CHAPTER 27

Aids to Navigation Seamanship

CONTENTS

ILLUSTRATIONS

ACKNOWLEDGMENTS AND BIBLIOGRAPHY

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Air Reduction Sales Co.: Oxyacetylene Welding and Cutting Instruction Course.

American Chain & Cable Co.: Catalog.

American Steel & Wire Co.: Catalog.

Boston Lockport Block Co.: Catalog.

Broderick & Bascomb Rope Co.: Riggers Handbook.

Columbus McKinnon Chain Corp.: Catalog.

Cornell Maritime Press: Merchant Marine Officers Handbook by Turpin and MacEwen; Shiphandling in Narrow Channels by Carlyle Plummer.

D. Van Nostrand Co., Inc.: Knight's Modern Seamanship, Standard Seamanship for the Merchant Service by Felix Riesenberg.

Electroline Co.: Catalog.

Pacific Maritime Association: Safe Practices pamphlets.

Plymouth Cordage Co.: Mr. S. A. Reed.

United States Naval Institute Proceedings, September 1941: Tips on Practical Shiphandling, by Capt. H. A. V. VonPflugh.

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United States Army Technical Manual: Stevedoring.

United States Coast and Geodetic Survey: Hydrographic Manual, K. T. Adams.

United States Navy Bureau of Personnel: Cargo Handling; Seamanship.

United States Navy Hydrographic Office—notes on ice breaking.

27-1 GENERAL

27-1-1 Purpose of This Chapter—

A. The maintenance of aids to navigation is one of the most important functions of the Coast Guard. The volume of maintenance work is enormous, and its complexity and extent is difficult for persons not directly concerned to visualize.

B. *Seamanship, general and specialized*, plays an important part in safe and efficient maintenance operations, both afloat and ashore. While it is realized that local conditions will govern which methods of accomplishing certain operations are better adapted for use, there are certain fundamental principles which form a firm basis of good seamanship upon which to predicate the variations to suit local conditions. It is the intent of this chapter to set forth these standard fundamentals of good seamanship and to add to them for informative purposes, facts, wrinkles, and ways and means developed by experienced seamen through the years. In addition, description of associated functions, closely allied to seamanship, and essential to maintaining the system of aids to navigation, will be included.

C. *Important factors.*—Timeliness is a most important factor in the maintenance of aids to navigation, for the value of such aids to the mariner is greatly reduced unless they have an unusually high degree of reliability, and corrections of all defects of location and operation are promptly made. The volume of maintenance work at all times is great, for light stations, buoys, and other aids are subject to the effect of the sea, waterfowl, marine borers, wind and storm. The work is made difficult by fouling of buoys and structures by bird lime, and by spiders, flies, and other insects getting into the complicated mechanical works. Many of the aids are equipped with complicated mechanical and electrical devices which may get out of order with hard usage to which they are subject. Those which are entirely automatic require the replenishment of fuel at comparatively short intervals. The variations in climate, geographic locations and hydrography affect the maintenance problem of aids to navigation. Corrosion of steel in salt air and salt water of the tropics and temperate zone, heavy fouling of buoys and structures in certain areas, and ice conditions in the eastern districts and Great Lakes areas all influence the maintenance program. Maintenance of floating aids in the Mississippi River system is a special problem due to floods and ice conditions, although the general servicing conditions in many respects are similar to conditions on the coasts and Great Lakes.

D. The field aspects of servicing operations are readily divided into three categories, as follows:

(1) Work performed by tenders.

(2) Work performed by depots.

(3) Work performed by field parties.

27–1–5 Duties of Great Lakes and Coastal Tenders—

A. The fleet of cutters of the tender class maintained by the Coast Guard provides the water transportation required in the establishment and maintenance of the system of marine navigational aids. The newer cutters of this class were designed for ice breaking, and to facilitate their use in performing other Coast Guard functions.

B. *Various duties.*—Tenders are used to transport men and supplies to lightships, and supplies, water and fuel to offshore light stations where other more economical forms of transportation are not available. They carry large quantities of construction material, as well as working parties, to points where normal maintenance operations are in progress or where new navigational aids are under construction by government forces. Tenders are also utilized by the operations and engineering officers in making inspections of lightships, light stations, and other aids.

C. *The most important function* performed by tenders is the handling of lighted and unlighted buoys, and the servicing of minor shore aids by working parties in a small boat. The Great Lakes and coastal-type tenders may be from 120 to 189 feet in length, and may have a boom or derrick capable of hoisting working loads ranging from up to 5 tons for the smaller vessels and to 20 tons for the larger ships. A description of the hoisting gear will be found under paragraph 27–3–50. The specialized operations to be performed with the boom are: the lifting of buoys from the deck and placing them overside; the removal of buoys and their appendages from the water and stowing them on deck; the servicing operations where buoys must be partially raised from the water and, while held in that position, supplied with new tanks of compressed gas or electric batteries; and the loading and unloading of the ship at the depot.

D. *Water and oil tanks,* of unusual size and number, are required aboard tenders, as they must deliver such supplies to lightships and the more isolated light stations where other forms of transportation are not available, at the same time providing fuel for propulsion to provide a large steaming radius.

E. *Various designs.*—While all tender-class cutters embody these general features, the special requirements of the highly diversified waters marked by the Coast Guard have resulted in many variations in design.

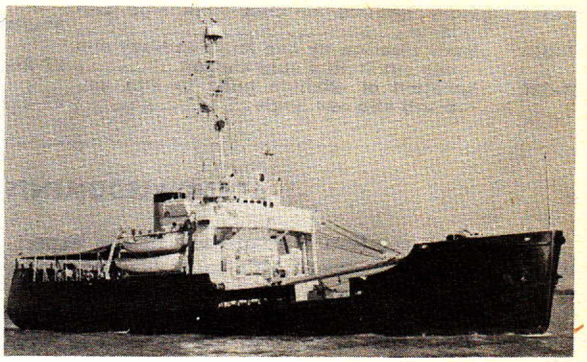

FIGURE 27–1.—180-foot class B tender *Sweetgum.*

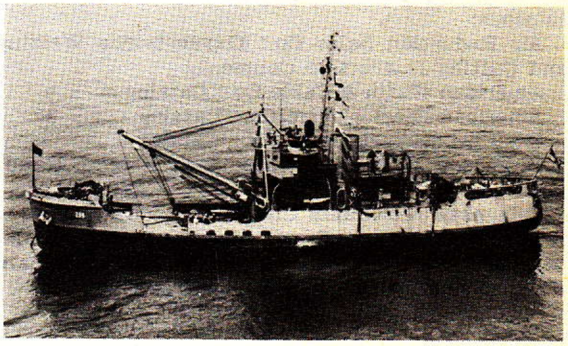

FIGURE 27–2.—180-foot class A tender *Woodbine.*

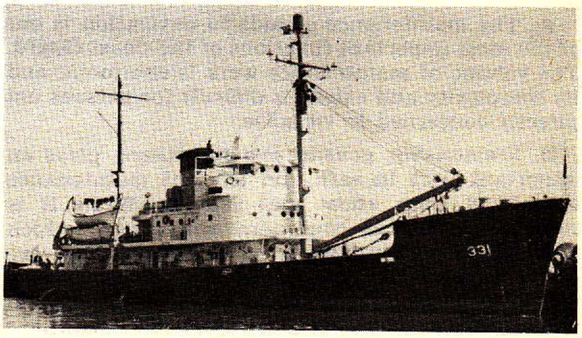

FIGURE 27–3.—189-foot tender *Heather.*

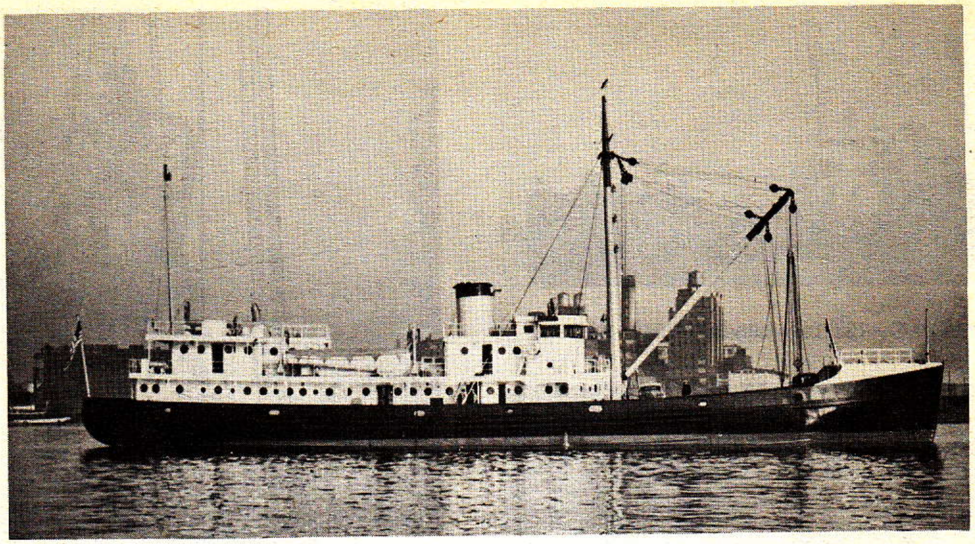

FIGURE 27–4.—177-foot tender *Juniper*.

F. *Naval service.*—The 180-foot class tender was successfully used as a Naval auxiliary during the war in connection with the establishment of heavy mooring buoys in advanced areas, and laying and servicing submarine and torpedo nets and booms. They often handled extraordinary loads for their size.

G. *Servicing buoys.*—The servicing work carried out by vessels is performed upon a fairly definite schedule, consisting of cruises or patrols made to various areas. However, there must be sufficient flexibility in the plan to provide for emergencies. Servicing may be broken down into three parts: the annual relief of buoys, the periodic replenishment of their acetylene gas or electric batteries, and emergency servicing operations; however, in actual practice, a tender-class cutter may be carrying out all three types of servicing on a single trip.

(1) Among other detail matters, buoy work includes:

(*a*) The replacement of acetylene cylinders or electric batteries in buoys while on station.

(*b*) The cleaning, adjustment and often the exchange of buoy lighting equipment including lanterns, lampchangers, flashers, valves, burners, and regulators, and the making of minor repairs to buoys while on station.

(*c*) The removal of buoys from station, their preliminary cleaning, and their replacement with relief buoys with the changing seasons.

(*d*) The replacement of damaged buoys, and the establishment of new buoys.

(2) *Planning work schedule.*—Several of the above functions may be performed by a tender while on a single patrol, it being the duty of the aids to navigation officer in each district to schedule or assist in so scheduling the work of the tenders as to best accomplish the end of maintaining all aids in an efficient condition. In planning patrol schedules of these vessels, consideration must be given to the number of buoys which can be carried on deck at one time, the times when various lighted buoys will require a replenishment of illuminant, any reports of defects which may have been received, and the schedule of annual relief of buoys.

H. *Emergency servicing* of buoys is usually the result of reports which have been received from mariners of buoys missing or off station, or of signaling equipment not functioning properly. Such defects are also observed frequently by tenders and other cutters during their normal cruising or patrols. *Tender-class cutters are required to check each aid passed for proper characteristic and position.*

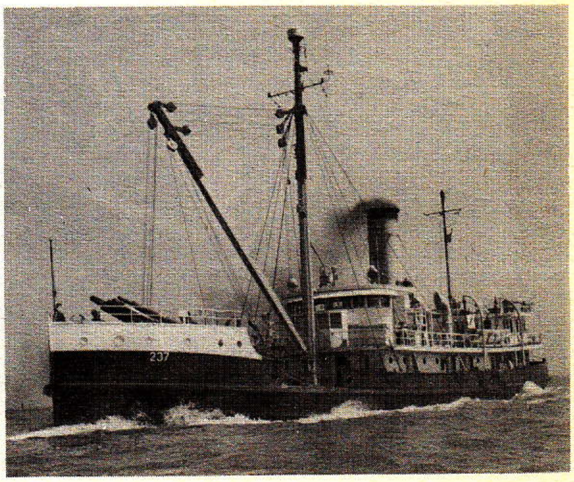

FIGURE 27–5.—173-foot tender *Mistletoe*.

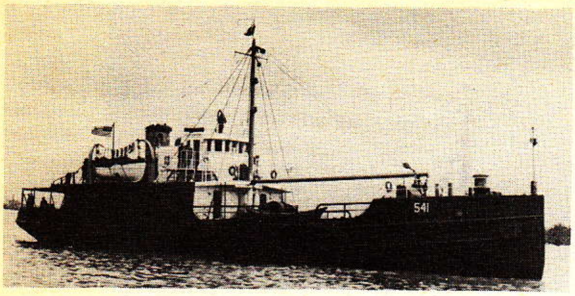

FIGURE 27–6.—133-foot tender *White Alder*.

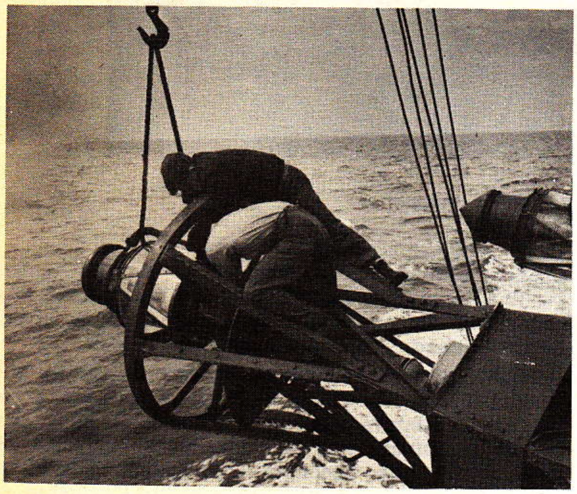

FIGURE 27–7.—Securing a 375-mm. lantern to a 9 x 32 lighted whistle buoy as tender proceeds to location where buoy is to be placed on station. *Men working on buoy should be wearing jackets.*

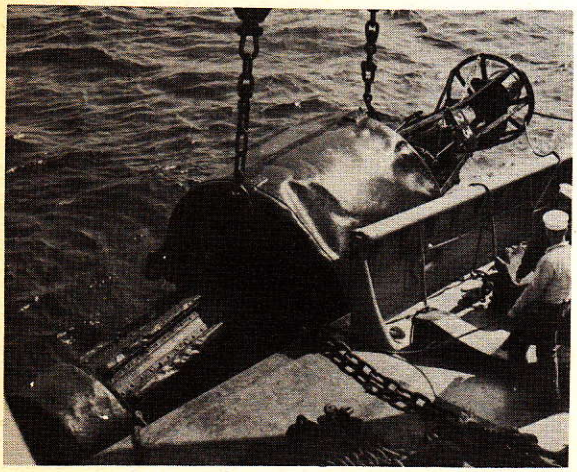

FIGURE 27–8.—The tender has arrived near the location where the lighted bell buoy is to be set, so the buoy has been lifted off the buoy deck and swung over the side. Note dents in buoy body from collision or other rough treatment this buoy has experienced in the past.

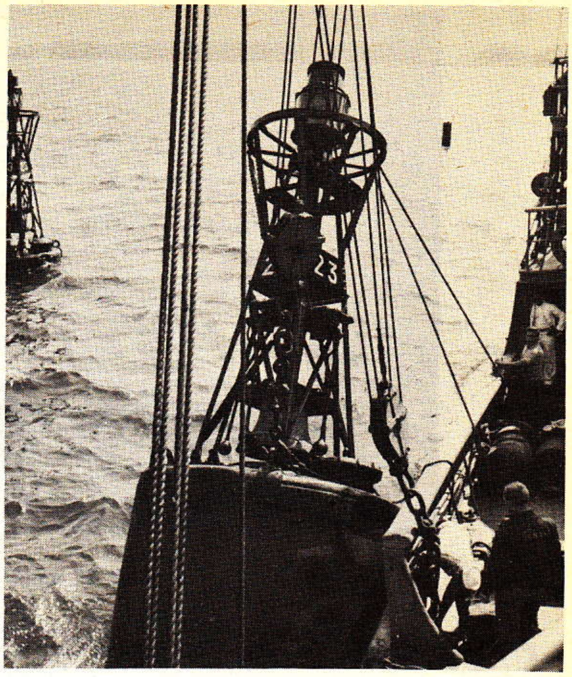

FIGURE 27–9.—A lighted bell buoy hanging in a vertical position from one lifting lug, ready for setting. Tender is maneuvering into position to place buoy in exact location near the buoy to the left, which is to be relieved.

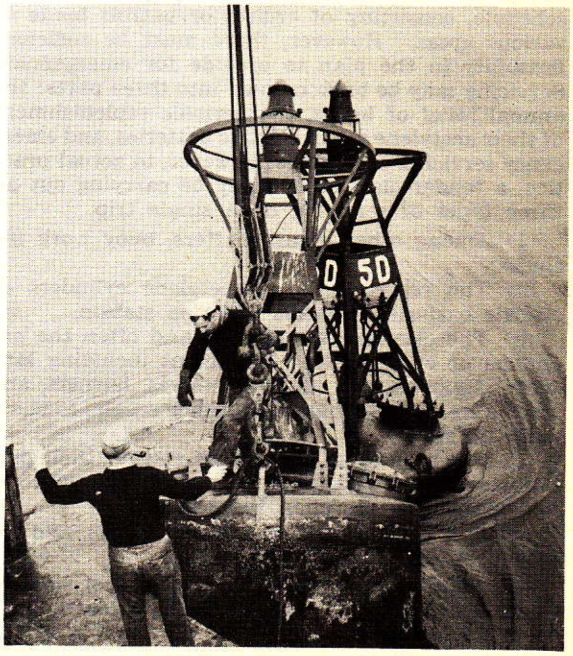

FIGURE 27–10.—The serviced lighted bell buoy is in position and the relieved buoy is being hoisted aboard the tender for transportation to a depot for annual overhaul. *Note that man on buoy should be wearing lifejacket.*

I. *Supplying light stations.*—In all districts, tenders make certain voyages, the purpose of which is the delivery of supplies to light stations. Fresh water deliveries are also made in some districts. In northern latitudes where the heating of quarters at light stations is a problem, the annual supplies will include large quantities of oil, coal, or wood. Frequently the quantities of these materials will require the making of several trips in order to supply all the stations of the district. Another bulky item requiring delivery by water at the offshore or isolated stations is fuel for the fog signal. Such deliveries are heaviest in districts where fog is most prevalent.

J. *Unattended lights and daybeacons,* where they are not readily reached by land transportation, are serviced by the tenders.

K. *Supplying lightships.*—In a district having several lightships, a periodic duty of one or more of the tender-class cutters is the delivery of supplies to these ships. On a normal trip of this nature, there will be carried food for as much as a month, fresh water, engineer and deck supplies and repair parts, mail for the crew, and any other material which it is necessary to place aboard before the lightship is next brought into port. Men returning from or going on shore leave also are transported on these supply trips. The length of time which the tender remains at the lightship depends upon the amount of water, fuel, oil, or other bulk commodity to be transferred, but three or four hours is an average.

L. *Removing buoys under ice conditions.*—Upon the Great Lakes, the Ohio River, the upper part of the Mississippi River, and in certain waters along the coasts, where ice interrupts or prevents navigation for longer or shorter periods each winter, provision is made for the gradual removal and replacement of the buoys. The problem for solution is one of keeping on station until the last practicable moment at least a skeleton system of aids to assist late traffic, bearing in mind that the complete removal of floating aids is a task requiring many days.

(1) Where buoyage is to be removed for the winter, the less important intermediate buoys are removed first and taken to the regularly assigned points for winter storage. It will also be possible to completely remove the aids from certain channels at a comparatively early date when it is known that all traffic has ceased before the actual forming of ice.

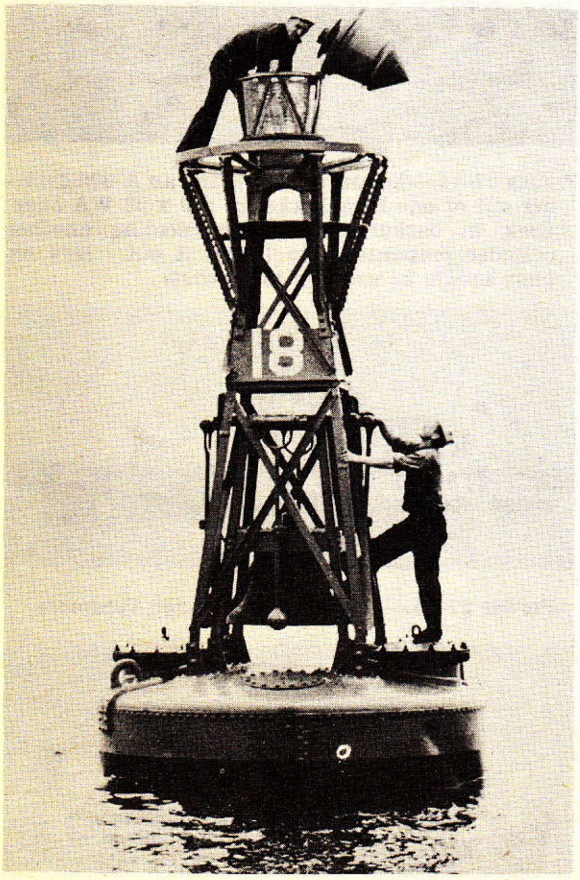

FIGURE 27–11.—Men from tender land on extinguished 9 x 32 lighted bell buoy to relight same on station. *Men should be wearing lifejackets.*

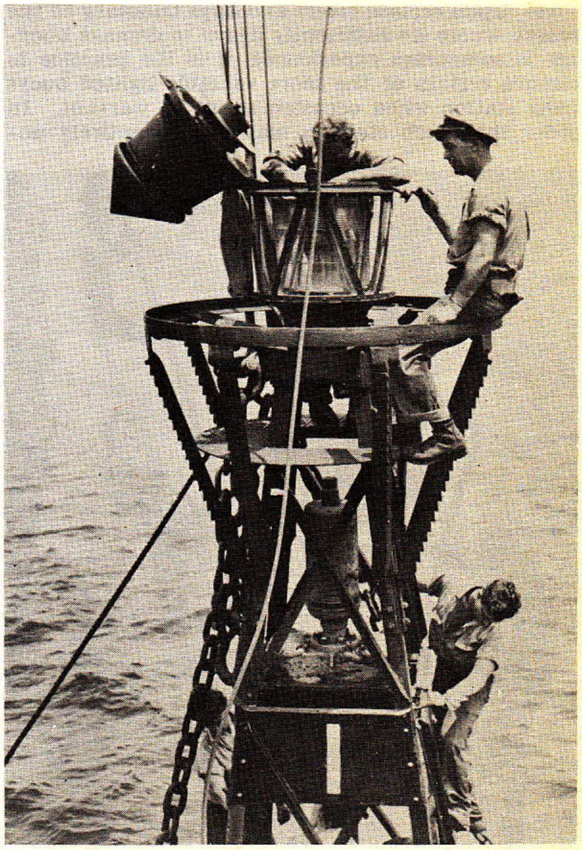

FIGURE 27–12.—Servicing a 9 x 38 lighted whistle buoy held alongside tender by main hoist. The steel members supporting the lantern gallery are saw-toothed to make masters of tugs with tows give this buoy a good berth. Towlines that foul these teeth are liable to be cut. Top of 375-mm. acetylene lantern is open with man cleaning and adjusting burner. *Men should be wearing lifejackets.*

(2) As it becomes necessary to remove more of the buoys, those having lighting apparatus or other signalling devices are next withdrawn, as such buoys, if caught in the ice, would be most readily damaged and this would constitute a substantial monetary loss. Spar, nun, and can buoys are left to the last. Their smaller size makes it possible for a tender to remove a considerable number in comparatively short time and transport them on a single trip. If some of these buoys cannot be reached in time and remain in the ice all winter, the likelihood of damage is comparatively small. While they will, undoubtedly, be carried off station with the breaking up of the ice in the spring, their recovery is reasonably certain. The monetary losses involved are small and more than justified, as the buoys assure reasonable safety for those vessels making late passages.

(3) The restoration of the floating aids in the spring of the year is substantially a reversal of the procedure of removal, with the addition of searches for missing buoys and the recovery of buoys which may have been reported as driven ashore at various points.

(4) Upon certain rivers and bays tributary to the coasts, where ice sufficiently heavy to damage buoyage is sometimes experienced, it is the practice to remove certain of the more valuable lighted buoys from station when occasion seems to warrant. In order that such stations may not be entirely unmarked, so-called station buoys are frequently employed, being placed near to the regular buoy, where they remain permanently. A station buoy may be a spar, or any type less likely to be damaged than the principal buoy, and on occasion both a bell buoy and a lighted buoy are established close together, rather than a single buoy on which are combined both types of signal.

FIGURE 27–13.—Recovery of, and preparation for, deicing a lighted buoy by a tender at the end of the navigation season on the Great Lakes. *Man on buoy should be wearing lifejacket.*

FIGURE 27–14.—Tender's crew lifting an A–300 cylinder out of one buoy pocket of a 9 x 38 WA buoy. Crew in background is disconnecting another cylinder preparatory to lifting it out. *Men on buoy should be wearing life jackets.*

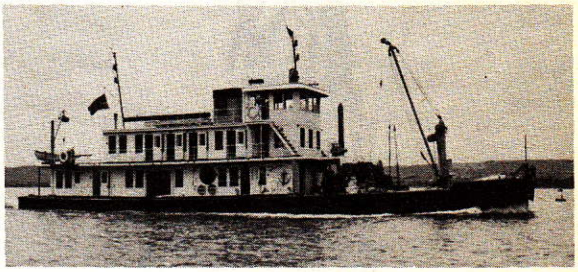

FIGURE 27–15.—113-foot river tender *Sycamore.*

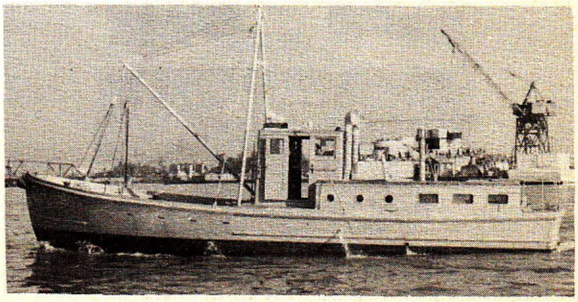

FIGURE 27–16.—52-foot buoy boat.

FIGURE 27–17.—40-foot buoy boat.

27–1–10 Duties of River and Inland Waterways Tenders and Buoy Boats—

A. There are a number of shallow-draft tenders used for the operation of aids to navigation in the Mississippi River system, Intracoastal Waterway, and other inland waters. These vessels range from 72 to 114 feet in length. In addition to performing aids to navigation work, these vessels are available for rescue work during floods, ice breaking, etc.

B. *Type of A/N work.*—Aids to navigation work in inland waters may consist of placing, moving and relieving hundreds of small lighted and unlighted buoys, which, unlike the average coastal buoys, may require frequent shifting of position when in unstable channels, such as the lower Mississippi. They also are engaged in the erection and servicing of minor lights and daybeacons ashore, and pile-driving and erection of minor lights and daybeacons on marine sites.

C. *Buoy boats* range in size from an open 38-foot boat to a 65-foot boat with temporary accommodations, and are used for handling small buoys in inland waters where the larger tenders are unable to navigate, and servicing minor fixed aids ashore and on marine sites. Buoy boats are equipped with an air-, hydraulic-, or gasoline-driven hoist with capacities of up to 1,500 pounds on the smaller boats and up to 4,000 pounds on the larger buoy boats.

D. *Transport supplies.*—Inland tenders and buoy boats may be called upon to transport supplies to isolated stations, but to a lesser extent than Great Lakes and coastal tenders.

27–1–15 Duties of a Depot—

A. *Location and chief function.*—Scattered throughout the various districts are a large number of depots which are servicing bases used in maintaining the system of aids to navigation. They may be separate Coast Guard units or a "facility" of another unit. The chief function of these depots is to provide a central point accessible to servicing vessels, where repair and storage facilities can be located. Some of the depots, depending on the number of aids in the area served by them or upon special circumstances surrounding these aids, are larger and more important than others.

B. *Facilities offered.*—The facilities of the depots vary with the type and number of aids that they serve. Practically all of them have equipment and space for the repair of buoys, and for the repair and servicing of the various types of lighting apparatus in use throughout the district or in the vicinity. They carry on hand a supply of spare parts for all the apparatus used in the area. They also have space for the storage of relief buoys, boats, and lightships. They usually have facilities for the repair and maintenance of small boats.

C. *Storage.*—Tools and equipment are stored for working parties and vessels. Tools, equipment and supplies in transit are held for transportation to units by trucks and tenders. Depots are headquarters for tenders and other Coast Guard vessels.

D. *The repair of buoys* is carried out almost entirely at depots. The repair as well as the painting of buoys, because of their size, requires a considerable amount of space. This work is usually carried on in the open and is most economically handled when it can be performed quite close to the edge of the dock where the buoys are deposited by the tenders. All buoys brought in from station, after the preliminary scraping given on board the tender, are thoroughly cleaned and painted. Repairs to the superstructure and body of buoys necessitated because of collision, ice damage, etc., are made at depots. This may consist merely of straightening parts or bumping out dents, or may involve more extensive work such as renewal of plates and the substitution of new superstructures. While extensive repairs are being made to lighted buoys, all lighting apparatus, storage batteries, and acetylene cylinders are removed.

E. *Overhauling lighting apparatus.*—Depots generally have specialized personnel, tools, and equipment for the overhaul of acetylene and electric lighting apparatus. Spare parts and complete assemblies are stocked.

F. *Moorings are overhauled,* worn links or eyes renewed or repaired, worn chain salvaged and made up into usable sections, etc.

G. *Acetylene cylinders* are handled for storage and for sending to recharging plants. The depot is responsible for maintaining cylinders in good condition, containing the proper amount of gas of good quality.

H. *Batteries.*—Electric storage batteries, or recharging materials of various types used for some of the lighted buoys and many of the minor lights, are among the items of equipment which must be supplied by the depots, along with any small parts and fittings required with them. Complete recharging facilities are available.

I. *Fabricating structures and equipment.*—Some depots prefabricate structures for minor lights and daybeacons, and miscellaneous fittings, adaptors, etc., for aids to navigation equipment. Depots serve as an assembly and storage point for new equipment for field construction.

J. *Servicing aids, training personnel.*—Personnel attached to a depot may be responsible for servicing minor aids in the vicinity. Training courses in the overhaul and servicing of aids to navigation lighting equipment are given in the lamp shops of certain large depots.

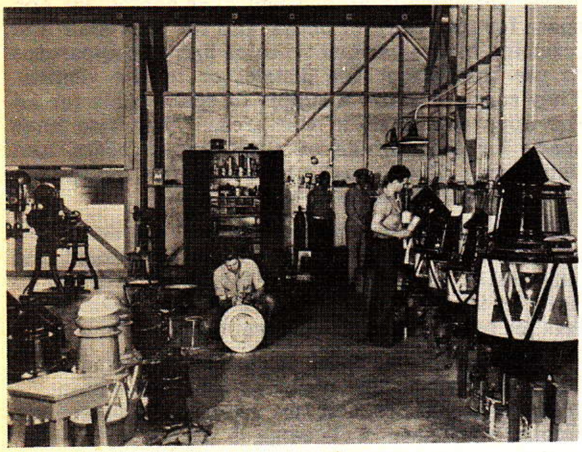

FIGURE 27–18.—Workmen in shop at depot making repairs to parts and equipment of buoys.

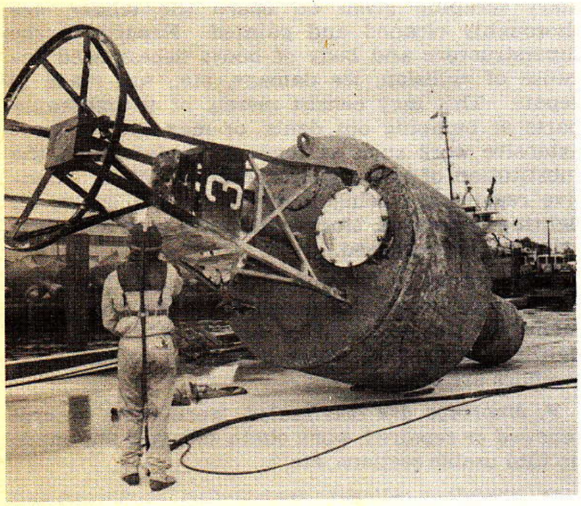

FIGURE 27–19.—Workman sandblasting a buoy.

27–1–20 Duties of Light Attendant Station—

A. A light attendant station may be a separate unit or a facility of another unit such as a light or lifeboat station. The duty of a light attendant station is to perform the routine servicing of minor aids in the immediate vicinity of the station and to effect emergency repairs to lighted buoys to keep them in operation until such time as a tender is available to relieve or recharge the buoy. A buoy boat is often assigned to a light attendant station, in which case small buoys are regularly relieved.

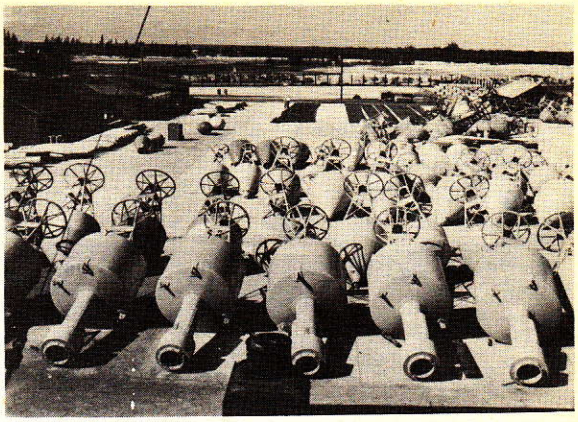

FIGURE 27–20.—Storage of buoys and chain at a depot.

27–1–25 Duties of Field Parties—

A. *Maintenance work at attended light stations,* such as the repair of lighting and fog signal apparatus, and the repair and painting of buildings, when beyond the capacity of the regular station crews, is usually carried out by working parties detailed by the district office. These details are transported to and from the stations by means of tenders or trucks, depending upon the circumstances. The size of the working parties and the specialities of the men will vary in accordance with the work program. Where the moving of heavy machinery is involved, the crew of a tender may be called upon for assistance.

B. *New construction.*—Each district field construction and maintenance organization is organized to suit the conditions in the district. For establishment of new aids, this organization depends on whether or not contractors are available and willing to submit reasonable proposals for such work. If the work is isolated, requires costly towing of plant and equipment to the site, and is difficult for contractors to accomplish, the Coast Guard may supply all or part of the deficiency, or perform all or part of the work by Coast Guard construction forces. Several districts have roving crews with small tenders, pile drivers, etc., kept continuously busy on establishment and maintenance work, largely in connection with aids in the Intracoastal Waterway.

27–2 ROPE

27–2–1 General—

A. Rope is one of the most valuable and constantly used tools available to a seaman. Aside from its standard uses in riggings, tackles, boat falls, lashings, and stoppers, its flexibility and its almost universal adaptability enable the seaman to use it in a variety of situations requiring improvisation.

B. Modern rope may be classified as fiber and wire rope. The descriptions contained herein deal only with types of rope as generally used in aids to navigation work. For more complete details, consult any standard text on seamanship. All rope of 3-

inch circumference or larger procured for Coast Guard use has a marker strip (tape) interwoven which gives data on the date of manufacture and identification of material.

27–2–5 Types and Construction of Fiber Rope—

A. The two most common types of fiber rope in use on vessels are manila and sisal. Rope made of the best quality manila is preferred because of its superior elasticity, strength, and resistance to wear and deterioration. Sisal fiber is similar to manila in color but is only approximately 80 percent as strong. Sisal rope deteriorates faster than manila and for boat falls and boom guys only manila should be used. Beware of remade rope. It can be detected by opening up the strands, exposing the soiled uneven strands inside. Line under 1¾-inch circumference is known as small stuff. Small cordage is often made from hemp fiber and is known in its various types as marline, houseline, roundline, spun yarn, seizing stuff and ratline stuff.

B. A rope consists of fibers, yarns, and strands. Ordinarily, yarns are formed by twisting fibers to the right; strands are formed by twisting yarns to the left; rope is formed by twisting strands to the right. This forms right-lay rope. The twists of the yarns and strands of the rope are made in opposite directions to counteract the tendency for unlaying. In right-lay rope, the strands run upwards to the right, vice versa for left-lay rope. When three, four, or six strands are twisted together, opposite to the twist of the strands, it is known as plain-laid rope. When three or four plain-laid three-stranded ropes are twisted together, the rope is called cable-laid. This rope has somewhat less tensile strength than plain-laid rope of equivalent diameter, but is superior for certain types of duty such as towing, etc., where elasticity and resistance to surface wear is required.

