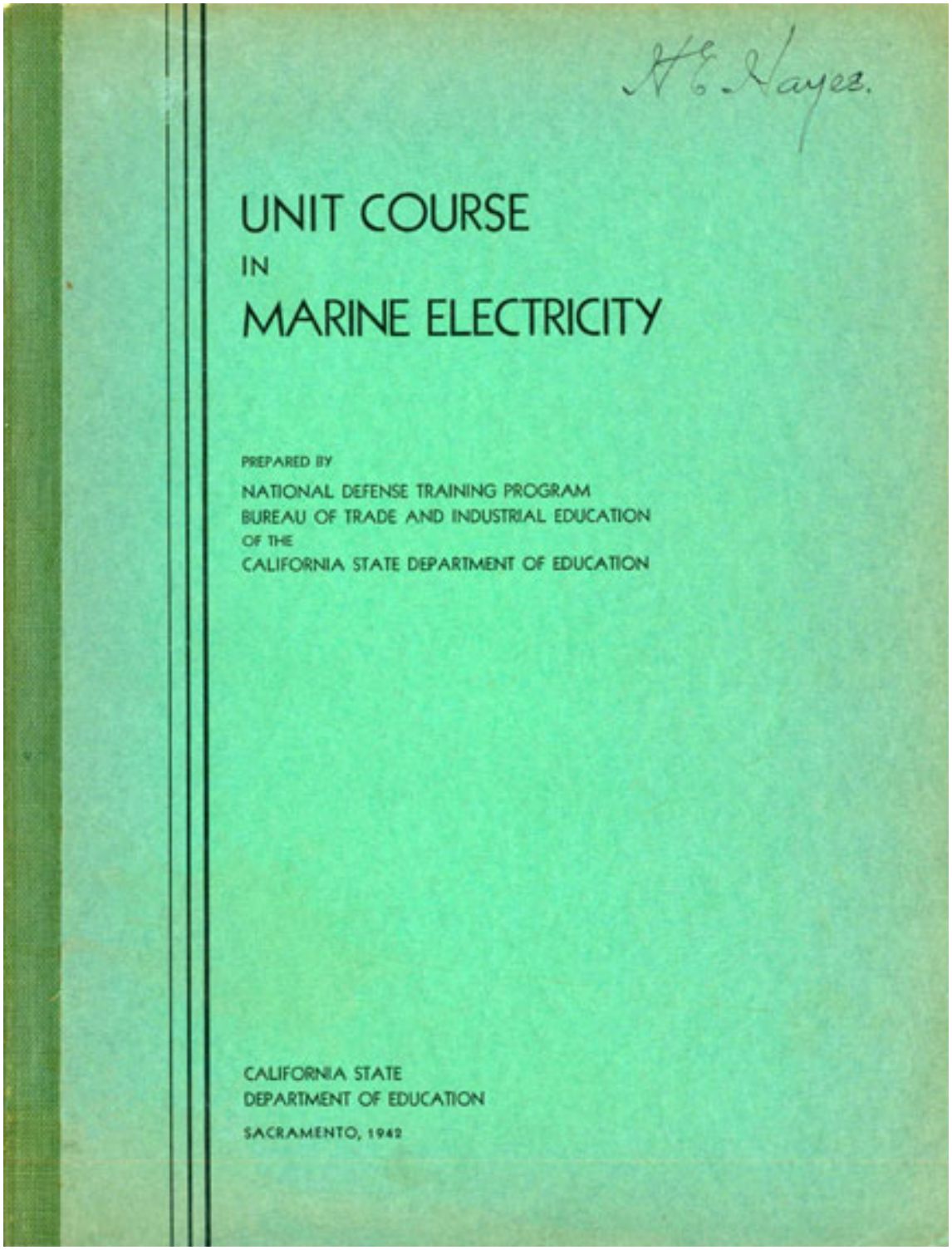

UNIT COURSE IN MARINE ELECTRICITY
Revised with Supplement

Prepared by
National Defense Training Program
Bureau of Trade and Industrial Education
of the
California State Department of Education

California State Department of Education
Sacramento, 1942

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H. J. Delaney, Naval Inspector

PREFACE

The safety of our country is dependent in large part, during this period of national emergency, upon the production of instruments of warfare that are essential to defense. The training of a great number of individuals for occupations essential to national defense is, therefore, vitally important at this particular time.

The defense training program is maintained under the provisions of Public Law No. 146 by state departments of education in co-operation with the United States Office of Education, through L. S. Hawkins, Director of Vocational Training for Defense Workers. Moneys are available to the states to train large numbers of personnel in defense occupations to meet the demands of local industries having defense contracts. Up-to-date instructional materials are necessary in order that this training may be most effective.

The California Plan of Vocational Education in and for Occupations Essential to National Defense has made provision, therefore, for the development and publication of instructional materials in defense occupations as a part of the state program.

California is actively engaged in training for shipbuilding, which is one of the most important industries in the defense program. This **Unit Course in Marine Electricity** has been developed by members of the staff of the Bureau of Trade and Industrial Education who are charged with the responsibility of preparing needed instructional materials for this program. Employees of the General Engineering and Dry Dock Company of Alameda, the Moore Dry Dock Company of Oakland, and the Todd-California Shipbuilding Corporation of Richmond acted as a committee for the development of this material. This committee received assistance and advice from H. J. Delaney, Naval Inspector, and from the Electricians Local Unions Numbers 6, 180, 302, 595, and 617 of San Francisco, Vallejo, Richmond, Oakland, and San Mateo, respectively.

Marion A. Grosse, Special Supervisor for National Defense Training, co-ordinated the work of the committee.

The material was edited and prepared for publication by the Special Supervisor for National Defense Training in Charge of Publications, Margaret McKieneavy.

The fine co-operation of the Moore Dry Dock Company in the defense training program is appreciated.

This revised edition includes a supplement covering certain information applicable to naval practices.

J. C. BESWICK
Chief, Bureau of Trade and
Industrial Education; and
State Director of Vocational
Training for Defense Workers

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CHAPTER 9
CABLING

BUREAU OF SHIPS NAVY DEPARTMENT

Approved 27 June 1951
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A

ELECTRONIC INSTALLATION PRACTICES MANUAL

This manual is intended for the use of the electronic installation worker. It may be used as a reference book on installation practices or in training beginners in Naval electronic installation work.

Subject matter in this text is intended as supplementary to, but not superseding existing and applicable specifications.

Appreciation is extended to the various Naval Shipyards, Commercial Firms, Service Representatives and Manufacturers who were contacted and without whose cooperation this manual would not be possible.

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Version 1.01, 10 Feb 06

Produced for ComSubLant by
Standards and Curriculum Division,
Training, Bureau of Naval Personnel

SUBMARINE ELECTRICAL INSTALLATIONS

June 1946

RESTRICTED

This is one of a series of Submarine Training Manuals. The series includes:

PREFACE

The Submarine School, Submarine Base, New London, Connecticut, and other activities of Submarines, Atlantic Fleet have collaborated in the preparation of this manual.

All submarine machinery is operated directly by electricity generated initially from energy supplied by the ship's diesel engines, or indirectly through the transmission media of high-pressure air or hydraulic systems. A thorough knowledge of the theory, operation, and maintenance of the electrical machinery is a requisite to successful operation of the submarine and the fulfillment of her mission in life-the destruction of the enemy's ships wherever and under whatever conditions they may be encountered. The accomplishment of this mission necessitates that operating personnel be trained to maintain the machinery in reliable operating condition as well as to operate it correctly.

The purpose of this manual is to acquaint the student with the theory, operation, and construction of the components of the electrical installations. Special emphasis is Oven to the more important maintenance features and methods.

A thorough knowledge of the ship and its machinery may, in an emergency, be the means of keeping it and its crew in battle condition.

The manual is intended as a primary instruction manual, ashore and afloat, for officer and enlisted personnel having duties in connection with submarine electrical installations. For details of construction and maintenance, the manufacturer's instruction books and Navy Department manuals should be consulted.

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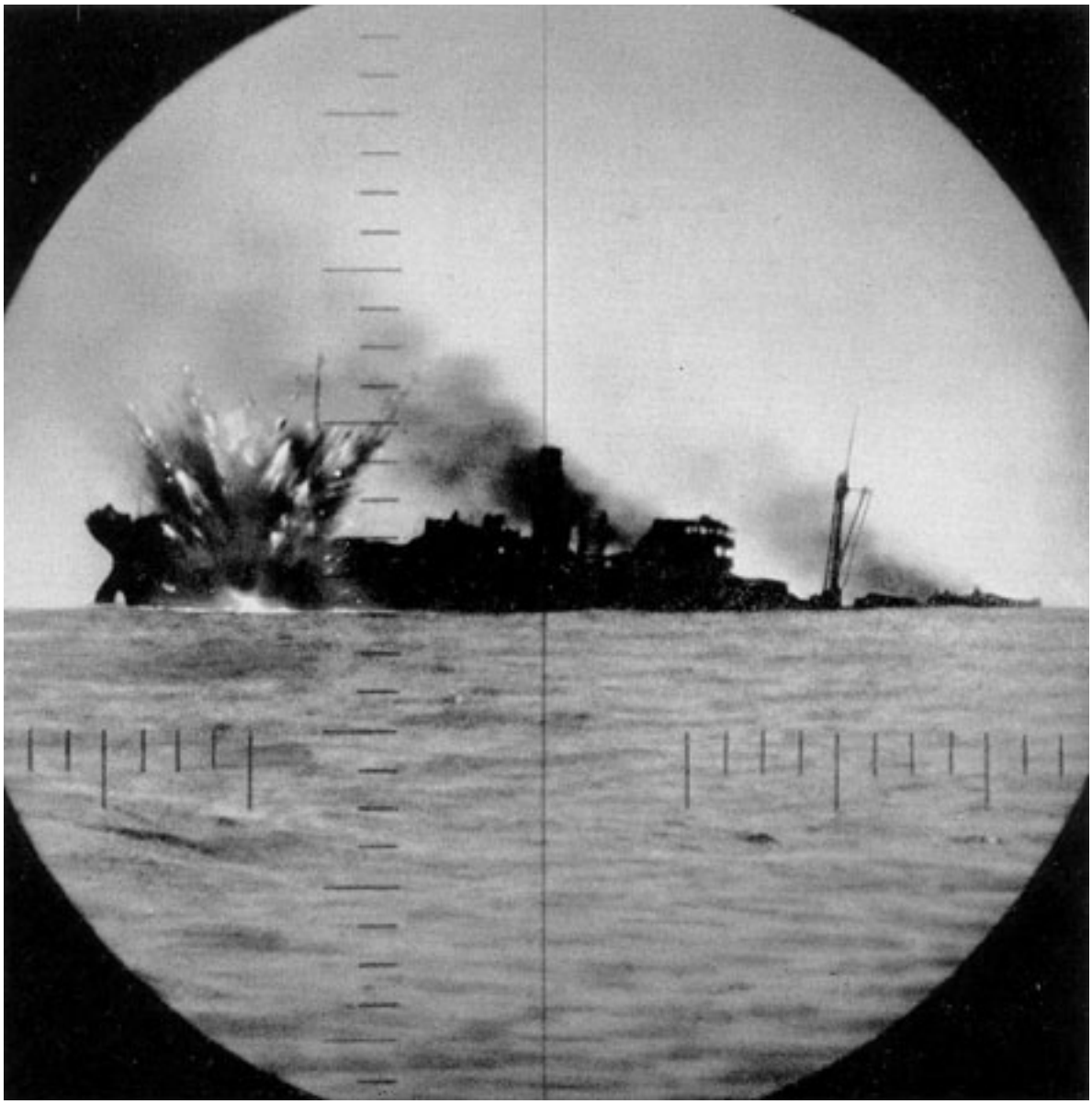
PART I

FLEET TYPE SUBMARINE
MAIN AND AUXILIARY POWER



Electrical power helped do this.

Fleetsub Home Page

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I. HAND TOOLS

A. **Introductory information**

The student must rely to some extent upon his mechanical ability to direct him in the proper use of tools. Only a few of the more important points in the care and use of tools are covered here.

The tools listed below are the minimum essentials which every helper should have before going out on a job.

B. **Supplies, tools, and equipment**

7" or 8" pliers (lineman or side cutter)
7" diagonal pliers
Channel lock pliers (pump pliers)
3" insulated screw driver
6" insulated screw driver
8" insulated screw driver
6" crescent wrenches
Heavy pocket knife
Linoleum knife
6' zig-zag, or other wooden rule
Ball peen hammer
Center punch

C. **Care and use of tools**

1. PLIERS (side-cutter type usually known as lineman's pliers)

a. These pliers are used for cutting wire and making up joints.

b. The proper cutting procedure is to give the pliers a slight downward twist as the pressure is applied to the handles.

c. The joint of the pliers should be oiled occasionally. Pliers should not be used to hold anything that is hot or is being heated, as heat takes the temper out of the pliers.

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C. **Care and use of tools** (continued)

2. DIAGONAL PLIERS

a. Diagonal pliers are used for cutting and skinning wire.

b. Their handling and care is the same as that for lineman pliers.

3. CHANNEL LOCK PLIERS (pump pliers)

a. Channel lock pliers are a special make of pump pliers that are used extensively by marine electricians because they are strong and safe. They are not as likely to slip as are other makes of adjustable pliers.

b. These pliers are used to install kickpipes and to tighten bushings and locknuts. They are also used wherever quickly adjustable pliers are needed.

c. Channel lock pliers require very little care except for an occasional cleaning of the gripping teeth.

4. INSULATED SCREW DRIVERS

a. Screw drivers are insulated to protect the user from electric shock.

b. They are used to drive, and to tighten or loosen screws. They must not be used as chisels or pry bars.

c. A screw driver is one of the most dangerous tools in the kit; it should be handled with great care. A slip in handling often means a punctured skin or the loss of an eye. Never carry a screw driver in your pocket with the handle down. Always keep the point protected.

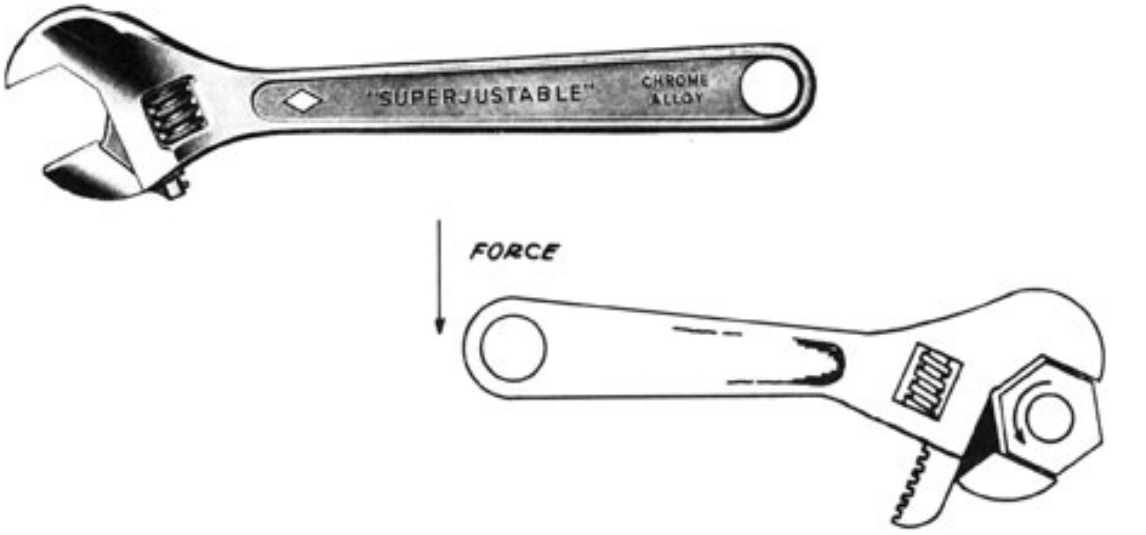
C. **Care and use of tools** (continued)

d. A screw driver should never be ground unless it is done by an expert. Incorrect grinding causes the screw driver to slip easily.

5. CRESCENT WRENCHES

a. Crescent wrenches are well-known, adjustable wrenches that have a wide use in the electrical field. They are used whenever a bolt can be easily reached.

b. When using a crescent wrench, one should make sure that the adjustable jaws are always on the side opposite the applied force. The wrench is so constructed as to form a brace against spreading of the jaws when used properly.



HOW TO USE A CRESCENT WRENCH

6. POCKET KNIFE OR LINOLEUM KNIFE

a. Knives are used to skin and scrape wires, to cut cable, and to cut, scrape or trim any soft metal or wood.

b. Knives should be kept sharp at all times. A fine-grit power emery stone, which is kept cool by frequently dipping it in cool water, can be used for this purpose. The knife should be ground slowly, as fast grinding may cause it to burn. A whetstone can be used to touch up the knife occasionally.

c. Do not use a knife in any way that may cause injury to yourself or others. Never try to split a round object, such as a cable, by holding the left hand under the knife while splitting, as a slip of the knife might cause serious injury.

C. **Care and use of tools** (continued)

7. SIX-FOOT RULE

a. A wooden zig-zag rule is selected because it is light and will not conduct electricity.

b. One should not attempt to estimate distances by "guess work"; the use of a rule for measuring is a necessary precaution against inaccuracy.

c. The rule should be oiled at the joints to permit easy working and to prevent wear. It should be kept absolutely clean; any paint or dirt spots which may get on it should be removed immediately.

8. BALL PEEN HAMMER

a. A ball peen hammer should be carried at all times and used wherever a hammer is needed.

b. The peen may be covered with rubber and friction tape to make a soft mallet for dressing and pounding cable.

C. **Care and use of tools** (continued)

9. CENTER PUNCH

a. A center punch is used to center holes for drilling. After the position of the hole is determined with the rule, the center punch is placed on the mark and struck with a hammer. This mark shows where the drill should be started.

b. The center punch should be kept sharp and should be ground always at the same angle as when new.

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II. CABLE HANGERS

A. **How to make cable hangers and lugs**

1. **Objective**

To show the proper method of manufacturing hangers and lugs used for the support of cables throughout the ship.

2. **Introductory information**

Cable hangers and lugs are used to support cable runs throughout the ship wherever it is necessary to keep the cables away from the deck or bulkhead. The "cable rack" is the complete installation and consists of hanging lugs, hanger, and strap. The success of the installation job depends upon the correct making of these parts, which requires accuracy in measuring and bending, as well as the proper use of tools.

3. **Supplies, tools, and equipment**

Center punch 1-lb. ball peen hammer Heavy-duty shear or power hacksaw 6' rule Bending machine Punch (size for punching 1/4" or 3/8" iron) Strap iron (1-1/4" x 1/4" x 3/8"--as specified in blueprint)

4. **Procedure**

a. MAKING THE LUG

1) Square and shear off one end of strap iron (material as specified).

2) Measure to length as specified (in this case 2-1/2 inches).

3) Shear off square. This gives us a flat iron bar 1-1/4" x 1/4" x 2-1/2". Two of these bars are needed for each hanger.

4) Put a center punch mark 1 inch from the end of each of these bars, being sure that it is in the center of the material.

5) Drill or punch a 3/8-inch hole at the center punch mark for the bolt. This completes the lug. Two lugs are needed for each hanger. (See accompanying illustration.)

A. **How to make cable hangers and lugs** (continued)

b. MAKING THE HANGER

1) Select the proper size of iron bar (as specified).

2) Square and shear off one end of iron bar.

3) Measure off the proper length for a 12-inch hanger (as specified). Allow for a 2-inch lip at each end to be bent at right angles. Since **inside** measurements are given, allowance must be made for thickness of material; therefore 1/2 inch is subtracted from total length. The total length is now 15-1/2 inches.

4) Shear off at this mark. (See illustration, Step 2.)

5) Measure 1 inch from each end and center punch in center of material.

6) Punch a 3/8-inch hole at each center punch mark. (See Step 3 of accompanying illustration.)

7) Since outside dimensions are given for the 2-inch lip, the flat bar is placed in the bender 1-3/4 inches from the end, and a 2-inch lip is bent at right angles on each end. (See illustration, Step 4.)

8) The hanger is next galvanized or zinc coated. Red lead paint is used when specified. Lugs do not need this coating as they are welded to the ship's structure.

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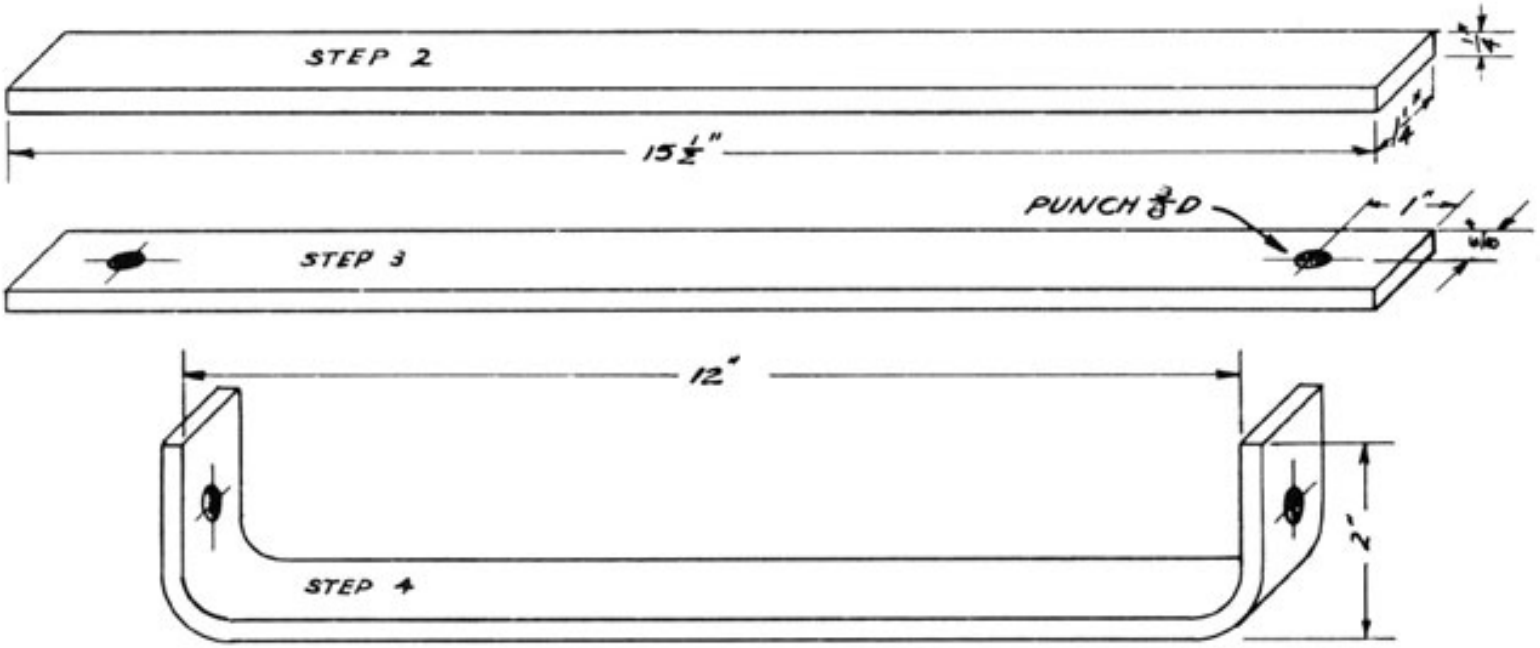
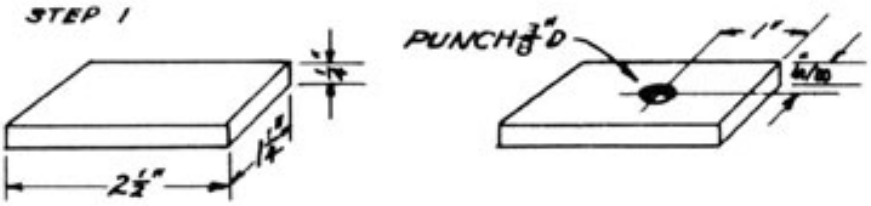
A. **How to make cable hangers and lugs** (continued)

5. **Illustrations**



STEPS IN MAKING 12" HANGER



STEPS IN MAKING HANGAR LUG

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B. **How to install cable hangers**

1. **Objective**

To show proper method of aligning and installing hanging lugs for the support of cable hangers.

2. **Introductory information**

All cables on shipboard are supported in cable racks built of a series of hangers and lugs, placed at regular intervals (as specified by the builders), and perfectly aligned. The cables are then secured to the hangers by suitable types of straps. The straps are secured in place by machine screws for which the hanger must be drilled and tapped. (See accompanying illustration, Steps 3 and 4.)

3. **Supplies, tools, and equipment**

6' rule
Channel lock pliers
Heavy gauntlet-type gloves
Chalk line
Ladder
Marking crayon
6" crescent wrench
Necessary number of lugs and hangers (hangers to be of the proper size to accommodate the number and size of cables to be in run)

4. **Procedure**

a. SECURE THE RIGHT NUMBER OF LUGS AND HANGERS OF THE PROPER WIDTH TO ACCOMMODATE THE CABLES TO BE RUN. (SEE ILLUSTRATION.)

1) Bolt a hanging lug to each lip of hanger. (See illustration, Step 1.)

2) Determine center line for the run of cable.

3) Put a mark at each end of the run over to one side of the center line, a distance of half the width of the hanger.

4) Run a chalk line between these two marks and line one side of the hanger to this line.

5) Mark off the distance between hangers as shown in the illustration.

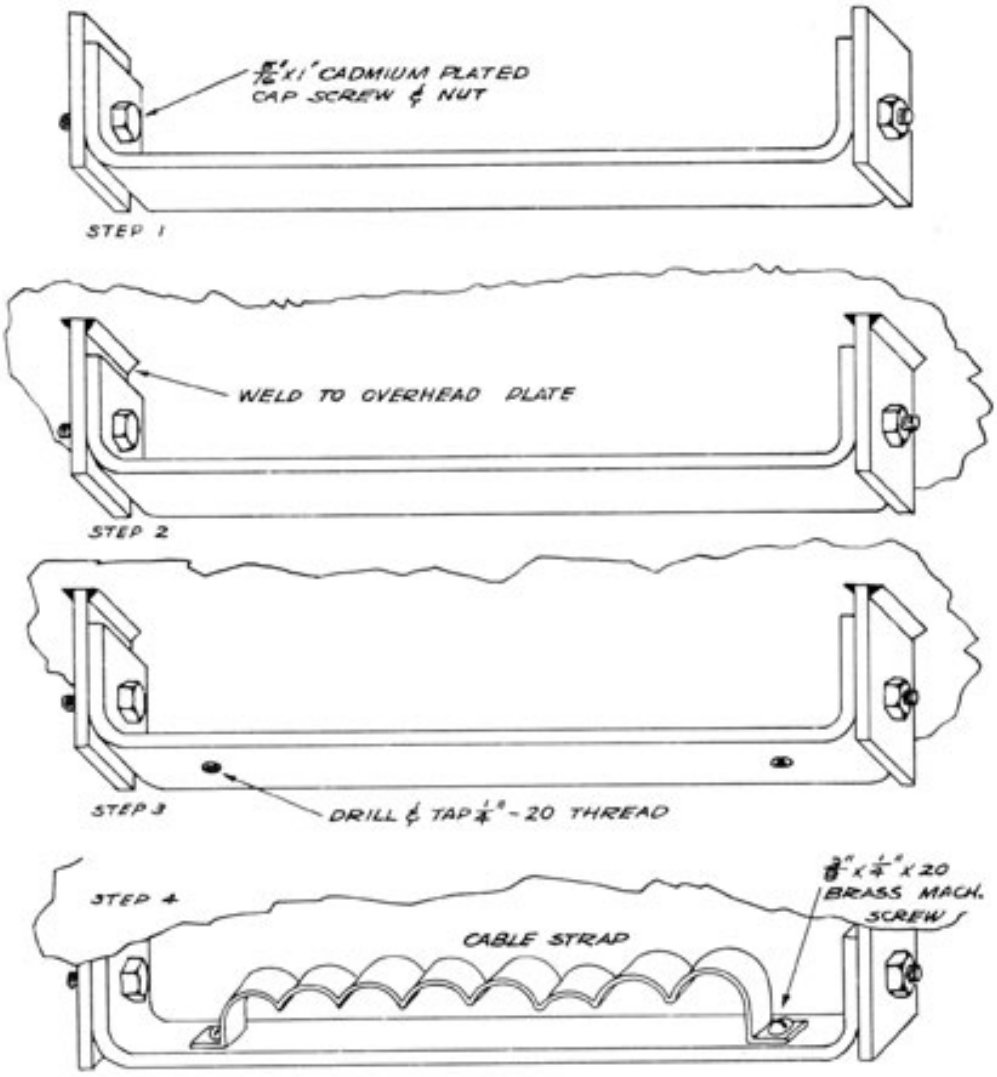
b. WELDING THE LUGS

1) When the electric welder is ready to weld the lugs to the deck or bulkheads, the helper will hold the strap square with the line of run, and one lug on

B. **How to install cable hangers** (continued)

the aligning mark while it is being welded in place. (See illustration, Step 2.)

Note: Wear heavy duty, gauntlet-type gloves to protect the hands and arms from welding sparks. Leave no part of the arms exposed to the arc. Use welding helmet to protect face and eyes. Never look directly at an electric arc unless properly fitted with dark glasses.



Installation of Hanger

III. MAKING KICKPIPES

A. **How to make a Type A kickpipe**

1. **Introductory information**

Cables which are run through decks are insured against mechanical injury by kickpipes. The installation of these cables is made watertight by the use of washers, locknuts, and red lead around the pipe where it goes through the deck or is welded to the deck. A properly packed terminal tube keeps the water from going through the pipe. The installation and packing of the tube will be given in another lesson. (See accompanying illustration.)

2. **Supplies, tools, and equipment**

Hacksaw	Conduit of proper size to
Reamer	accommodate cable to be
Rule	run through it
Stock and dies	Conduit coupling
Pipe wrenches	Terminal tube
Pipe vise	2 brass locknuts
Cutting oil	2 canvas washers
Conduit bushing	

3. **Procedure**

a. PUT A LENGTH OF CONDUIT IN VISE.

1) Thread 1/2 inch or more, according to size of conduit.

2) Ream it.

b. SCREW ON A CONDUIT COUPLING.

1) Tighten with pipe wrench.

c. MEASURE OFF AND MARK THE CONDUIT 18 INCHES FROM THE TOP OF COUPLING. (THIS WILL BE THE TOP OF THE THREADS WHEN THEY ARE CUT ON THE CONDUIT.)

d. MEASURE THE DISTANCE THROUGH THE DECK.

1) Add the space taken up by the locknuts, washers, and bushing.

2) Add 1/2 inch.

e. ADD THE ABOVE TOTAL DISTANCE TO THE 18-INCH MARK.

1) Cut off the conduit with a hacksaw.

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A. **How to make a Type A kickpipe** (continued)

f. THREAD A STRAIGHT THREAD (NOT TAPERED) TO THE 18-INCH MARK.

1) Ream the end.

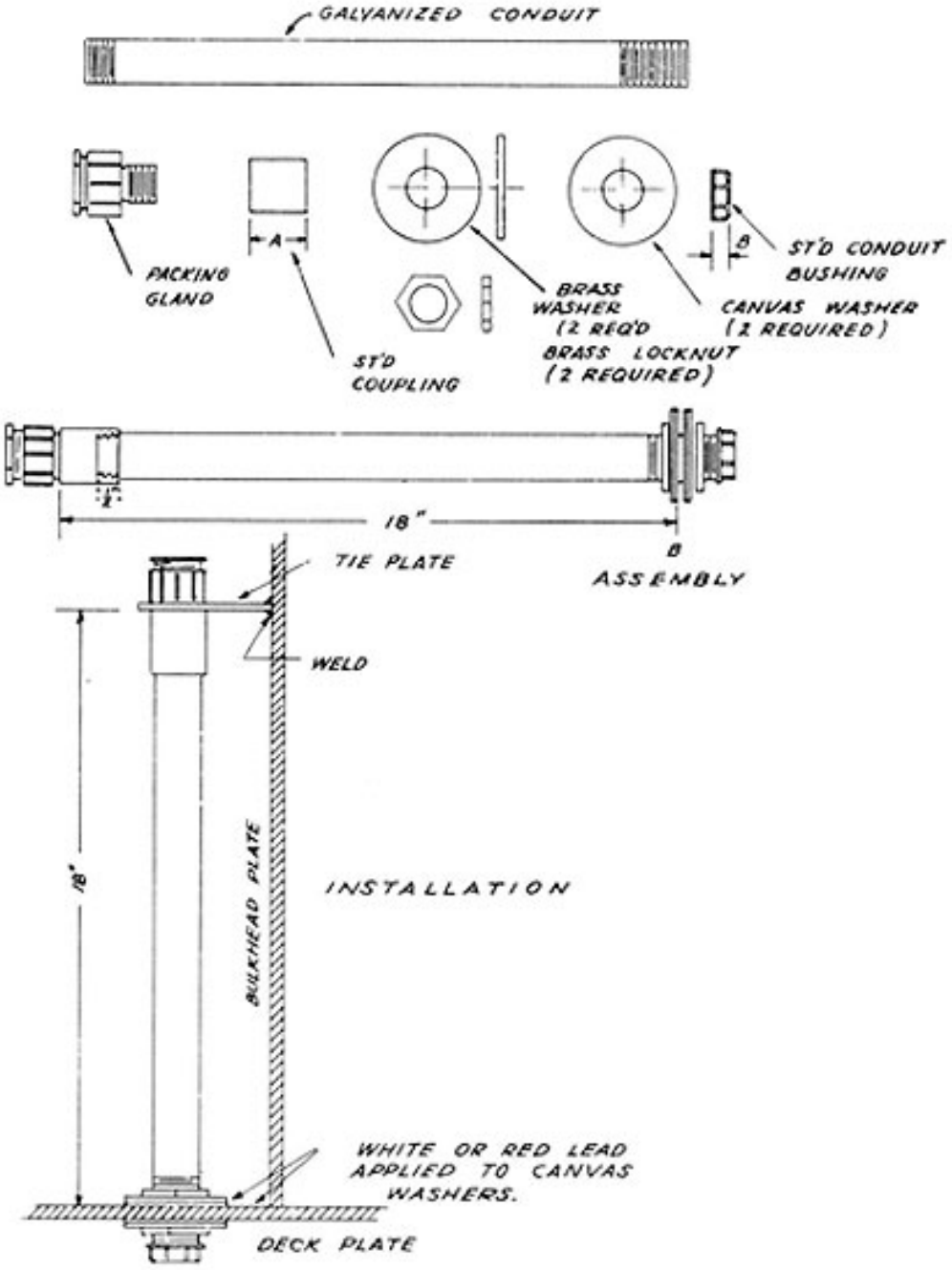
g. SCREW ON A LOCKNUT.

1) Put on a brass washer, two canvas washers, another brass washer, another locknut, and the bushing.

h. SCREW A TERMINAL TUBE INTO THE COUPLING. (IT NEED NOT BE TIGHTENED AS IT WILL HAVE TO COME OUT AGAIN WHEN THE PIPE IS INSTALLED.)

i. THE KICKPIPE IS NOW COMPLETED AND READY FOR INSTALLATION.

4. **Illustrations**



Type A Kickpipe
(Parts)

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B. **How to install Type A kickpipe**

1. **Introductory information**

All kickpipes in any one grouping, regardless of their size, must be the same height above the deck to insure a good looking job. It will be assumed that two or more kickpipes are going in this location and that the holes are already laid out and drilled through the deck. The pipes are held securely at the top by tie plates which are already on hand. The tie plates are to be welded to the bulkhead after the pipes are installed. (See illustration.)

2. **Supplies, tools, and equipment**

Completed kickpipes of proper size
Tie plates
Pipe wrench
Lock channel pliers

3. **Procedure**

a. DETERMINE THE PROPER SIZE OF KICKPIPE FOR THE FIRST HOLE ON EITHER END.

b. TAKE OFF THE BUSHING, FIRST LOCKNUT, BRASS WASHER, AND CANVAS WASHER.

c. PUT A GOOD COATING OF RED OR WHITE LEAD AROUND TEE HOLE.

d. INSERT THE THREADED END OF THE KICKPIPE THROUGH THE HOLE WITH TEE CANVAS WASHER AGAINST THE DECK.

1) Put a coating of red or white lead on the under side of the deck around the hole.

2) Put the canvas washer over the pipe against the deck.

3) Put on the brass washer and then the locknut. Screw tight with wrench.

4) Put on the bushing and screw tight with channel lock pliers.

e. (ABOVE DECK) TAKE OFF THE TERMINAL TUBE AND INSERT IT THROUGH THE PROPER TIE PLATE.

f. SCREW THE TERMINAL TUBE (WITH TIE PLATE) INTO THE COUPLING AGAIN AND TIGHTEN WELL WITH PIPE WRENCH.

Note: The tie plate will be welded on to the bulkhead later.

g. PUT THE NEXT KICKPIPE INTO THE ADJACENT HOLE IN THE SAME MANNER.

C. **How to make a Type B kickpipe**

1. **Introductory information**

On a Type B kickpipe, an extra-heavy coupling is screwed onto the lower end of the pipe. This coupling goes through the deck and is welded in place. Otherwise the procedure is the same as for making a Type A kickpipe. Measurements, however, are different. Regardless of type, they both measure 18 inches from the deck to the top of the top coupling.

