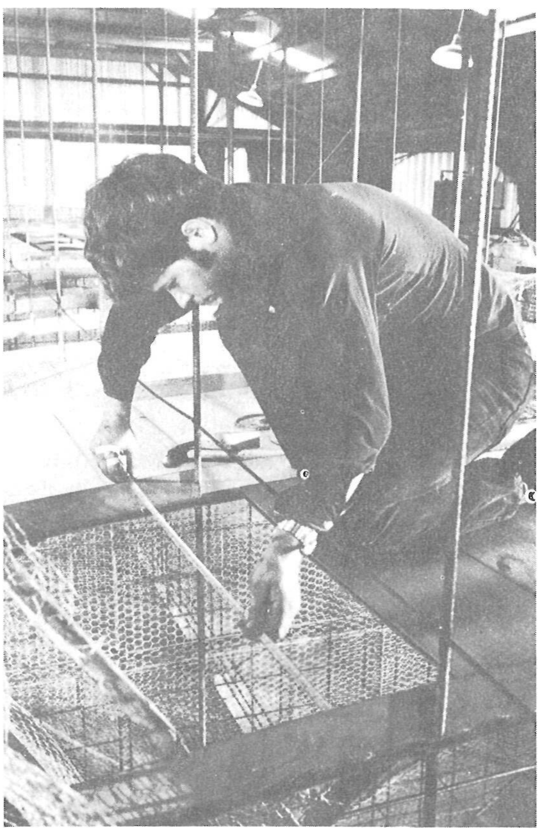
The following points should be noted in fitting the deckhead planking:

1. Work should start amidships and progress fore and aft.

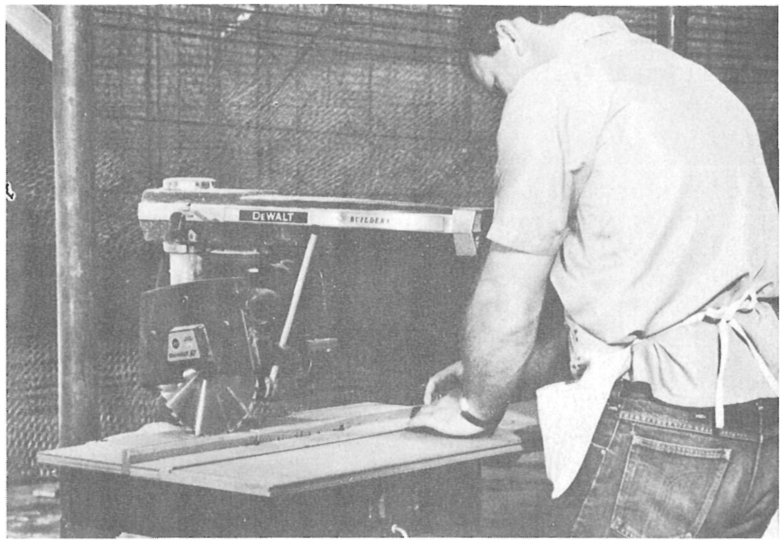
2. The fore and aft down-side edges of the boards should be beveled to half-thickness at 45°. In this way contact will be avoided with the weld seams in the deck beams and the boards will lie flat.

3. The boards should be aligned neatly fore and aft, the good side laid downwards.

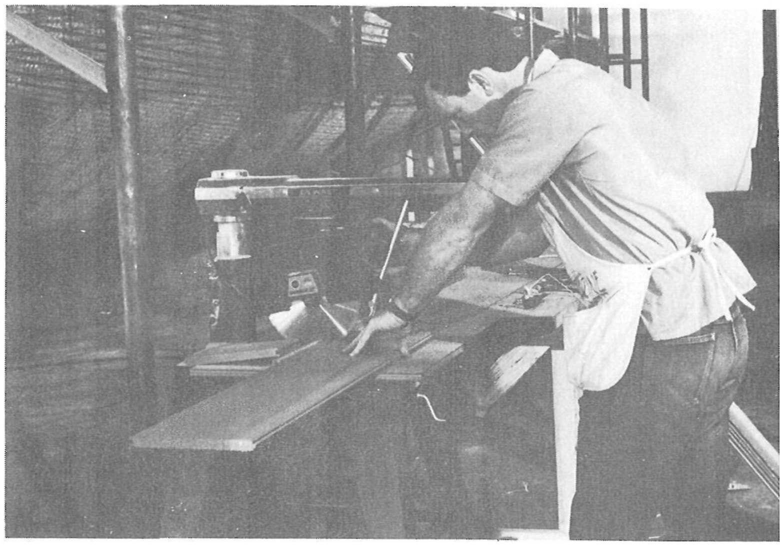
4. The end-grain of the boards should be particularly well sealed with red lead paint.

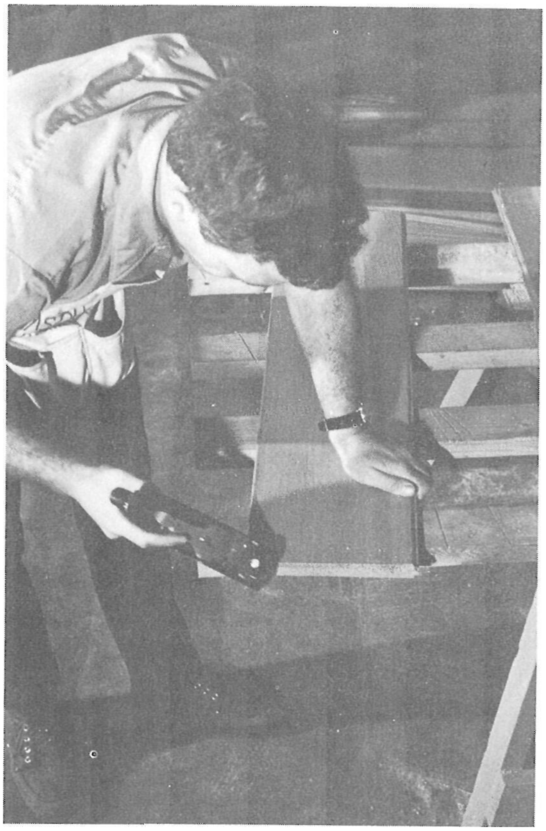


Measuring the space between deck beams for the red cedar tongue-and-groove planking.

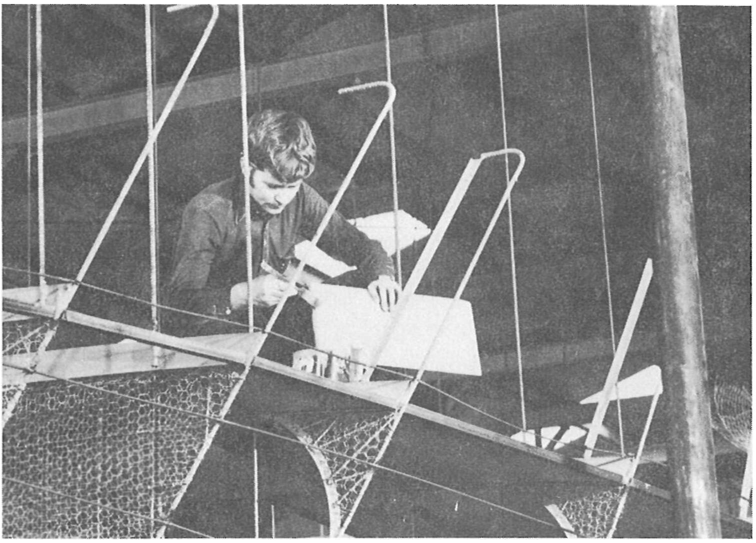


Marking the measurement onto the plank.

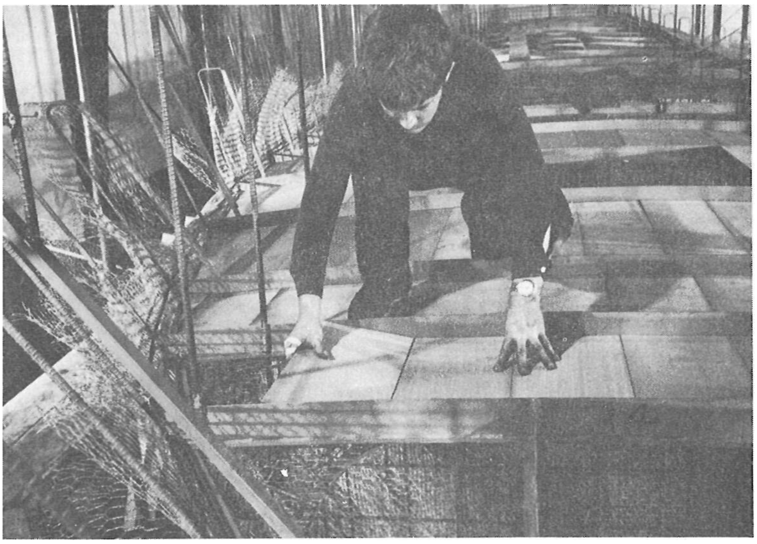

Sawing the planks to size.


Beveling the edge of the planking to avoid fouling the welding beads on the deck beams.

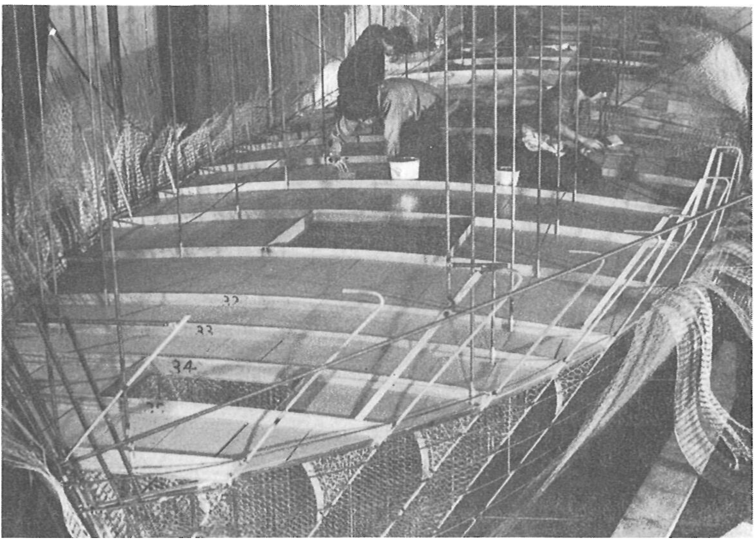

Throwing the prepared plank to the man on deck.



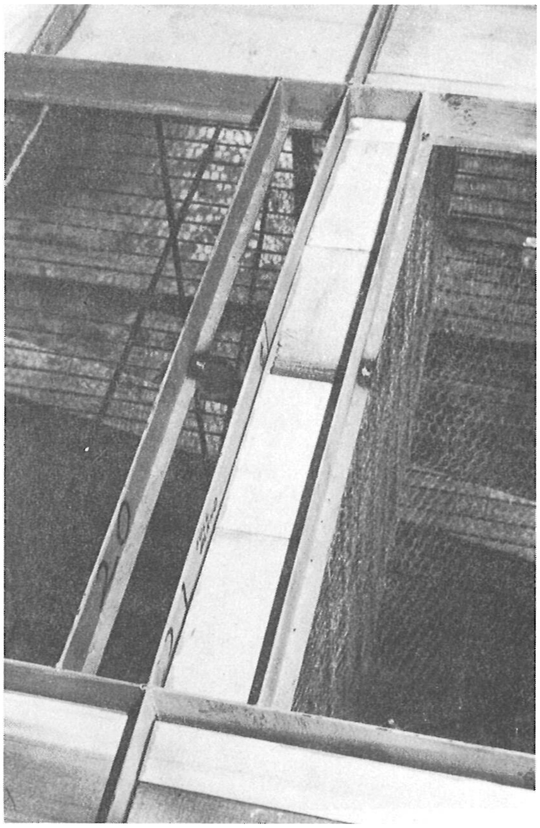
Sealing the edges of the planks with red lead paint.



Inserting the tongue of the plank into the groove of the preceding one.



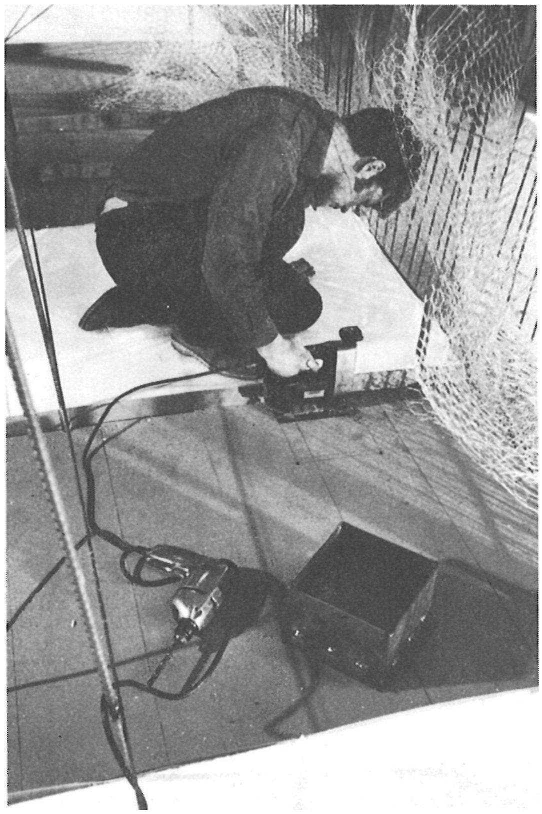
Painting the topside of the deckhead planking after installation.



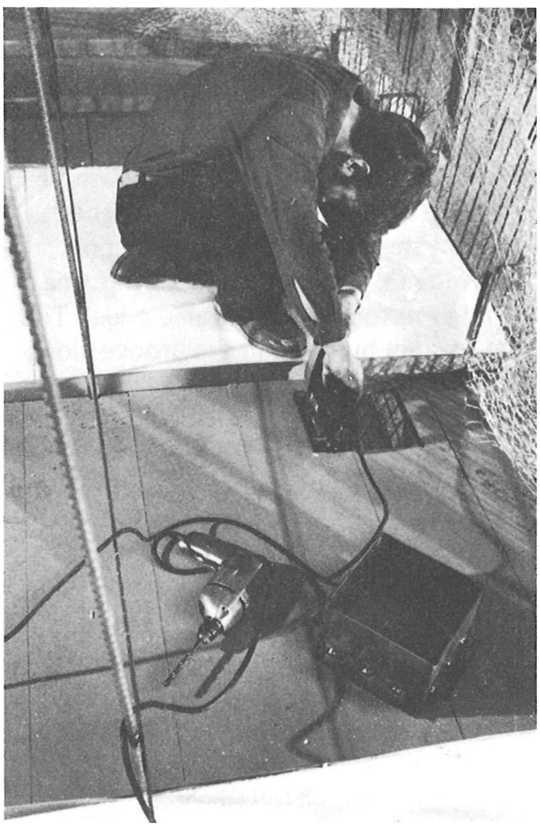
Detail of planking between the midships hatches.

TASK 2 — Installing Deck Ventilator Coamings

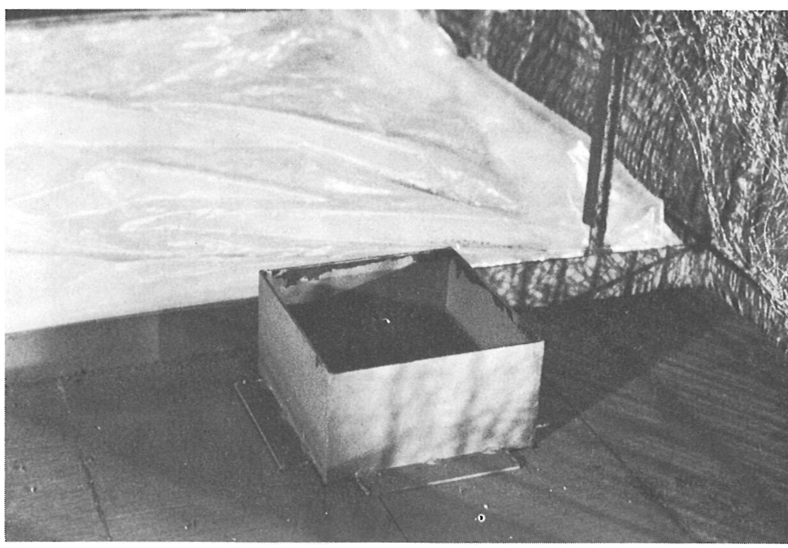
The deck ventilator coamings which were fabricated in Job 2, Task 4, are ready for installation. Measurements for locating the six ventilator coamings are shown in Figure 5. The positions are then marked accurately on the topside of the deckhead wooden lining. A hole is drilled through the planking at each corner of the 6" x 6" (150 mm x 150 mm) aperture marking, the sides are cut away with a saber or key-hole saw. The square aperture is then trimmed to a snug fit around the coaming with a rasp. The coaming is simply dropped into place, supported on the planking by its two lateral flanges.



Sawing out the marked positions of the deck ventilator coamings.



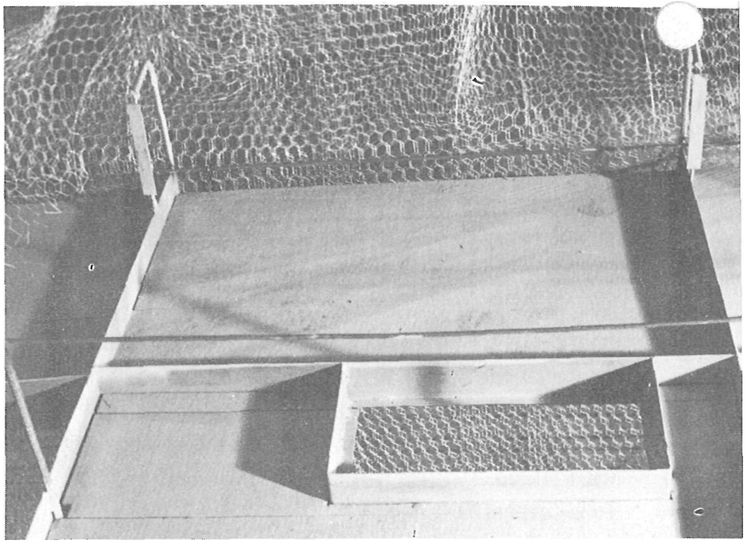
A power drill and saber saw are used for cutting through the planking.



The coaming, already painted, rests on its supports in the aperture.

TASK 3 - Paint Deckhead Planking

The tongue-and-groove deckhead planking had previously been primed with red lead paint only on its edges. The top-side surface of the planking may now be painted. If the underside of the red cedar planking is not to be clear varnished this also may now be primed with red lead paint.



Detail of painted deckhead planking around engine room vent.

TASK 4 - Fitting Insulation Material

Polyurethane foam insulation material is generally supplied in slabs four feet (1,200 mm) wide and in varying length multiples of two feet (600 mm) up to 12 feet (3,660 mm), maximum length. The thickness of the slab required is two inches (50 mm). It is more economical to use the longest slabs available when ordering this material.

The slabs of foam insulation material are sawn into lengths of one meter (39 inches) with a power saw. The sawn slabs are then checked for fit, trimmed if necessary, then wrapped with 4-mil vinyl sheeting which has been previously laid over the deck. The slabs are fitted between the deckbeams above the wooden deckhead lining.

At the deck sheer line, where the deck joins the sides of the hull, the slabs of foam insulation material are beveled at 45° to half their thickness. When the deck is plastered the concrete will be well vibrated into this groove formed by the beveled edge of the slabs and so form a good strong joint of deck to hull side. Care must be taken not to form too deep a beveled edge. Too much concrete will build up in the groove along the sheer line bringing unnecessary weight to the hull.

The procedure for laying the foam insulation slabs is as follows:

1. Clear vinyl sheeting, 4 mil thick, is laid over the deckhead planking and stapled down lightly to keep it spread open between the deck beams. Sufficient lap is given to the sheeting to enable it to fold over the slab completely when laid in place.

Plastic sheeting is laid over the planking and lightly stapled down. Sufficient lap is given to enable the sheeting to enfold the foam.

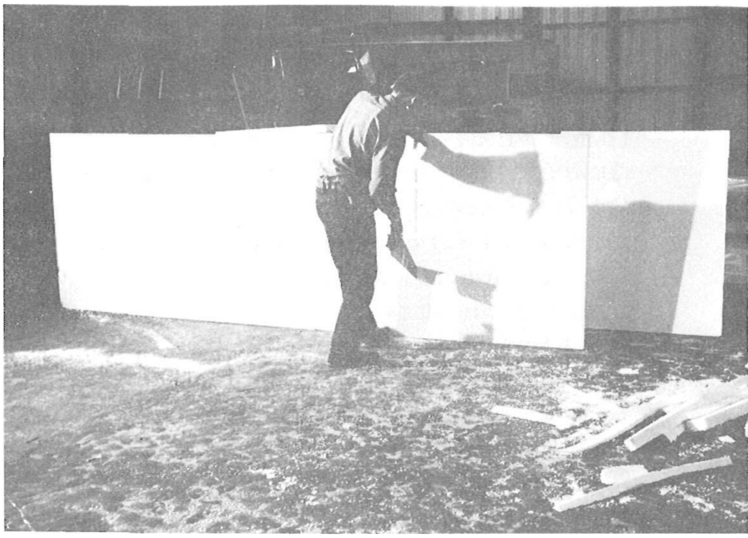
2. The 4'x 12' x 2" (1220 mm x 3660 mm x 50 mm) polyurethane foam material is sawn into one-meter (39 inches) lengths with a hand saw.