27–2–10 Size and Use of Fiber Rope—

A. *How measured.*—Fiber rope is measured by circumference, except in the case of small stuff which is designated by the number of threads it contains, i. e., 6-thread, 12-thread, 21-thread. Fiber rope is available in sizes from ¾- to 16-inch circumference. However, 10- or 12-inch rope is the largest used on vessels of this service. The length of rope is expressed in fathoms and is issued in coils of 100 to 200 fathoms.

B. *Use.*—Three-strand plain-laid manila rope is used for general duty such as cargo slings, falls, working tackles, boom guys, scaffold slings, lifelines, lashings, and stoppers,. Four-strand manila with a fiber heart is no longer used, since it has lower tensile strength and is subject to kinking.

C. *Common sizes, and their use on tenders.*—Commonly used sizes of fiber rope found aboard tenders may be as follows: mooring lines, 5 or 6 inches; cross deck lines, 5 or 6 inches; boom guys, 3 or 3½ inches; boat falls, 3 or 3½ inches; sinker

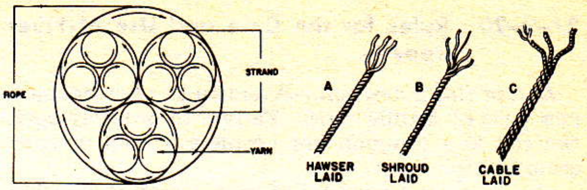

FIGURE 27–21.—Structure of and kinds of fiber rope.

stopper lines, 3 to 6 inches; deck lashings, 2 to 6 inches; life lines, 21 thread to 2 inches; buoy head lines, 2 to 4 inches; hoisting tackle hook tripping lines, 12 to 21 thread; straps and slings, 3 to 6 inches.

27–2–15 Computing Strains for Fiber Rope—

A. *The breaking strain* is the load, tested and set by the manufacturer, that will part the line. To determine the breaking strain of a line, in the absence of tables, square the circumference and multiply the result by 900 to get the B. S. in pounds, or divide by 2.5 to get it in tons (2,240 pounds).

B. *The safe working load* is the greatest load which may be repeatedly applied while maintaining an acceptable factor of safety during the normal life of the rope. Overloading the rope is foolhardy and dangerous. The safety factor is the ratio between the minimum breaking strain and the load applied. Under ordinary operating conditions, a safety factor of five is recommended, with reasonable allowance made for the condition of the rope and length of prior service, and the nature of the job to be performed. For a new rope used for a single lift, a safety factor of three or four might be adequate, but for boat falls a safety factor of eight is more desirable.

(1) To determine the safe working load of a line, divide the breaking strain by the constant five or such other safety factor as may be chosen.

(2) To find the size of manila line required for any given load, divide the load by 180 and take the square root of the quotient. The result is the circumference of the line in inches.

C. *Tests* made with manila rope of 2.68-inch actual circumference based on lower limit breaking strength of 2¾-inch normal circumference three-strand manila, gave the following results for certain types of splices and knots:

Type of knot or splice	Average load at break (pounds)	Percent of strength of rope	Type of failures
Eye splice, 2 tucks	4, 657	64. 7	At end of splice.
Eye splice, 4 tucks	4, 747	66. 1	Do.
Bowline	2, 120	29. 4	At short end.
Slip knot	3, 097	43. 0	At bight and at pin.
2 turns around pin-ends seized to standing part.	2, 340	32. 5	Two strands at pin.
Fisherman's bend	2, 450	34. 0	At bight.
Round turn and half-hitches.	2, 860	39. 7	Do.
Clove hitch	3, 600	50. 0	Do.

NOTE: It was found that the breaking strength of 4-strand manila is approximately 5 percent less than 3-strand manila of the same quality.

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27–2–20 Rules for the Care and Use of Fiber Rope—

A. *Opening a new coil.*—Avoid kinks when opening new coils of manila rope. Failure to properly open the coil is a common but needless breach of good seamanship.

(1) To open a new coil of rope, loosen the burlap cover and lay the coil on the flat side with the fag end nearest the deck.

(2) Reach down through the coil and draw the fag end up through the center and out of the coil. Newer coils of rope generally have the proper end tagged.

FIGURE 27–22.—Uncoiling rope.

B. *Thoroughfooting.*—When a rope in service has become kinked, it may be thoroughfooted by coiling down against the lay and bringing the lower end up through the center of the coil and coiling down again, this time with the lay. If there are many turns in the line, coil small; if few turns, coil large. In the case of a boom guy where both ends are not free, begin with that part of the line at the cleat and coil down counterclockwise (for right-hand lay rope), then dip the end down through the coil, pulling it out. Capsize the coil and then coil down with the lay.

C. *Caution.*—Do not attempt to put maximum strain on a rope which has seen continuous service under a moderate strain, nor one which has been close to the breaking point. The safety of rope decreases rapidly with use, depending to some extent upon the amount of strain. This is due to the fact that the fibers slip a small amount under each strain in spite of the twisting.

D. *Use on capstan or windlass.*—The principle of the contrary turn in rope making must be considered in the care of rope used on a capstan or windlass. If the rope is thrown on always in the same direction, the "after turn" will be continually thrown out, and the rope will be injured. When using rope on winch heads at each end of a shaft, care must be taken when the winch is running and there is no strain on either one of the ropes, that the turns on the idle head do not chafe.

E. *Taut dry ropes should be immediately slacked off when wet by rain.* Rope shrinks about 4 percent in length when wet, and may subject the line to a greater strain than its ordinary load.

F. *Keep rope away from acid or acid fumes, alkali, paint, or oil.* Damp rope will absorb acid fumes readily. Acid generally turns the fibers a brownish color. Alkali turns them yellow.

G. *Rope should never be stored while wet or damp.* After use, clean off sand, grit, and salt water by washing down with fresh water, and hang it up to dry. Rope should be stored in a clean, dry, well-ventilated place. An occasional sunbath will do it a lot of good. Rope damaged by dry-rot will have a musty odor and the fiber will appear brownish in color. Deterioration of all rope is hastened by moisture and high temperatures. Rope stored even under the best conditions has some deterioration. When stored under humid conditions, deterioration is more rapid. Now that rope is dated, units should use the oldest rope first.

H. *Remove all kinks* before putting a strain on rope. A kinked section of rope may be expected to fail at loads of 20 to 30 percent below the strength of the section not kinked. Remove kinks before ropes dry.

I. *Do not use chain stoppers or slings on rope.* Chain will cut the fibers and kink the rope. Avoid short nips and bends through fairleads, chocks, etc.

J. *Examine blocks* for rusty, frozen, or broken sheaves at regular intervals.

K. *Use the proper size block and sheave.* Generally the length of the block should be three times the circumference of the rope and the diameter of the sheave should be twice the circumference. For example, a 12-inch block would generally be suitable for use with 4-inch rope.

L. Following are some miscellaneous notes on the care and use of fiber rope:

(1) Coil ropes right-handed or clockwise.

(2) Keep rope from touching stays, guys, or other standing rigging.

(3) When surging line around bits, take off enough turns so that it will surge smoothly and not with jerks.

(4) If rope becomes chafed or damaged, cut and splice. A good splice is safer than a damaged section.

(5) Do not lubricate the rope.

(6) Whip or splice all rope ends.

(7) Rope should be inspected frequently for deterioration. Open the lay and inspect the fibers. White powdery residue indicates internal wear.

(8) Dragging a rope over sharp or rough objects will cut or break the outer fibers. When rope is dragged on the ground, other particles are picked up which eventually work into the rope, cutting the inner strands. To insure longer life, rope should be run over as smooth a surface as possible.

(9) Rope exposed to the atmosphere will deteriorate about 30 percent in 2 years, due to weathering alone.

(10) Rope loaded in excess of 75 percent of its breaking strength will be permanently damaged. An inspection of the inside threads will reveal if they are partially or wholly broken, depending on the overload.

(11) All 3-inch or larger rope for Coast Guard use is fungicidal-treated, resulting in an unnatural color, gray-green or dark brown. Field application of preservative compound to rope is not recommended since all of these compounds involve a reduction in strength. When factory treated initially, the original specifications are increased to take care of this reduction.

(12) Although other fibers, nylon, etc., have been tested for use in rope, none have matched the performance per dollar of manila with fungicidal treatment. However, for rope kept in the water over long periods (moorings for small boats, etc.), certain synthetic ropes have proven useful.

27–2–25 Useful Knots, Bends, and Hitches—

A. *Whipping the end of a rope.*—A plain whipping is a short length of service, or a short seizing at the end of a rope, to prevent it from unlaying. This is usually made with sail twine, and when the twine is carried over the whipping along the lay of the rope and stitched through the rope above and below the whipping, it is a sail-maker's or sewed whipping.

To put on an ordinary whipping, without a needle, heave all turns taut over the end, leave a few turns loose, tuck the finishing end back under these, then heave them taut and pull the end up under them, cutting it off. If both beginning and finishing ends are brought up between the same turns, the whipping can be made very secure by square-knotting them and pushing the knot under the turns.

B. *Definitions.*—Following are some pertinent definitions:

(1) *A knot* is a knob formed at the end of a piece of rope by interweaving its strands.

(2) *A bend* is a method of fastening one rope to another or to a ring or loop. Many ties, which are strictly bends, have come to be known as knots, and for the purpose of clarity, they will be referred to as knots under this section.

(3) *A hitch* is a temporary tie by which a rope is fastened to a spar or post so as to be readily untied.

(4) *Knots, bends, and hitches* are made from three fundamental elements; a *bight*, a *loop*, and a *round turn*. The free end of the rope is referred to as the "loose" or "running" end and the remainder is called the "standing part".

(5) A good knot is one that is tied rapidly, holds fast when pulled tight, and is untied easily.

C. *The overhand knot* serves chiefly as a base or part of other knots. It should not be used as a stopper knot to prevent the end of a rope from passing through a block, as it jams easily and is difficult to untie. The strength of the overhand knot is actually less than half the strength of an unknotted rope. The overhand knot is tied by passing the loose or running end of a line over the standing part and through the loop that has been formed.

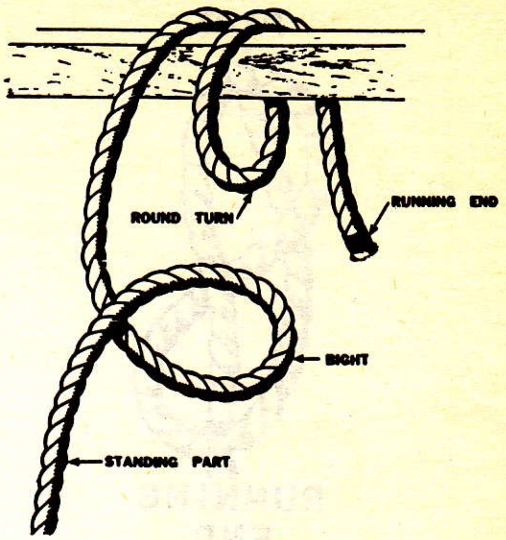


FIGURE 27–23.—Elements of a knot.

FIGURE 27–24.—Overhand knot.

D. *The figure-8 knot* is an excellent knot to use to prevent a rope from passing through a block, because it will not jam and can be untied easily.

To tie the figure-8 knot, make a loop in the end of the rope, pass the running end around the standing part, beyond the loop, and then back through the loop.

FIGURE 27–25.—Figure-8 knot.

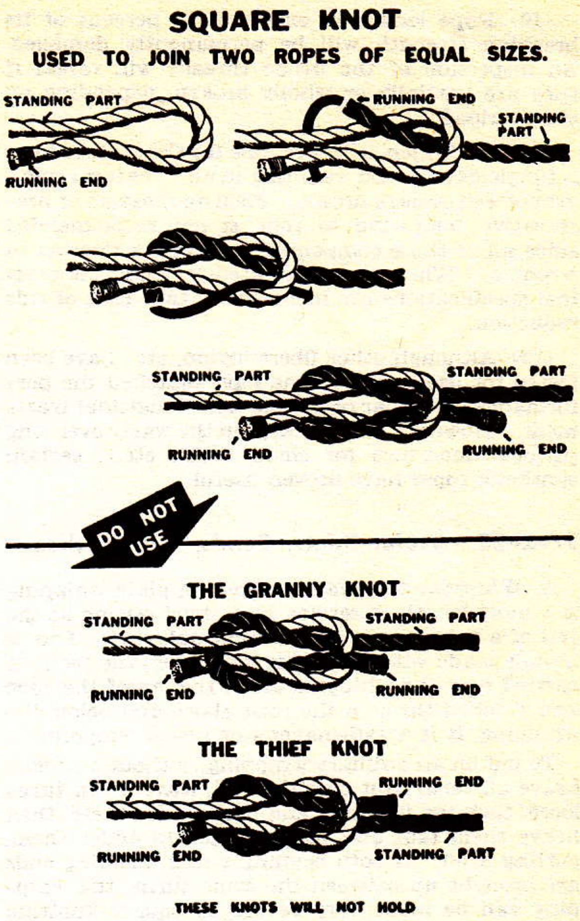


FIGURE 27–26.—Square knot.

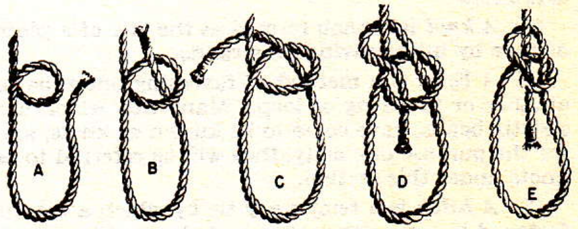


FIGURE 27–27.—Bowline

E. *The square knot* is used commonly for joining two ropes of the same size and should not be confused with the *granny knot* or the *thief knot.* Note that the square knot consists of two overhand knots parallel to each other, the granny knot is two overhand knots crossed, and the thief is two overhand knots with a running end in each. The square knot will not slip but will draw tight under a heavy strain; when tied in wet rope it will slip and draw tight. The granny and thief knots slip, are more difficult to untie, and should not be used.

To tie the square knot, bring the two ends together and cross them, making an overhand knot; then cross the ends so that each is alongside its own standing part, and tie a second overhand knot. If this rule is not observed, a granny instead of a square knot will result.

F. *The bowline* is the best knot for forming a loop that will not slip under strain and that may be untied easily.

(1) To make a bowline; make a bight in the standing part by passing the running part over the standing part in a counterclockwise direction (see fig. 27–27, A); pass the running end up through the bight (B); pass the running end around under the standing part, going from right to left (C); pass the running end back through the bight (D); then draw the knot tight.

(2) In tying the bowline it is essential that the two parts passing through the bight are alongside of each other, otherwise a knot resembling the single carrick bend is formed.

G. *The bowline-on-a-bight* is principally used to form a loop at a point in a rope where the ends are not available, and, like the bowline, is easily untied and will not slip. It can be used as a loop to place in hooks, or as a seat sling for lowering persons, although a French bowline is better for the latter purpose.

To tie the bowline-on-a-bight, make a bight in a doubled portion of the rope and pass the loop end of the doubled portion through the bight (fig. 27–28 A). Reach through the loop and pull the remainder of the knot through it, grasping the standing part of the doubled portion, and draw the loop tight on the bight (fig. 27–28 C and D).

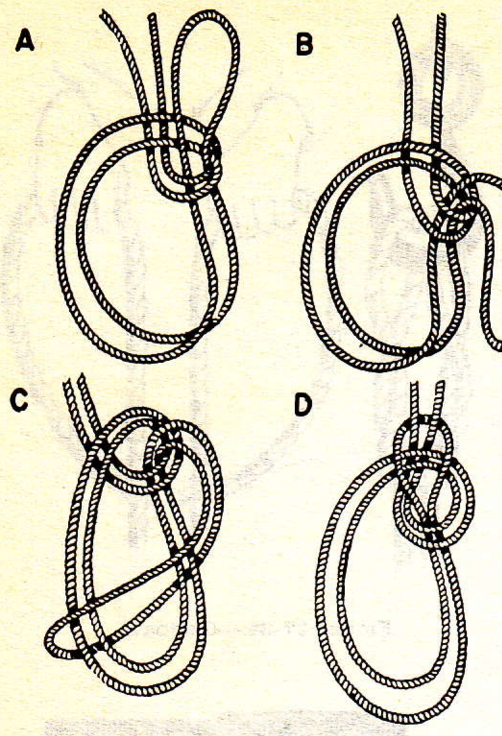


FIGURE 27–28.—Bowline-on-a-bight.

H. *The French bowline* is better than a bowline-on-a-bight when a man is to be lowered over the side or into a hold, or for any job where he must have support and still be able to use both hands. The knot forms two loops, one for the man to sit in and the other to go under his armpits. The weight of the man keeps the armpit loop tight around his back, safeguarding him from falling out.

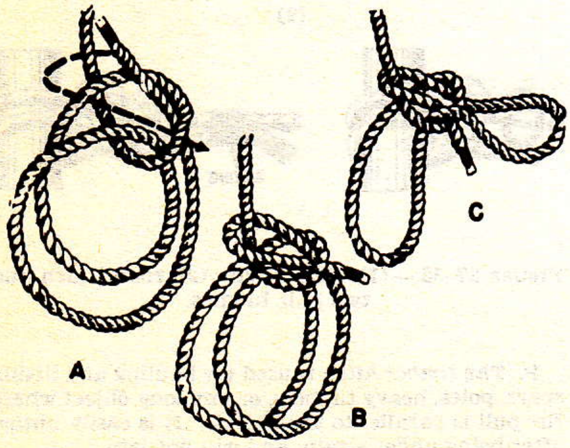


FIGURE 27–29.—French bowline.

The French bowline is made by taking the standing part in the left hand, and with the right hand, passing the running end over the standing part to form a small bight. The running end is then brought from behind and through the bight, and instead of going around the standing part at once like an ordinary bowline, the running end is given a round turn around the original bight (fig. 27–29 A), and is then brought around the standing part to be completed like an ordinary bowline (fig. 27–29 B and C).

I. *The single sheet, or becket, bend* is used to tie wet ropes together, or ropes of unequal size, and for uniting a rope's end to an eye. In cases where heavy strain is expected, a piece of wood may be inserted through the knot, which when driven out leaves plenty of slack to unbend.

To tie the single sheet bend, form a bight in the larger rope. Making the bight in the larger rope is important, because if the bight is made in the smaller rope, the knot will slip; it is also much harder to pass the larger rope around the smaller one. After making the bight in the larger rope, pass the running end of the smaller rope through the bight (fig. 27–30 A) and around both parts of the larger rope (B) and back under its own part (C). Then draw the knot tight (D).

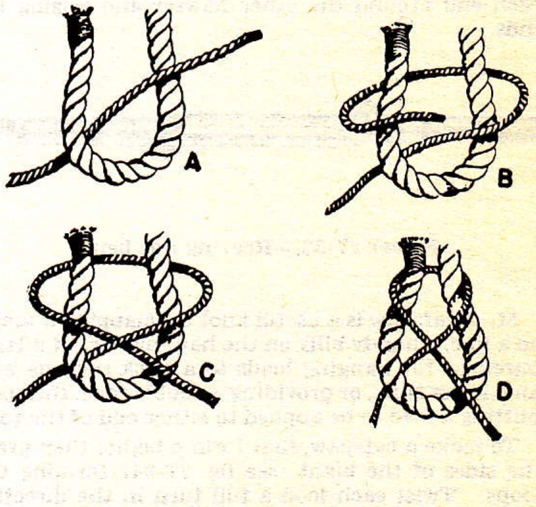


FIGURE 27–30.—Single sheet bend.

J. *The double sheet bend* is made similarly to the single sheet bend, except that the running end of the small rope is passed around the bight in the large rope twice and then passed between the bight and the standing part of the small line.

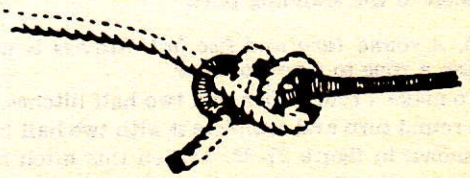


FIGURE 27–31.—Double sheet bend.

K. *The fisherman's, or anchor, bend* is used for securing a line to a buoy, or a hawser to the ring or jew's harp of an anchor. It is formed by passing the end twice around the ring and under the turns. Seize the end back.

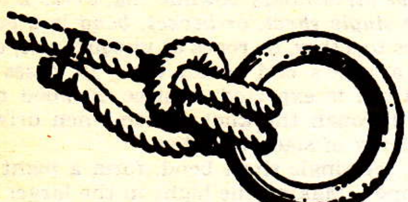


FIGURE 27–32.—Fisherman's bend.

L. *The reeving line bend* is a method of connecting two hawsers in such a way that they will reeve through an opening, offering as little obstruction as possible. It is made by taking a half hitch with each end around the other hawser and seizing the ends.

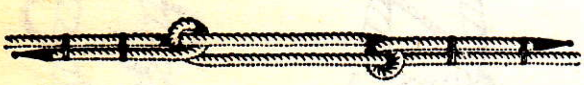


FIGURE 27–33.—Reeving line bend.

M. *A catspaw* is a useful knot for clapping a tackle on a line, a handy billy on the hauling part of a large purchase for hanging loads to a hook such as with an endless sling, or providing a double rope, thus permitting a load to be applied to either end of the rope.

To make a catspaw, first form a bight; then grasp the sides of the bight (see fig. 27–34) forming two loops. Twist each loop a full turn in the direction indicated by the arrows.

N. *The half hitch* is very insecure and should never be used alone, as its only purpose is to serve as a basis for other hitches.

The half hitch is tied by forming a single loop around another rope, pole, or spar, and passing the running end beneath the standing part, applying tension to the standing part.

O. *A round turn and two half hitches* is used to fasten a rope to a pole or spar.

To make a round turn and two half hitches, make one round turn and complete it with two half hitches as shown in figure 27–35. When this hitch is used permanently, the running end should be seized to the standing part.

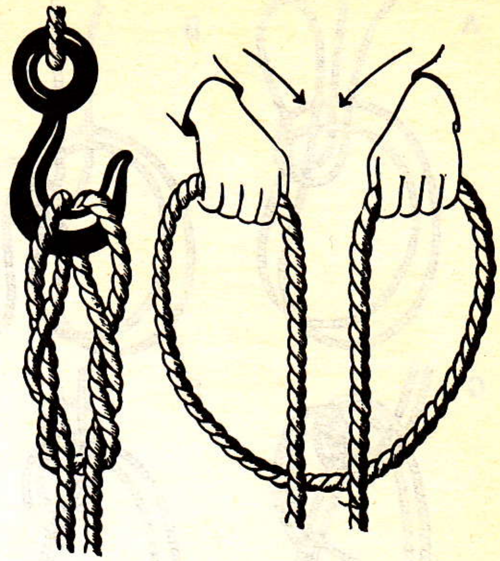


FIGURE 27–34.—Catspaw.

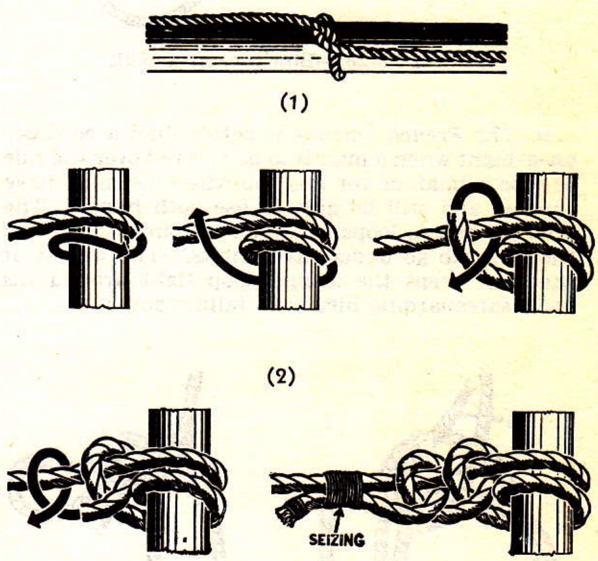


FIGURE 27–35.—(1) Half hitch; (2) round turn and two half hitches.

P. *The timber hitch* is used for hauling and lifting spars, poles, heavy timbers, or any long object where the pull is parallel to the object. It is easily untied after being under strain, and will not jam.

The timber hitch is made in the same manner as the half hitch, except that the running end is given three or more turns around itself. In making this hitch, care should be taken to make sure that the turns are made around the running end and not the standing part.

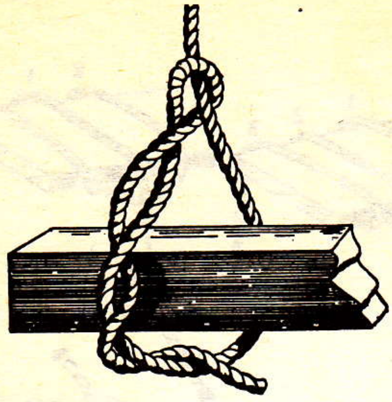


FIGURE 27–36.—Timber hitch.

Q. *The clove hitch* is widely used to attach a line to a spar or pole, or the beginning and end of a lashing. It will tighten as tension is applied, no matter which end of the hitch is pulled on. It can be tied at any point of the rope.

(1) To make a clove hitch at the end of a rope, first make one turn around the object, usually a spar or post, and then make a second turn, crossing over the standing part of the first turn (see fig. 27–37 (1) (A)) and bringing the running end beneath the second turn (B).

(2) To tie a clove hitch in the middle of a line, make two loops in the same direction (either both overhand or both underhand). (See fig. 27–37 (2) (B).) This will place both ends between the loops. Actually the clove hitch is one half hitch and another half hitch reversed.

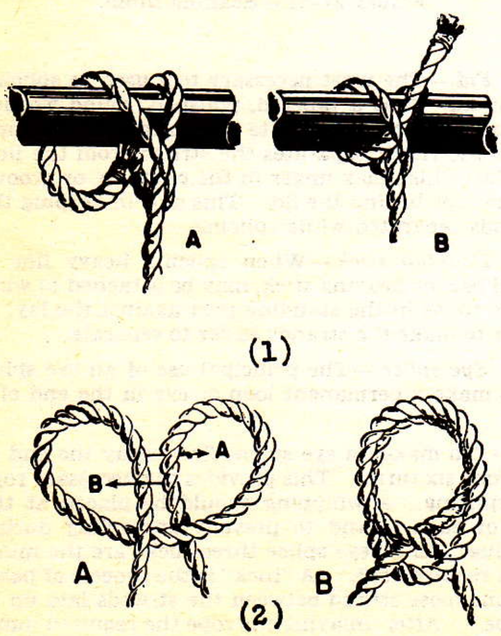


FIGURE 27–37.—(1) Clove hitch—end of line; (2) clove hitch—middle of line.

R. *The blackwall hitch* is used to attach a rope to a hook. It can be made quickly and when tied properly, it is secure. It is seldom used except when there is insufficient end remaining to make a bowline.

To make a blackwall hitch, form a loop in the rope, placing the running end behind the standing part (see fig. 27–38 A). Bring the loop around the hook (B); hold the running end in the left hand and pull the standing part with the right hand, placing the hitch in position (C).

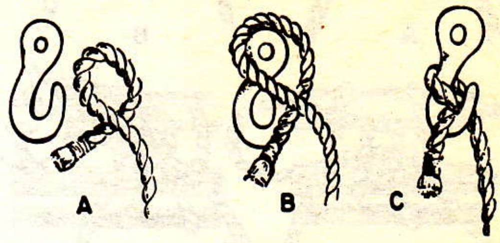


FIGURE 27–38.—Blackwall hitch.

S. *The rolling hitch* is used to secure a rope to a pipe, pole, line, or spar so that it will not slip along the object. It is of special value when the running end of a line must be loosened while tension is still maintained on the standing part.

To make a rolling hitch, pass the end twice around the spar or rope, crossing the standing part on the top side each time, then hitch the end around the spar or rope, on the opposite side of the two turns.

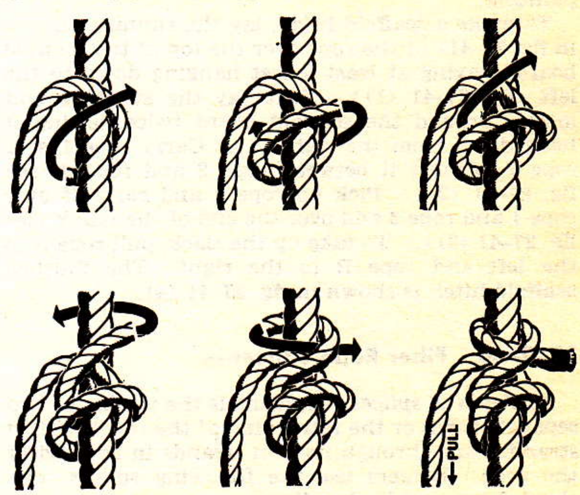


FIGURE 27–39.—Rolling hitch.

T. *The sling shortener* is used to shorten an overlong sling and to draw the draft up closer to the cargo hook.

A short bight off the excess sling length is held in each hand (see fig. 27–40 B) and the double ropes forming these two short bights are tied in an overhand knot (C) like the first half of a square knot. The hcok for lifting the draft is then inserted through the two ends of the short bights as shown in (D).

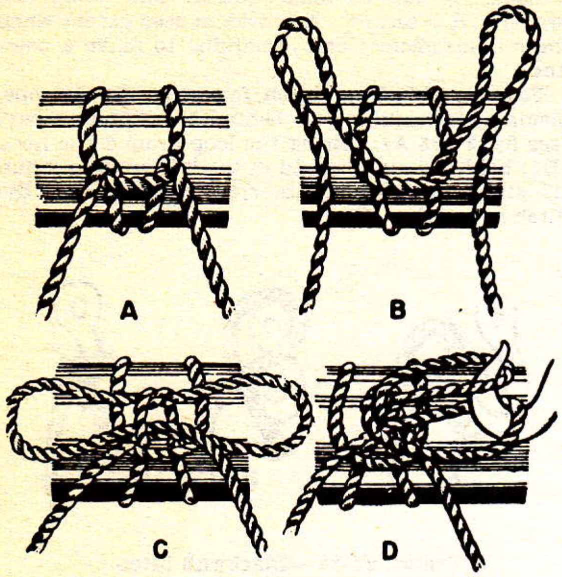


FIGURE 27–40.—Sling shortener.

U. *The scaffold hitch* is used when there is a need for a single board or plank hung by a single rope at each end of the board. Some of the most common uses of a scaffold are for ship repair, scraping, and painting.

To make a scaffold hitch, lay the running end (A in fig. 27–41) of the rope over the top of the scaffold board, leaving at least 3 feet hanging down to the left (fig. 27–41 (1)). Next, lay the standing end loosely around the scaffold board twice, letting it hang down from the right (1). Carry rope 1 over rope 2, placing it between rope 2 and rope 3 (see fig. 27–41 (2)). Pick up rope 2 and carry it over rope 1 and rope 3 and over the end of the plank (see fig. 27–41 (3)). To take up the slack, pull rope A to the left and rope B to the right. The finished scaffold hitch is shown in fig. 27–41 (4).

27–2–30 Fiber Rope Splices—

A. *Types of splices.*—Splicing is the joining of two separate ropes or the retracking of the rope's unlaid strands back through its own strands in the end of the rope. Riggers use the following splices: *eye, short, long, and back splices.*

(1) In the *eye splice*, the running end of the line is formed into a loop of the desired size and then joined to the standing part.

(2) In a *short splice*, the ends of the line, or two separate lines, are joined together, increasing the diameter of the rope.

(3) In a *long splice*, the ends are joined together without increasing the diameter of the rope.

(4) In a *back splice*, the strands at the end of the line are spliced back into its own standing part.

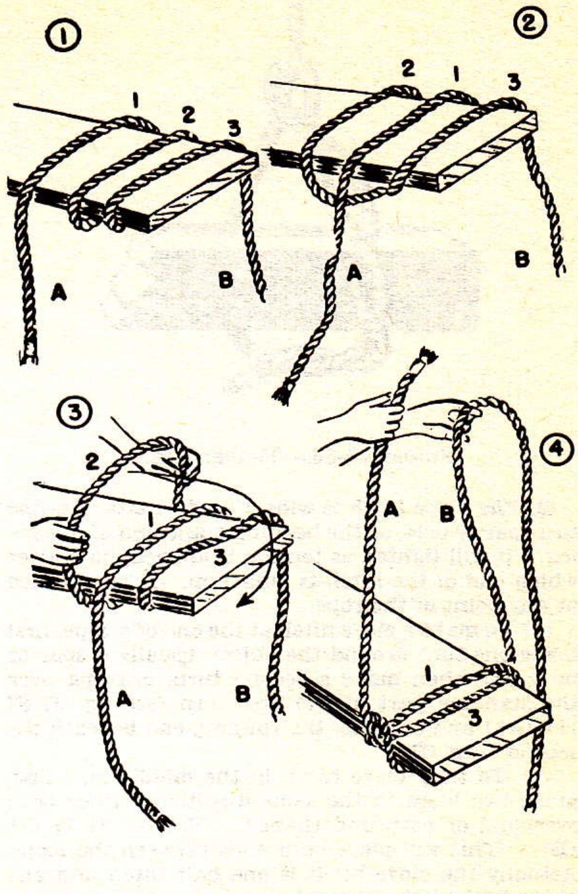


FIGURE 27–41.—Scaffold hitch.

B. *Fid.*—The most necessary tool used in splicing is the fid. It is a tapered, polished, round wooden peg and is used to separate the strands of the rope. After the rigger separates the strand from the line, he places his index finger in the cantline, or groove, of the rope behind the fid. This aids in keeping the strands separated while splicing.

C. *Heaving stick.*—When splicing heavy line, a small bar, or heaving stick, may be attached to wind a few turns in the standing part against the lay, in order to make the strands easier to separate.

D. *Eye splice.*—The principal use of an eye splice is to make a permanent loop or eye in the end of a line.

(1) To make an eye splice, first unlay the end of the rope six turns. This provides the necessary rope for splicing. A whipping should be placed at the end of each strand to prevent unraveling during splicing. In an eye splice three tucks are the minimum requirement. (A "tuck" is the process of passing one loose strand between the strands laid up in a rope.) After unlaying the rope the required number of turns, lay the running end back and parallel to the standing part, forming a loop of the required size. Lay the three loose strands along the standing

part. The loose strand on top of the running end and in the middle of the other two loose strands (strand M, fig. 27–42) is the first strand to be tucked. Insert the fid beneath strand 1 in the standing part of the rope, and hold strand 1 open until strand M is inserted beneath it from right to left, the loose strand coming out of the left and beneath strand 1. Strand L, figure 27–42, will be the second strand to be tucked. Insert the fid beneath strand 2 and tuck strand L beneath strand 2, going from right to left as in the first step. The remaining loose strand on the right (R) is next tucked from right to left beneath the remaining strand in the standing part which does not have any loose strand tucked beneath it.

(2) After the initial strands are tucked once, the three loose strands lose their identity and can be tucked in any order, always working from right to left and taking only one tuck at a time in each strand. The principle to remember is "over one and under one." This simply means to bring the loose strand over the strand next to it in the standing part and beneath the next strand in order. To complete the splice, tuck each loose strand twice more. Be sure that only one loose strand is coming out between two strands of the standing part. After the tucks have been completed, cut off the remainder of the loose strands (not too close to the splice) and pound or roll the splice smooth. If a tapered effect is desired, the strands may be split on the last tuck (or an extra tuck taken) and the lower half of the strand cut off. The remainder of the strand is tucked as before.

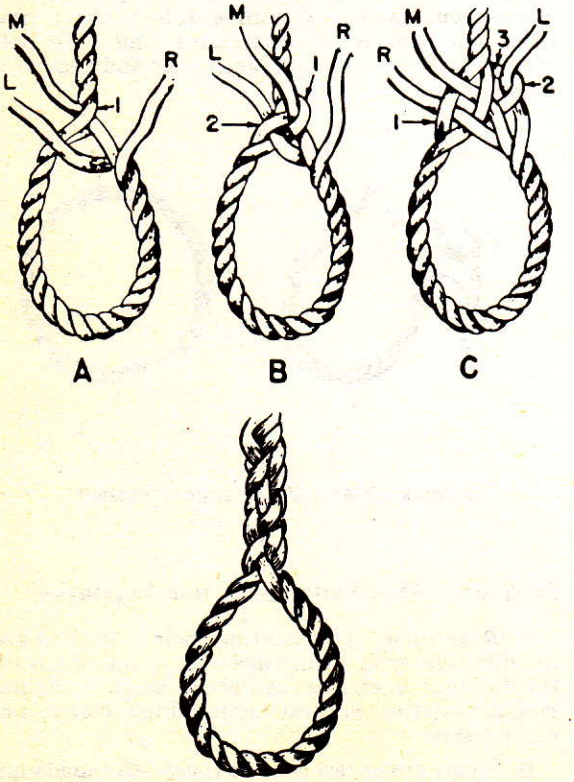


FIGURE 27–42.—Eye splice.