2. **Supplies, tools, and equipment**

Hacksaw
Reamer
Rule
Stock and dies
Pipe wrenches
Pipe vise
Cutting oil
Proper size conduit to accommodate the cable to be run through it
Regular conduit coupling
Extra-heavy conduit coupling
Bushing

3. **Procedure**

a. PUT A LENGTH OF CONDUIT IN THE PIPE VISE.

1) Thread one end.

2) Ream this end with a pipe reamer.

b. SCREW ON A CONDUIT COUPLING.

1) Tighten it with a pipe wrench.

c. TO DETERMINE THE POINT AT WHICH TO CUT OFF THE CONDUIT, PROCEED AS FOLLOWS:

1) Measure off on the conduit 18 inches from the top of the coupling.

2) Hold an extra-heavy coupling alongside the conduit with its center at the 18-inch mark.

3) Estimate the distance the conduit will screw into the coupling, and mark the conduit for cutting at this point.

d. CUT OFF THE CONDUIT WITH A HACKSAW AT THIS LAST NARK.

e. THREAD THIS END OF THE CONDUIT.

1) Ream it with a pipe reamer.

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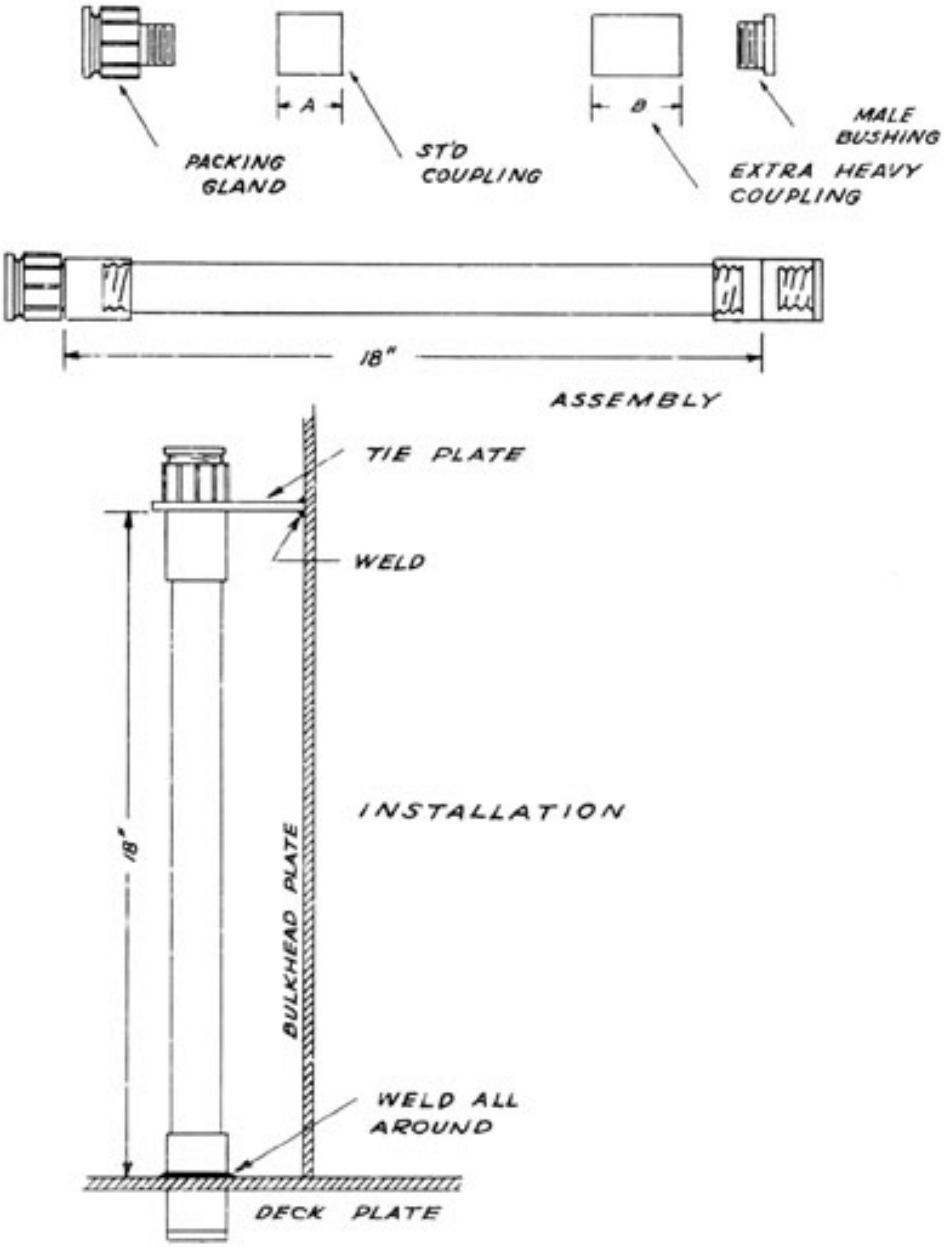
C. **How to make a Type B kickpipe** (continued)

f. SCREW ON THE EXTRA-HEAVY COUPLING AND TIGHTEN IT WITH A PIPE WRENCH.

g. SCREW A BUSHING INTO THE OPEN END OF COUPLING.

h. THE TYPE B KICKPIPE IS READY FOR INSTALLATION.

4. **Illustrations**



Type B Kickpipe
(Parts)

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IV. HOW TO MEASURE CABLE RUN

A. **Introductory information**

After the cable run has been determined from the blueprints, it is generally spotted in, chalked in, or painted in on the ship's structure. It is then necessary for the electrician or his helper to measure the length of the run in order that the cable may be cut the correct length before pulling in. It must be measured from its start to its finish with all due allowances made for offsets and for racking. (See accompanying illustration.)

B. **Supplies, tools, and equipment**

6' zig-zag rule
pencil
Paper

C. **Procedure**

1. DETERMINE THE LOCATION OF THE TWO ENDS OF THE RUN FROM THE BLUEPRINT.

2. FIND THE LOCATION OF THE CABLE RUN WHERE IT HAS BEEN SPOTTED IN BY THE LAYOUT MAN.

3. START AT ONE END AND ALLOW FOR MAKING UP IN JUNCTION BOX, OUTLET BOX, OR OTHER TERMINAL BOX. (SEE ILLUSTRATION, A.)

    a. This measurement is based on an estimate gained by experience. The beginner should ask the electrician the allowance to make.

4. MEASURE THE FIRST STRAIGHT RUN. (SEE ILLUSTRATION, B.)

    a. Do not take off for cable cutting across bends.

    b. Make all measurements as though they were at right angles.

5. MEASURE ALL STRAIGHT RUNS (A TO B, B TO C, D TO E, AND E TO F) IN THE SAME WAY. (SEE ILLUSTRATION.)

6. MAKE ALLOWANCE FOR MAKEUP IN TERMINAL BOX AS IN PROCEDURE NO. 3.

7. ADD TOGETHER ALL MEASUREMENTS TAKEN.

    a. If the run is a long one, it is advisable to add 5 feet for every 100 feet of run. (Add 2-1/2 feet for 50 feet of run, etc.)

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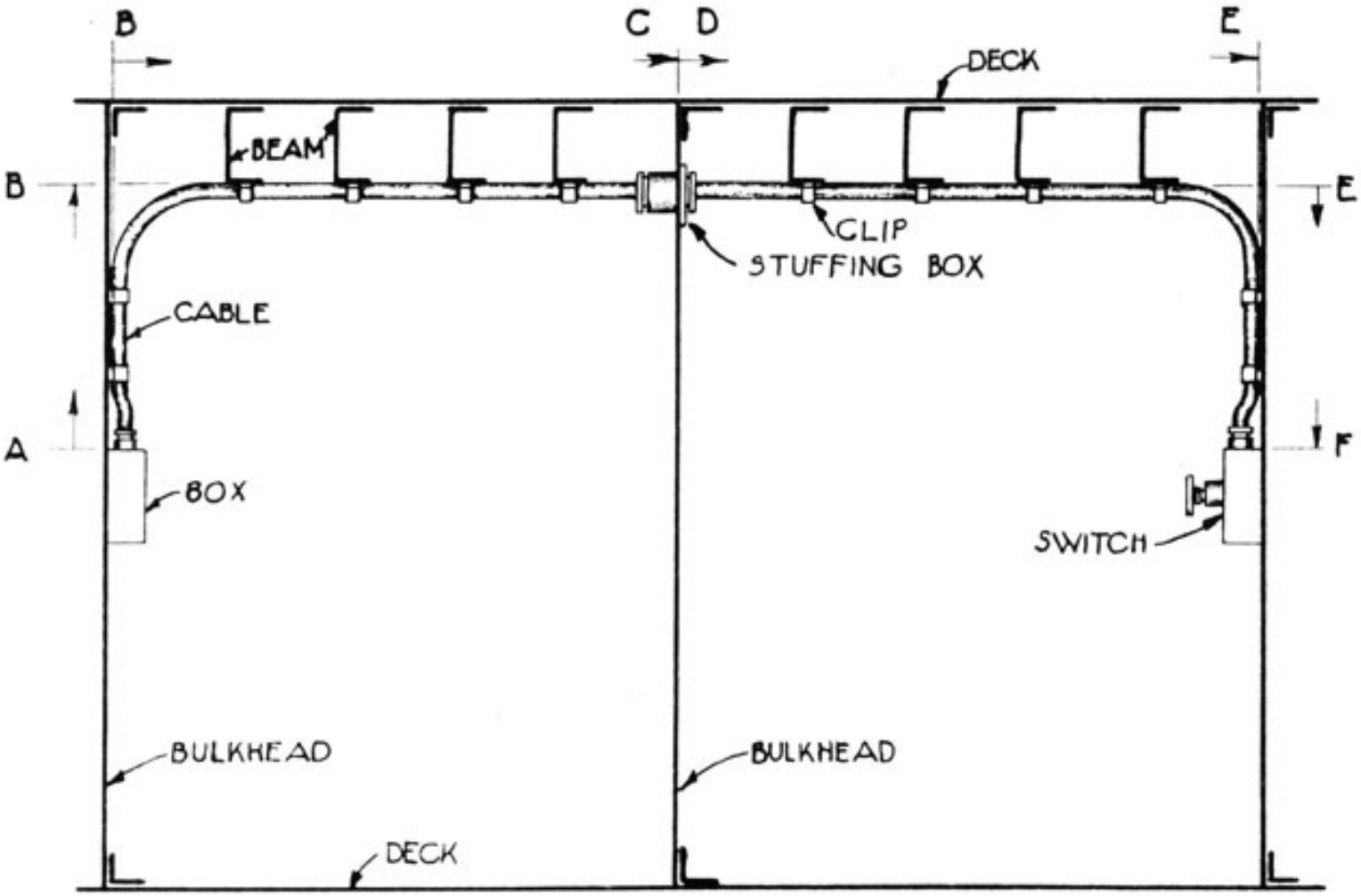
D. **Illustration**



MEASURING CABLE

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Next Part

Version 1.00, 15 Jan 06

V. HANDLING CABLE

A. **How to cut cable to length and prepare for pulling**

1. **Introductory information**

Cables are always shipped on reels with size and type marked on the reel. The reels are set on cable jacks or horses so that they will turn freely. The worker can then reel off cable and cut to any length desired. Under no condition must the cable be twisted, bent sharply, or kinked.

2. **Supplies, tools, and equipment**

Proper size and type of cable
Cable jacks or horses
Length of proper size pipe
Hacksaw
Screw driver
Rule

3. **Procedure**

a. DETERMINE FROM THE BLUEPRINT THE PROPER SIZE AND TYPE OF CABLE FOR THE RUN.

b. SELECT A CLEAR SPACE IN WHICH TO REEL OFF THE CABLE.

c. ROLL THE REEL OF CABLE TO ONE END OF THE CLEARED SPACE.

1) Put a pipe through hole in the center.

2) Jack up on cable jacks or horses.

3) Put a mark about three feet in front of the reel and from this mark measure off the desired length.

4) Mark the space off in five-foot lengths.

5) Pull off free end of cable and reel it out to the proper mark.

d. CUT OFF AT THE BEGINNING MARK IN FRONT OF THE REEL. (USE HACKSAW FOR CUTTING.)

Note: If the cable is to be carried some distance to the job, it should be **rolled** up again into a roll and the two ends tied to the roll with a piece of marlin.. On the job it should be **unrolled** and laid out straight before starting the pull in.

e. PREPARE ONE END OF THE CABLE FOR PULLING IN BY FORCING BACK SEVERAL INCHES OF THE ARMOR WITH A SCREW DRIVER.

A. **How to cut cable to length and prepare for pulling** (continued)

1) Cut off the remaining lead and cable with a hacksaw.

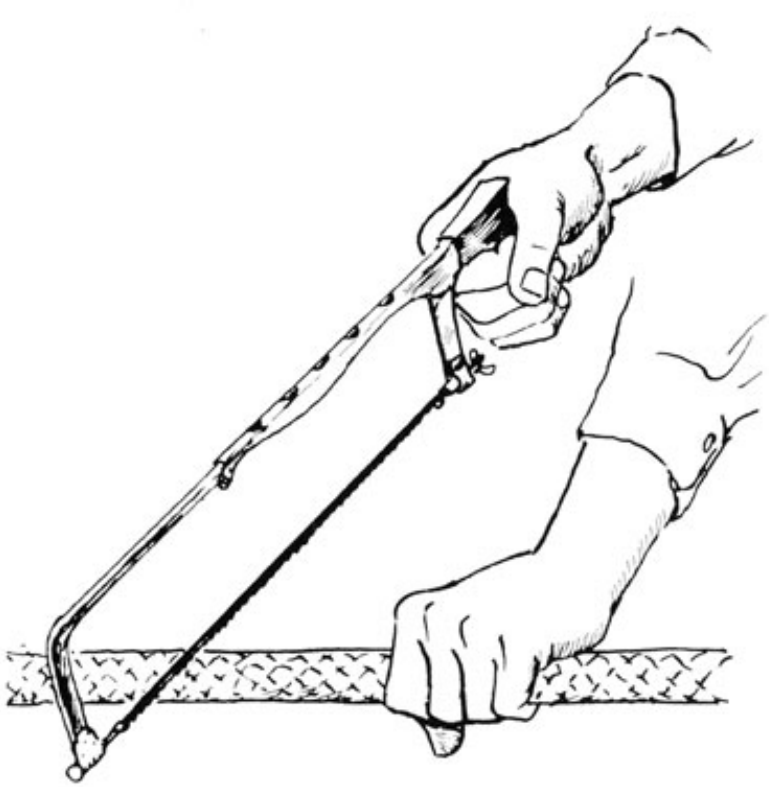
f. PULL THE ARMOR BACK OVER THE END AND TWIST TO A POINT IF IT IS TO BE PUSHED IN.

1) If it is to be pulled in, form the armor into an eye and tie a rope into it.

Note: Small cables are **pushed** in, and larger cables are **pulled** in.

4. **Illustration**

a. The proper method of cutting cable by hand.

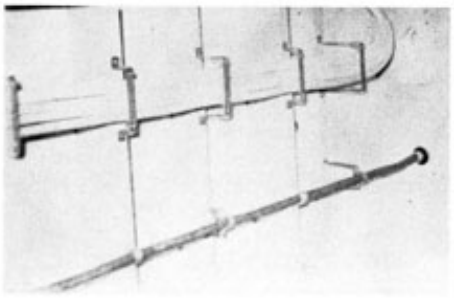


19

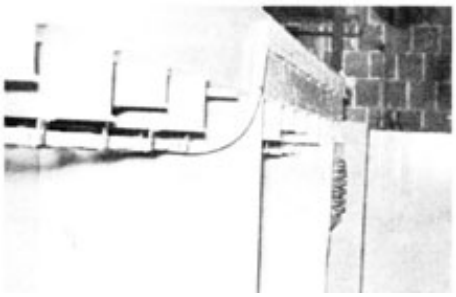
B. **How to rack cable and strap it in place in cable hanger**

1. **Introductory information**

All cables in any one run are laid parallel. Special care should be taken not to damage the cable in any way. Small cables may be bent to a radius of two diameters and the larger cables should be bent to a radius of eight diameters. (See accompanying illustrations.) Regardless of size, all the cables in one run must be bent to conform to the largest cable. Do not bend the cables sharply away from packing or stuffing tubes. (See illustration on page 35, Chapter V.) They must come through the tube **straight** for at least one inch before beginning the bend. Cables must not cross one another.



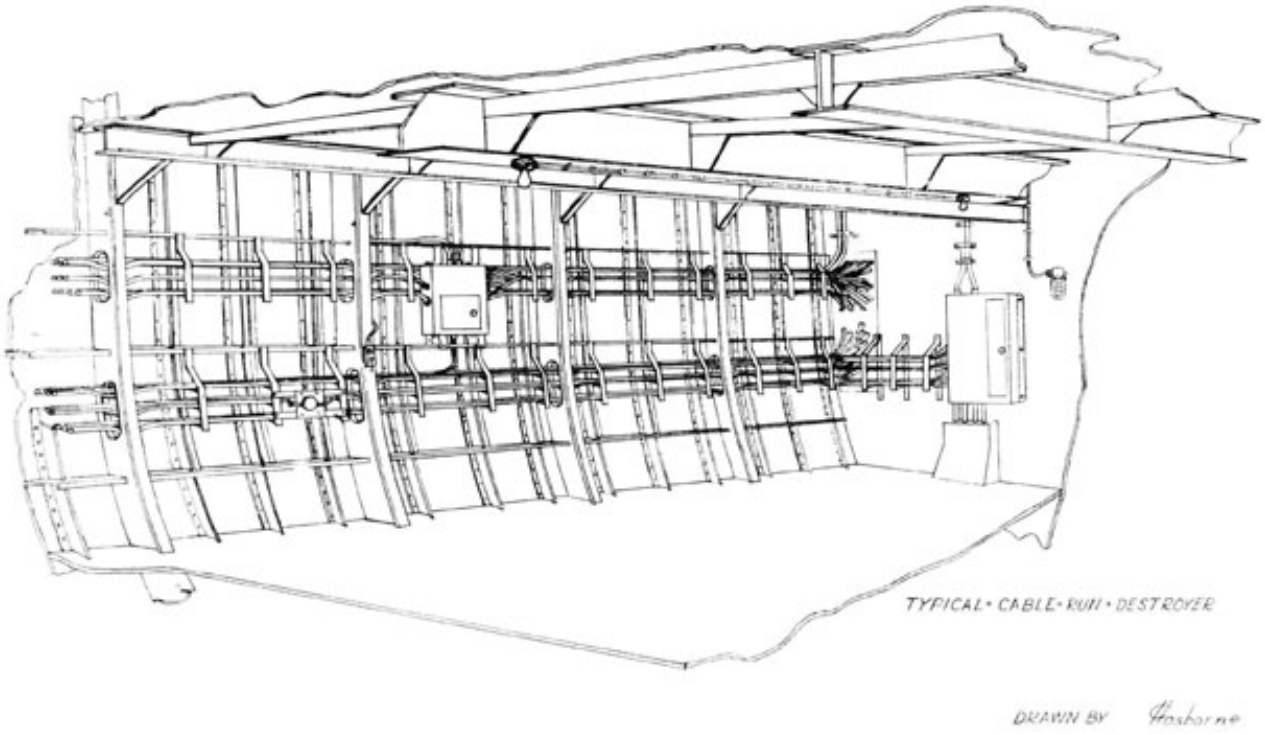
Overhead View of Cable Run



Side View of Above Cable Run Showing Bend

20

B. **How to rack cable and strap it in place in cable hanger** (continued)



21

B. **How to rack cable and strap it in place in cable hanger** (continued)

2. **Supplies, tools, and equipment**

Soft-headed hammer
Wood prybars
Rope or marlin

3. **Procedure**

a. SKID ONE END OF CABLE. (SEE INFORMATION ON "HOW TO SKIN CABLE" PAGES 45 - 50 INCLUSIVE.)

1) Enter it into stuffing tube of outlet box.

b. BEGINNING AT ONE END, DETERMINE TAE ORDER IN WHICH CABLE WILL BE LAID.

c. FORCE ALL THE CABLES UP BETWEEN THE FIRST HANGING LUGS.

1) Bolt hanger into place.

d. CONTINUE ALONG THE RUN UNTIL ALL CABIES ARE IN THE RACKS.

e. START AT THE FIRST HANGER AGAIN AND SEE THAT EACH CABLE CONES OUT OF ITS STUFFING TUBE STRAIGHT.

1) If any offset is to be made, make it about one inch from the tube.

f. SECURE THE CABLE OR CABLES IN PLACE IN THE FIRST HANGER WITH A CABLE STRAP FASTENED TO THE HANGER WITH MACHINE SCREWS.

g. IF ANY CABLE OR CABLES BREAK AWAY 1,',ROM THE MAIN RUN, BEND THEM TO THE PROPER RADIUS FOR THE LARGEST CABLE THE RUN.

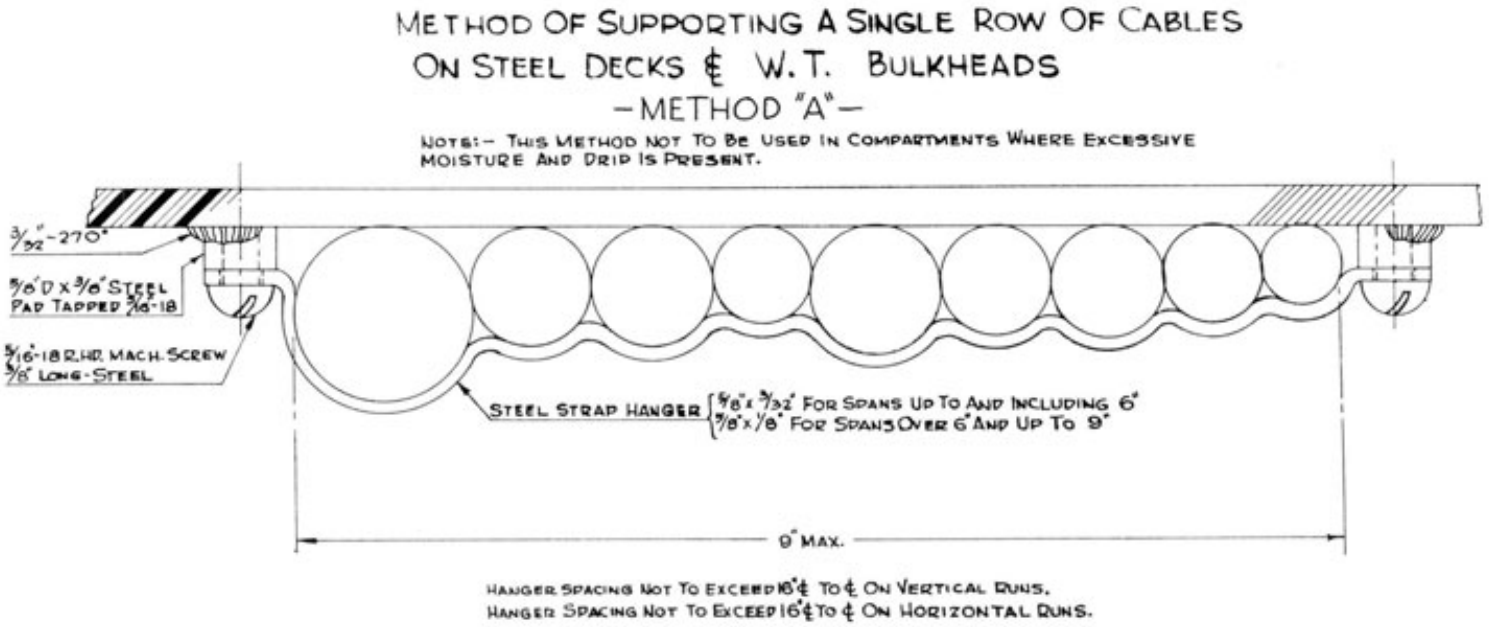
h. OFFSETS FOR DECK OR BULKHEAD TUBES SHOULD BE MADE AS IN THE ABOVE PROCEDURE.

4. **Illustrations**

The following are some types of hangers used in marine wiring; these include Section 1--single racks, and Section 2--double and triple racks (as required by specification of the job).

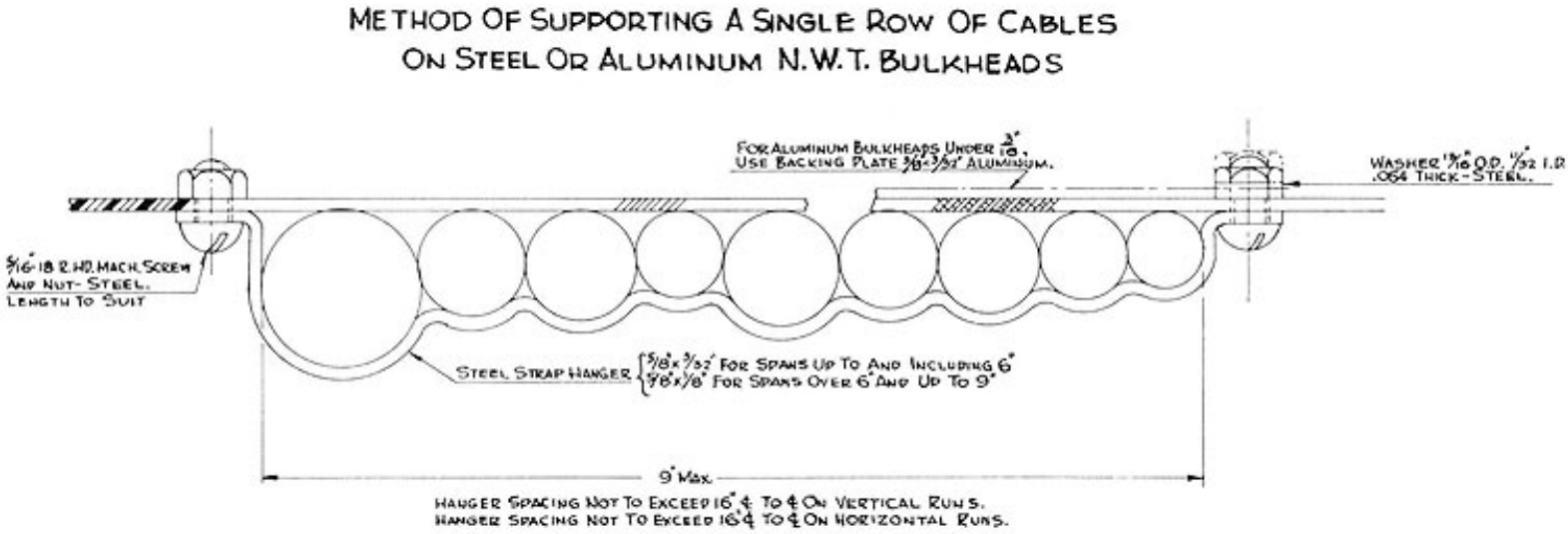
B. **How to rack cable and strap it in place in cable hanger** (continued)

a. Section 1



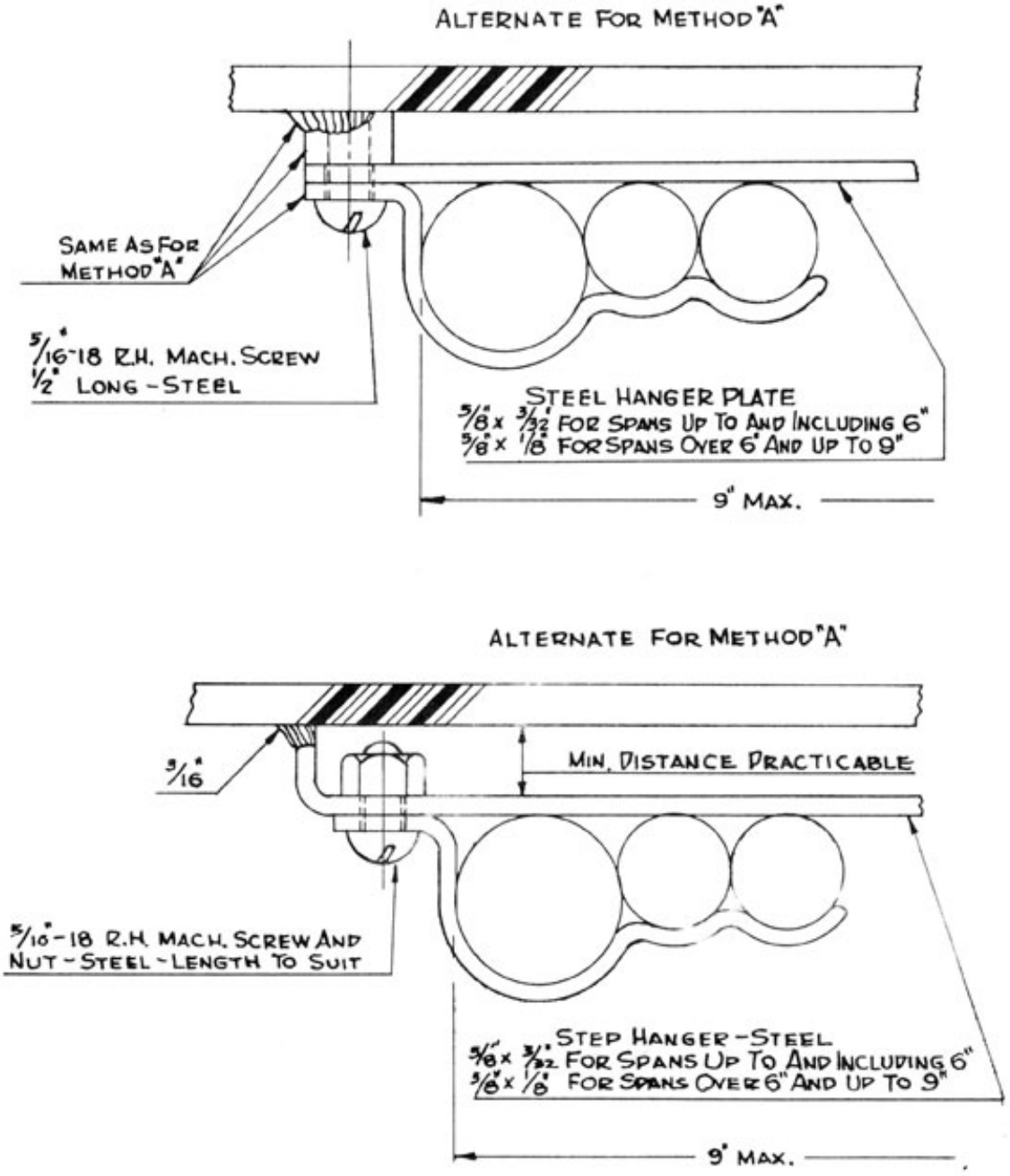
23

B. **How to rack cable and strap it in place in cable hanger** (continued)

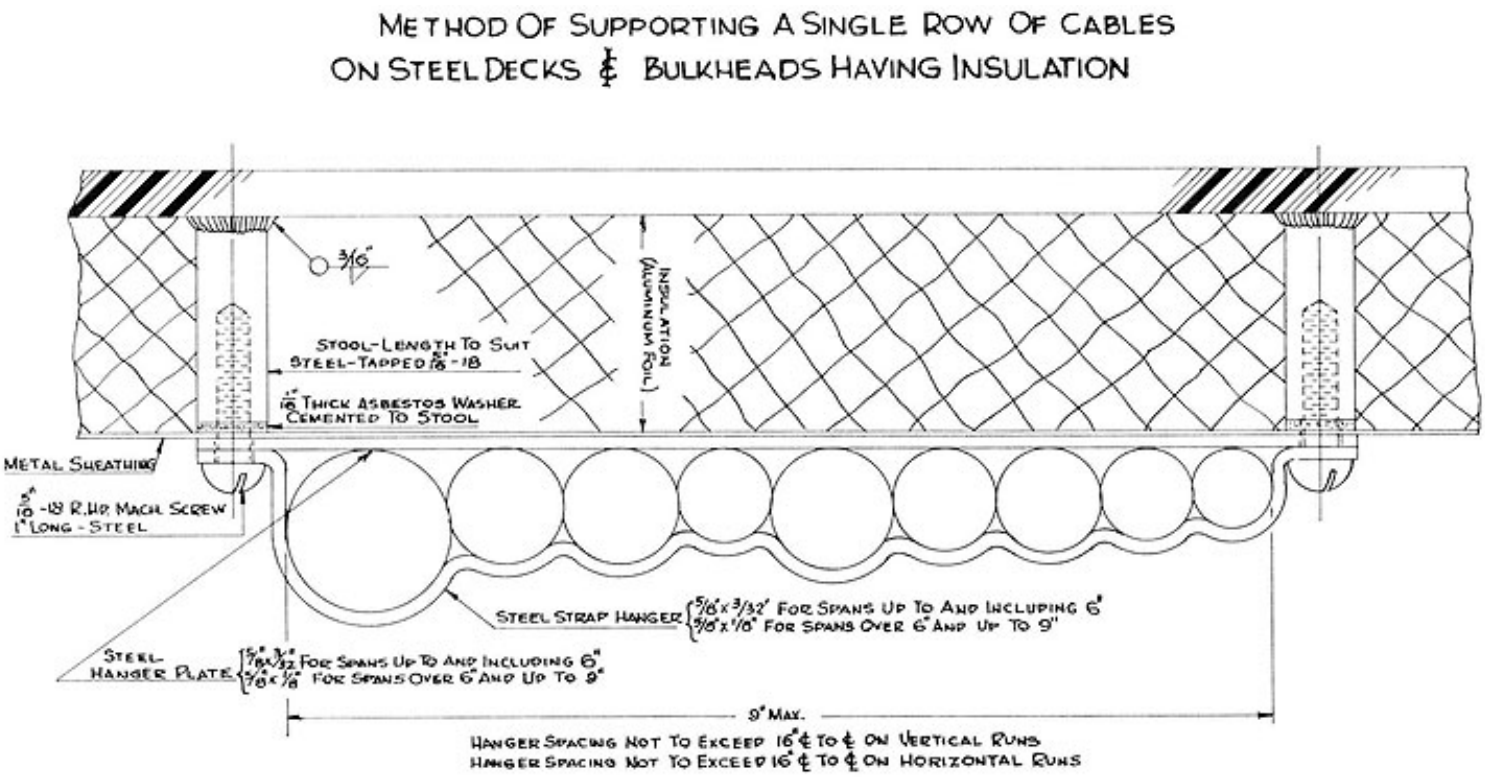


24

B. **How to rack cable and strap it in place in cable hanger** (continued)



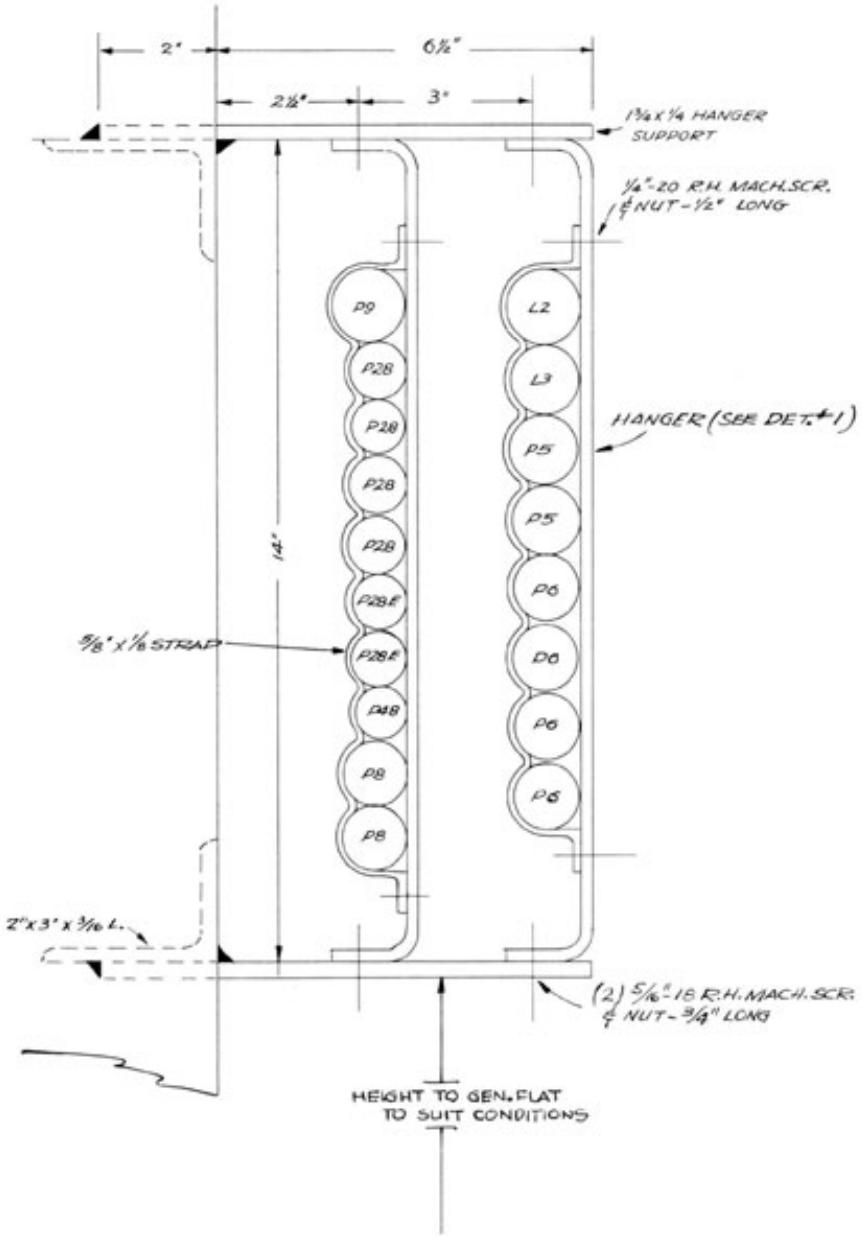
B. **How to rack cable and strap it in place in cable hanger** (continued)