3. A man stationed on deck checks and marks the slabs for fit and trim. Where the slab intercepts a hatch opening or ventilator coaming it is marked for cutting. Where the slab adjoins the hull side it is marked for cutting and beveling.

4. The slab is cut according to the marks, beveled if required.

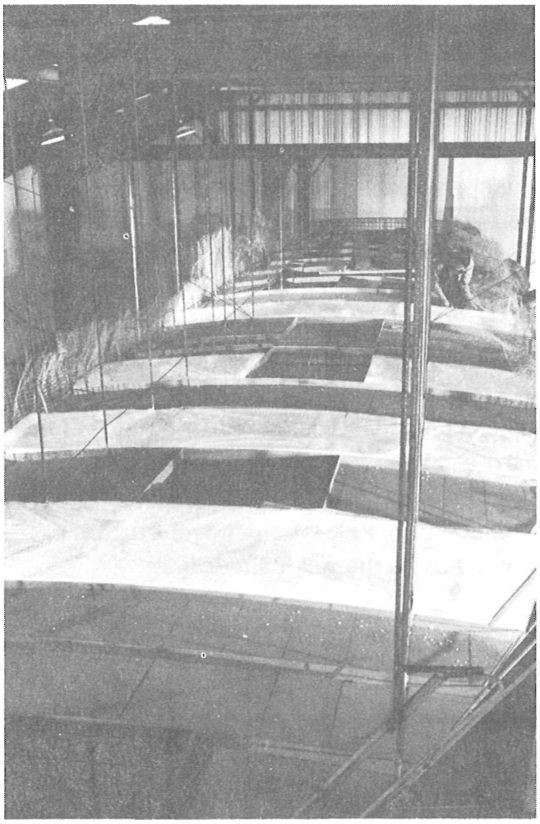
5. The slab is checked for fit.

6. The slab is fitted into place, above the deckhead planking, between the deckbeams. The surplus ends of vinyl sheeting are folded neatly over the top of the slab, wrapping it completely and lightly stapled down.

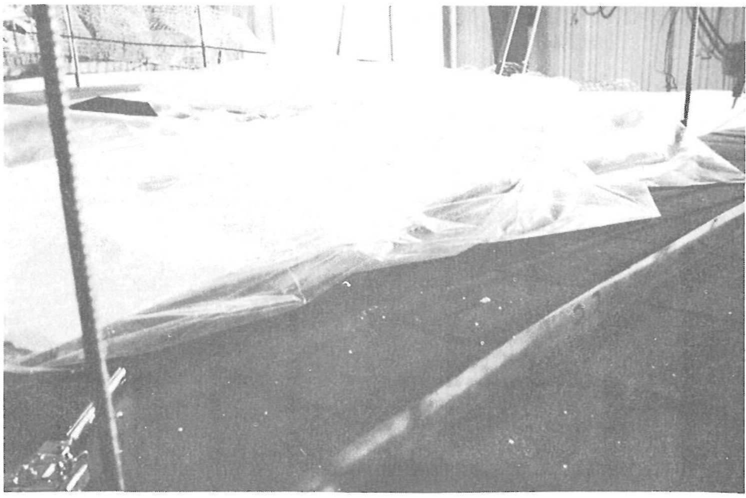


Slabs of polyurethane foam insulation material.

Measuring the area between deck beams for the insulation material.



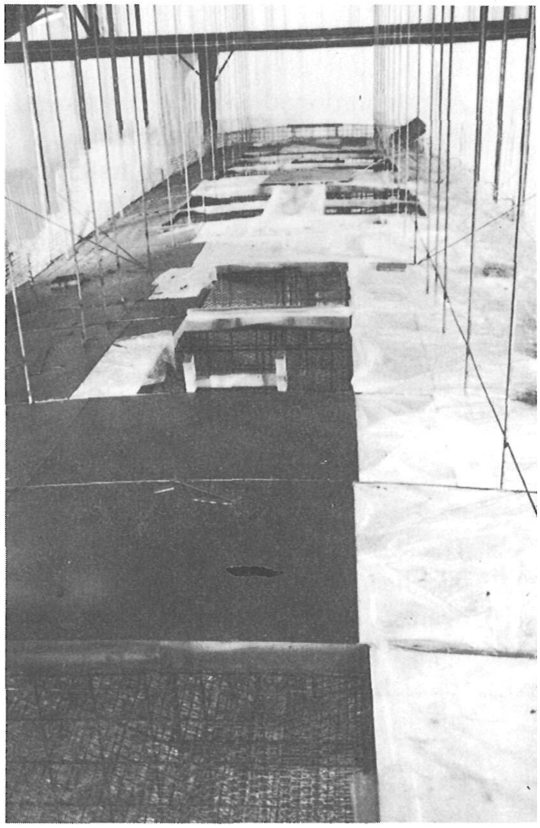
Once the insulation material is fitted into place the ends of the plastic sheeting are folded over the top and stapled down.



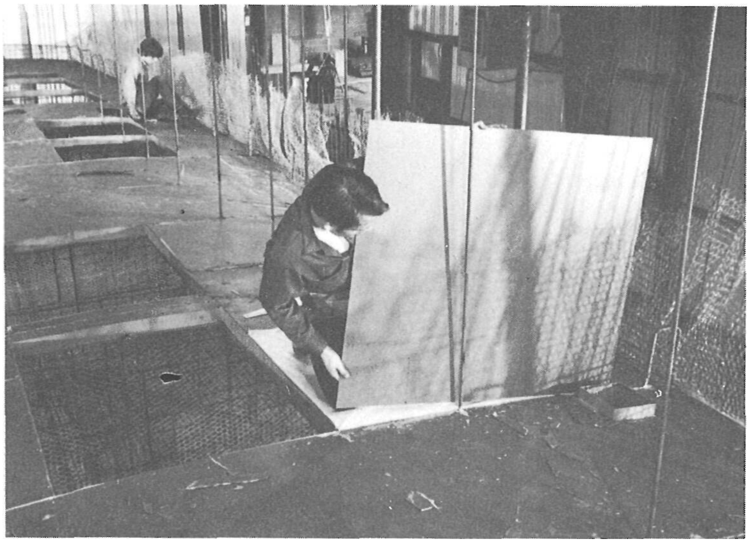
Insulation material in place, plastic sheeting about to be folded over the top. Note hammer stapling tool on left.

TASK 5 — Laying Hardboard Panels Above Deckhead Insulation Material

Compressed hardboard panels, 4' x 8' x 1/8' (1220 mm x 2440 mm x 3 mm), complete the deckhead lining materials. It is fitted between the deck beams above the polyurethane foam insulation material. Its purpose is to give the foam insulation material protection against weld burn when the deck reinforcing rods are welded to the upper edges of the deckbeams. The compressed hardboard, 1/8-inch (3 mm) thick, also secures staples better than the foam insulation material and eases the work of laying the first four layers of mesh over the deck.

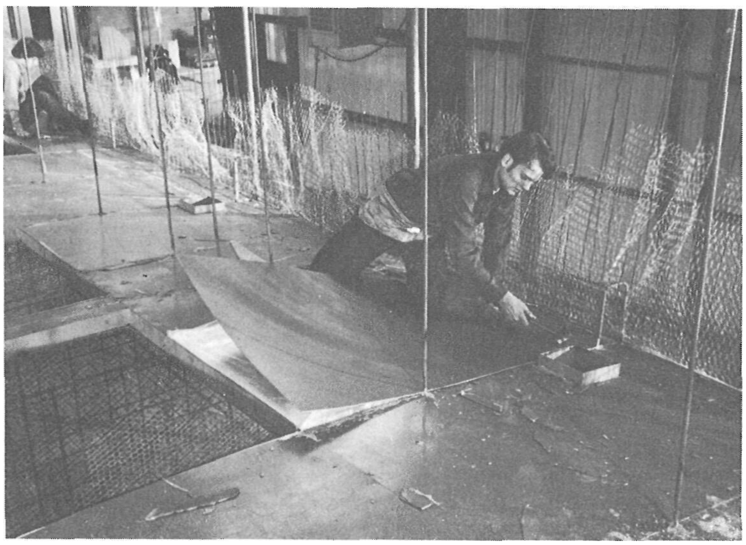


Compressed hardboard panels are laid over the insulation material, between the deck beams.



Fitting the hardboard panels.

The compressed hardboard panels are cut into one-meter (39 inches) lengths and fitted between the deck beams. Due to the thickness of the deckhead planking and the wrapped foam insulation material, the hardboard panels finish virtually level with the upper edge of the deck beams. The panels are secured to the deckhead lining below with galvanized roofing nails. The hardboard is cut to fit nearly around hatch openings and ventilator coamings. The panels are cut to the starting edge of the bevel on the insulation slabs at the deck sheer line.



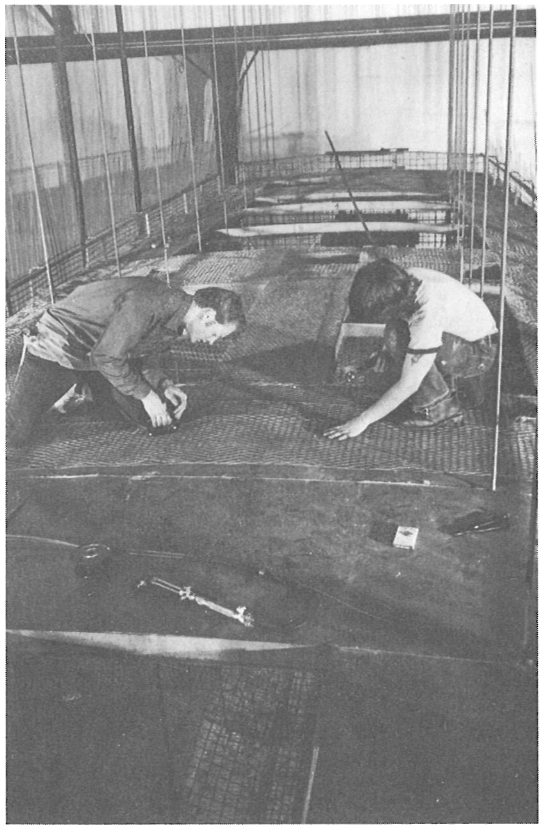
The panels are lightly nailed down with galvanized roofing nails.

STAGE 2-JOB 4
LAYING MESH AND RODS ON DECK

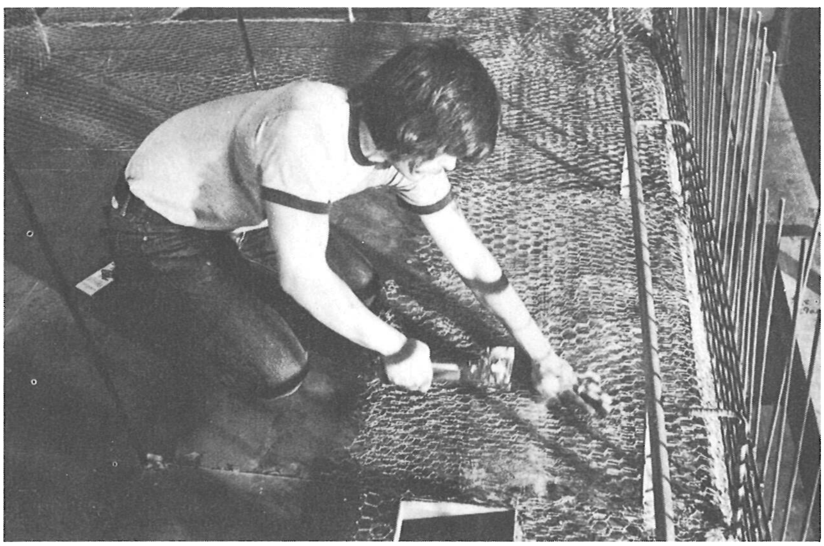
The deckhead lining with its layers of planking, insulation material, and protective covering of compressed hardboard is now complete. The deckhead lining so prepared has now formed a convenient mold on which to lay down the mesh and rod reinforcing for the ferro-cement deck.

The reinforcing for the deck is as follows: four layers of mesh, longitudinal reinforcing rods at 3-inch (75 mm) centers, athwartship rods at 3-inch (75 mm) centers, another four layers of mesh on top.

The deck reinforcing combines with the hull reinforcing to form one, integral unit. Deck longitudinal rods project fore and aft over the sheer to be turned downwards and welded to the hull reinforcing rods. Athwartship rods project through the bulwarks at the sheer, their ends to be alternately turned downwards and upwards and welded to the hull reinforcing. Mesh left surplus at the sheer when the first four layers were applied to the hull is turned and stapled down to merge with the first four layers of mesh on the deck. The four upper layers of mesh on deck are folded upwards to merge with the mesh fastened to the inside of the bulwarks.



First strips of mesh are stapled to the deckhead lining which now forms an effective insulated mold for the ferro-cement deck.

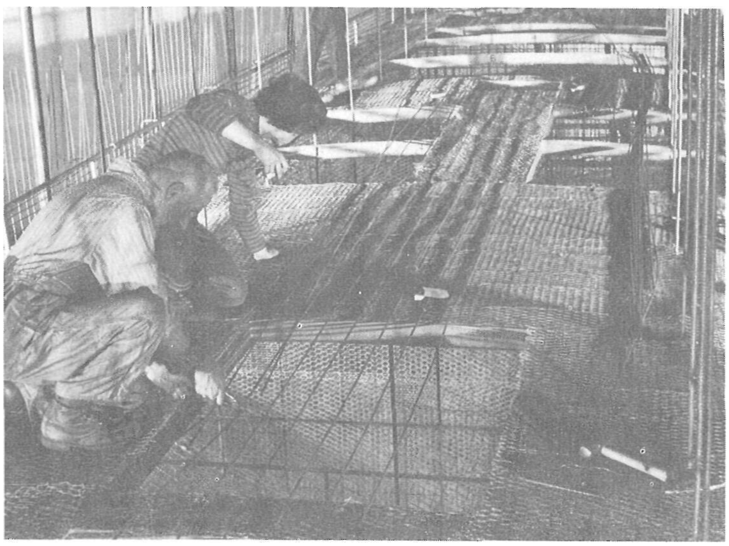


The surplus ends of the four inner layers of mesh fastened to the hull are stapled down to the deckhead lining. Note the 45° beveled edge to the deck insulation at side.

Four layers of mesh are stapled down.

TASK 1 — Laying First Four Layers of Mesh on Deck

Folded strips of mesh are laid athwartships over the deck. The mesh is fastened with a minimum of 1/2" (50 mm) staples to the hardboard deck lining. At the sheer, the 6" (150 mm) strips of mesh left surplus from the hull mesh are folded down and stapled over the deck mesh. Two layers of folded strips are laid over the deck, each strip lapping the next, making four layers of mesh in this first application. As an economical measure, it is a good idea to use on the deck all short pieces of folded mesh which have been left over from previous work.



Longitudinal reinforcing rods are laid over the mesh and welded to the top edges of the deck beams.

TASK 2 - Weld Longitudinal Reinforcing Rods Over Deck Beams

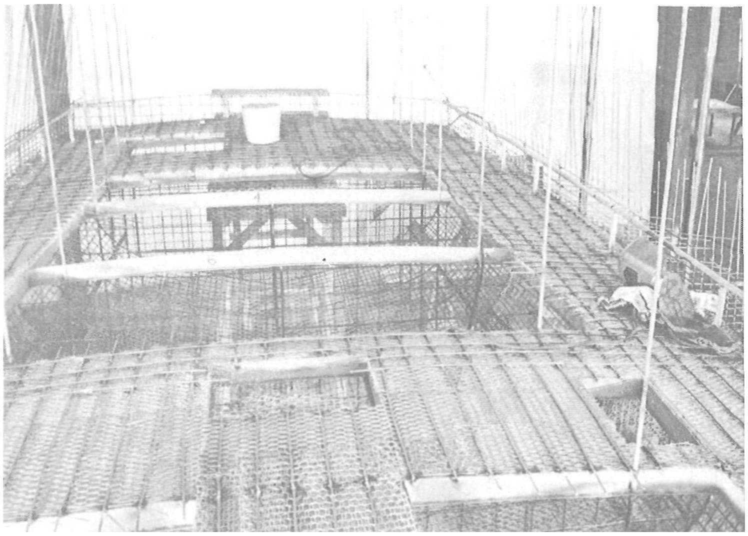
Reinforcing rods of 1/4" (7 mm) diameter are laid longitudinally over the first four layers of deck mesh. The rods are spaced at 3" (75 mm) centers and are welded through the mesh to the top edges of the deck beams. The top edge of the deck beam was left clear of the hardboard panels as described in Job 3, Task 5.

The rods are allowed to run through the bulwarks fore and aft and are clipped off at 3" (75 mm) beyond the sheer. Where the rods encounter a deck aperture they are clipped off at 3" (75 mm) beyond the deck beams. Where the rods encounter a deck ventilator coaming they are butt-welded to the steel coamings.

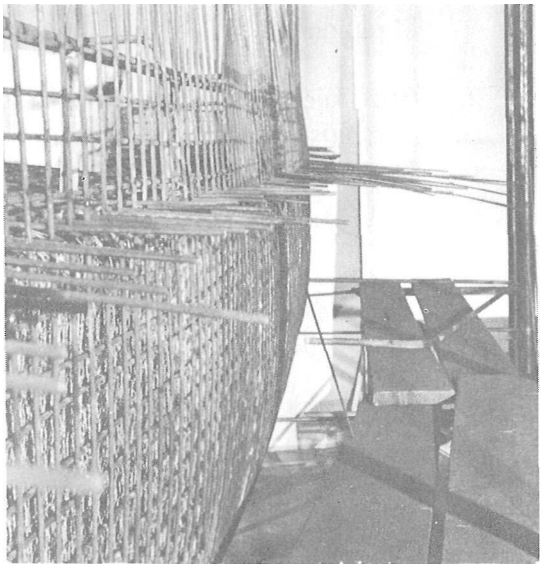
Welded longitudinal deck rods, looking forward.

TASK 3 - Weld Athwartship Reinforcing Rods Above Deck Longitudinal Rods

Reinforcing rods of 1/4" (7 mm) diameter are laid athwartships over the deck longitudinal reinforcing rods. The rods are spaced at 3" (75 mm) centers and are welded to the longitudinal rods.

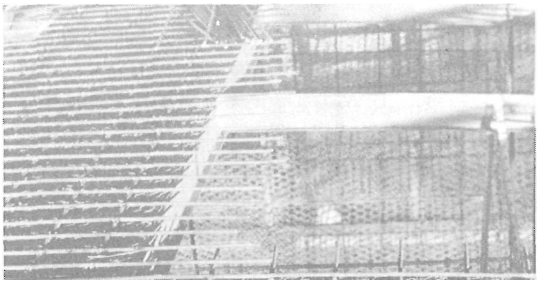


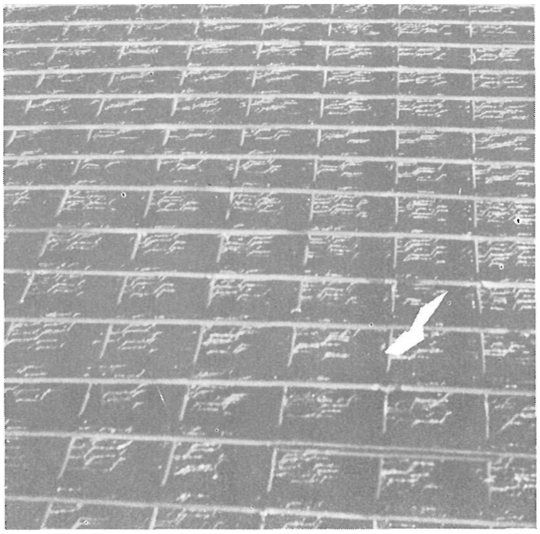
Athwartship rods are welded over the deck longitudinal rods. Note rods left projecting at deck apertures.



Athwartship deck rods protrude at the sheer line.

The rods are allowed to run clear through the bulwarks to port and starboard. They are clipped off at 3" (75 mm) beyond the sheer. When the rods encounter a deck aperture they are clipped off at 3" (75 mm) beyond the longitudinal deck girders. The rods are butt-welded to the steel ventilator coaming.





Deck rod reinforcing complete.

STAGE 2-JOB 5

TASK 1 - Apply Bulwarks Screed

The screed used to finish the longitudinal inside edge of the bulwarks is 3/4" (19 mm) I.D. piping. The piping is galvanized as part of it will remain exposed to the weather once the bulwarks have been concreted. This screed runs around the entire hull on the inside edge of the bulwarks.