E. *The short splice* is used when it is necessary to join two ropes where an increased diameter will not affect operation. As a completed short splice will increase the diameter of the rope at the point where it is spliced, it will not pass through a sheave in a block. One of the principal uses for a short splice is to make an endless sling for cargo, etc. When possible, a short splice should be made rather than a long splice, because it does not consume as much rope and can be made more quickly.

(1) To make a short splice, first unlay both ends of the ropes six turns, which is the allowance made for the actual tucking operation. Next, put a temporary whipping on each of the loose strands in both ropes. Marry the strands; that is, interlace the loose strands of one rope with the loose strands of the other. If the line is large, stop down the ends on one side while working on the other.

(2) Begin the tucks, following the principle of "over one, under one." Complete three or more tucks (tapering, if desired, as for the eye splice) on one side, then do likewise for the other. Take care not to cut the remaining ends of the loose strands too close. If this is done, when a strain is placed on the rope the strands might pull through, undoing one tuck. Remember, in making the tucks, always to work at right angles to the lay of the rope.

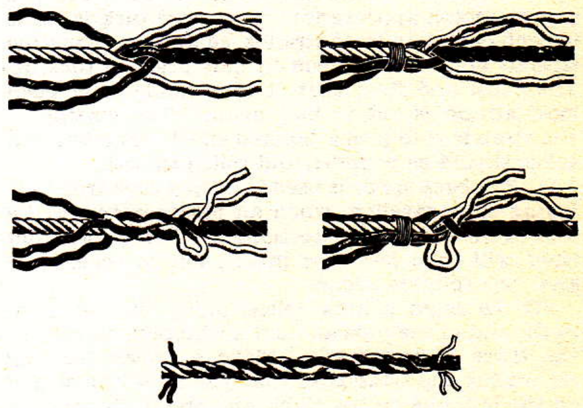


FIGURE 27–43.—Short splice.

F. *A long splice* does not materially change the diameter of the rope. Therefore it is used to join two ropes when it is necessary that the rope run over sheaves in a block.

(1) To make a long splice, unlay each end of the ropes 15 turns and put a temporary whipping on each loose strand. Marry the strands as in the short splice. After marrying, select any opposite pair of loose strands, and unlay the standing part of one of these strands back 10 more turns. (See fig. 27–44 (B).) Now replace those 10 turns with the second loose strand in the pair. Where these strands intersect each other, tie an overhand knot with the lay of the rope. Repeat this procedure for another pair of strands in the opposite direction. If the first pair goes to the right of the point where they were married, the second pair goes to the left. Now there is remaining but one pair, which is located at the point

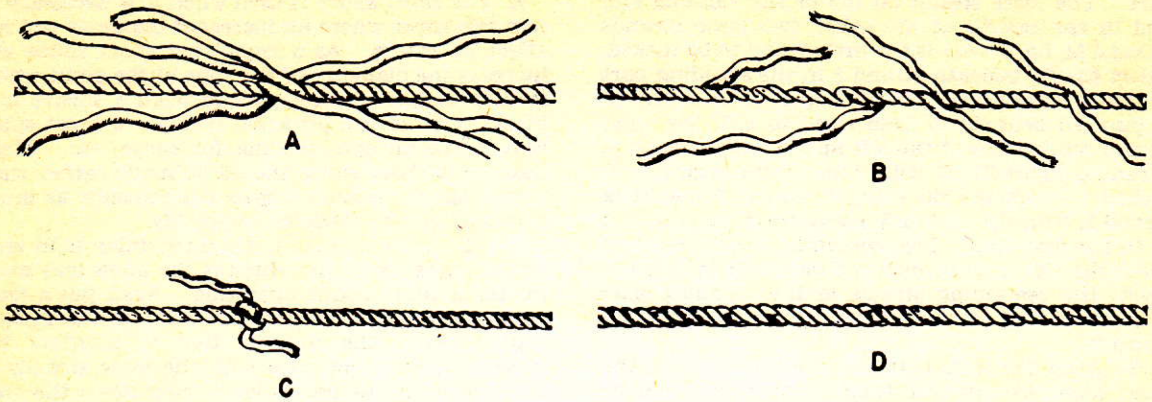


FIGURE 27–44.—Long splice.

where the strands were originally married. These two strands are tied in an overhand knot with the lay of the rope.

(2) All three pairs of loose ends may now be cut, leaving five turns between each pair of ends. Separate each of the six loose strands in half and cut the half that is closest to the main rope; the outer half of the strand will bind and cover the cut section to give a smooth appearance. One more tuck is made in each of the six loose strands, again separating the strands and cutting them in half prior to tucking. The third and final tuck is then made after each loose strand is cut in half again. The cutting of the strands is to give a tapered effect. The finished splice should be pounded and rolled smooth.

G. *The back splice* is used to keep a rope from unlaying or unraveling, when an enlargement of the rope at the end is not objectionable. The crown knot itself will keep the rope intact, but to secure the knot, the splice is added.

(1) To begin a back splice, unlay six full turns in the end of the rope and put a whipping on each of the three loose strands. Make a crown knot by separating the strands so that you have one strand on the left, one on the right, and one in the middle, going away from you. The strands are numbered as follows: 1-middle, 2-left, and 3-right. Take strand 1 and bend it toward you in a loop. Pick up strand 2 on the left and bring it in front of the loop made in strand 1, and lay it across strand 3. Pass strand 3 straight through the loop in strand 1. Tighten each strand separately and evenly. This completes the crown knot.

(2) The three loose strands are then spliced back into the rope following the same principle, "over one and under one," for three tucks.

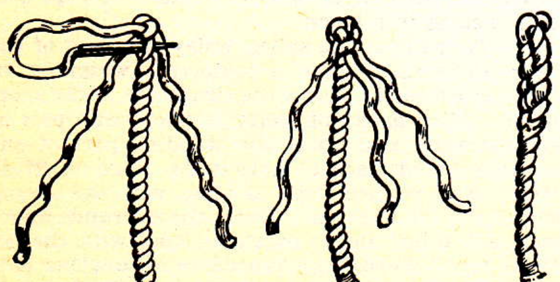


FIGURE 27–45.—Back splice.

H. *To make a grommet*, take one strand of rope of the size desired and cut the strand 3½ times as long as the circumference of the grommet you wish to make. Form a circle of the size desired and lead the long end of the strand around the circle, following the grooves or lay of the rope until you are back where you started. Continue this a third time until you have a three-stranded ring. Tie both ends in an overhand knot, and taper and tuck as in a long splice.

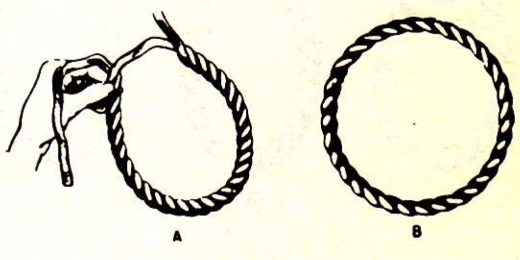


FIGURE 27–46.—Fiber rope grommet.

27–2–35 Fiber Rope Slings and Tackles—

A. *Rope slings* are important tools in loading and handling material. They are used on board tenders for hoisting acetylene cylinders, small unlighted buoys, batteries, general cargo, ship's stores, and other items.

B. *Slings are of two general types*—the single line with an eye splice or thimble in each end, and the endless sling, also known as a strap.

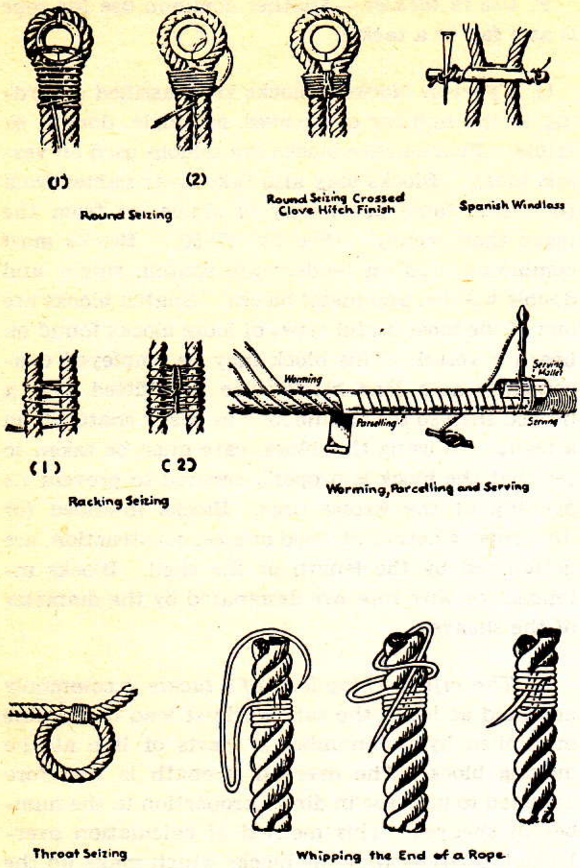


FIGURE 27–47.—Fiber rope seizing; worming, parcelling and serving; whipping the end of a rope. (Reprinted from Knight's Modern Seamanship by permission of D. Van Nostrand & Co.)

C. *The single line sling* with the eye splices in each end, or "snorter," can be used by looping it around the load and hanging both ends on the hook, or it can be used by slipping one end through the eye on the opposite end and hoisting by a single part. The first method should never be used with only one sling as there is practically no grip on the load. When used in the second manner with packages of the same size, the wear is always on the same spot, necessitating the discard of the sling when worn in only a very short section, even though the ends are continually reversed. Frequently a hook is spliced in each end, and a bight seized in the middle for hoisting.

D. *The double sling* can be used as an open loop, by carrying the double sling around the load and putting both loops over the hook, or by slipping one loop through the other, thus making a self-binding sling. This type of sling has the advantage of not causing the bight to occur continually in the same spot. Double slings are made from 2½- to 6-inch line, generally 3 to 6 fathoms long, with the ends joined in a short splice.

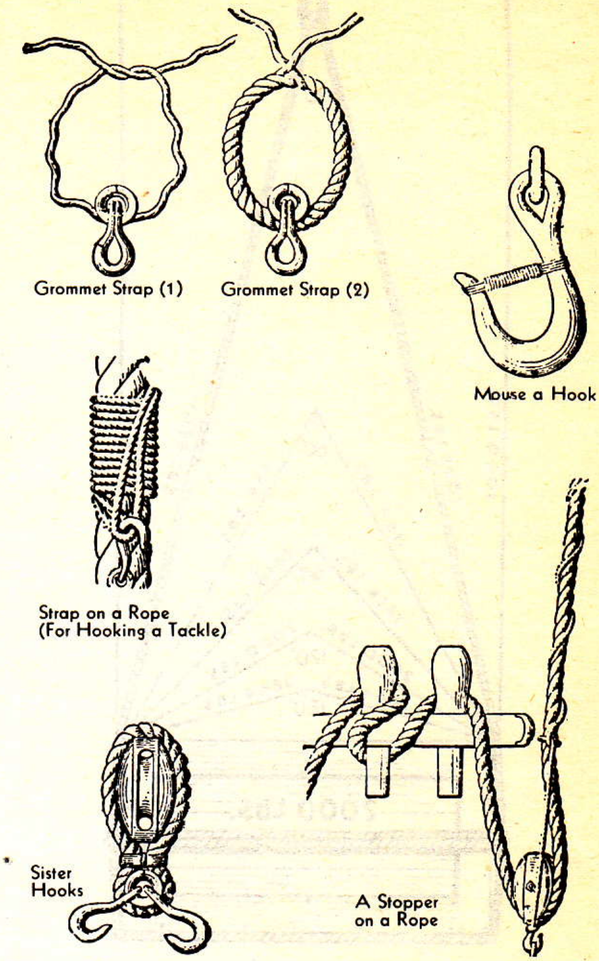


FIGURE 27–48.—More bits of rope work. (Reprinted from Knight's Modern Seamanship by permission of D. Van Nostrand & Co.)

E. *When using slings, take these precautions*:

(1) Protect sharp corners by padding.

(2) Keep the angle of the sling to the load as small as possible, otherwise extra tension is placed on the rope. Figure 27–49 shows how rapidly the tension in the rope increases as the angle of the sling over the load increases.

(3) Make due allowance for the sharp bend of the rope over the hook. All of the foregoing tend to reduce the effective strength of the rope.

(4) Watch the rope for cuts and abrasions.

(5) Bear in mind that multiplying the number of parts of the sling does not increase the effective strength in proportion. Friction and sharp angles prevent the full utilization of all the parts.

(6) Whenever possible, rope should be spliced rather than knotted. A well made splice retains up to 90 percent of the strength of the rope, yet a knot is only up to 50–percent efficient.

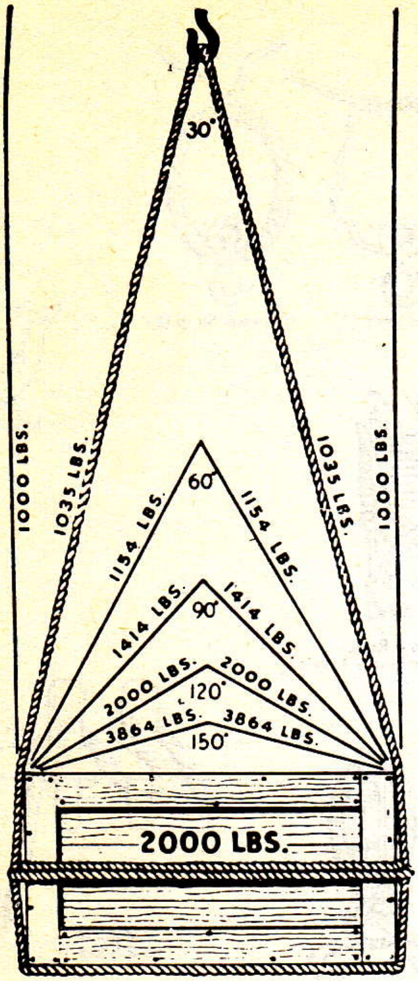


FIGURE 27–49.—Rope tension increases rapidly as the angle of the sling over the load increases. (Reprinted by permission of Plymouth Rope Co.)

Safe loads for manila slings in pounds (using safety factor of 5)

Circumference	Diameter	Safe load for straight pull	Double (2-leg) sling, degrees of angle with the horizontal.		
			60°	45°	30°
1½	½	530	743	612	437
1¾	9/16	690	968	797	569
2	⅝	880	1,234	1,016	726
2⅛	11/16	980	1,374	1,132	809
2¼	¾	1,080	1,515	1,247	891
2½	13/16	1,300	1,823	1,502	1,073
2¾	⅞	1,540	2,160	1,779	1,271
3	1	1,800	2,525	2,079	1,485
3¼	1 1/16	2,100	2,945	2,426	1,733
3½	1⅛	2,400	3,366	2,772	1,980
3¾	1¼	2,700	3,787	3,119	2,228
4	1 5/16	3,000	4,208	3,465	2,475
4½	1½	3,700	5,189	4,274	3,053
5	1⅝	4,500	6,311	5,198	3,713
5½	1¾	5,300	7,433	6,122	4,373
6	2	6,200	8,696	7,161	5,115

F. *Use in tackles.*—Another common use for rope is as a fall in a tackle.

G. *Types of blocks.*—Blocks are classified according to the number of sheaves, as single, double, or triple. Four-sheave blocks are seldom used on vessels today. Blocks may also take their names from their use, some peculiarity of shape, or from the place they occupy. (See fig. 27–50.) Blocks most commonly used on tenders are snatch, single, and double wooden and metal blocks. Snatch blocks are one of the most useful types of loose blocks found on board a vessel. This block may be employed conveniently as a lead block since it is fitted with a hinged shell so that a line may be easily snatched on a bight. In using this block, care must be taken to see that the block is properly secured to prevent its opening at the wrong time. Blocks intended for fiber rope, whether of wood or steel construction, are designated by the length of the shell. Blocks intended for wire rope are designated by the diameter of the sheaves.

H. *The safe working load of a tackle* is commonly accepted as being the safe working load of the line multiplied by the number of parts of line at the moving block. The over-all strength is therefore assumed to increase in direct proportion to the number of sheaves. This method of calculation overlooks the strength of the blocks which make up the tackle. Unfortunately, most blocks are not as strong as the new line which can be rove through them, and the strength of the block does not increase in proportion to the number of sheaves. Despite this weakness, the blocks themselves rarely fail completely. The overloads show up in bent pins and binding sheaves, which make necessary early repair or replacement. Blocks procured under Navy Specifications, and certain commercial "heavy duty" blocks, are generally of equal strength to the designed rope specified. The following tables have been compiled from those published by the Boston & Lockport Block Co. They are based on the tensile strength of material, allowing a factor of safety of five, except in the case of blocks for heavy lifts. These tables apply only to specific types of blocks manufactured by this company. For only one type was comparable data found on blocks of another manufacturer. The values given in the two cases were the same.

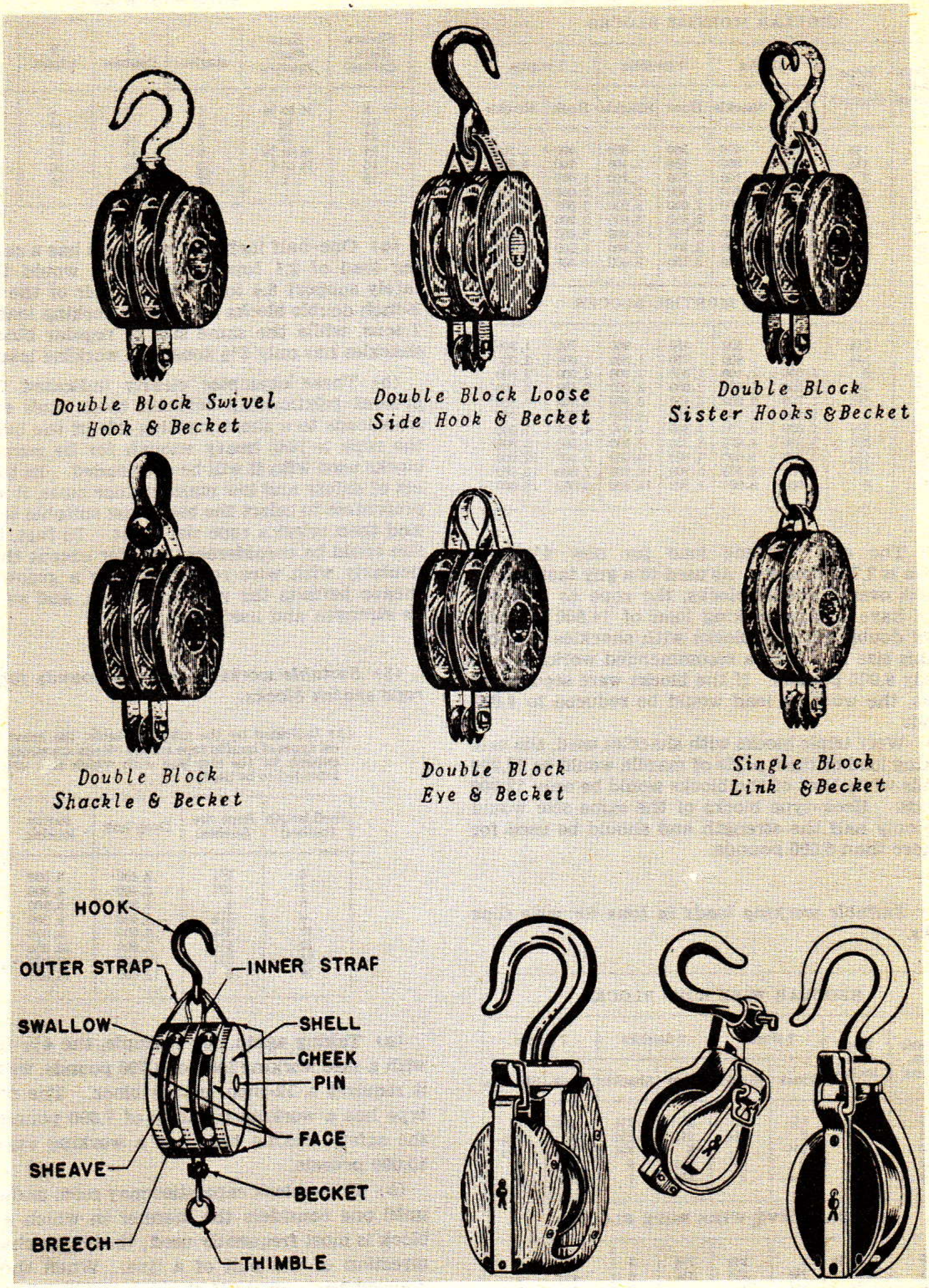


FIGURE 27–50.—Simple and compound tackle; nomenclature of a block; snatch blocks.

(1) *Suitable working loads in pounds for manila blocks.*

Length shell (inches)	Rope circ. (inches)	2 singles		2 doubles		2 triples	
		Hook	Shackle	Hook	Shackle	Hook	Shackle
REGULAR MORTISE BLOCKS							
3	1⅛	200	400	300	800	400	1,200
4	1½	400	800	550	1,400	700	1,800
5	2	500	1,100	750	1,700	1,000	2,100
6	2¼	1,000	1,600	1,500	2,400	2,000	3,000
7	2¾	1,500	2,000	2,000	3,000	2,500	3,700
8	3	1,700	2,400	2,450	3,600	3,200	4,400
9	3	2,300	2,700	2,900	3,800	3,600	5,000
10	3½	2,600	4,000	3,400	5,400	4,200	6,400
12	3¾	3,000	5,000	3,750	8,000	4,500	10,000
HEAVY WIDE MORTISE BLOCKS							
3	1⅛	400	500	550	900	700	1,300
4	1½	500	800	750	1,500	1,000	2,000
5	2	1,000	1,100	1,500	2,200	2,000	2,800
6	2¼	1,500	1,600	2,000	3,000	2,500	4,000
7	2¾	1,700	2,000	2,450	3,800	3,200	4,800
8	3	2,200	2,400	2,900	4,700	3,600	6,700
9	3½	2,600	2,700	3,400	5,000	4,200	7,000
10	3¾	3,000	4,000	3,750	7,000	4,500	9,000
12	4½	3,600	5,000	4,800	9,000	6,000	12,000
14	5½	4,400	6,500	5,700	11,000	7,000	15,000
16	6	6,000	8,000	7,500	14,000	9,000	18,000

(*a*) The safe working load for new 4½-inch manila is 3,700 pounds. As used in a guy tackle with 4 parts over 2 double blocks, the rope as a whole would have a safe working load of 14,800 pounds. Heavy double 12-inch blocks with shackles suitable for this size line have a recommended working load of only 9,000 pounds. If the blocks were secured by hooks, the working load would be reduced to 4,000 pounds.

(*b*) Were triple blocks with shackles used, the safe working load of the 6 parts of manila would be 22,200 pounds while that of the blocks would be only 12,000 pounds. Hook-type blocks of the same size would have only half the strength and should be used for no more than 6,000 pounds.

(2) *Suitable working loads in tons for wire rope blocks.*

Sheave diam. inches	Rope diam. inches	2 singles		2 doubles		2 triples	
		Hook	Shackle	Hook	Shackle	Hook	Shackle
REGULAR WIRE ROPE BLOCKS							
6	⅜	1½	2	2	2½	2½	3
8	½	2	2½	2½	3½	3	4½
10	⅝	2½	3	3	4½	3½	5½
12	⅝	3	4	4½	6	5½	7
14	¾	4½	5	5½	7	6½	8
EXTRA HEAVY WIRE ROPE BLOCKS							
6	⅜ to ½	2	2½	2¼	3	3	4
8	½ to ⅝	2½	3½	3½	6	4½	7
10	⅝	3½	4	4½	7	5	8
12	¾	4½	5	5	10	6	12
14	¾ to ⅞	5	6½	6	12	8	14
16	⅞ to 1	6½	8	8	15	10	18
18	1	7½	10	9	18	11	20

EXTENDED PLATE TYPE WIRE ROPE BLOCKS WITH SHACKLES					
Sheave diam. (inches)	Rope diam. (inches)	2 singles	2 doubles	2 triples	2 quadruples
8	½ to ⅝	4	7	8	9
10	⅝	6	9	10	12
12	¾	7	12	14	16
14	¾ to ⅞	9	14	16	18
16	⅞ to 1	10	18	20	22
18	1	12	20	22	25

(*a*) One-half inch IPS wire rope has a safe working load of 2.1 tons. Four parts would therefore safely support 8.4 tons. But a pair of the heaviest 8-inch double blocks has a safe working load of only 7 tons, while the same size of regular blocks with shackles has only 3½ tons safe working load.

(*b*) These examples clearly indicated that the present relationship between block sizes and rope sizes leads to a short working life of the blocks. If the rope is just heavy enough for its purpose, the blocks used with it will be overloaded. In the interest of safety and low maintenance costs, it would be preferable to select the block size suitable to the job and then select a rope size to fit. In fact, the rope size could be considerably smaller except that, particularly with wire rope, too wide a groove in the sheave permits the rope to flatten, and so reduces its strength and useful life.

(3) *Suitable working loads in pounds for manila rope snatch blocks.*

[As indicated by the following table, the heaviest types of manila rope snatch blocks are strong enough for the size line with which they are intended to be used]

Shell length (inches)	Rope circ. (inches)	Drop link	Safety locking
6	2¾	2,400	3,000
7	2¾	3,400	4,000
8	3	4,800	5,000
9	3½	5,400	6,000
10	3¾	6,600	8,000
12	4½	7,600	10,000
14	5½	10,000	12,000
16	6	12,000	16,000

(*a*) Taking again, for example, the 4½-inch line with a safe working load of 3,700 pounds, we see that it requires a 12-inch snatch block. The drop link type has a working capacity of 7,600 pounds, while the safety locking type has a working capacity of 10,000 pounds.

(*b*) These block capacities may seem unduly large until one considers the manner in which a snatch block is most frequently used; that is, to change the direction of the pull of a line. When the line is doubled back on itself through the block, the load on the block is twice that of the load on the line. Therefore, 3,700 pounds on the line would place 7,400 pounds on the block. Even the 10,000-pound capacity of the safety locking type of 12-inch snatch block is not excessive when it is considered that an overload which breaks the rope would probably at least distort the block. The 6-inch block is not strong enough for 2¾-inch manila, which has a safe working load of 1,540 pounds. This would put a maximum load of 3,080 pounds on the block.

(c) Wire rope snatch blocks do occasionally fail, either by straightening of the hook or breaking of the locking device. Reference to the table below will indicate the reason.

(4) *Suitable loads for wire rope snatch blocks.*

Sheave diameter (inches)	Rope diameter (inch)	Drop link type (tons)	Safety locking type (tons)	Heavy trucking type (tons)
6	⅜ to ½	1½	2	
8	½ to ⅝	2½	3	
10	⅝	3½	4	
12	¾	4½	5	7 for rope diameter ⅝.
14	¾ to ⅞	5½	6	9 for rope diameter ¾.
16	⅞ to 1	7	7½	12 for rope diameter ⅞.
18	1	8	10	
20	1¼	------	12	
20	1½	------	14	

A ⅝-inch IPS wire rope fall has a safe working load of 3.3 tons. With this load on a fall doubled back on itself through a snatch block in the wings to pull cargo into place, the load on the block (and also on the beam clamp or padeye) would be 6.6 tons, but the working load for a safety locking-type snatch block is only 4 tons. If an 8-inch drop link snatch block were used, the safe working load would be cnly 2½ tons. Only the heavy trucking-type snatch blocks have sufficient strength for the size of rope recommended.

(5) The load placed on the snatch block by a given strain on the rope varies, of course, with the angle between the incoming and outrunning line. If these were 180° apart, there would be no load on the block. At 90° the block load is 1.4 times the tension on the line, and the maximum block load of twice the line tension is reached when the two parts of the line are parallel to each other.

If it is remembered that the safe working load of a snatch block is based on the actual load on the block, and not the line going through the block, it is easy to see why the block, rather than the line, usually fails.

(6) *Cargo blocks.*—Heel blocks and gin blocks often bear a statement of the safe working load cast into the block itself. For Boston & Lockport blocks of this type (and probably for those of other manufacturers) "SWL 5 tons" means that 5 tons can be hoisted on a line passing through that block. For blocks of this type only, the safe working load refers to the tension on the rope and not to the total load on the block. For a 5-ton load the strain on the block could be as high as 10 tons. Some 5-ton blocks bear the additional statement, "Tested to 20 tons." This is a bit confusing. It might reasonably be interpreted to mean that the block had been tested to 4 times the safe working load. Actually it means that the test load of 20 tons was the total load on the block representing a load of 10 tons picked up on a fall passed through the block at the head of the boom.

(7) *Summary:*

(a) Blocks are weaker than the number of parts of the size of manila or wire rope which can be passed through them.

(b) Overloading of the blocks in a tackle rarely causes complete failure of the block, but does necessitate early overhaul or replacement.

(c) Manila rope snatch blocks are of adequate strength for the size rope for which they are intended.

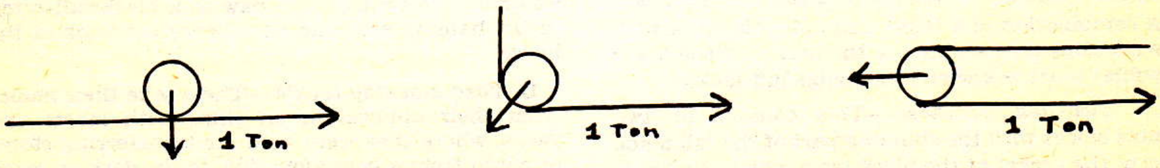
(d) Wire rope snatch blocks have considerably less strength than rope of the size for which they are intended, and complete failure of the block is not uncommon.

(e) Blocks should be selected in terms of the load which will be placed upon them rather than merely on the basis of the size of rope.

I. *Types of tackle in use.*—Some of the common tackles used aboard ship are as follows: (friction is disregarded in speaking of the mechanical advantage here. In practice, allow 10 percent of the load for each sheave). (Circled numbers in the following figures indicate the order of reeving.)

(1) *Single whip.*—A fixed single block with a line rove through it, the end of which is secured to the weight to be moved. Since there is no movable block, it does not multiply the force applied, but does change the direction of pull and furnish a convenient method of hoisting.

(2) *Runner.*—A single movable block which is free to move along a line, the end of which is the standing part. M. A. is 2.



Load on Block 0.0 | Load on Block 1.4 tons | Load on Block 2.0 tons

FIGURE 27–50A.—Examples of strain on a snatch block.

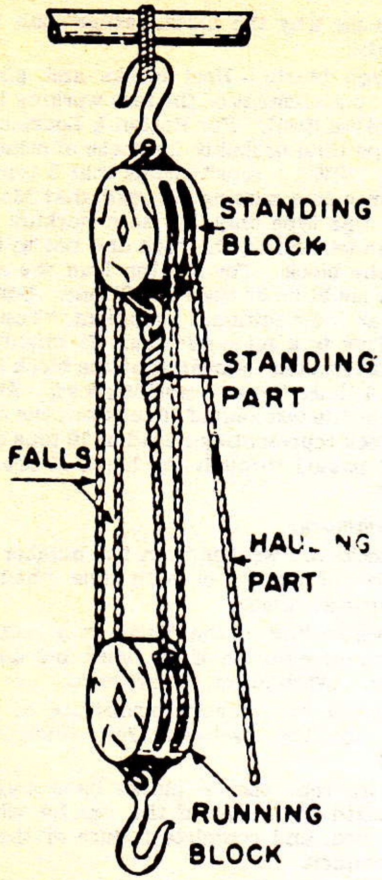


FIGURE 27–51.—Parts of a tackle.

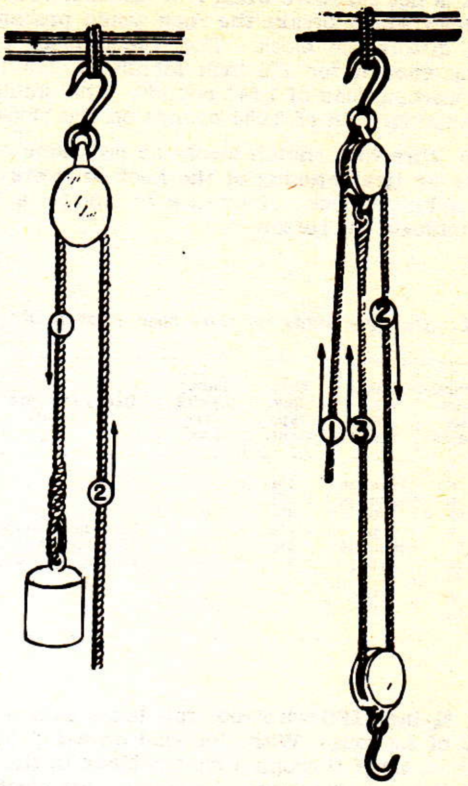


FIGURE 27–52.—Single whip—Gun tackle.

(3) *Whip and runner.*—Two single blocks, one fixed, and one rigged to move along a line, one end of which is the standing part. M. A. is 2.

(4) *Gun tackle.*—Two single blocks, one fixed, the other movable, the standing and the hauling parts leading from the same block. M. A. is 2 or 3, depending upon which block is attached to the weight.

(5) *Luff, jigger, or watch tackle.*—This is one of the most useful tackles aboard ship. It consists of a double and a single block. The standing part of the fall is made fast to the becket of the single block, rove through the double block, back through the single block, and again back through the second sheave of the double block. When the single block is attached to the weight, the M. A. is 3. When the weight is attached to the double block, the M. A. is 4.

A combination of a triple and a double block with the standing part secured to the becket of the lower (double) block is known as a double luff tackle.

(6) *Two-fold purchase.*—This consists of two double blocks with the standing part of the fall made fast to the becket of the block from which the hauling part comes. The M. A. may be 4 or 5.

(7) *Three-fold purchase.*—This consists of two triple blocks rigged similarly to the two-fold purchase. The M. A. may be 6 or 7.

J. *When reeving tackle*, assuming that the line to be rove as a fall is right-handed, the two blocks to be used are placed on the deck, hooks up. The end which is to be the standing part is led into the sheave from which it is intended to lead the hauling part, and the tackle is rove from right to left, or counterclockwise. When the standing part comes to an end, splice or blackwall-hitch it into the becket of the block to which it is to be made fast.

K. *Luff upon luff.*—It is sometimes a good plan to clap a tackle on to the hauling part when great force is required. The proper rigging of a luff upon luff is to bend the double block of one luff to the hauling part of the other luff. Such a rigging would have an M. A. of 12 (disregarding friction). The simplest manner of attaching a tackle to the hauling part of another is to form a cat's paw or a blackwall-hitch in the hauling part and slip it over the hook of the block.

L. *Yard and stay tackle.*—These take their names from their application on ships with masts and yards, where they were used for transferring stores or cargo from a boat alongside, to the deck or cargo hold of the ship. The general principle involved in the yard and stay is of wide application on shipboard in cases where a weight is to be lifted and transferred to a point at no great distance away. See figure 27–54.