26

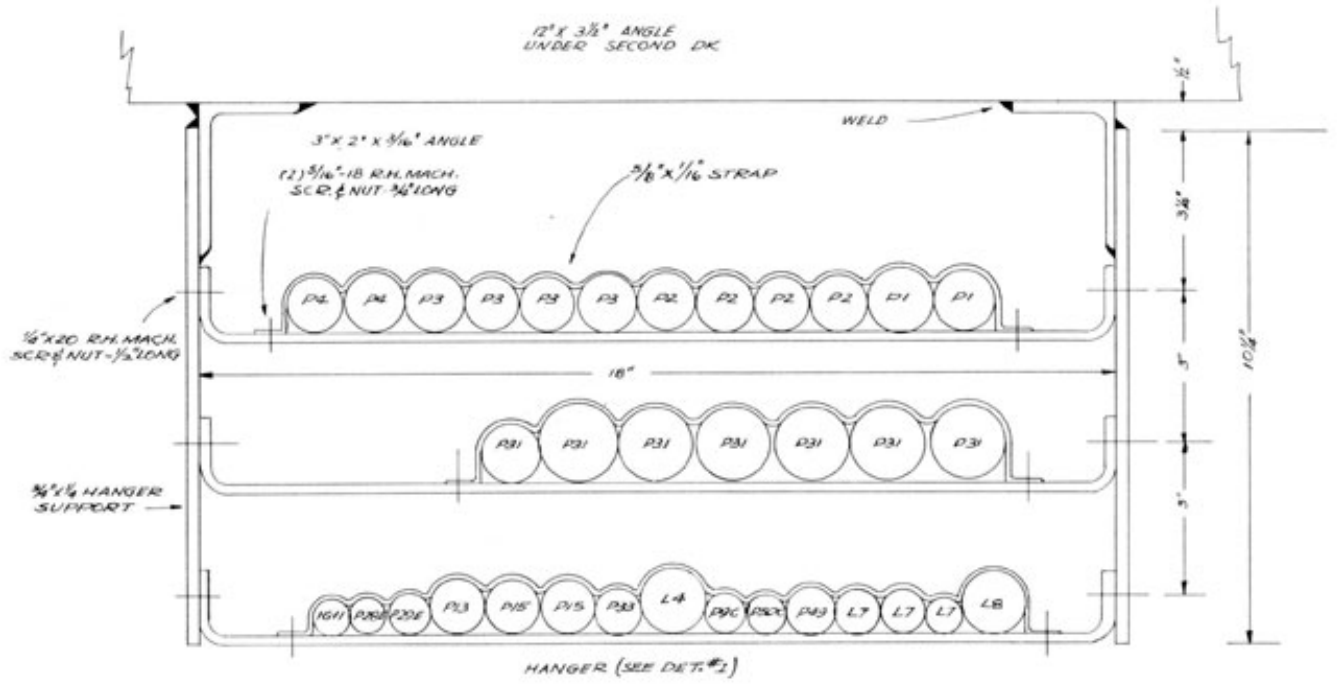
B. **How to rack cable and strap it in place in cable hanger** (continued)

b. Section 2



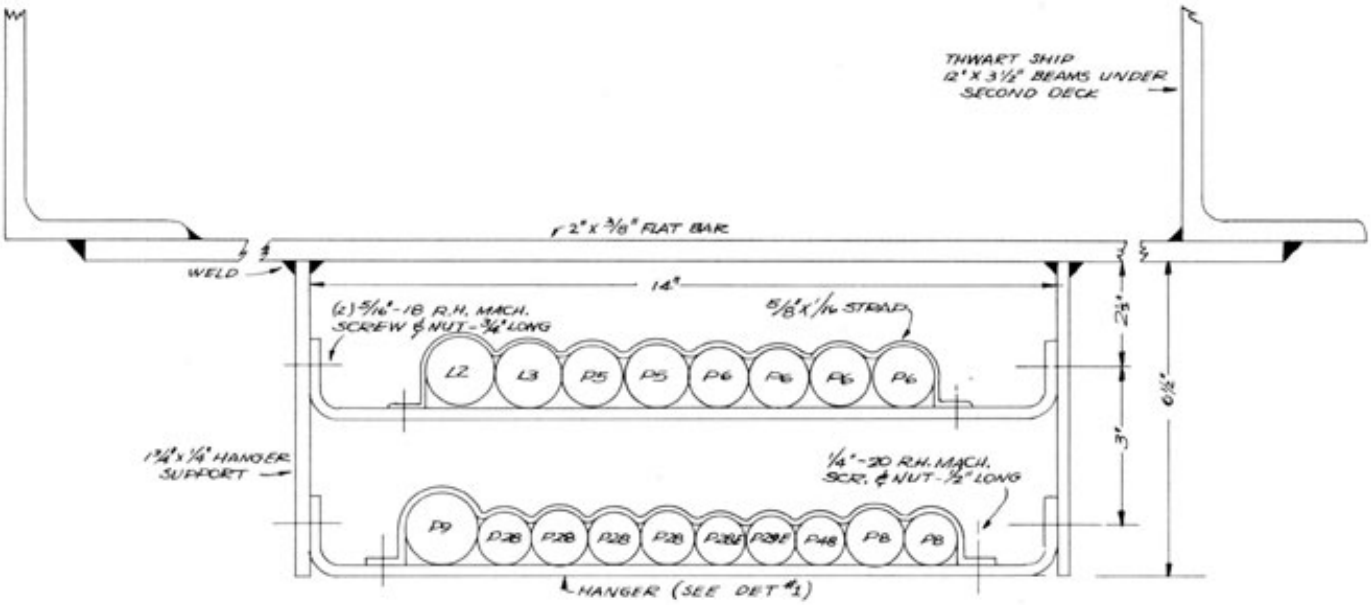
27

B. **How to rack cable and strap it in place in cable hanger** (continued)



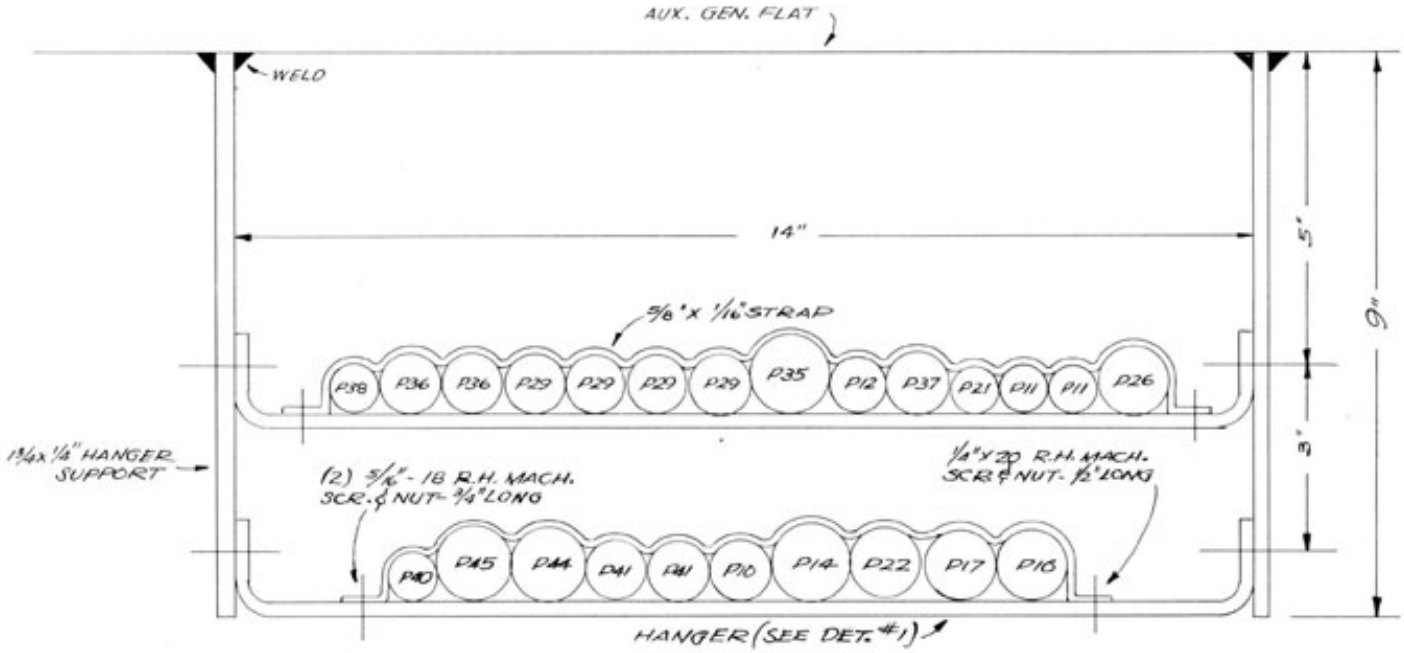
28

B. **How to rack cable and strap it in place in cable hanger** (continued)



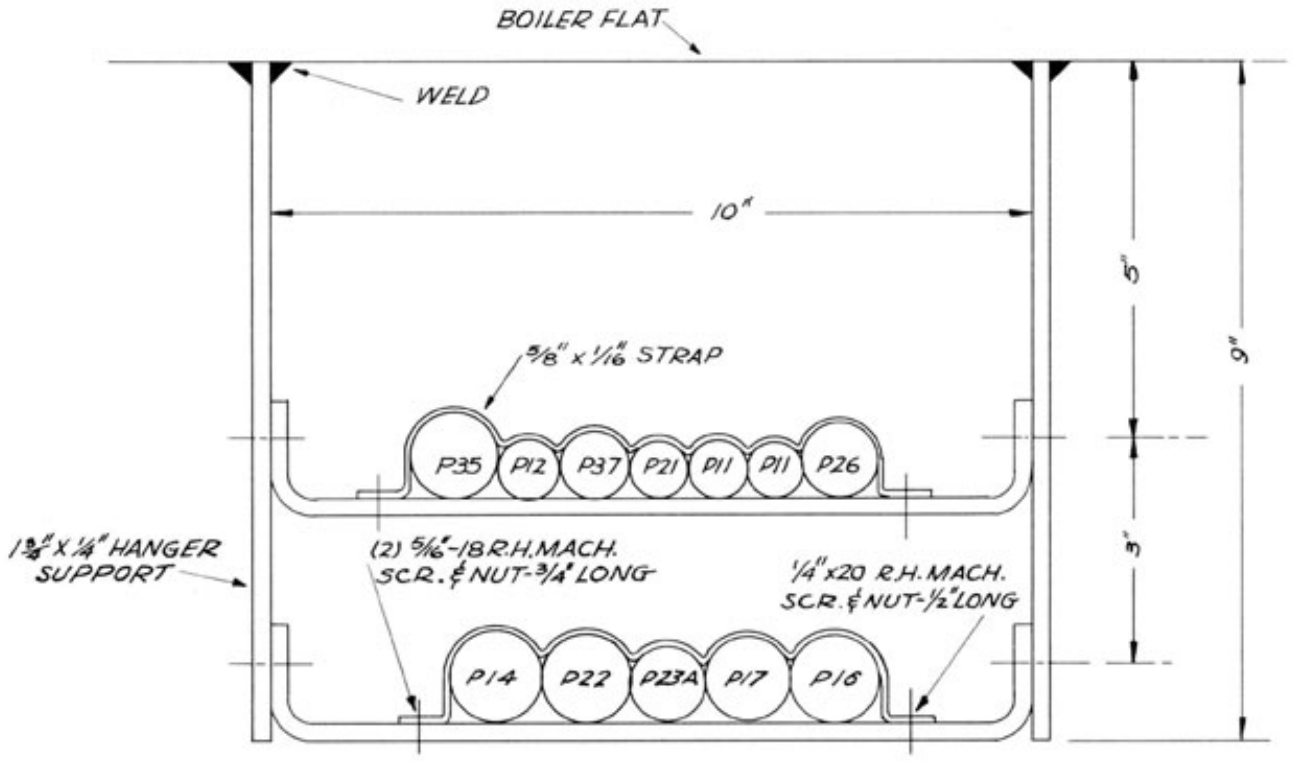
29

B. **How to rack cable and strap it in place in cable hanger** (continued)



30

B. **How to rack cable and strap it in place in cable hanger** (continued)



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C. **How to form and strap cable**

1. **Objectives**

a. To point out the factors to be considered in forming and strapping cable.

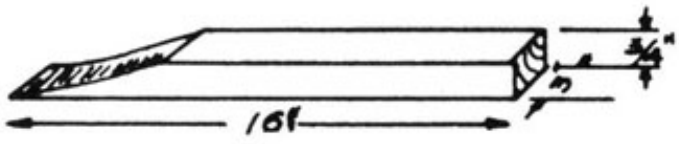
b. To show how to form and strap cable.

2. **Introductory information**

After all cables in a particular rack have been pulled in and racked, the cable is ready to form and strap.

3. **Supplies, tools, and equipment**

Rubber mallet
Channel locks
Screw driver
Drift
6" crescent wrench
Pry
Straps
Machine screws (if clearance holes are used)
Nuts
Drill (either a tap size or clearance drill for bolt that is to be used. If straps are to be bolted, use clearance drill.)
Rope, 6 feet and 3/8 inches long (if cable is larger than 3/0)
A piece of hard wood 16 inches long, 3/4 inches thick, and 3 or 4 inches wide, which is tapered on one end.



4. **Procedure** a. ASCERTAIN FROM WHICH POINT THE STRAPPING IS TO BE STARTED.

1) Strapping may be started at some given point and strapped both directions from the point, or may be started at one end of the run and strapped through to the other end.

2) Never start strapping from both ends and work toward the center, for this procedure would cause an accumulation of slack, and there would be no possibility of disposing of it.

C. **How to form and strap cable** (continued)

b. DRILL HOLES IN SPREADER TO SECURE STRAPS.

1) See that the holes are located in such a manner that when the strap is fastened the cable will lie in a straight line.

Right Wrong

Note: In illustration above of wrong method the holes are not drilled in the proper line; therefore the cable is not lying straight. Before cinching a strap tight, all waves in the cable should be worked out.

c. LOOK AT CABLE RACK FROM THE SIDE.

1) Waves illustrated below will always be apparent.

2) These waves can be worked out by tapping with the rubber mallet on the peak of the bend.

3) In some instances it is necessary to hold a flat board against the opposite side of the cable in order to make the cable flex. The 16" hard wood will generally suffice.

d. THE SLACK GAINED IN THIS PROCESS MUST BE WORKED IN THE DIRECTION THE STRAPPING IS BEING DONE.

e. WAVES IN THE HORIZONTAL PLANE MUST ALSO BE WORKED IN THE DIRECTION THE STRAPPING IS BEING DONE.

1) At this point, if the rack has some cables that are a great deal more rigid than others, it is best to shape the rigid cables first.

2) If the lighter cables are straightened first, they are likely to be pushed out of shape in the process of shaping the stiffer cables.

C. **How to form and strap cable** (continued)

3) Because there are a number of cables side by side in the rack, it is not practical to try to get the waves out by means of the rubber mallet alone.

f. USE TAPERED END OF HARD WOODWORKED BETWEEN THE CABLE.

1) Do the hammering on the wood.

2) If the cable to be straightened is the third or fourth cable from the outside, do not hammer on the outside cable to straighten it. This may damage the outside cable before you straighten the other cable.

3) Never hammer a cable hard enough or long enough in one place to flatten it, because this might result in serious damage to the insulation and sheathing as well as ruin the appearance of the job.

4) For the same reason, do not use a metal-faced hammer.

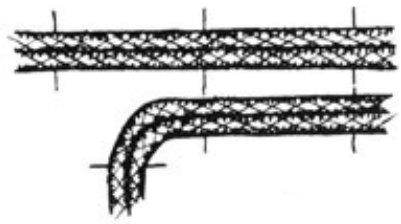
g. A GOOD BEND SHOULD BE MADE IN THE CABLE WHEN A POINT IS ENCOUNTERED WHERE THE CABLE IS TURNING INTO THE RACK OR OUT OF IT.

1) A bend with a radius equal to eight times the diameter of the cable should be made.

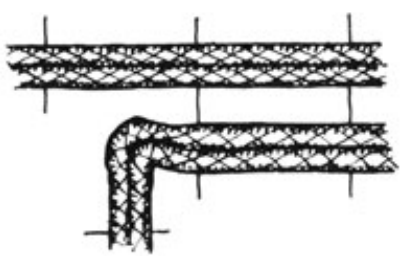
2) If there are different sized cables, the stiffer cables should be shaped first and the lighter cables shaped to fit the stiffer cables.

3) The bend should be shaped in such a manner that it does not distort the shape in the rack. (See the following illustrations.)

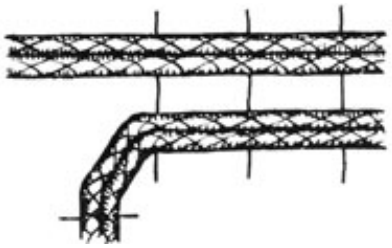
C. **How to form and strap cable** (continued)



Right procedure



Wrong procedure
Bend throws cable out of line before it leaves rack.



Wrong procedure
Bend is too abrupt. It is likely to damage insulation or armor. It does not show neat workmanship.

h. PUT AT LEAST ONE STRAP ON THE BRANCH RUN TO HOLD SHAPE OF BEND WHEN COMPLETED.

1) Continue one strapping of the main run unless instructed differently.

i. WHEN ENCOUNTERING A BULKHEAD, PASS THE CABLES BEYOND IT THROUGH THE STUFFING TUBES.

1) Shape from the last hanger to tube in such a way that the cable is on the same plane as the tube.

Right Wrong

C. **How to form and strap cable** (continued)

Note: In illustration showing wrong method, the cable, in entering the tube so abruptly, does not lend itself to easy access of the tube for packing, nor does it permit proper finishing of packing tube with white lead.

2) Along the path of the cable there may be places where one or more cables are to go through the deckhead inside of kickpipes. Never assume that any cable will be all right in any kickpipe that is of proper size, for invariably there is a definite cable to enter a specific kickpipe.

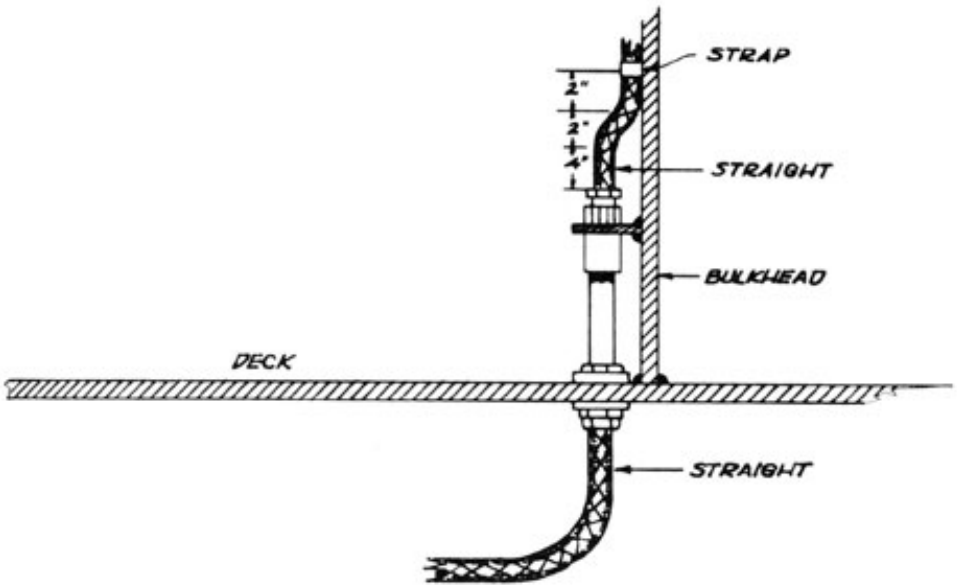
j. USE A ROPE OR PRY WHERE A BEND IS TO BE MADE ON HEAVY CABLE.

1) This will make the process much easier. The method of applying the pry or rope will depend upon prevailing conditions.

k. CONTINUE THIS PROCESS UNTIL CABLE IS STRAPPED FROM ONE EXTREMITY TO THE OTHER.

1. CABLE MUST ENTER KICKPIPE STRAIGHT.

1) Cable that breaks out of a kickpipe must be kept straight for about 3 or 4 inches; then it should break against the bulkhead. (See illustration below.)



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D. **How to pack tubes**

1. **Objectives**

a. To point out factors to be considered in the packing of tubes

b. To show how to pack tubes

2. **Introductory information**

The packing of tubes consists of few details, but is in itself a very important job.

In most instances the packing of a tube calls for a water-tight job.

3. **Supplies, tools, and equipment**

Channel locks	Improvised fishing tool or screw driver
Hammer	White lead
Packing tool	Packing
Knife or pliers	

4. **Procedure**

a. BACK PACK-NUT OUT OF TUBE AND FASTEN ON CABLE, OUT OF THE WAY.

b. LIFT OUT PACKING RING.

Note: This usually can be accomplished by hooking with a narrow-bit screw driver. If the ring fits too closely around the cable, it may be necessary to flatten an end of a piece of wire and use it for a fishing tool.

c. AFTER THE RING HAS BEEN FISHED OUT, FASTEN IT OUT OF THE WAY.

Note: The tube is now ready for packing. The size of the packing will be governed by the size of cable and tube. In most cases 1/4-inch and 3/8-inch packing is used.

d. MEASURE LENGTH OF THE PACKING TO BE USED BY PUTTING ONE TURN AROUND THE CABLE.

1) Cut this turn about 1/16 inch shorter than the circumference of the cable.

Note: If the packing is cut the same length as the circumference of the cable, the ends will lie as shown in illustration.

D. **How to pack tubes** (continued)

This creates a condition that makes it almost impossible to start the pack-nut when the proper amount of packing is in the tube.

When the packing is cut slightly short, the ends will lie flat as shown below.

If the proper size of packing is used there will be room for two to three rings of packing in each tube.

e. PUT EACH RING OF PACKING IN SEPARATELY BY MEANS OF HAMMER AND PACKING TOOL.

f. CUT PACKING WITH EITHER A KNIFE OR PLIERS.

g. PLACE PACKING IN SUCH A WAY THAT THE CUT ENDS OF ANY TWO RINGS ARE NOT TOGETHER.

Note: When the packing tool is being used, great care should be taken to prevent damaging of the threads on the inside of the tube.

h. PUT PACK RING IN POSITION AFTER THE PROPER AMOUNT OF PACKING HAS BEEN

PLACED.

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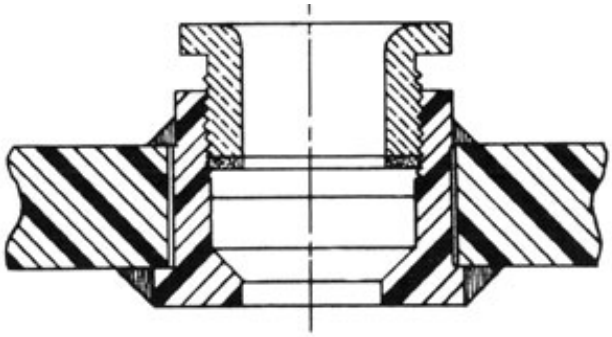
D. **How to pack tubes** (continued)

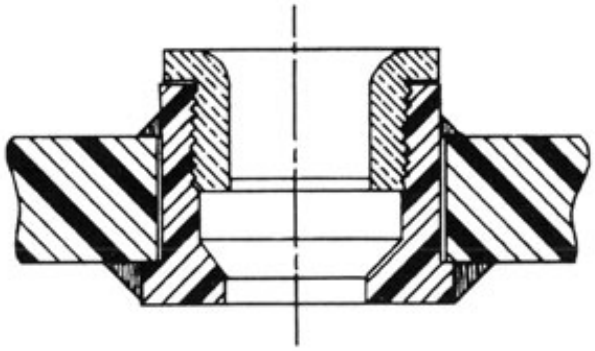
Note: The starting of the pack-nut can be made much easier if the pack ring is set by driving with the packing tool and hammer. Care must be taken in starting the pack-nut in order that the threads are not crossed. If nut tightens with two or three twists of the nut, one may assume that the threads are crossed and the nut should be backed off and started over. The threads are fine; as they are made of brass, they damage very easily. A pair of channel lock pliers is a good tool to use for tightening the pack-nut.

If the proper amount of packing is used in filling the tube, the nut should be tight before it screws all the way down. (See illustrations below.)

There should be 1/8-inch to 3/16-inch space between nut and tube when the pack-nut is tight on the packing. (See illustration.)



If the nut is tight on tube it is impossible to tell whether nut is tight against packing or tube.



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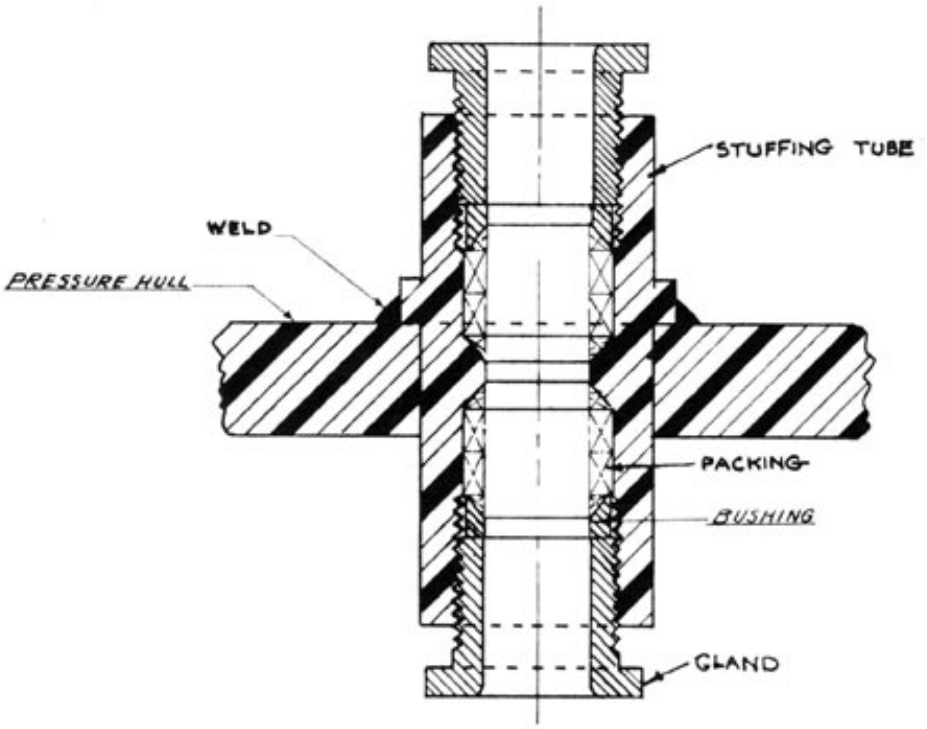
D. **How to pack tubes** (continued)

i. AFTER THE PACK-NUT IS TIGHT, FILL GROOVE BETWEEN NUT AND CABLE WITH WHITE OR RED LEAD. THIS WILL MAKE A WATERTIGHT JOB.

5. **Illustrations**

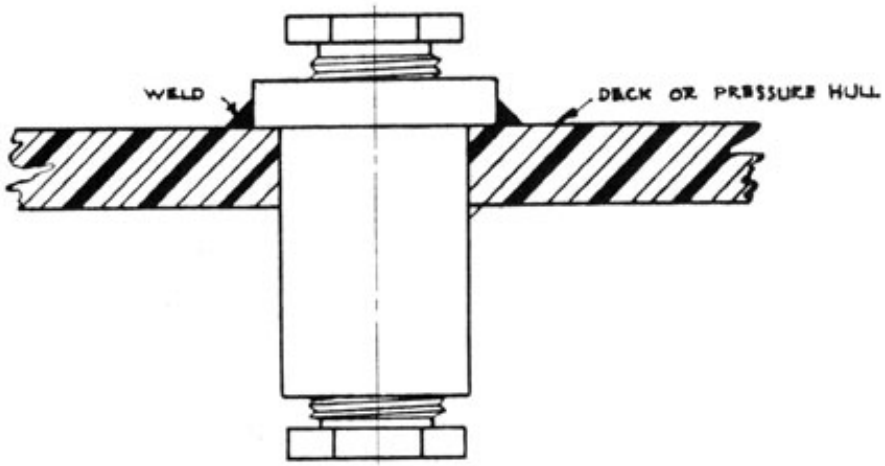
The following illustrations show various types of stuffing tubes used in marine electrical wiring:



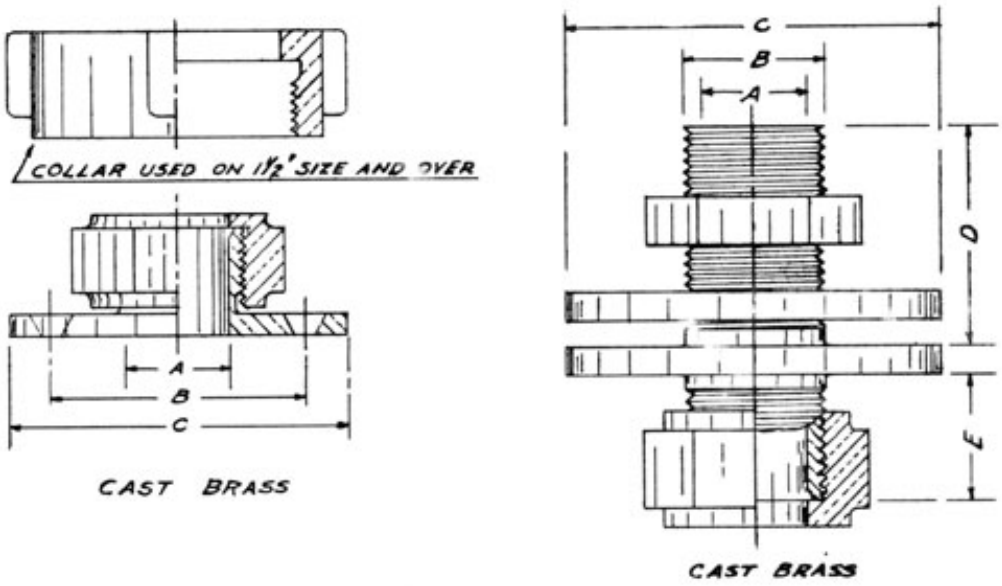
SECTION TYPICAL

STUFFING TUBE-STEEL
ALTERNATE FOR PRESSURE HULL
SUBMARINES
USED FOR PASSING CABLE THROUGH PRESSURE HULL (KICKPIPE PROTECTION NOT REQUIRED)
SCALE: 9" = 1-FT.

D. **How to pack tubes** (continued)



DECK AND PRESSURE HULL WITHOUT KICKPIPE
USED FOR PASSING CABLES THROUGH DECK AND PRESSURE HULL AND W.T. BULKHEAD (KICKPIPE PROTECTION NOT REQUIRED)



Deck and Bulkhead Flanges

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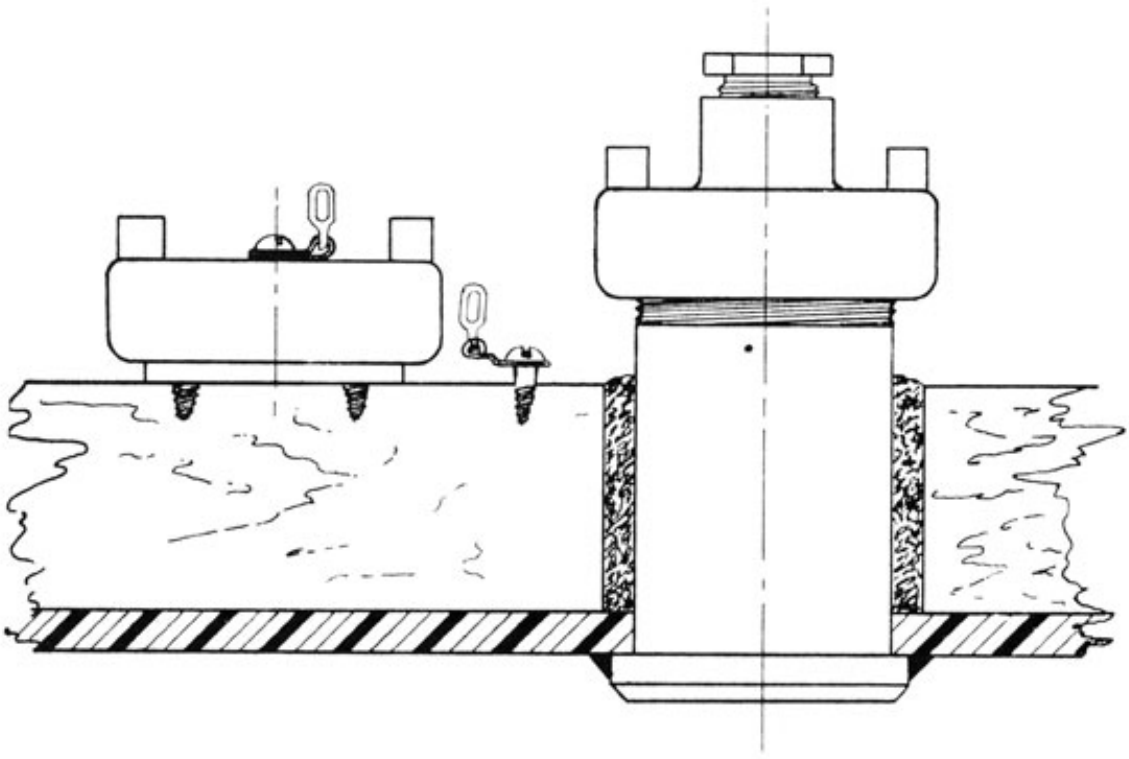
D. **How to pack tubes** (continued)



SURFACE VESSELS

PORTABLE CABLE THROUGH WEATHER DECK WITH WOOD COVERING

USED FOR PASSING PORTABLE CABLE THROUGH WEATHER DECK WITH WOOD COVERING, PRIMARILY FOR LEADS TO LIGHTS ON JACKSTAFF

SCALE: 9"=1 FT

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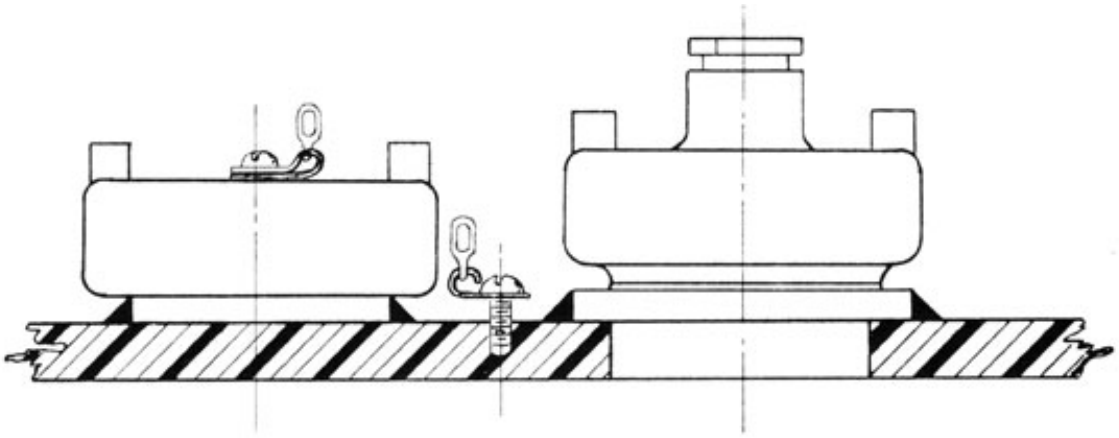
D. **How to pack tubes** (continued)

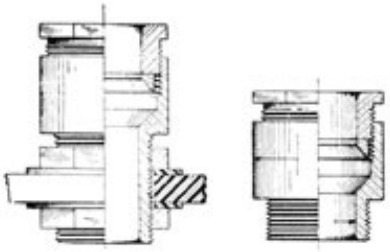


PORTABLE CABLE THROUGH WEATHER DECK AND HULL

USE FOR PASSING PORTABLE CABLE THROUGH HULL AND WEATHER DECKS (WITH OUT WOOD COVERING) USED FOR LEAD TO LIGHTS ON FLAGSTAFF AFT, LEADS TO BOOM LIGHTS AND TO GANGWAY LIGHTS

NOTE: INSTALLED ON OUTSIDE OF HULL FOR LIGHTS ON FLAG & JACKSTAFF AND ON INSIDE OF HULL FOR BOOM LIGHTS

SCALE: 9" = 1-FT.