The builder's attention is drawn to Stage 1, Job 3, Task 8, which describes the fabrication of the bulwark supports on the hull frames. Here provision was made for the longitudinal piping screed to nestle into the bulwark support at the top of the vertical T-bar screed. (See photograph of completed bulwark support which accompanies the above-mentioned task.)

Great care must be exercised in laying and bending the screed fairly to the bulwarks as it forms one of the principal eye-catching lines to the completed hull. For right-'angle curves in the screed, as the ones required at the turn of the transom and at the stem-head, a hydraulic pipe-bender should be used. The curves of the bulwarks screed at the bow are best preformed on the lofting floor. Ensure that good ventilation is available before beginning welding work on the piping screed as the galvanizing releases objectionable fumes.

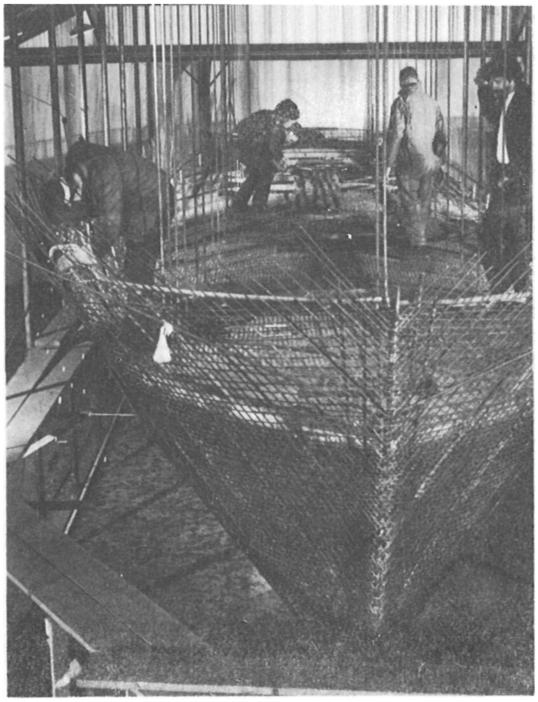
The procedure is as follows:

1. The 3/4" (19 mm) I.D. galvanized piping is fastened with tie wire to the bulwark supports along the midships and stern sections.

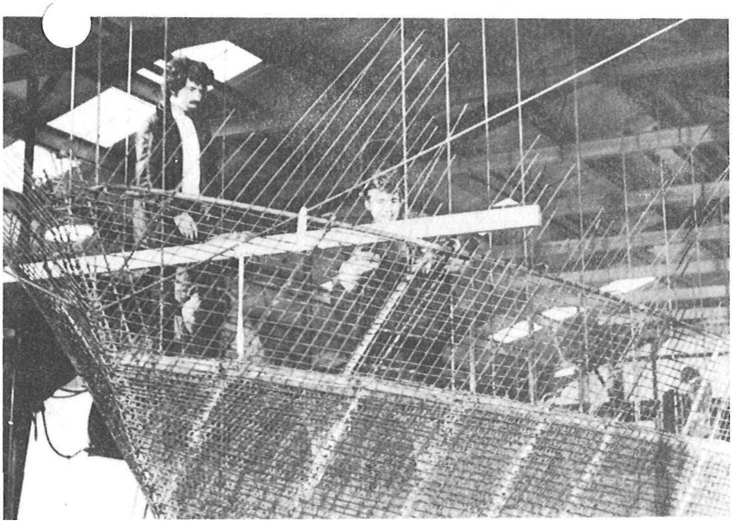
2. The piping is checked for fairness. The bulwark supports are adjusted by cutting and welding until the piping screed lies fair on the supports. Lengths of piping are butt-welded together.

3. Once fair, the piping screed in the midships and stern sections is welded to the bulwark supports.

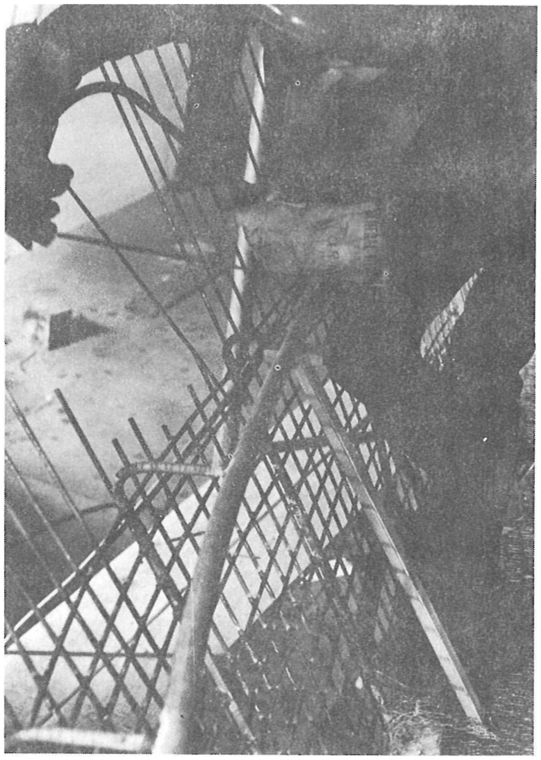
The piping bulwarks screed nestles into the bulwarks supports.



Installing the bulwarks screed.



The curves of the piping screed at the bow are difficult to form and are best pre-formed on the lofting floor.

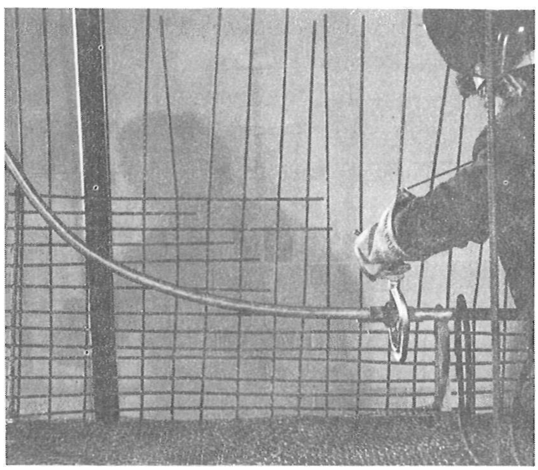


Welding the screed into place at the bow.

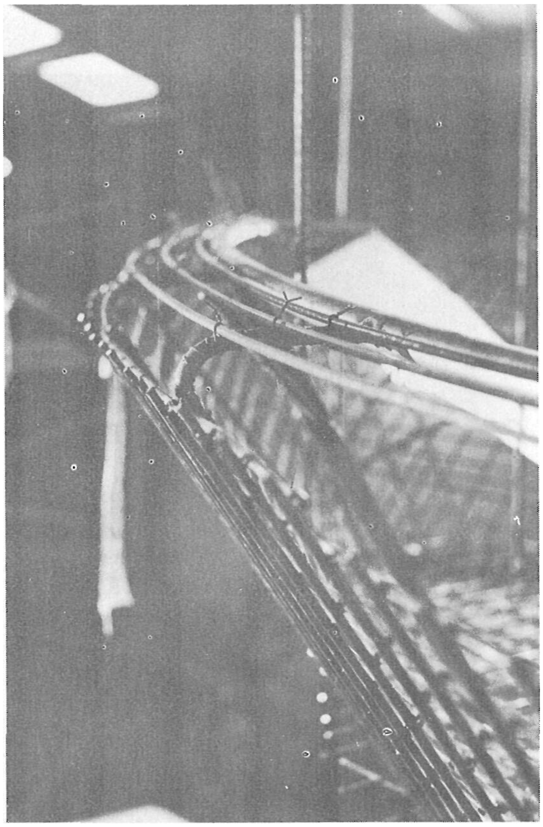
Two short lengths of pipe are heated and bent to conform to the hull profile lines on the lofting floor at the turn of the raised bulwarks to the bow. Longer lengths of pipe are taken for inside the bow bulwarks and curved gently on the lofting floor to conform to the shape of the sheerline. (See Stage 1, Job 1, Task 6, Figure 19.) After checking for fairness, the piping screed is welded to the bulwark supports.

The right-angle curves to the piping screed at the turn of the transom and at the stem-head are formed in an hydraulic pipe-bender. The short pieces at the stem-head are butt-welded into place.

The transom bulwark screed is made last. The pipe is bent gently to accompany the athwartship curve of the transom. The two sharp curves bent in the hydraulic bender at (par 5) are then welded to the transom piping screed. These curves form reinforcing "knees" to the transom corner of the bulwarks. This complete piece is supported with T-bar struts at three points along its length and butt-welded to the port and starboard bulwark screeds.



A pre-formed section of piping screed is welded into place at the turn of the raised bulwarks forward.



Longitudinal reinforcing rods accompanying the curve of the bulwarks piping screed at the bow. Note that rods are fastened into place with tie wire prior to welding.

The vertical reinforcing rods had previously been left untrimrned at the sheer. (See Stage 2, Job 1, Task 7.) In practice it is difficult to measure the exact point on the hull vertical rods where they should be bent over at the sheet to meet the bulwarks piping screed. This is due, in part, to the fact that the sheer line is a gentle compound curve. It is further complicated by the weld distortion which has occurred to the reinforcing framework of the bulwarks. For this reason pre-bent rods are prepared for forming the radius at the bulwarks sheer. Existing hull vertical rods are cut off just below the sheer and these pre-bent pieces of rod are lap-welded to them after fairing and alignment.

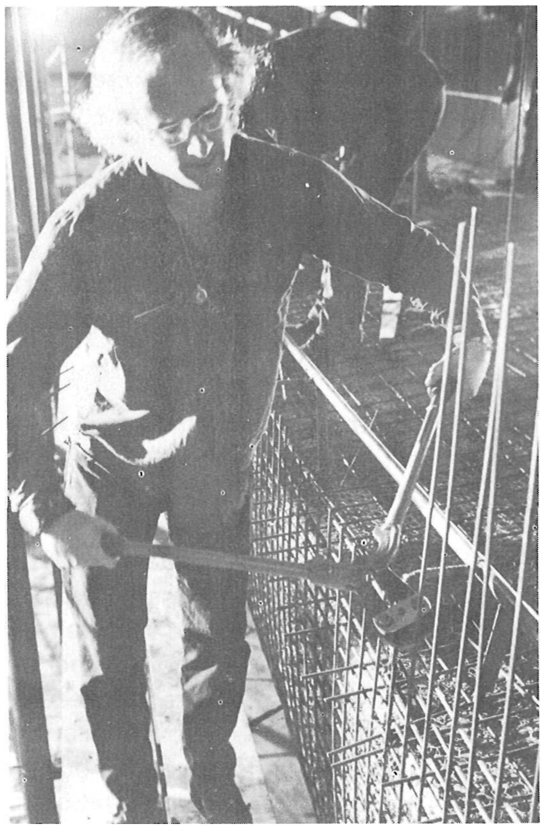
The bulwarks sheer rods are made of 1/4" (7 mm) diameter rods in exactly the same way as the starter rods described in Stage 2, Job 1, Tasks 8 and 9.

TASK 2 — Weld Bulwarks Longitudinal Rods

With the galvanized piping screed in place, longitudinal reinforcing rods may now be laid on top of the horizontal arms of the bulwark supports. Three 1/4-inch (7 mm) diameter rods are laid at equal spacings on top of the bulwarks supports and accompany the curve of the piping screed. The rods are welded to the bulwark supports.

TASK 3 — Bend Bulwark Sheer Rods

In service, a ferro-cement hull is always vulnerable to chipping at the bulwarks sheer line. To minimize chances of damage along the sheer the bulwarks are neatly rounded off. This is achieved by giving, first of all, a radius to the vertical rods which form parts of the bulwark reinforcing.



Clipping off excess lengths of vertical rod just below the bulwarks sheer line.

TASK 4 - Fair Bulwarks and Weld Sheer Rods in Place

The hull reinforcing framework at the bulwarks sides must be faired perfectly smooth before welding the sheer rods in place. The untrimmed lengths of vertical reinforcing rod are first cut off at 3" (75 mm) below the sheer and the procedure is then as follows:

1. A batten is laid horizontally along the outside of the bulwarks reinforcing framework and the framework checked for fairness.

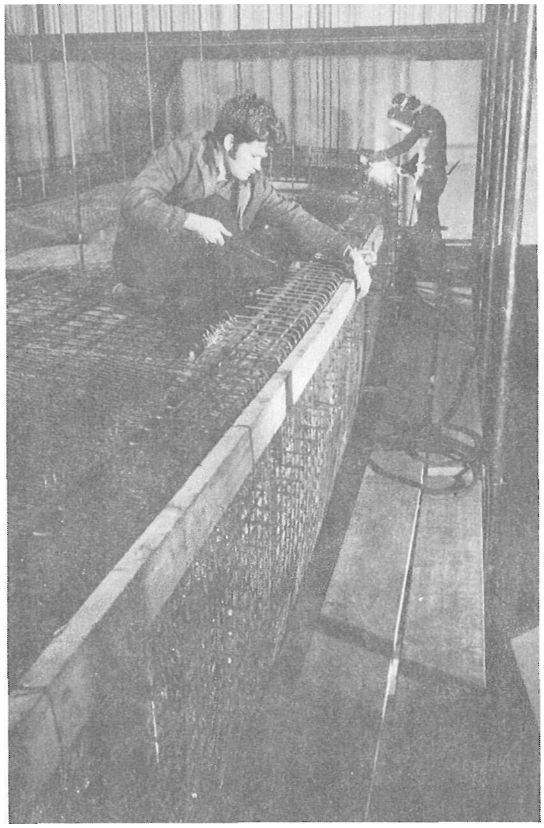
2. Unfair sections are pounded smooth and fair, checking constantly with the use of a batten.

3. When a section of bulwarks reinforcing becomes fair, a batten is temporarily fastened with wire between two hull frames at a point immediately below the bulwarks sheer line.

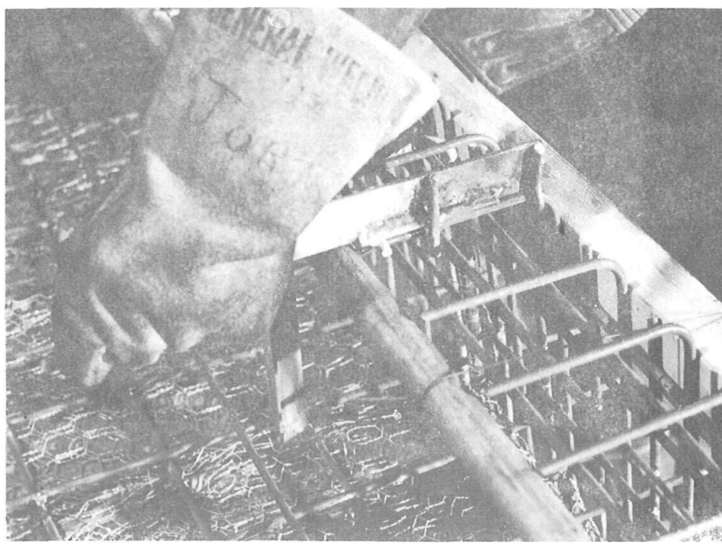
4. The sheer rods are lap-welded to the vertical reinforcing rods in the bulwarks framework. The vertical positioning of the bulwarks sheer rod is guaranteed by the batten fastened in (par 3). The positioning on the horizontal plane is guaranteed by the three underlying longitudinal rods which were welded in place in Task 2.

5. The horizontal arms of the sheer rods are cut off at the bulwarks screed.

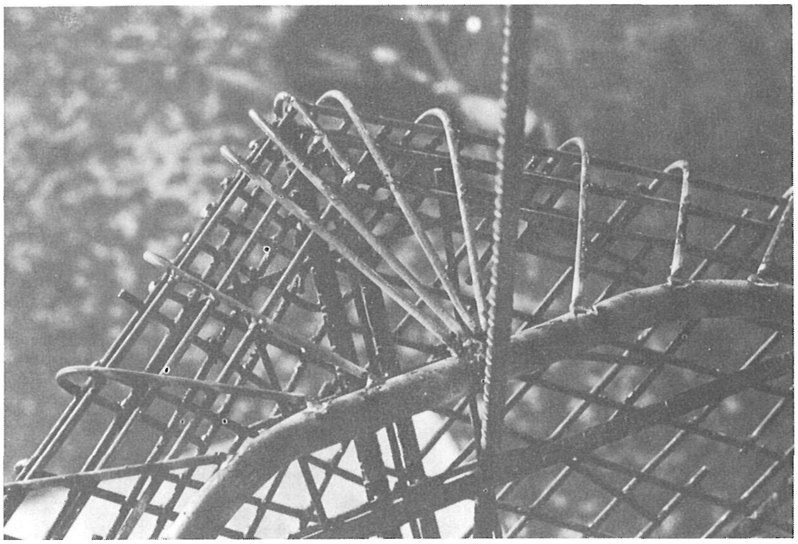
6. The horizontal arms of the sheer rods are welded to the galvanized piping screed and to the longitudinal reinforcing rods.



Using a 2" x 4" (45 mm x 90 mm) batten to fair the bulwarks and align the bulwarks sheer rods.

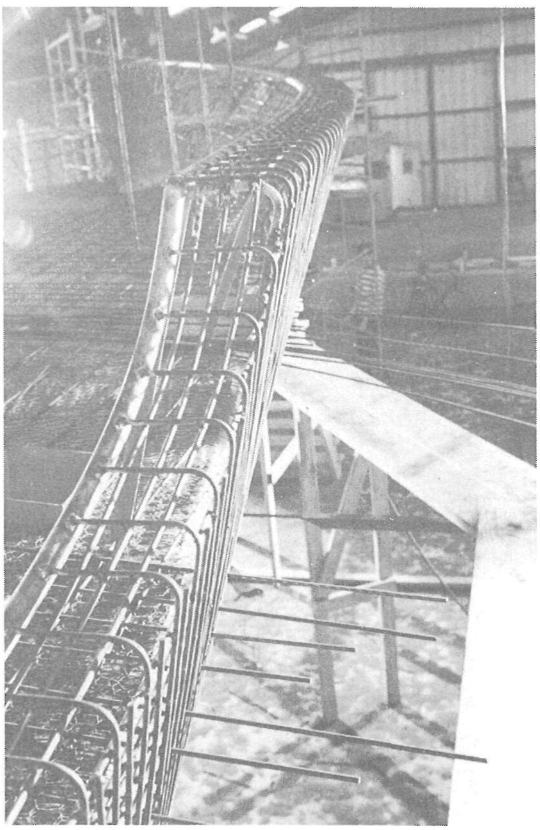


Clamp made to secure bulwarks sheer rods in place for welding to piping screed.



Detail at the stem-head.

This procedure is followed all around the bulwarks sheer. The transom and the bow require the use of more flexible battens than along the sides. A 2" x 4" (45 mm x 90 mm) piece makes a good batten for the bulwarks sides.



The bulwarks sheer rods at the bow expertly welded into place.

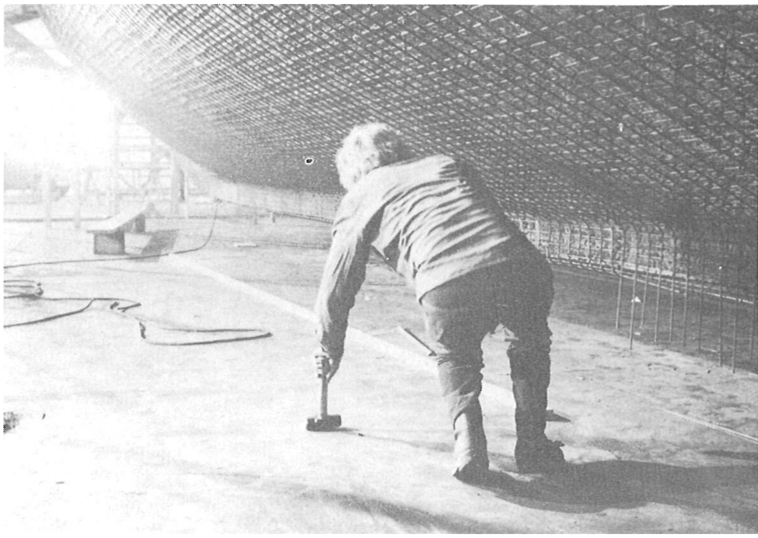
The bulwarks sheer rods at the bow require accurate alignment.

TASK 5 - Fair Hull Steel Reinforcing

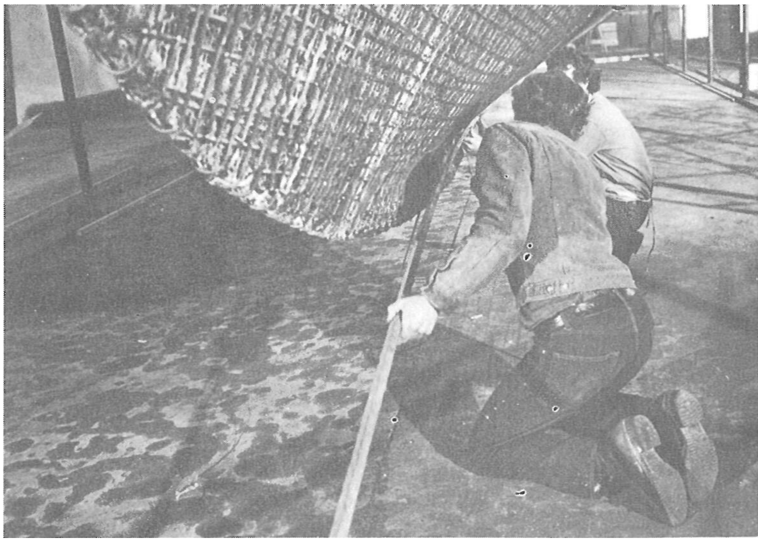
It is at this stage in the construction that the entire hull steel reinforcing framework requires fairing. The welding has caused distortion to the rod reinforcing between the hull frames. The reinforcing rods, however, are mild steel and pounding with 2-lb (1 kilo) short-handed hammers will soon bring the intervening framework into fair.