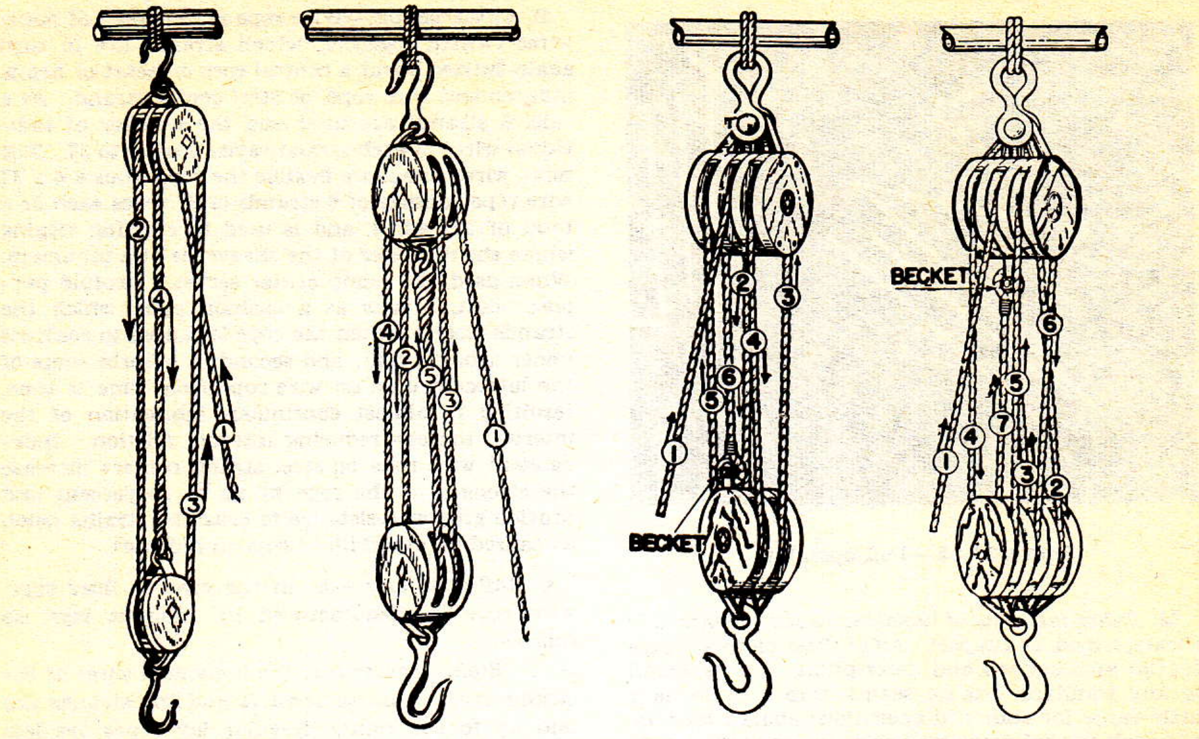


FIGURE 27–53.—Single luff tackle—Two-fold purchase—Double luff tackle—Three-fold purchase.

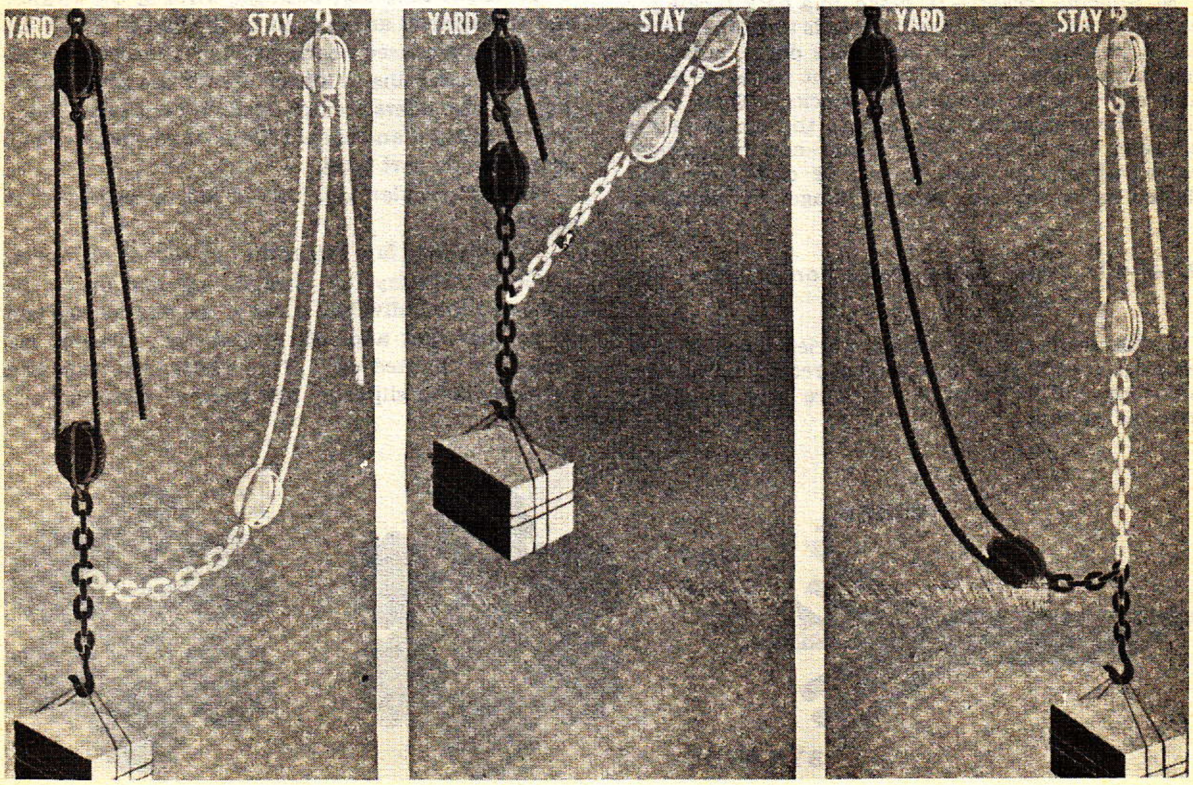


FIGURE 27–54.—Yard and stay tackle.

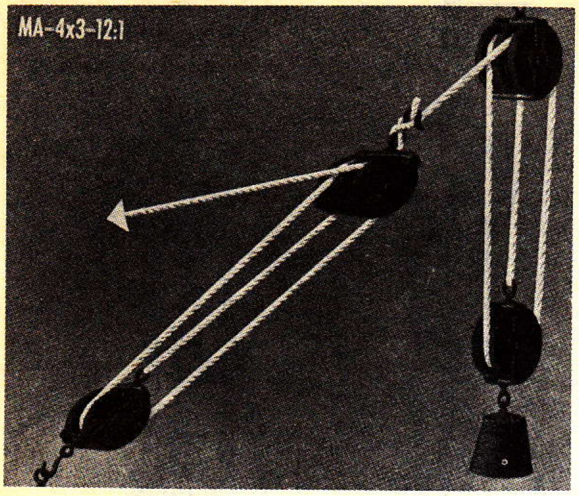


FIGURE 27–55.—Luff upon luff.

M. *Other methods of handling heavy weights are:* shears, tripod, or gin pole. All of these methods have special applications, and descriptions will be found in any standard text on seamanship. These have little value for standard operations aboard tenders, although special cases may arise in connection with putting machinery or vehicles ashore at isolated stations where such a rig may prove useful.

N. *Stowing tackle.*—To make up a deck tackle for stowing away, haul through the falls until the blocks are 3 feet apart. Place the blocks down, points of hooks up (hook should always point the same way) and coil the fall around the blocks. Then clove hitch the end of the fall around the whole tackle between the blocks. The tackle can be stowed, carted about, and still it can be cast loose and fleeted or overhauled, without danger of jamming.

27–2–40 Types and Construction of Wire Rope—

A. Although there are many varied types of wire rope designed to fit a multitude of requirements, the following will be restricted to wire rope generally used on tenders.

B. *Construction.*—Wire rope is composed of many wires twisted together, which strands are in turn again twisted about a central core or heart of hemp, independent wire rope, or steel center strand. As a rule, 6 strands are used and the number of individual wires in each strand varies from 6 to 37. The more wires, the more flexible the rope, thus a 6 x 37 wire rope consists of 6 strands of 37 wires each or a total of 222 wires, and is used in running rigging where the diameter of the sheaves is at a minimum. When used, the hemp center serves a twofold purpose; first, it acts as a cushion upon which the strands close in when the rope is caused to contract under a heavy pull; and second, it absorbs some of the lubricant used on wire rope from time to time, resulting in almost continuous lubrication of the interior, thereby reducing internal friction. Independent wire rope or steel strand centers increase the strength of the rope by up to 10 percent and provide greater resistance to crushing strains (such as caused by overriding turns on a drum).

C. *Different lays.*—As in the case of fiber rope, wire rope is manufactured in different lays, as follows:

(1) *Right-regular lay;* the individual wires of the strand are laid up to the left and the strands are laid up to the right. Regular lay ropes are less likely to be kinked, and give additional resistance to crushing, distortion, and rotating.

(2) *Right-lang lay;* both the wires of the strands and the strands are laid up to the right. Lang lay rope gives increased wearing surface for certain types of service resulting in longer life for the rope. Lang lay rope also offers greater flexibility but has a tendency to untwist and should not be used with a swivel or in a single part hoist.

(3) *Left-regular lay;* this is the opposite of (1) above.

(4) *Left-lang lay;* this is the opposite of (2) above.

(5) *Reverse lay;* the strands are laid up to the right and the individual wires of the strands are laid up to the right and left alternately. Reverse lay ropes have limited use. They resist distortion and prevent clamp slippage, but sacrifice other advantages.

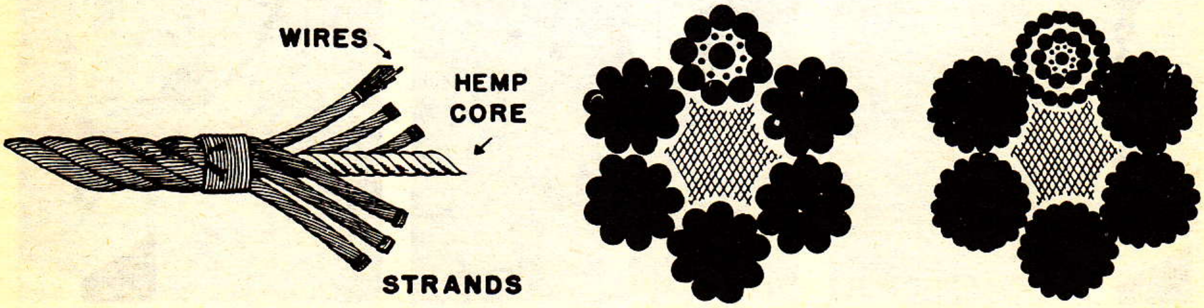
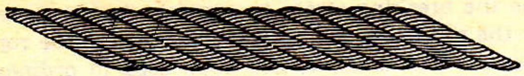
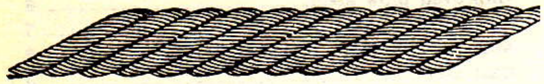


FIGURE 27–56.—Structure of wire rope. 6 x 19 and 6 x 37 wire rope.



Right lay, regular lay.

Right lay, Lang lay.



Left lay, regular lay.

Left lay, Lang lay.

Reverse lay.

FIGURE 27–57.—Different lays of wire rope.

D. *Grades.*—Wire rope is made in the following grades: improved plow steel, plow steel, mild plow steel, cast steel, and other grades for special purposes such as iron, bronze, and stainless steel.

E. *Preformed wire rope.*—Wire rope is now available with preformed strands, i. e., each strand and the wires of each strand are preformed to the exact shape they assume in the finished rope. Preformed ropes have many advantages over regular wire rope in that they withstand a greater number of bends over a sheave, have greater flexibility, resist kinking, permit better attachment of sockets or feige fittings, are easier to wind smoothly and evenly on drums, and when worn are safer to handle, as the broken wires will not stick out. Preformed wire can be cut without seizing.

27–2–45 Size and Use of Wire Rope—

A. *Only plow steel or improved plow steel wire rope should be used for running rigging on tenders. It should be uncoated* as galvanizing weakens the rope up to 10 percent. Corrosion is not a problem on boom rigging since the rope must be kept well lubricated anyway.

B. *Size of boom rigging.*—Wire rope used on tender boom rigging is 6 x 19 or 6 x 37 strand, and varies from ½- or ⅝-inch diameter for small vessels to ¾- and ⅞-inch for the large tenders. The 6 x 19 strand wire rope has greater resistance to abrasion and crushing strains such as are caused by overriding turns on a drum. The 6 x 37 strand rope, being more flexible, permits the use of smaller sheaves in the blocks.

C. *Standing rigging* on the older tenders is generally 6 x 7 or 6 x 12 cast or plow steel galvanized wire rope of up to 1½ inches in diameter. Where extra strength is required, 6 x 19 wire rope may be used.

D. *When measuring wire rope,* take the longest diameter (from the top of one strand to the top of the strand directly opposite (see fig. 27–58)). It is wise to take at least three measurements at intervals of several feet, and strike an average. The length of wire rope is measured in fathoms, as is fiber rope.

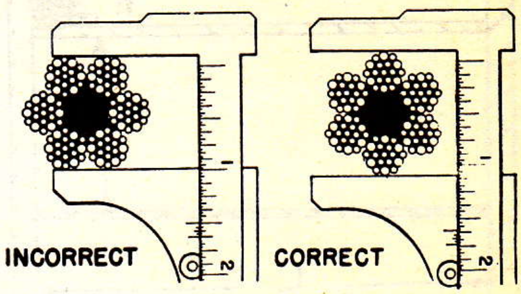


FIGURE 27–58.—Measuring wire rope.

E. *Size of sheave.*—Special care must be given to the size sheave to be used with a specified diameter wire rope. The minimum sheave diameter for 6 x 19 rope is 30 times the diameter; for 6 x 37 rope, 18 times the diameter of the rope. Using a sheave larger than the minimum will give increased rope life.

F. *Fleet angle.*—When wire rope passes over a fairlead sheave and on to a drum, the side angle at which the rope approaches the sheave from the drum should be kept to a maximum of 1½° in order to obtain the best wire rope service. This 1½° angle is the equivalent of about 40 feet of lead for each foot of rope traverse travel either side of the center line of the sheave. Thus a drum with a total of 3-foot traverse travel should be located about 60 feet from the fairlead sheave.

G. *To calculate amount of rope on a drum.*—To determine the length of wire rope wound on a reel, measure the depth of material (h) wound on the drum and add to this figure the diameter (s) of the drum (the hub). Multiply this sum by the depth (h), then multiply the product by the inside length (L) of the drum. Then multiply by a constant (K) as shown below for various sizes of rope. The result will be the length of the rope on the reel. All the measurements are in inches and the length of the rope will be in feet.

$$(h+s)\ h \times L \times K = \text{Length of rope in feet}$$

Constants:

Diameter rope (inches)

½=1.05
⅝= .670
¾= .465
⅞= .342
1 = .262
1⅛= .207
1¼= .168

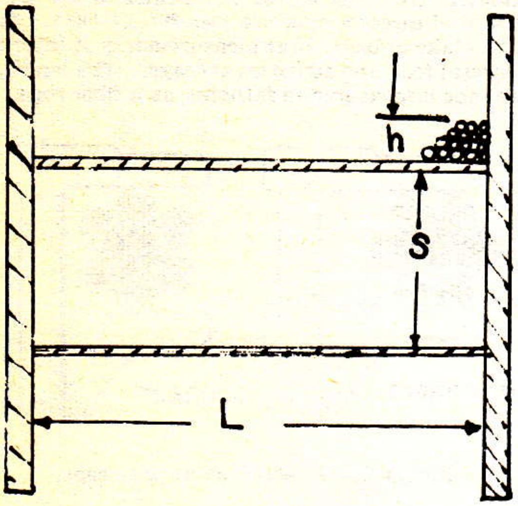


FIGURE 27–59.—Computing length of wire rope on reel.

27–2–50 Computing Strains for Wire Rope—

A. *The breaking strain* of a wire rope is the load tested and set by the manufacturer that will part the rope. Following is a table showing average breaking strains for commonly used 6 x 19 and 6 x 37 wire rope.

6 x 19 WIRE ROPE								
Improved plow steel			Plow steel			Mild plow steel		
Diameter, inches	Weight per foot, pounds	B.S., tons	Diameter, inches	Weight per foot, pounds	B.S., tons	Diameter, inches	Weight per foot, pounds	B.S., tons
½	0.40	10.8	½	0.40	9.4	½	0.40	8.5
⅝	.63	16.6	⅝	.63	14.4	⅝	.63	13.1
¾	.90	23.7	¾	.90	20.6	¾	.90	18.7
⅞	1.23	32.2	⅞	1.23	28	⅞	1.23	25.4
1	1.60	42	1	1.60	36.5	1	1.60	33
1⅛	2.03	53	1⅛	2.03	46	1⅛	2.03	41.5
1¼	2.5	65	1¼	2.5	56.5	1¼	2.5	51
1½	3.6	92.5	1½	3.6	68	1½	3.6	72.5
6 x 37 WIRE ROPE								
½	0.39	10.6	---	----	9.2	---	----	8.4
⅝	.61	16.1	---	----	14	---	----	12.8
¾	.87	22.8	---	----	19.8	---	----	18.1
⅞	1.19	30.5	---	----	26.5	---	----	24.2
1	1.55	39.5	---	----	34.4	---	----	31.5
1⅛	1.96	49.9	---	----	43.5	---	----	39.7
1¼	2.42	61.5	---	----	53.5	---	----	48.9
1½	3.49	88.2	---	----	76.7	---	----	70

B. *To find the safe working load* of wire rope, divide the breaking strain by a safety factor chosen for the particular conditions under which the rope is used. For example, new rope used in ordinary hoisting service should have a safety factor of five. Rope which is to be used under severe conditions, or which is worn, should have the safety factor increased accordingly.

If a table of breaking strain is not available, the safe working load may be computed as follows: square the diameter and multiply the result by one of the constants listed below.

Improved plow steel	8
Plow steel	7
Mild plow steel	6
Cast steel	5

The result will be the safe working load in tons.

C. *Strength of fastenings.*—The following table represents average values of percentage of rope strength obtainable by various methods of rope fastenings. They are listed in their order of reliability.

Method of fastening	*Percent of rope strength*
Wire rope socket (poured zinc type)	100
Wire rope socket (poured zinc type if improperly poured)	50 to 80
Wire rope socket (feige type)	100
Thimble or eye splice with 4 or 5 tucks—	
⅜ to ¾ inch	up to 90
⅞ to 1 inch	up to 88
1⅛ to 1½	up to 82
Thimble in end of rope fastened with wire rope clips	80
(If improperly attached)	70
Three bolt-type wire rope clamps	75

In the case of wire rope clips, a sufficient number should be used, as follows:

Size of clips corresponding to diameter of rope in inches	Number of clips to develop maximum strength	Maximum size wrench to use
½	2	12
⅝	3	12
¾	3	12
⅞	4	12
1	4	16
1⅛	5	16
1¼	5	16
1½	6	16

D. *Wire rope clips.*—When attaching wire rope clips, be sure that the U-bolt rests on the short or bitter end of the rope and the flat base rests on the tension part, otherwise the rope will be injured by putting a crimp into the tension side. Never stagger the clips. See figure 27–60. Clips should be spaced a distance apart equal to 6 diameters. After attaching a clip on a wire rope, tighten all nuts again after the rope is under tension. On operating ropes, tighten after the rope has been in operation for a few hours. When inspecting clip fastenings, it is extremely important to examine the rope at the clip farthest from the bight, as fatigue breaks often develop at this point, due to the fact that rope vibrations or whipping are dampened here. Fatigue damage is less pronounced with preformed rope.

Improved type.—An improved patented clip with two nuts on opposite sides is available. This permits a full swing with any type wrench, and it is impossible to install the clip improperly since the two halves are identical, providing a bearing surface for both the live and the dead end of the rope. The flat bearing surfaces do not distort the rope and thus permit its repeated use. (See fig. 27–61.)

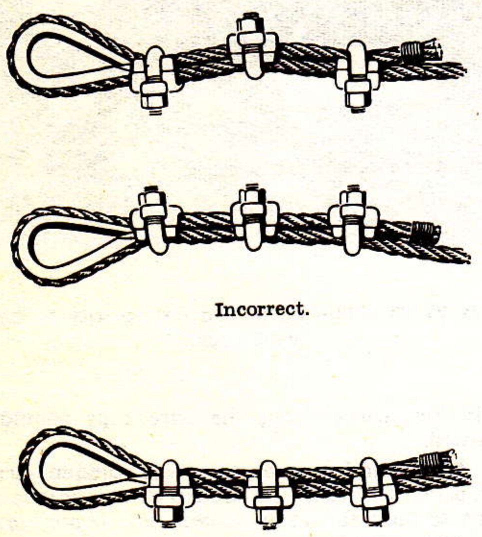


FIGURE 27–60.—Attaching wire rope clips (clamps).

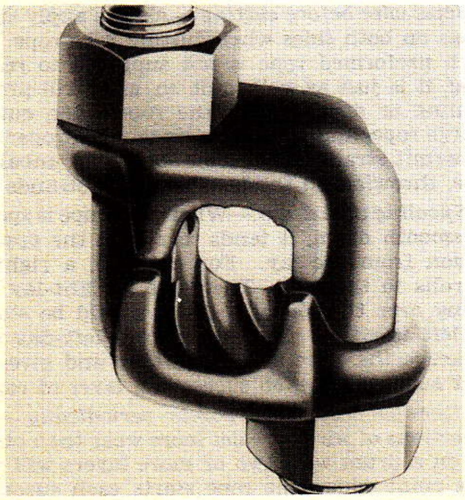


FIGURE 27–61.—Improved-type wire rope clip. (Reprinted by permission of American Steel and Wire Co.)

27–2–55 Rules for Care and Use of Wire Rope—

A. *Lubrication.*—Wire rope must be properly lubricated to insure long life and safety. The internal parts of the wires move one against another wherever the rope passes over a sheave or winds on a drum. Each wire rotates around its own axis, and all wires minutely slide by each other. Internal wear can only be minimized by lubrication. The proper lubricant, with the required amount of lubricating qualities, should be used so as to stay with the rope as long as possible without dripping, wiping, peeling, or flaking. The lubricant should be thin enough to penetrate to the core so as to be absorbed by the hemp.

(1) Commercial lubricants may be obtained. The best is a semiplastic compound applied hot in a thinned condition. It will penetrate while hot and then cool to a plastic filler, excluding the entrance of water. To lubricate properly with a heated lubricant, the wire should be run slowly through a heated tank of the substance. Where this is not possible, application of a thinner unheated lubricant will give better results.

(2) It must be remembered that wire rope is not necessarily lubricated when the outside appears greasy. Therefore care must be taken to insure the penetration of the lubricant into the interstices of the rope.

(3) Some vessels use a medium graphite grease mixed with flake graphite. The exact proportion must be determined for the particular need involved. This makes a good waterproof coating to resist the corrosion of salt water.

(4) Raw linseed oil or old crankcase oil can be used. The linseed oil will dry and be less greasy to handle.

B. *Some common causes of wire rope failure are:*

(1) Rope of incorrect size, construction, or grade.
(2) Rope allowed to drag over obstacles.
(3) Rope not properly lubricated.
(4) Rope operated over sheaves and drums of inadequate size.
(5) Rope overriding or cross winding on drums.
(6) Rope operating over sheaves and drums out of alignment.
(7) Rope operating over sheaves and drums with improperly fitted grooves or broken flanges.
(8) Rope permitted to jump sheaves.
(9) Rope subjected to moisture or acid fumes.
(10) Rope with improperly attached fittings.
(11) Rope permitted to untwist.
(12) Rope subjected to excessive heat.
(13) Rope destroyed by internal wear caused by grit penetrating between the strands and the wires.
(14) Rope subjected to severe overload due to inefficient operation.
(15) Rope kinked.

C. *Size of sheave groove.*—Grooves in sheaves should always be larger than the actual diameter of the wire. The actual diameter of wire rope may be slightly greater than its theoretical diameter. It should be remembered that a sheave groove becomes *smaller,* not larger, through use. However, if the sheave groove is too large, the rope is not properly supported and tends to flatten under tension. If the groove is too small, the rope is pinched and an undue amount of rope abrasion against the sheave flange takes place. For a rope of ⅜- to ¾-inch diameter, the groove clearance should be $\frac{1}{32}$ inch. For rope of ⅞-inch diameter and larger, the groove clearance should be $\frac{3}{64}$ inch.

D. *Unreeling or uncoiling.*—Wire rope has a tendency to kink when unreeling or uncoiling, especially after it has been in service for a long time. When running wire off a reel, the reel should be mounted on large wooden blocks or on a special frame with a pipe or bar for an axle, and the wire slowly run off straight forward. If the wire rope is being run off of one reel on to another, it should always be run from the top of one reel to the top of the other, or bottom to bottom. It should never be run from the top of one to the bottom of the other as the reverse bend will injure the rope. Wire rope which is in a coil should be stood on the edge of the coil and rolled like a wheel. Never lay the coil flat and attempt to pull the rope out as in a coil of manila. When hand coiling wire rope into a coil on the floor or bench, coil it in the direction that will take the twist out of the rope. Right-lay rope will coil in a clockwise direction.

E. *Removing kinks.*—If a wire rope becomes kinked, the kink should not be pulled out by putting a tension on each part. This will permanently damage the rope. As soon as the loop—always the beginning of a kink—is noticed, it should be taken in hand at once. Prevent all tension on the rope. Then uncross the ends by pushing them apart. This reverses the process that formed the kink. Now, turn the rope over and place the bent portion on your knee or some firm object and push downward until the kink straightens out somewhat. Then pound it smooth with a wooden mallet.

F. *Measure of wear.*—When the outside wires are worn to one-half their original diameter, or numerous broken wires show, the wire rope should be discarded.

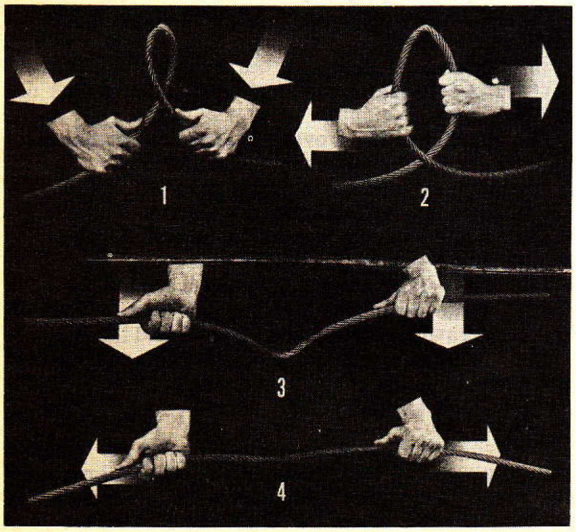


FIGURE 27–62.—The correct way to take out a kink in wire rope (four steps).

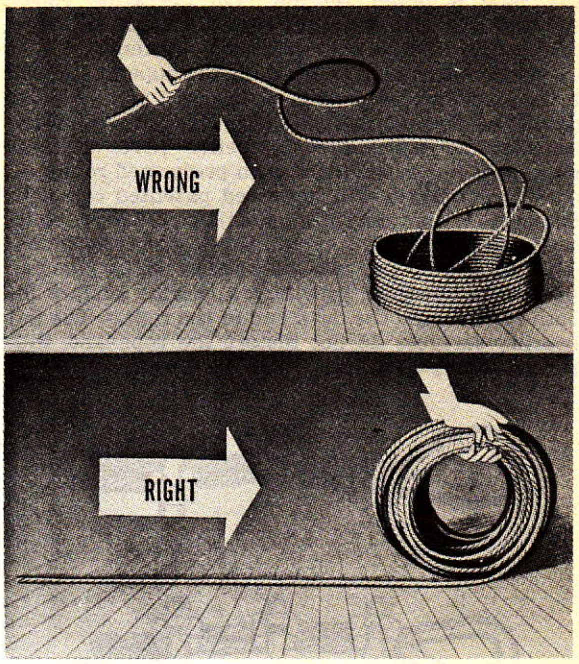


FIGURE 27–63.—The *right* and *wrong* way to uncoil wire rope.

G. *Avoid sudden strains.*—Avoid sudden strains when using wire rope. A sudden strain may be sufficient to part the rope. *Never test boom rigging by jerking a load.*

H. *Inspection.*—Inspect all wire rope at regular intervals and renew the protective coating of lubricant regularly.

I. *Seize wire before cutting.*—Always apply strong seizings on both sides when cutting wire rope. Although preformed rope is not supposed to require seizing, it is just as well to do so, as it will prevent flattening or distortion of the rope when cutting. On large rope, apply triple seizings. Improper seizings permit strands to become loose and unbalance a rope, throwing all the load on a few strands.

J. *Spooling on a drum.*—When wire rope is spooled on a smooth drum, it tends to roll in the opposite direction from the lay. For example, a right-lay rope rolls to the left. Therefore a right-lay rope spooling over the top of a drum should be started from left to right. Conversely for a left-day rope. This keeps the coils firmly together and gives the proper support for each succeeding layer of rope.

K. *Change cross-over points periodically.*—Certain sections of wire rope get more wear than others. Rope on a drum with two or more layers will wear at the point where the rope starts each successive layer, and also at points where the upper layer crosses the lower. Therefore it is good practice to move the rope at regular intervals in order to distribute wear. This can be done by cutting a few feet from the end of the rope from the drum end and refastening. This cut should be of such length as to move the change of layer at least one full coil from its original position and enough to move the crossover points approximately one-quarter turn around the drum. It has been found that hoisting wire rope often wears out on the drums almost as fast as when running through the blocks. Thus end for ending the tackles is a poor risk if new wire is available.

27–2–60—Wire Rope Splices—

A. Several of the different methods of making an eye splice in wire rope are described below. Choice of method rests largely on the preference of the individual. Eye splices with or without a thimble are the most commonly used form of making a permanent loop or eye in a length of wire rope, and develop a higher percentage of strength than wire rope clips. A short splice for joining the ends of two ropes is made in a similar manner to that made in fiber rope except that the strands are tucked over one and under two instead of under one. However, it is seldom used. A long splice may be made in wire rope similar to that made in fiber rope, although, when a boom tackle is in such condition as to require splicing, in the interest of safety it should be renewed entirely.

B. Following is a list of tools used in splicing wire rope:

Side-cutter pliers.
Carew cutters.
Sailmakers pricker.
Marlinespike.
Mallets (wooden and serving).
Knife.
Ball-peen hammer.
Cold chisel.
Rope (hemp) strap and bar.
Riggers screw or vise.

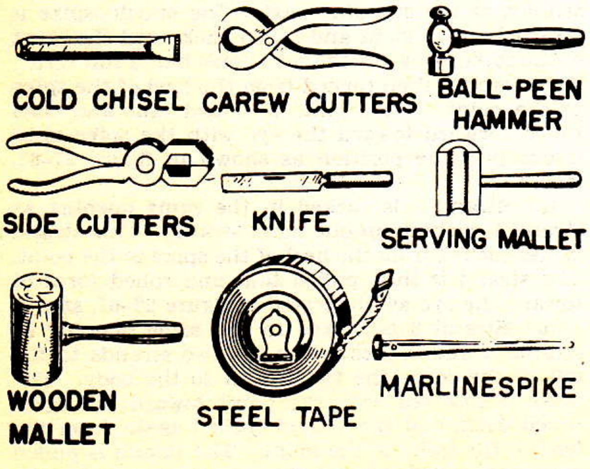


FIGURE 27–64.—Wire-splicing tools.

C. *Seizing wire rope.*—The ends of wire rope must always be seized, otherwise, except in the case of preformed rope, the wire will unlay violently. To make a seizing on wire rope, wind annealed iron seizing wire onto the rope by hand, keeping the coils tight, and considerable tension on the wire (fig. 27–65 (1)). Twist the ends of the wire together counterclockwise, so that the twisted portion of the wires is near the middle of the seizing (2). Tighten the twist just enough to take up the slack (3). Do not try to tighten the seizing by twisting; tighten the seizing by prying the twist away from the axis of the rope (4). Tighten the twist (5) again as in (3). Repeat (4) and (5) as often as necessary to make the seizing tight; then cut off the ends of the wires and pound the twist close against the rope (6).

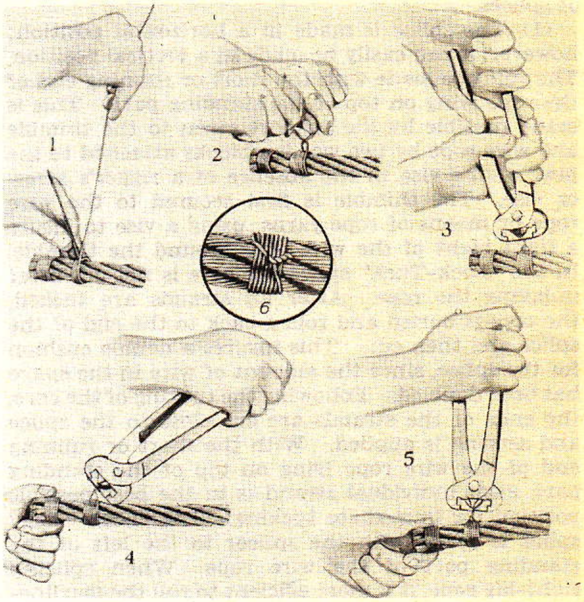


FIGURE 27–65.—Applying wire rope seizing. (Reprinted by permission of American Steel and Wire Co.)

D. *When cutting wire rope*, care must be taken to prevent spreading of the strands, especially if the rope is to be attached to fittings with small openings. After seizings are placed on each side of the spot to be cut, the wire can be cut in any of the following ways:

(1) Sledge hammer and a special wire rope cutter made for that purpose (for any size rope smaller than 1½ inches).

(2) A sledge hammer and a long tapered chisel (commonly used on wire rope three-fourths inch and larger). The chisel point must be wider than the rope being cut, and must have a keen edge.

(3) Bolt clippers (can be used on rope five-eighths inch and smaller).

(4) A hacksaw (not very useful on wire rope made of small wires).

(5) Holding the rope over a sharp steel corner and striking with a sledge hammer. This method is not recommended for wire rope larger than ½ inch as it will spread the strands.

(6) Wire rope may also be cut with an oxyacetylene torch.

E. *The "Lock-Tuck" wire rope eye splice* consists of five complete tucks for each individual strand. Numerous tests have proved that this splice, when properly made, retains more than 90 percent of the rope's original strength. It is a strong, safe, sturdy splice and can be used without danger of the splice pulling out. It is also the most rapid of current methods of splicing. Because of its simplicity, the "Lock-Tuck" wire rope eye splice can be taught to untrained personnel more rapidly than other types of splices.

(1) The splice is made in a horizontal position; however, it can easily be made in a vertical position. The splice is made with the short or running end of the rope lying on top of the standing part. This is made possible by the support given to the thimble and wire rope by two wooden blocks attached to the jaws of the vise in the absence of a rigger's screw or vise. The thimble is first secured to the wire rope by means of rope yarns, using a vise to insure a tight bight of the wire rope around the thimble. In the "Lock-Tuck" splice the core is not cut after unlaying the rope. After all strands are tucked, the core is buried and rolled back to the end of the splice and then cut. This insures a double cushion for the splice, since the amount of wire in the splice has been doubled. Following the tucking of the core, the ends of the strands are cut close to the splice and serving is applied. With the short or running end of the wire rope lying on top of the standing part, each individual strand is in the best possible position for immediate tucking. The "Lock-Tuck" splice is made with the splicer to the left of the standing part of the wire rope. When splicing right-lay rope, it is more efficient to roll the marlinespike back and forward with the right hand, thus placing the splicer closer to his work and simultaneously developing speed.

To begin the splice, strand 1 is tucked once and then working left to right, strands 2, 3, 4, 5, and 6 are tucked once. Beginning with strand 6, the "lay" of each individual strand is taken out; that is, untwisting the strand until it opens up. This opening of the strand guarantees a strong, tight tuck, a firm well-rounded splice, and spreads the stress and strain on all wires in the strands. When strand 6 is tucked five times, the splicer tucks strand 5 four more times, strand 4 four more times, and so on until strand 1 is completely tucked.

(2) Procedure for "Lock-Tuck" Wire Rope Eye Splice—

(*a*) To begin the splice, the seizing is removed from the running end of the wire rope, all six strands are unlayed back to the seizing near the throat of the thimble, and divided as shown in figure 27–66, step 1, with the core in the center and three strands to the left and the three remaining strands to the right of the core. The strands are numbered as follows: Beginning at the lower left—1, 2, 3, 4, 5, and 6.

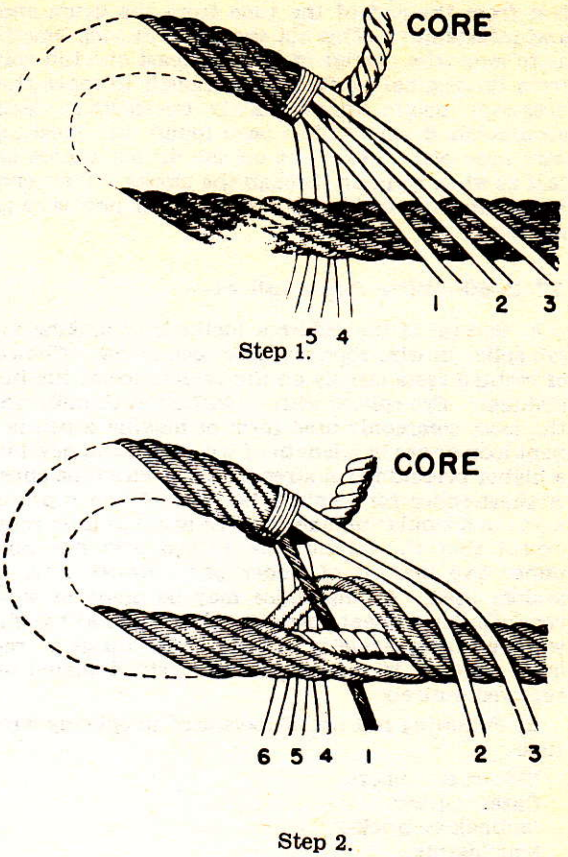
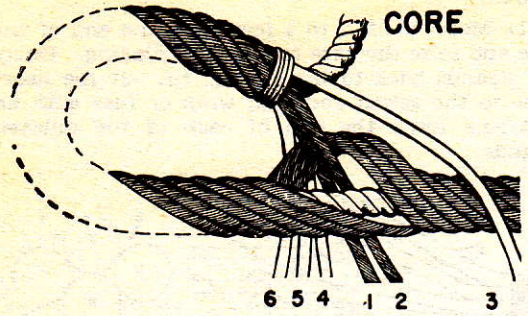


FIGURE 27–66.—Steps 1 and 2—Lock-Tuck eye splice.