Stuffing Tube **Terminal Tube**

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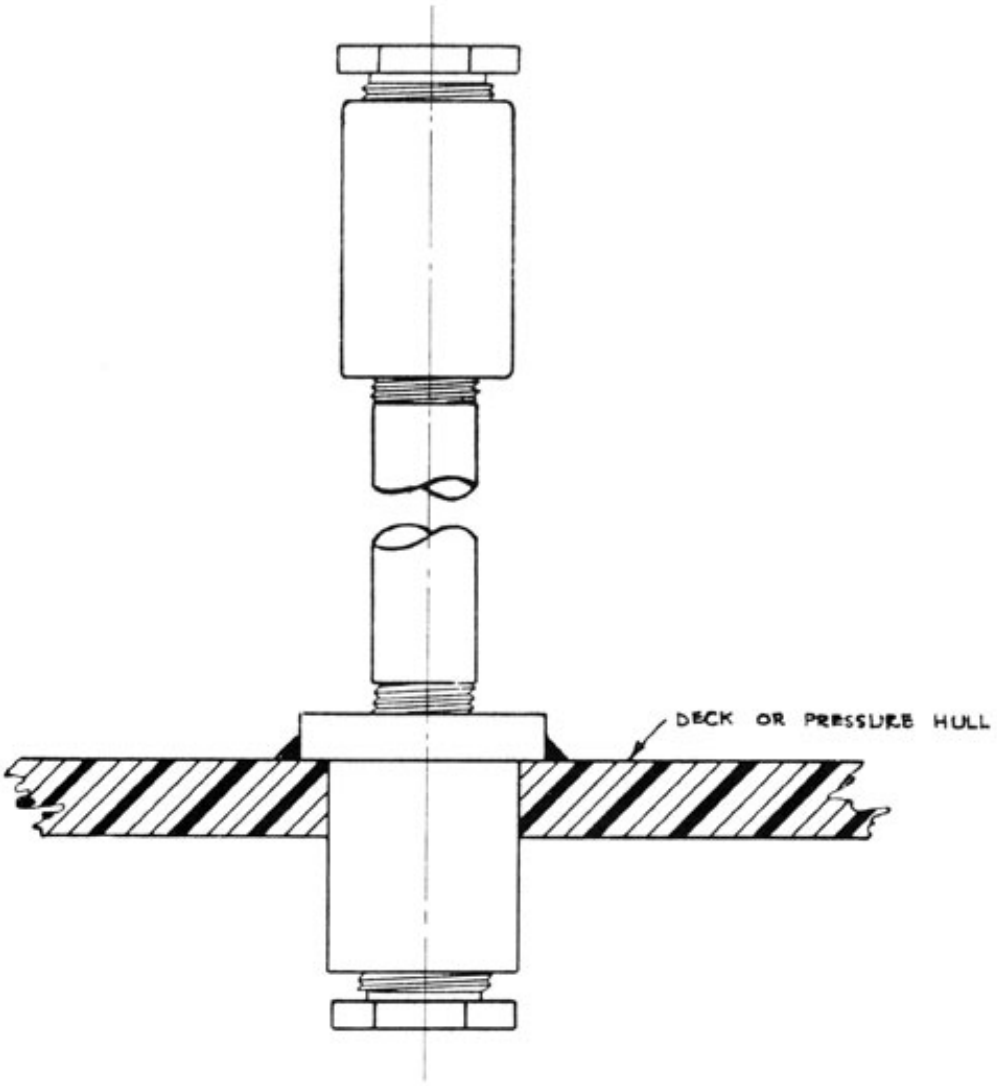
D. **How to pack tubes** (continued)



DECK AND PRESSURE HULL WITH KICK PIPE
USED FOR PASSING CABLE THROUGH DECK AND PRESSURE HULL (KICK PIPE PROTECTION REQUIRED)
SCALE: 9" = 1-FT

E. **How to skin cable**

1. **Introductory information**

The outside sheath of cable must be removed before the individual wires can be terminated. Care must be taken to cut the cable the proper length.

Caution: It must not be cut too short.

2. **Supplies, tools, and equipment**

Hacksaw
Rule
Line or side-cutter pliers

Cable-skinning tool (patented or linoleum knife)
Friction tape
Screw driver

3. **Procedure**

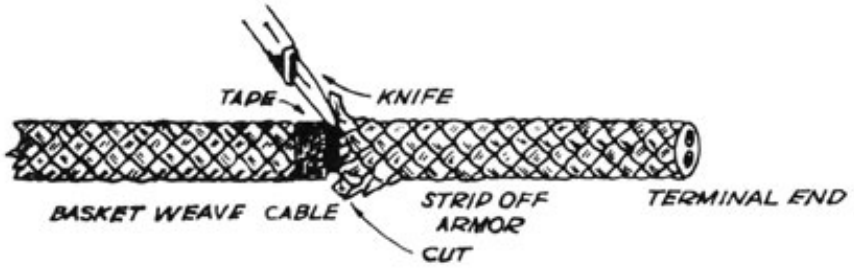
a. ARMOR FABRIC-COVERED CABLE

1) Wrap a turn or two around the cable to serve as a marker and to keep the armor from fraying.

2) Cut through the armor.

3) Do not cut too deep.

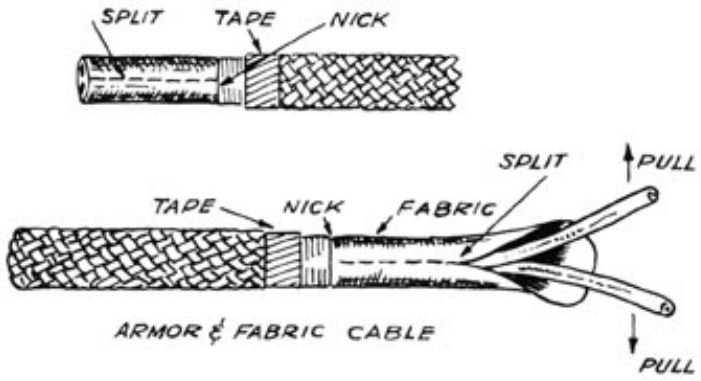
4) Lift armor at cut with screw driver and strip off by grasping at cut and pulling towards terminal end. (See illustration.)



5) Make a cut around the cable with the knife about 1/4 inch to 1/2 inch from the armor. This cut should be no more than two-thirds through the fabric.

6) Pull the skinning knife or tool lengthwise of the cable and skin out the wires. Sometimes the wires can be skinned out for a few inches at the end and pulled in opposite directions. (See accompanying illustrations.)

E. **How to skin cable** (continued)



Note: Do not make the cuts too deep as it is very easy to nick the insulation on the wires.

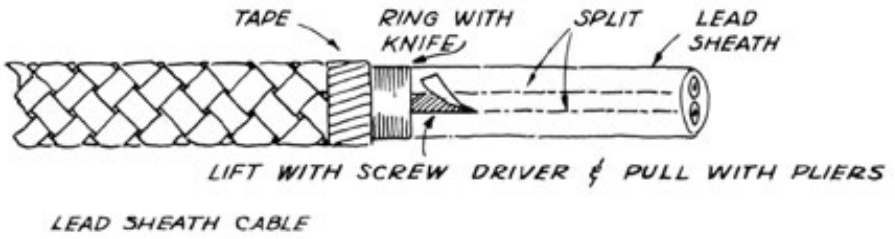
b. ARMOR LEAD-COVERED CABLE

1) With the skinning tool, ring the lead sheath about 1/4 inch to 1/2 inch from the armor and split towards the end.

2) Make another split about 1/4 inch to 1/2 inch from first split. This forms a strip running lengthwise of the cable.

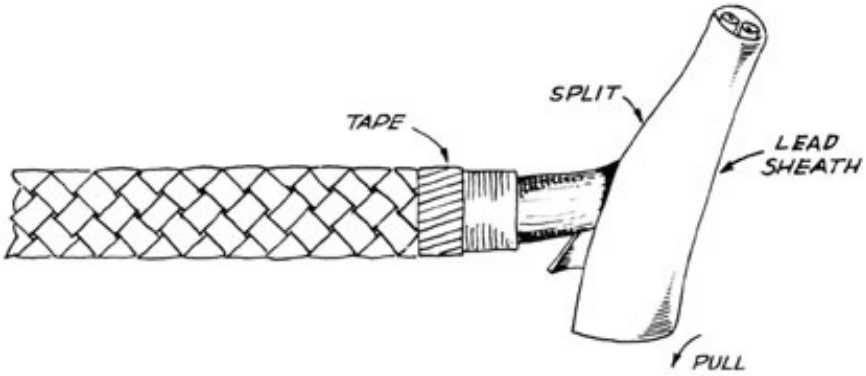
3) Break the lead at the ring by moving back and forth.

4) Pry up the strip with a screw driver and pull out with pliers.



5) Sometimes the lead may be taken off with one split as shown in illustration below. Start the opening with. a screw driver.

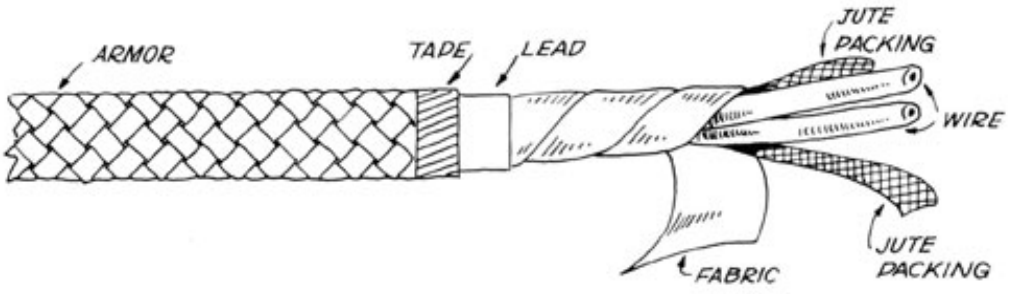
E. **How to skin cable** (continued)



Note: Do not cut through the armor as this may injure the wire underneath.

c. UNWIND THE FABRIC TAPE UNDER THE LEAD.

1) Cut off jute packing at the end of the lead or fabric sheath. (See illustration.) This jute is placed in the cable to make it hold its round shape and to serve as protection.



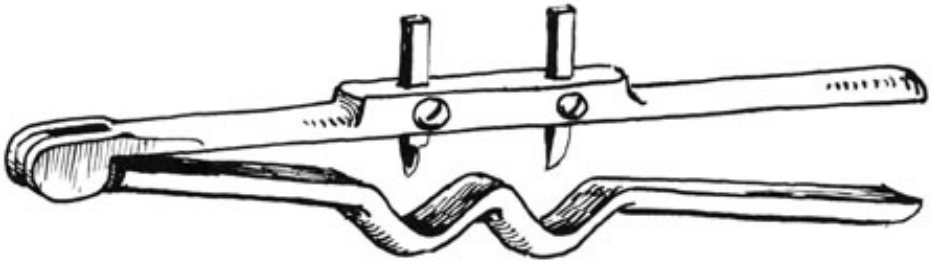
47

E. **How to skin cable** (continued)

d. OTHER TYPES OF ARMORED CABLE ARE HANDLED IN MUCH THE SAME WAY AS DESCRIBED.

e. DIFFERENT TYPES OF SKINNING TOOLS ARE ILLUSTRATED BELOW:

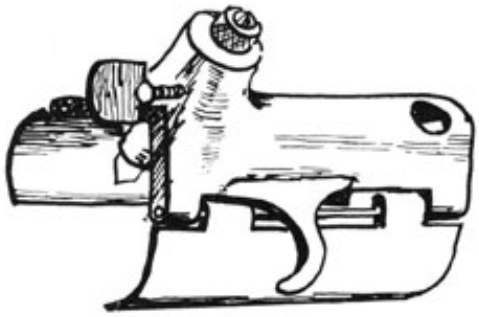
Cable Skinning Knife



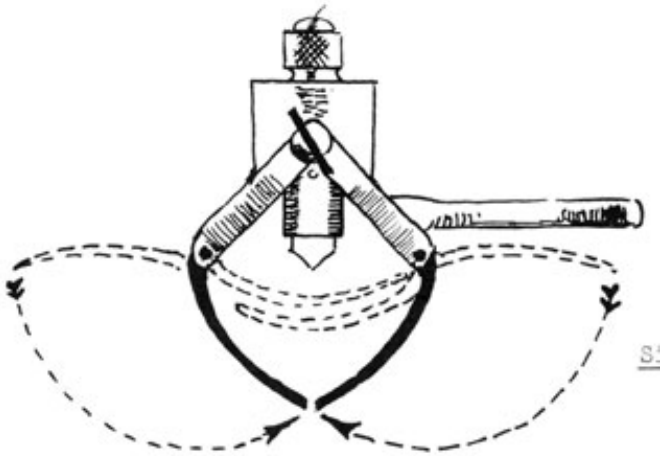
Tool for Ringing and
Stripping Marine Cable

48

E. **How to skin cable** (continued)



End View



Side View

Cable Skinning Tool (2 Views)

49

E. **How to skin cable** (continued)

f. A STANDARD-TYPE MARINE ARMOR CABLE, CUT SECTIONALLY TO SHOW CONSTRUCTION, IS ILLUSTRATED BELOW:

F. **How to serve and lace cable**

1. **Introductory information**

Any cable that terminates in the open and is therefore subject to damage should be served or laced, or both. In open switchboards it is desirable to insulate the cables by serving from the point of entry to the terminal lugs and laceing it into a form. Varnished cambric insulation, and types of insulation that may unwind and leave the conductor bare, should be served for protection.

2. **Supplies, tools, and equipment**

Diagonal pliers
Lacing twine
Tape

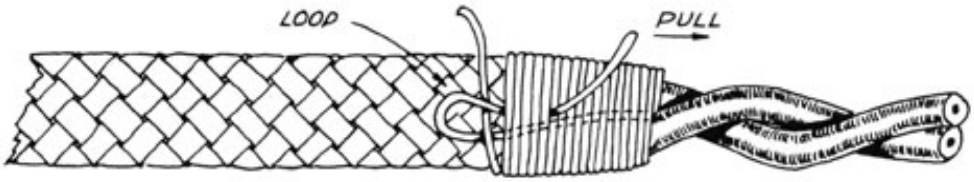
3. **Procedure**

a. PREPARE THE CABLE AS DESCRIBED IN SKINNING CABLE.

b. LAY ONE END OF LACING TWINE ALONG THE CABLE.

1) Wrap back the cable from the wire towards the armor and over it.

2) Be sure the twine is held tight. (See illustration.)



c. DOUBLE BACK THE EXCESS TWINE THAT WAS LOOPED UNDER THE WRAPPING IN ORDER TO FORM A LOOP.

1) Take five or six more tight wraps and run the end through the loop.

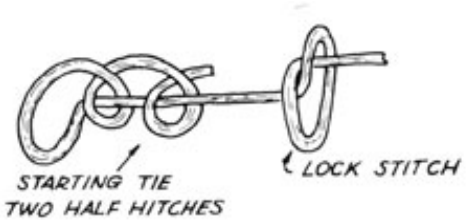
2) Pull the loop under the wraps until the end is held securely. (See illustration.)

3) Tape wrapped under serving helps to make a smooth job.

F. **How to serve and lace cable** (continued)

d. VARNISHED CAMBRIC INSULATION IS SERVED IN THE SAME WAY AS ORDINARY CABLE. (SEE ACCOMPANYING ILLUSTRATION.)

e. LACING CABLE FORMS IS ACCOMPLISHED BY A LOCK STITCH AS SHOWN IN ILLUSTRATION BELOW.

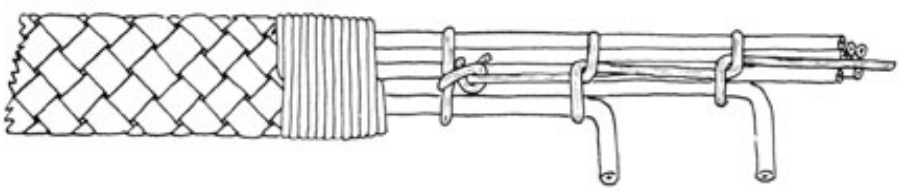


1) The starting tie is two half hitches taken around the line.

2) Do not use a half hitch for lacing as this tie is apt to come loose. (See illustration.)

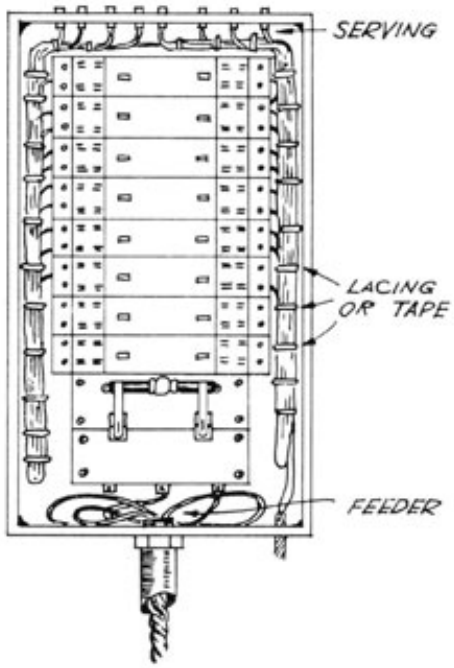
3) The accompanying illustration shows a typical form with conductors broken out for termination.

F. **How to serve and lace cable** (continued)



4) The illustration below shows how cable is laced in a panel.

Note: Tape can be used for lacing. (Sometimes it is required.)



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G. **How to connect and hook up cable**

1. **Objectives**

a. To slow the necessity of tight and solid connections

b. To show the proper method of preparing wire for soldering

c. To make good electrical connections

2. **Introductory information**

The process of connecting wires together or connecting lugs to wires is done by soldering. It is also done with solderless connectors or lugs. Either method is satisfactory and the one used depends upon job specifications and material furnished.

3. **Supplies, tools, and equipment**

Presto torch or plumber's furnace	Assorted cable--stranded and solid with various types of insulation
Solder pot and ladles	Solder
Cloth or pad for wiping	Flux
Knife	Solder type lugs
8" crescent wrench	Solderless type lugs
Allen wrench	Solderless connectors
Terminal strip	

4. **Procedure**

a. REMOVE ALL PARTICLES OF RUBBER, INSULATION, DIRT, OR FOREIGN MATTER THAT MAY BE ON THE SURFACE OF THE BARE WIRE AFTER THE WIRE HAS BEEN CUT TO PROPER LENGTH AND SKINNED.

Note: Do not handle the bare wire any more than necessary, as any oil or grease from the hands or gloves that gets on the surface of the wire before soldering may result in a poorly soldered connection. The wire must be thoroughly clean and bright; if necessary, it should be scraped.

b. JOIN WIRES TO BE SPLICED AND SERVE AS PREVIOUSLY SHOWN.

c. SPREAD THIN COAT OF FLUX OVER ENTIRE SPLICE.

d. USE WIRE SOLDER IF A **PRESTO TORCH** IS USED. (SEE ILLUSTRATION BELOW.)

G. **How to connect and hook up cable** (continued)

Note: The lineman's outfit as shown in the above illustration is a combination of soldering copper and open-flame torch stem with an interchangeable torch handle and a handle for carrying an MC Tank. This outfit answers all requirements--soldering, brazing, and splicing on wire, cables, transformers, switchboards, generators, and lighting fixtures.

1) Heat splice carefully and thoroughly.

2) When the wire solder upon contact with splice will run without the flame touching the solder, the splice is hot enough to apply solder.

e. FEED THE SOLDER INTO THE SPLICE ON ALL SIDES.

1) Keep the flame constantly on the joint until the splice is thoroughly saturated with solder.

f. TURN OFF TORCH AND WIPE OFF ANY EXCESS SOLDER WITH PAD OR CLOTH WHILE STILL HOT.

g. INSPECT SOLDERING JOINT WHEN FINISHED TO RE SURE IT IS THOROUGHLY SOLID AND TIGHT.

Note: The full size of wire must always be maintained. Never remove any strands of the wire to accommodate a connector or lug. If necessary, get a larger connector or lug to fit the full size of the cable used.

If a plumber's furnace is used, heat bar solder in pot. Splice is prepared as above and flux applied. Two ladles are used. The solder is

---

G. **How to connect and hook up cable** (continued)

poured over the splice from one ladle and the other ladle held below to catch solder. The solder must be poured over splice several times to insure thorough heating of the wire. Determine by observation when the splice is thoroughly impregnated with solder and wipe off excess solder while still hot. Inspect work carefully.

Solder-type lugs (see illustration) should be of proper size to accommodate the full size of the cable to be used. Cable should be skinned so that it will fit into the lug recess as deeply as possible; it also should be thoroughly cleaned and scraped.

h. HOLD LUGS FIRMLY IN A VERTICAL POSITION.

1) Apply a small amount of flux in recess of lug and apply flux to bare wire.

i. APPLY HEAT FROM TORCH TO SIDE OF LUG AND INSERT WIRE SOLDER UNTIL ALMOST FULL.

1) Put bare wire into recess of lug, while keeping lug hot. 2) Keep heat on lug for several seconds.

j. REMOVE WIRE TO SEE IF IT IS THOROUGHLY TINNED AND SATURATED WITH SOLDER.

1) When it has reached this state, apply heat again to lug and add more solder to fill recess of lug.

2) Insert tinned wire and keep flame on lug until all solder visible is in a liquid state.

k. REMOVE FLAME AND WIPE ANY EXCESS SOLDER AWAY IMMEDIATELY.

G. **How to connect and hook up cable** (continued)

1. HOLD BOTH LUG AND WIRE FIRMLY UNTIL SOLDER COOLS.

1) Any movement of wire or lug during the cooling period will result in a poor electrical connection.

Note: The cooling can be speeded up by the application of a wet cloth or brush.

Solderless lugs and connectors of many types (see accompanying illustration) are now in general use, and the same care in preparing and cleaning the wire is necessary. The full size of the wire must be maintained; the nuts, set screws, and Allen screws must be tightened as much as possible to insure a good electrical connection.

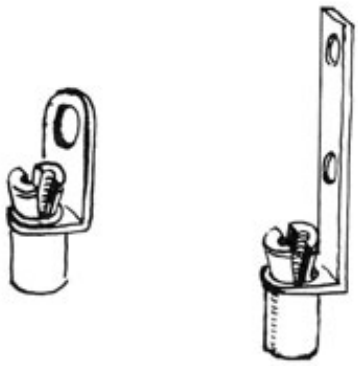
A loose or poor electrical connection may be caused by a poor soldering job, dirty or greasy wire, or solderless lugs or connectors which are not properly fitted or tightened. This usually results in a high-resistance joint or in a partial or an intermittent open circuit, both of which are sometimes very difficult to locate. The importance of clean wire, proper soldering, and the making of tight connections, therefore, cannot be treated lightly.

Connecting the lug to the terminal is usually done with a nut or locknut.

Caution: Terminal studs and nuts should be checked and made tight before attaching lugs as they sometimes work loose in shipping.

After making sure that whole assembly is tight, lug may be attached to terminal and terminal nuts tightened.

G. **How to connect and hook up cable** (continued)



Solderless Lugs

H. **How to weld a pad**

1. **Supplies, tools, and equipment**

A supply of pads of the proper size
Screw driver
Pliers

Hammer
Rod 2' long, with screw (of same thread as the pad) welded on one end
Goggles (dark glass)
Gloves
Leather sleeves

2. **Procedure**

a. OBTAIN PADS FROM THE ELECTRIC SHOP.

1) Ask your leaderman to tell you the size of the pads to be used.

2) Estimate the number of pads needed by counting the places on the job which are marked in white chalk. These marks are usually made by a dot, or by an x with a circle.

3) Obtain requisition from your leaderman to secure the pads from the electrical supply shop.

b. DETERMINE WHERE TO PUT THE PADS.

H. **How to weld a pad** (continued)

1) Check over job to be done. All installations are laid out ahead of time by a layout man, and white chalk marks will show the location of all pads to be welded.

c. HAVE WELDING FOREMAN FURNISH A TACKER.

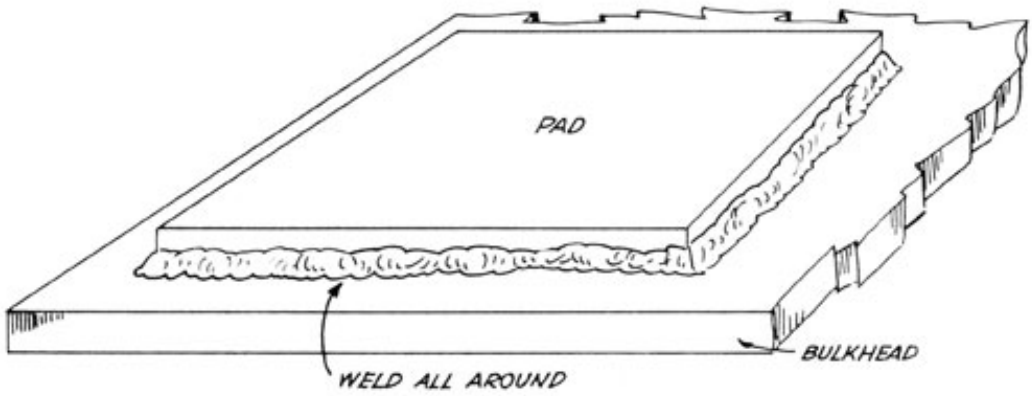
1) Ask your leaderman what procedure to follow in securing a welder. He will usually take care of this himself; if not, he will advise you where to get one.

d. EXPLAIN TO WELDER HOW THE PAD IS TO BE WELDED.

1) To assure a level surface tack-weld the pad on all four sides before welding.

2) The weld should extend all around the pad.

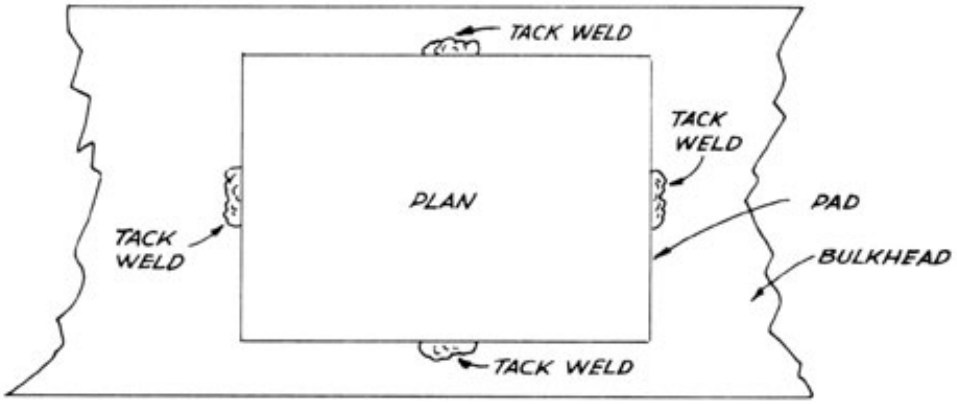
Note: The top of the bead should be below the surface of the pad in order that this surface be left smooth. Should the bead extend above the surface of the pad, the cable will not strap in place as it should and the projecting bead is likely to damage the cable. (See following illustrations.)



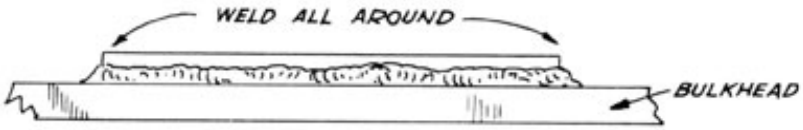
Perspective View of a Correctly Welded Pad on the Bulkhead of a Ship

59

H. **How to weld a pad** (continued)



End View of a Correctly Welded Pad on the Bulkhead of a Ship



Side View of a Correctly Welded Pad on the Bulkhead of a Ship

e. ASSIST WELDER BY HOLDING THE PAD IN PLACE WHILE HE TACKS THE PAD TO THE METAL OF THE SHIP.

1) Assist the welder in order to promote speed and to insure that pads are welded on straight. The welder is unable to see the pad after he pulls his hood down over his face.

f. WATCH WELDING CAREFULLY TO SEE THAT ALL PADS ARE WELDED ON STRAIGHT AND THAT NO WELD IS ALLOWED TO GET INTO THE THREADS OF THE PAD.

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H. **How to weld a pad** (continued)

1) Make sure the pads are straight; if they are not straight, cable will not fit properly.

2) Keep threads in the pad free from weld; otherwise screw will not fit.

3) If pad is damaged while welding, have the chipper chip the damaged pad off and weld a new pad in its place.

g. HAVE WELDER HIT EACH PAD HE WELDS WITH HIS HAMMER.

1) Do this to make sure that the weld is a good one and that the pad will not come off when the cable is strapped on.

h. SEE THAT ALL PADS ARE WELDED ON IN A STRAIGHT LINE.

1) Strive to have all installations done as neatly as possible.

I. **How to secure a power panel to foundation**

1. **Supplies, tools, and equipment**

2 wrenches
Rule
Level
Declevity board
6 bolts (size per blueprint)
6 nuts (size per blueprint)
6 lockwashers (size per blueprint)
Power panel

2. **Procedure**

a. SECURE BLUEPRINT AND PANT, TO BE MOUNTED.

1) Secure blueprint from shop's print man.

2) Secure panel from electrical storekeeper.

a) Panel is used to safely tap the feeder.

b) Branches are connected to one side of circuit breakers and feeder to the other side.

c) Panel is needed to safely feed branch circuits and protect other circuits if trouble develops in one.

b. CHECK THE PANEL MOUNTING STRAPS, FOUNDATION, AND PRINT FOR MOUNTING HOTRS.

I. **How to secure a power panel to foundation** (continued)

1) Measure distance between holes on panel and foundation to see if they are equal. Compare these dimensions with note on print. They should all agree.

2) Use this method because it is both rapid and workable.

c. OBTAIN WRENCHES AND MOUNTING BOLTS, NUTS, AND WASHERS.

1) Obtain wrenches from tool room.

2) Obtain mounting bolts, nuts and washers on order from warehouse.

3) Determine size of bolts, nuts and lockwashers from blueprint.

d. MOUNT PANEL AND PLACE BOLTS IN TOP HOLES.

1) Place panel against foundation in such a manner that bolts slip through top holes of panel and foundation.

2) Place lockwashers and nuts on these top bolts so panel will not tip or fall.

e. PLACE LOCKWASHERS AND NUTS ON ALL BOLTS.

1) Use lockwashers to lock nuts on bolts.

2) Place lockwashers on bolt after bolt has passed through panel strap holes and foundation holes.

f. TRUE UP PANEL AND TIGHTEN BOLTS.

1) Use declevity board and level to true up or straighten panel on foundation.

2) Do not tighten up all the way on one bolt first. Make a few turns on each bolt until all are firm and tight.

g. CHECK PANEL POSITION WITH PRINT.

1) Take rule and measure all points that are detailed in print.

h. RETURN TOOLS TO SHOP AND PRINT TO RACK.

1) Return tools to tool room and receive signed slip from tool keeper.

2) Return prints to shop's print man and receive slip you signed.

I. **How to secure a power panel to foundation** (continued)

3) Keep close watch on signed slips as they are important.

i. REPORT COMPLETED PANEL JOB TO FOREMAN.

1) The job is not finished until your report is made. The foreman will determine in advance at what stage of the job a report is to be submitted. When this point is reached, a written or verbal report should be made immediately to the foreman or his assistant.

J. **How to put a strap on a cable (drill and tap)**

1. **Supplies, tools, and equipment**

Hammer
Center punch
Air drill, or electric drill
13/64" taper shank drill bit or straight shank drill bit
1/4" - 20 starting tap
1/4" - 20 finishing tap
A small amount of grease or oil
A single hole cable strap to fit cables
1/4" - 20 R. H. brass screws
Screw driver (about 8")
Soapstone

2. **Procedure**

a. OBTAIN THE TOOLS AND MATERIAL.

1) Obtain the drill, bit, and tap from the tool room.

2) Secure the other tools from your own tool box.

3) Secure the necessary screws and straps either from a supply available on the job or by order from the electrical supplies storeroom.

b. LOCATE THE STRAP.

Note: It is assumed that the cable run is already laid out and that layout is a separate job.

1) Locate the first strap either 8 inches from the first tube or lightening hole, or 18 inches from the last preceding strap, as the case may be.

2) Place the strap so that it will line the cable up properly and mark with pencil the center of the screw holes.

J. **How to put a strap on a cable (drill and tap)** (continued)

c. CENTER PUNCH THE HOLE.

1) Set the center punch with the point on the mark just made so that it stands squarely with the plate.

2) Strike it a light blow and check to be sure the punch has not slipped. If correct, re-insert the center punch in the punch mark and strike it a hard blow, leaving a full-sized punch mark.

d. DRILL THE HOLE.

1) A 13/64" drill is the proper tap size for a 1/4" - 20 brass screw in steel plate. A 7/32" drill may be used in some cases but usually it will make a loose fit and inferior job.

2) Drill the hole clear through the plate, but before doing so be certain that there is nothing on the other side of the plate that you might damage by drilling here.

e. TAP THE HOLE.

1) Tap the hole first with the starting tap and next with the finishing tap.

2) Use plenty of oil or grease.

3) The job may be done in soft steel in one operation only with the finish tap if you are skillful enough, but it is best to do the job in two stages.

Note: Be very careful in this operation as there is great danger of breaking the tap if too much pressure is applied, or if the twist on the wrench is uneven. Usually a broken tap cannot be removed from the hole; however, if tap is broken, care should be taken to see that there are no small pieces of hard steel left in the hole since these would cause another tap to break when job is being completed.

f. PLACE CABLE IN POSITION.

1) Bring the cable into its proper position; while holding it up by hand straighten it out so it will remain in the proper position.

g. PLACE STRAP ON CABLE.

1) Place screws and screw driver within easy reach.

2) Place the strap on the cable in its proper place with one hand.

J. **How to put a strap on a cable (drill and tap)** (continued)

3) Secure screws and screw driver with the other hand.

h. INSERT SCREW IN STRAP AND SCREW UP.

1) Insert a 1/4" - 20 round head brass screw in the strap and start it in the tapped hole.

2) Be careful not to start it cross threaded.

3) Screw it up tight enough to hold the weight of the cable.

i. STRAIGHTEN THE CABLE.

1) Pull the cable up by hand.

2) Tap it with the hammer handle to take out humps.

3) Be careful that you do not damage the cable.

j. STRIKE THE STRAP WITH HAMMER TO TAKE UP SLACK.

1) Tighten up the screw and then hit the strap hard enough to set it firmly against the plate, being careful that you do not distort it or damage the cable.

k. TIGHTEN UP THE STRAP.

1) Tapping the strap should enable you to take up the screw a little more.

2) Do not twist off the head of the screw.

l. INSPECT THE JOB.

1) Check the job and correct any faults in alignment and workmanship which may be discovered.

3. **Questions**

a. How could you put a strap on a cable without drilling and tapping a plate?

b. What method do you think would be most suitable on an aluminum bulkhead?

c. Would you expect a screw in a tapped hole to be watertight?

d. Why wouldn't you run a cable along the deck--or would you?

e. Suppose that you had so much cable to strap up that you had 50 holes to drill and tap. Can you think of a way to make the job easier?

K. **How to install cable in a battery compartment**

1. **Objectives**

a. To properly install batteries in the battery room or box.

b. To properly install and protect from acid, wiring and fittings in battery room or box.

2. **Introductory information**

Batteries on board ship must be ready for service at all times as they are used for starting and running emergency equipment, general alarm bells, telephones, etc. Only lead cable should be used in battery compartments.

Open flame should never be used around batteries or in a battery compartment. Care must be taken not to drop or tip batteries. They should remain on the charging line as long as practical and should be installed just before the final tests.

3. **Supplies, tools, and equipment**

Pocket tools	Rubber tape
Electric drill	Insulating varnish or Glyptal
Drills and taps of appropriate size	Packing and Hydroseal
Hammer	Vaseline
Center punch	

4. **Procedure**

a. REMOVE THE OUTER STEEL OR BRONZE ARMOR FROM THE POINT WHERE THE BATTERY LEADS ENTER THE BOX.

1) Never leave any metal other than lead on the cables.

2) When a battery compartment is used, the armor is removed to a point well out of reach of the acid mist which the battery gives off during the charging period (about 4' above the battery shelf, or from the point where they leave the kickpipe if it is under the shelf).

b. REMOVE THE TAPE PROTECTION UNDER THE ARMOR, THUS EXPOSING THE LEAD.

1) Handle with care cable that has the armor and tape removed, as the lead breaks very easily.

c. STRAP THE CABLE VERY SECURELY TO THE POINT WHERE THE LEAD IS TO BE REMOVED FOR HOOKING UP.

1) Remove the lead about 18 inches from the end.

d. SOLDER ON BATTERY TERMINALS.

K. **How to install cable in a battery compartment** (continued)

e. COVER THE EXPOSED WIRES FROM TERMINAL TO A POINT AT LEAST 2 INCHES OVER THE LEAD.

1) Cover with a double layer of rubber tape.

2) Be sure no wire is exposed.

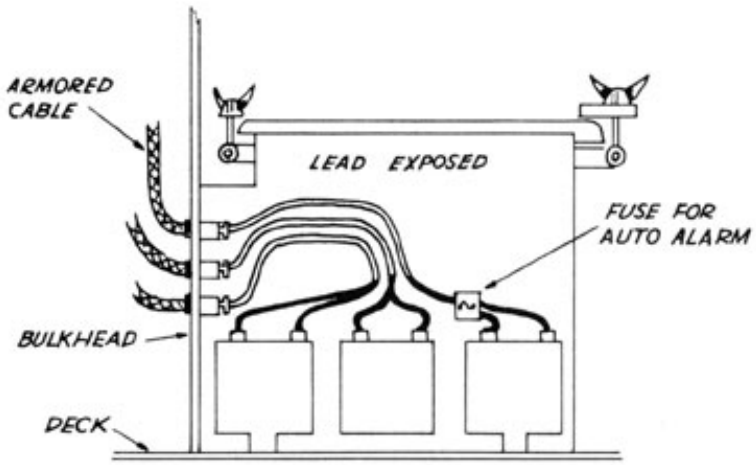
f. PAINT THE CABLE FROM THE POINT OF ENTRY TO THE BATTERY TERMINAL.