The bulwark sides have already been pounded fair in Task 4. While work proceeds on Task 4 (welding the bulwarks sheer rods in place), the crew who are working on the fairing may continue working downwards on the hull. The sheer line, where the deck meets the hull sides, is the next critical area to be faired for here the protruding ends of the deck reinforcing rods are to be bent downwards and upwards, alternately, and welded to the hull reinforcing rods.

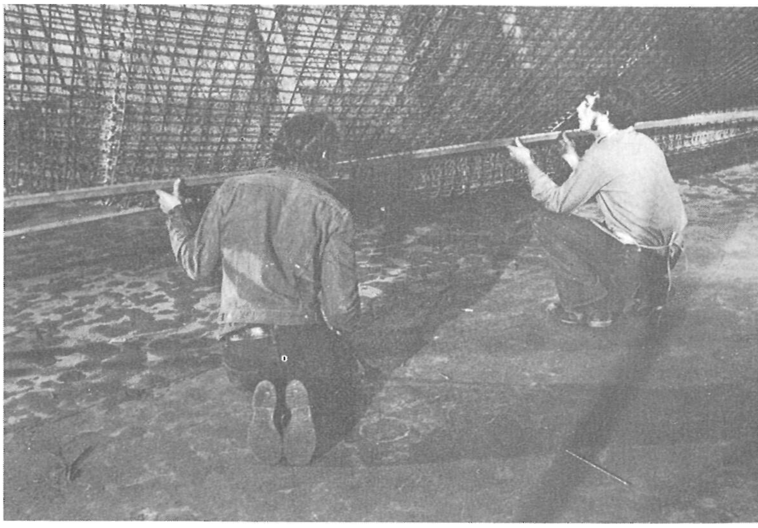
Fairing the hull reinforcing is a long, painstaking job. It must be done with great care for any deformity left in the reinforcing framework will eventually show in the concreted hull. It is recommended that a four-man crew be used: two men to bend the batten to the hull, to sight along the batten and to give directions to the two men with hammers, one inside and one outside the hull, who will pound the reinforcing framework into shape.



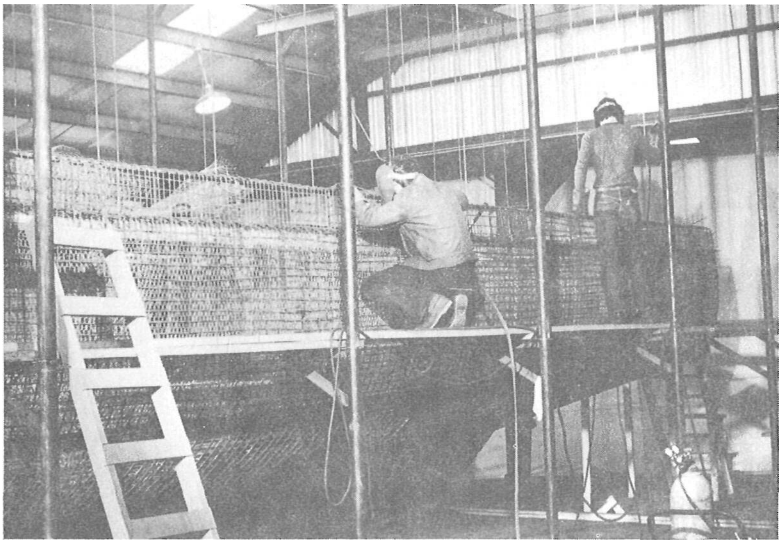
Checking the entire hull reinforcing framework for deformations caused by welding.



A pliable batten is used as a final check for hull fairness.



Scarcely visible through the hull reinforcing framework is a third person who pounds the framework outwards on directions from the two.

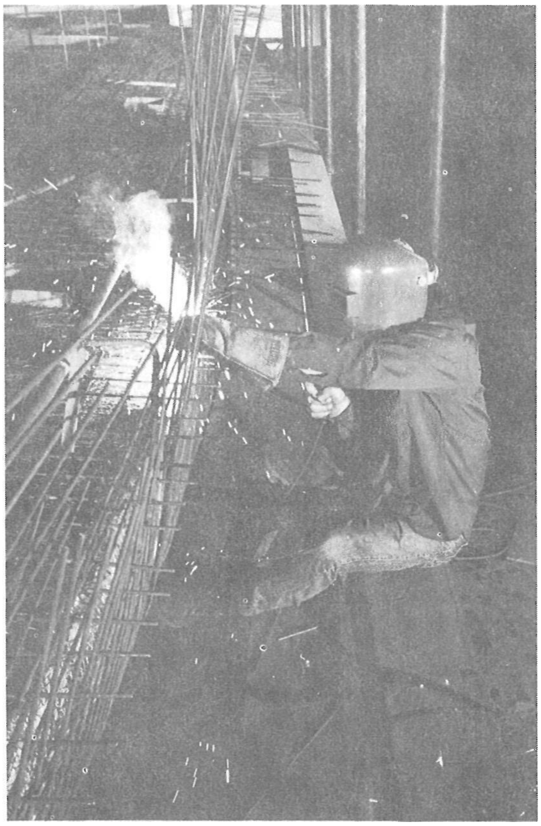


The ends of the deck reinforcing rods are welded one upwards and one downwards, alternately, to the hull reinforcing framework.

TASK 6 - Weld Deck Steel Reinforcing to Hull Framework

The protruding ends of the deck reinforcing rods may now be hammered, alternately downwards and upwards, and lap-welded to the hull vertical reinforcing rods.

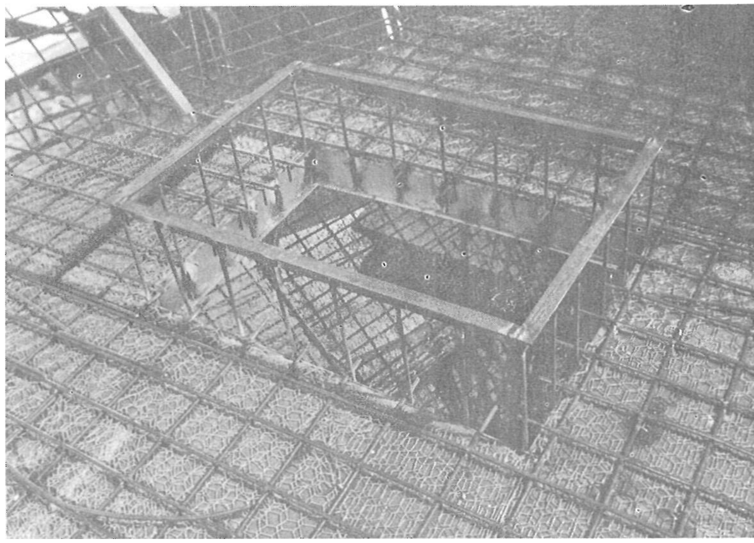
The ends of the rods protruding into the deck apertures and hatches may also be hammered down and welded to the deck beams and longitudinal girders.



Left: A welder starts work bending over the ends of the deck reinforcing rods and lap-welding them to the hull reinforcing framework.

STAGE 2-JOB 6
HATCH COAMING AND SCUPPERS

The deck reinforcing is now complete but for the final four layers of wire mesh which will later be fastened above the second layer of rods. The next step is to prepare the hatch coaming steel reinforcing and weld them into place in the bulwarks.



The hatch coaming screeds are made from T-bar at the welder's workbench then welded to vertical rods placed around the hatch aperture.

TASK 1 — Fabricate Hatch Coaming Screeds

The hatch coaming screeds are made from 1" x 1" x 1/8" T-bar (25 mm x 25 mm x 3 mm) and are welded together on the welding shop floor. The dimensions of the required coamings are shown on Figure 5. It is convenient to take advantage of the welding shop floor or a work bench to make their coaming screeds which are required to be perfectly rectangular and level.

TASK 2 — Weld Hatch Coaming Reinforcing in Place

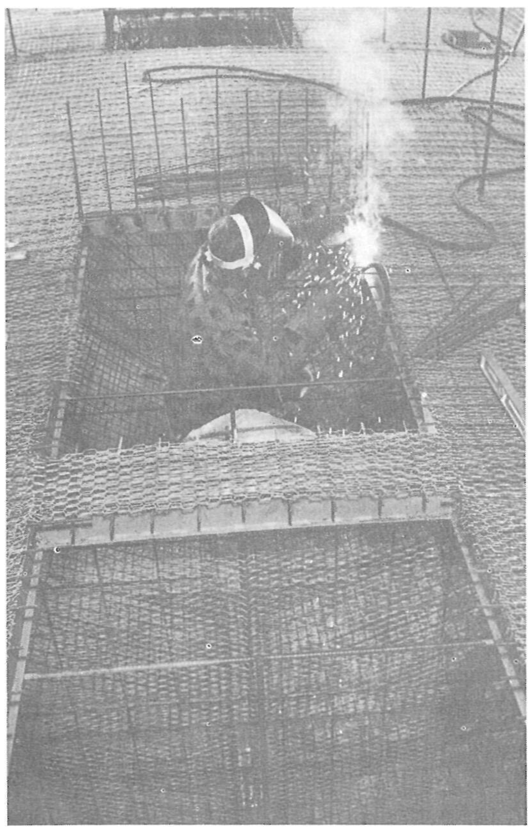
Vertical reinforcing rods of 1/4" (7 mm) diameter, are welded to the sides of the deck beams and longitudinal girders which form the deck apertures. The rods are spaced at 3" (75 mm) centers. The procedure is then as follows:

1. The vertical rods are clipped off at a height of 12" (300 mm) above the deck.

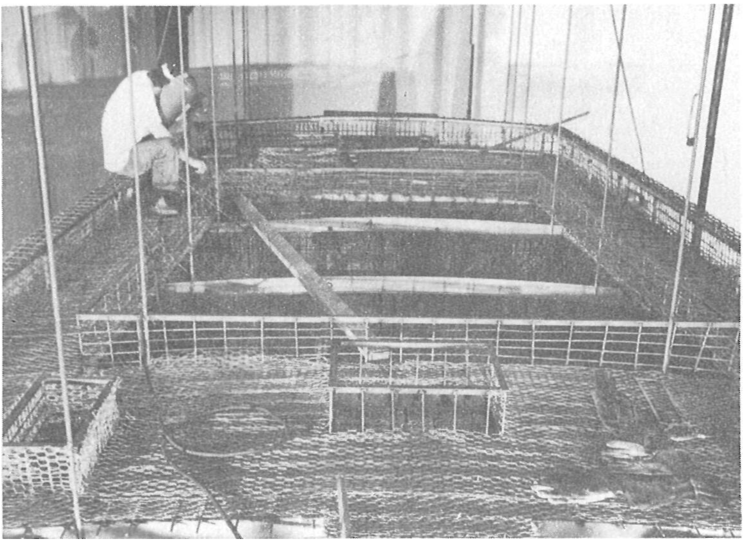
2. The T-bar screed which was prepared in Task 1 is welded to the vertical reinforcing rods.

3. Longitudinal rod is welded around all sides of the hatch coaming at 3" (75 mm) centers to the vertical rods.

All coamings as shown on Figure 5 are prepared in this way.



Welding hatch coaming vertical reinforcing rods into place.

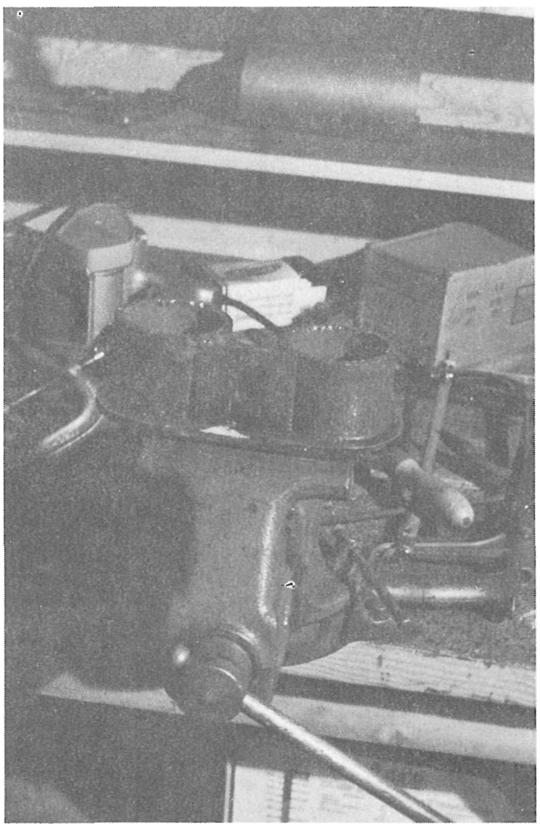


The aft cabin coaming with T-bar screed and longitudinal reinforcing rods already welded in place.

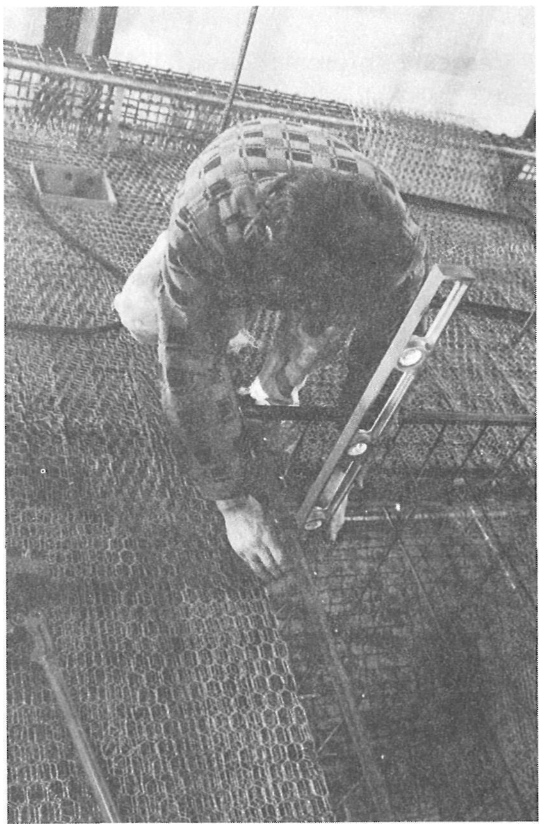
TASK 3 - Make Scuppers

The screeds for the scuppers are made from 1-1/4" x 1/8" (32 mm x 3 mm) flat bar. A simple jig is required for making the round-end scupper screeds. It can be made from two short pieces of 21/2" (64 mm) I.D. steel pipe welded vertically to a common base at 5" (127 mm) centers. The flat bar is heated and bent around the two pipe pieces of the jig and the two ends welded together.

As the scupper screeds will remain exposed to the weather and are constantly subject to chafing from mooring lines, it is recommended that they be galvanized before welding into place. Sand-blasting and painting with epoxy is an alternative to galvanizing if chis facility is not available.

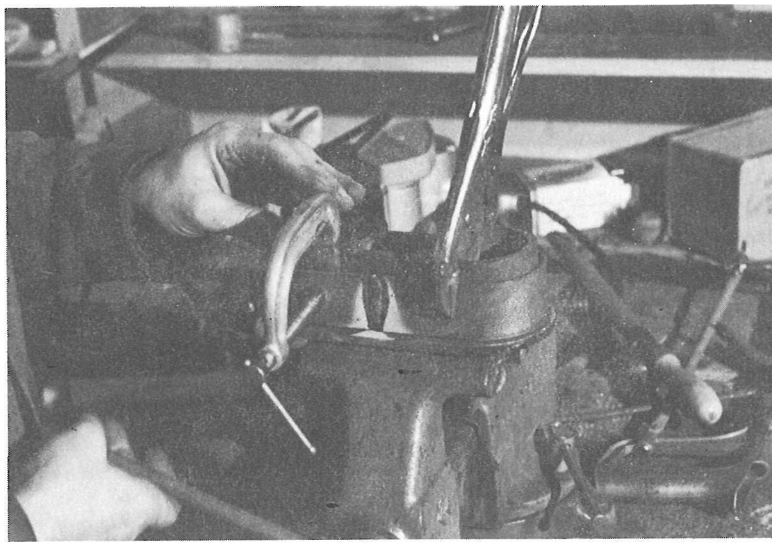


A simple jig for forming scupper screeds made from two pieces of pipe and scraps of flat bar.



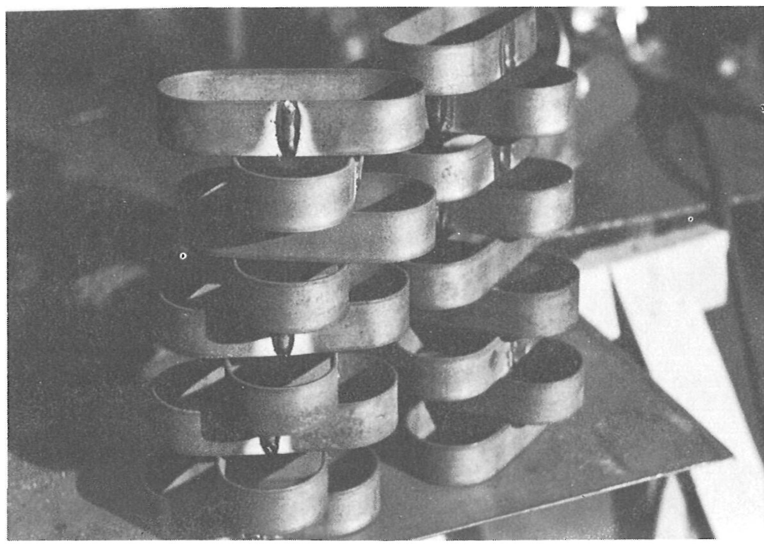
The sides of the coamings are checked for plumb.

A strip of flat bar is heated and bent around the jig, the two ends of the strip of flat bar then welded together.



Removing the scupper screed from the jig.

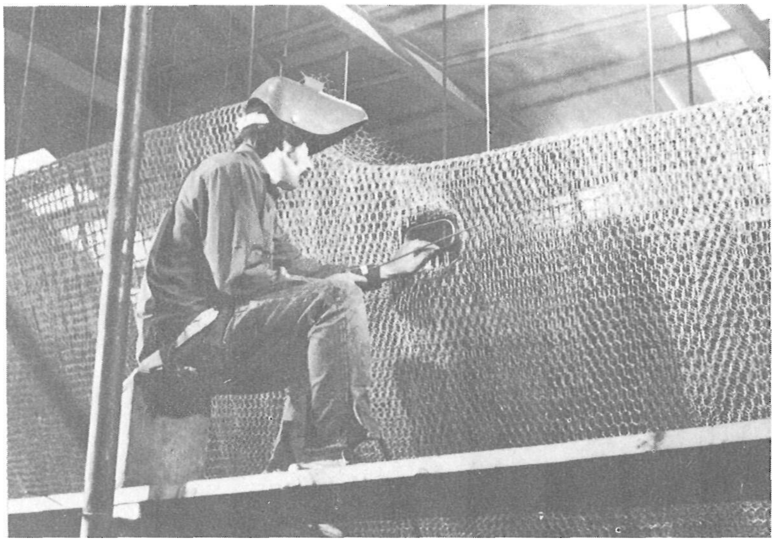
Scuppers ready for hot dip galvanizing.



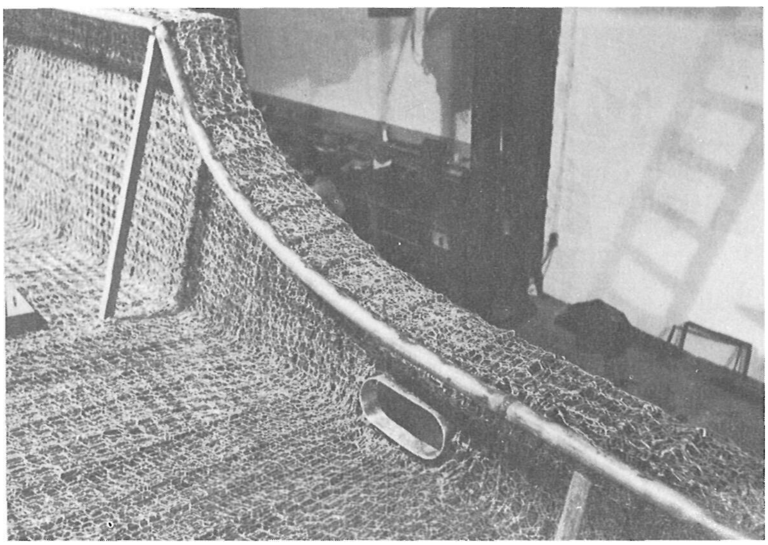
TASK 4 - Weld Scuppers in Place

When marking the positions of the scuppers in the bulwarks, allowance must be made for the surface level of the completed deck. The bottom of the screed must coincide with the level of the deck to give unimpeded passage to water being drained off at sea. The scuppers must also lie perfectly in line with the sheer.