(*b*) Strand 1 is first tucked under the two top strands of the standing part. The marlinespike is inserted left to right and rolled back until the point of the spike is toward the body (one-half a full turn). The strand is then tucked from the heel of the spike to the point. The strand is pulled taut and then rolled forward toward the eye with the spike until it occupies the position as shown in figure 27–67, step 3.

(*c*) Strand 2 is tucked in the same opening as strand 1, picking up one more strand. This strand is also tucked from the heel of the spike to the point. The strand is then pulled taut and rolled forward toward the eye as illustrated in figure 27–67, step 4.

(*d*) Strand 3 is tucked in the same opening as strands 1 and 2, picking up the two strands to the left of the core—the two closest to the body. The spike is inserted with the point toward the deck, rolled back, and the strand tucked again from the heel of the spike to the point. The strand is pulled taut and rolled toward the eye and occupies the position shown in figure 27–68, step 5.



Step 3.

Step 4.

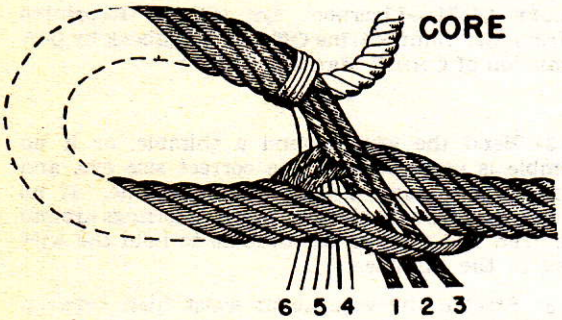
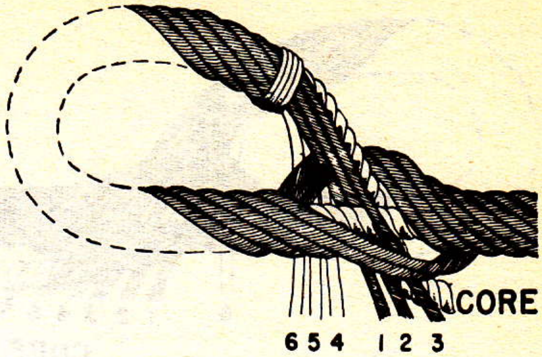


FIGURE 27–67.—Steps 3 and 4—Lock-Tuck eye splice.



Step 5.

Step 6.

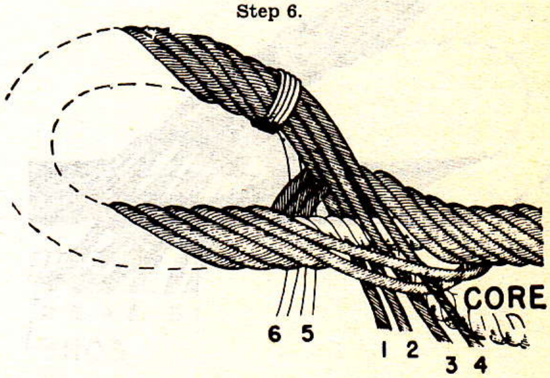


FIGURE 27–68.—Steps 5 and 6—Lock-Tuck eye splice.

(*e*) The core is tucked in the same opening as strand 2. The spike is inserted above the core in the standing part, dividing the six strands, rolled back until an opening large enough for the core is made to the left of the spike, and the core is tucked into the opening. The spike is rolled forward against the core, tucking it into position as shown in figure 27–68, step 6.

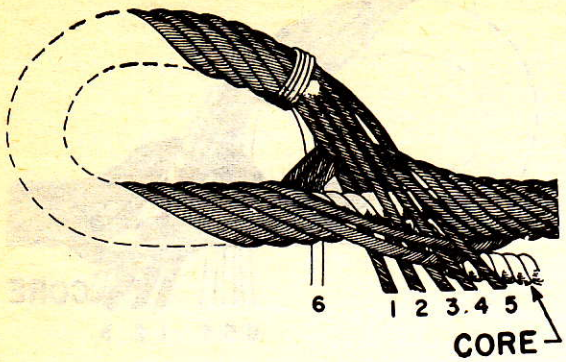
(*f*) In order to tuck strand 4, the spike is inserted from the deck up, picking up the first strand to the left of the opening made by the strands 1, 2, and 3. The spike is rolled back one full turn until the heel of the spike is toward the body, and the strand is tucked with the lay from the point to the heel of the spike. From here on, all strands are tucked from the point to the heel of the spike. The strand and spike are rolled forward toward the eye as illustrated in figure 27–69, step 7.

(*g*) To tuck strand 5, insert spike from left to right, picking up the next strand to the right of the last tuck. The spike is rolled back and the strand tucked from the point of the spike to the heel. The spike and strand are rolled forward to the position occupied in figure 27–69, step 8.

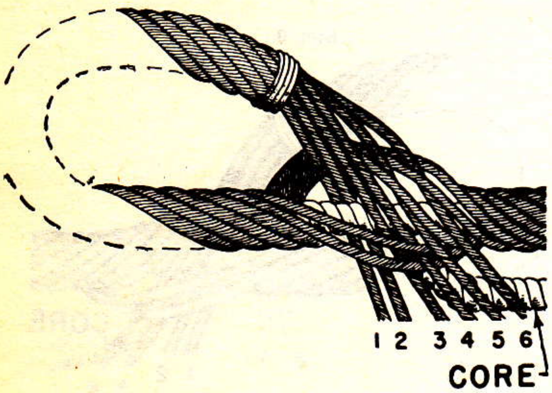
(*h*) Strand 6 is tucked by inserting the spike left to right, picking up the next strand to the right of the last tuck. Important—beginning with the strand 6, all tucks are made after the lay has been taken out of the individual strand. The spike is rolled back, and the strand tucked from the point of the spike to the heel as shown in figure 27–70, step 9. The spike is not withdrawn from the wire rope until strand 6 is tucked four more times.

(*i*) After strand 6 is tucked once, the spike is rolled back again, and the strand tucked four more times as shown in figure 27–70, step 9. This completes all the tucking required for strand 6.

(*j*) After strand 6 is tucked five times, starting with strand 5 and working back to 1, all strands are tucked four more times. The core is then buried and cut at the end of the splice. The completed "Lock-Tuck" wire rope eye splice is shown in figure 27–70.



Step 7.



Step 8.

FIGURE 27–69.—Steps 7 and 8—Lock-Tuck eye splice.

Step 9.

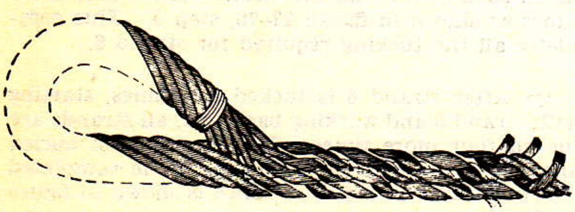


FIGURE 27–70.—Step 9 and completed Lock-Tuck eye splice.

F. To make a "Liverpool" eye splice, proceed as follows:

(1) Measure off 2 to 4 feet from the end of the rope and seize the wire to prevent unlaying. Unlay the strands back to the seizing, cut out the heart close to the seized end, and whip or fuse with an acetylene torch the end of each of the unlayed strands.

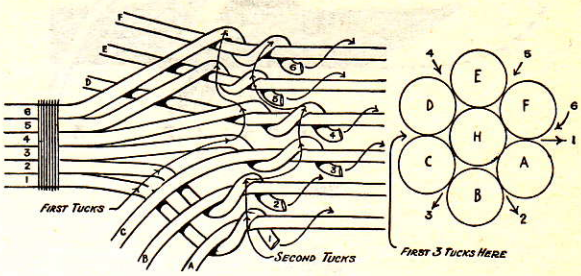


FIGURE 27–71.—Liverpool eye splice, (Reprinted from Merchant Marine Officer's Handbook by permission of Cornell Maritime Press.)

(2) Bend the wire around a thimble, or if no thimble is used, bend to the correct size eye, and seize the two parts together with marline. If no rigger's vise is available, pass marline seizings around the head and sides of the thimble to hold the wire snug in the thimble.

(3) Stretch the wire about waist high between two permanent objects, or clamp the eye in a vise and secure the standing part (some riggers prefer to work with the eye and vise in a vertical position, stopping off the standing part to the overhead), and ease some of the twist out of the wire by turning the eye several times before inserting it in the vise. Taking some of the twist out of the standing part is important in any splice, as it makes the insertion of the marline spike into the strands much easier, and lessens the danger of crimping the wire, as when forcing the spike perpendicularly into the rope. The spike should always be inserted at a sharp angle to the rope. When splicing horizontally, the twist is eased by using a hemp stopper and a bar.

(4) Assume that the splice is to be made horizontally; with the strands lying about parallel to the part of the wire rope through which they are to be tucked, and the eye in a vertical position, stand with the eye on your left side and face in the direction in which the tucks are to be made. Divide the tucking strands so that three are on each side of the standing part.

(5) Open the standing part through the center with a marline spike and tuck the top strand over the right side through the opening. This step is shown in figure 27–71, when tucking strand 1 passes under strands C, B, and A of the standing part.

(6) The next strand on the right is tucked through the same opening but comes out under two strands on the right. This step is shown in figure 27–71 where tucking strand 2 passes under the strands C and B of the standing part and comes out between strands B and A.

(7) The last strand on the right also is tucked through the same opening but comes out under one strand. This step is shown in figure 27–71 where tucking strand 3 passes under strand C of the standing part and comes out between strands C and B.

(8) The top tucking strand on the left side is now passed over and around the top strand on the left side of the standing part. This step is shown in figure 27–71 where tucking strand 4 passes over and around strand D of the standing part.

(9) The next tucking strand is passed over and around the next strand of the standing part. This is shown in figure 27–71 where tucking strand 5 is passed over and around strand E of the standing part.

(10) The last tucking strand is passed over and around the last strand of the standing part. This is shown in figure 27–71 where strand 6 passes over and around strand F.

(11) This completes the first tuck of all six strands. The marline spike should be used to force or clinch each tuck up close to the thimble. When working vertically, it is sometimes easier, after working the spike through the proper strands, to run the spike up around the standing part a turn or two, following with the strand to be tucked (be sure the tucking strand makes the exact number of turns as the spike, in order to maintain its proper relationship to the strands of the standing part); then push the strand through the opening under the spike. A strand should always be pushed through the opening on the side of the spike nearest the thimble so that the leverage exerted by the spike will be forcing the strand tighter into the splice. It will be found in larger sizes of wire that it is easier to push the tucking strand through the rope if the opening has been run back a turn or two with the spike, and it does not make such a sharp crimp in the wire when pulling and clinching it tight. Now run the spike and the strand under it around back into the splice.

Caution: A marlinespike should never be inserted perpendicularly into a wire rope. To do so may distort the strands. Always hold it at a sharp angle to the rope and work it cautiously between the strands, being careful not to nick the individual wires. A sailmaker's pricker is often used to make a small opening for the spike.

(12) The second tuck for each strand is made by passing the tucking part around and under the strands of the standing part following the lay of the wire. This second tuck is shown in figure 27–71 by the small arrow marked "second tuck."

(13) To finish the splice, take one or two more tucks with each strand in the same manner; pound the splice into shape with a wooden mallet, and cut off the ends of the tucking strands close to the splice. Cut the marline seizings around the thimble and serve the splice with seizing wire to protect the hands of personnel using the rope. Permanent splices, such as in standing rigging, are often painted with red lead, wormed, parcelled, and double-served in the way of the thimble.

G. *The "Molly Hogan" eye splice* was originated by the logging industry and can be easily made with a minimum of tools in a few minutes. It will develop an efficiency of from 75 to 85 percent. It is more easily made with preformed wire rope but can also be made with regular wire rope. Using preformed wire rope, the splice is formed by unlaying the rope to form two strands or sections, each containing one-half the original strands, for a distance of a little more than twice the length of the loop or eye desired. The loop is formed by tying the two sections together in an overhand knot and then continuing the twisting (as laying in a grommet) until the loop is completed. When using unpreformed wire, in order to obtain the original lay of the rope, it is necessary to "roll" the strand into position with a marline spike. To make the Molly Hogan splice, proceed as follows:

(1) Unlay the wire rope in two sections 3 to 4 inches longer than the circumference of the eye desired, cutting out the core. (See fig. 27–72 (A).) If desired, the core may be left in one section of wire. Make a simple overhand knot, letting the strands fall together when you have the desired size eye (fig. 27–72 (B)).

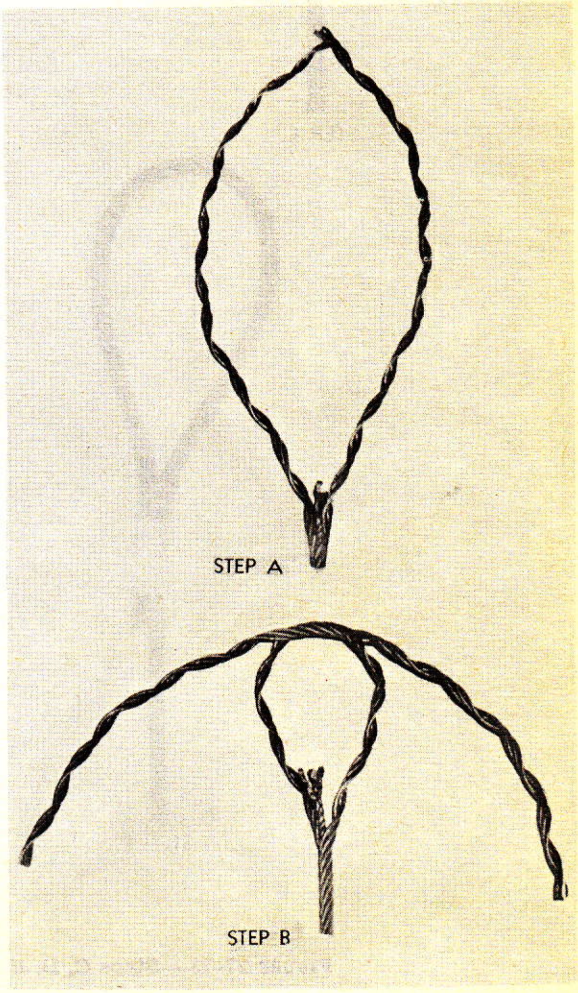


FIGURE 27–72.—Steps A and B—Molly Hogan eye splice.

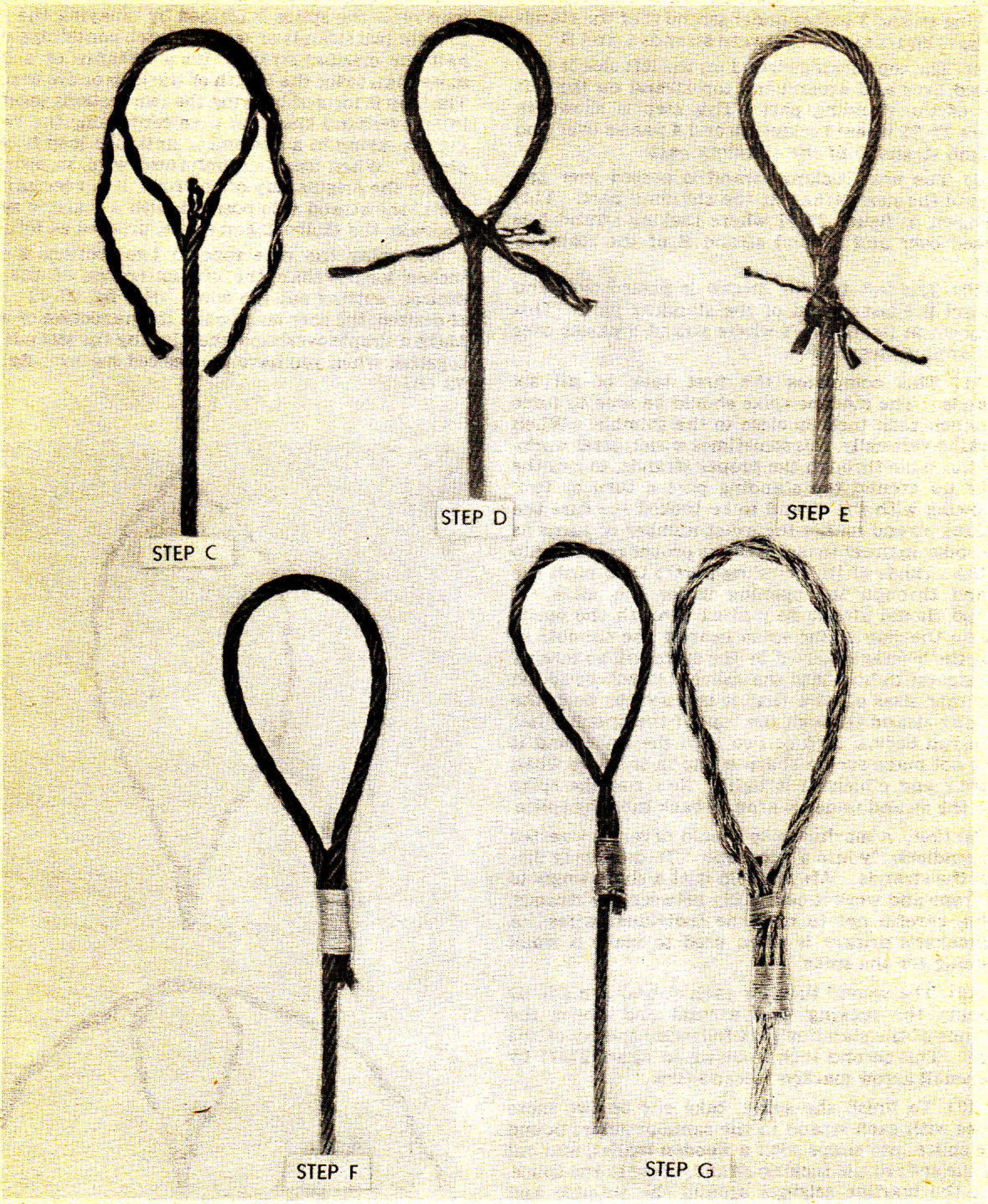


FIGURE 27–73.—Steps C, D, E, F, and G—Molly Hogan eye splice.

(2) Bend the sections through the eye, letting them spring into place (fig. 27–73 (C)). Continue bending around again until the eye is complete (as in making a grommet) (fig. 27–73 (D)). Secure the two ends together with a couple of twists and seize to the standing part. (See fig. 27–73 (E) and (F).) Figure 27–73 (G) shows the splice when made with nonpreformed wire.

H. *Other splices.*—There are several other good methods of eye splicing, namely the "Gun Factory" and the "West Coast Logging" splices, etc. Short and long splices are not described herein since their use on board a tender will be slight. Good descriptions of these splices will be found in a standard text on seamanship.

27–2–65 Wire Rope Sockets—

A. *Poured zinc wire rope sockets* are used on the topping lift of the older type tenders and on the ends of standing rigging. A properly poured socket develops 100 percent of the strength of the rope. Poured sockets are available in closed or open end types. To attach a poured zinc type socket, proceed as follows (see fig. 27–74):

(1) Place an additional long seizing on the rope end to be socketed at a distance equal to the length of the basket of the socket from the end of the rope. It is important that this seizing be carefully applied, and of sufficient length to prevent any untwisting of the strands which would result in unequal tension on the strands when the socket is attached.

(2) Place the rope end upright in a bench vise. Remove any seizing above the one referred to under (1) above. Cut the hemp core at the seizing.

(3) Untwist the strands and broom out the wires. The wires should be separated but not straightened.

(4) The wires, for the distance that they are to be inserted in the socket, should be carefully cleaned with gasoline, naphtha, or benzine, and dipped into a bath of commercial muriatic acid for about 30 seconds to 1 minute, or until the acid has thoroughly cleaned each wire. Care must be taken that no acid touches any part of the rope under the seizing. The acid should be neutralized by next dipping the wires into boiling water to which has been added a small amount of soda.

(5) Place a temporary seizing on the wires at the end and force the socket down over the rope end until it reaches the seizing on the rope. Remove the temporary seizing on the end and allow the wires to expand within the socket basket. The ends of the wires should be level with the upper end of the socket basket. Care should be taken to see that the axis of the socket is in line with the axis of the rope.

(6) Seal the base of the socket with putty, fire clay, or similar substance. Heat the socket so that the zinc when poured will cool more slowly.

(7) Fill the socket basket with molten zinc. The zinc must not be too hot or it will anneal the wires, particularly on small ropes or ropes consisting of small wires. From 800° to 875° F. is the correct temperature. If a pyrometer is not available, the following less accurate test is sometimes used; place a stick of pine wood into the zinc. If it chars but does not ignite, then the zinc is ready to pour. If the zinc is too hot, it has a red color and the stick will ignite.

(8) The socket should be allowed to cool slowly. The seizing can then be removed.

(9) Never use babbit, lead, or other antifriction metal.

B. *Feige sockets.*—Tenders of the 180-foot class are equipped with patented feige-type wire rope sockets for ¾- and ⅞-inch wire rope. These sockets when properly fitted will develop 100 percent of the strength of the rope. Feige-type sockets are available in open-, eye-, and stud-end sockets. Feige-type sockets are smaller in size than poured zinc sockets because the large basket for the hot metal in the old socket has been eliminated. There is no zinc to heat. Only a carefully designed plug is inserted. Care must be taken to insure that only 3° fluted plugs and 3° sleeves are used, since the 3° angle of bore taper has been found to provide the maximum holding strength. Six degree plugs and sleeves were originally furnished in some instances, but they should be replaced. Identification may be made from plan 76TE1701–52 for 3° plugs. In all cases where a socket is opened, the plug should be thrown away and a new plug used for reassembly. The plugs are made of bronze and distort from use.

(1) When attaching feige-type fittings to preformed wire rope, no seizings are required. The proper distance should be marked on the rope with chalk or pencil. Use a six-fluted plug with six strand wire ⅜ inch diameter or larger.

(2) Apply one seizing on regular wire rope beyond the two that are on the end, at a distance from the end of the full length of the sleeve, plus the length of thread on the sleeve, plus one-half of the hexagon for six-strand rope, or plus the whole of the hexagon for eight-strand rope.

(3) Adjust second seizing far enough from the end of the rope so that the hemp center can be cut out the distance equal to the length of twice the threaded section of the sleeve.

(4) Remove the seizing nearest the end. When using the six-fluted plug, separate the strands, cut out the hemp core down to the second seizing (do not cut out wire center, if any).

(5) Drive the second seizing up toward the end of the rope with a hammer and pliers so as to bring the strands together.

(6) Slip the sleeve over the end of the rope and screw the socket end of the fitting on the sleeve a couple of turns, driving the assembly down the rope until the strands extend beyond the sleeve, the length of the threaded section plus one-half of the hexagon for six-stranded rope, then remove the socket part of the fitting.

(7) Insert the plug between the strands. See that the strands fit into the grooves of the plug. Tap the plug down gently with hammer and punch and while doing this, with one hand grip the strand ends, rotating them slightly in the direction opposite to the direction of lay of the rope, thus permitting the

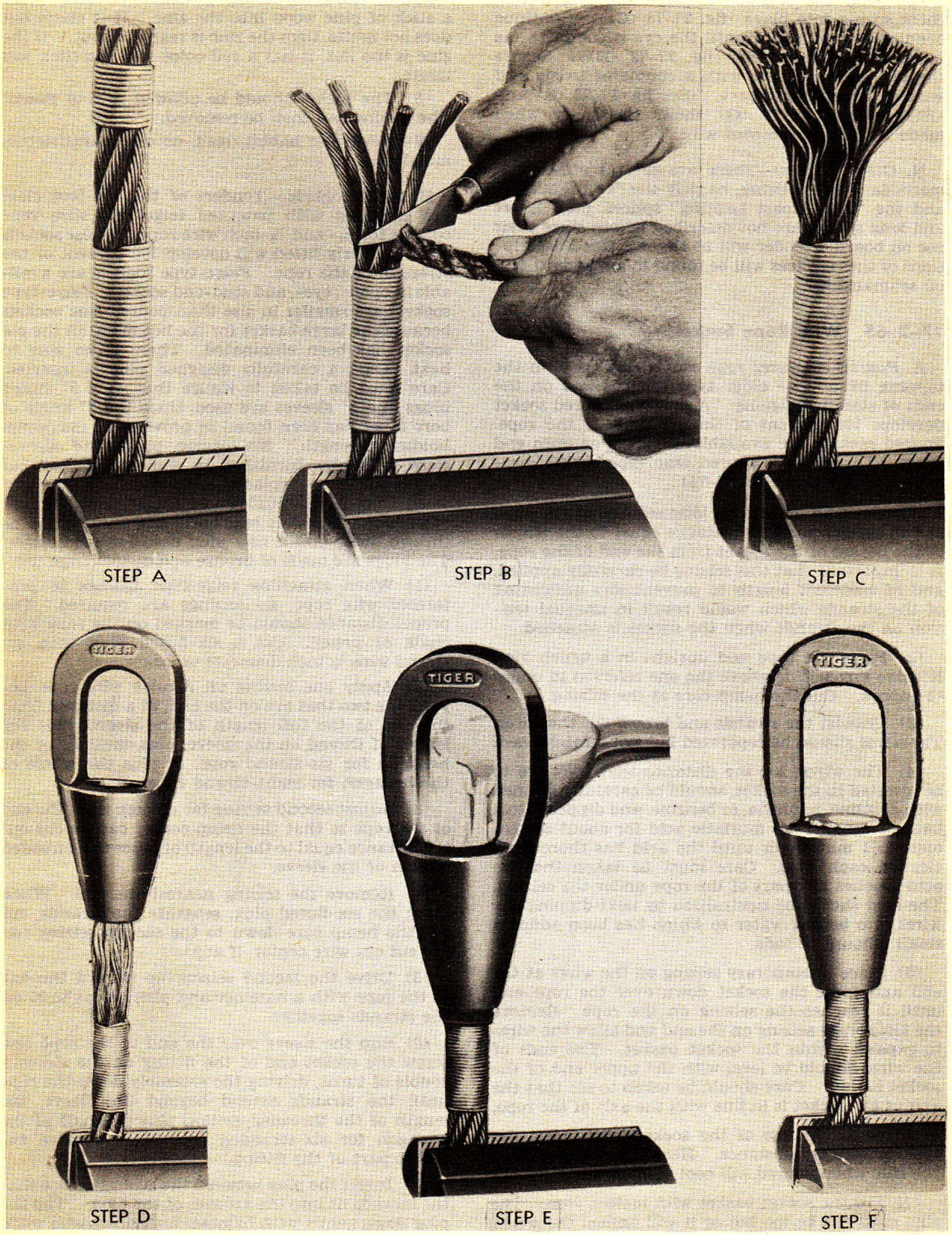


FIGURE 27–74.—Pouring a zinc wire rope socket. (Reprinted by permission of American Steel and Wire Co.)

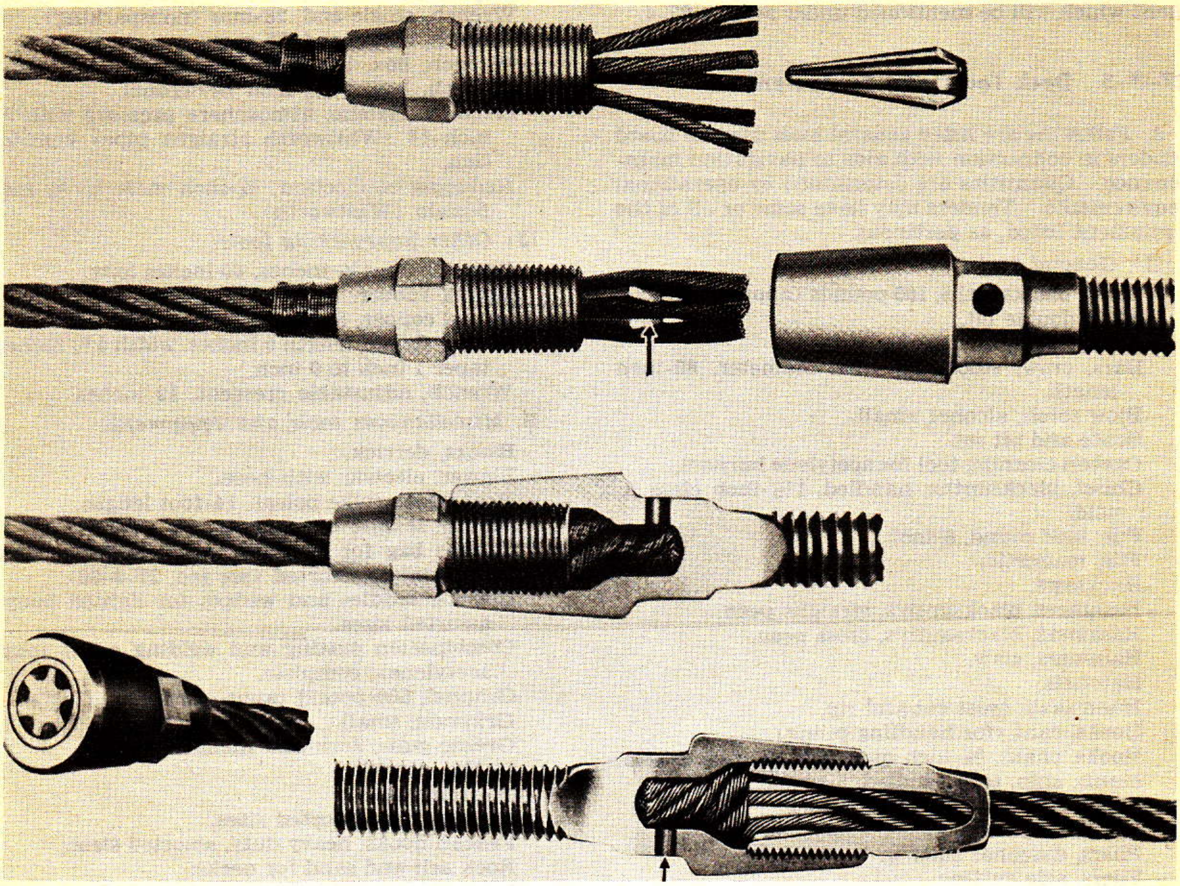


FIGURE 27–75.—Feige wire rope socket. (Reprinted by permission of Electroline Co.)

strand ends to adjust themselves in the grooves of the center plug.

(8) Grip the hexagonal section of the sleeve in a vise or wrench and drive the plug down firmly with hammer and punch, making sure that it goes down as far as possible.

(9) Place the socket over the end of the rope and screw down firmly. (Do not screw together by rotating the sleeve.)

(10) When tightened as much as possible, if properly installed, there will be one or two threads visible on the sleeve. Remove all seizings.

(11) Inspect installation by noting if the wires are fully visible in the inspection hole. If properly installed, the wires will be visible, grouped at an angle to the axis of the rope and the fitting.

27–2–70 Wire Rope Slings—

A. *Use of slings.*—The most general use of wire rope slings on board tenders and at depots is for hoisting bundles of chain, small buoys, vehicles, and boats, etc. Some tenders use a braided wire pendant, fitted with a thimble at one end and a hook at the other, for handling small lighted and unlighted buoys.

B. *Type of wire rope to use.*—A 6 x 19 improved plow steel wire rope is considered to be the best for slings. The 6 x 19 construction has great resistance to abrasion, yet has sufficient flexibility for sling use, particularly for ropes up to 1 inch in diameter. Rope with a steel center is better when crushing conditions exist, as in sling use.

C. *Safety factor.*—A general safety factor of 5 is chosen for average use, and when sling deterioration cccurs, such that the loss of strength is equal to reducing the safety factor to 4 (in the case of the above average), the sling should be discarded.

D. Specific sizes and lengths of slings for use in handling buoys will be discussed in other sections.

27–3 BUOY HANDLING GEAR

27–3–1 General—

A. This section lists and describes tools, apparatus, spare parts, and equipment necessary to carry out the functions of servicing aids to navigation. Although described primarily from the point of view of tenders, certain of the tools and equipment are used by shore units such as depots and light attendant stations. Depots also use certain specialized equipment which will be mentioned under section 27–4.

27–3–5 Deck Tools and Equipment—

A. Following are listed general tools used on board tenders in connection with aids to navigation maintenance. Quantities are determined by operational requirements. Tenders may have some or all of the equipment listed, as pertinent.

(1) *General tools:*

Anvil, blacksmiths, 100 pounds (approximately).
Axes, double bit.
Axes, single bit.
Bars, crow, stock, 1½-inch diameter, 60-inch length.
Blow torch, alcohol, small.
Brace and bit set.
Carbon cleaning tool for acetylene burners.
Chisel, blacksmiths, handled, 1½-inch class A, cold.
File, half round, 8-inch.
File, magnetic.
Hacksaws.
Hammers, blacksmith's, straight peen.
Hammers, blacksmith's, cross peen.
Hammers, claw.
Hatchets.
Hand saws, cross cut and rip.
Hooks, cant (for handling piling).
Hooks, chain, ⅝-inch diameter, 32-inch length.
Mauls, ship, top, handled, 5-pound.
Pliers, slip joint, 10-inch.
Pliers, long nose.
Pliers, diagonal cutting.
Pliers, side cutting.
Pry bars, brass.
Punch and chisel set.
Saws, cross cut, large (for trees).
Scrapers, ship bottom type LV, 61-inch length.
Screwdrivers, common, assorted sizes.
Sledges, class II, double face, 6-pound.
Sledges, class II, double face, 10-pound.
Sunvalve, adjusting key.
Tape measure and steel square.
Tweezers.
Wrench, stillson, 6-inch.
Wrenches, clamping ring and crowfoot.
Wrenches, adjustable jaw, crescent, 4-inch, 8-inch, 12-inch, and 15-inch.
Wrenches, socket, ¾-inch, square drive, complete set with accessories to 1⅝-inch size.
Wrenches, box, complete set.
Wrenches, open end, complete set.
Rule and chalk line.

(2) *Special tools for servicing acetylene apparatus:*

Hickey, tube, bending.
Pliers, burner.
Wrench, Tee, 8-mm. square socket.
Wrench, double end, 8- and 12-mm.
Wrench, double end, 13- and 15-mm. (nonsparking).
Wrench, double end, 27- and 28-mm. (nonsparking).
Wrench, single end, 28-mm (nonsparking).
Wrench, single end, 33-mm.
Wrench, box, 1$\frac{5}{16}$-inch hexagonal.
Wrench, box, 1$\frac{11}{16}$-inch hexagonal.
Gages, acetylene, atmosphere pressure with ½ inch–14 (Whitworth straight pipe) connection.
Reducing connection, ¾-inch male to ½-inch female (Whitworth).

(3) *Other nonsparking tools:*

Bars, pinch, 1¼ inches, 60 inches long.
Mallet, rubber.
Mauls, copper, 5-pound.
Wedge, flange, length 9 inches, width 1½ inches, taper 1 inch to 0 inch.
Wrench, adjustable crescent, 12 inches.