1) Paint with two coats of insulating varnish.

2) Cover the terminals with vaseline.

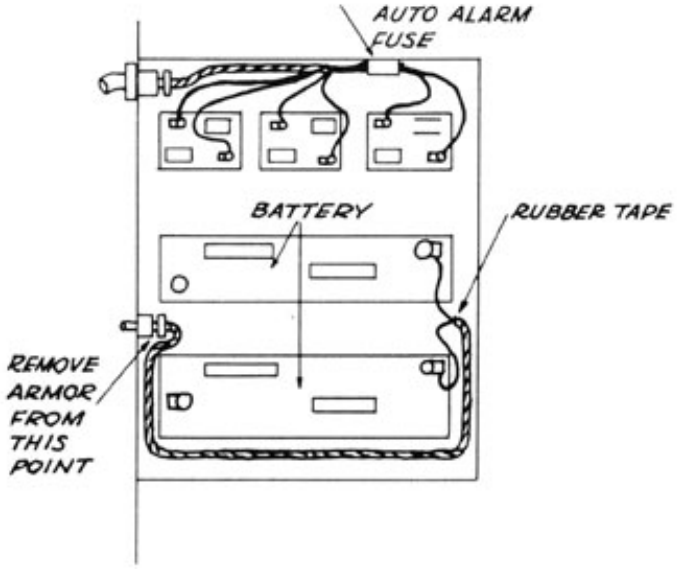
5. **Illustrations**

a. Battery installations

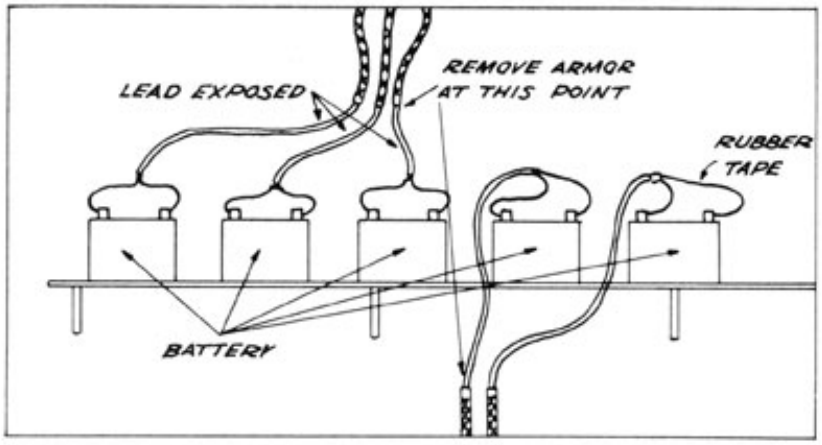


Section of Battery Box

K. **How to install cable in a battery compartment** (continued)



Cable with Armor and Tape Removed (Top View)



Battery Box

Note: Mark all terminals so they may be identified easily (+ on white wire and - on black wire).

Previous Part Electricity Home Page Next Part

VI. ELEMENTARY ELECTRIC CIRCUITS

A. **General information**

Electric current: (The Ampere) All matter is said to be composed of positive and negative charges of electricity. The positive charge, or PROTON, is the neucleus of the smallest particle of matter around which revolves in continuous motion the electrons. The electrons are negative charges of electricity. Molecules of different materials differ in the number and the arrangement of the electrons and protons. Some materials have more or less free electrons in their molecules; that is, electrons which are free to move from one molecule to another under an electrical pressure. These materials are said to be conductors of electricity.

There are also materials that have no free electrons in their molecules, and an electrical pressure will not cause them to move from their molecules. Such materials are said to be nonconductors of electricity or INSULATORS.

Gold, silver, platinum, and copper are conductors of electricity. Copper, due to its relatively low cost and good conductivity, is the material most used for conductors of electricity. Porcelain, rubber, oiled paper, mica, and glass are some of the best insulators or non-conductors of electricity.

When electrons move along a conductor under an electrical pressure, their movement is said to constitute the flow of an electric current. When a certain number pass a given point in one second of time, one AMPERE of current is said to flow along the conductor.

As previously stated, it takes an electrical pressure to cause the electrons to flow along the conductor. One such source of electrical pressure is a battery. Another is the electric generator. The battery, by chemical actions, separates the electrons from the protons. The electrons going to one plate of the battery leave the other plate with just the protons, since they are not free to move. The plate having the excess of electrons is said to be the negative plate, and the plate which has the deficiency of electrons, is said to be the positive plate.

THE LAW OF ELECTRICAL CHARGES states that unlike charges attract one another, and like charges repel one another. Since by chemical action the battery has separated the positive and negative charges (electrons and protons), there is a continuous effort being exerted by them to get back together again. This effort to get back together is called the electro-motive-force. It can readily be seen that the more electrons which have been separated from their protons, the greater will be the effort to get together again; hence a greater electro-motive-force or pressure is exerted.

A. **General information** (continued)

If the two plates of the battery--the negatively-charged plate and the positively-charged plate--are connected together by a good conductor, the electrons will find a path by which they can get together. As the electrons flow along this conductor from the negative plate to the positive plate, their flow constitutes the flow of an electric current.

A conductor is run between one pole of the battery to the bell. Another wire is run from the other pole of the battery to the push button. (The push button is a device for making or breaking the circuit.) Then another wire is run from the push button to the bell. When the push button is pushed in, it makes contact and completes the path by which the electrons can go from the negative plate of the battery to the positive plate. This current, going through the bell, causes it to ring. It should be noted that the push button can be placed in either wire from the battery to the bell. It breaks the path in either wire and interrupts the flow of current to the bell.

Electric current is not "used up" in the bell. The same amount returns to the positive plate of the battery as left the negative plate. This electric current must be thought of as a medium for transferring power from one place to another, much in the same manner as an endless belt transfers power from the source of power to the load. In transferring that energy, the belt is not "used up." The same amount of belt returns to the driving pulley as went away from the driving pulley. Thus, electric current (thought of in this way) goes out from its driving source (the battery or generator), does its work, and returns to its source again.

In the foregoing discussion you should have learned:

1. Negative charges of electricity are called ELECTRONS. Positive charges of electricity are called PROTONS.

2. Negative charges are the ones that move.

3. The movement of electrons through a circuit constitutes the flow of electric current.

4. Unlike charges attract one another, and like charges repel one another.

5. The attraction between unlike charges separated from one another produce an ELECTRO-MOTIVE-FORCE or electrical pressure.

6. In order that electric current may flow, there must be a continuous path of some conducting material from the source of supply to the load, and from the load back to the source again.

A. **General information** (continued)

7. A conducting material is a material having free electrons in its molecules.

8. Electric current flows from the NEGATIVE pole, around through the CIRCUIT, and returns to the POSITIVE pole.

9. Electric current is not used up in doing its work but returns to its source.

B. **Ohm's Law**

1. **General information**

We have learned that an electrical pressure was necessary to cause electrons (electric current) to flow in a circuit. This pressure, or electro-motive-force, is measured in volts. The VOLT, then, is the unit of electrical pressure. In every circuit there is some opposition to the flow of electric current. This opposition or resistance to the flow of electric current is measured in OHMS. The OHM, then, is the unit of resistance. When a certain number of electrons flow past a certain point in one second, we say that one ampere of current flows through the circuit. Now let us consider the relationship between volts (pressure), ohms (resistance), and amperes (current).

If the pressure is increased across an electrical circuit and the resistance of the circuit remains the same, it is natural to suppose that the current will be increased. If the electrical pressure is doubled, the current will also be doubled. On the other hand, if the resistance of the current is increased, the flow of the current under the same electrical pressure will decrease. Let us try to put this down as a single statement.

The current (amperes) flowing in a circuit is directly proportional to the electrical pressure (volts) and inversely proportional to the resistance (ohms) of the circuit. This is Ohm's Law. In the form of an equation it would be stated as follows:

$$\text{Amperes} = \text{Volts} / \text{Ohms}$$

PROBLEM: How much current will flow in a circuit which has a resistance of 2 ohms across which there is an electrical pressure of 50 volts?

SOLUTION: Amperes = 50/2 or 25 amps.

If the pressure (volts) is the unknown quantity and the current and resistance are known, this formula can be transposed to read:

$$\text{Volts} = \text{Amperes} \times \text{Ohms}$$

B. **Ohm's Law** (continued)

PROBLEM; What pressure (volts) is required to force 7 amperes of current through 10 ohms of resistance?

SOLUTION; Volts = 7 x 10, or 70 volts

If the resistance of the circuit is the unknown quantity and the current and the pressure are known, the formula is transposed to read;

Ohms = Volts / Amperes

C. **The parallel circuit**

1. **General information**

First, let us connect one bell to a battery. The bell requires 2 amperes of current to make it operate properly. In order to get this current, it must be connected directly to a 6-volt battery. If we were to connect another bell to this same battery, we would extend the two wires from the first bell to the second bell. Since the battery maintains a pressure of 6 volts across the two-line wires, both bells have a pressure of 6 volts across their terminals. We have already stated that each bell requires 2 amperes to operate it; therefore the battery must supply 4 amperes of current to the 2 bells. Thus, 4 amperes flow out from the battery to the first bell where the current divides, 2 amperes going through the first bell and 2 amperes going on to the second bell.

On the return wire, 2 amperes flow from the second bell to the first bell where it is joined with the 2 amperes coming through it, and 4 amperes now flow between the first bell and the battery. This is called a PARALLEL circuit.

Summary; The voltage across a parallel circuit is the same across all parts of the circuit.

The current flowing in a parallel circuit is the sum of the currents flowing in each part of the circuit.

PROBLEM; Four bells requiring the same voltage but different amounts of current are connected in a parallel circuit. Bell No. 1 requires 2 amperes, bell No. 2 requires 4 amperes, bell No. 3 requires 4-1/2 amperes, and bell No. 4 requires 6 amperes.

(1) What is the voltage across each bell?

(2) What current must the battery supply to the 4 bells?

C. **The parallel circuit** (continued)

SOLUTION: (1) In a parallel circuit the voltage is the same across all 4 bells.

(2) The total current taken by all 4 bells is the sum of the current taken by each bell or a total of 2 plus 4 plus 4-1/2 plus 6 = 16-1/2 amperes.

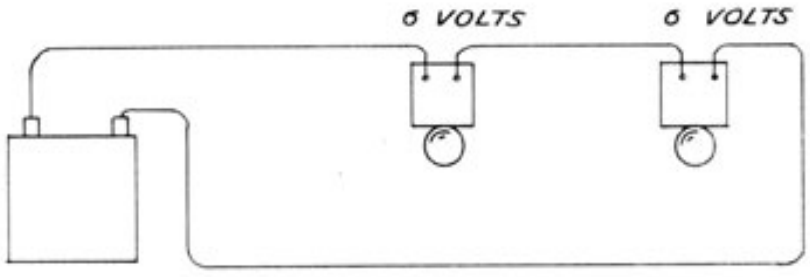
PROBLEM FOR SOLUTION: Draw a circuit of the above problem and indicate the amount of current flowing on each wire between the battery and bell No. 1; bell No. 1 and bell No. 2; etc.

C. **The series circuit**

1. **General information**

In a series circuit, the current must flow through one piece of electrical apparatus in order to get to another one. As previously explained, the current that goes to the bell must also go through the push button. It does not matter which wire the push button is in; the fact to be remembered is that in order to flow through one, the current must also flow through the other. If the current cannot flow through the push button, it cannot flow through the bell either. The bell and push button are said to be connected in series.

Let us consider a more complicated series circuit where 2 bells, each requiring 6 volts pressure and 2 amperes of current, are connected in such a manner that the same current going through one must also go through the other. (See accompanying illustration.)



Since each bell requires 6 volts, the battery must produce a total pressure of 12 volts. We have already stated that each bell requires 2 amperes of current. Since they are connected so that the same current flows through each bell, the battery must put out just 2 amperes.

D. **The series circuit** (continued)

Summary: (1) The total voltage across pieces of electrical apparatus connected in series is the sum of the voltages across each piece.

(2) The current flowing in a series circuit is the same in all parts of the circuit.

PROBLEM: Four pieces of electrical apparatus, each requiring 10 volts pressure and 4 amperes of current, are connected in series.

(1) How much current flows in the circuit?

(2) What is the total voltage across the circuit?

SOLUTION: (1) In a series circuit the current is the same in all parts of the circuit; therefore the total amount of current flowing is 4 amperes.

(2) The total voltage across a series circuit is the sum of the voltage across each piece; therefore the total voltage across this circuit would be 10 x 4, or 40 volts.

PROBLEM FOR THOUGHT: Could pieces of electrical apparatus requiring different amounts of current be connected in a series?

VII. ELEMENTARY LIGHTING CIRCUITS

A. **Installation of lighting circuit, Job No. 1**

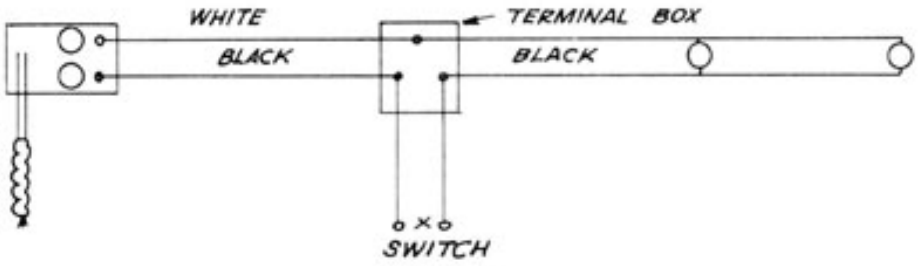
1. **Objectives**

a. To acquaint the beginner with electrical circuits

b. To show methods of connecting electrical equipment in SERIES and in PARALLEL

2. **Introductory information**

These circuits are to be installed on a practice board and should be done in a neat and workmanlike manner. Sockets and cutout are to be screwed to the board with wood screws. Where wires are necessary, they should be fastened securely with saddle tacks. All bends are to be square bends. Wires should be run parallel, either vertically or horizontally.



3. **Supplies, tools, and equipment**

Cutout or fuse block	Saddle tacks
2 porcelain lamp sockets	Hammer
1 single pole switch	Side-cutter pliers
4 ft. #14 R. C. wire (white)	Knife
6 ft. #14 R. C. wire (black)	Screw driver

4. **Procedure**

a. ASSEMBLE ALL WIRES AND TOOLS LISTED.

b. INSTALL CUTOUT AND LAMP SOCKETS AS SHOWN IN DRAWING. (TOP TERMINAL SHALL BE THE CONNECTION TO SHELL OF SOCKET.)

A. **Installation of lighting circuit, Job No. 1** (continued)

1) Run white wire from top terminal of cutout to the top terminal of lamp socket. (Note the lamp.)

2) Run black wire from lower terminal of cutout to switch.

3) Run another black wire from switch to both lamp sockets.

4) Connect an extension cord to line side of cutout.

5) Put in 15-ampere plug fuses and test.

c. HAVE INSTRUCTOR INSPECT THE JOB.

B. **Two switches controlling two lights each, Job No. 2**

1. **Objectives**

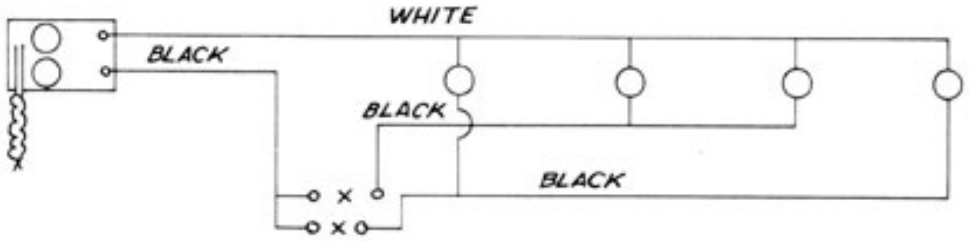
a. To show methods of controlling groups of lights from separate switches

b. To demonstrate series and parallel connections

2. **Introductory information**

In a PARALLEL circuit the voltage or electrical pressure is the same across all parts of the circuit. Lamps of the same voltage rating, therefore, must be connected in parallel.

In a SERIES circuit the current (amperes) is the same in all parts of the circuit. The switch, therefore, must be placed in a series with the lamp or lamps which it is to control, so that it will control all the current going to the lamps.



B. **TWO switches controlling two lights each, Job No. 2** (continued)

3. **Supplies, tools, and equipment**

Cutout	Tape
4 light sockets (receptacles)	Hammer
2 single pole switches	Side-cutter pliers
#14 R. C. (rubber covered) wire, both black and white	Knife
Saddle tacks	Screw driver
	Solder

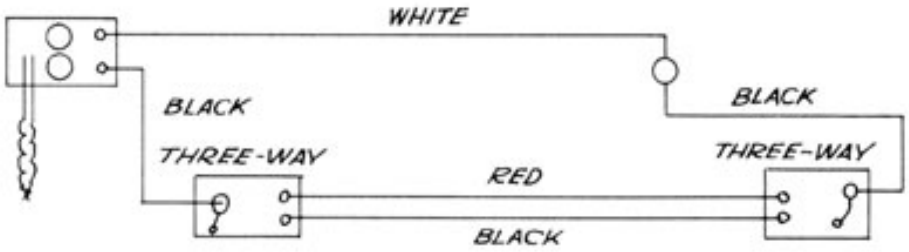
C. **Three switches controlling one light, Job No. 3**

1. **Objective**

a. To demonstrate the connection for three-way switches to control one or more lights from two places

2. **Introductory information**

As in previous jobs, the white wire is run to the lamps and the black wire is run to the switches. A three-way switch is always considered as a single pole switch because it breaks only one side of the circuit. A white wire should never be run to a single pole switch. Study the construction of the three-way switch. Notice that it has only three terminal screws--two on one end and one on the other. The black line wire is connected to the side having only one screw.



3. **Supplies, tools, and equipment**

Cutout	15-ampere plug fuses
2 three-way switches	Saddle tacks
1 lamp receptacle	Hammer
#14 R. C. (rubber covered) wire, both black and white	Side-cutter pliers
	Knife
	Screw driver

C. **Three switches controlling one light, Job No. 3** (continued)

4. **Procedure**

a. INSTALL CUTOUT, SWITCHES, AND RECEPTACLES AS SHOWN IN DRAWING.

1) Run white wire to lamp receptacle.

2) Run black wire from cutout to nearest three-way switch.

3) Connect to the side having only one terminal screw.

4) Connect a black wire from the single terminal of the opposite three-way switch and run it to the lamp receptacle.

5) Run two black wires (called "parallels" or "Jockey Legs") between the two three-way switches.

6) Test.

VIII. FIXTURES AND FITTINGS

A. **Objectives**

1. To identify fixtures and fittings used in marine installation

2. To locate and install fixtures and fittings

B. **General information**

The use of fixtures in marine electrical work and industrial work is governed by the same principles; the only difference is in the materials used, methods of construction, and conditions for which they are used. Conditions which severely affect marine work are salt water and dampness; the greatest care must be taken, therefore, when installing marine fixtures, as uninterrupted service on a ship is far more important than in an industrial plant. A ship at sea is entirely dependent upon her own resources.

Fixtures that are used in marine work are subjected to severe conditions, such as jarring and vibration. It is necessary that they be constructed and installed so that connections will not be loosened, small coils will not become displaced, and relays will not be affected.

Fittings may be divided into two classes; watertight (WT) and non-watertight (NWT). The difference between a watertight and non-watertight circuit box or compartment is that the former must be drilled and tapped for installation of a packing or terminal tube for entry of the cable, whereas only a cable clamp is necessary in a non-watertight fitting. (See following illustrations of various types of fixtures.)

Fittings used in marine work are generally furnished by manufacturers, and a large assortment of parts for replacement are always available or can be quickly obtained. If a piece of equipment becomes defective while a ship is at sea, an order may be sent by radio to port for replacement and can be installed upon arrival of the ship to port. (A number of fittings used in marine work are illustrated on the following pages.)

B. **General information** (continued)

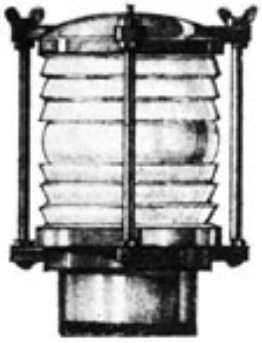
Ceiling Fixtures

Globe

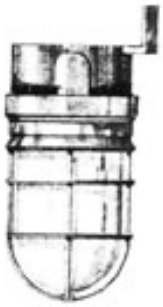
Cargo Light

Guard

Bulkhead Fixtures



Morse Blinker



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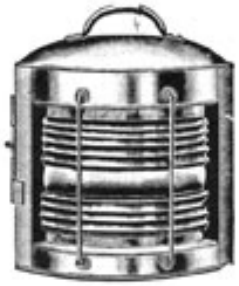
B. **General information** (continued)

One Red for Port

Navigation Lights



Side Lights

One Green for Starboard

Bow, Masthead, Stern, Range, or Towing Lights

Anchor or Riding Lights

Marine Searchlight

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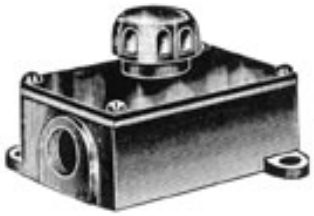
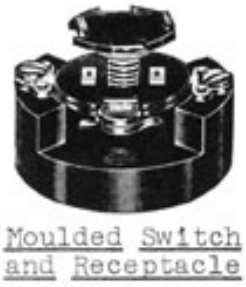
B. **General information** (continued)

Switches

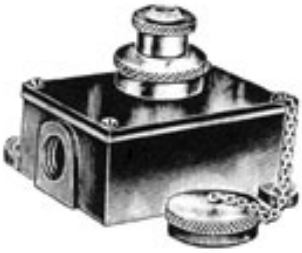




Moulded Switch and Receptacle

Watertight Plug Receptacles

Moulded Plug



Moulded Receptacle Interior

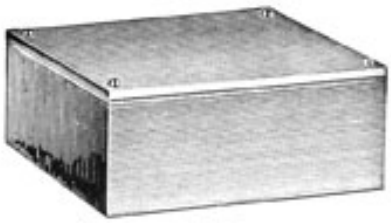
General Alarm Bell

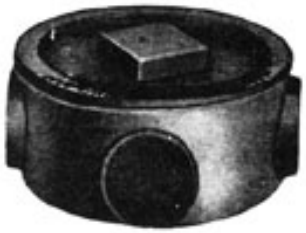
Single Switch and Receptacle

Watertight Push Button

B. **General information** (continued)

Junction Boxes





Screw Cover Type
Junction Box

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B. **General information** (continued)

Special fixtures and fittings are made for magazines, handling rooms, and similar compartments. All electrical devices in these rooms must be absolutely sealed when completed.

Identifying fixtures and fittings. See illustrations of the various fixtures and fittings. Refer also to catalogues of the various companies which supply marine electrical supplies and equipment.

Installations. Illustrations Nos. 1, 3, 4, 5, and 6 show the methods of installing fixtures to watertight and non-watertight decks and bulkheads of aluminum and steel as well. The methods used in illustrations Nos. 2, 7, 8, and 9 are for installing fixtures to decks or bulkheads of steel only, both watertight and non-watertight. Illustration No. 10 shows the installation of fixtures to non-watertight bulkheads only.

Locations. Fixtures should be placed in the most convenient places. Switches should be placed 48 inches from the deck to center, and phones and other means of communication should be placed 58 inches from deck to center of instrument. Whistle pulls and control devices measure 36 inches to the handle or key. Convenient outlets or plug receptacles are placed 72 inches from the deck, while radio and fan outlets are placed 15 inches from the finished ceiling unless otherwise indicated. Connection or junction boxes (other than fuse boxes), that are seldom opened should be placed to evenly distribute the light. Usually the plans give the location of all fixtures. To locate the center of the room, measure half the distance from one side and half the distance from one end. The two lines cross in the center.

Note: Porcelain should never be used on shipboard. Bakelite, hard rubber, fiber, or synthetic plastic are preferable because they are more rugged and durable.

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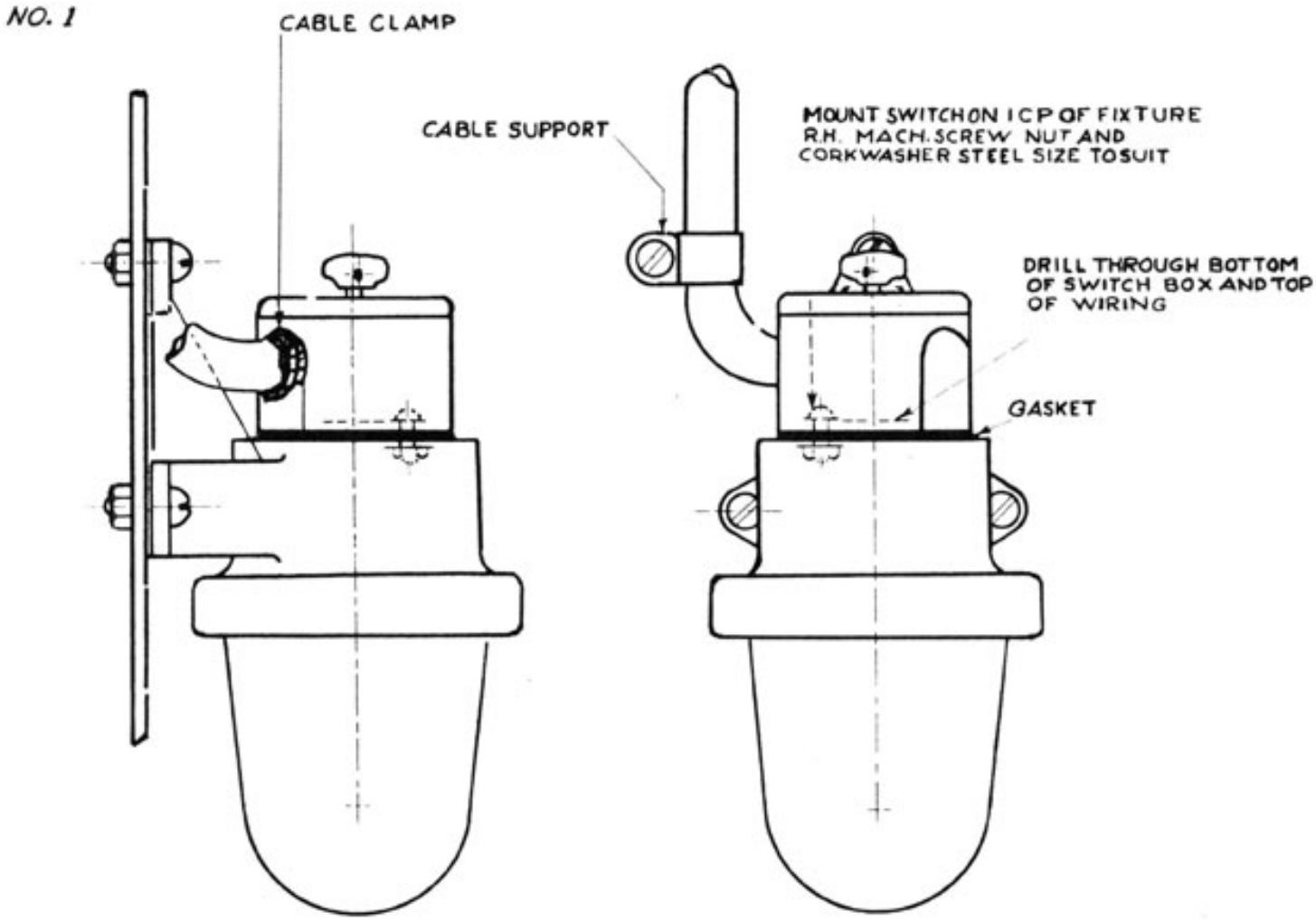
C. **Illustrations**

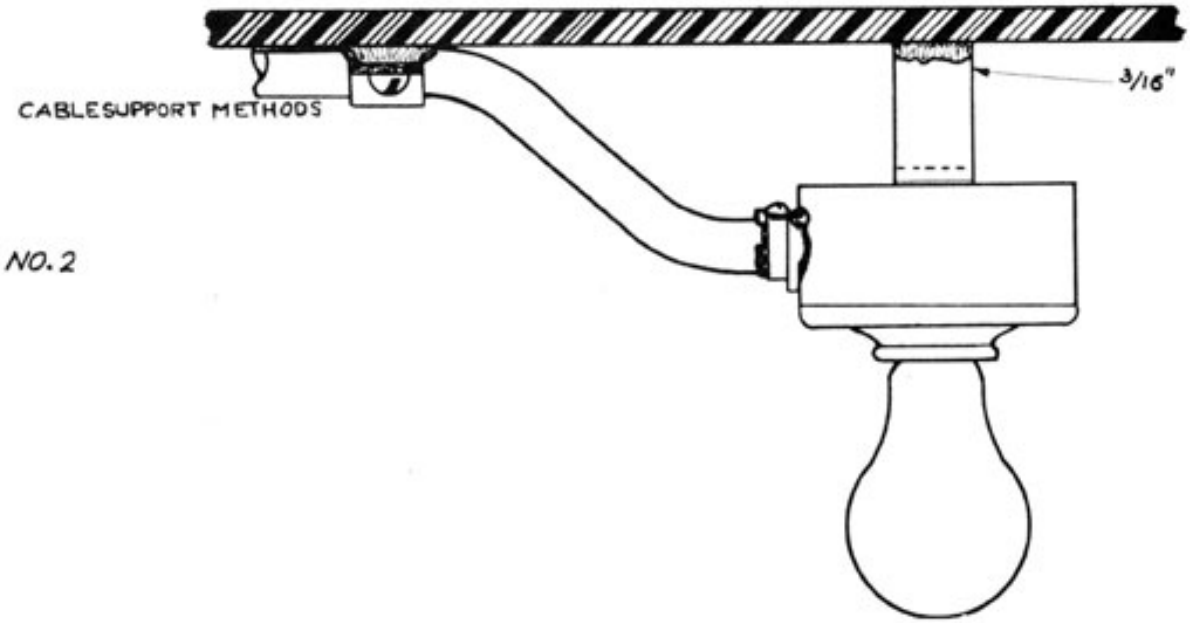
METHOD OF SECURING COMBINED N.W.T. FIXTURE AND APPLIANCE TO W.T. OR N.W.T. STEEL OR ALUMINUM BULKHEADS



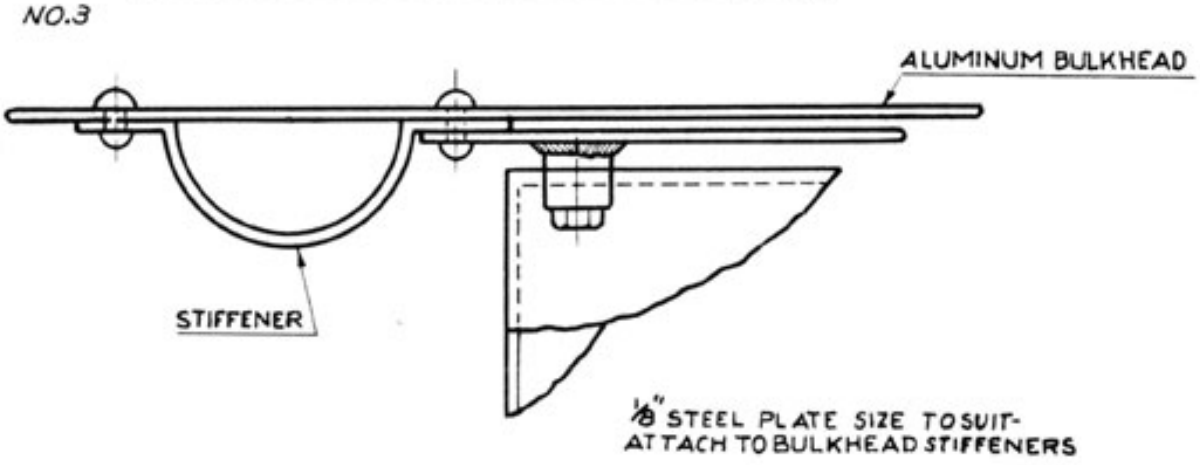
85

C. **Illustrations** (continued)

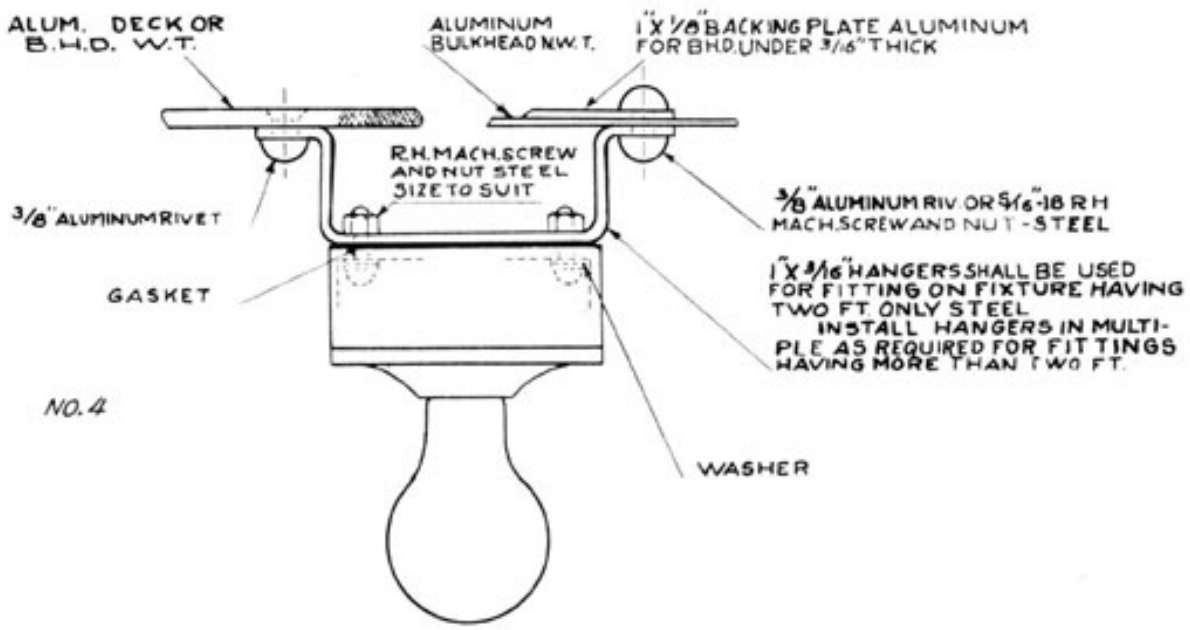
METHOD OF SECURING CABLE TO N.W.T. FIXTURE



METHOD OF SECURING LARGE PANEL OR BOX TO ALUMINUM BULKHEAD

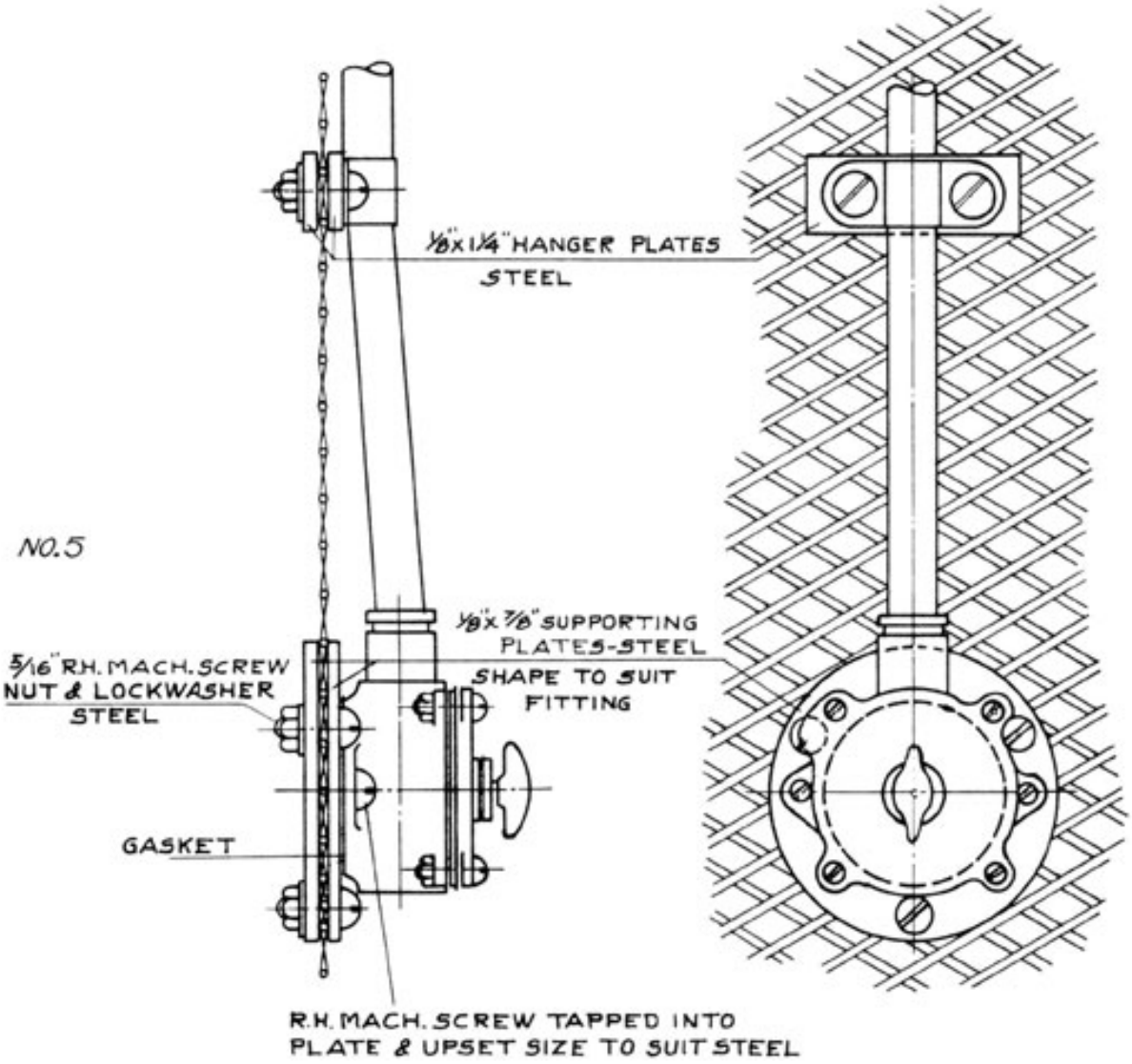


C. **Illustrations** (continued)



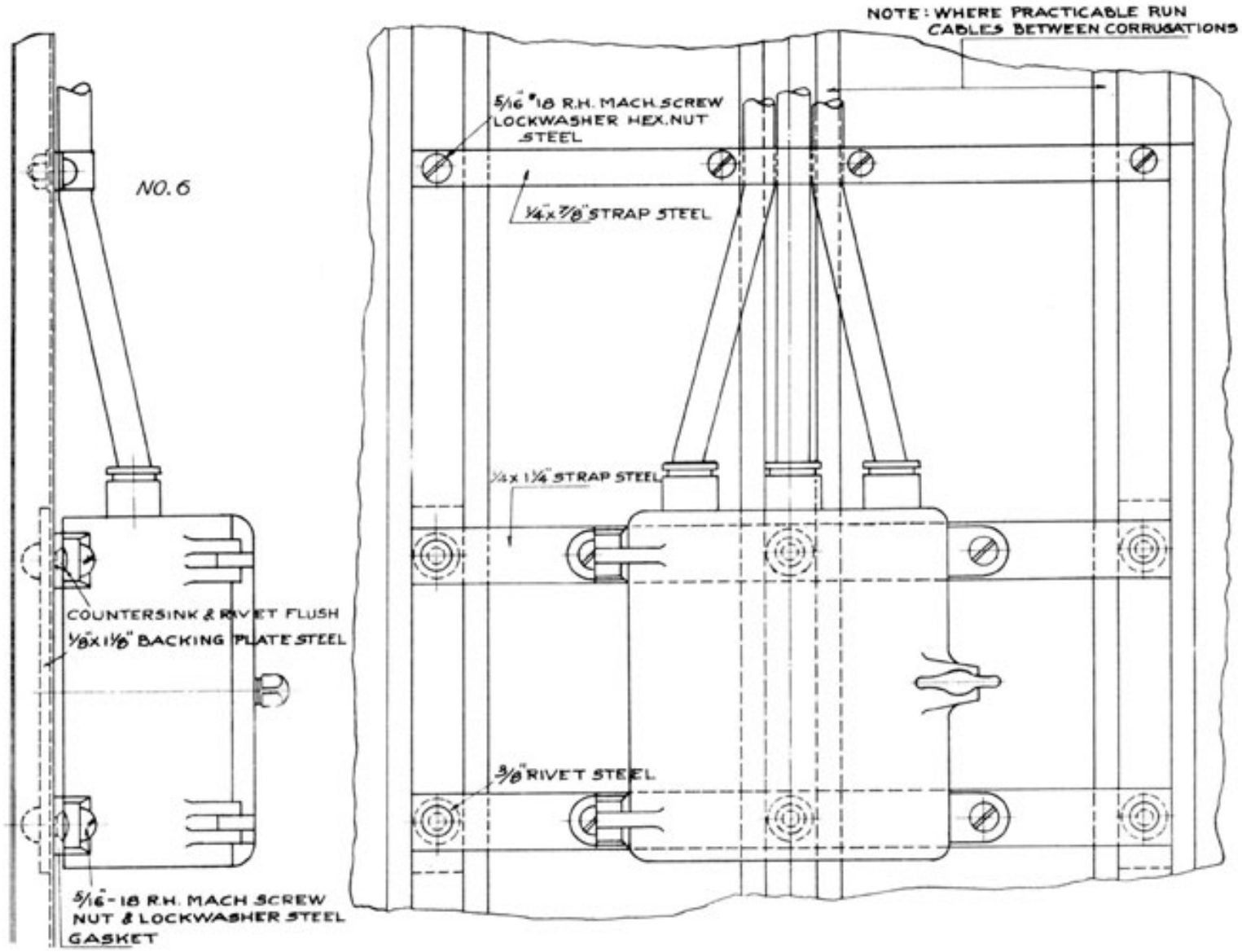
METHOD OF SECURING FIXTURE OR FITTING-
TO ALUMINUM DECK OR BULKHEAD
W.T. AND N.W.T.-EXTENSION