The position of the scuppers are shown on Figures 4 and 5. The profile of the screed is marked into the bulwarks reinforcing rods and the intervening rods are cut out. The scupper screed is then placed into the aperture, and the reinforcing rods butt-welded to the screed. Note that the screed is left sticking out from the vertical reinforcing rods by 1/4" (7 mm). This is to allow for the remaining six outer layers of mesh which are yet to be fastened to the outside of the hull reinforcing. 1-1/4" (32 mm) scupper screeds are used to allow for the thickness of the radius which builds up between the deck and bulwarks.



An opening is cut into the hull reinforcing framework to accommodate the scupper screed.



The scupper screed is welded to the hull reinforcing rods. Its inner edge protrudes marginally beyond the surface of the mesh to allow for the radius which will be formed in concrete between the deck and the bulwarks.

STAGE 2-JOB 7
MESH DECK, COAMING AND BULWARKS

The deck is now ready to receive the final four layers of mesh. The folded strips of mesh will be fastened to the upper layer of the deck reinforcing rods and will be allowed to run up the insides of the bulwarks.

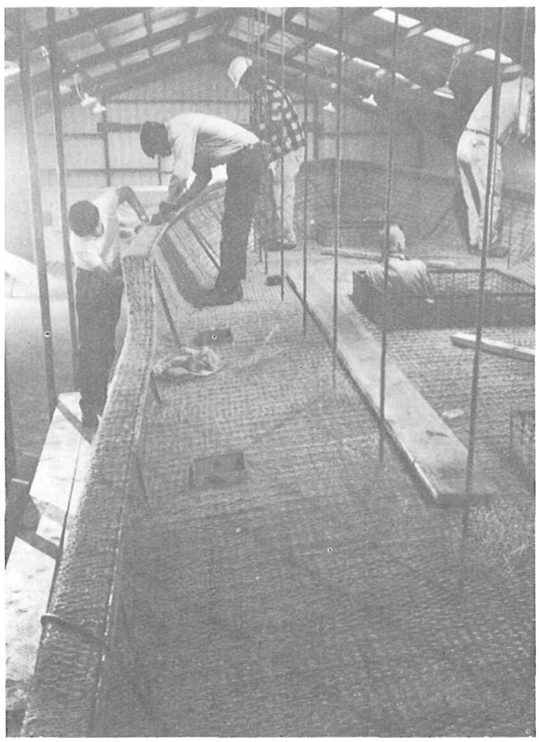
The hatch coamings require mesh, inside and outside. The outside mesh of the coamings will be butted to the mesh covering the deck.

In general, there are two important considerations which the builder must constantly bear in mind when laying and fastening mesh. These are:

1. The layers of mesh are fastened to the welded steel framework of the hull as one continuous, taut covering. All joints of mesh are staggered. The mesh covering hatch coaming and deck knees, for example, is butted to the mesh surrounding these structures on the deck and hull. No laps are permissible in mesh work. If the mesh is lapped one layer over another mortar penetration will become difficult where any extra layers of mesh have built up. Resist the temptation to lap the mesh from hatch coamings to deck mesh, bulkheads to hull mesh, for mortar penetration will be extremely difficult at these joints. 100% mortar penetration in corners is far more desirable than extra mesh in these areas which become riddled with voids in the concrete. The joint between the hull and the deck, or the deck and the cabin (if a concrete cabin is used) is the only joint which is under stress. Both of these joints can be adequately reinforced with steel rods which do a much better job than mesh.

The final layers of mesh are those which make contact with the plasterers' trowels. For this reason the final layers of mesh must be laid and fastened with special care. The surface is required to be taut and flat. If any loose ends of surface mesh are not meticulously fastened down with staples the plasterer's trowel will inevitably find it, will snag in the mesh, and the immediate area becomes impossible to plaster properly.

The decks and broad surfaces of the hull are relatively easy to inspect for loose ends of mesh on the eve of plastering day. Stringers and deck knees, in particular, the inner and undersides of the bulwarks, require more diligent inspection. It is clearly more desirable to have conscientious mesh work carried out in these areas right from the beginning.



Fastening mesh to the deck, coamings and bulwarks.

TASK 1 — Laying Four Layers of Mesh Above Deck Reinforcing Rods

The deck mesh has run up inside the bulwarks and, where possible, has been turned under the bulwarks cap and trimmed off at the screed of galvanized piping. Here, again, the trimmed mesh edges must be well fastened down at the screed and tightly tied at the turn of the bulwarks to the underside of the cap. It is an awkward corner to work to and, if not properly done, will make the plasterer's work doubly difficult.

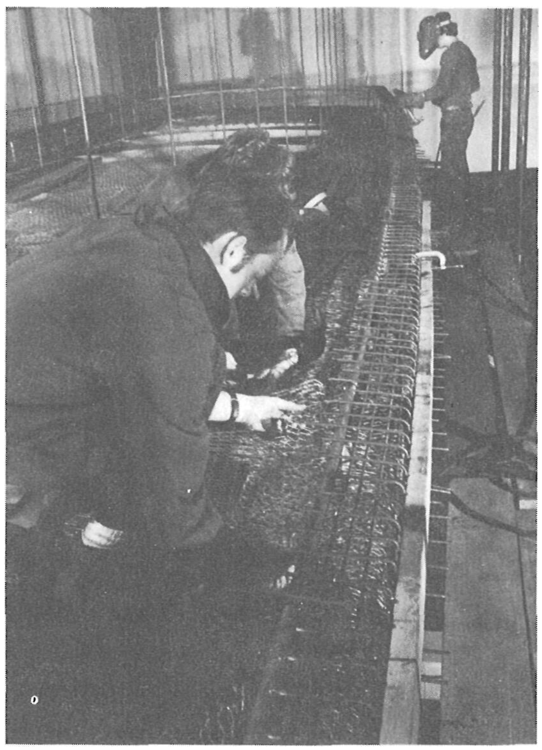
Where the deck mesh has turned upwards at the insides of the bulwarks the mesh has traversed the open top of a "V"-shaped crevice where the beveled edge of the deck mold joins the hull. This "V"-shaped crevice at the deck sheer is designed to form a good strong, watertight bond between deck and hull and mortar will be well vibrated into this crevice on plastering day. It is important that the mesh is well fastened down at the edge of the deck, mold and also at the upwards turn inside the bulwarks in order to facilitate the plasterer's work. If the mesh work is not properly fastened down, too heavy a build-up of concrete will occur at this joint.

Other awkward areas to mesh are the turn of the transom bulwarks and inside the bulwarks at the stem. Pieces of mesh must be cut to fit these areas. The edges of these small mesh pieces often require fastening down with tie wire.

Where mesh terminates at a screed, the following procedure should be adopted.

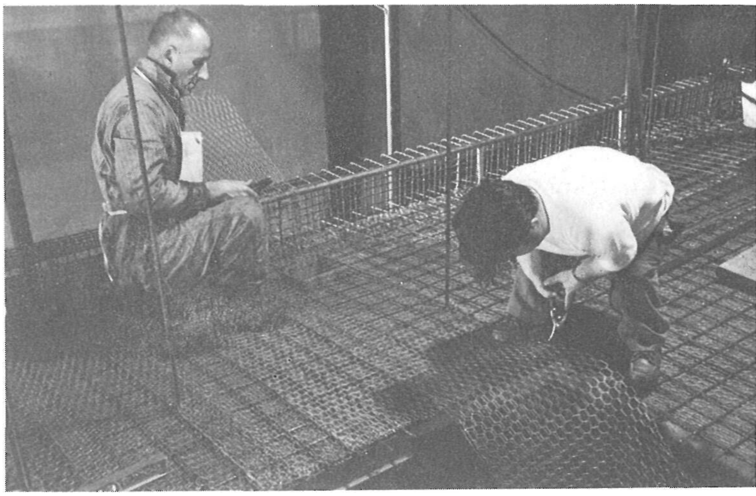
1. Cut 16 or 18 gauge soft annealed tie wire into 2' (610 mm) lengths.
2. Weave the wire through the mesh around the corner reinforcing rod pulling the mesh in tight to the corner.
3. Twist tie the ends of tie wire together where one joins another. Bend the twist into the mesh.

The topmost layers of mesh are allowed to run upwards on the inside of the bulwarks, then terminate under the bulwarks cap.



Fastening the ends of the strips of deck mesh to the bulwarks and under the cap.

Folded strips of mesh are laid athwartships over the deck reinforcing rods and fastened down with hog ring staples. The mesh is allowed to run up inside the bulwarks and underneath the cap. When the mesh encounter coamings it is run up the sides of the coamings and trimmed off at the coaming screed. Four layers of mesh are laid down in strips folded double. The first applications of strips of folded mesh is fully lapped by the second with particular attention being paid to all edges being stapled down flat and to a good surface tension being maintained on the mesh.

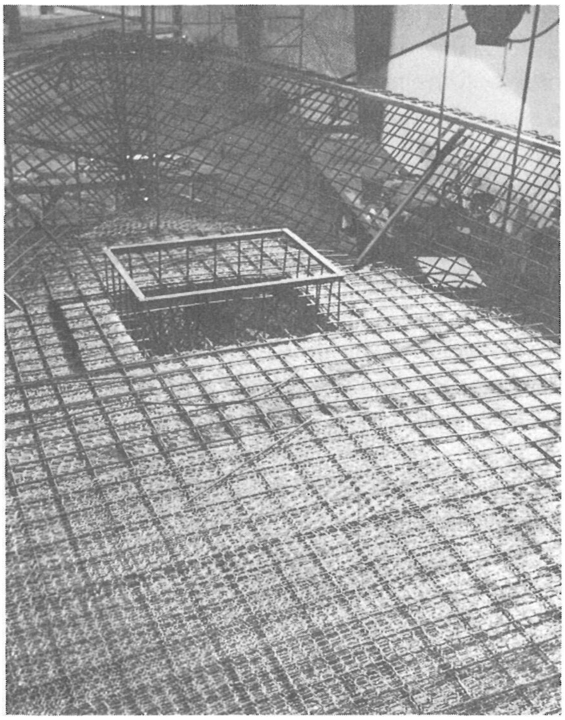


Trimming and fastening strips of mesh on deck.

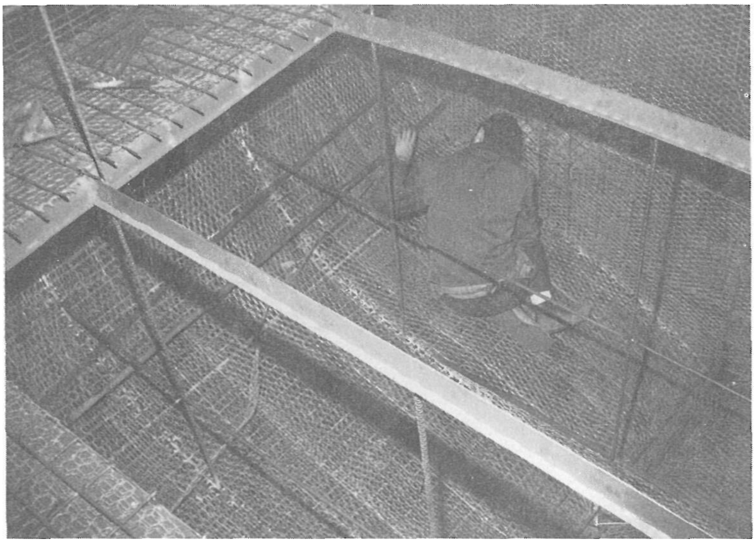
TASK 2 - Mesh Coaming and Bulwarks

The hatch coamings are meshed inside and outside until four layers of mesh have been built up on both sides. As was explained in Task 1, some of the mesh was applied to the coaming sides when the deck mesh was being laid down. The mesh is trimmed off at the coaming screed of T-bar in such a way that the horizontal arm of the "T" overlaps the trimmed edges. The mesh ends must be well laced down close to the T-bar screed so as to avoid snagging with the plasterer's trowel.

Forepeak hatch coaming meshed inside. The mesh has yet to be laced tightly to form sharp, vertical corners inside the coaming.



The forward deck partially meshed.



Narrow folded strips of mesh are applied to both sides of the stringers and the sole supports.

Fastening mesh to the stringer up forward.

STAGE 2-JOB 8
STRINGERS AND SOLE SUPPORTS

The deck, with its coamings and bulwarks, has received its final layer of mesh. There remains a series of jobs to be done inside the hull, however, before the six outer layers of mesh can be fastened to the hull. The reason for this is that every one of the jobs which will be described here require welding to the hull steel reinforcing framework. Clearly, this welding work will be more advantageously carried out without the impediment of overlying mesh.

TASK 1 - Mark Sole Support Positions

The level of the cabin soles, or floors, run parallel to the hull waterlines and the Base Line. The positions of these soles, which differ in the three hull compartments which call for them, are shown on Figure 6, entitled "Inboard Profile and Frame Groups."

The ideal point of reference to measure all the soles is the mark of Water Line No. 5 which was lightly sawn onto the hull frame rods in Stage 1, Job, 1, Task 11. Measurements are made from Water Line No. 5 and chalked onto the hull frame rod.

TASK 2 - Weld Sole Support Starter Rods

Starter rods, prepared in the bending jig, are welded to the hull frame rods at the chalk marks made on the hull frame rods. While the starter rods are still soft with welding heat the inner projecting arm of the starter rod is bent into an horizontal position with the aid of a spirit level. The rod is then clipped off inside at a distance of 3" (75 mm) from the hull frame.

In welding the outer arm of the starter rod the same procedure is followed as with the welding of the Diagonal "D" Stringer starter rods in Stage 2, Job 1, Task 10. The outer arms are welded on the diagonal to the hull vertical and longitudinal reinforcing rods.

TASK 3 - Weld Sole Support Screeds

A steel screed of 1" x 1" x 1/8" T-bar (25 mm x 25 mm x 3 mm) is bent to conform to the curve of the hull side at the line of the sole support. The T-bar screed is then welded to the tips of the inner arms of the sole support starter rods. The horizontal arm of the "T" is welded strictly in a horizontal position so when the sole support is finally meshed and plastered it will provide one level horizontal support for the sole joists.

Once the T-bar screed is levelled and welded in place additional starter rods may be welded between the screed and the hull vertical reinforcing rods. The T-bar screed terminates at the fore and aft bulkheads of each compartment. No longitudinal reinforcing rods are used in the sole supports.

TASK 4 - Weld Diagonal "D" Stringer Screeds

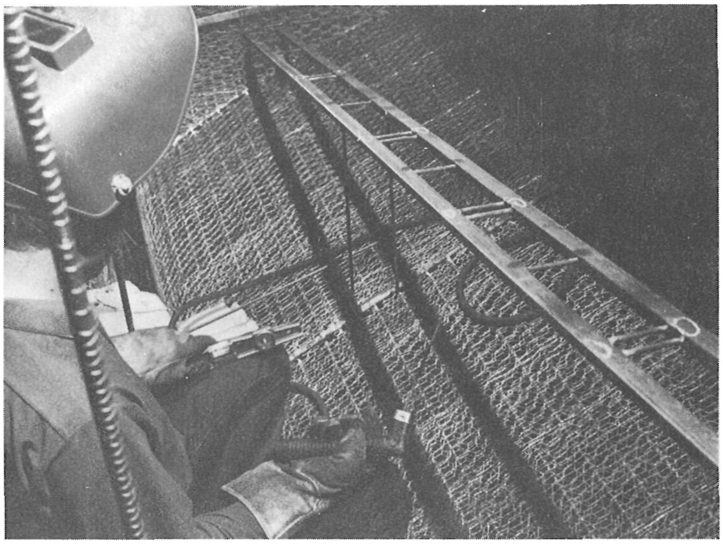
As shown in Figures 1 and 4, the stringers on the Diagonal "D" Line run the entire length of the hull passing through all the compartment bulkheads. The positioning and welding of the stringer starter rods was described in Stage 2, Job 1, Task 10. Constructional details of the stringers are shown on Figure 7.

Lengths of T-bar screed are welded to the tips of the projecting arms of the starter rods and faired to run true with the line of Diagonal "D." The lengths of T-bar screed are terminated 3" (76 mm) inside each bulkhead. If the T-bars are run through the bulkheads leaks will occur at these areas. The position of the T-bar screed in relation to the starter rods is that the vertical arms of the "T" accompany the projecting angle of the arm of the starter rod throughout.

Three longitudinal 1/4" (7 mm) diameter reinforcing rods are welded to the inner arms of the starter rods at equal spacings and accompanying the curve of the T-bar screed.

TASK 5 - Mesh Sole Supports and Diagonal "D" Stringers

The sole supports and stringers are meshed on their upper and lower sides with folded strips of mesh. These strips are merged with the inner layers of mesh to the hull. The mesh is securely fastened down with hog ring staples and tie wire.



These T-bar screeds for the top of the engine beds are first prepared on the welder's workbench.

STAGE 2-JOB 9
INSTALLATION OF ENGINE BEDS AND STERN TUBES

The reinforcing for the twin engine beds, the stern tubes and the rudder stuffing box supports are the last of the internal structures which require welding to the hull reinforcing framework before applying the final layers of mesh to the hull exterior. The siting of these parts and structures is critical and requires accurate preparatory work on the part of the builders.

Figures 7 and 8 provide the necessary details for construction and installation.

TASK 1 - Mark Engine Bed Positions

The construction details for the engine beds shown in Figures 6 and 8 show that the top surfaces of the beds are edged with T-bar screed. The T-bar specified is 1" x 1" x 1/8" (25 mm x 25 mm x 3 mm). The procedure for marking the engine bed positions is as follows:

1) Two smoothly finished, straight wooden battens are prepared. Ideal dimensions of these battens should be: 13 ft. x 3/4" (4 m x 20 mm x 20 mm).

2. The terminal positions of the 8 T-bar screeds on an horizontal plane (that is to say, as the T-bar screeds strike the fore and aft engine room bulkheads) are marked onto the two wooden battens. The center line is also marked onto the battens.

3. One wooden batten is fastened with tie wire to the forward engine room bulkhead at a position which is accurately centered and horizontal. The height of the batten on the bulkhead is that which places the bottom face of the horizontal batten at exactly the height of the top face of the tip of the T-bar screed. A second batten is fastened in the same manner to the aft engine bulkhead. Note that there is a considerable difference in heights to the two horizontal battens as the engines and stringers are installed at an inclination of 1:7.

TASK 2 — Fabricate Engine Bed Screeds

The T-bar screeds to the engine beds are made up in pairs on the welder's work bench. The welder obtains the correct lengths to the T-bar by measuring from the batten fastened to the forward engine room bulkhead to the batten fastened to the aft engine room bulkhead. To discover the correct length of the outer engine bearers the welder is obliged to weld the inner bearers in place first. Then, with the use of a spirit level, laid across from the inner bearer, the spot in the hull framework where the bearer terminates can be established. From this spot to the forward bulkhead will give the length of the bearer screed.

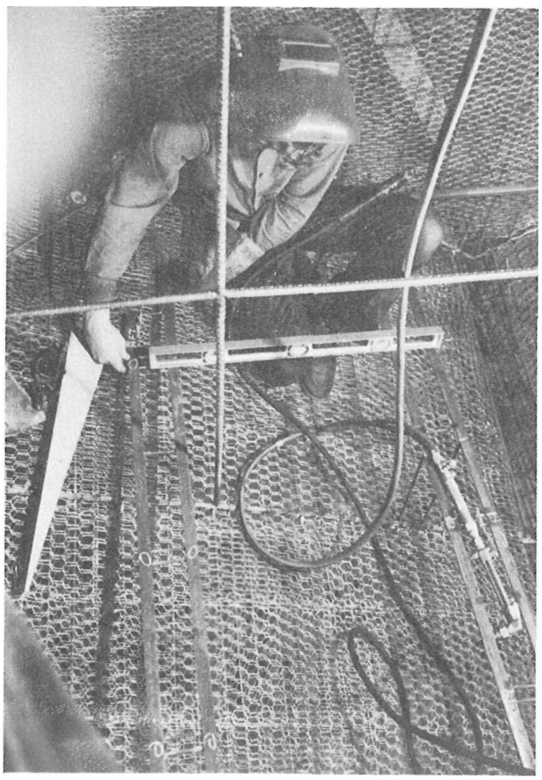
The screeds are welded together in pairs by means of 1/4" (7 mm) diameter reinforcing rods cut to a length which gives exactly 120 mm (approximately 4-3/4") from outside edge to outside edge. Each pair is welded flat and level on the work bench.

Four bolts will later be welded fast between each of the pairs of screeds. The purpose of these bolts is to secure the engine bearer steel members to the engine beds. Where a bolt is located two screed joining rods are welded which will pass on both sides of the bolts and lend it support. The spacings and sizes of the bolts are shown in Figure 8.