B. *Miscellaneous tools and equipment:*

Blocks, derrick.
Blower, electric, with hose.
Boat hooks (pike poles), 14-foot length.
Burner sealing compound.
Canvas bag for carrying tools aboard a buoy.
Chain slings, assorted (see sec. 27–3–20).
Chocks, saddles and wedges for lighted buoys, assorted sizes.
Combination cutting and welding outfit (oxy-acetylene), complete.
Grapnel, 500-pound (approximately).
Grapnels, small.
Grease guns, Zerk and Alemite.
Hooks, derrick.
Hydrometer.
Manila rope, assorted sizes.
Pelican hooks, heavy duty, assorted sizes.
Rock salt and sand for decks.
Sling chains, single and double branch, assorted sizes.
Snatch blocks, 10-, 12-, 14-inch size.
Special filling syringe for low-discharge batteries.
Stencils, 6 inches high, numerals and alphabet.
Stencils, 10 inches high, numerals and alphabet.
Stencils, 14 inches high, numerals and alphabet.
Taps and dies, for F–10, 20, 40 connections (std. ¾, ½, ¼ x 14 TPI Whitworth).
Turnbuckles, heavy duty.
Usual consumable deck supplies; i. e., graphite grease, thimbles, wire rope clips; screw shackles, welding rod, nails, goggles.
Voltmeter, 0–50 d. c.
Watch tackles (handybilly), assorted sizes.
Welding outfit, electric arc.
Wire rope, assorted sizes.

27–3–10 Deck Lines, Slings, Straps, and Stoppers—

A. A multitude of uses is found for manila (or sisal) and wire rope stoppers, straps and slings; pelican hooks; and manila hooklines, on board a tender. Vessels equipped with the mechanical chain stopper will find that it eliminates the need for some of the stoppers described herein.

B. *Cross-deck hookline.*—The most important line on the buoy deck is the cross-deck hookline. It is usually a length of 6-inch manila line with a hook, similar to that of the whip, spliced into the end. It may be used as a single part or doubled up through an extra snatch block. One hookline is used when bringing aboard a medium-sized buoy such as a 6 x 20, 8 x 26, or a bell buoy. For handling 9-foot buoys, and when recharging buoys alongside, two hooklines are used. On smaller tenders, hooklines of smaller diameter may be used, commensurate with the size of the buoy to be handled. *The cross-deck hooking should be given the very best of care, inspected daily, and end-for-ended or renewed whenever indicated.* It should be long enough to reach from the windlass or capstan to a snatch block at the extreme after end of the buoy deck and back to the buoy port area, with sufficient extra length to allow for end-for-ending the hook when necessary. The hookline is an important factor in the safety of the crew and the ship, and must never be underestimated or disregarded. Only proper size snatch blocks should be used, and they should be so hooked into padeyes that the hook of the block is always pointed up. Thus when the strain is slacked off, the block will not fall out of the eye and come adrift. Care should be taken not to surge the hookline unnecessarily on the gypsy head. *The direction of placing the turns on the capstan or gypsy head should be frequently alternated,* otherwise the line will unravel and prematurely require renewal. Since tenders often do not have padeyes (ring pads) located so as to provide any desired angle of lead, many ships stretch a section of large open-link buoy chain between two padeyes, and then hook the snatch block into any desired link.

C. *Stopping off sinkers and chain.*—Manila (or sisal) rope is widely used for stopping off sinkers over the side for tripping. Used in sizes of 3½ inches to 6 inches, commensurate with the weight of the sinker, they are made with an eye spliced in one end, which is secured to a padeye in the deck. The other (whipped) end of the stopper is passed through the bail of the sinker or through a shackle inserted in the chain, and brought back aboard and secured to a cleat. The practice of passing the stopper through one of the links of the chain leads to a jammed stopper so often that it should not be used. Sinkers are also stopped off by passing a wire strap through the bail of the sinker and securing the ends by means of a shackle and pelican hook respectively, or by securing the chain directly in the pelican hook. Mooring chain may be stopped off by means of a heavy manila strap fitted with a shackle in the end to place into the chain. A better method is to pass a wire strap of suitable size through the chain and secure with a pelican hook, or secure the chain directly into the pelican hook itself. If any severe strain is expected, the chain should be shackled into a padeye in the deck.

The mechanical chain stopper described in section 27–3–40 provides a safe and easy means of stopping off sinkers for tripping, and for stopping off chain securely at any time.

D. *Other uses of manila rope.*—Manila (sisal) rope is also used for tripping lines on the hoisting tackle hooks, head and tail lines passed to a buoy for the purpose of steadying it, and for stopping off bights of mooring chain on deck. Since line used for the latter purpose is generally expended, only old line ready for survey is used. There are many other applications of manila rope on the buoy deck which will be apparent with experience, such as the weighted endless sling or strap used for lassoing unlighted standard buoys (the bight broken by a length of chain, or with a section of the bight weighted by several shackle pins).

An important use of manila rope is in slings used for hoisting cargo or small unlighted buoys, batteries, acetylene cylinders, etc. Slings may be of several types; the single with an eye or a hook spliced in each end (this may be varied by seizing a bight in the middle for hoisting, thus having two legs), or the endless sling or strap (this is most commonly used for handling cargo). Slings may be of practically any size line up to 6-inch, depending on the weight to be lifted. Six-inch line is seldom used except for hoisting a motor boat, and even for this purpose wire slings are preferred, if available.

E. *Wire rope* is widely used for lashings, straps, slings and stoppers, varying in size from ½ to 1 inch. Vehicles, boats, and heavy machinery are lifted aboard with wire straps or slings; chain is often stopped off with wire rope, especially when the chain itself would be a poor fit in the pelican hook. Special braided wire rope pendants or slings, fitted with a thimble in one end and a hook in the other, are often used in hoisting small and medium size buoys, when a more flexible arrangement for getting them hooked on than that afforded by the heavy block and hook of the hoisting tackle is desired.

F. The use of manila and wire rope for lashings is described separately below.

G. *Pelican hook.*—A most useful stopper on the buoy deck is the pelican hook. Vessels are equipped with these tripping hooks in several sizes to accommodate all sizes of mooring chain now in use. The chain itself may be directly secured in the hook, or the eye of a wire strap may be placed in it. Care must be taken when using a pelican hook that provision is made for a safety pin to prevent premature opening of the hook. Also, when striking the sliding link to trip the hook, watch out that when the hook opens, particularly if there is a heavy strain, it does not strike the hammer and send it flying. It is better to strike the sliding link on the side than on the top.

H. *Sling chains* are an important and necessary part of buoy handling equipment. They are used in loading heavy buoys, for hoisting mooring chain, or for any other lift where very heavy weights are encountered. A complete description of sling chains is given under section 27–3–20.

I. *Pendant.*—Several tenders have found that an eight-part braided wire sling or pendant in various lengths is useful for hoisting buoys, and may even be used in picking up chain. The size of the wire used in these slings may be up to 7/16 inch for large buoys. A hook is spliced in one end of the sling or pendant and an eye with thimble in the other.

27–3–15 Deck Lashings—

A. The proper securing of buoys and other deck cargo is an essential of safe and efficient operation. To accomplish this, manila (or sisal) rope, wire rope, and even chain, is used along with associated equipment such as shackles and turnbuckles. The heavy weights involved in the handling of buoys make it imperative that the buoy never be permitted to "take charge" on deck; therefore, the lashings and their application must be in accordance with the best possible seamanship under the circumstances. See section 27–5–1 for details of stowing and securing buoys on deck.

B. *Manila rope* (sisal is often substituted) of sizes ranging from 12 thread up to 3½ inches circumference, is used to lash batteries, acetylene cylinders, small buoys, chain and sinkers. Lashings of manila rope larger than 3½ inches are unwieldy and difficult to properly pass and tighten, and are seldom used.

C. *Wire rope.*—Heavier weights such as medium lighted buoys, and large unlighted buoys such as tall-types or bell buoys, may be secured with wire rope straps having an eye in each end of a single part. They, in turn, are secured by shackles and turnbuckles. Wire rope of ½ to ⅞ inch diameter is used, the size varying according to conditions. Once again, a larger size of wire rope will prove unwieldy and difficult to handle. Many tenders prefer to use chain lashings even on smaller buoys. The size of turnbuckle to use is determined by the job to be done, and should be commensurate with the size of wire lashing. Turnbuckles should be kept well greased and so rigged that there are no bending strains.

D. *Chain.*—The large buoys are secured with chain lashings, usually a spare piece of buoy mooring chain being used in sizes ranging from ¾ to 1 inch or 1⅛ inches in diameter. Heavy turnbuckles and chain slings are used in connection with the chain.

E. *No set rules.*—Round, bulky objects such as buoys can be difficult to secure, and no set rules can be laid down as to exactly how a lashing shall be passed, particularly in view of the crowded buoy deck which is generally the rule, rather than the exception, among tenders. It must be remembered that the object must be braced against movement in *every* direction, not just gripped down to the deck. Following the dictates of general good seamanship, experience, and common sense is the best advice that can be offered. Further details regarding the securing of particular types of buoys will be given in section 27–5–1. Whenever possible, secure the object against a permanent part of the ship such as a bulwark or bulkhead. Remember that manila lashings are particularly prone to work loose, especially after being wet and drying out in the hot sun. Even turnbuckles, unless set up with lock nuts, can work loose with the motion of the vessel. All lashings must be inspected regularly.

27–3–20 Sling Chains—

A. *Used for hoisting buoy moorings.*—Single sling chains, or nipper chains, are widely used in handling buoy moorings. Links of buoy chain are often too small to permit insertion of the hoisting hook directly into the chain. Forcing a hook into chain too small to allow its proper insertion is dangerous and hard on the gear. Short lengths of especially treated steel chain fitted with reinforced pear-shaped end links are used to grab the chain and hold it securely for hoisting. A chain sling is made fast by passing the length of sling chain around the mooring chain to be hoisted, passing one end link through the other, and causing the chain to jam securely down on the mooring chain. The free end link is then placed on the hook of the hoisting tackle. Sling chains are also used for hoisting sinkers over the side preparatory to stopping them off for tripping. This is accomplished by making fast to the mooring chain a fathom or so above the sinker.

B. *Other uses.* Other types of commonly used sling chains consist of a single length with one pear-shaped end link and a hook in the other end, or two legs of chain secured to a large lifting ring, each leg having a hook in its bitter end. These chain sling bridles are used for lifting large lighted buoys aboard at depots, or when recharging alongside when it is desired to keep the buoy vertical. Sling chains can be used for a multitude of rigging and heavy lifting problems aboard ship, and are stronger than wire straps of similar size. In recovering sunken wire cable, sling chains, when properly passed (using half hitches or a jamming stopper knot), will grab the wire securely for hoisting. If, however, the chain is not properly secured, the wire will slip through the sling, and once started, will be difficult to stop. Always hoist wire carefully, especially when under a heavy strain. When using a small size chain sling, pass several round turns around the chain being lifted in order to securely bind the chain sling.

C. *Made from high grade steel alloy.*—Sling chains should be made of a special high grade alloy steel and since they are used for extremely heavy loads, it is important that the factors and rules of care given in the following paragraphs be strictly observed. The data given below pertains specifically to the Herc-Alloy sling chain manufactured by the Columbus-McKinnon Chain Co. However, the general rules apply to all equivalent high grade steel alloy chains.

D. *Periodic inspection.*—Sling chains are registered at the factory and are identified by individual serial numbers stamped on one of the master links, rings, or hooks. Periodic inspections should be made and recorded. For proper inspection, the chain should be cleaned so that marks, nicks, wear, and other defects can be seen. After a link-by-link inspection for damage, the chain should be suspended, and measurements made of the reach (distance from bearing point to bearing point). Comparison of this measurement on subsequent inspections will indicate if the chain has been stretched or worn. The link-by-link inspection should be made with emphasis on detecting the following: twisted or bent links, nicks or gouges; excessive wear at bearing points of links; stretched links; spread in throat, openings of hooks; and distorted or damaged master links, coupling links, or attachments. Under ordinary conditions, wear will be confined to the ends of the links where adjoining links rub together. If wear is detected, each link should be lifted and cross-section measured. In the case of Herc-Alloy sling chains, if the wear exceeds the maximum allowed in the following table, the chain should be removed from service.

Size of chain (inch)	*Maximum allowed wear at any point of link (inch)*
1/2	7/64
5/8	9/64
3/4	5/32
7/8	11/64
1	13/64

A stretched chain indicates overloading and can be avoided by use of proper size chains. It is possible and often a fact that only a small portion of a chain is stretched. When considered by over-all length, the percentage of stretch may be well within an allowable limit, but the individual links may be dangerously elongated. Therefore, a visual link-by-link inspection is the best way of detecting dangerously stretched links. The least sign of binding at juncture points of links indicates collapse in the sides of the link due to stretch. Such a condition is dangerous, and the chain should be removed from service.

E. *Repairing.*—Sling chains may be returned to the factory for repairs.

F. *Care when not being used.*—Much damage is done to sling chains when they are not in use. They should never be stored in damp, dirty places, or exposed to weather. Chains should be oiled before prolonged storage and hung in a clean dry place. They should be cleaned occasionally during service to remove damaging abrasive grit which may be ground between the links, causing undue wear. "Herc-Alloy" sling chains are heat-treated and should never be annealed.

G. *Operating rules.*—Twists, knots, or kinks in chain cause stresses which may result in failure of the chain even at some later date when handling only a light load. Before lifting, be sure that the chain is free from twists and kinks, that the load is properly seated in the hook (not on the point), and that the chain is free from nicks or damage resulting from previous abuse. Avoid sudden jerking in lifting or lowering. Avoid unbalanced loads. Never force a hook or chain into place by hammering. Avoid crushing the chain when lowering loads. Be sure to consider the angle of lift when using a sling chain bridle. Consult the table below for safe loads at various angles of spread.

H. *Suggested safe working loads for "Herc-Alloy" sling chains.*

Size	Single type (straight lift)	Double branch type used at angles of		
		60°	45°	30°
Inch	*Pounds*			
1/2	11,250	19,500	15,900	11,250
5/8	16,500	28,600	23,300	16,500
3/4	23,000	39,800	32,500	23,000
7/8	28,750	49,800	40,700	28,750
1	38,750	67,100	54,800	38,750

Safe working loads shown above are based on 50 percent of the proof test. It should be remembered that deterioration of the chain by strain, usage, weathering, or by lapse of time, will lessen the load that the chain will safely withstand.

I. There is a large variety of chain slings in use at present, which is being standardized. Recommendations from the field as to the foregoing are solicited. Following is a list of sling chains such as may normally be used on board a coastal tender handling up to the largest size lighted buoy. Smaller tenders handling smaller buoys will have few, if any, of the heavier chains, and may have a larger amount of smaller ones.

Chain size, (inches)	Number of slings	Type of sling	End attachments	Length (feet)	Typical use
1	1	Double branch DPS.	Pear center link, two end slip hooks.	12	Recharging large ltd. buoys alongside.
3/4	1	do	do	10	Recharging smaller ltd. buoys alongside.
5/8	1	do	do	10	Loading first class standard buoys, other moderate weights.
1/2	1	do	do	10	Loading lightweights.
7/8	1	Double branch (special).	Pear center link, hook on 5-foot br joiner link on 10-foot br.	5 10	Handling 9 x 32 ltd. buoy in horizontal position.
1	2	Single, SPS	Pear link and slip hook.	4	
1/2	2	do	do	4	
3/4	2	Single, CP	Pear links both ends.	5	Hoisting large mooring chain.
5/8	2	do	do	5	Hoisting smaller mooring chain.
1/2	4	do	do	3	
3/8	2	do	do	3	

27–3–25 Spare Buoy and Minor Light Equipment—

A. Following is a list of spare equipment generally carried on board tenders. The exact items are dependent on the particular types of apparatus serviced by the tender.

(1) *Acetylene*—

Burners, 1, ¾, ½, and ⅜ cubic feet.
Caps, valve, V–14.
Couplings, F–190.
Dies for all commonly used acetylene connections.
Flashers; 50, 130 mm single; I. Q. Fl.; Gp. Fl.
Lanterns, complete, 150, 200, and 375 mm.
Lenses for 150, 200, and 375 mm. lanterns.
Plugs, pipe, V–18, V–98, blind and chain.
Shades, clear for 150-mm. lantern.
Shades, red and green for 150, 200, and 375-mm. lanterns.
Single Pilots, A. G. A., for ½ cubic foot burner and larger.
Single Pilots, A. G. A., for ⅜ cubic foot burners.
Spare acetylene cylinders, A–300, A–50, A–25.
Stock or die holder.
Storm panes for 200 and 375 mm. lanterns.
Test pipe with F–10 connections, length 10 feet.
Tubing, spare 8- and 4-mm., coil.
Tubing with F–10 connections, lengths; 0 foot, 16 inches, 0 foot 30 inches, 3 feet, 4 feet 1 inch, 5 feet 6 inches, 6 feet 7 inches, 7 feet, 7 feet 6 inches, 9 feet.
Valves, shut-off, V–270.
Washers, aluminum, F–13, F–23, F–43, F–63.

(2) *Electric*—

Air cells.
Battery lugs, jumpers.
Battery racks, all types as needed.
DHB 5–1 low discharge batteries.
Edison primary cells.
Flashers, spare 12–16V, 6–10V, 3–4V (if used in area).
Lampchangers.
Lamps, assorted.
Lanterns, 90, 150, and 200 mm. complete with lampchanger and flasher.
Shades, red and green as required for types of aids serviced.
Shunts, assorted.
Spare batteries.
Solder.
Tape, friction, rubber.
Wire, rubber covered, No. 12.

(3) *Miscellaneous Spares*—

Assorted screws and bolts for flashers and lanterns.
Bell clappers.
Bolts, ¾ inch, swing, for buoy pockets, complete with nuts.
Buoy vent.
Buoy chain, assorted sizes.
Bridles, assorted sizes.
CO_2 cylinders.
Connection for gaging tanks.
Gaskets for A–50 and A–300 cylinder pockets.
Shackle keys, split and ring types.
Paint for buoys and structures.
Lumber for repairing structures.
Reflector material mounted on tin strips, assorted colors.
Shackles, all sizes, split key and riveted head types.
Sinkers, assorted sizes.
Swivels, all sizes.
Wedges, wood, 12-inch length for wedging cylinders in pocket.
Pocket covers, A–50 and A–300 size.

27–3–30 Stowage of Buoy Handling Gear—

A. *Lamp locker.*—All tenders have a lamp locker in which spare lighting equipment for buoys and minor lights is stowed along with servicing tools and other small gear. It is essential that some means of check-off be kept on spare lighting apparatus parts to insure their replacement when next in the home port. When these parts are needed, the tender is generally many miles away from the depot, and the safety of marine traffic may be imperiled by the lack of a spare piece of apparatus. There are many varied pieces of apparatus used in connection with lighted aids to navigation, and a neat means of stowage is essential.

B. *Straps, stoppers, snatch blocks, turnbuckles, sling chains,* etc. may be stowed in a boatswain's locker, or hung from racks under the forecastle deck. Chain slings should never be left lying around the deck to rust when not in use. Hang them up, and when not to be used for a period, apply some light oil to prevent rust. Slings, straps, and stopper lines are more readily identified for use when needed, if hung up neatly. Buoy-handling gear is important to the safety of the crew and should be cared for accordingly.

C. *Inspection.*—Inspect hammers and mauls frequently for loose handles. Make someone responsible for keeping a check on the tools to maintain them in good order and in sufficient quantity.

D. *Shackle stowage.*—Some of the older ships kept a shackle barrel on deck filled with oil for the storage of split-key shackles. Although somewhat messy, the shackles were always freed up and easy to connect. This can be important at times. Always keep a few easy-working shackles about the deck for stopping off, etc.

27–3–35 Oxyacetylene Cutting and Welding Apparatus—

A. Oxyacetylene cutting and welding apparatus is widely used in connection with the repair and servicing of aids to navigation. At depots, it is used for cutting links of chain and for cutting out sections of damaged buoy plating. Acetylene tubing fittings are brazed, and other acetylene welding jobs are performed. On board tenders, shackles and chain frequently have to be cut, shackle pins heated up for heading over, etc. The apparatus may be needed in an emergency when a man has become entangled in the buoy mooring or deck gear.

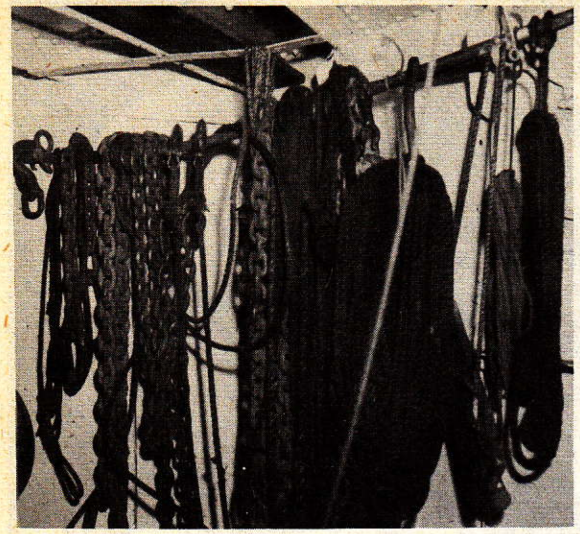


FIGURE 27–76.—Typical stowage of hook-lines, stoppers, and chain slings.

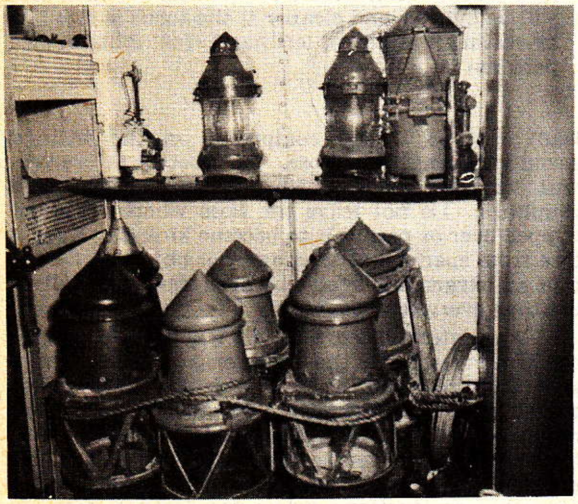


FIGURE 27–77.—Stowage of spare lanterns in tender's lamp locker.

B. *Train several operators.*—The use of oxyacetylene cutting and welding apparatus involves the use of compressed gases, and can be hazardous unless properly handled. Several members of the buoy handling crew should be thoroughly familiar with the proper use of this apparatus. In an emergency there is no time to send for an expert. However, only qualified persons should be permitted to operate the gear.

C. *Cylinders of compressed gas* should always be equipped with protection caps except when hooked up for use. Cylinders stored out in the open should be protected from accumulations of ice and snow, direct rays of the sun, or corrosion. Cylinder temperatures should not exceed 125° F. Cylinders containing gas should be segregated from empty ones. All cylinders, full or empty, should be handled carefully, not dropped or dragged over the pavement or deck, and should never be used as rollers for other heavy weights. Unless the cylinders are being conveyed in a welding truck, the regulators should be detached, and the protection cap screwed in place while the outfit is being moved. A cylinder found to be leaking should be moved out-of-doors immediately, and warning signs posted. A leaking cylinder is a potential source of explosion. (If the leak is through a valve, a regulator may be attached to temporarily stop the leak.) Cylinder valves must be opened slowly and carefully, otherwise damage to the regulator may result.

(1) *Oxygen cylinders* are charged at high pressure. If a fully charged cylinder is damaged by falling or being hit, it may burst with destructive force. Oxygen combines with oil or other inflammable materials with explosive violence. For this reason it is essential to keep oxygen cylinders spotlessly free from oil or grease. Do not handle cylinders with greasy or oily hands. Do not store the cylinders near radiators or other sources of heat. *Never withdraw oxygen from a cylinder unless a regulator is used.*

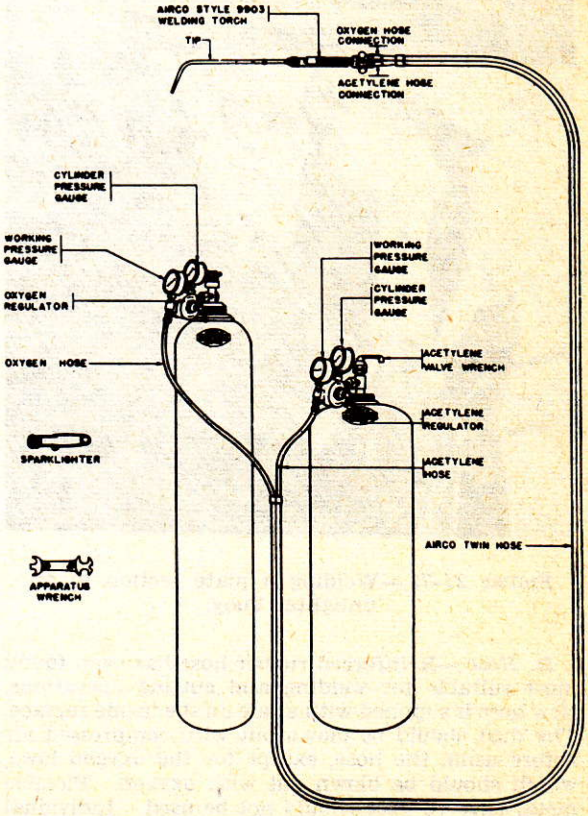


FIGURE 27–78.—Oxyacetylene welding outfit.

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(2) *Acetylene gas and cylinders* are fully described in Chapter 20 of this manual. Do not withdraw acetylene from a cylinder rapidly, or when it is in a horizontal position. Like oxygen, acetylene cylinders should be stored in a cool place. If the cylinder valve becomes covered with ice, do not attempt to thaw the ice away with an open flame or boiling water or steam. Transfer the cylinder indoors and allow the ice to melt gradually. *Do not remove acetylene from a cylinder except through a regulator.* In the case of acetylene installations in buoys and minor lights, there is a regulator in the flasher mechanism which serves the same purpose as the regulator used with cutting and welding apparatus. Be careful not to jam the cylinder valve in the open position. Tools or clothing should not be placed on top of the cylinder, as they may damage the safety plugs or prevent the valve from being quickly closed in an emergency. Never attempt to transfer acetylene from one cylinder to another. When a cylinder is exhausted, close the valve and replace the cap.

(3) Compressed gas cylinders should be carried on deck, and not more than one pair stored in the machine shop below decks, and that only when required for use. Be sure that the valves are closed when not in use.

FIGURE 27–79.—Welding a plate section in an unlighted buoy.

D. *Hose.*—Reinforced rubber hose has been found most suitable for welding and cutting operations. New hose is supplied with a talc on the inside surface. The dust should be blown out with compressed air before using the hose, except for the oxygen hose, which should be blown out with oxygen. Flexible metal-covered hose should not be used. Individual hoses are supplied for oxygen and acetylene, and to prevent interchanging, the fittings on the end of the hose have opposite threads. Do not permit the hose to come in contact with oil or grease, either internally or externally. Do not use any lubricants, white lead, or pipe thread compound on the fittings. Avoid long lengths of hose. It is better to use several standard lengths joined with special thread couplings. Do not leave the hose where it can be tripped over or permit it to become kinked. Keep it free from sparks, hot slag, and hot objects. Do not tape an oxygen and acetylene hose together solidly—use tape every few feet only.

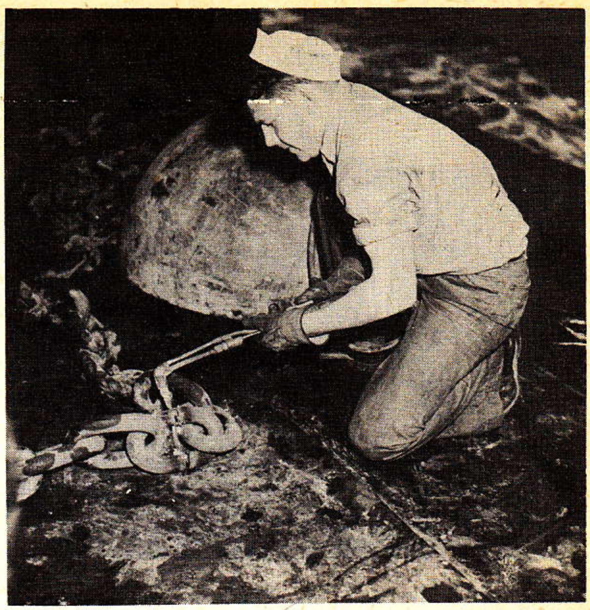


FIGURE 27–80.—Cutting improperly with an oxyacetylene torch. Man should be wearing goggles. Cut will be quicker and cleaner if the torch is steadied by resting it on top of left hand (for right-handed persons).

E. *Regulators*, fitted with two gages, one to measure the pressure in the cylinder and the other to show the pressure being released, are connected to the valve of each cylinder. Oxygen and acetylene regulators are *not* interchangeable. The regulator handle when screwed to the right depresses a diaphragm and permits the gas to flow. See general operating instructions below for further data on regulators.

To adjust the working pressure correctly on a regulator, the torch needle valve must be open and the gas flowing. The adjusting screw is then turned until the desired pressure is shown on the gage. If the pressure is adjusted with the valve closed, it will not be maintained when the torch is placed in operation, but will fall below that desired, making further adjustment necessary. Especially in cutting, where heavier oxygen flows are involved, it is essential that the cutting oxygen pressure be adjusted with the cutting torch high pressure valve momentarily held open. Unless this is done, satisfactory results cannot be obtained.

F. *Checking equipment for leaks.*—Oxygen and acetylene gas cylinders and pipelines, valves, regulators, hose and torch connections should be checked carefully for leaks. Large leaks can be heard. Acetylene gas is detectable by its odor. Small leaks can be detected with soapsuds. Leaks between cylinder or pipeline and torch may be detected by closing the valves. If the high pressure gage recedes, you will know that your equipment is leaking.

G. *Lighting the torch.*—To light the cutting or welding torch, proceed as follows:

(1) Open torch acetylene gas valve and immediately ignite the gas by using a friction lighter or other suitable source of ignition. Do not use matches for this purpose.

(2) Adjust the acetylene valve for proper quantity of gas. If too much gas is used the flame will blow away from the tip; if too little is used the flame will snap back or backfire.

(3) Open preheat oxygen valve on the torch until proper flame is obtained. This should be a small blue cone within the flame. See paragraph (K) below.

(4) In the case of a cutting torch, open the cutting-oxygen valve momentarily and readjust the oxygen preheat valve if necessary, to obtain the proper flame. The equipment is now ready for use.

H. *To shut off the torch* when finished with the equipment, proceed as follows:

(1) Extinguish the flame by closing the preheat oxygen and acetylene gas valves on the torch, in the order mentioned.

(2) When welding or cutting work is stopped for a period of more than one-half hour, close the cylinder or pipeline valves and open the torch valves to release the pressure in the hose. Release both pressure adjusting screws on the regulators.

(3) When work is completed for the day, make certain that all cylinder valves are closed and all gas pressures are released between the cylinders and the torch. It is good practice to disconnect the hose, torch and regulators, placing them in storage and replacing the protection cap on the cylinders. If the regulators are left attached to the cylinders, always release the pressure on the diaphragm by turning the adjusting handle several turns to the left. Protect the regulators with a canvas cover.

I. *Backfires and flashbacks* are caused by improper handling or conditions of equipment. Improper handling includes dirty tips (obstruction or slag inclusion), leaking tips at seat caused by faulty seat or improper assembly, or internal leakage within the torch. A backfire, or flashback, travels from the tip forward to the cylinder or pipeline. If it is confined to the torch tip, it is usually called a backfire. If the fire proceeds into the torch, hose or regulators, it is of more serious nature and is usually called a flashback.

(1) When a backfire occurs, immediately close the oxygen and acetylene valves in the order mentioned. If the torch tip is hot, cool it in a bucket of water. Make sure that the tip seat is not scored; replace the tip, tightening it by means of a wrench. Relight the torch in accordance with previous instructions and proceed with the work.

(2) If the torch flashed back, shut off the oxygen and acetylene valves as quickly as possible in the order mentioned. If the flashback is noticed in the hose, release both oxygen and acetylene regulator adjusting screws in order mentioned as soon as possible, and close the oxygen and acetylene cylinder or pipeline valves. Have all regulators, hose and torch connections checked over and repaired before attempting to use it again.

J. When using a torch on a buoy, *never* use it inside a buoy body. When welding or cutting around a buoy, be sure that it and all adjacent buoys are gas-free.

K. *Adjusting flame.*—After the torch is lighted, to produce the pure acetylene flame, the acetylene needle valve should be adjusted until sufficient acetylene emerges to form a gap of about ⅛-inch between the tip and the flame. The oxygen needle valve is then opened and adjusted until the flame burns with the proper characteristic.

(1) *The neutral or balanced flame* is achieved by mixing 1 part of oxygen to 1 part acetylene. It is a clearly defined flame readily obtained with a little practice, and is composed of two distinct parts to the flame, known as the inner core and the outer envelope. The inner core is a brilliant white cone from 1/16- to ¾-inch long. The outer envelope, or sheath flame, is only faintly luminous, and has a delicately bluish color. When the flame is on the carburizing (excessive acetylene) side, whitish streamers of unburned acetylene are seen leaving the inner cone and entering the sheath flame. As the acetylene supply is decreased, these streamers decrease in length until there remains only the sharply defined inner cone and the sheath flame. At that instant the neutral oxyacetylene flame has been found. The final adjustment of a neutral flame is made by starting with an excess of acetylene and reducing it to achieve the desired effect.

(2) *The carburizing flame* has a higher ratio of acetylene to oxygen than the neutral flame. The oxidizing flame has a higher ratio of oxygen to acetylene, and is identified by a "harsh" sound, with the inner cone appearing shorter and less sharply defined.

(3) *Setting of the proper flame* is of great importance to the operator, as without it, no amount of manipulative skill will accomplish a satisfactory job. See figure 27–82 for a table of types of flames used for welding certain substances.

(4) Oxyacetylene welding on board tenders in connection with aids to navigation work is generally confined to brazing acetylene tubing connections in which a slightly oxidized flame is used. See Chapter 20 for brazing details. Welding of all sorts is done in depots where buoys are repaired, dents in buoy bodies heated and taken out, etc. The greatest use for oxyacetylene apparatus in aids to navigation work is for cutting chain and heating shackles. For this purpose a neutral flame is best.

L. *Cutting metal* involves the selection of the proper torch cutting tip to suit the thickness of the metal, adjustment of the proper flame, and manipulative skill of the operator. Thickness of the metal is the primary guide for selecting the proper tip. However if rust, scale, or paint is heavy, a larger tip is required, since these surfaces present greater resistence to the preheating flame. See figure 27–81 for cutting tip-thickness of metal table. The use of oversize cutting tips and excessive pressures is uneconomical.

TABLE I
APPROXIMATE GAS PRESSURES FOR WELDING
WITH WELDING TORCHES STYLES 9803 AND 9903

Tip No.	0	1	2	3	4	5	6	7	8	9	10	11	12
Mixer	00–1	1–7	1–7	1–7	1–7	1–7	1–7	6–10	6–10	6–10	10–12	10–12	10–12
Thickness of Metal (In.)	1/32	1/16	1/8	1/4	3/8	1/2	5/8	3/4	1	1 1/2	2 up	2 up	Extra Heavy
Oxygen Pressure (psi.)	1	1	2	3	4	5	6	5	6	8	8	10	12
Acetylene Pressure (psi.)	1	1	2	3	4	5	6	5	6	8	8	10	12

TABLE II
APPROXIMATE GAS PRESSURES FOR CUTTING
WITH CUTTING TORCHES STYLES 9000, 3000, 1100, 9975—STYLE 144 TIPS

Thickness of Metal (In.)	1/4	3/8	1/2	3/4	1	1 1/2	2	3	4	5	6	8
Airco Cutting Tip Size	0	1	1	2	2	3	4	5	5	6	6	7
Oxygen Pressure (psi.)	30	30	40	40	50	50	50	50	60	50	55	60
Acetylene Pressure (psi.)	3	3	3	3	3	3	3	4	4	5	5	6
Cleaning Drill Size For Cutting Jet	63	57	57	55	55	53	50	46	46	42	42	35

For Complete Combustion of Acetylene—One molecular volume (380 cubic feet at 60° F.) of acetylene plus two and one half molecular volumes of oxygen burns to form two molecular volumes of carbon dioxide plus one molecular volume of water vapor liberating 542,700 B.T.U. of heat.

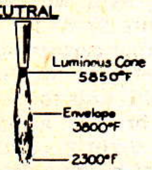
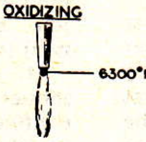
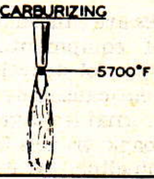
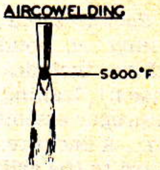
	NEUTRAL	OXIDIZING	CARBURIZING	AIRCOWELDING
Torch Flames				
Ratio Oxygen / Acetylene	1.04-1.14 / 1	1.15-1.70 / 1	0.85-0.95 / 1	0.92-0.98 / 1
Effect on Metal	Metal is clean and clear, flowing easily.	Excessive foaming and sparking of metal.	Metal boils and is not clear.	Similar to neutral flame—little or no puddling necessary.