C. **Illustrations** (continued)

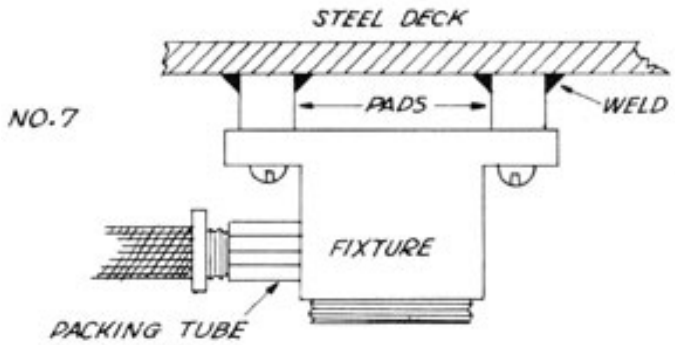


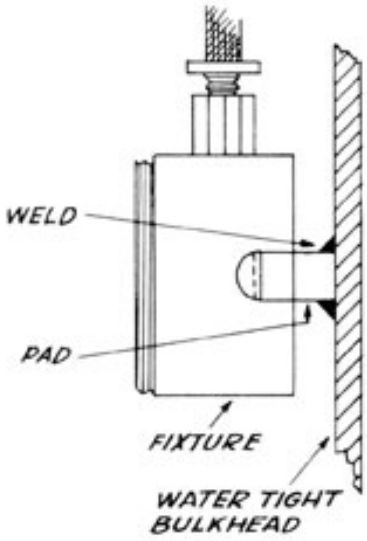
METHOD OF SECURING FIXTURE OR FITTING TO EXPANDED METAL OR WIRE MESH BULKHEADS

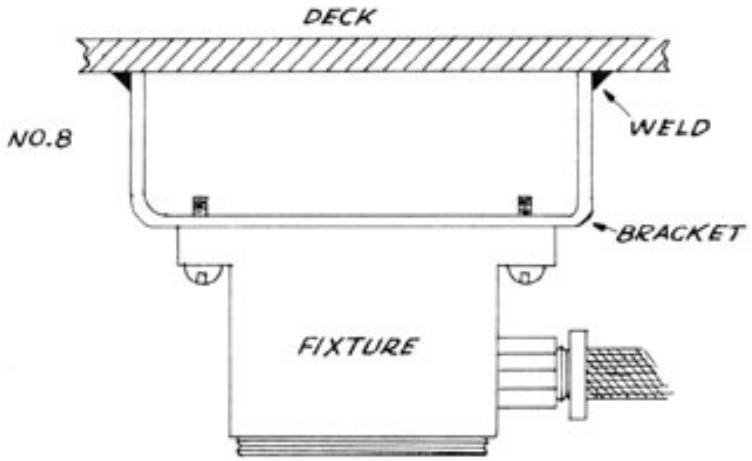
C. **Illustrations** (continued)

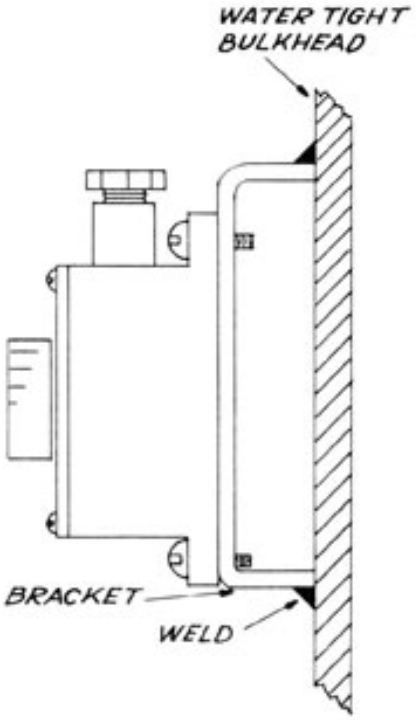


C. **Illustrations** (continued)

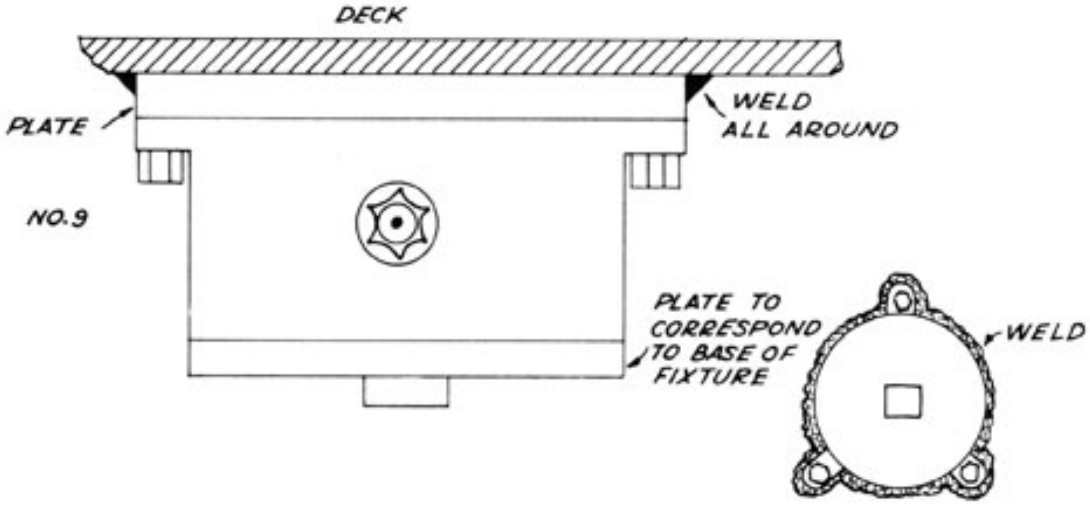


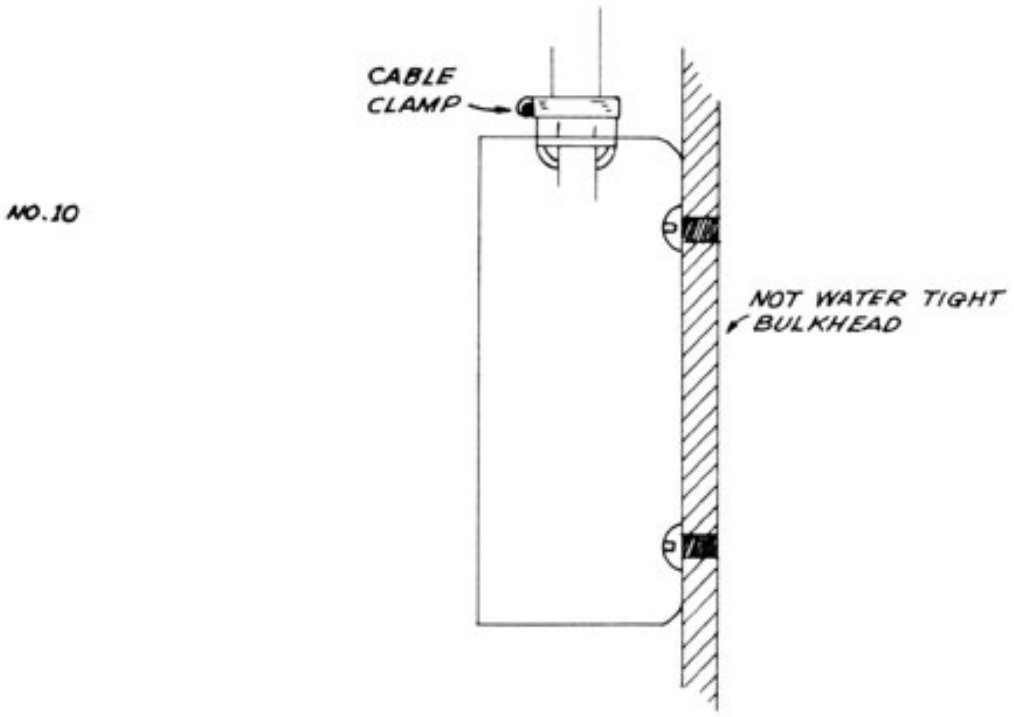






C. **Illustrations** (continued)


DECK
PLATE
WELD
ALL AROUND
NO.9
PLATE TO
CORRESPOND
TO BASE OF
FIXTURE
WELD

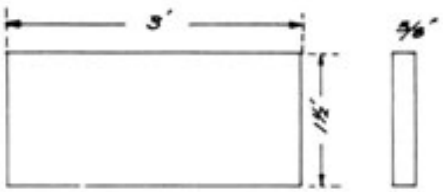

CABLE
CLAMP
NO.10
NOT WATER TIGHT
BULKHEAD

IX. SIMPLE SKETCHES

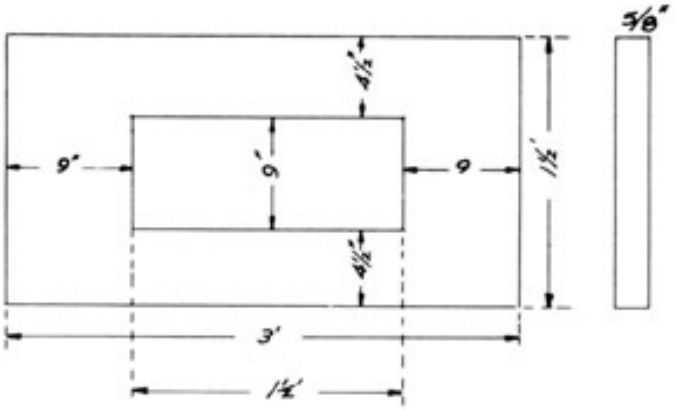
A. **General information**

In the reading of ordinary freehand sketches or drawings, there are certain minimum measurements and related information necessary for a comprehensive understanding. In studying an illustration, special attention should be given to the following: (1) over-all length, (2) over-all width, (3) thickness, (4) inside measurements, (5) distance between centers of holes, (6) alignment of holes in respect to a given line, (7) specific types of material, such as flat bar, angle bar, channel bar, plate, galvanized or plain sheet metal, and the number of pieces required for the job.

For a plain flat plate, the following is sufficient:

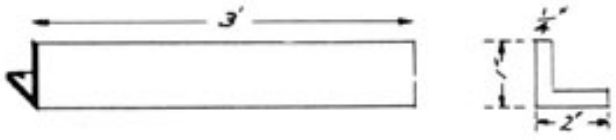


For a plate with an opening cut in it, the following information should be given:

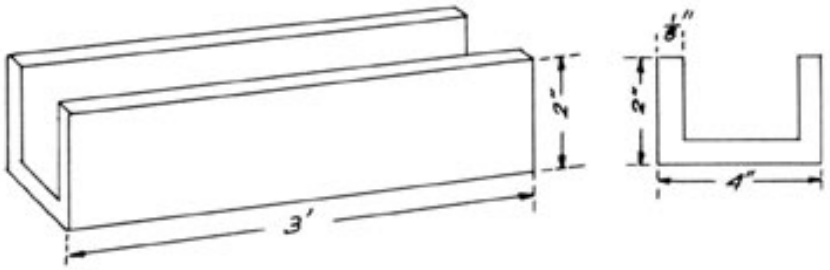


A. **General information** (continued)

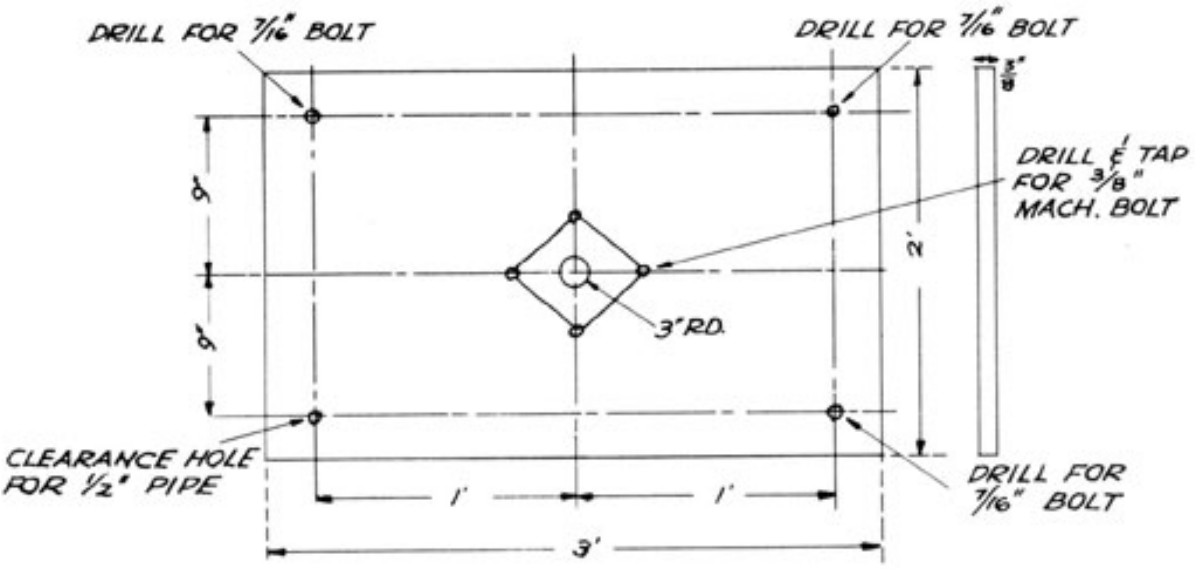
For an angle bar, the following dimensions are needed: over-all length, thickness of metal, and width of each side of angle bar.



For channel iron, the dimensions of over-all length, thickness of material, and depth and breadth of channel are needed.

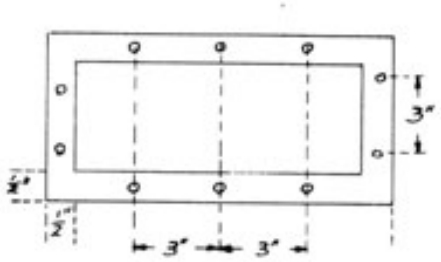


For a plate that is to be drilled, the holes should be designated as to size or purpose and location.

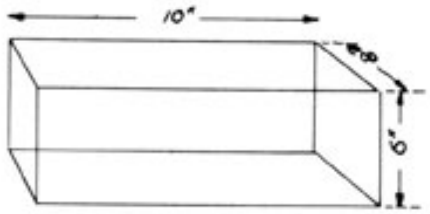


A. **General information** (continued)

A box to be made of sheet metal should show inside measurements of box, size of opening, and how cover is to fasten.

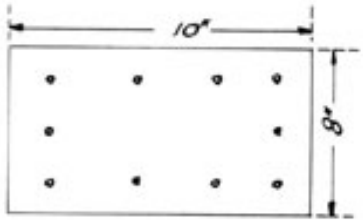


HOLES DRILLED & TAPPED
¼" - 20 MACH. SCREWS



1 BOX 20 GAUGE GALV.

Top and Perspective Views of Box



HOLES
CLEARANCE ¼"-20

Cover of Box

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B. **How to make a layout sketch**

1. **Supplies, tools, and equipment**

Blueprints
Paper
Pencil
Rule

2. **Procedure**

a. SECURE MATERIALS FROM SHOP BLUEPRINT MAN.

1) Supply your own rule.

b. CLASSIFY CABLES SHOWN ON PRINTS AND CHECK THEIR RUN.

1) Cables must be run separately due to different voltages.

2) There are four general classes of cables: (1) power, (2) lighting, (3) fire control, and (4) intercommunication.

c. STUDY ARRANGEMENT PRINT AND CHECK COMPARTMENT ARRANGEMENT

1) Measure different units in compartment and check with print.

2) Arrangement study is needed, due to limited space and clearance.

d. DRAW LINES ON PAPER TO REPRESENT EACH CABLE IN COMPARTMENT AND CHECK WITH PRINT.

1) Cables are marked when shown on sketch so as to eliminate braiding any crosses in cable runs.

e. DRAW SYMBOLS SHOWING LIGHTS, BOXES, SWITCHES, OUTLETS, ETC., AS SHOWN ON ARRANGEMENT PRINT AND CABLES FEEDING THESE UNITS.

1) These symbols are shown by squares, ovals, rectangles, cones, etc., with a key symbol list.

f. CHECK ALL UNITS AND CABLES WITH PRINTS FOR ERRORS OR OMISSIONS.

g. INFORM LAYOUT BOSS THAT YOUR SKETCH IS COMPLETE AND READY FOR HIS CHECK AND APPROVAL.

h. RETURN BLUEPRINTS TO SHOP BLUEPRINT MAN AND RECEIVE SIGNED SLIP.

B. **How to make a layout sketch** (continued)

1) The blueprints should be returned immediately upon completion of the sketch because these prints are of a confidential nature and must be watched closely.

i. TURN SKETCH OVER TO THE FOREMAN.

Note: The job of making a sketch varies in man-hours, due to size of compartment on boat and to number and size of cables located in compartment. The time would range from 3 hours to 120 hours for this job. The more experience the man gets on layout, the bigger sketches he is given to do.

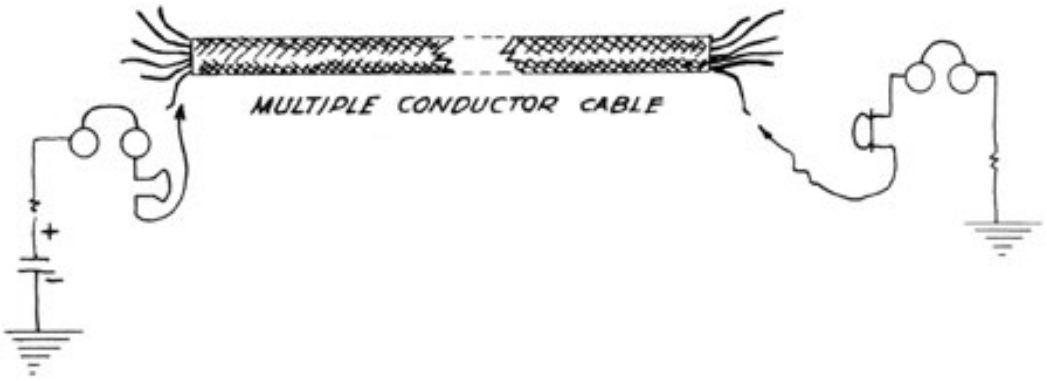
X. CABLE TESTING FOR CONTINUITY AND IDENTIFICATION

A. **Objective** 1. To demonstrate one method of testing a multiple conductor cable for continuity and identification of conductors.

B. **Introductory information**

The requirement is to test a 16-conductor cable and identify the various conductors. The cable we have chosen is one run between the steering gear motor and the rudder angle indicator on the bridge. This cable is not in one continuous length. A junction box is cut in somewhere along its length.

It is necessary to test the cable between the steering gear, therefore, and also from the rudder angle indicator on the bridge to the junction box. This is a new installation and the conductors are not color-coded or otherwise identified.



C. **Supplies, tools, and equipment**

2 headphone test sets
Screw driver
Knife
Pliers

D. **Procedure**

1. SKIN AND CLEAN BOTH ENDS OF ALL CONDUCTORS PREPARATORY TO TESTING.

2. FAN OUT ALL CONDUCTORS AT BOTH ENDS SO THAT THEY DO NOT TOUCH EACH OTHER OR GROUND.

D. **Procedure** (continued)

3. IDENTIFY EACH CONDUCTOR AT ONE END OF CABLE WITH IDENTIFICATION TAGS.

Note: These identifications may be terminals, either soldered to the wire or put on the conductor with solderless connection. One man (usually the helper) will put on one head set and connect one of the test leads to a good ground.

A test should be made by tapping the other test lead to another part of the ship to determine whether or not it is a good ground. If a click is heard in the phones, it is a good ground.

The free test lead of the phones should be connected to the first conductor to be tested.

4. BEGIN THE TEST.

Note: The journeyman goes to the other end of the cable, puts on his test phones, and connects one lead to the ground. He now begins by touching the free test prong to each individual conductor in turn, until a click is heard in the test phones. This click will also be heard in the phones at the other end. The helper should immediately reply by giving the number of the conductor.

As soon as the journeyman has repeated the number, the helper should connect the next conductor to be tested. This operation is repeated until all conductors in that cable are identified. If for any reason a click is heard in the test phones and communication cannot be established, it usually means a grounded conductor. It may be an accidental ground and should be cleared. If a helper waits a considerable length of time without getting a click in his phones, it may be best to test again to make sure his phones are still grounded. If the ground is all right, move test lead to another conductor, leaving the dead one on until the last. There may be an opening in that particular wire.

The helper should stay at his station with his test phones on until relieved by the journeyman.

The headphones should be tested for polarity before starting the test. Each headphone has its own battery. The proper lead of each headphone must be grounded or they will not work. The phones should be connected together and the proper ground lead for each phone determined before attempting to test the cable.

XI. SHIP LOCATIONS AND NOMENCLATURE

ABOARD--On or in a ship.

AFT--In the direction of or toward the stern.

AMIDSHIPS--In the vicinity of the middle portion of a vessel, as distinguished from her ends. The term is used to convey the idea of general locality, but not that of definite extent.

ASTERN--Signifying position, in the rear of, or abaft the stern; in regards motion, the opposite of going ahead; backwards.

ATHWARTSHIP--In a transverse direction; from side to side at right angles to the fore and aft centerline of a vessel.

BATTERY BOX--A lead-lined box which holds the storage batteries.

BELOW--Underneath the surface of the water. Underneath a deck or decks.

BETWEEN DECKS--The space between any two, not necessarily adjacent, decks. Frequently expressed as "'Tween Decks."

BILGE--The rounded portion of the hull between the side and bottom.

BINNACLE--A stand or case for housing a compass so that it may be conveniently consulted. Binnacles differ in shape and size, according to where used and the size of compass to be accommodated.

BOOBY HATCH--The hatch covering the escape trunk from the propeller shaft tunnel.

BOW--The forward end of the ship.

BRIDGE--The athwartship platform above the weather deck from which the ship is steered.

BRIDGE, NAVIGATING OR FLYING--The uppermost platform erected at the level of the top of pilot house. It generally consists of a narrow walkway supported by stanchions, running from one side of the ship to the other and the space over the top of the pilot house. A duplicate set of navigating instruments and controls for the steering gear and engine room signals are installed on the flying bridge so that the ship may be navigated in good weather from this platform.

BULKHEAD--A term applied to any of the partition walls used for subdividing the interior of a ship into the various compartments. The main partition walls also serve as strength members of the ship's structure and as a. protection against water passing from one compartment to another.

BULKHEAD, OIL TIGHT--A partition of planking reinforced where necessary with stiffening bars and capable of preventing the flow of oil under pressure from one compartment to another.

BULKHEAD, WATERTIGHT--A partition of planking or plating reinforced where necessary with stiffening bars and capable of preventing the flow of water under pressure from one compartment to another.

CABIN--The interior of a deck house, usually the space set aside for the use of officers and passengers.

CAPSTAN--A revolving device, with axis vertical, used for heaving in lines.

CARGO HATCH--Large opening in a deck to permit loading of cargo.

CHAIN LOCKER--Compartment in forward lower portion of ship in which anchor chain is stowed.

CHART ROOM--Small room under bridge used for charts and navigational instruments.

COAMING, HATCH--A frame bounding a hatch for the purpose of stiffening the edges of the opening and forming the support for the covers.

COFFERDAM-The space between two bulkheads located very close together.

COMPANION WAY--A passageway or hatchway.

COMPASS, MAGNETIC--The compass is the most important instrument of navigation in use on board ship, the path of a ship through the waters depending upon the efficient working and use of this instrument.

CROW'S-NEST--A lookout station attached to or near the head of the mast.

DAVIT--Heavy vertical pillar, of which the upper end is bent to a curve, used to support a small boat.

DECK--A deck in a ship corresponds to the floor in a building. It is the plating, planking, or reinforced concrete covering, or any tier of beams above the inner bottom, forming a floor, either in the hull or superstructure of a ship.

DECK, QUARTER--A term applied to the after portion of a weather deck. In a warship that portion allotted to the use of the officers.

DOOR, WATERTIGHT--A door so constructed that when closed it will prevent water under pressure from passing through.

DOUBLE BOTTOM--Compartments at bottom of the ship between inner and outer bottoms, used for ballast tanks, water, or fuel oil.

DOUBLING PLATE--A plate fitted outside or inside of another to give extra strength or stiffness.

ENGINE ORDER TELEGRAPH--Transmits the engine orders from the bridge to the engine room.

EXHAUST TRUNK--An outlet for engine exhaust from diesel-driven boats.

FIDLEY HATCH--Hatch around smokestack and uptake.

FIRE DETECTOR AND I. C. TRUNK--Cable rack for fire detector and interior communicative cables.

FLAGSTAFF--Flag pole at stern of ship.

FLAT--Part of deck of a ship.

FOREWARD-A term used in indicating portions or that part of a ship at, or adjacent to, the bow. Also applied to that portion and parts of the ship lying between the midship section and stem; as fore body, fore hold, and foremast.

FORE PEAK--A large compartment or tank just aft of the bow in the lower part of the ship.

FORE AND AFT--Parallel to the ship's centerline.

FORECASTLE--The forward upper portion of the hull, usually used for crew's quarters, lamp room, boatswain's stores, or paint locker.

FORWARD--In the direction of the stem or bow.

FRAME--A term generally used to designate one of the transverse ribs that make up the skeleton of a ship. The frames act as stiffeners, holding the outside plating in shape and maintaining the transverse form of the ship.

GALLEY--The space on a ship where the food is prepared; ship's kitchen.

GANGPLANK--A term applied to boards or a movable platform used in transferring passengers or cargo from a vessel to or from a deck.

GANGWAY--A term applied to a place of exit from a vessel. Gangways are fitted in the sides of a vessel or may be movable portions of bulwarks or railing on the weather decks.

GASKETS--Packing materials, by which air, water, oil, or steam tightness is secured in such places as on doors, hatches, steam cylinder, manhole covers, or in valves, between the flanges of pipes, etc. Such materials as rubber, canvas, asbestos, paper, sheet lead, and copper, soft iron, and commercial products are extensively used.

GIRDER--On ships this term is generally applied to continuous beams running in a fore and aft direction under the decks. They are used in connection with stanchions for the purpose of supporting the decks and binding the deck beams together.

GRATINGS--A structure of metal bars so arranged as to give a support or footing over an opening, while still providing spaces between the members for the passage of light and the circulation of air.

HAWSE PIPE--A large fitting attached to the bow of a ship through which the anchor chain passes.

HEADS--Toilets.

HELM--A term applied to the tiller, wheel, or steering gear, and also the rudder.

HOLDS--Spaces or compartments between the lower-most decks and the bottom of the ship; or top of the inner bottom, if one is fitted. The spaces below decks allotted for the storage of cargo.

HYDROPHONE--Submarine telegraph which transmits by sound vibrations through water.

INBOARD--Toward the center; within the vessel's shell and below the weather decks.

IMPACT OSCILLATOR--The oscillator which produces sound for depth sounding.

JACKSTAFF--Flag pole at bow of ship.

LADDER--A framework consisting of two parallel sides connected by bars or steps which are spaced at intervals suitable for ascending or descending. On shipboard, the term ladder is also applied to staircases and to other contrivances used in ascending or descending to or from a higher or lower level.

LIGHTENING HOLE--A large hole cut in a floor plate, or longitudinal to reduce its weight.

MAGAZINE--Spaces or compartments devoted to the stowing of ammunition.

MAIN DECK--The highest continuous deck running from bow to stern, which is in general the upper strength member of the ship's girder. This term is especially applicable to warships.

MANHOLE--A round or oval hole cut in decks, tanks, boilers, etc., for the purpose of providing access.

MANIFOLD--A casting or chest containing several valves. Suction or discharge pipes from or to the various compartments, tanks, and pumps are led to it, making it possible for several pumps to draw from or deliver to a given place through one pipe line.

MIDSHIP SECTION--The vertical transverse section located at the midpoint between the forward and after perpendiculars. Usually this is the largest section of the ship in area.

OUTBOARD--Away from the center toward the outside; with the hull.

PILOT HOUSE--A house designed for navigational purposes. It is usually located forward of the midship section and should command an unobstructed view in all directions except directly aft.

PLATFORM DECK--A partial deck below the main deck. Platform decks generally have neither camber nor sheer.

POOP--The after, upper portion of the hull, usually containing the steering gear.

PORT, AIR--An opening in the side or deckhouse of a vessel, usually round in shape, and fitted with a hinged frame in which a thick glass light is secured.

POWER TRUNK--Cable rack for power cables.

QUARTER DECK--That space on a naval vessel so designated by the commanding officer where all ceremonies are held and where officers come on board.

QUARTERS--Living spaces for passengers or personnel. It includes staterooms, dining saloons, mess rooms, lounging place, passages connected with the foregoing, etc.; individual stations for personnel for fire or boat drill, etc.

RANGE, GALLEY--The stove, situated in the galley, which is used to cook the meals. The heat may be generated by coal, fuel oil, or electricity.

RUDDER--A device used in steering or maneuvering a vessel.

SAMSON POST OR KING POST--A heavy vertical post that supports the cargo booms.

SCUPPER--A drain from the edge of a deck discharging overboard.

SCUTTLE BUTT--A drinking fountain.

SHAFT TUNNEL OR ALLEY--Enclosed alleyway around the shaft extending from engine room to after peak tank.

SHEER--Fore and aft curvature of a deck.

SOUNDING--Measuring the depth of water or other liquid.

SMOKE STACK--A metal chimney or passage through which the smoke and gases are led from the uptakes to the open air.

SPLINTER PROTECTION--Light armor used exclusively for protecting personnel.

STANCHIONS--Short columns of supports for decks, handrails, etc.

STARBOARD SIDE--That side of a vessel to the right hand when looking from the stern toward the bow.

STEERING GEAR--A term applied to the steering wheels, leads, steering engine, and fittings by which the rudder is turned.

STEM--The bow frame forming the apex of the triangular intersection of the forward sides of the ship.

STERN--The after end of a vessel; the farthest distant part from the bow.

STIFFENER--An angle bar, T-bar, channel, or bulb angle used to stiffen plating of a bulkhead.

STRINGER--A fore and aft continuous member used to give longitudinal strength; as for example, hold stringers, bilge stringers, side stringers, or deck stringers.

SUPERSTRUCTURE--A structure built above the uppermost complete deck; a pilot house, bridge, galley house, etc.

TANKS--Compartments for liquids or gases. They may be formed by the ship's structure, as double-bottom tanks, peak tanks, deep tanks, etc., or they may be independent of ship's structure and installed on special supports.

TEMPLATE--A mold or pattern made to the exact size of a piece of work that is to be laid out or formed, on which such information as the position of rivet holes, size of laps, etc., is indicated.

TOPSIDE--That portion of the side of the hull which is above the designed waterline.

TRANSOM--The aftermost transverse frame.

TRUNK--A vertical or inclined shaft formed by bulkheads or casings extending one or more deck heights, around openings in the decks, through which access can be obtained, cargo stored, and handled, or ventilation provided without disturbing or interfering with the contents or arrangements of the adjoining spaces.

TURRETS--Structures designed for the mounting and handling of the guns and accessories (usually main battery guns) of a war vessel.

UPTAKE--A sheet metal conduit connecting the boiler smoke box with the base of the smokestack. It

conveys the smoke and hot gases from the boiler to the stack and should be made double thickness with an air space between to prevent radiation.

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VENTILATORS, BELL-MOUTHED OR COWL--Terminals on open decks in the form of a 90-degree elbow with enlarged or bell-shaped openings, so formed as to obtain an increase of air supply when facing the wind and to increase the velocity of air down the ventilation pipe.

VOICE TUBE--A tube designed for the carriage of the human voice from one part of, or station in the ship, to another.

WARDROOM--A room or space on shipboard set aside for use of the officers for social purposes, and also used as their mess or dining room.

WATERTIGHT COMPARTMENT--A space or compartment within a ship having its top, bottom, and sides constructed in such a manner as to prevent leakage.

WEATHER DECK--Decks above, including the highest continuous deck running from bow to stern, which are partially or entirely exposed to the weather.

WINCH--A hoisting or pulling machine fitted with a horizontal single or double drum. A winch is used principally for the purpose of handling, hoisting, and lowering cargo from a dock or lighter to the hold of a ship, and vice versa.

WINDLASS, STEAM--An apparatus in which horizontal drums or gypsies and wildcats are operated by means of a steam engine for the purpose of handling heavy anchor chains, hawsers, etc.

YARD--A term applied to a spar attached at its middle portion to a mast and running athwartship across a vessel as a support for a square sail.

YARD-ARM--A term applied to the outer end of a yard.