TASK 3 — Install Engine Bed Reinforcing

The procedure for installing the complete engine bed steel reinforcing is as follows:

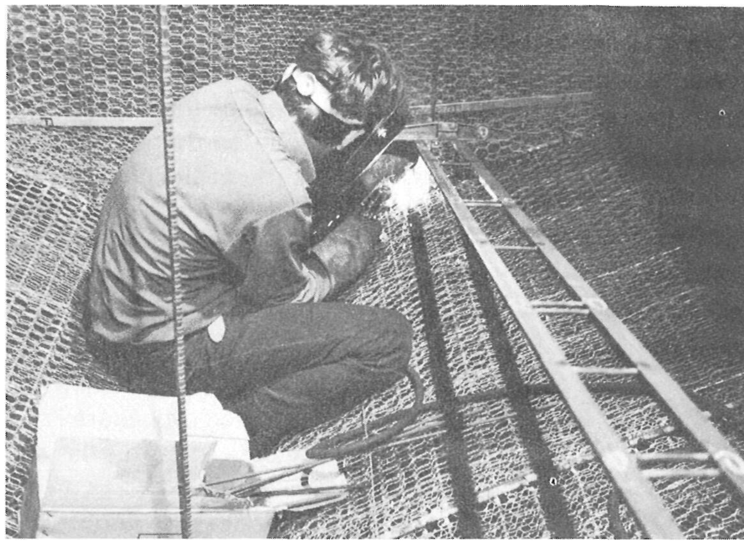
1. The pre-fabricated screeds to the inner engine bed bearers are welded in place to the bulkhead steel reinforcing grids at the positions indicated by the marked battens. Athwartships level is checked with a spirit level.



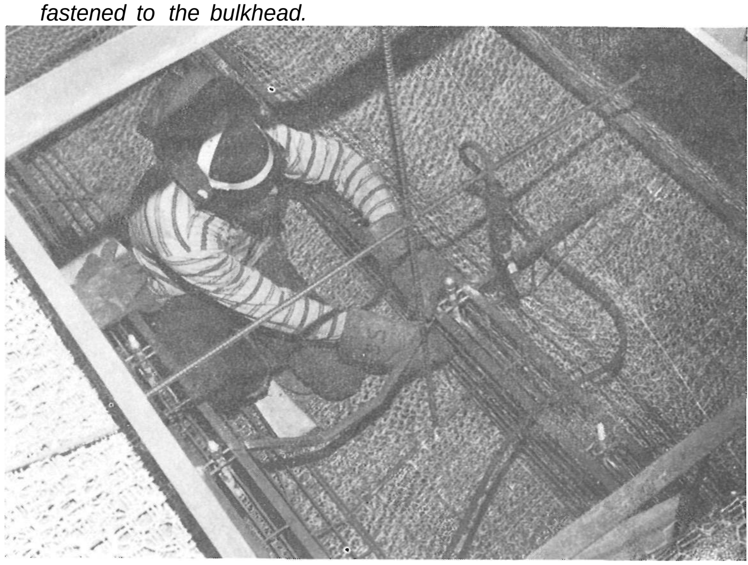
A spirit level is used from the inner engine bed T-bar screeds to assess the positioning of the end of the outer T-bar screeds.

2. The formed edge of the outer engine bearer screeds are welded in place. The aft edge is trimmed and welded in place to the hull side reinforcing framework, its exact spot being established with the aid of a spirit level laid across from the inner engine bearer.

3. When all four engine bed screeds are satisfactorily installed, vertical reinforcing rod may be welded to the underside of the T-bar screeds and allowed to pass through the hull reinforcing framework. The rods are bent over at the underside of the hull reinforcing framework and welded to the hull rods.



Welding the T-bar screed assemblies accurately into place. Note the spirit level, also the marking batten fastened to the bulkhead.

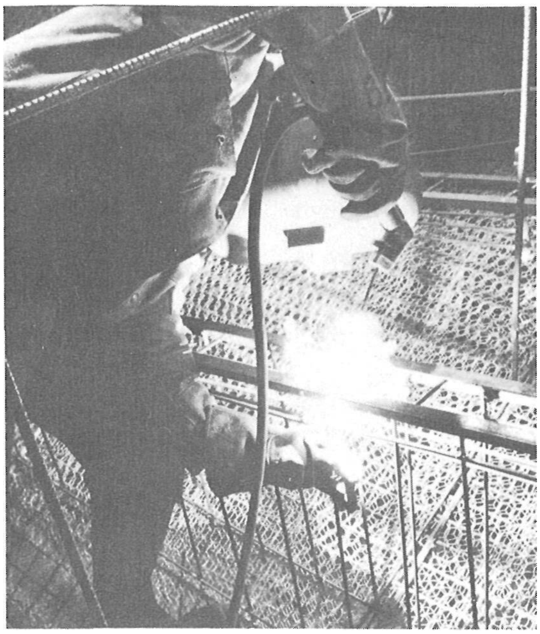


The shape of the T-bar screed to the web below the engine sump.

The four 5/8" x 8" (15.88 mm x 203 mm) bolts for securing the engine bearer steel members are now welded in place between the T-bar screed joining rods. The bolts are checked for alignment and plumb with the use of set square and builder's line. Longitudinal reinforcing rods are welded to one side of these heads and shanks of the bolts as an additional safeguard. (The purpose of putting this longitudinal reinforcing on only one side of the bolt shanks is to allow passage for the pencil vibrator to be inserted deep into the engine beds at the time of plastering.)

Longitudinal reinforcing rods of 1/4" (7 mm) diameter are welded to the vertical reinforcing rods at 3" (75 mm) centers. Note that a rod is laid along the base of the engine beds, wherever possible, so that mesh can be fastened tightly at the base of this structure.

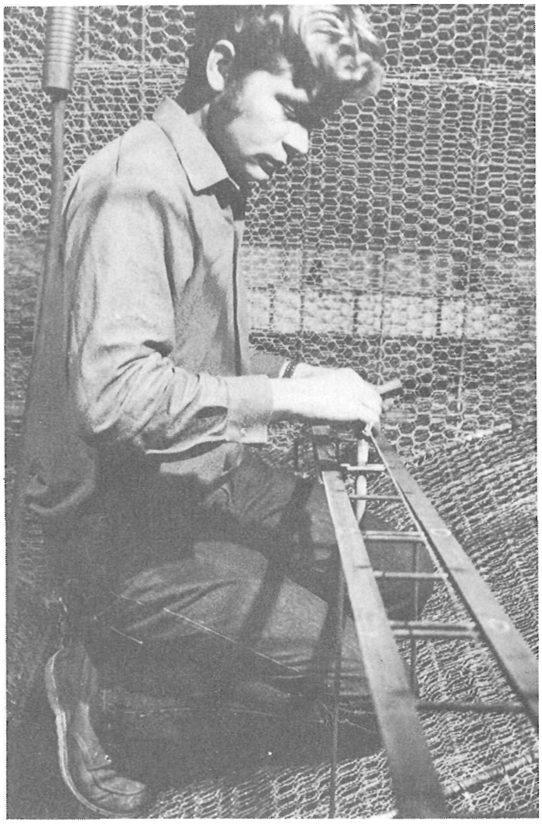
The outer side of the outer engine bearers takes additional reinforcing in the form of a face inclined at 45° and joining to the hull reinforcing framework. This same reinforcing procedure is repeated at the base of both sides of the inner engine bearers.



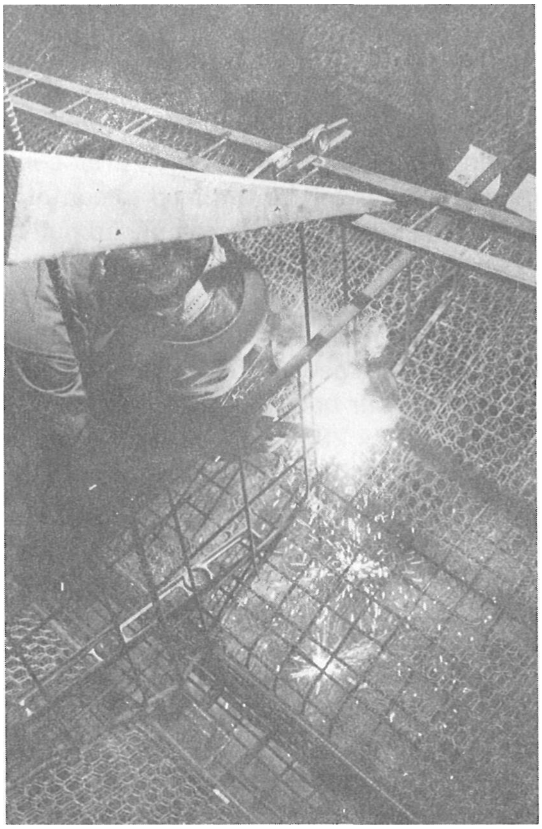
Welding vertical reinforcing rods from the T-bar screed down through the hull framework.

7. At Station 12 a reinforcing web is run athwartships, traversing the engine bearers. The web is topped with a T-bar screed. Where allowance has to be made for the low-slung sumps of the future engines the T-bar screed is shaped accordingly.

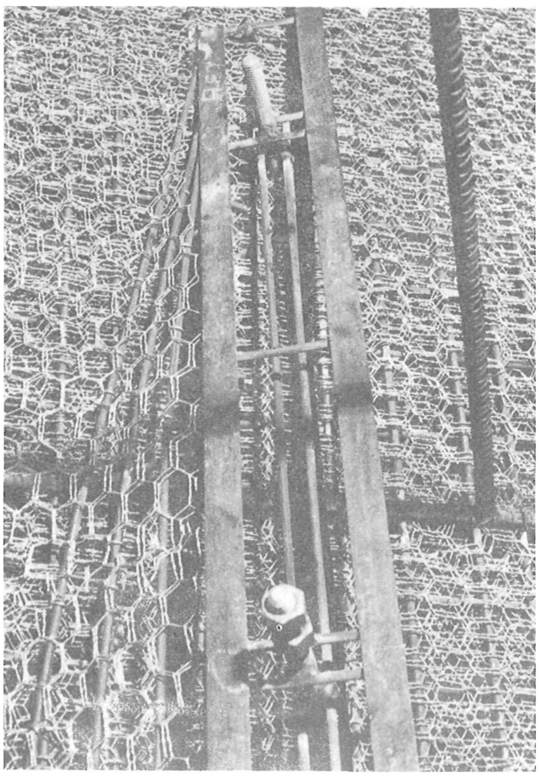
When welding the steel reinforcing to the engine beds and joining it to the hull framework care should be taken to avoid dense build-ups of rod and T-bar. Although the resulting structure may appear gratifyingly strong in these areas, it will often make penetration of the concrete extremely difficult. Voids are likely to form in the hollows of the T-bars and beneath longitudinal reinforcing rods. If a leak appears, is discovered and patched, water will sometimes course through the neighboring voids and the same leak reappear elsewhere.



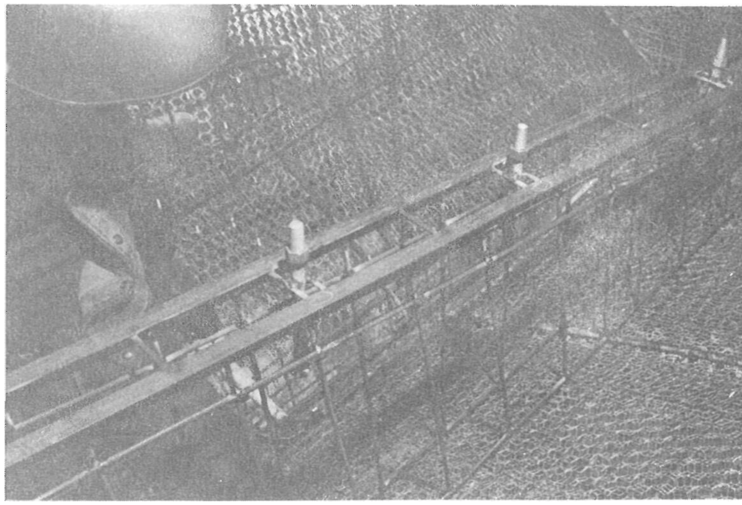
Marking the positions of the engine mount bolts.



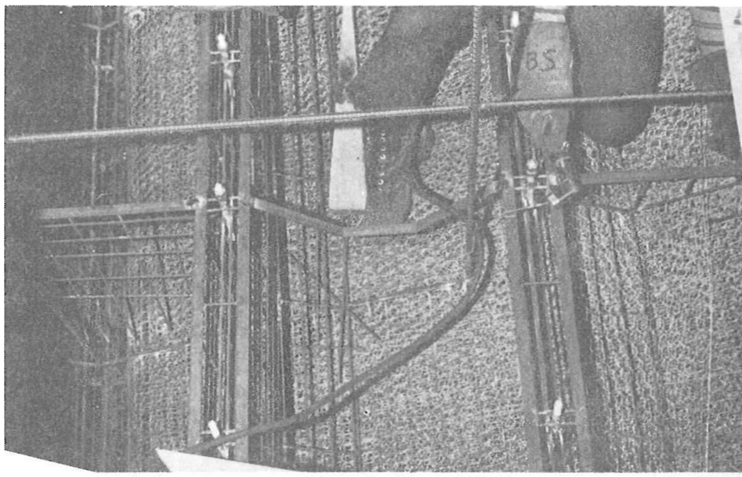
Welding vertical reinforcing rods alongside the existing web on Station No. 12.



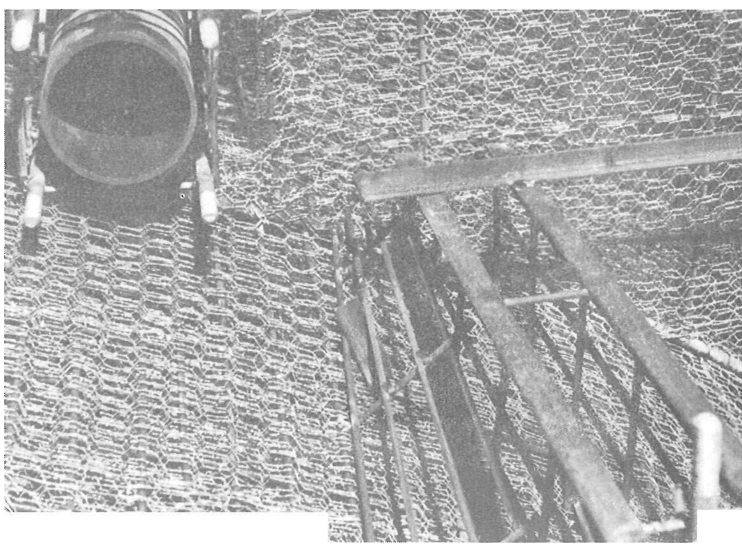
Tapered fairing at the ends of the outer engine bearers.



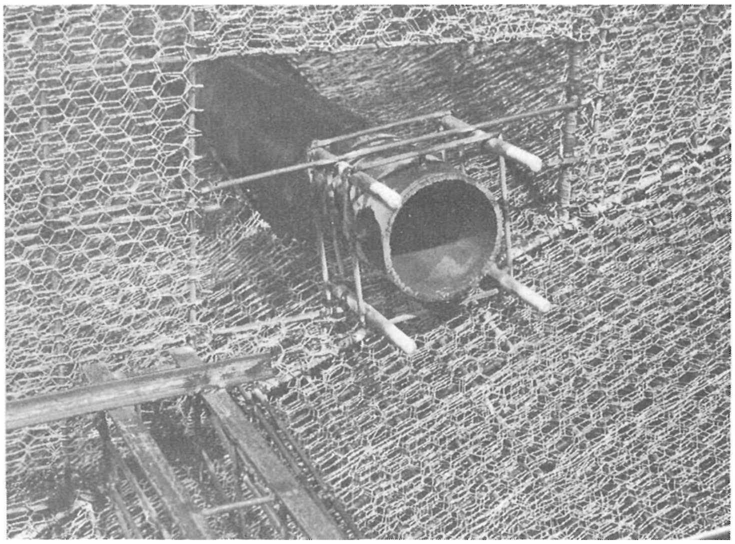
Engine mount bolts welded into place.



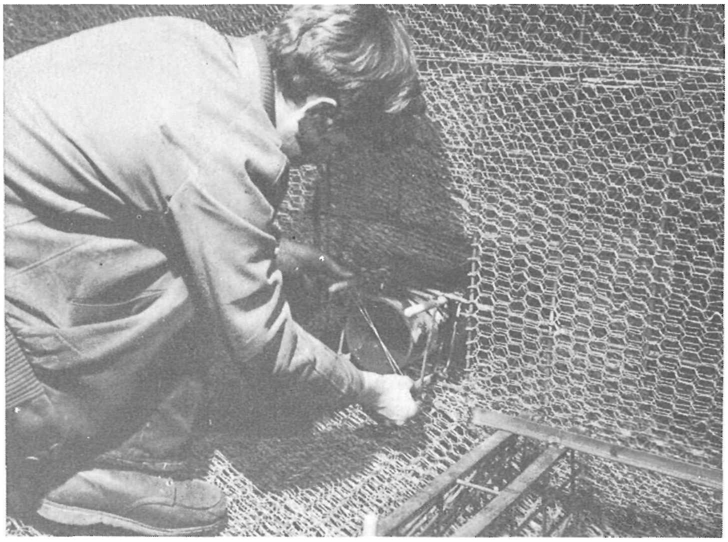
Note additional reinforcing at outer base of engine beds in the form of an inclined 45° face.



Detail of 45° reinforcing at the aft end of the inner engine bearers.



Stern tube with 4-bolt assembly for securing the propeller shaft stuffing box housing. The stern tube is temporarily suspended in place awaiting alignment.



Affixing thin rubber bands diagonally across the stuffing box bolts.

TASK 4 — Fabricate Stern Tubes

The two stern tubes are cut 5" (122 mm) I.D. Schedule 40 black steel pipe. The length of the stern tubes is such that they project beyond the calculated thickness of the hull shell after concreting. The tubes will be trimmed to conform to the exterior surface of the completed hull after curing.

The engine room end of the stern tubes receives a small framework of reinforcing rod which support four bolts. The four bolts, 5/8" x 8" (15.88 mm x 203 mm), will secure the future propeller shaft stuffing box housing. For the sake of accuracy, the four bolts are best welded together on the work bench within the small rod framework. The framework, complete with projecting bolts, is then welded squarely to the stern tube. Figure 9 explains how this is done; the accompanying illustrations also give a clear indication.

Even though the stern tubes when installed will be covered with a faired, reinforced concrete housing, additional measures should be taken against potential sources of leaks. It is difficult to achieve perfect penetration of mortar around the smooth cylindrical surface of the stern tube. It is recommended, therefore, that a length of narrow flat bar or reinforcing rod be welded around the circumference of the stern tube at a central point of its length to serve as a "stop-water" when embedded in the concrete housing.

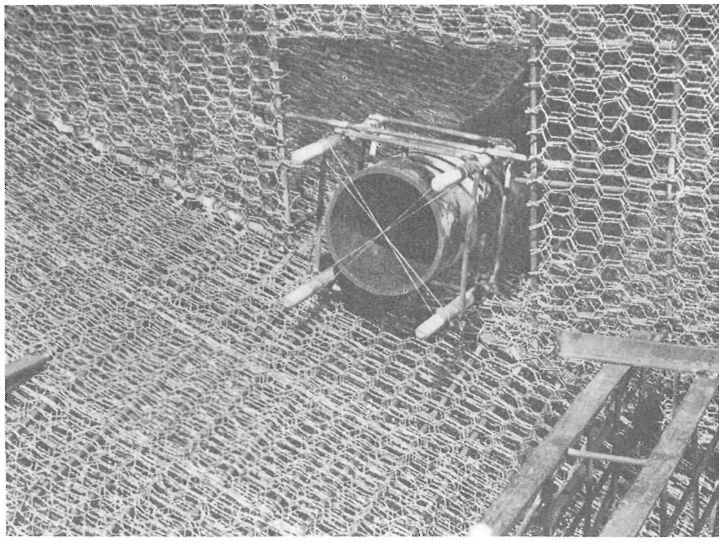
TASK 5 — Prepare Stern Tube Alignment Sights

The position and the inclination of the engine beds determine the ultimate alignment of the stern tubes. The following information must be collected and assessed before work can begin on alignment:

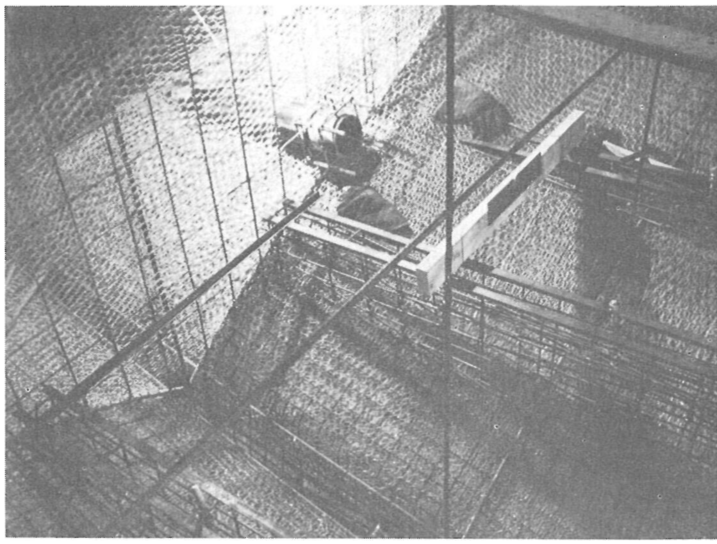
a.) The combined height of the rubber pad and the steel engine bearers plus an assessment for the shims. (Details of the rubber pad, steel engine bearer members and shims will be found on Figure 6.)

b.) The measurement from the axis of the propeller shaft to the contacting surface of the support brackets on the engine. (This measurement will depend, of course, upon the choice of engine. For GM six-cylinder diesel engines, designation 64 HN 9, this measurement is calculated at 7/8" (22.23 mm) but builders are advised to confirm the date of manufacture of this model as the support brackets to the engine are reported to vary according to year of manufacture.

c.) With the results of the data collected in (par a) and (par b) calculate the required height of the axis of the propeller shaft above the top surface of the T-bar screeds. In the case of the 6M 64HN9 engine this height is calculated at 3.937" (100 mm) but can be slightly higher if thicker engine shims are preferred.