FIGURE 27–81.—Tables of gas pressures and characteristics of oxyacetylene welding flames.

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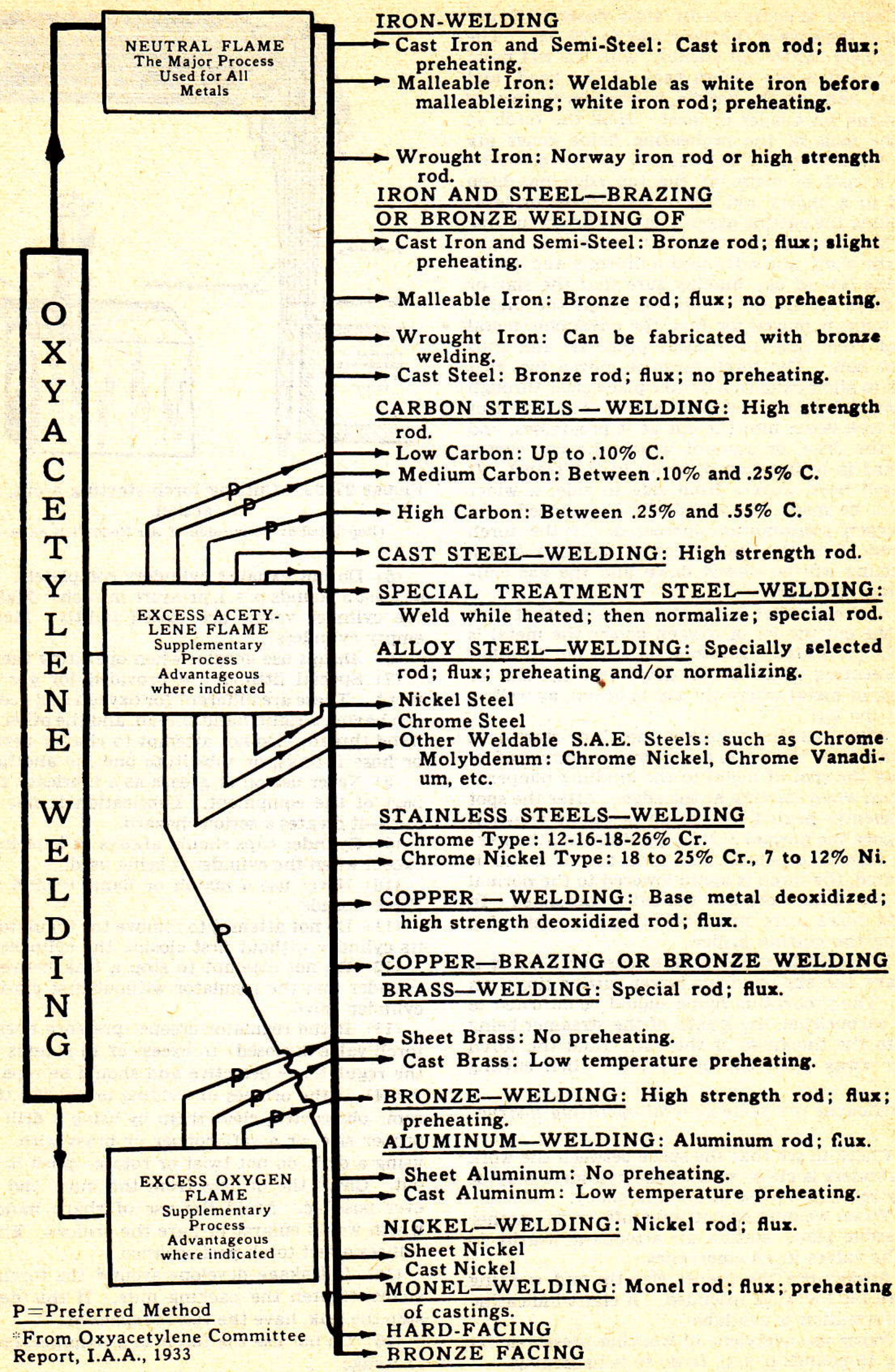


FIGURE 27–82.—Oxyacetylene welding and its applications.

(Reprinted by permission of Air Reduction Sales Co.)

M. *Cutting procedure.*—In most cases cuts are started at the edge of the piece (see fig. 27–83). The torch is held lightly but steadily, with the left hand supporting it a few inches back of the head, and the right hand on the handle, in position to operate the cutting jet trigger or lever. Hold the torch so that the ends of the preheating flame cones are about 1/16-inch above the surface of the material. When a spot of metal at the top edge has been heated to a cherry red, press the trigger or lever controlling the cutting oxygen jet, and begin cutting.

(1) The torch must be held at the proper height above the work, and advanced uniformly and slowly along the line of cut, making sure that the slag or oxide flows freely and cleanly through the metal. If the torch is moved too fast, the advancing metal will not have time to preheat properly, and thus will not flow. The torch must be moved just fast enough to allow oxidation to take place clear through the material as the cut progresses. The operator should look down into the cut as it progresses, and watch the drag, or amount which the cut curves backward in a direction opposite to the travel. If the torch head wavers from side to side, a wider kerf will be made, the speed will be reduced, and the oxygen consumption increased. If the torch is moved along the line of cut at irregular speed, the cutting will be slowed down and the gas consumption increased.

One of the greatest faults of operators is that they apply the cutting jet of oxygen *before* the metal is properly preheated. Another fault is not to allow the preheating flame to run down over the side of the edge of metal where the cut is begun, as well as to heat the top.

(2) When burning a hole in metal, or starting a cut away from the edge, more time is consumed in bringing the spot of metal to the kindling temperature than when starting at the edge. After the spot is sufficiently heated, the torch is raised one-half inch above the normal cutting position and the oxygen is turned on slowly, As soon as the metal is perforated, the torch is again lowered to the normal height above the work and the cut is completed. In piercing holes, care must be taken to avoid slag plugging the cutting orifice.

(3) When cutting cast iron, intense preheating is necessary, thereby requiring larger cutting tips than usual. The preheating flame should be adjusted to strong carburizing, the length of the streamer being equal to the thickness of the cut. Hold the torch farther away from the metal than when cutting steel.

N. *Following are some general operating instructions:*

(1) Check to see that the space between the work and cylinders is clear, so that the cylinders may be quickly reached in case of an emergency.

(2) When welding or cutting aloft, or in another inaccessible place, station an attendant nearby to close the valves in an emergency.

(3) Always use the proper size tip and working pressure for the work intended. A chart indicating this information is available.

(4) *Never* use acetylene at working pressures exceeding 15 pounds p. s. i.; to do so is hazardous.

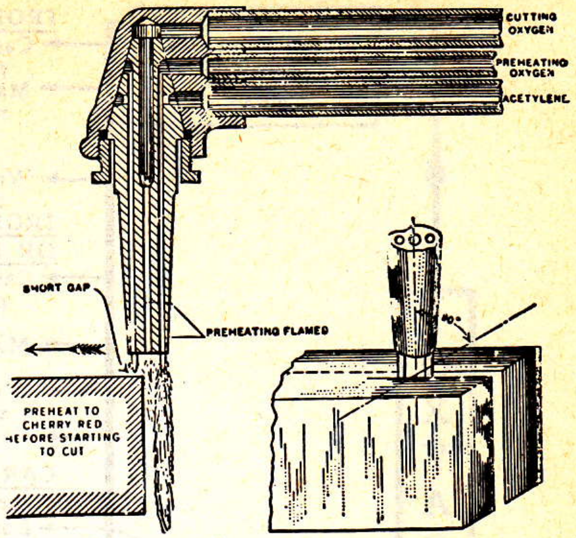


FIGURE 27–83.—Cutting torch starting a cut, and in action.
(Reprinted by permission of Air Reduction Sales Co.)

(5) Do not exhaust cylinders completely. Leave at least 5 pounds p. s. i. pressure in each. Make sure the cylinder valves are closed tightly. Mark the empty cylinders.

(6) *Always* use goggles when operating the torch.

(7) Special fittings are provided for gas equipment. These are different for oxygen and acetylene, one having a right-hand thread, and the other a left-hand thread. Do not attempt to change regulators or hose fittings, or substitute one for another.

(8) Never use oil or grease as a lubricant for any part of the equipment. Lubrication is not necessary—it creates a serious hazard.

(9) Cylinder caps should always be kept in place, except when the cylinder is being used.

(10) Never use a match or flame to find a leak. Use soapsuds.

(11) Do not attempt to remove the regulator from its cylinder without first closing the cylinder valve.

(12) Do not attempt to stop a leak between the cylinder and the regulator without first closing the cylinder valve.

(13) If the regulator creeps (pressure rises when torch valve is closed) in excess of 10 pounds p. s. i., the regulator is defective and should be repaired.

(14) If the orifices of welding or cutting tips become obstructed, clear them by using a drill of the proper size, or a soft copper or brass wire. When using a drill, do not twist or rotate—push it in and out. Clean the orifices from the inner end whenever possible. Avoid the use of sharp hand tools which would enlarge or flare the orifices. Enlarged orifices affect torch performance.

(15) If leakage develops around the torch valve stems, tighten the packing nuts. If this does not stop the leak, have the valves repacked.

(16) Do not use the torch as a hammer, crowbar, or wedge.

(17) Do not hang the torch and hose on regulators or cylinder valves.

(18) Excessive pressure caused by opening the cylinder valve too quickly may damage the pressure regulator gauges. This is indicated by the pointer when it will not return to zero. Such gauges should be returned to the manufacturer for repairs.

(19) When regulators are to be left out of service for several days or longer, it is advisable to adjust the tension on the regulator screw. This relieves the pressure on the valve seat and lengthens its life.

(20) If the torch gas adjusting valves turn too easily, thus allowing the flame to be continually knocked out of adjustment, or if gas leaks past the valve stem, tighten the packing nut or install new packing in the gland or nut threads.

(21) If the needle valve does not shut off completely, remove the valve assembly and wipe seat and plug with a soft clean rag. If the leak continues, grind the valve to a new seat, or replace the worn parts with the new ones ordered from the original manufacturer of the torch.

(22) When changing tips or inspecting torch, never use pliers or a Stillson wrench on the nut—use the proper wrench.

(23) When changing heads, tips, or extensions, make sure that all seating surfaces are clean. A loose connection or a piece of dirt on the tip seat may cause backfire or even flashback. When tightening, use only enough force to make a gas-tight fit.

27-3-40 Mechanical Chain Stopper—

A. Hoisting buoy mooring chain with sling chains, or with the hoisting hook directly inserted into the links of the chain, has been standard practice for many years. Nevertheless, a hazard exists for the personnel who must pass the chain sling or insert the hook, especially before the buoy has been unshackled, and in rough weather. A hazard similarly exists during the unshackling period. The mooring is usually held on one of the boom tackles, although many ships pass a chain, or wire stopper, or pelican hook to secure the mooring to the deck while the buoy is being unshackled. A sudden surge or roll of the ship while the stopper is being passed may prove disastrous and may even pull the buoy over the side, in addition to putting an undue strain on the boom and its tackle. During this period of hooking on to the mooring for hoisting or stopping off purposes, a man or two must work in an exposed position at the edge of the deck between the buoy and the mooring. The unexpected parting of the hoist or a severe roll of the ship may crush the man seriously or even fatally. Manila, wire, or chain stoppers have been the time-honored means of stopping off chain. However, in any of these methods, personnel must expose themselves to what may be a hazard under certain conditions.

B. *Stopping off sinker.*—The mechanical chain stopper has been devised for the purpose of providing a strong, positive means of securing a mooring chain without the assistance of personnel on deck. In addition, the stopper affords an easy means of stopping off a sinker preparatory to dropping it. When a sinker is to be used again, much time is saved in not having to heave it aboard and later stop it off over the side in a pelican hook, or manila or wire stopper, as before. It is left hanging in the mechanical stopper until ready to be tripped. Sinkers, when sanded in, may be safely pulled on by the ship without danger of excessive strains on the boom or deck gear. Tests have shown that chain being hoisted aboard through the stopper will not be lost over the side in the event the hoist parts.

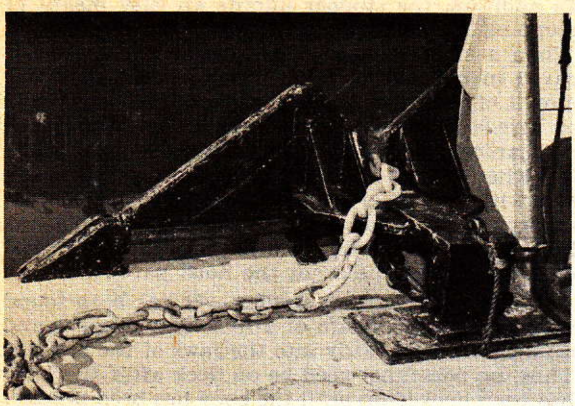
C. *Securing chain in stopper.*—It has been found that the mooring chain of 6-foot lighted buoys and smaller will lead easily into the jaws of the stopper. Thus, no personnel need be on deck after the buoy has been hooked on until the buoy has been brought safely aboard and the chain secured in the stopper. Then the men can unshackle the buoy, secure in the knowledge that a sudden surge of the ship will not pull the buoy down onto them. Once the chain has been unshackled, it may be rapidly hoisted aboard, using one purchase only (generally the single whip of vessels so equipped), the stopper grabbing the chain as the purchase is lowered for another bight.

(1) More difficulty will be experienced in getting the mooring of the larger 8- and 9-foot buoys to lead fair into the stopper due to the length of the bridle and size of the buoy. Passing a cross-deck hookline into the chain has been found advantageous in hauling the chain over into the stopper.

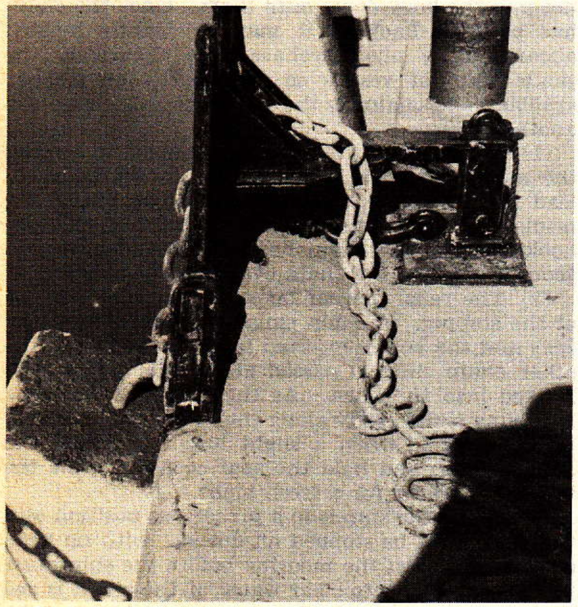
(2) The relief of spar buoys is facilitated by use of the stopper. A chain sling is passed around the spar and the end is inserted into the stopper. Another chain sling is passed above the first and is hooked into the hoist. As the spar is raised, the first sling slides easily along the spar until the hoist is two-blocked, when a slight lowering causes the sling to grab and hold the spar securely while the tackle is lowered for a fresh bight.

(3) When the ship is in a precarious position and the buoy must be stopped off quickly, with no time available to hoist the mooring before the ship must be backed away into clear water, if the chain is secured in the mechanical stopper, the ship may be backed at once without fear of parting any gear or putting an undue strain on the boom.

D. As the mechanical chain stopper is installed on more ships, it is expected that many new uses will be found. The stopper will accommodate all sizes of buoy chain now in use. A tripping latch permits the entire hinged jaw section to fall outboard when it is desired to trip the chain, such as when dropping a sinker. A spring is provided to absorb the shock when tripped, and to return the jaw section "to battery." Specific measurements and details of the stopper will not be given here, inasmuch as the design is undergoing minor modifications from time to time, as service tests and usuage indicate advisable. Requests for installation of this device may be submitted to the Office of Engineering, Headquarters.



View looking outboard.



View looking forward.

FIGURE 27–84.—Mechanical chain stopper.

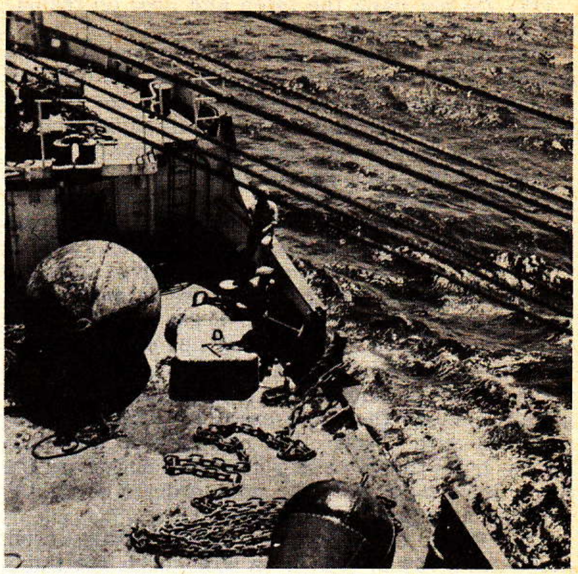


FIGURE 27–85.—Sinker has just been tripped from mechanical chain stopper.

27–3–45 Capstans and Windlasses—

A. *Older-type tenders.*—An important and necessary accessory to the handling of buoys is the deck capstan or windlass. The older large tenders are equipped with a vertical capstan located on the forecastle deck, and driven from the anchor windlass below on the main deck by gears and shafting. There are two gypsyheads attached to the windlass shaft. The windlass may be powered by steam, or in the case of a diesel or diesel-electric powered ship, by electric motor. The capstan on deck and the gypsies on the windlass shaft can be worked independently of the anchor cable wildcats on the shaft. Smaller tenders have electric motor windlasses equipped with gypsyheads on the horizontal shaft.

B. *Inland waterways tenders.*—The 114-foot *Foxglove* class tender has two capstans mounted on the main deck fore and aft, with electric motor and gear case located below the deck. They have a capacity of 3,000 pounds at a rate of 30 feet per minute.

Certain tenders used on inland waterways are equipped with vertical spuds such as are used by dredges, for holding the floating plant stationary. The spuds consist of built-up sections of steel plate pointed on the bottom. They may be rapidly raised and freely dropped in spud wells by an air-driven hoist.

C. *The 180-foot-class tenders* are equipped with an anchor windlass located on the forecastle deck, which consists of two wildcats for the anchor cables, two gypsy heads, and a drum for the deep-sea anchor cable. The windlass is driven by an electric motor. It has been found that the locking nuts and studs of the wildcat clutches may break off if they are permitted to work loose, and the windlass turned when they are not set up tight. There is a tendency to forget to retighten them after clutching the wildcats in or out. There is very little clearance between these nuts and the foundation when the windlass is rotating. Fairlead roller-type chocks are provided on the after 'thwartships section of the forecastle deck to provide a suitable lead for the cross-deck hookline from the buoy deck. It has been found that in leading a line to the gypsy head from a snatch block on deck, care must be taken to insure that the lead of the line is such that it bears against the inboard roller of the chock, otherwise over-riding turns will occur on the gypsy drum. For example, when working a buoy from the port side of the ship, the cross-deck hookline, being lead across to a snatch block located at the starboard side of the deck, should lead, when practicable, to the port windlass gypsy head.

D. *The converted 189-foot (Jonquil) class tender* is equipped with two capstans located forward. A disadvantage of this arrangement, which is shared by nearly all the larger vessel layouts, is that an extra man must be provided to operate the windlass or capstan controls. Some of the older, since-decommissioned, tenders had a remote control valve wheel located in the deck, which the man tending the line at the capstan could operate with his foot.

E. The importance of good line hauling gear for handling buoys cannot be over emphasized. The handling of moderate to large lighted buoys in anything other than calm water without the restraint of cross-deck hooklines to a capstan or windlass is poor seamanship, and in rough weather, downright dangerous to men and ship.

27–3–50 Hoisting Machinery—

A. Hoisting machinery used on tender-class vessels consists of five types: steam, electric, compressed air, gasoline motor, and hydraulic. Only one installation of the latter has been made to date. Two-cylinder steam hoisting engines were generally used on the older coastal-type tenders, and were recently installed on the converted 189-foot (*Jonquil*) class. Electric hoists are used on all 180-foot-class diesel-electric tenders, on the *Juniper*, and on some of the smaller inland water tenders. The majority of small tenders have compressed air-driven hoisters, and many buoy boats obtain their hoisting power from a small two-cylinder auxiliary gasoline engine.

B. *Steam versus electric.*—Steam hoisting engines have certain advantages over motor-driven hoisters, in that a more rapid rate of hoist and lowering may be obtained, the rapid lowering feature being achieved by permitting the load to fall freely, controlled only by a mechanical brake. Rapid lowering is an advantage when handling a large buoy in rough weather when it is necessary to get the buoy quickly waterborne so that the ship may get clear before damage is done to the lantern, etc. When hoisting a buoy in rough weather, once it is hooked on it is well to hoist quickly so that the buoy may be swung inboard and landed on deck before the rolling ship causes the buoy to swing about. A disadvantage of the steam winch is that the presence of numerous control levers (a friction clutch, brake, and locking-dog lever for each drum, plus a throttle lever at each end) makes the operation more complicated than the electric hoist, and the training of boom operators correspondingly more difficult. The operation of the tackles under a heavy load is jerkier. (See par. (H) below.) Early designs of the electric hoists on the 180-foot tenders hampered efficient operation because only one drum could be operated at a time. This precluded the lowering of the relief or whip while hoisting the main tackle, as when overhauling mooring chain. This has subsequently been remedied so that two drums may be operated at the same time. The requirement of lowering under power has not proved quite as serious a disadvantage as was first expected. However, it has been necessary to accommodate to this procedure. Under certain conditions of rough weather, the ability of the steam hoist to lower rapidly is a decided asset, and vessels not so equipped must govern their procedures accordingly.

C. *Steam versus electric hoisting speeds.*—A comparison of hoisting speeds between a typical steam-driven hoister and the 180-foot class A tender electric winch gives the following results: With a 15-ton load at full power, the steam winch hoisted the load with a five-part tackle at the rate of 67 feet per minute at full power and 46 feet per minute at normal power, respectively. The electric winch raised the same load at the rate of 19 and 13 feet per minute at full and normal power, respectively. Other tests made of a class A tender gave a 20 foot per minute full power hoisting speed and a 28½ foot per minute full lowering speed, using a five-part purchase with a 20-ton load. With the 180-foot tenders now rigged for three part tackles, the rated speed is 27 feet per minute lifting a 15-ton load at full speed.

It may appear, by comparison of hoisting speeds, that electric machinery cannot be made as efficient as steam. It is a matter of generator capacity, as against available steam capacity. The steam hoist takes its power direct from the main boilers of the vessel, whereas the electric hoister is dependent on the generator capacity which must also furnish power for all other shipboard use. Although electric winches could be developed that would equal or exceed the speed and power of steam, the present electric hoisters have been designed to give adequate speed and power for the job to be accomplished, commensurate with a reasonable cost of operation and available generator capacity.

D. *180-foot class tender hoisting machinery.*—Although there were three classes of 180-foot tenders developed, only two principles of boom (derrick) arrangements are involved. Details of the boom and rigging will be given under section 27–3–55. In each type of boom, four electric motor-driven hoisting drums are used, although located in different positions for each type. The motors installed on the class A (*Cactus*) and class B (*Mesquite*) 180-foot tenders are operated on direct current and have six speeds ahead and astern, controlled by varying the output through two motor-generator sets by the Ward-Leonard system so that two motors may be operated at one time. The motors develop 22 horsepower at 2,200 r. p. m. with a normal line pull of 8,840 pounds at a rate of 90 feet per minute line speed. The class C (*Iris*) tenders are equipped with alternating current squirrel-cage induction motors having three speeds ahead and reverse, namely 600, 1,200, and 3,600 r. p. m. respectively. The motors have "constant torque" characteristic on the slow and intermediate speed points, developing 15 and 30 horsepower respectively. All rated loads may therefore be lifted on the slow and intermediate speed positions. The high speed position is designed to permit rapid lowering of a hook load when necessary, or a quick positioning of the boom, such as when swinging a buoy across the deck or griping it in against the side of the vessel. This motor winding will develop 35 horsepower ahead, or will lift five-eighteenths of the rated loads at three times the intermediate speed;

thus the three-part purchases may be used to handle loads up to 8,333 pounds at a speed of 81 feet per minute.

(1) *Caution.*—In lowering hook loads on the high speed point, the operator should pause momentarily at the intermediate and slow speed points when stopping the load in air, in order to brake the load electrically. Otherwise the inertia effect of the motor running at 3,600 r. p. m. would be too great to overcome with the electric brake on a sudden stop. On the class C 180-foot tenders, the hoister motors and any other deck machinery may be run simultaneously and in any combination desired.

(2) All electric motors used in all classes of the 180-foot tender have a magnetic-type brake.

E. *Weekly inspection.*—All machinery should be carefully inspected weekly, and necessary routine maintenance performed. Brakes should be adjusted as necessary. The inspections and tests for electric-driven hoisting equipment shall include resistance tests of all circuits and inspection of motors, gears and electrical connections. Control equipment should be thoroughly inspected and contacts checked for proper tension and arcing. Megger reading for the electric hoisting motors shall be entered in the Machinery History. All watertight motors and controllers should be checked for collection of water due to condensation or leakage. Most of these units have drain plugs, but if these are not provided, a bolt or screw, permitting drainage, should be removed. If possible, a dry day should be chosen for this test, and if the air is dry, it may be desirable to remove inspection plates to permit air to circulate through the equipment. If water is found, it should be ascertained whether it is fresh or salt, and appropriate action taken. The collection of a small amount of condensation in these units under some climatic conditions is not an uncommon occurrence; however, the maintenance of the best possible air and water seals will reduce this effect to a minimum.

F. *Annual inspection.*—Complete inspection and overhaul of all hoisting machinery shall be made annually. Component parts subject to extensive wear and deterioration should be inspected and overhauled as indicated by the extent of use. It is the intention that during these inspections, all moving parts shall be thoroughly inspected, and where applicable, lubricated. The following should be included in the annual inspection:

(1) *Steam hoisting engines.*—During the annual inspection, all steps practiable should be taken to place the steam hoisting engines in good condition.

(2) *Brakes.*—Where band brakes are employed on the drums, the friction linings should be inspected and renewed if necessary. Care should be taken to prevent oil or grease from accumulating on the brake drum. Brake-operating mechanisms, latches, and pawls should be inspected to insure that they function satisfactorily, and that there are no defects not disclosed by daily and weekly inspections.

(3) *Friction clutches.*—When the winch drums are driven by friction clutches, inspection should be made to insure that the wooden blocks or other friction material have not deteriorated, and that grease and oil do not prevent satisfactory operation. Where positive clutches are used, all sliding parts should be properly lubricated, and the locking device on the shifting gear should be inspected to insure that it will prevent the clutch from separating when holding a load.

(4) *Gears.*—Clearance and general condition of gears and bearings shall be checked, and repairs and replacements made as necessary.

(5) *Electric motors.*—Motors shall be disassembled, and the condition of the bearings, bearing seals, shafts, the spider, and the windings, carefully checked.

(6) Upon reassembly of all hoisting equipment, it should be tested at 1½ times the rated capacity by lifting and rotating specified weights on the main and relief purchases and the whip. Results of these inspections and tests shall be entered in the daily log of the vessel and the Hull History.

G. *Reassembly of waterproof hoisting motors.*—Many vessels are equipped with Westinghouse type SK waterproof hoisting motors. Extensive tests have shown that when properly assembled, these motors are waterproof even when submerged for several hours. With usage, due to the heating and cooling of the motor, there will frequently be some breathing of air around the shaft, with the resulting possibility of condensation within the motor housing. Adherence to the instructions in paragraph (E) above will minimize any difficulty from this source.

(1) Experience has shown that the entrance of water into these motors is usually due to improper assembly after overhaul. Since the ball bearings are constructed so as to be waterproof, it is probable that when water enters the motor, it must seep through between the contact surfaces of the end bell and motor frame, securing bolts, or under the gaskets of the inspection plates. In overhauling these motors, special attention shall be given to securing the end bells. The contact surface of the end bell, end bell securing bolts and adjacent surface on the frame must be absolutely clean and free from burrs. On these cleansed surfaces, a *light* coating of ordinary red lead is applied; the end bell is then drawn up tight to the frame of the motor before the red lead dries.

(2) New inspection plate gaskets, which are made of shredded cork and Neoprene, should be used each time the motor is given a general overhaul. Before installing these gaskets, the contact surface on plates and end bell must be perfectly clean and smooth. When tightening down on the inspection plates, care should be exercised that the pressure is applied evenly and is sufficient to insure a watertight joint.

(3) Application of excessive paint to the hoisting motor housings should be avoided. No air can be circulated through a waterproof motor, so all of the waste heat must be dissipated through the motor casing. Tests have shown that multiple layers of paint on the outside of the casing greatly increase the operating temperature of the motor, hence the thickness of such paint should be kept to the minimum necessary for preservation.

H. *Use of friction coupling in steam hoisters.*—There have been complaints relative to the jerky operation of steam hoisting machinery, particularly under certain conditions involving heavy loads. The practice of starting the engine and then engaging the friction while simultaneously releasing the brake has been resorted to to ease this jerkiness. This practice is not recommended. From a study of the construction details of the average friction mechanism, it is apparent that these mechanisms were intended for use primarily as a coupling which engages smoothly and requires no specific angular relationship between the two shafts in order to lock them together. The amount of wearing surface on these friction couplings, and their heat dissipating capacity, is such that they cannot withstand prolonged use as friction devices.

(1) A steam hoisting engine is a device which would start a load very smoothly, were it not for the static friction in the engine and hoisting rigging. As the throttle on the hoisting engine is opened and the steam pressure in the cylinders becomes great enough to lift the load and to overcome static friction, the load begins to move. Since the static friction of all blocks and sheaves is considerably greater than the moving friction, as soon as the load starts to lift the tension on all of the wire rope is reduced, and it tends to snap back to a less elongated condition. This occurs at the same instant that the static friction in the hoisting engine has changed to rolling and sliding friction, thereby creating a condition that would cause the engine to accelerate rapidly even if the load on the drum were not suddenly decreased. This results in the jerking frequently observed when a heavy load is started.

(2) On a tender, the boom, mast, stays and hoisting purchases make up a somewhat elastic system, so under some circumstances there is actually an oscillation or vibration of the whole system when a load is started. The operator who advocates continuous operation of the hoisting engine and starting off the load by use of the friction coupling between the engine and the hoisting drum, eliminates the difficulty caused by static friction within the hoisting engine, and places in the system a friction clutch which is an excellent device for damping out the vibrations set up in the hoisting assembly. Unfortunately however, as stated above, these friction couplings are not built to withstand such use continuously, and it is likely to result in a great deal of maintenance.

(3) Proper operation of buoy hoisting equipment requires skill and judgment, and the methods employed by various ships undoubtedly differ. In the interest of reducing maintenance man-hours and material cost, it is desirable to avoid, insofar as practicable, slipping these friction couplings. The peculiarities of brake and throttle action on different vessels are unpredictable quantities, but it would seem that, in most cases involving lifting or swinging heavy loads, excessive jerking of the boom gear can be avoided by coupling the steam engine to the hoisting drum with the drum brake applied, opening the throttle such amount as experience has indicated will move the load, and then gradually easing off on the brake to get the load in motion.

I. *Other electric hoisters.*—Several of the smaller inland tenders such as *Forsythia, Shadbush,* and one coastal-type tender, *Juniper,* have electric hoister motors. The smaller motors have a line pull of 1,000 pounds at 58 feet per minute. The larger motor used on the *Juniper* is 30 horsepower direct current with eight speeds in either direction. It is capable of hoisting a 40,000 pound working load on a five part tackle at the rate of 12 feet per minute.

J. *Compressed air hoisters.*—A number of the inland waterways tenders such as the 100-foot (*Cosmos*) class are equipped with air motor-powered hoisters (such as the Sullivan type E112) with a line speed of 55 feet per minute at 2,000 pounds single line load. Air-driven hoisting machinery is very powerful for its size and weight, and is flexible in operation in that it will back up in case of an overload, can be operated up or down while in gear, or can be thrown out of gear to permit rapid lowering of loads "by the run" such as when placing buoys in the water. This feature, common to steam hoisters but not available in electric installations on the 180-foot class tenders, is very advantageous when setting buoys in rough water.

K. *Gasoline motor-driven hoisters.*—The 38-foot buoy boat is equipped with a single friction-driven-type winch connected by spur gear drive to a two cylinder 8 horsepower gasoline engine. The winch is capable of a 1,600 pound pull on single line at the rate of 100 to 120 feet per minute.

L. *A hydraulic-type hoisting winch* is being installed on the coastal tender *Fir*-class tenders. Details of this type of machinery will be promulgated at a future date.

M. *Operation of hoisting machinery.*—See paragraphs 27-3-55 (S) and (U) for notes on operating procedures of booms and related hoisting equipment.

27–3–55 Booms (Derrick) and Rigging—

A. There are many diverse types of booms and rigging in use on aids to navigation tenders. No attempt will be made to cover every type. However, a representative few will be described and illustrated below.

B. *The 180-foot tender* is the newest design and the most numerous class. Two fundamentally different means of suspension and support for the boom are involved in this type of vessel. The class A (*Cactus*) boom, having the single topping lift suspended from the head of a tubular A frame mast, is but a variation of the standard boom supported from a single mast as used on all the older coastal steam tenders, the converted 189-foot class, and many of the smaller vessels. The class B (*Mesquite*) and class C (*Iris*) 180-footers have a boom involving an entirely different principle of support, having two separate topping lifts suspended from opposite reinforced corners of the bridge superstructure. The advantage of this arrangement is that the boom is never free to swing, its weight always lying in the point of the vee formed by the two multiple-purchase topping lifts. The use of manila vangs (guys), or the need for hooking one of the hoisting tackles into the far side of the deck for a power vang is (except on rare occasions) eliminated. A disadvantage of the double-topping lift-type boom is that in heavy seas, when the ship is pitching violently, the boom will lift in the air and jerk downward in the vee of the topping lifts with some severity at times. Also, should the vessel be hooked on to a load such as a buoy over the side, and a sudden strain from an astern direction be put on the boom, it will rise up in the air, one topping lift becoming slack, and there is a possibility that the boom may jackknife back over the bridge. Therefore, whenever a strain in an astern direction is anticipated, one of the hoisting tackles should be hooked into a padeye in the deck as a preventer. In the design of the boom, provision was made for rigging a single manila vang or preventer tackle leading from a point near the end of the boom. This may be used in lieu of hooking a power tackle into the deck.

C. *Class A (Cactus) 180-foot tender*.—This class is equipped with a 50-foot tubular boom and tripod (A frame) mast designed to handle a maximum load of 40,000 pounds with the boom at an elevation of 45°. Four electric hoisters are clustered about the foot of the boom and are controlled from a station on top of the wheelhouse. The 4 hoisting drums operate the topping lift (six-part ⅞-inch 6 x 19 wire rope), the main and relief hoisting tackles (three-part ⅞-inch 6 x 37 wire rope), and a single whip (⅞-inch 6 x 37 wire rope). (All wire rope used on large tenders is high-grade plow steel. That used on some of the smaller tenders is "Kordless," or equivalent.) The boom was formerly rigged as a five-part main and relief, using ¾-inch wire rope. When rigged in 3 parts, using ⅞-inch 6 x 37 improved plow steel wire rope, the normal load is 30,000 pounds, which is hoisted at a rate of 30 feet per minute. When rigged as a five-part tackle, the hoisting speed for a 40,000 pound load is 18 feet per minute. The topping lift blocks are 20-inch sheave diameter, and the remaining blocks are 18-inch diameter. All wire rope connections are ⅞-inch Feige type. The normal length of wire rope on each drum is 350 feet. The 2 manila vangs are 3½-inch rope rove through two 10-inch double blocks and secured to the boom by 15-foot ¾-inch wire pendants. The boom may be swung out to an angle of 75 degrees off the center line of the ship when at a 45° elevation. Total elevation of the boom is restricted to 75° from horizontal. The list of the vessel with the boom in "hard over" position with no load is about 4°. The reach of the main tackle from the top of the bulwark rail is 17 feet; the relief, 12 feet 8 inches. The minimum elevation of the boom is 30°. The reaches for the main and relief tackles in this condition are 23 feet 10 inches and 18 feet 3 inches respectively. Lowering the boom thusly causes an additional 1° of list.