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Version 1.00, 15 Jan 06

SUPPLEMENT

Information Applicable to Naval Practices

I. HOW TO LAY OUT A MAIN WIREWAY

A. **Supplies, tools, and equipment**

Blueprints	Pencils
Paper	Ruler
Compass	Triangle
T-square	Drawing board

B. **Procedure**

1. OBTAIN MAIN WIREWAY PRINT AND DETERMINE THE RUNS.

a. Check master sheet to obtain the blueprint number.

b. Determine where the prints are kept.

c. Secure the prints.

d. Select the section to be laid out.

e. Locate the bulkheads, and note the frame numbers.

f. Note whether the bulkheads are watertight or non-watertight, aluminum or steel.

g. Study the section selected very closely, noting every detail.

1) Check the following details on the blueprint:

a) Cable rack width and type of hangers used (See method print.)

b) Cable rack length

c) Cable rack clearance

d) Insulated areas and type of hangers used (See method print.)

e) Non-insulated areas and type of hangers used (See method print.)

f) Slots in beams, etc., for the cable run, size, and location

g) Up and down tube areas and type of tubes (See method print.)

h) Note where cables are to be run beneath or over pipes, below beams, etc.

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B. **Procedure** (continued)

i) Check print closely to determine if there will be any obstruction in the runs, drains, vents, etc.

h. Learn cable designations and their meaning.

1) Cable designations

DCP	Double conductor portable
DHFA	Duplex heat flame resistant armored
FHFA	Four conductor heat flame resistant armored
GICF	General I.S. Flexible
MCP	Multiple conductor portable
MHFA	Multiple conductor heat flame resistant armored
SHFA	Single conductor heat flame resistant armor
SRHLA	Single conductor radio high tension lead armor
SRLL	Single conductor radio low tension lead
TCP	Triple conductor portable
THFA	Triplex heat flame resistant armored
TTHFA	Twisted pair telephone heat flame resistant armored
Cabloy	Radio cable (radio frequency capacity)
SLPP	Single light and power, plain
SLPA	Single light and power, armored
DLPP	Duplex light and power, plain
DLPA	Duplex light and power, armored
DLB	Duplex lighting, braided
FLP	Four conductor, plain
FLA	Four conductor, armored

Note: The prefix letter on all cables except the "M" cable indicates the number of conductors in the cable.

The suffix numeral on all cables except the "M" cable indicates the size of the conductors in 1,000 C.M. (circular mils).

The prefix letter "M" on cables indicates a multiple conductor cable (two or more conductors) and the suffix numeral represents the number of conductors.

The size of the wire in all "M" conductor cables is No. 16.

i. Learn to distinguish the circuits by the circuit markings on the blueprint.

B. **Procedure** (continued)

1) **Lighting and power**

F	General lighting and power
FB	Battle lighting and power
XFE	Emergency lighting and power

When no numeral precedes the circuit marking, the circuit is a feeder

FB 100

When a numeral precedes the circuit marking, and no letter or number follows the marking, the circuit is a main.

1 - FB - 100

The numeral "1" indicates the first position on Power Panel, K. Box, etc., "2" the second position, etc.

When a numeral precedes the circuit marking and a letter follows, the circuit is a submain.

1 - FB - 100 A

The "A" indicates the first position, "B" the second position, etc.

A numeral preceding the circuit marking and a letter and a numeral following it indicate a branch or a sub-branch.

1 - FB - 100 A 1

The last numeral "1" indicates the first position, "2" the second position, etc.

When the number following the circuit marking is one hundred series (FB 100), the circuit can be assumed to be a lighting circuit of 120 volts; the figure "1" indicating the voltage. The remaining figures in the number will be the circuit number. There will be exceptions to this rule; for instance, a circuit with the number "165" or "326," and a few others. These will be located on the power print, for they are considered power circuits. Generally the figures "1" and "4" indicate a lighting voltage of 120, or a power voltage of 440, respectively.

2) Interior communication is called I.C.

3) Fire control is called F.C. circuits (guns)

4) Sound circuits

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B. **Procedure** (continued)

5) Radio

6) Degaussing

j. Keep all large cables within the machinery spaces inboard of the cable rack. The remainder are to be installed in the way they will best fit the particular location.

k. Whenever possible, group power and light, I.C. and fire control, and radio.

2. CHECK ALL DETAILS ON MAIN WIREWAY PRINT SUCH AS CABLE MARKINGS AND THEIR INTERPRETATIONS, POWER, LIGHTING, FIRE CONTROL, I.C., AND RADIO.

a. Identify the different circuits, noting service they perform and where they will be found aboard a ship.

b. List in small notebook all I.C. and fire control circuits, cable data and stuffing tube hole data and any other information that may be helpful.

c. Study prints of various types of hangers, in order to visualize types of hangers used in different cable runs.

3. OBTAIN BLUEPRINTS COVERING ALL THE CIRCUITS AND LIST EACH CIRCUIT INDIVIDUALLY.

a. Start with the lighting circuit.

b. Locate the bulkheads in the section selected.

c. Begin with the forward bulkhead of the section and consider this as the source of the cables that enter the section.

Note: The source of the remaining cables will be at the point where above cables start. The place or point where the cables stop or leave the section will be the cable destination.

d. When listing the cables, show the number of the frame or bulkhead of the cable source and destination.

1) If the destination of the cables is a box, show the kind of box and its location.

2) If the destination is a tube area, show direction, whether up or down, and location of the area, frame number, port or starboard or C/L, whichever the case may be.

e. Omit the local runs when laying out main runs. They are to be put in later.

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B. **Procedure** (continued)

f. List the cables in the following manner:

Cable	Kind	Circuit	Source	Destination
THFA3	Light	1-FB-10 2	BLK #159	BLK #183
THFA3	Light	FB-10 2	BLK #159	Fr. 170-2K box C/L
THFA3	Power	F-426	BLK #159	BLK #183
THFA3	Power	F-326	BLK #159	BLK #183
THFA3	Power	F-434	BLK #159	Fr. 170-up C/L
MHFA10	I.C.	LD#C-LC25	BLK #159	Fr. 166-20 wire box
MHFA4	F.C.	LD#G-GU5	BLK #159	Fr. 170-up C/L
MHFA19	Radio	LD#R-RRB	BLK #159	Fr. 180-Term. outlet

4. RE-ARRANGE THE ABOVE LISTING TO SUIT THE BRANCHING OFF OF THE CABLES.

a. Arrange the cables so that the through cables will extend to the outboard of the run. The next longest group of cables will follow the through cables.

b. Place each cable in its proper place with respect to the farthest aft.

Cables Listed to Suit Branching off of the Cables

Cable	Kind	Circuit	Source	Destination
THFA3	Light	1-FB-102 BLK	159 BLK 183	
THFA3	Light	FB-102	BLK 159	Fr. 170-2K box C/L
THFA3	Power	F-426	BLK 159	BLK 183
THFA3	Power	F-326	BLK 159	BLK 183
THFA3	Power	F-434	BLK 159	Fr. 170-up C/L
MHFA10	I.C.	LD C-LC25	BLK 159	Fr. 166-20 wire box
MHFA4	F.C.	LD G-GU5	BLK 159	Fr. 170-up C/L
MHFA19	Radio	LD R-RRB	BLK 159	Fr. 180-Term. outlet

5. MAKE A COMPOSITE LIST OF THE CABLES IN TEE ABOVE ORDER.

a. Place the through cables, light, power, I.C., fire control, and radio to the outboard of the run, and place the remainder of the cables according to their branching-off point.

B. **Procedure** (continued)

Composite Listing

Cable	Kind	Circuit	Source	Destination
THFA3	Light	1-FB-102	BLK 159	BLK 183
THFA3	Power	F-426	BLK 159	BLK 183
THFA3	Power	F-326	BLK 159	BLK 183
MHFA10	Radio	LD R-RRB	BLK 159	Fr. 180-Term. outlet
THFA3	Power	F-434	BLK 159	Fr. 170-up C/L
THFA3	Light	FB-102	BLK 159	Fr. 170-2K box C/L
MHFA4	F.C.	LD G-GU5	BLK 159	Fr. 170-up C/L
MHFA10	I.C.	LD C-LC25	BLK 159	Fr. 166-20 wire box

6. MAKE A COMPOSITE DRAWING OF THE ABOVE LISTING.

a. Obtain the following supplies:

Drawing board	Triangle
T-square	Thumb tacks
Pencils	Eraser
Paper	

b. Make a drawing from the composite listing, showing bulkheads, boxes, tube areas, etc.

Note: Make sure to properly name each cable.

7. MAKE A DRAWING OF THE CABLRS IN RACK AT BULKHEADS.

a. Check main wireway to determine the type of hangers to use.

b. Look up the type on blueprint.

c. Study this type carefully, noting all details.

d. Make a sketch of this type of hanger and show cables in their proper location.

8. LAY OUT TUBE AREAS.

a. Secure shipfitters print covering the bulkhead to be considered.

b. Check carefully for size of area.

c. Check to see if the tubes are put directly into the bulkhead, or if a plate is cut out.

d. Check the kind of plate (lap of insert).

e. Check the kind of tubes to be used.

f. Refer to tube and hole chart to obtain proper sizes.

B. **Procedure** (continued)

g. Lay out an area on paper the proper size.

h. Arrange tubes to fit into the area, keeping as near as possible the same location as that in which the cables lay in the rack.

i. Have no crosses at the area.

j. Do not allow cables to cross one another from one side to the other. However, cables may change tiers by either dropping down or going up.

k. When the area has been properly arranged to suit the cables, make a permanent layout of the area on heavy cardboard by drawing circles the actual size and spacing of the tubes and printing the cable and tube designation within each circle.

l. In laying out cables in the machinery spaces, keep all large cables to the inboard of the rack, and all through cables on the bottom tiers.

m. In the rest of the ship, keep through cables to outboard of rack and on bottom of tiers.

n. Where possible, arrange cable grouping as shown below:

Power Light	) Together
I.C. F.C.	) Together
Radio	) Alone

o. Maintain polarity of single-conductor cables in order to avoid magnetic loops for all D.C. circuits. Negative and positive leads should **never** exceed 12-inch spacing; that is, D.C. circuits should be neutralized at all times.

p. Use multi-conductor cable when practicable; that is, duplex for single phase and triplex for 3 phase.

Note: When for special reasons it is necessary to run separate phase leads, the individual leads for the single or 3-phase circuits should be kept as close together as possible throughout their lengths. They should be twisted together not greater than 16 times the pitch diameter. Single-conductor cables carrying A.X. should not be grouped in the same hangers with cables carrying D.C.

II. CABLE TYPES AND USES

TYPE SLPP AND SLPA--These letters refer to single lighting and power plain, and single lighting and power armored. This cable ranges from 4,000 to 1,500,000 circular mils in approximate cross-sectional area. The smallest size, approximately 4,000 circular mils, consists of the single-stranded conductor, a layer of 40 per cent rubber, a layer of rubber-filled tape, and a cotton braid. Type SLPA has, in addition, an outside layer of basketweave armoring.

All cable of these two types with the exception of the smallest size is made differently. These cables consist of the stranded conductor, varnished cambric insulation, rubber-filled tape, reinforced rubber sheath, rubber-filled tape, and a cotton braid. The armored variety of these larger sizes has a basketweave metal armoring in place of the cotton braid.

Plain cable is to be used in turret columns and like installations where **flexibility** is important. The armored type, SLPA, is used in **permanently installed** lighting and power leads throughout the vessel where a single conductor is required.

TYPE SRLL--This is a single-conductor, low-tension, lead-sheathed cable for **radio** use only.

TYPE SRHLA--This is a single-conductor, low-tension, lead-sheathed cable for **radio** use only.

TYPE DLPP AND DLPA--This is a duplex cable for lighting and power use, and may be obtained either plain or armored. As in the case of the single conductor of this type, the smallest size is manufactured differently from the larger sizes, The smallest size, approximately 4,000 circular mils, consists of two conductors, each one of which has a layer of 40 per cent rubber insulation and a layer of rubber-filled tape. The largest size is 400,000 circular mils. (SLPA insulation is in the same sizes, from 4,000 circular mils to 1,600,000 circular mils.) These two conductors are twisted together. Dry jute filler is used to obtain circularity of cross section. The conductors are then covered with a layer of rubber-filled tape, a layer of 40 per cent rubber, another layer of rubber-filled tape, and a cotton braid. In the case of the armored variety, a basket-weave metal armoring is used instead of the cotton braid.

The larger sizes run from 9,000 to 60,000 circular mils approximate cross-sectional area. In these sizes, each conductor is covered with varnished cambric. The two conductors are then twisted together and filled with jute, as in the smallest size described above. The conductors are then covered with a double layer of varnished cambric tape half lapped, a layer of rubber-filled tape, and a cotton braid. In the armored variety, the cotton braid is replaced with basket-weave metal armoring.

The plain variety of this cable shall only be used in **special or approved installations**. The armored variety is used throughout the vessel for **permanently installed** lighting and power leads where a duplex cable is required.

In general, duplex cable of approximately 60,000 circular mils or less is to be used in preference to two leads of the single cable. Referring to the table of limiting current capacities, note that the single cable is to be used for cable sizes larger than the 60,000 circular mil type.

TYPE DLB--This duplex, lighting, braided cable consists of two conductors, each covered with a layer of 40 per cent rubber and a layer of rubber-filled tape. The two conductors are then twisted together using dry jute as a filler. The next layer is a layer of rubber-filled tape followed by an outside covering of cotton braid. This cable should not be used for permanently installed lighting leads.

TYPE DRHLA--This duplex, high-tension, leaded and armored cable has a very high insulation resistance and is to be used only on **high-tension** circuits.

TYPE TRLL--This twin conductor, low-tension, lead-sheathed cable is for **radio** use only.

TYPE TRHLA--This triplex, high-tension, leaded and armored cable, like the duplex variety, has a very high insulation resistance and should be used only for **radio** work.

TYPES TLPP AND TLPA--This triplex cable is for lighting and power use. Each conductor is twisted together, using dry jute to maintain circularity of cross sections. The group of conductors is then covered with rubber-filled tape, a layer of 40 per cent rubber, a second layer of rubber-filled tape, and a cotton braid. The armored variety is covered with a basket-weave metal armoring in place of the cotton braid. The above description refers to the smallest size, approximately 4,000 circular mils, of the triplex cable. The larger sizes, from 9,000 to 60,000 circular mils, inclusive, are prepared as follows:

Each conductor is covered with varnished cambric. The three conductors are then twisted together, using dry jute as a filler. The group of conductors is then covered with a double layer of varnished cambric tape, half lapped. This is followed by a layer of rubber-filled tape, a rubber sheath, a layer of rubber-filled tape and a cotton braid. In the case of the armored variety a basket-weave metal armoring is used instead of the cotton braid.

The triplex plain cable is used for leads only in **special or approved installations**. The triplex armored variety is used for **permanently installed** lighting and power leads which require a three-conductor cable.

TYPE FLB--This four-conductor braided cable is for lighting use. Each conductor is covered with a 40 per cent rubber insulation and a layer of rubber-filled tape. The four conductors are then twisted together, using dry jute filler. The group of conductors is then covered with a layer of rubber-filled tape and cotton braid. This braided cable is **not** to be used for permanently installed lighting leads.

TYPE FLP--This is a four-conductor plain cable for lighting use only. It is similar to Type FLB except that the group of conductors is covered with a layer of rubber-filled tape, a reinforced rubber sheath, a layer of rubber-filled tape, and a cotton braid. This cable shall be used for leads only in **special or approved installations**. The maximum current carrying capacity is 10 amperes.

TYPE FLA--This four-conductor armored cable is for lighting use only. It is similar to Type FLP except that a basket-weave metal armoring is used instead of the cotton braid. This cable shall be used for all **permanently installed** lighting leads throughout the vessel which require **four** conductors. The maximum current-carrying capacity of this type is 10 amperes.

TYPE FPC--This is a flame-proof cable. This cable consists of a single conductor covered with an asbestos layer and an asbestos braid which has been made flame proof by a special cement.

TYPES GICP AND GICA--This is a multiple-conductor cable for general interior communication use. The smallest size consists of two conductors. Each stranded conductor is covered with a cotton thread, a layer of 40 per cent rubber, and cotton braid. The two conductors are then twisted together, using dry jute as a filler. The group of conductors is then covered with rubber-filled tape, 40 per cent rubber insulation, rubber-filled tape, and a cotton braid. The armored variety of this cable is covered with a basket-weave metal armoring in place of the cotton braid.

The larger cable for interior communication use contains 4, 7, 10, 14, 19, 22, 26, 30, 37, and 40 conductors per cable. Each conductor is prepared in the same way as the conductors in the twin cable. The conductors are then twisted together in layers. The direction of lay for successive layers of conductors is alternated. One conductor in each layer is solid color: red, black, or green. The group of conductors is covered with rubber-filled tape, reinforced rubber sheath, rubber-filled tape, and a cotton braid. The armored variety of this cable is covered with a basket-weave metal armor instead of the cotton braid.

Type GICA cable is used for all permanently installed interior communication and fire control leads which operate at a pressure **less than 600 volts**. The plain variety of interior communication cable is for use in the center column of turrets where **flexibility** is most important and as leads to instruments mounted on guns where the cable is led through the center of the gun mount.

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TYPES TPTP AND TPTA--This twisted pair, plain and armored telephone cable, is for use where the circuit operates below 50 volts. Each conductor consists of a single untinned copper wire covered with enamel, silk, and cotton. Each pair of conductors is twisted together. The smaller size cable of this type has one pair of conductors; the next larger size has three pairs of conductors. These pairs are twisted together and then covered with a layer of varnished cambric. The next layer is rubber-filled tape, followed by 40 per cent rubber insulation, rubber-filled tape, and a cotton braid. In the armored variety a basket-weave metal armoring is used instead of the cotton braid. The next larger size of this type cable contains 5 pairs of conductors and the succeeding sizes contain 10, 15, 20, 25, 30, 40, 50, or 60 pairs of conductors. In all these larger sizes the several pairs are twisted together in layers. The direction of lay is alternated for successive layers. One conductor of one pair in each layer shall be marked with a solid color--red, black, or green. This group of conductors is then covered with a layer of varnished cambric and a layer of rubber-filled tape. The next layer is reinforced rubber sheath, followed by a layer of rubber-filled tape and a cotton braid. The armored variety is covered with a basket-weave metal armor in place of the cotton braid.

In general, Type TPTA cable is used for all **permanently installed** leads for the telephone system. Type TPTP cable is used in the center column of turrets where **flexibility** is important and as leads to instruments mounted on guns where the cable is led through the center of the gun mount.

TYPE TCP--This is a telephone cord, plain, with two or three conductors.

TYPE TCP-1--This is an extra flexible, ship's service, two-conductor cord for **connecting transmitters and receivers to the reel**. Each conductor consists of 12 very fine copper strands covered with silk and copper braid. One conductor has a green and the other an orange marker thread. They are twisted together with white cotton filler cord and covered with a flexible black cotton braid. TYPE TCP-2--This is a two-conductor cord for **fire control telephone** use. Each conductor consists of three wires of tinned steel or bronze twisted at the center of a group of nine wires of tinned copper. This conductor is covered with cotton thread, rubber insulation, and a red or black cotton braid. One red and one black conductor are then twisted together using jute as a filler. The group of conductors is then covered with a rubber insulation and a glazed black cotton braid. TYPE TCP-3--This is a three-conductor cord for **fire control telephone** use. This cord consists of three conductors similar to those described above in Type TCP-2. Each conductor is covered with cotton thread and a rubber insulation, followed by a cotton braid of red, black, or yellow. One conductor of each color is used to make the cable. After three colored conductors are twisted together, they are covered with a 40 per cent rubber insulation and a glazed cotton braid.

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TYPE TCS--This is a sheathed telephone cord and may be obtained with two or three conductors.

TYPE TCS-1--This is a two-conductor type. Each conductor consists of three wires of tinned steel or bronze about which are wrapped nine wires of tinned copper. This conductor is covered with cotton thread, rubber insulation, and a red or black cotton braid. One red and one black conductor are twisted together and covered with a rubber sheath.

TYPE TCS-2--This is similar to Type TCS-1 except that it consists of three conductors, colored red, black, and yellow. Types TCS-1 and TCS-2 telephone cord are used where highest flexibility and the smallest diameter of cord are **not** important.

TYPE PCP--This is a portable cord, plain, and may be obtained as a two-conductor, four-conductor, or five-conductor cord. There are three sizes of the two-conductor cord; namely, 1,400, 2,600, and 4,100 circular mils.

Type PCP cable is used for leads connecting outlets to electric fixtures of the **semi-portable type**, such as boom, steering, anchor, peak, blinker, and running lights; also for leads connecting outlets to such fixtures as fans, portable blowers, electric tools, and portable lighting units.

TYPE PCP-1--This is the 1,400 circular mil two-conductor cord. Each conductor consists of 14 copper wires twisted together and covered with cotton and rubber insulation. The pair of conductors are then twisted together and finally covered with a tough rubber sheath.

TYPE PCP-2--This is the 2,600 circular mil cord. It is similar to type PCP-1 except that it contains 26 copper wires instead of 14.

TYPE PCP-3--This is the 4,100 circular mil, two-conductor cord. It is similar to the other two conductor cords except that each conductor consists of 41 copper wires twisted together.

TYPE PCP-4--This is a four-conductor cord, of 1,400 circular mil cross section. Each conductor is prepared the same as the conductor of Type PCP-l. The four conductors are covered with different colored cotton braid and then twisted together. The group of conductors is covered with a tough rubber sheath.

TYPE PCP-5--This is the five-conductor cord and is also a 1,400 circular mil cord, but consists of five conductors. Otherwise it is similar to Type PCP-4.

TYPE GRC--This is a multiple-conductor cable for **gyro repeater** use, and may be obtained with 7, 10, or 12 conductors. Each conductor consists of 14 copper wires twisted together and covered with cotton thread, rubber insulation, and a cotton tape. The whole group is then covered with a tough rubber sheath.

TYPE BW--This is bell wire and consists of a seven-wire conductor covered with cotton thread, and a rubber insulation, before being finally covered with a waterproof cotton braid.

Type BW cable is for use where high flexibility is not required, for instrument wiring, and for miscellaneous small wiring of switchboards and panels.

TYPE BC--This is known as bell cord. Each conductor consists of 26 copper wires twisted and covered with cotton thread followed by a rubber insulation. The conductor is next covered with a braid of silk, colored green. Both conductors are then twisted together to form the bell cord. Bell cord is used as a flexible lead connecting outlets to push buttons and such other applications as may be **specifically approved by the bureau**. If it is desired to use three conductors, Type BC-3 may be used. This is exactly the same as Type BC-2 except that three conductors are used instead of two.

TYPE IW--This ignition wire consists of a single conductor of 19 copper wires, covered with a rubber insulation and a braid which will resist oil, gasoline, water, ozone, and weather.

This cable shall be used **exclusively** for wiring internal combustion engines.

TYPES SHFA, DHFA, THFA--Conductors same as L.P. type.

Insulation as per copper conductor:	)
Felted asbestos	)
Varnished cambric	) Conductor
Felted asbestos	)
	)
Felted asbestos	)
Special impervious sheath armor	) Cable
	)

TYPES MHFA AND MHFP--These are the same as GICA and GICP, but insulation is the same as I.D. and THFA.

III. CABLE TYPES WITH ABBREVIATIONS

Abbreviation	
SICP	Single instrument cable, plain
SLPP	Single light and power, plain
SLPA	Single light and power, armor
SRLL	Single radio low tension, lead and armor
SRHLA	Single radio high tension, lead and armor
SHFP(3)	Single heat and flame resistant 3KV propulsion
SHFP(5)	Single heat and flame resistant 5KV propulsion
SHFS	Single heat and flame resistant SW bd. and panel wire
SHFW	Single heat and flame resistant wire
SRIG	Synthetic resin insulated glass braid
SRIB	Synthetic resin insulated, braided
SFPP	Single flame proof, plain
SFPA	Single flame proof, armor
SFPS	Single flame proof, switchboard wire
SHFA	Single heat and flame resistant, armor
DHFP(3)	Double heat and flame resistant 3KV propulsion
DHFP(5)	Double heat and flame resistant 5KV propulsion
DCOP	Double conductor oil resistant, portable
DLPP	Duplex lighting and power, plain
DLPA	Duplex lighting and power, armor
DLB	Duplex lighting, braided
DRHLA	Duplex radio high tension, lead and armor
DFPP	Duplex flame proof, plain
DFPA	Duplex flame proof, armor
DHFA	Duplex heat and flame resistant, armor
THFP(3)	Triple heat and flame resistant 3KV propulsion
THFP(5)	Triple heat and flame resistant 5KV propulsion
TCOP	Triple conductor oil resistant, portable
TTHFF	Twisted pair telephone heat and flame resistant, flexible
TRLL	Twin radio low tension, lead
TLPP	Triplex light and power, plain
TLPA	Triplex light and power, armor

TRHLA	Triplex radio high tension, lead and armor
TPTF	Twisted pair telephone, flexible
TFPP	Triplex flame proof, plain
TFPA	Triplex flame proof, armor
TSW	Telephone switchboard wire
TPTA	Twisted pair telephone, armor
TPTP	Twisted pair telephone, plain
THFA	Triplex heat and flame resistant, armor
TTHFA	Twisted pair telephone heat and flame, armor
FCOP	Four conductor oil resistant, portable
FLB	Four conductor lighting, braided
FLP	Four conductor lighting, plain
FLA	Four conductor lighting, armor
FFPP	Four conductor flame proof, plain
FFPA	Four conductor flame proof, armor
FHFA	Four conductor heat and flame resistant, armor
MCOS	Multi conductor oil resistant, portable

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Abbreviation

MUFF	Multi conductor heat and flame resistant, flexible
MFPP	Multi conductor flame proof, plain
MFPA	Multi conductor flame proof, armor
MHFA	Multi conductor heat and flame resistant, armor
MCMB	Multi conductor marker buoy
GICP	General Interior Communication, plain
GICF	General Interior Communication, flexible
GICA	General Interior Communication, armor
BW	Bell wire
BC	Bell cord
VLS	Volt meter leads sub
SCP	Single conductor, portable
DCP	Double conductor, portable
TCP	Triple conductor, portable

FCP	Four conductor, portable
MCP	Multi conductor, portable
MCS	Multi conductor, shielded
PCP	Portable cord, plain
GRC	Gyro repeater cable
325AB	Single conductor sound cable, R.C.
325AD	Twin conductor sound cable, armor
325 J	Twin conductor sound cable, lead and armor
325 K	Twin conductor sound cable, rubber cover
325 L	Five conductor sound cable, rubber cover
325 M	Five pair sound cable, lead and armor
325 N	Four conductor sound cable, rubber cover
325 Z	Twin conductor sound cable, rubber cover

Note: The prefix letter on all cables indicates the number of conductors in the cable except the "M" and "GIC" cables.

The suffix numeral on all cables except the "M" and "GIC" cables represents the size of the conductor in 1000 circular mils. On the "M" and "GIC" cables, the suffix numeral represents the number of conductors in that cable. The size of wire on all "M" and "GIC" cables is number 3 Navy or 3000 circular mils.

IV. STANDARD CONDUCTORS BEFORE INSULATING

Nearest A W G	NAVY standard size designation copper conductor	Number of strands	Nominal strand diameter in inches	Diameter over stranded conductor in inches	Area of stranded conductor in cir. mils
22	3/5	1	.0250		642
23	1/2	21	.0050	.028	525
20	1	19	.0070	.036	950
20	1	1	.0320		1,024
20	1	7	.0126	.039	1 120
18	1-1/2	1	.0400		1,600
18	1-1/2	16	.0100	.049	1,616
18	1-1/2	41	.0063	.049	1,640
16	2-1/2	1	.0510	.051	2,601

16	2-1/2	26	.0100	.061	2,626
15	3	7	.0200	.061	2,828
15	3	19	.0126	.065	3,040
14	4	1	.0640	.064	4,110
14	4	7	.0250	.076	4,494
14	4	41	.0100	.077	4,141
13	5	19	.0159	.080	4,826
12	6	1	.0810	.081	6,530
12	6	19	.0179	.090	6,088
12	6	65	.0100	.097	6,565
11	8	1	.0910	.091	8,280
10	9	7	.0360	.108	9,030
10	9	90	.0100	.120	9,090
9	13	1	.1140	.114	13,100
9	14	7	.0450	.136	14,350
9	14	140	.0100	.145	14,140
7	21	1	.1440	.144	30,736
7	23	1	.0570	.171	22,820
7	23	226	.0100	.180	22,826
5	30	19	.0400	.202	30,780
5	30	304	.0100	.330	30,400
4	40	19	.0450	.226	38,950
4	42	209	.0140	.260	42,218
		(19 x 11)			
3	50	19	.0510	.254	49,020
2	60	37	.0400	.282	59,940
1	75	37	.0450	.317	75,850
0	100	61	.0400	.363	98,820
00	125	61	.0450	.045	125,050
000	150	61	.0510	.547	157,380
000	153	760	.0140	.500	153,520
		(19 x 40)			
0000	200	61	.0570	.514	198,860
	250	61	.0640	.577	250,710
	253	1254	.0140	.660	253,310

		(19 x 66)			

Nearest A W G	NAVY standard size designation copper conductor	Number of strands	Nominal strand diameter in inches	Diameter over stranded conductor in inches	Area of stranded conductor in cir. mils
	300	91	.0570	.628	296,660
	400	127	.0570	.742	414,020
	400	2,052	.0140	.825	400,500
	500	127	.0640	.833	521,970
	650	127	.0720	.936	657,860
	672	3,330	.0140	.985	672,660
		(37 x 90)			
	800	127	.0810	1.051	829,310
	814	4,033	.0140	1.255	814,666
	1000	127	.0910	1.187	1,046,000
	1600	127	.1140	1.480	1,662,000

V. COLOR CODE FOR TTHFA

New Synthetic Insulation

1	White	other wire	Blue
2	White	other wire	Orange
3	White	other wire	Green
4	White	other wire	Brown
5	White	other wire	Slate
6	White	other wire	Black
7	White	other wire	Red
8	White	other wire	Yellow
9	White	other wire	Purple

10)
to) Blue is paired with 2 to 9
17)

18)
to) Orange is paired with 3 to 9
24)

25)
to) Green is paired with 4 to 9
30)

31)
to) Brown is paired with 5 to 9
35)

36)
to) Slate is paired with 6 to 9
39)

40)
to) Black is paired with 7 to 9
43)

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VI. INSTALLATION NOTES FOR ELECTRICAL EQUIPMENT
Standard Naval Practice

1. All motor controllers, distribution panels, and similar apparatus (except switchboards and switchboard panels which have special installation requirements) shall be installed at a height so that either the bottoms of the enclosing cabinets shall be not less than five feet, or the top not more than seven feet above the deck.

2. All hand-operated appliances, including distribution boxes with switches, individual switches, receptacles with switches, push buttons, jack boxes, etc., shall be installed on bulkheads at a height of not more than six feet above the deck.

3. Connection boxes, feeder connection boxes, feeder distribution boxes, feeder junction boxes and distribution boxes without switches may be installed overhead, provided the deck height does not exceed nine feet, and the minimum-head room under the appliances is not less than seven feet.

4. All controllers, panels, and apparatus shall be so installed that they are completely accessible for operation repairs, renewal of fuses, testing, maintenance, etc.

5. All watertight and explosion-proof electric wiring equipment shall be fitted with standard terminal tubes for the entrance of cables. When the equipment has aluminum cases, the terminal tubes shall be aluminum. In installing aluminum tubes in aluminum boxes, the terminal tubes shall be threaded into the boxes until the shoulder of the tube touches the side of the box. The end of the threaded part of the tube shall be flush with the inside wall of the box. The aluminum thread of box and terminal tube shall be coated with an anti-seize compound of petrolatum and zinc dust.

6. The entrance of cables through the bottom of vertically installed non-watertight appliances shall be avoided where side or top entrance is practicable and involves no undue increase in wiring. Care shall be taken, however, that the saving in weight intended by the use of such non-watertight appliances is not offset by the installation of additional cable lengths to avoid bottom entrance to the cable for such appliances. Where cables do enter the top of non-watertight fittings, standard terminal tubes shall be used.

7. Cables shall be carried into the side of such appliances so that they are maintained to their full diameter at least flush with the inside surface of the box wall.

8. Cables entering watertight appliances shall use standard terminal tubes except that where such appliances are used in connection with a non-watertight installation, cable clamps shall be used, unless modified by note No. 6.

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9. All unused outlets in watertight junction boxes, distribution boxes, feeder distribution boxes, etc., shall be tapped and plugged. Standard Brass I.P.S. plugs shall be used in composition boxes and galvanized steel I.P.S. plugs in aluminum boxes.

10. The installation of lighting fixtures shall not be made until the general arrangement of all other fittings, furniture, etc., has been decided upon and they shall be in complete accordance with the final arrangement of structural material, fittings, furniture, etc., within the compartment. In cases where lighting units are installed to satisfy contemplated arrangement of structural material, fittings, furniture, etc., and such arrangement is later changed on the vessel, the location of lighting units shall be changed to suit. Fixtures shall be accessible and shall be so installed that illumination is not interfered with by ventilation ducts, pipes, cables or other overhead fittings and equipment.

11. In storeroom, issuing room, and commissary spaces, particular attention shall be given to the location of lighting units in order that these units will be in the center of aisle spaces and not on top of bins, fittings and equipment, etc., and that the maximum illumination valves may be obtained in the working spaces.

12. In crew and C.P.O. berthing spaces, lighting fixtures shall be located in the aisle between berths; however, particular attention shall be paid to the stowage of lifebelts.

13. In mess spaces, particular attention shall be given to the location of lighting fixtures so as to properly illuminate mess tables.

14. In general, all switches controlling lights shall be located near the access and shall be about four feet six inches above the deck, with the exception of the switches for blue light bulkhead lights which shall be nippled to the fixture.

15. Where switch and single receptacles or switch and double receptacles are fed from distribution boxes with switches, the switch in the distribution box shall be blanked. The switches shall also be blanked for feed to relay operated howlers, single phase indicators on control panels or for similar alarm units.

16. In connection with the installation of lighting fixtures in machinery spaces, fireroom, and other hot spaces, consideration should be given to the tightening of the supporting screws for the sockets in order to prevent the splitting of the insulation due to too much tension.

17. In congested areas and elsewhere if required, stuffing tubes shall be staggered on either side of bulkhead; that is, alternate tubes are to be located on each side of bulkhead to allow more space for welding.

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18. Cable hangers shall be spaced a maximum of sixteen inches center to center, and cables passing through deck beams or stiffeners shall be supported at a distance not to exceed eight inches on both sides of the deck beam or stiffener.

19. All permanently installed cables shall be secured to decks and bulkheads by standard methods. Special attention shall be given to the support of heavy banks of cable. Where practicable and except where otherwise specified, cables shall be run on bulkheads in preference to overhead on the under side of deck.

20. Where cables pass through non-watertight bulkheads or beams of over 1/4 inch thickness, no stuffing tubes shall be used, but the holes therein shall be drilled slightly larger than the cable and the edges rounded off to prevent chafing of the leads. Where the non-watertight bulkheads or beams are 1/4 inch and under in thickness, standard or special bushings shall be used. On all non-watertight bulkheads where sharp bends occur in the cable immediately after passing through such holes, standard or special bushings shall be used.

21. In food handling or storage spaces, cable hangers shall be bracketed away from flat surfaces and the cable runs restricted to single layers, unless otherwise specifically approved, to enable spraying for insect control.

22. Main wireways and through cable runs shall be so arranged that the cable will not be disturbed by disassembly or removal of machinery.

23. Care should be exercised to avoid the grouping together cable of different voltage and phase relationship and different service application, power, interior communication, telephone, etc., in such a manner as to pile up electrical or magnetic stresses or interfere with the proper functioning of the electrical circuits involved.

24. a. If any other lead is practicable, electric cables shall not be led into or through the following spaces, nor in spaces adjacent thereto, which are ordinarily open to such spaces when powder is being handled:

1) Powder magazine and other spaces where powder is stored.

2) Powder handling rooms and gun chambers and other spaces where exposed powder is handled.

3) Warheads, depth charges, mine charges, and aerial bomb magazine and other T.N.T. magazines.

b. If cables are run through the above spaces, they shall in every case be of armored type and shall be of unbroken length within the space. If led into the above spaces, they shall be of unbroken length to the fixture at which they terminate.

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c. Cables which are led into or through the above spaces shall be run overhead where practicable, in which case they shall be strung in clips so spaced as to prevent droop.

d. Where it is necessary to run cables along or down a bulkhead, they shall be protected against mechanical injury, if required by inspector, by a non-watertight five-pound steel casing. The casing surrounds the electric cables in magazines and other spaces in which ammunition is handled. Suitable air space shall be provided between the above protective casing, bulkhead, or deck and the cable, with openings or holes in the casing as may be necessary to ventilate the air space itself. Adequate drainage will be provided for casing located on the floor.

25. Wherever circuit trunking cable runs are installed for two electrical systems, one of which is auxiliary or secondary to the other, or emergency for the other, the trunking of the cable shall be such that the two systems are maintained as widely separated in the vessel as is possible in order to reduce the likelihood of damage to both from the same causative agency. Where multiple stations are installed to provide secondary control, in case of damage to one or more station, the cable leading to each station shall be separated as much as possible throughout their entire length.

26. Cables which are installed where they will be subjected to mechanical injury in service shall be

protected within such exposure zones by suitable metal casings.