The intersection of the two rubber bands forming the "X" alignment sight.



The aft "V"-aperture sight accurately fastened in place to the engine beds. Not visible is a second "V"-aperture sight mounted at the forward end of the engine beds.

With the date from (par. a, b, and c) duly assessed the alignment sights may now be made. The equipment for the alignment sights is as follows:

1. Take four straight pieces of 3" x 1/8" (75 mm x 3 mm) steel flat bar (two pieces for each engine bed) and cut them approximately 12" (300 mm) long. At the center point of their respective lengths drill one neat 1/4" (7 mm) hole at the distance of 1" (25 mm) from the edge of the flat bar. From the center point of the drilled hole to the edge of the flat bar mark and saw a perfect "V" with 45° arms. The resulting piece of flat bar now forms a "V"-aperture sight of the pattern sometimes used as a backsight on rifles.

2. The "V"-aperture sights are now screwed to a length of 2" x 4" (45 mm x 90 mm) lumber. The height of the center point of the hole at the base of the "V" is set at exactly 3.937" (100 mm) from the base of the lumber.

3. Each pair of "V"-aperture sights screwed to its wooden base is then set across the T-bar screeds of the engine beds, one at each end. The center line running between the parallel engine bearers is determined and the center points of the two "V"-aperture sights set upon this center line. The two wooden bases are then temporarily fastened with tie wire to the T-bar screeds.

4. A different set of sights is now prepared. This consists of a piece of cardboard cut to fit inside the stern tube. At its center a 1/2" (13 mm) hole is cut out to serve as a round aperture sight. The cardboard sight is inserted into the stern tube at about 2" (45 mm) from the end.

The remaining equipment required to complete the alignment sights is a good light which can be hung from the deckhead of the engine room and piece of white cardboard or plywood to serve as a back-drop. This back-drop will be propped against the forward engine room bulkhead in order to make the "X" and "V" sights stand out clearly when viewing through the stern tube round aperture sight.

TASK 6 - Align and Weld Stern Tubes in Place

Everything is now ready to align and weld the stern tubes in place. The first step is to rest a light wooden batten in the "V"-aperture sights in their positions on the engine bed and note where the tip of the batten strikes the aft engine room bulkhead. Using this spot as a center point cut an approximately 9" (225 mm) square aperture around this point in the bulkhead mesh and rod reinforcing. Proceed in the same manner with the second engine bed. Then draw the batten through the bulkhead aperture, still resting in the "V"-aperture sights, and note where the tip of the batten strikes the hull. Here the hull reinforcing framework must be cut through practically to the web at Station 6. The width of the aperture should be at least 6" (150 mm) to give lateral play to the stern tube when placed here for alignment. Proceed in the same manner for the second stern tube aperture, then:

1. Suspend the stern tubes from wires in their appointed apertures. Note that the stuffing box bolts should protrude well into the engine room past the face of the aft engine room bulkhead. One set of suspension wires can be fastened from the bulkhead reinforcing to the forward rod of the framework which supports the stuffing box bolts. The second set of suspension wires can be passed around the aft end of the stern tube and fastened to the hull framework.

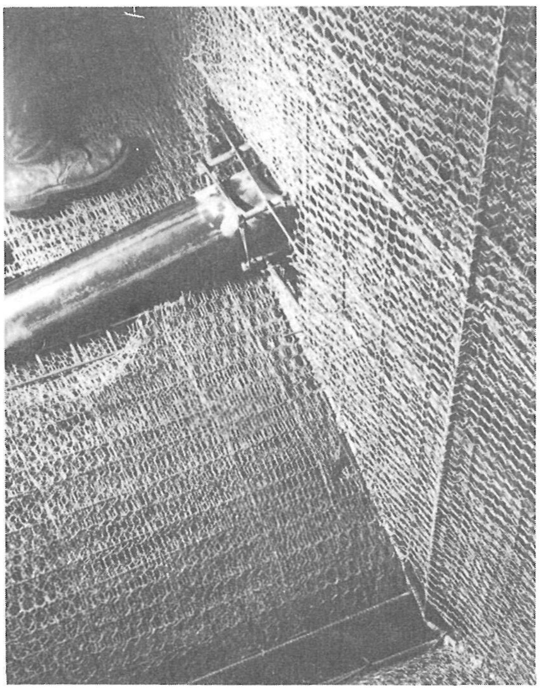
2. At this stage only the forward end of the stern tube is in alignment. There remains to bring the round aperture sight into perfect alignment with the two "V"-apertures and the "X"-sight. For this purpose the man stationed abaft the engine room bulkhead will adjust the aft suspension wires until the view through the stern tube sights will closely resemble this following symbol: (X) . At this stage, with the center point of the round aperture sight in alignment with the intersection point of the "X" which, in turn, is in alignment with the center points of the two "V"-sights, the welder may proceed to weld the stern tube in place with short pieces of reinforcing rod. The future engine and sterngear will be truly aligned.

The stern tubes should be reinforced in their positions after alignment. Short pieces of reinforcing rod may be butt-welded at 45° angles from the stern tubes to the adjacent hull frame-work. Longitudinal pieces of rod are then welded above to form the frame-work for a streamlined housing above the stern tube.

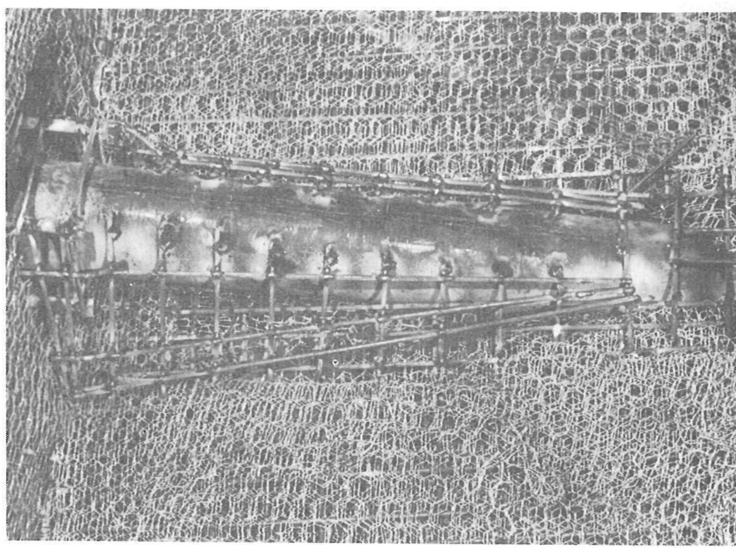
Station one man close to the suspen-sion wires. Station a second man with welding equipment at the ready close to the aft suspension wires. Both men should exercise care that their weight does not disturb the hull reinforcing framework while the alignment process is being carried out.

Station a third man with a good "eye" for alignment (preferably a good rifle-man) beneath the hull at the aft end of the stern tube.

As the man stationed at (par 4} peers through the round aperture sight at the aft end of the stern tube he will note that the two "V"-aperture sights on the engine beds are perfectly aligned, that the "X" sight at the far end of the stern tube is not aligned. He will then direct his helper in the engine room to adjust the suspension wires until the intersection point of the "X" sight lies directly in line with the center points at the base of the two "V"-aperture sights. As an additional aid in alignment he will note that upper arms of the "X"-sight will accompany the angle of the "V"-apertures.



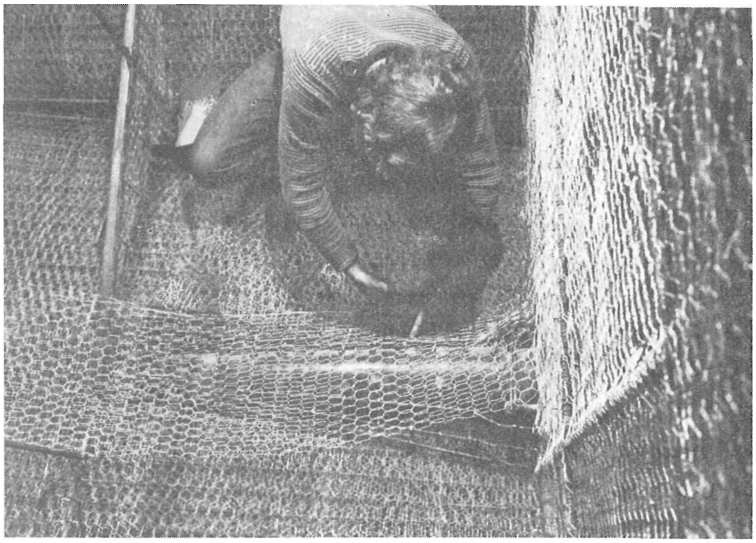
The openings cut into the bulkhead and the hull framework for the positioning of the stern tube.



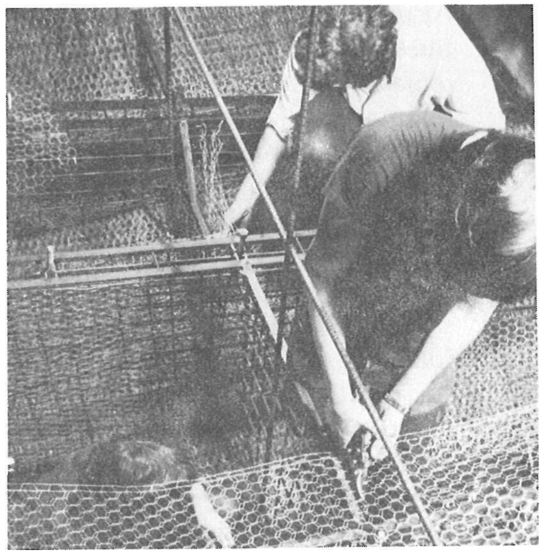
Faired reinforcing framework to secure the stern tube in place.

TASK 7 - Mesh Engine Beds and Stern Tubes

Four layers of mesh are fastened with hog ring staples to the engine bed reinforcing framework and to the housings over the stern tubes. The mesh is applied tautly and butted to the surrounding interior meshwork on the bulkheads and hull.



Fastening mesh over the stern tube housing.



The engine beds are meshed.

STAGE 2-JOB 10
INSTALL RUDDER STUFFING BOX SUPPORTS

TASK 1 - Prepare Rudder Stuffing Box Housings

The design calls for twin rudders. The location of the rudder shafts and the stuffing box, or gland, housings is in the steering compartment, the aftermost compartment of the hull. Details of construction will be found in Figure 8.

The rudder stuffing box housings will be best prepared at the welder's work bench. The same pipe stock is used as for the stern tubes, 5" (127 mm) I.D. Schedule 40 steel pipe, cut in this application to two lengths of 10" (254 mm). For securing the stuffing box six bolts are used, size 5/8" x 6" (15.88 mm x 152.4 mm). Fabrication procedure is as follows:

1. A length of 1"x 1/2" (25mm x 3 mm) flat bar is taken, heated, and bent into a circle with an outside diameter of 12" (300mm).

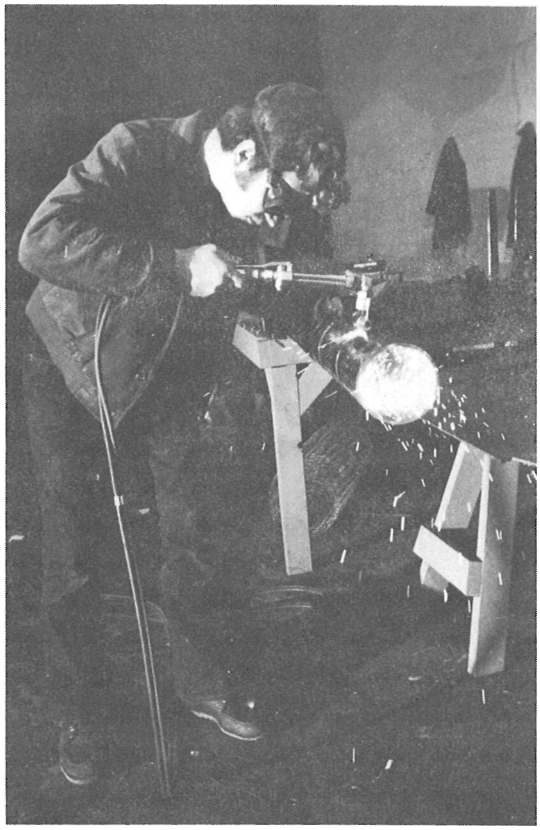
2. A length of 1/4" (7 mm) diameter reinforcing bar is taken, heated, and bent into a ring with an outside diameter of 9-3/4" (250mm).

3. Two circular covers are prepared from 1/4" (7 mm) steel plate with an outside diameter of 12" (300mm). Six holes are then drilled into the plate of equal centers on a concentric circle of 8-5/8" (220 mm), the holes being for the 5/8" (15.88 mm) stuffing box securing bolts. These cover plates will serve two purposes. They will serve as a jig for holding the bolts in the next step, (4), and will act as a screed to produce a fair level surface when the stuffing box housings are eventually concreted. The mortar will be poured into the housings, vibrated, and then topped with an excess of mortar. The plate will then be gradually fastened down over the fresh mortar using a spirit level to maintain the plate absolutely level.

4. The six bolts for securing the stuffing box are welded to the inner circumference of the ring prepared in (par 2). To ensure that the bolts are first fastened with nuts to the plate prepared in (par 3), the bolts are welded to the ring at the underside of the head and the start of the shank.

5. The circular screed, or band, prepared in (par 1) is now welded to the bolt assembly prepared in (par 4) and to the section of piping. Short pieces of rod are butt-welded to the pipe and to the inner circumference of the screed, the pipe being placed at center, and the upper end of the pipe made level with the upper edge of the screed, the short, connecting pieces of rod are positioned to make contact with the shanks of the six bolts. The threaded section of the bolts is left protruding above the level of the screed.

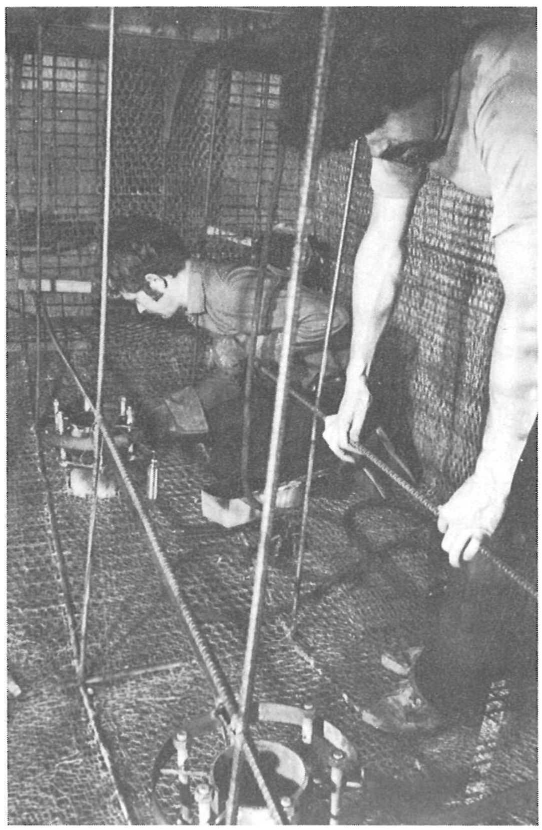
6. A length of 1" x 1" x 1/8" (25 mm x 25 mm x 3 mm) T-bar is now welded between the two prepared rudder stuffing box housings. The ends of the T-bar are welded to the outer circumference of the flat bar screeds. The assembly is welded on the work bench, carefully checked that all parts are level and aligned, and the length of the interconnecting T-bar calculated to place the axis of the two future rudder shafts at exactly 59.05" (1500 mm). The T-bar connecting the two rudder stuffing box housings is then marked at center.



Cutting sections of pipe to form rudder stuffing box housings.

TASK 2 - Mark Rudder Stuffing Box Positions

The purpose of connecting the two housings in the previous task has been to eask the work of establishing the position of the housings in the steering compartment. Principal measurements are given in Figure 8. The procedure is as follows:



Establishing the position of the twin rudder stuffing box assembly.

1. A plumb line is suspended at the correct distance aft of the bulkhead at Station No. 3. The tip of the plumb bob is lowered to the required level of the rudder stuffing box housings, this measurement being ascertained by reading off from the waterline No. 5 brace rods welded to Stations Nos. 1 and 2.

2. The twin rudder stuffing box housings connected with the length of T-bar screed are placed in the steering compartment. The assembly is then chocked into position with the plumb line touching the center mark on the T-bar screed.

3. The rudder stuffing box housing assembly is then checked for level, fore and aft, port and starboard.

4. The distance from the bulkhead at Station No. 3 adjacent to the axis of the two housings is now checked and adjusted. The assembly is now perfectly level and aligned.

5. The area where the bottom edges of the piping pieces in the housings make contact with the hull reinforcing framework is marked. The complete assembly is temporarily removed.

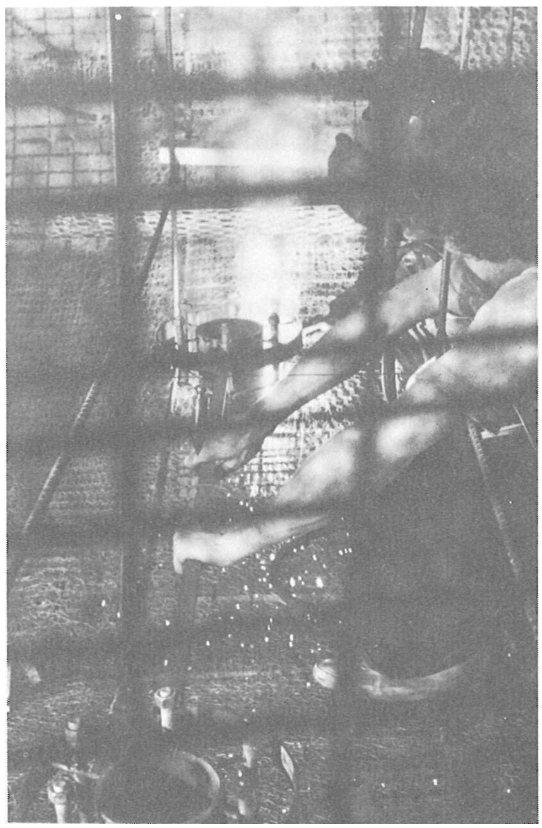
TASK 3 - Install Rudder Stuffing Box Housings and Fabricate Supports

The twin areas for the rudder stuffing box housings marked in the previous task are now cut through the hull reinforcing framework. The assembly is again placed in position, this time the top of the plumb bob must just touch the center mark on the T-bar screed connecting the two rudder stuffing box housings. The tip of the plumb bob marks the required height of the upper surface of the housings (the top surface of the T-bar screed is, of course, on the same level).

The same procedure as was carried out in the previous task must now be repeated in order to level and align the assembly in its final position. Once satisfactorily in position the rudder stuffing box housing assembly may be welded to the adjoining hull reinforcing framework with short pieces of rod.

Figure 8 shows how the supports are made to the rudder stuffing box assembly. It will note that these supports are in the form of webs radiating from the central housings. Fabrication procedure is as follows:

1. The T-bar connecting the twin rudder stuffing box housings now forms the screed for the central athwartships web. Outer extensions are made to port and starboard, the T-bar screed descending at the angle prescribed on the plans to meet the hull reinforcing framework.



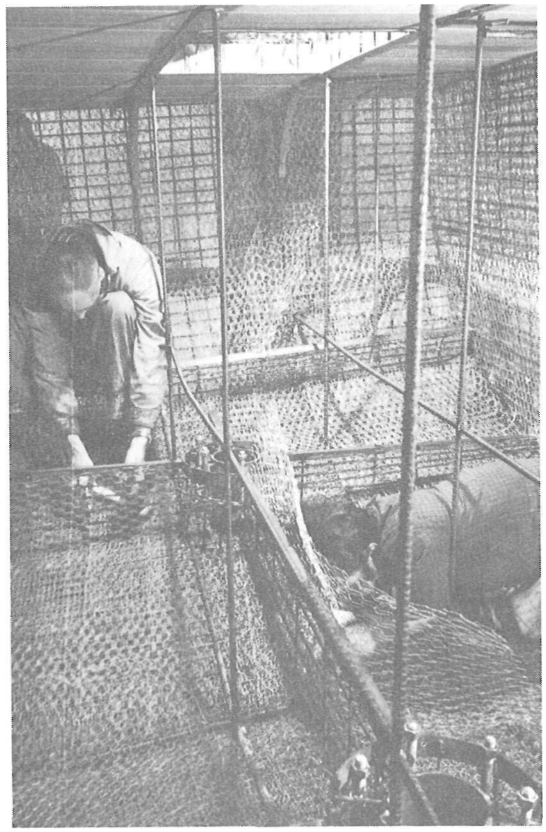
Welding the twin rudder stuffing box assembly into place.

2. T-bar screeds are now fore and aft from the housings. The forward screed runs parallel with the water line to join the bulkhead reinforcing at Station No. 3. The aft screeds descend at an angle to join the hull reinforcing framework. (Note that in all cases where T-bar screed joins the hull reinforcing framework or a bulkhead that it is advisable to cut off a short section of the flat upper surface of the T-bar to ensure good mortar penetration at the joint.)

3. Vertical reinforcing rod is welded to the outside of the T-bar screeds and allowed to pass through the hull reinforcing framework to remain untrimmed for a length of three inches (75 mm).

4. Longitudinal rods are welded to the supporting webs at 3" (75 mm) centers.

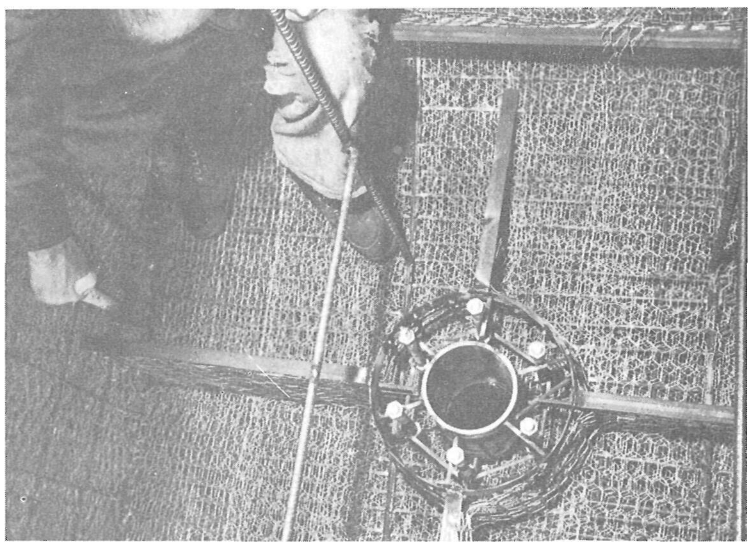
5. Untrimmed ends of the vertical reinforcing rods are bent over and lap-welded to the hull reinforcing framework.



Fastening mesh to the stuffing box supports.

TASK 4 - Mesh Rudder Stuffing Box Supports

Four layers of mesh are fastened to the rudder stuffing box supports with hog ring staples. The mesh is trimmed neatly to the underside of the T-bar screeds and stretched flat and taut with the staples. The mesh is trimmed at the joint of support webs to hull so as to achieve good mortar penetration.



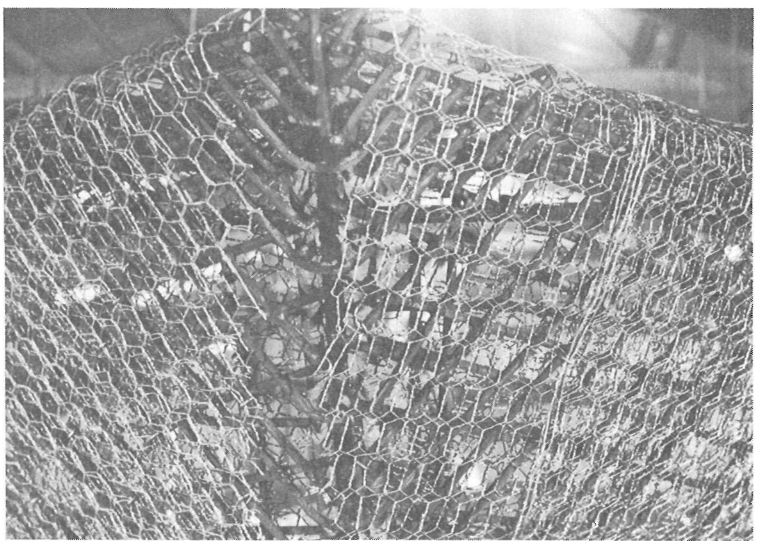
Plan view of the rudder stuffing box support showing the bolt assembly.

STAGE 2-JOB 11
HULL EXTERIOR MESH

The hull steel reinforcing framework has been completed and has been faired true. The last of the steel reinforcing rods which form part of internal structures such as stringers, engine beds, etc., have been welded to the hull reinforcing and no further welding work is required to this framework. An inspection of the hull at this stage reveals the stern tubes and rudder stuffing box housings installed, all deck and hull interior mesh work completed. There remains to modify the external bracing to the hull so that the final, outer layers of mesh can be fastened to the hull without hindrance.

TASK 1 - Modify Hull External Supports and Braces

The lateral bracing to the scaffolding supports at Waterline No. 5 must now be removed to facilitate the work of applying the outer layers of mesh to the hull. It is recommended that the wooded blocks for supporting the keel, which will be required at the start of Stage 3, be prepared at this time. The wooden blocks may be temporarily placed under the keel and secured with wedges while the work of cutting away the lateral braces proceeds.



Illustrating the concentration of reinforcing rods at the stem and the consequent need for less mesh at this point for achieving better concrete penetration.

The lateral braces will be replaced with overhead diagonal braces of 1/2" (13 mm) rod running from the top of the steel pipe pillars supporting the overhead structure down to the hull suspension rods at a height of 3" (75 mm) above the deck. Diagonal braces will be run to port and starboard but are not required at every hull station; every second station will give sufficient lateral rigidity to the suspended hull. Once the diagonal bracing is welded in place the keel support blocks may be removed for they will interfere with the mesh work which is to follow.

TASK 2 - Apply Outer Layers of Mesh to Hull

Before starting work on the mesh work to the exterior of the hull it is recommended that quantities of mesh be cut and folded on the mesh benches in advance and that all personnel be issued the following tools:

1 — Carpenter's apron.
1 — Pair hog ring pliers and a supply of hog rings
1 — Pair plain pliers
1 — Roll of 18-gauge tie wire
1 — Claw hammer

The personnel will also equip themselves with a short piece of rod for stretching the mesh and a short block of wood suitable for pounding the mesh. Supplies of hog ring staples will be checked beforehand. The larger, 3/4" (20 mm) size of hog ring staple will be used only in those places where a mesh fastening has to be made at an intersection of two reinforcing rods. The smaller, 1/2" (13 mm) size will be used in greater quantities and is applied where mesh is fastened to a reinforcing rod.

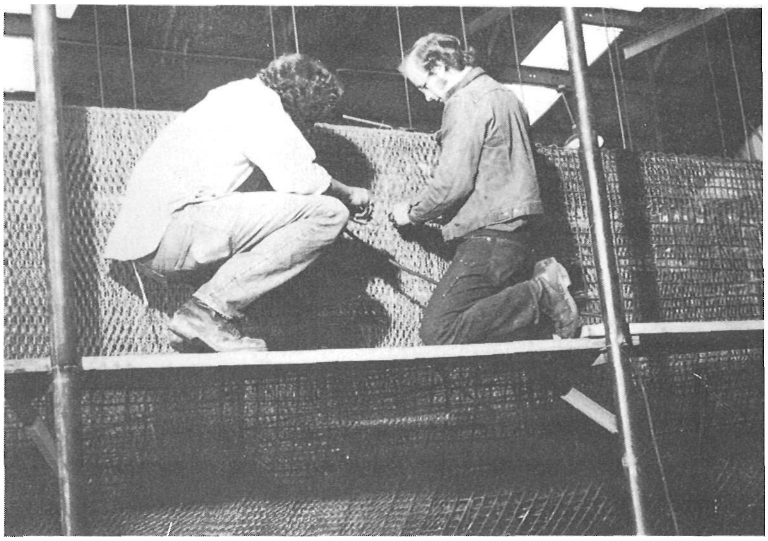
Six layers of 1" (25 mm) x 21 gauge hexagonal mesh, galvanized after weaving, will be fastened to the hull framework exterior. The points to consider, when applying this mesh, are these:

1. Work starts amidships and proceeds fore and aft.
2. The folded strips of mesh are first secured to the bulwarks' cap then pulled downwards over the hull sides in as vertical a plane as possible. The hull frames and vertical reinforcing rods serve as guides to the alignment of the mesh.
3. Short pieces of rod, inserted into the mesh and into the hull framework, can be used to lever the mesh taut. A minimum of staples is recommended for fastening the first four layers of mesh.
4. The mesh is left temporarily untrimmed at the keel, stem and transom.

All strips of folded mesh are butted, one to the other, as fastening proceeds on the hull. The butt-joints of the strips beneath.

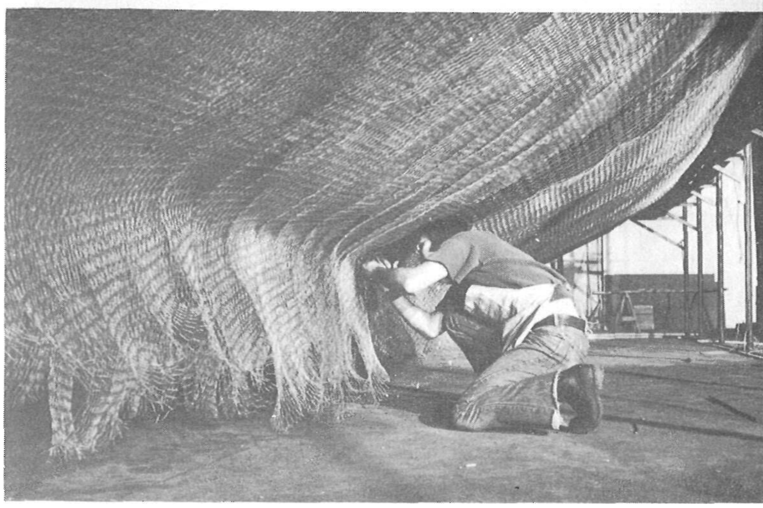
At the bulwarks' cap the mesh is trimmed at the inside edge of the piping screed and the loose ends of mesh tucked downwards between the screed and the inner-most of the longitudinal reinforcing rods.

At the scupper screeds a similar procedure is followed: Here loose ends of mesh are tucked down the outside edge of the screed. In this way the screed will finish fair with the surface of the concrete.

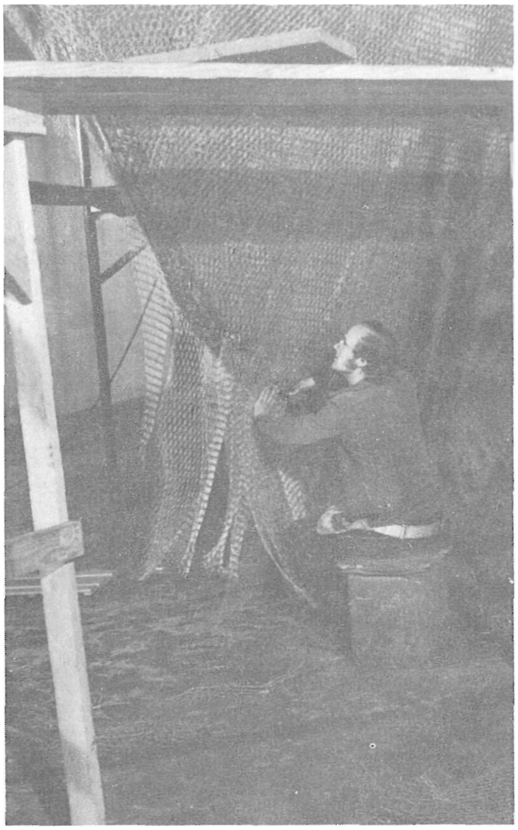


Loose ends of mesh are tucked neatly inside the scupper screed.

Fastening the hull exterior mesh.



The strips of folded mesh are butted one to the other, overlying joints being staggered. The first four layers require few staples.

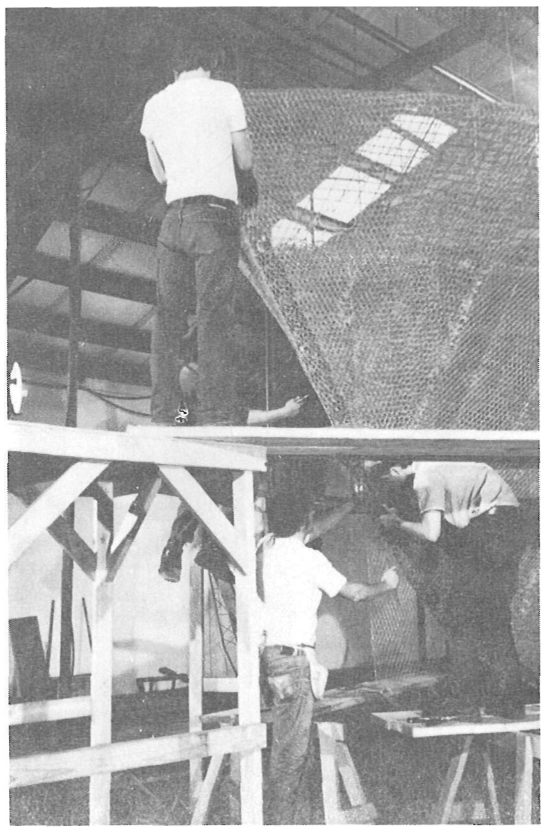


Trimming the mesh back at 6" (150 mm) from the stem.

8. The final two of the six outer layers of mesh are laid with more tension and with more use of fasteners than the previous layers. Hog ring staples are applied at 4" (100 mm) centers to ensure that the mesh lies absolutely tight and fair to the hull framework. Care is taken to prevent the hexagonal "eyes" of the overlying layers of mesh aligning with those beneath.

9. At the stem and forefoot the mesh is trimmed back bare to the reinforcing rods for a distance of approximately 6" (150 mm). The reason for this is the existing accumulation of reinforcing rods in this vicinity. If the layers of mesh were allowed to build up above this relatively dense framework of rod, penetration would be made extremely difficult on plastering. With penetration difficult the likely outcome is leaks. Only a single strip of folded mesh will be fastened down the stem and under the forefoot. The edges of the mesh will be fastened with lacings of tie wire.

Lacing one folded strip of mesh over the stem and forefoot



The strips of mesh are trimmed to shape and every loose end carefully fastened down.

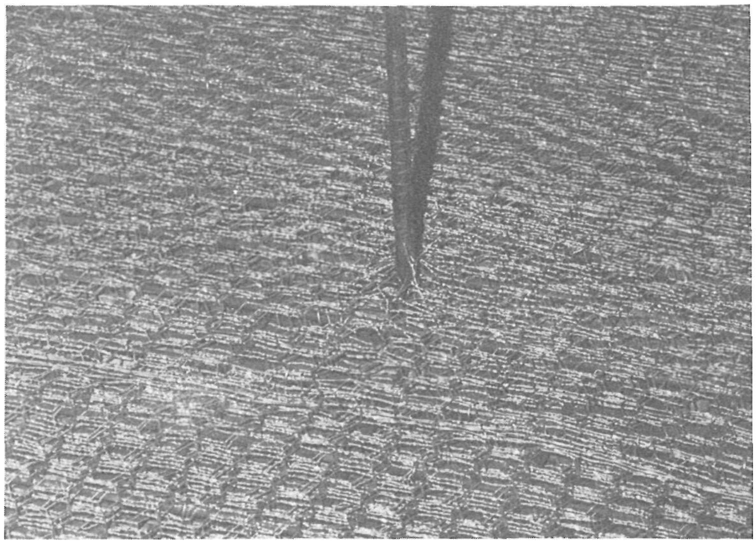
10. Similarly, at the keel, the mesh will be trimmed back to just above the turn of the underneath section. Here, again, only a single folded strip of mesh will be fastened to the underneath section. The reason here is to allow the loose mortar to fall completely through the mesh at the opening stages of plastering. Note that although only two layers of mesh are applied at the stem and beneath the keel, neither section will lack for strength. Both are reinforced with 5-1/2" (13 mm) diameter steel rods plus a grid of 1/4" (7 mm) diameter rods. The keel and stem will receive an exterior plastering at the first stage, then both will receive a second plastering, well vibrated, at the second stage after steam curing.

11. As the mesh fastening proceeds aft along the hull and reaches the transom, it is worked over the edge and fastened to the transom reinforcing framework. The transom mesh is butted, one strip to another, as on the hull sides. The joints of overlying mesh are staggered with those below and carried around the transom edge. The object is to prevent a thick concentration of mesh at the transom edge which inhibits good mortar penetration.

TASK 3 — Fairing, Cleaning and Final Inspection of Mesh

The outer layers of mesh will now be faired, cleaned, and finally inspected before making preparations for the next stage in construction, which is the plastering.

Fairing, cleaning and final inspection are carried out with the requirements of the plastering operation borne very much in mind. If only in the inspectors' imagination, a steel trowel is scraped over every square inch of the surface mesh, inside the hull and outside, and a snag for the trowel is sought. When that snag is found it is put right, for, on plastering day, it will be too late to start re-working mesh which has been carelessly fastened.



Loose ends of mesh discovered at the base of a suspension rod on deck. These loose ends will be tucked down and the mesh faired flat around the base of the rod.

It cannot be emphasized too strongly the importance of final fairing and mesh inspection. It is as well to remember that any mistake in meshwork, or deformation in fairing will, if not rectified before plastering day, become permanently immured in hardened concrete. It will become an ineffaceable reminder of a piece of work not done quite right. Here is a procedure to follow for final inspection of the mesh:

1. With the use of wooden, hand-held blocks pound the mesh flat and fair to the hull framework. Take care that the mesh does not become pounded hollow between the reinforcing rods.

2. Check the fairing of the mesh with particular attention at:

    Bulwarks cap and sheer.

    b) Stem and forefoot.

    c) Transom edge.

    d) Along the deck sheer line to the bulwarks interior.

    e) Beneath the bulwarks cap.

f) Hatch coamings, also along stringers and sole supports.

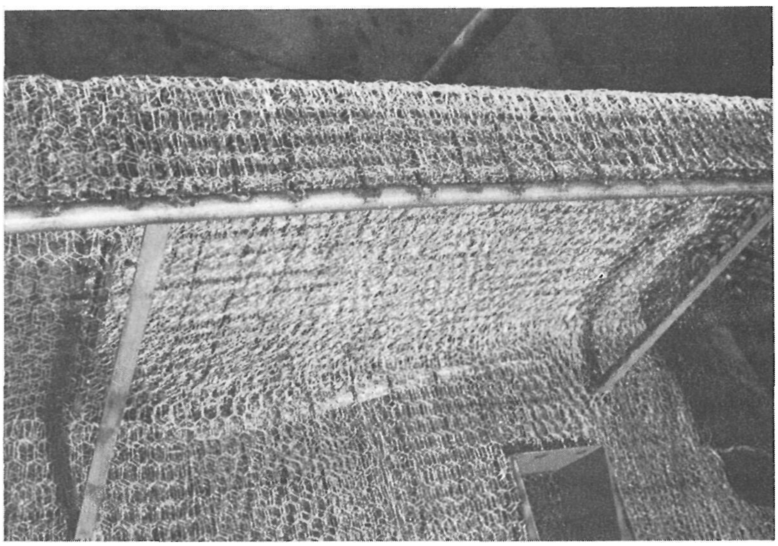
g) Inside corners of the hatch coamings; ensure that they are sharp and laced tightly.

3. Check for loose ends of mesh at every joint on deck and inside and outside the hull. Fasten down any loose end or protruding staple which might snag the plasterer's trowel. Check with particular attention the underside of all screeds on coamings, bulwarks, engine beds, webs and stringers. Tuck in loose ends beneath the screeds.

4. Ensure that the surface of the mesh is taut. Check that hog ring staples and tie wire are securing the mesh to the hull framework at 4" (100 mm) centers.

5. Check the inside of the keel and the bilges for scraps of waste material. Extract by hand all reject ends of welding rods. Use a vacuum cleaner on scraps of wood and insulation material which have been caught in the mesh.

Once absolutely satisfied that the hull meshwork is as tight and as clean as it can be made, and that it lies fair on the hull framework, preparations can begin for plastering.



The reason for the mesh inspection: a neglected area between the deck and bulwarks. The mesh will be fastened tightly to the bulwarks to form a neat radius with the deck surface.

Ends of mesh are tucked down between the bulwarks piping screed and the first longitudinal reinforcing rod.

- END VOLUME I -

FOR PLASTERING DETAILS OF THIS HULL

REFER TO

VOLUME II