27. Where required, the protection of leads passing through decks shall be in accordance with standard methods by means of conduits (kick pipes) forming a part of the stuffing tube. Such kick pipes shall be fourteen inches in height except in special cases where a deviation from the type is specifically approved. The height of all kick pipes installed in one group shall be uniform.

28. Where eight or more cables are installed through a deck other than a weather deck, a community riser shall be provided in lieu of kick pipes. On weather decks kick pipes shall be used exclusively unless otherwise specifically approved.

29. Where four or more cables are run through decks or bulkheads with insulation, the insulation shall be cut away and short stuffing tubes used. In installations of less than four cables, stuffing tubes of a length suitable to pass through the insulation shall be used.

30. The run and grouping of cables shall be such as to avoid inaccessible pockets of sufficient size to provide harborage for rats. Cables shall be hung away from structural members parallel to the cable run that would form pockets and partially conceal spaces so that top surfaces may be readily inspected and kept clear of nesting material. Where cables pass through trunks or ducts, either the clearances of the duct or trunk shall be kept to less than one-half inch or the ends of the duct or trunk

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shall be protected by rat wire. In cases where structural or other conditions interfere with the above type of installation, special ways and means of accomplishing rat proofing shall be given a thorough study in order that the final layout shall be such that rat proofing requirements are accomplished insofar as practicable.

31. All cables on bulkheads in the following areas shall be mounted so as to provide a space approximately 3/8 inch between bulkheads and cable in order to allow condensation to run down bulkhead and not collect in back of cables:

a. Crew's washrooms

b. Officers' shower room

c. Engine room

d. Fire rooms

e. Underwater sound room

f. Steering geer room

g. Laundry

h. Galley

i. All bulkheads and areas exposed to weather

32. In connection with the installation of cables through bulkheads and decks, the cables should be arranged in such a manner that adequate inspection shall be provided between all cables in connection with the elimination of nesting material and rat harborage.

33. If any other lead is practicable, electric cables shall not be installed under such conditions or in such locations as may cause it to be subjected to excess heat. The following conditions and locations shall be considered as falling within this category:

a. Boiler rooms

b. Over, or in too close proximity to, turbine steam piping or other hot locations in engine room.

Note: Unless otherwise specifically approved in each individual case, electric cables shall not be located within the vicinity of super-heated steam piping or machinery. Such cables shall be kept as far as practicable from the hot surfaces and **in no case closer than three feet**.

c. Over, or in too close proximity to, resistors, rheostat, transformer or other heat-dissipating appliances of the electrical system.

34. If there is any practicable alternative, cable runs shall not be made over boilers or in the upper portion of boiler room, or in any other location where, under certain operating conditions, the cables may be blanketed with very hot air.

35. In general, and except where otherwise specifically approved, cable runs shall be made along bulkheads in the lower portion of boiler room so as to take advantage of ambient temperature conditions.

36. Horizontal runs shall be utilized to the greatest extent practicable in order to reduce the tendency of the cable lubricant or saturant to migrate.

37. Where such cable runs cannot be avoided, cable leads over or in too close proximity to turbine steam heater, steam piping, electric resistors, rheostats, etc., and other heater apparatus shall be provided with suitable heat insulating barriers.

38. In general and where it is practicable to avoid same, electric cables shall not be installed adjacent to fire mains, water and steam pipes and other apparatus or piping which may cause injury to the cable by leaks, flooding or drip. Where such proximity is unavoidable, the cable shall be provided with suitable drip-proof protection overhead or other suitable barrier against water.

39. All cables exposed to radio frequency fields, also all cables entering and within radio spaces (including portable cables to deck fixtures, bracket fan, etc.) shall be of the metal-armored type or metallicly shielded throughout their entire length, the shielding to be grounded.

40.

a. Where cables enter non-watertight or molded Phenolic fixtures and appliances which are exposed to radio frequency fields, grounding shall be accomplished by cleaning the armor of the cable at the point the securing clamp is fastened, and grounding the clamp to the ship's structure with 3/8" x 1/16" aluminum strap.

b. In the use of metallic fixtures and fittings fitted with terminal tubes, the armor of the cable will be grounded by inserting as the last ring a ring of flexible metallic packing.

c. In all cases the ground connection shall be painted immediately after installation.

41. In the handling of electric cable both prior to and during its installation aboard ship, care shall be taken to avoid abrasions, crushing by blows or by bending too sharply without aid of mandrel or other device, particularly where the cable is very cold. Also the contact of cables with water and/or lubricating oil or grease shall be carefully avoided. No damaged cables shall be installed and any cable damaged during or subsequent to its installation aboard ship shall be removed and replaced by satisfactory cable. The minimum safe bending temperatures are as follows:

a. 40° F. for cable Dia. up to 1-1/4"

b. 50° F. for cable Dia. larger than 1-1/4", but less than 2"

c. 55° F. for cable Dia. over 2"

42. Whenever electric cable is cut into lengths for the purpose of installation, all cut ends, whether on the lengths being installed or on the lengths remaining on reels or in coils, shall be sealed in a suitable manner so as to prevent the entrance of moisture into the interior of the cables via the cut ends. In this connection it cannot be too strongly emphasized that such cut ends are the most vulnerable portions of the cables and any failure to observe the necessary precautions at the proper time may result in the boxing up of moisture entailing subsequent serious hazard.

43. In the case of cable provided with a protective basket-weave metal armor, the ends of such armoring shall be secured in a suitable manner whenever the cable is cut into lengths to prevent the armor from loosening up and springing back from the cut end.

44. All cable entrances in non-watertight appliances shall be made tight against drip or vermin by the use of a suitable compound (Duxseal, Halowax aluminastic) applied to the joints between the cable and the box wall.

45. Solderless-type connectors shall be used for all flame and heat-resistant cable.

46. For solderless connectors, the cable end shall be prepared for the terminal connection by neatly turning back the insulation for the required distance, thoroughly cleaning the individual strands, and then twisting them tightly together before clamping the solderless connector.

47. All terminals for interior communication system shall be solderless type as far as practicable, except as noted below.

48. All terminals for sound powered telephone equipment shall be of the standard soldered type.

49. In connection with the use of soldered terminals, the terminal shall be tightly clamped over the prepared conductor so as to grip it solidly before soldering.

50. Cable insulation and its protective covering shall be intact close up to the terminal. Where the copper conductors have been exposed in making connections the insulation shall be renewed by carefully wrapping the conductor with an approved insulating tape, Phenolic or cord. The cable end and cable

insulation shall be thoroughly saturated and sealed with insulating varnish approved for the purpose. The finished connection shall present a neat and workmanlike appearance. Leads within electrical fittings shall be bound by cord with loops separated by a distance depending on conductor size, and varnished (rubberoid-glyptal).

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51. For all 3-phase 440-volt circuits where the leads are separated they shall be provided with additional insulation consisting of one layer of linen tape thoroughly painted with black insulating varnish. In the case of 440-volt circuits to push buttons, etc., no additional insulation shall be provided over the individual conductors. No additional insulation shall be provided for circuits less than 440 volts except as required by note listed under No. 50 above.

52. Where clamp fittings (Bureau Standard Drawing) are specified, such as used with STD junction boxes, etc., the cable ends shall be bared and the individual strands thoroughly cleaned and twisted together and then soldered to form a neat solid terminal for fitting under the clamp. In order to increase the size of the terminal thus formed in small conductors, the bared strands may be bent back on themselves before being twisted and soldered.

53. Where a connection is to be made under a screw head and the use of a standard terminal is not practicable, a loop or eye shall be formed on the cable end by baring the conductor for the required distance, thoroughly cleaning the wire strands, twisting them tightly together, bending them around a mandrel so as to form an eye of suitable size and dipping the whole eye in the solder so it will form a solid terminal integral with the cable. Graumets may be used on approval.

54. To obtain the greatest degree of compactness practicable, those types and sizes of cable having the smallest permissible radii shall be placed on the inner side of the cable group, allowing cable having larger bending radii to be placed on the outside of the group.

55. Where shorter bends are required for terminal entrances, standard angle type terminal tubes, either forty-five degree or ninety-degree type, shall be used.

56. In the case of horizontal bends of large radii, particularly in such location as might be subject to damage by personnel or by vibration, a suitable mechanical supporting member shall be employed and the cable securely attached thereto at frequent intervals.

57. Special care shall be taken to maintain proper phase relation of all wires from the switchboards to appliances, etc., that is, phase wires A, B, and C shall be similarly connected throughout their length for feeders, mains, submains, and branches.

58. In order to standardize connecting of phase wires to equipment, the following system shall be used on lighting and power cable (three wire) where color coding is used, black to be wire A; white to be wire B;

and red to be wire C.

59. The bus arrangement and connection to switchboards or panels looking at the back of the switchboard or panel shall be A-B-C respectively from left to right, top to bottom, or front to back, the front being the bus nearest to the switchboard panel.

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60. For uniformity in wiring installation, the wiring appliances and front connected panels shall be installed and connected in a manner so that phase rotation facing the appliance or front of the panel shall be A-B-C respectively from top to bottom, right to left, or front to back.

61. The terminals of rotating machines will be marked with phase designation so that when these terminals are connected to the source of supply in the same order; that is, A to A, B to B, and C to C, the rotation of the motor shall be clockwise facing the power end of the machine.

62. For counterclockwise rotation of the motor, phase wires A and B shall be interchanged.

63. **No spliced connections** shall be permitted in the electric plant installation.

64. All steel straps and hanger material except pads and welded studs shall be galvanized after forming. All bolts, nuts, screws, washers, etc., shall be cadium plated, or suitably painted.

65. All aluminum hangers, casings and supports shall be painted with one coat of zinc chromate primer and one coat of aluminum paint as soon as possible after forming, and a second coat shall be applied after assembly and installation on the ship.

66. All faying surfaces of aluminum alloys shall be painted with one coat of zinc chromate primer and allowed to dry, and the fittings separated from the bulkhead or deck by a canton flannel (for light work) or canvas gasket (for heavy work) soaked in zinc chromate iron oxide paint just before installing.

67. All cables shall be painted with one coat of aluminum paint, all painting being done after cables are pulled and before they are strapped down. The painting shall be accomplished by spraying.

68. All aluminum pipe shall be painted with one coat of zinc chromate primer and two coats of aluminum paint.

69. All aluminum castings are painted with one coat of zinc chromate primer and two coats of aluminum paint, and where the zinc chromate primer has been scratched or damaged due to installation, the fittings shall be retouched with zinc chromate primer before the additional coats of aluminum paint are applied.

70. Threads of aluminum pipe shall be coated with an anti-seize compound.

71. Great care shall be taken that electrical insulators are not painted, such as molded or pressed insulation of various forms, cable cleats, etc., which might introduce leakage. Care shall also be taken that gaskets, rubber packing or any jointing of watertight work are free from paint.

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72. Canvas washers for aluminum stuffing tubes shall be soaked in linseed oil or Phenolic Resin varnish and painted with a thick coat of zinc white paste when in contact with steel decks or bulkheads, and shall be soaked in zinc chromate iron oxide paint when installed in contact with aluminum decks or bulkheads.

73. All cables shall be painted as per note No. 89, after which they may be painted to match their surroundings. If no other finishing coat is applied, an additional coat of aluminum paint shall be applied as a final finish.

74. All electrical fittings, fixtures, etc., except molded type (See note No. 77) shall be painted after installation to match their surroundings.

75. All emergency lighting fixtures shall be painted green, except those on molded insulation. Since the latter may not be painted they shall be marked as emergency lighting fixtures by painting a green ring on the structural deck or spring hanger support adjacent to the fixture, or by providing a suitable name plate marked "Emergency Lighting" on or adjacent to the fixture.

76. All ungalvanized steel work in back of cables or boxes shall be painted with one coat of aluminum paint in addition to the priming coat, before the installation of cable.

77. Fixtures of molded insulation shall not be painted other than as required by the following subnotes:

a. Holes drilled in fixtures or boxes of Phenolic material for the entrance of electric cables shall be painted with bakelite varnish immediately after drilling to prevent moisture absorption.

b. Flash edges present in molded electrical fittings shall be painted with bakelite varnish to prevent moisture absorption.

78. Name plates and tags shall be located in readily accessible positions where they can be read at all times without danger to personnel.

79. When a name plate is mounted on a panel or switchboard, it shall be placed in close proximity to the equipment to which it refers and generally either directly above or directly below it.

80.

a. After the drilling operation in the Electrical Shop, the Phenolic pieces shall be cleaned with carbon-tetrachloride and then refinished with a Glyptal or equivalent coating.

b. In all cases where practicable the Phenolic boxes, fixtures, etc., should be covered with some sort of paper jacket after installation to keep the outer surface of the pieces as clean as possible.

c. Upon arriving at the completion point of the compartment, the Phenolic pieces should be wiped with carbon-tetrachloride if considered necessary, and touched up with Glyptal or equivalent coating.

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81. All cables shall be tagged at each point of connection and on both sides of a deck, bulkheads or other barrier. Where cables feed directly to current-consuming devices and do not pass through decks, bulkheads, or barriers, they shall be tagged once, which shall be at the point where they leave the source of supply; however, tags may be omitted from branch leads to outlets in the same compartment fed from boxes, having individual branch circuit name plates which have sufficient identification to trace the lead to the outlet.

82. Cables shall be tagged as close as practicable to the point where the terminals connect to the panels or piece of equipment.

83. Cable tags shall be marked with the feeder, main, submain, or branch circuit designation for lighting and power cables and with the **circuit designation** and **cable number** for interior communication and fire control system.

84. Name plates shall be fastened securely to such parts of machinery or equipment as ordinarily will not be renewed during their service life. The attachment shall be by means of screws, self-threading screws, or steel drive pins.

85. All electrical appliances in the nature of switches, control apparatus, etc., located in another compartment or at a distance from the unit controlled shall be clearly marked with a name plate showing the use and operation of same and the location and ship's designation of the unit controlled.

86. Where power and lighting leads run into a distribution panel the main lugs and buses shall be stamped with the circuit letter and number, and the phase designation. Suitable name plates shall be provided adjacent to the switch handles for all branch circuits on the panel itself, and on the outside of the panel box cover for feeders and panel designation. Terminal lugs shall be marked with the circuit letter and

number, and also with the phase designation in the case of three-conductor cables.

87. The terminals on back of all switchboards shall be marked with the circuit letter and number. Where buses are provided, this marking may be stenciled on the bus.

88. The buses of switchboards need not be marked with the polarity or phase indication as this information will be self-evident from the location of the buses, except that' when a set of bus bars do not constitute a full three-phase supply (a single-phase tap) the buses shall then be marked.

89. All terminal lugs for cables on switchboards and distribution panels shall be marked with a phase marking, A, B, C, (for AC) or plus or minus (for DC).

90. Projecting bus structure in the rear of switchboard shall be protected by insulating material barriers, to prevent personnel from being thrown against live buses by movement of vessel.

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91. In general, all voice tube outlets shall be installed five feet above the deck, except that mouthpiece set at an angle of forty-five degrees from the horizontal shall be installed fifty-seven inches above the deck.

92. All interior communication and fire control wire terminals shall be stamped with **circuit markings and wire number** as shown on the various elementary diagrams, so as to clearly identify the wire and its function in the circuit. In addition to the markings required above, all wire terminals for call Bell Systems (circuit A and E) shall have on the reverse side the number of the cable which contains the leads to which the terminal is marked as shown on the Isometric diagram of the system. This reverse marking shall be made only in the case of leads emanating from connection boxes or similar conditions, such as a single lead to a push button or bell where the cable number is evident.

93. Blown fuse indicators shall be provided for all fuses on fire control, inter communication, A.C.O. switchboards, all control circuits on main switchboards, for vital operation such as voltage regulators, circuit breakers, etc., and on all three-phase mains and submains on power and lighting circuits.

94. Care shall be exercised that all permanently installed motors other than bracket fans are thoroughly grounded.

95. Electrical fittings of aluminum alloy where mounted on steel decks and bulkheads, plates, hangers, etc., shall have between faying surfaces canvas washers soaked in raw linseed oil or Phenolic Resin varnish and painted with zinc white paste. Electrical fittings of molded Phenolic material when similarly mounted shall have between faying surfaces felt or duck washer impregnated with Phenolic Resin varnish.

Note: All the foregoing notes are standard Naval practice.

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APPENDIX

I. Symbols Used in Marine Electrical Blueprints

II. Color Codes Used in Marine Electrical Blueprints and Wiring

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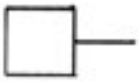
APPENDIX

I. **Symbols used in marine electrical blueprints**

MANUAL STARTER
WITH SPEED REGULATOR

M-G SET

MOTOR (H.P. RATING)



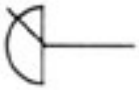
ELECTRICAL UNIT

CONTROLLER

MANUAL CONTROL
THERMAL TYPE OVERLOAD PROTECTION

SERIES FIELD

SHUNT FIELD



MASTER SWITCH

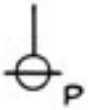
"START" OR "STOP" SINGLE BUTTON P.B.
MOMENTARY CONTACT WITH IND. LIGHT

"START" OR "STOP" SINGLE BUTTON P.B.
PERMANENT CONTACT WITH IND. LIGHT

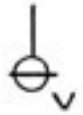
"START - STOP" TWO BUTTON P.B.
MOMENTARY CONTACT WITH IND. LIGHT

"START - STOP" TWO BUTTON P.B.
PERMANENT CONTACT WITH IND. LIGHT

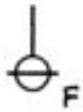
THERMOSTATIC SWITCH



PRESSURE SWITCH



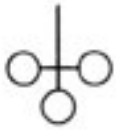
VACUUM SWITCH



FLOAT SWITCH

COLORED IND. LIGHT (COLOR SHOWN)

BLOWN FUSE INDICATOR

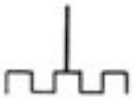


"F'W'D-REV-STOP" THREE BUTTON P. B.
MOMENTARY CONTACT

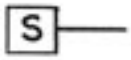
MANUALLY OPERATED SPEED REGULATOR

SOLENOID BRAKE

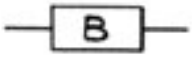
RHEOSTAT



RESISTOR

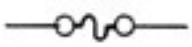


SOLENOID VALVE

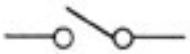


STORAGE BATTERY

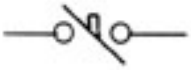
CIRCUIT BREAKER



FUSE



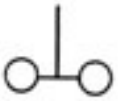
SWITCH



TUMBLER TYPE SWITCH

"START" OR "STOP" SINGLE BUTTON P.B.
MOMENTARY CONTACT OR
SPRING RETURN SWITCH.

"START" OR "STOP" SINGLE BUTTON P.B.
PERMANENT CONTACT



"START-STOP" TWO BUTTON P.B.
MOMENTARY CONTACT OR
SPRING RETURN SWITCH

"START-STOP" TWO BUTTON P.B.
PERMANENT CONTACT.

U.V. - UNDERVOLTAGE — G.E.Co. WINCH SYM.

O.L. OVERLOAD P.U. 300% — SERIES COIL

SB STEP BACK WARP 140 DO 45/100 P.U. ANCHOR 290 — SHUNT COIL Z

SBR STEP BACK RELAY P.U. LESS THAN 65% VOLTS — NORMALLY OPEN TIP

LR LATCH RELAY D.O. 10 SEC. — NORMALLY CLOSED TIP

SH.F.W. SHUNT FIELD WEAKENING { PICK UP — NORMALLY OPEN TIME OPEN T.O.

TR. TRI. TRANSFER { AT LESS THAN 65% VOLTS — NORMALLY CLOSE TIME CLOSING T.C.

F.W.R. FIELD WEAKENING P.U. 28% D.O. - 20 F.L.A.

ACCELERATING RELAYS 3A.R. 1 SEC. 5A.R 5 SEC. 4A.R 1 SEC. 6A.R. 3 SEC.

R — ELECTRIC TACHOMETER CORP. TYPE-1C1 SHAFT REVOLUTION INDICATOR + COUNTER WITH LAMPS · BKHD. MFG. DR.# 1069D3

R — " " " " " " PANEL MFG. TYPE 1C1

R — " " TRANSMITTER & COUNTER TYPE TM1

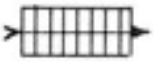
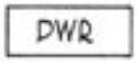
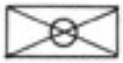
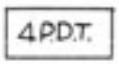
10 — 10 WIRE CONN. BOX LOVELL CAT. 715

CHOKE COIL ELEC. TACH. CORP. DR # 1069-D-3

RUDDER ANGLE IND. (DIAL LAMP & DIMMER RHEO.) HENSCH CAT. 10-781

RUDDER ANGLE TRANSMITTER " " 10-785

(CALL BELL SYST.) DENOTES EQUIPMENT SHOWN IN ELIMENTARY DIAG.

	CAT. NO.	MFG.
 GYRO STEERING STAND	328	SPERRY
 STEERING REPEATERS (GYRO PILOT MOUNTED)	3G-256	"
 BEARING REPEATERS (BRIDGE)	3G-155	"
 RADIO DIRECTION REPEATER (SUPPLIED WITH RADIO EQUIP)		
 COURSE RECORDER	3G-170	SPERRY
 ALARM UNIT COMPASS	103 A	"
 MASTE' GYRO COMPASS	100 B	"
 MOTOR GENERATOR SET	113	"
 POWER UNIT	333	"
 VOLTAGE REGULATOR	410	"
 COMPASS CONTROL PANEL	112	"
 REPEAT SWITCH PANEL	405	"
 AMPLIFIER PANEL	395	"
		
 DC-AC DYNAMOTORS	177	"
 MOTOR CONTROL PANEL	337	"
 4P.D.T. SW (SHEET STEEL ENCLOSED DRIP PROOF)	TRUMBULL-3981	TYPE
 STEERING GEAR PUMP MOTOR SW P.O. (FURNISHED WITH ANY POWER EQUIP		

STEERING GEAR PUMP MOTOR SW. B.D. (FURNISHED WITH AUX. POWER EQUIP.

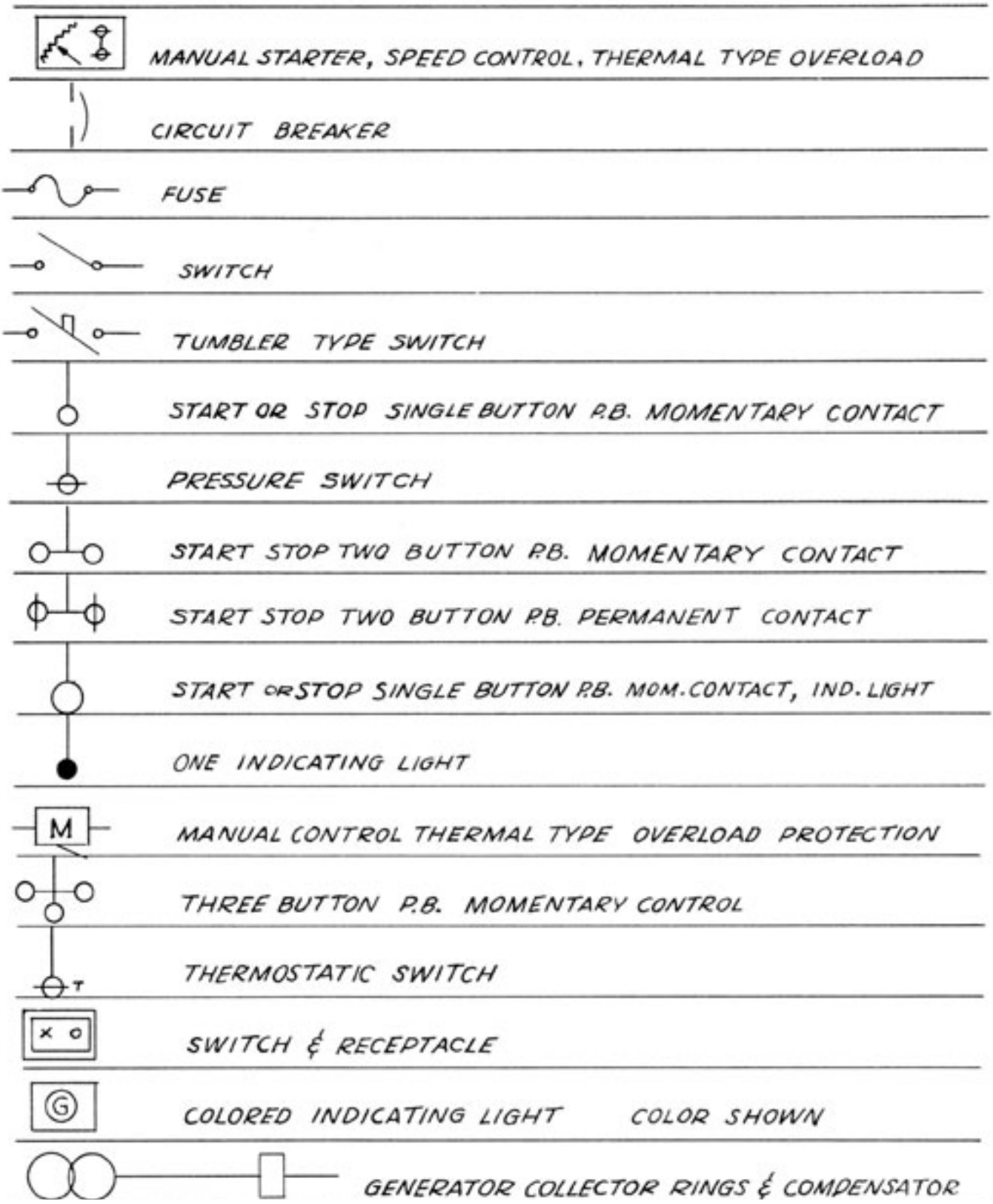
BENJ. 8874	EMERGENCY PUSH BUTTON CLOSED CIRCUIT	
10 / G	10" VIBRATING BELL	
HENSCHEL B / BA 20 M	BUZZER W.T. - 115 V. - D.C. - BURGLAR ALARM	6874
3" / BA.	3" VIBR. BELL N.W.T. - 115 V. - DC HENSCHELL	2017
3 / A	3" VIBR. BELL - 24 V. DC. - CALL BELL SYSTEM	
	DOOR CONTACTOR W.T. BURGLAR ALARM	CAT. NO. 60 - 107
	RELAY & HOUSING 24 V. D.C. EDW.	955
60	ANNUNCIATOR PANEL 60 DROP BULL'S EYE "	422
L	INDICATOR LIGHT FOR DOOR	7231
HENSCHELL	GENERAL ALARM CONTACT MAKER LOCKED ON OR OFF	20-104
" 8" / G	8" VIBRATING BELL - 20 VOLTS D.C.	"
10" / 6	10" " " " " "	
LOVELL	JUNCTION BOX W.T. NON-FUSED	810
RES 3A	" " " FUSED 3 AMPS.	F6868
H	FATHOMETER HYDROPHONES - 2 PHONES TYPE	134 F
	IMPACT OSCILLATOR	538
	AMPLIFIER PANEL RESISTANCE	423 R
	FATHOMETER INDICATOR DEPTH RECORDER	484 C 505 TYPE

	FATHOMETER INDICATOR DEPTH RECORDER	505
	TANK HYDROPHONES & OSCILLATOR	TYPE 356-J MFG 156J

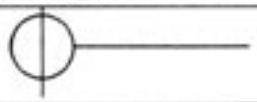
1-4 T	TELEPHONE SPLASH-PROOF TYPE "S.P.B." BHD. MFG WITH 4" BELL	AE SALES CO. AM 76
1-2¼ T	" CABIN TYPE "CAB". BHD. MFG. WITH 2¼" BELL	AM 75
1-6 T	" SPLASH-PROOF TYPE "S.P.B." BHD. MFG. 6" BELL	A.M 85
T	" " " " " "	WITHOUT BELL AM 76
1-6 T	" W.T. TYPE W.T.P. PEDESTAL MFG. WITH 6" "	AM 83
10	10 WIRE CONNECTION BOX W.T.	LOVELL 715
20	20 " " " " "	716
T	HOWLER W.T. 20 VOLTS D.C.	BENJAMIN 8526
T	TELEPHONE POWER SIGNAL RELAY W.T. MICRO SW.	AE SALES DR.# 55557
16	ANNUNCIATOR 16 DROP WITH SWS & 6" BELL 15 V.-D.C. MET CAB	HENSCHELL L # 50-077
	PUSH BUTTON W.T. EDW. 200 DOUBLE CONT. P.B.	EDW 623 NON. W.T. PB SW
10 F.A.	10" VIBRATING BELL 115 V D.C. W.T.	DR.# 20-028-1
	CONTACT MAKER	
3A	FUSED JUNCTION BOX W.T. 3 AMP. FUSES	RUSSELL & STOWELL DR.# F6863 ALL NO.4
5	5 WIRE CONN. BOX W.T.	LOVELL CAT. NO. 714
S	SALINITY CELL & VALVE ASSEMBLY	
S	SALINITY INDICATION PANEL	

S SALINITY INDICATION PANEL

FLUE GAS THERMOCOUPLE. MFG. ILL.TESTING LAB.TYPE 3430



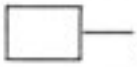
GENERATOR COLLECTOR RINGS & COMPENSATOR



OVERSPEED DEVICE

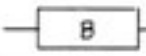
ENGINE ORDER TELEGRAPH		CAT. NO.
HENSCHELL 12" D.F.S.E. TRANSMITTER WITH REPLY TYPE II	HENSCH DR.	10-747-2
16" INDICATOR WITH REPLY		10-778
D.R.D.T. TRANSFER RELAY W.T.		60-168
CONSTANT RINGING RELAY PANEL		60-159
10" VIBRATING BELL		20-147
40 WIRE CONN BOX	LOVELL	717
CURRENT FAILURE ALARM PANEL	HENSCH	40-031

POWER HP MOTOR



ELECTRIC UNIT

CONTROLLER



B STORAGE BATTERY

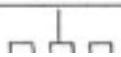
SERIES FIELD

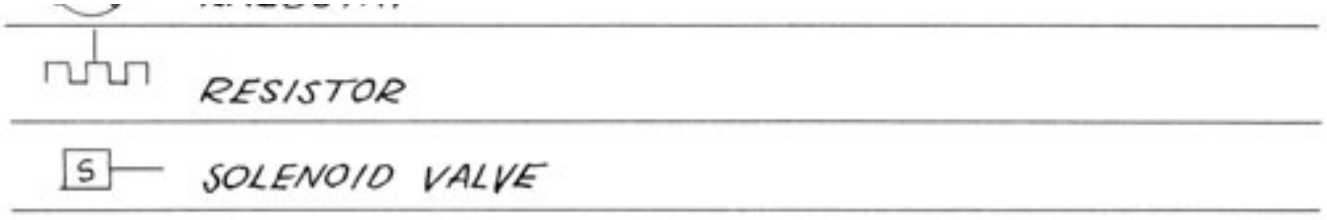
SHUNT FIELD

MASTER SWITCH

SOLENOID BRAKE

RHEOSTAT





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II. **Color codes used in marine electrical blueprints and wiring**

Navy Type

Conductor No	Base Color	Tracer Color	Tracer Color
1	Black		
2	White		
3	Red		
4	Green		
5	Orange		
6	Blue		
7	White	Black	
8	Red	Black	
9	Green	Black	
10	Orange	Black	
11	Blue	Black	
12	Black	White	
13	Red	White	
14	Green	White	
15	Blue	White	
16	Black	Red	
17	White	Red	
18	Orange	Red	
19	Blue	Red	
20	Red	Green	
21	Orange	Green	
22	Black	White	Red
23	White	Black	Red

24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange
36	Orange	White	Blue
37	White	Red	Blue
38	Brown		
39	Brown	Black	
40	Brown	White	
41	Brown	Red	
42	Brown	Green	
43	Brown	Orange	
44	Brown	Blue	

Telephone Twisted Pair Code #22

Twisted pair color code: When furnished as twisted pair, the following color code shall apply:

Pair Number	One Wire	Other Wire
1	Blue	White
2	Orange	White
3	Green	White
4	Brown	White
5	Slate	White
6	Blue/white	White

7	Blue/orange	White
8	Blue/green	White
9	Blue/brown	White
10	Blue/slate	White
11	Orange/white	White
12	Orange/green	White
13	Orange/brown	White
14	Orange/slate	White
15	Green/white	White
16	Green/brown	White
17	Green/slate	White
18	Brown/white	White
19	Brown/slate	White
20	Slate/white	White
21-40	First twenty repeated	Red
41-60	First twenty repeated	Black
61-80	First twenty repeated	Red/white
81-100	First twenty repeated	Black/white
101-120	First twenty repeated	Red/black
121-140	First twenty repeated	Black/orange
141-160	First twenty repeated	Black/green
161-180	First twenty repeated	Black/brown
181-200	First twenty repeated	Black/slate

Capacitance. The capacitance of a 50-foot twisted-pair sample, after first drying for 4 hours at 30° C., and then followed by exposure for 24 hours to 30° C. and 90 per cent relative humidity, shall not exceed 2500 micro-microfarads at 1000 cycles per second. When the capacitance measurements are made, the sample shall be removed from the coil frame used for humidification purposes, and tested either in a straight length or in such position as to avoid errors due to too close proximity of any one portion of the

test specimen to any other portion (such as might be introduced were adjacent loops to touch in a closely coiled specimen).

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Telephone Twisted Pair Code #22 (continued)

Insulation resistance. The direct current insulation resistance (between conductor) of a 50-foot twisted-pair sample, after exposure for 24 hours to conditions of 30° C. (86° F.) and 90 percent relative humidity, shall be not less than 1,000 megohms. The insulation resistance measurements shall be made immediately following the capacitance measurements.

#22 Single Wire Telephone Code. Single conductors shall be furnished in the following colors, as required:

White	Blue/white	Green/slate
Blue	Blue/orange	Brown/white
Orange	Blue/green	Brown/slate
Green	Blue/brown	Slate/white
Brown	Blue/slate	Red/white
Slate	Orange/white	Black/white
Red	Orange/green	Red/black
Black	Orange/brown	Black/orange
	Orange/slate	Black/green
	Green white	Black/brown
	Green/brown	Black/slate

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Foldout 1 - Outboard Profile - Typical Allweld Cargo Vessel.

Foldout 2 - Inboard Profile Single Screw Cargo Motor Ship.

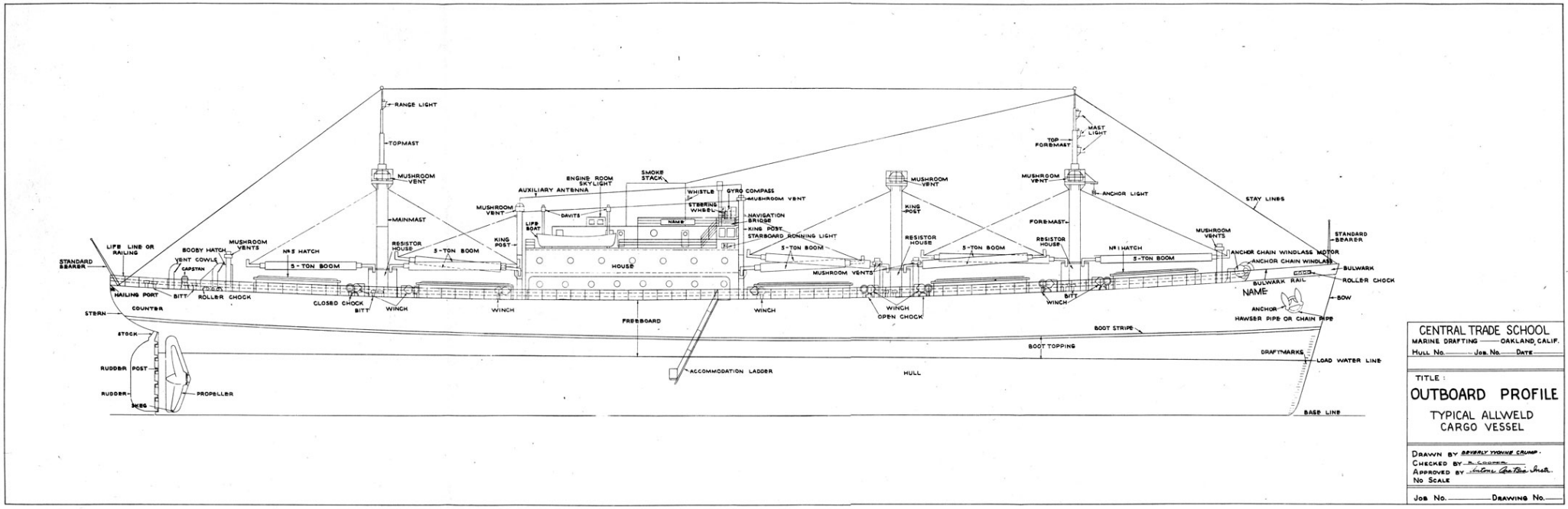
 

Previous Part Electricity Home Page

Version 1.00, 15 Jan 06

Foldout 1 - Outboard Profile - Typical Allweld Cargo Vessel.

Electricity Home Page



CENTRAL TRADE SCHOOL
MARINE DRAFTING — OAKLAND, CALIF.
HULL No. — JOB No. — DATE

TITLE:
OUTBOARD PROFILE
TYPICAL ALLWELD CARGO VESSEL

DRAWN BY BEVERLY YVONNE CRUMP.
CHECKED BY —
APPROVED BY —
No SCALE

JOB No. — DRAWING No. —

Version 1.00, 5 Feb 06

Foldout 2 - Inboard Profile Single Screw Cargo Motor Ship. Electricity Home Page