(1) *Power vang*.—Padeyes, 2-inch wire diameter, are provided on deck for anchoring the main or relief purchases when acting as a power vang (guy), and for other purposes. Due to the fact that tremendous loads are induced in the vang lines when the vessel lists under loads (this force becomes very nearly equal to the hook load, depending on the angle of heel), it is necessary to use the heavy purchases as vangs when the hook load or sea conditions so indicate. The power vang is to be rigged at all times to the most favorable padeye location, in order that the boom may not get out of control and the strain may be at a minimum.

(2) *Manila vangs*.—The manila vangs may be secured to padeyes or ring pads welded on the bulwarks, one rigged forward on the side opposite the buoy port being worked, and the other aft. This provides the most favorable position for steadying the boom (assuming for a moment that a power vang is not being used). If the boom is not to be trimmed very far outboard, many ships rig both vangs aft, so that the forward one is out of the way of the lanterns of lighted buoys being swung across the deck. When working either side of the ship alternately, constant shifting of the manila vangs is not practicable, therefore both vangs are led aft.

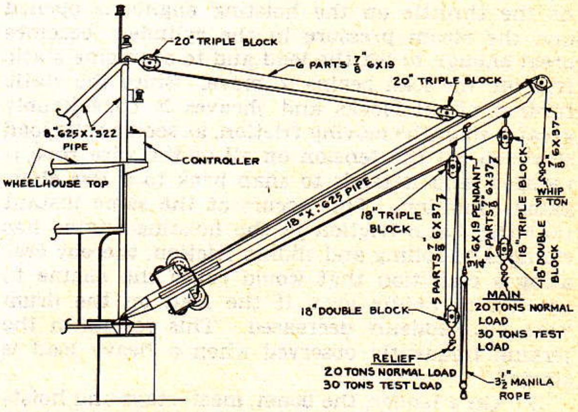


FIGURE 27–86.—180-foot class A tender—boom and rigging.

D. *Class B (Mesquite) and class C (Iris) 180-foot tender*.—The derrick of the class B and C 180-foot tender consists of a 50-foot tubular boom and reinforced bridge structure, designed for a normal hook load of 40,000 pounds with the boom at an elevation of 45°. Two hoisting motors are located near the bridge supports and are connected to operate the dual topping lifts for elevating and rotating the boom; two other hoisters are located on the boom for operating the two lifting purchases. The upper purchase may be rigged as a single whip with a capacity of 8,333 pounds at 81 feet per minute, or as a 3-part tackle with a capacity of 30,000 pounds at 27 feet per minute. The lower purchase may be rigged as a 3- or 5-part tackle. When rigged in 5 parts, it has a capacity of 40,000 pounds at 16 feet per minute. It is intended that the lifting purchases be rigged for 3 parts when handling the larger lighted buoys up to and including the 9-foot type. The boom may be elevated to 75°, and swung out at an elevation of 45° to 75° from the center line, similarly to the class A tenders. The topping lifts are 7-part purchases, using about 400 feet of ⅞-inch 6 x 37 improved plow steel wire rope on each drum. The hoisting tackles use ⅞-inch wire rope.

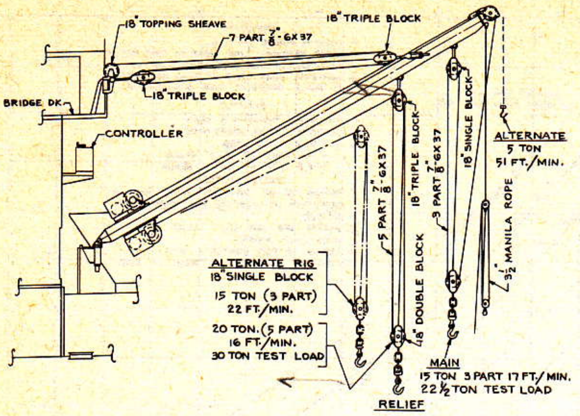


FIGURE 27–87.—180-foot classes B and C tender—boom and rigging.

E. *Stability during lifting; 180-foot tender.*—In the 180-foot class tender, certain measures may be taken to increase the stability when handling heavy loads.

(1) Loads up to 40,000 pounds may be handled without introducing counter-heel. The chart, Maximum Lifting Capacity, figure 27–88, illustrates the amount of load that can be handled at two different outreaches without exceeding 15° heel, dependent on the net GM at the time of hoisting, which is reflected in the period of roll. To use the chart the following two observations are necessary:

(*a*) Determine the mean draft of the vessel.

(*b*) Determine the period of roll.

The observations should be made with the ship in the condition in which lifting is to be undertaken. The period of roll should be determined by averaging at least five observations. The rolling can be initiated by alternately shifting the rudder while under way. If waves of constant period act upon the ship for a sufficiently long time, the ship will ultimately roll in the period of the waves. Therefore, in making observations for the period in a seaway, this condition should be avoided. In service conditions where it is required to hoist with a capacity deck load aboard without any appreciable cargo in the holds, it may be necessary to load temporary ballast in the hold to maintain initial stability for lifting.

(2) For hook loads greater than 40,000 pounds, it is recommended that fixed ballast be installed, a counter heel be introduced, and definite loading of tanks be obtained prior to hoisting. Upon request, the amount of ballast will be authorized by Headquarters according to the assignment of the vessels. On the class C (*Iris*) vessels, all oil tanks (frames 116–126) and water tanks (frames 140–147) should be at least two-thirds full, the fore peak empty, and the forward tanks (frames 30–44), the center line cargo tank, and the wing tank furthest from the load, full, and the wing tank nearest the load filled to the height of the external water line.

F. *Older-type booms.*—The converted 189-foot *Jonquil*) class, and most of the older steam coastal tenders such as *Mistletoe, Oak, Fir*, etc., the diesel-electric tender *Juniper*, and several smaller diesel tenders such as *Narcissus*, have similar boom rigs in which a built-up or tubular boom is suspended from a gooseneck at the base of the foremast, and by a multiple (usually six-part) topping lift leading from the upper section of the mast to a double block located at, and a single block located near, the end of the boom. A multiple (usually five-part) "main" tackle is suspended from the end of the boom, with the hauling part leading through a sheave within the boom to one sheave of a quadruple fairlead block suspended from the mast just below the topping lift block, and down to a hoister drum. Next inboard from the end of the boom is a single "whip," rove through a sheave within the boom up through the fairlead block on the mast and down to the hoister. Farthest inboard is another multiple tackle, the "relief," which may be rigged identically to the "main" or have more or less parts. The "main" and "relief" tackles may both or either be rigged as three-part tackles instead of five when the size of the loads in the area permits. Rollers are located along the sides of each boom sheave opening to prevent chafe. Two multiple manila tackles are secured by wire pendants to the end of the boom for steadying purposes (vangs). The mast is braced by wire stays in conventional manner.

(1) It was found in the 189-foot converted tenders (*Jonquil* class), that when the boom was topped high, the tackles were spaced too close together, causing them to foul. Alterations have been authorized to correct this deficiency by expanding the distances between the tackles and relocating the topping lift blocks to retain proper support and boom strength.

(2) Some vessels such as the *Hemlock* and *Ivy* have their whips rigged with a single lower block instead of a single part hoisting wire.

(3) One 189-foot tender found the whip impracticable to use as a vang, and rigs the relief for this purpose, always working from the starboard side. The starboard manila vang is led to the after warping capstan.

G. *Juniper; Fir-class tenders.*—The *Juniper*, a 177-foot coastal tender, uses ¾ inch diameter 6 x 19 improved plow steel wire rope for hoisting tackles; a three-part "main," five-part "relief," and single "whip." Two 3½-inch manila four-part vangs are secured to the end of the boom. The electric-driven motor hoister is located in the main hold. The boom has a maximum working load of 40,000 pounds. The conventional mast is stayed with 1¼-inch and 1⅜-inch stainless steel shrouds. The *Fir* class (*Walnut, Hollyhock*) is rigged similarly to the *Juniper*, except that the "main" is five parts, and the hoisting engine, steam-operated, is located on deck at the base of the mast. A fairlead sheave for each wire is located on an axle on the mast at the gooseneck.

(1) It should be remembered that the exact number of parts of any specific hoisting tackle are subject to change, determined by the workload of the particular vessel.

(2) The ¾-inch wire rope mentioned above has, on many ships, been replaced by ⅞-inch wire rope. Where the size of the wire has been increased, the number of parts of the hoisting tackle may be de-

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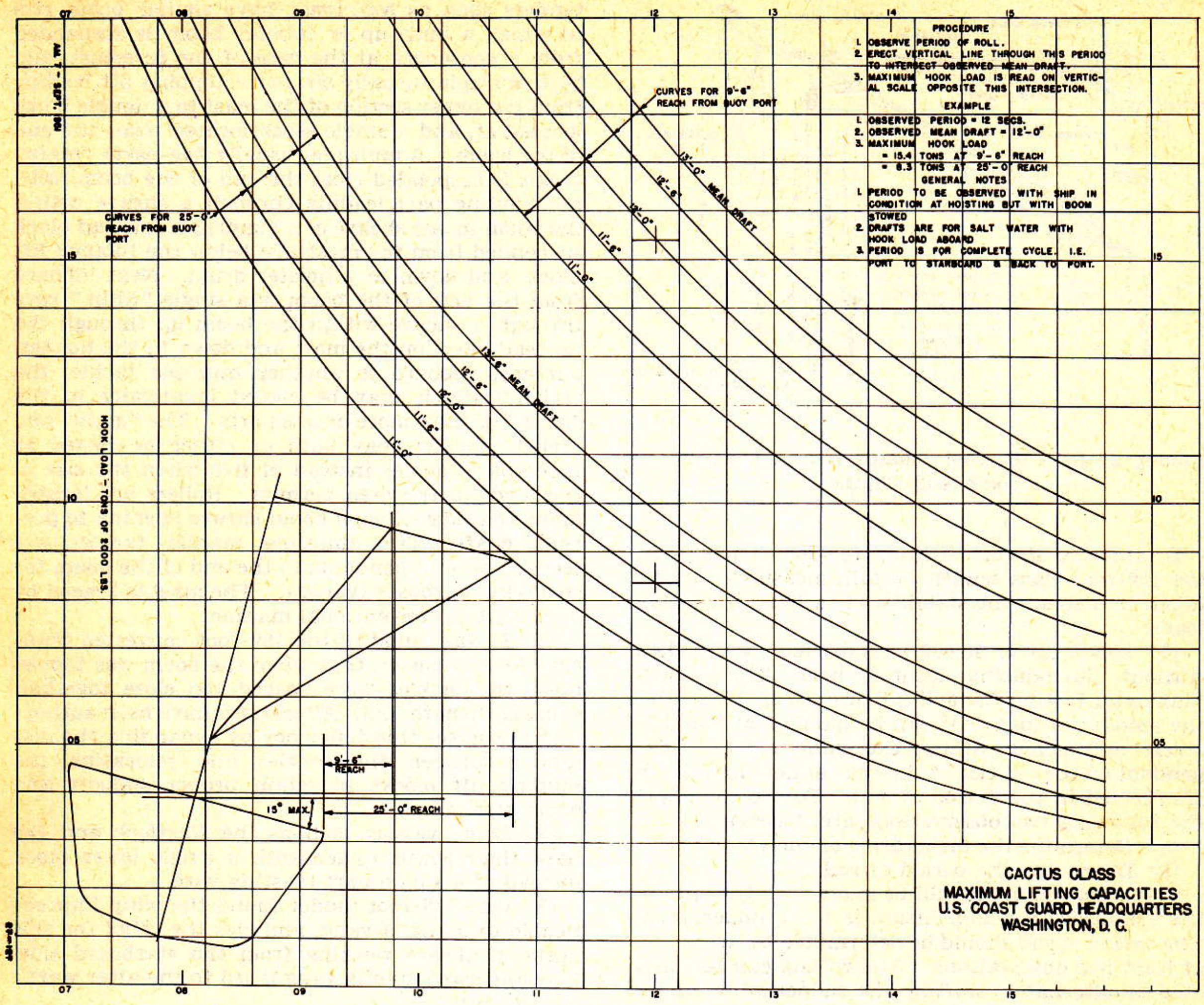


FIGURE 27–88.—Maximum lifting capacities, class A 180-foot tender.

creased commensurate with the loads to be handled, thus achieving increased speed of operation.

NOTE.—The *Fir* has recently been converted to hydraulic hoister operation. It is planned to equip the *Walnut* and *Hollyhock* with a hydraulically-operated double topping lift-type boom similar to the class B 180-foot tender.

H. *Oak-class tenders.*—The *Oak* (*Hawthorne*), 160-foot tender, is rigged similarly to those listed in Paragraph (G) above. The *Narcissus* (*Zinnia*) is a smaller tender used in bays and rivers. The general arrangement of the boom is similar to the larger tenders listed above (five-part main and relief), except that ⅝-inch diameter wire rope is used with 10-inch blocks. Manila vangs are 3-inch circumference. The mast is braced by two tubular legs in lieu of wire stays.

I. *The converted 131-foot class* (*White Sage*) is used to handle small buoys in coastal and harbor waters. It has a tubular boom supported by a fourfold ⅝-inch wire topping lift consisting of a double block on the mast and on the end of the boom, and a single fairlead block on the mast. The "main" and "relief" are threefold purchases with a workload of approximately 11,200 pounds for both together, or either. Two threefold manila vangs are used to steady the boom. Unlike the large tenders, there is no single "whip," and the "main" and "relief" hauling parts are led along the underside of the boom to a block at the base of the boom, thence to the hoister machinery located on deck.

J. *The 114-foot Foxglove-class inland waterways tender* has a 27-foot boom with a three-part hoist having a working load of 6,000 pounds at the rate of 18 feet per minute. It is equipped with a compressed air motor-driven hoister with 2,000-pound line pull at 55 feet per minute.

K. *The 113-foot Forsythia-class inland waterways tender* has a boom free to swing 360°. Using three-part tackle with 7/16-inch wire rope, the electric hoisters handle a 6,000-pound load at 20 feet per minute. The hoisters are equipped with automatic electric and mechanical brakes, and push-button control.

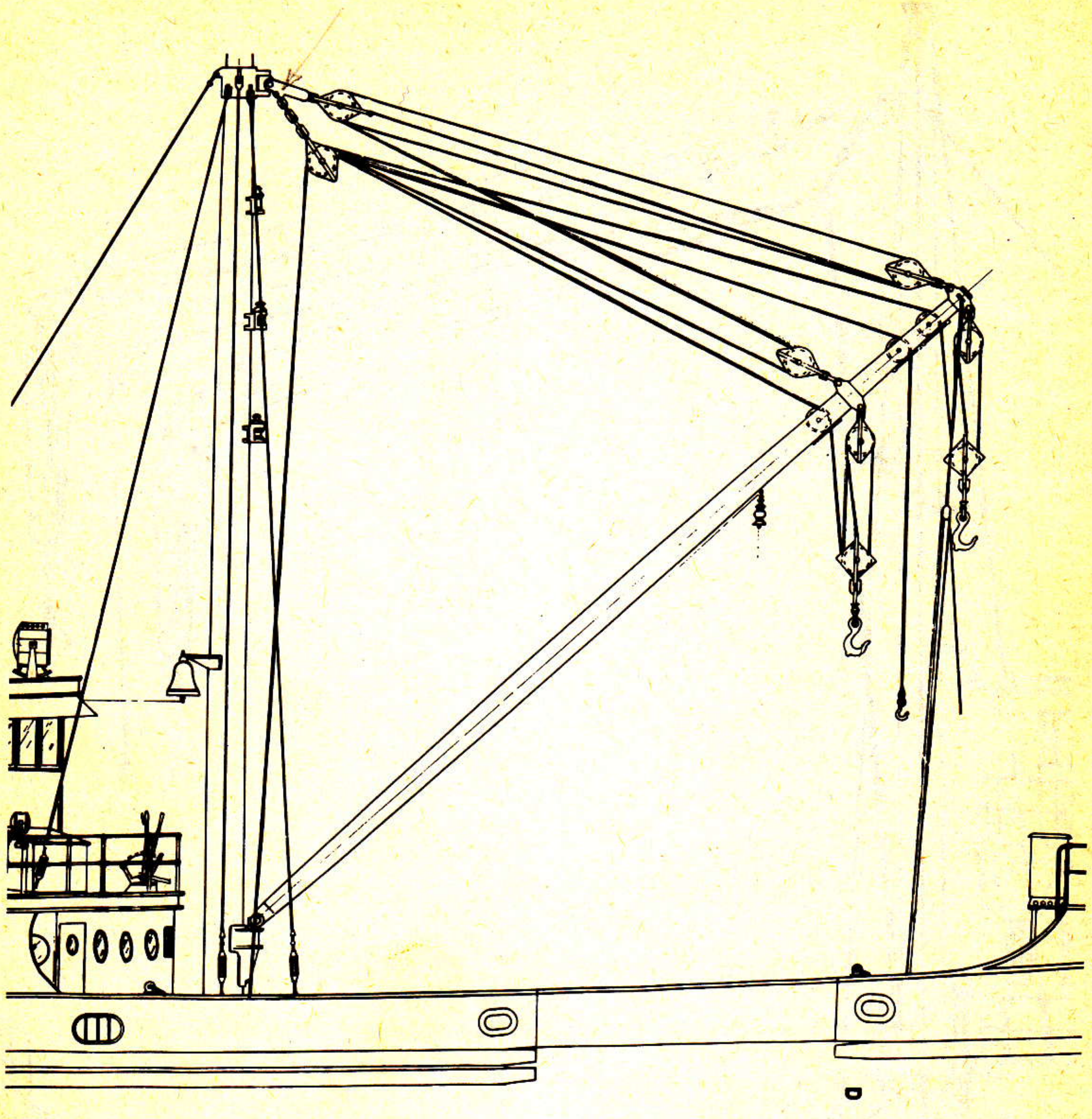


FIGURE 27–89.—177-foot tender *Juniper*—boom and rigging.

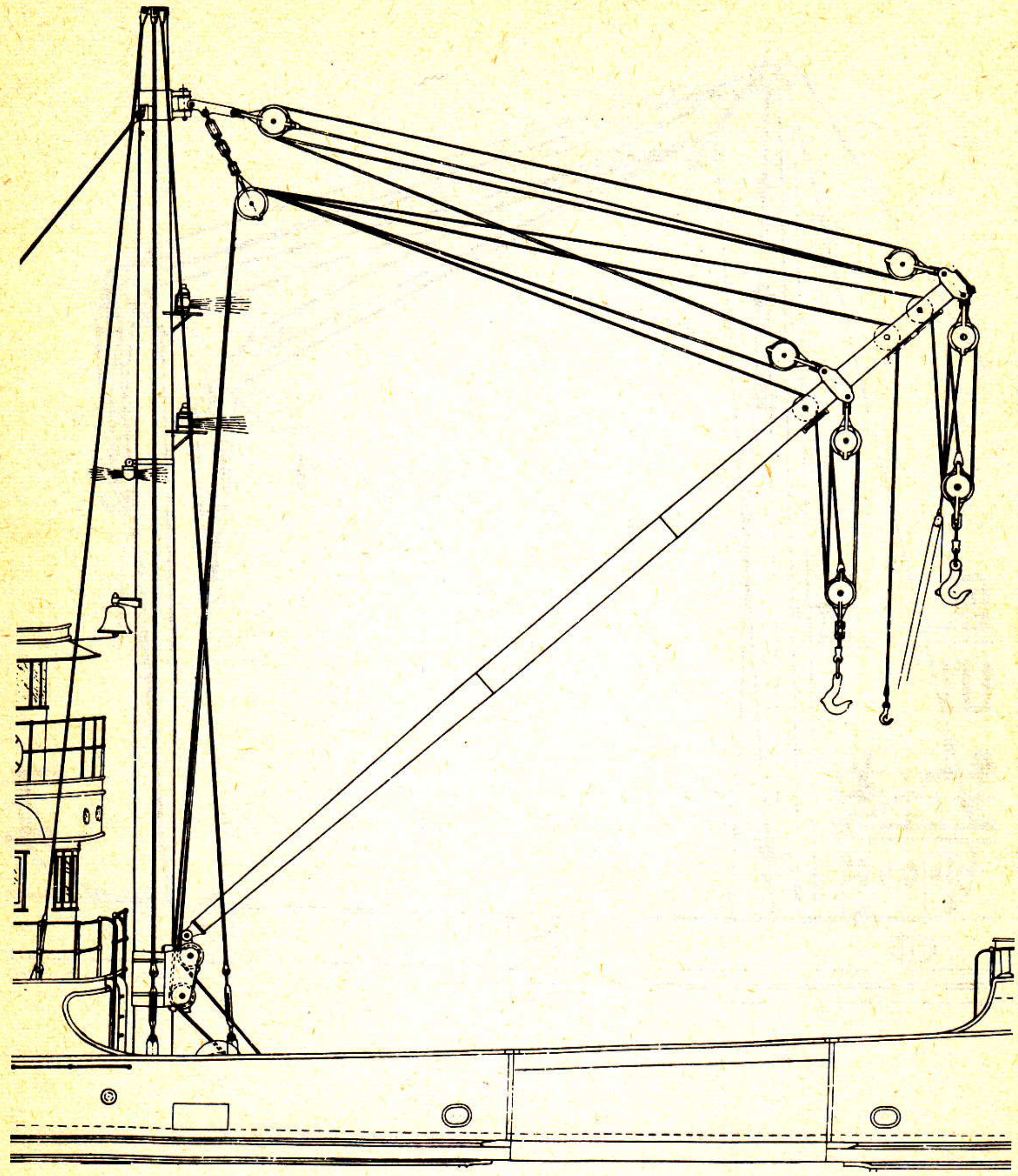


FIGURE 27–90.—175-foot tender *Fir*—boom and rigging.

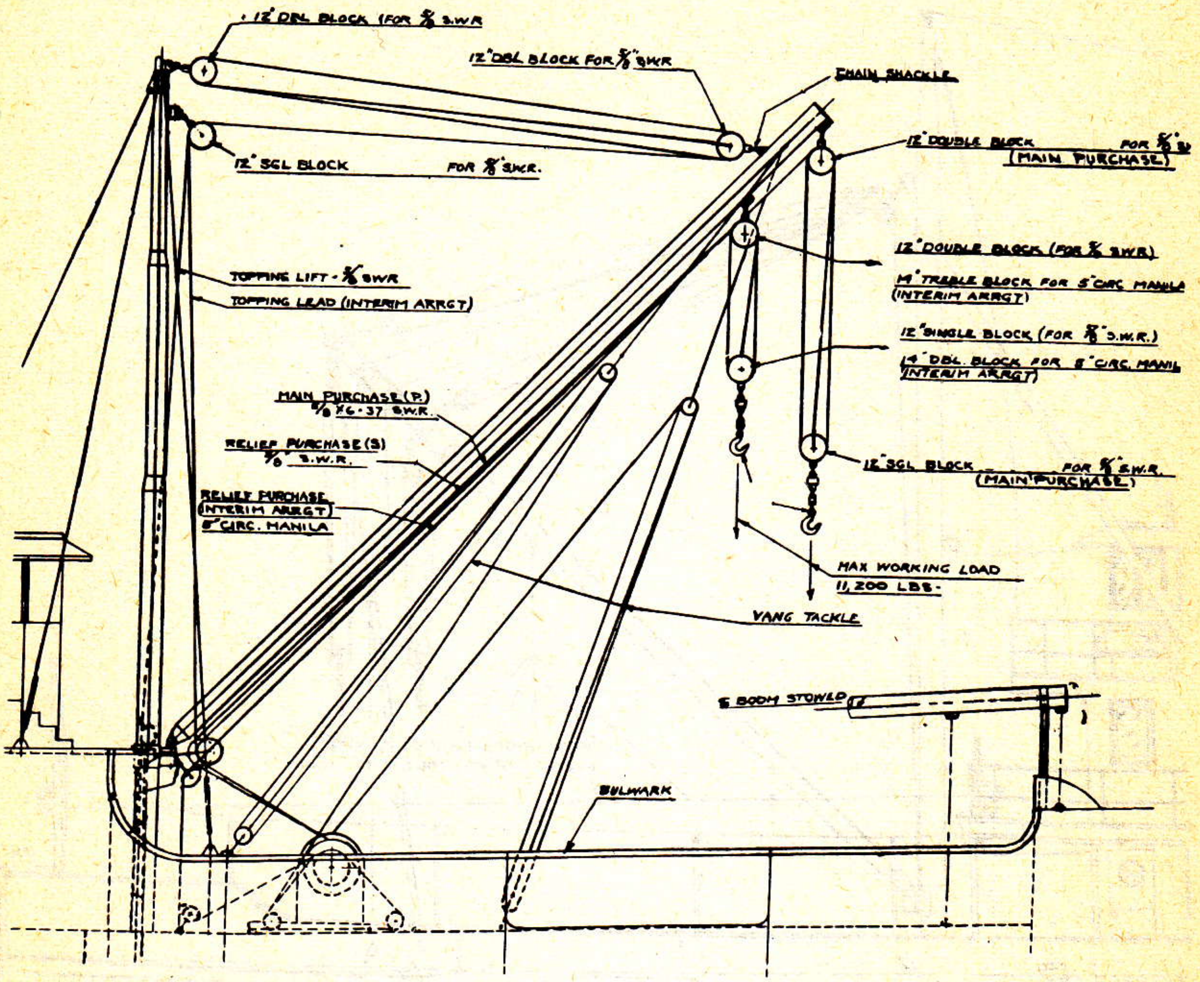


FIGURE 27–91.—133-foot-class tender *White Heath*—boom and rigging.

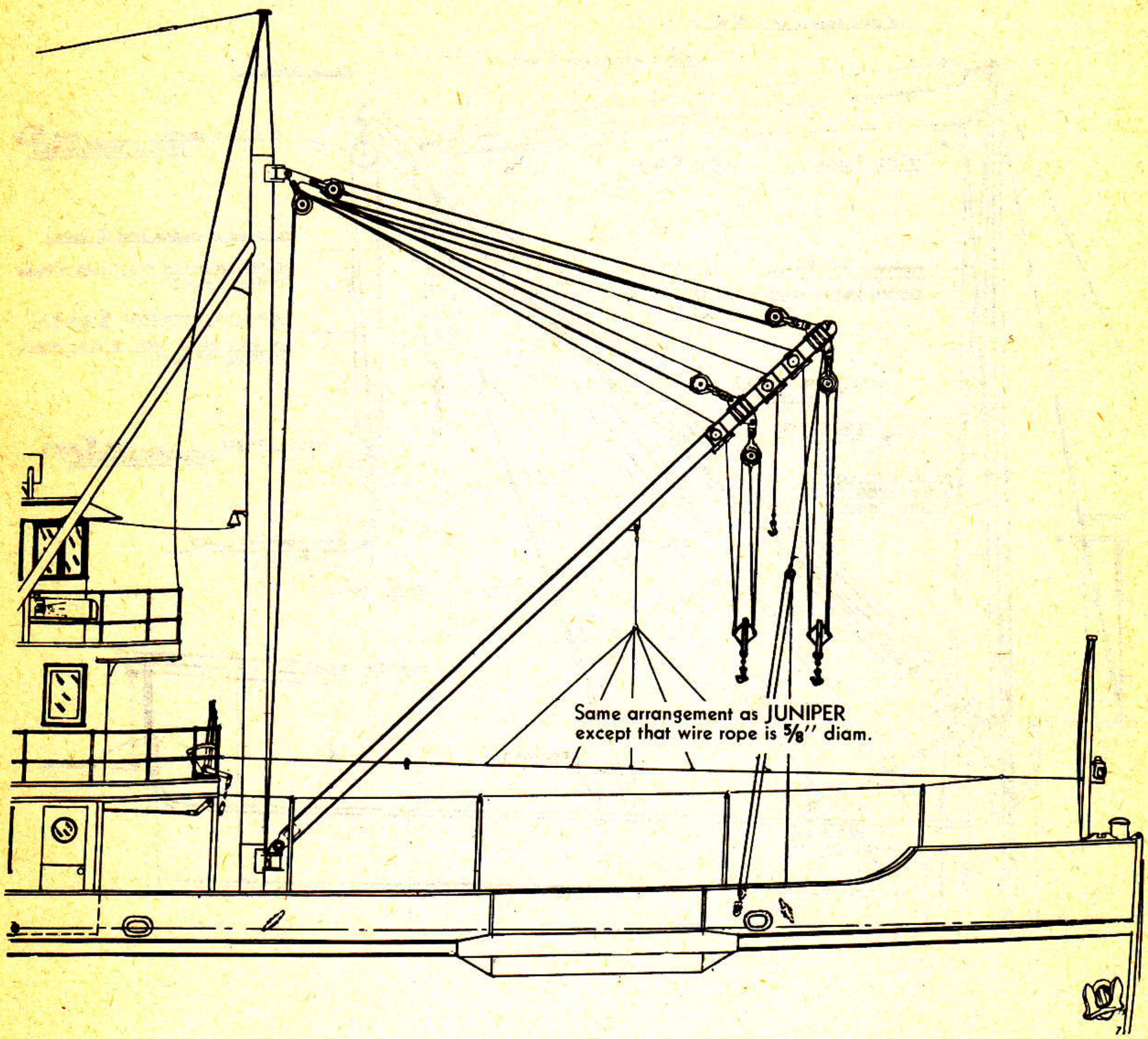


FIGURE 27–92.—122-foot-class tender *Narcissus*—boom and rigging.

L. *The 100-foot Cosmos-class inland waterways tender* has a 27-foot tubular boom equipped with five-part "main" and single "whip" hoisting tackles using 7/16-inch Korodless type wire rope. The working capacity is 10,000 pounds at 12 feet per minute for the "main," and 2,000 pounds at 60 feet per minute for the "whip." The hoister comprises three individual single drum clutch and contracting brake type winches driven by compressed air motors developing 2,000 pounds line pull at 60 feet per minute. They will each withstand a static pull of 14,600 pounds. The whip, located on the end of the boom, uses 65 feet of wire, the main, 170 feet, the topping lift, 140 feet of wire. The blocks are 10-inch steel double sheave type.

Many of the inland waterways-type tenders use a stubby kingpost in lieu of the conventional-type mast for supporting the boom.

M. *The 73-foot Shadbush-class inland waterways tender* is equipped with electric winches developing 1,000 pounds line pull at 58 feet per minute. The working load is 3,000 pounds, using a three-part tackle.

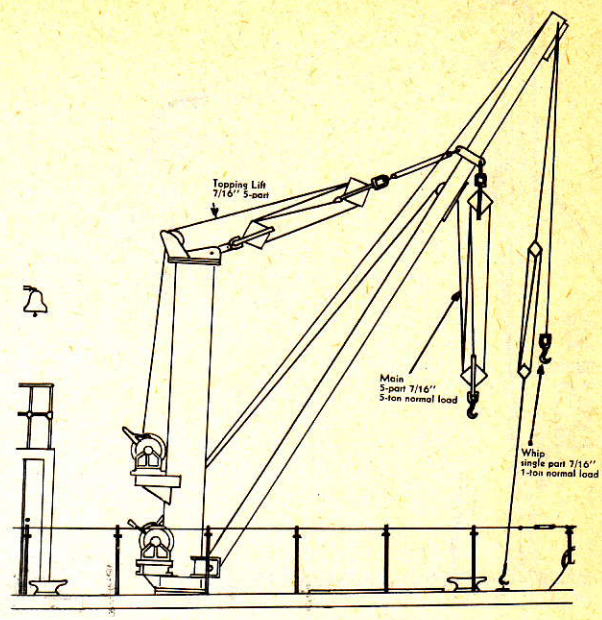


FIGURE 27–93.—100-foot class tender, *Cosmos*—boom and rigging.

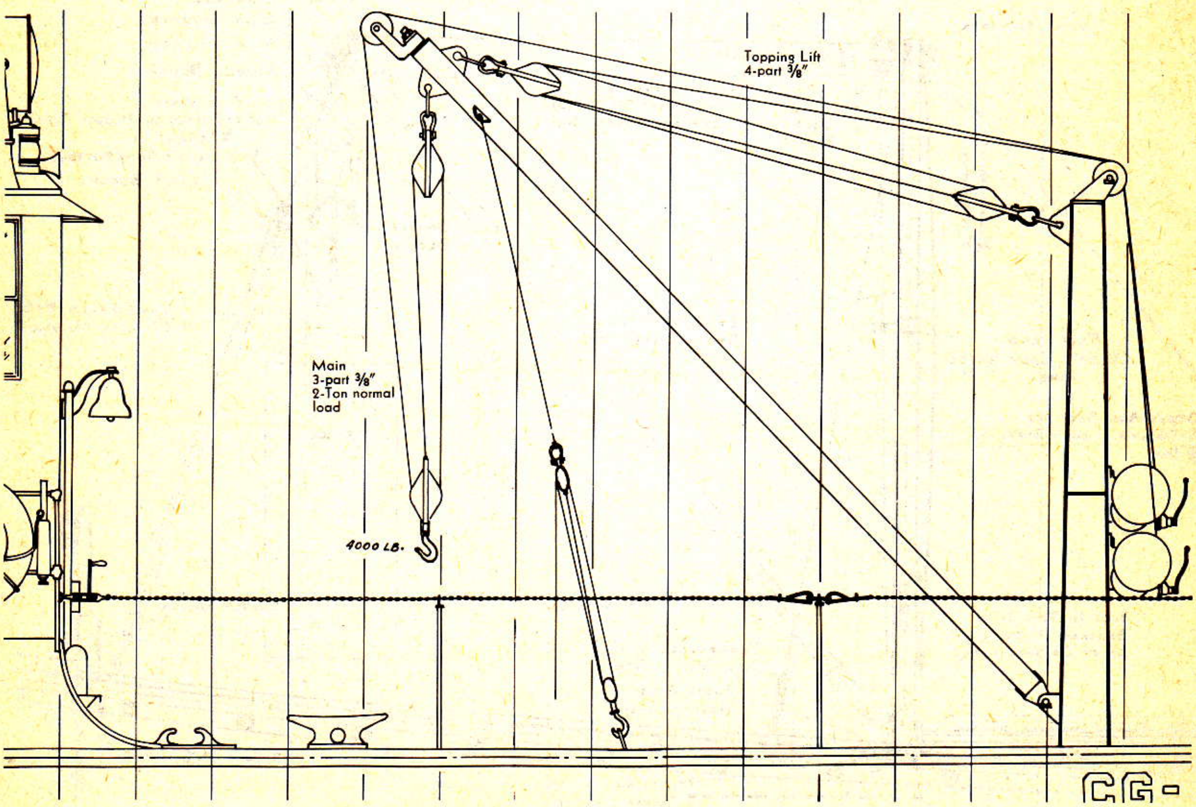


FIGURE 27–94.—65-foot buoy boat—boom and rigging.

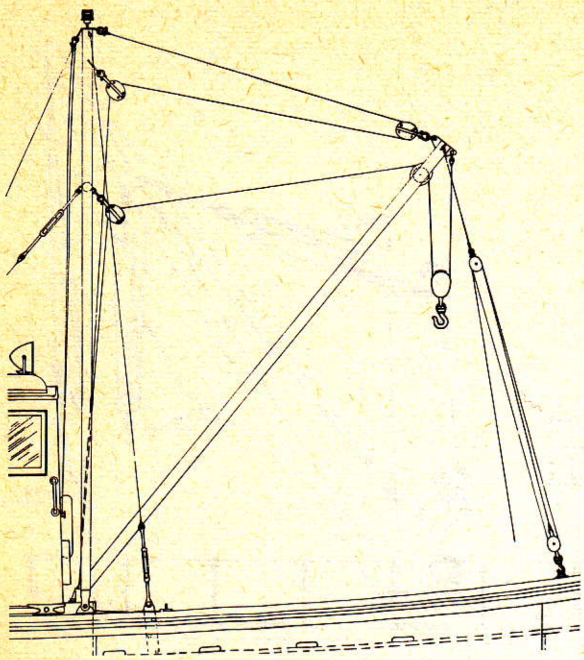


FIGURE 27–95.—52-foot buoy boat—boom and rigging.

N. *The 65-foot buoy boats* used in the Second District are equipped with a short tubular boom facing aft and suspended from a kingpost-type mast. The topping lift is four parts, and the one hoisting tackle is three parts, both hauling parts leading through fair-lead sheaves on top of the kingpost to compressed air winches secured to the forward side of the kingpost. The working load of the hoist is 4,000 pounds, using ⅜-inch diameter wire rope.

O. *Other buoy boats* are equipped with various types of single-hoist booms with maximum capacities ranging from 1,500 to 4,000 pounds, dependent on the size of the boat and gear. The falls may be a small diameter wire rope or a suitable size manila rope. The 38-foot buoy boat, for example, has a 10-foot mast, 15-foot boom, and one five-part 2½-inch manila purchase operated by a 1,600-pound winch at 100 feet per minute, gear-driven by a two-cylinder gasoline engine.

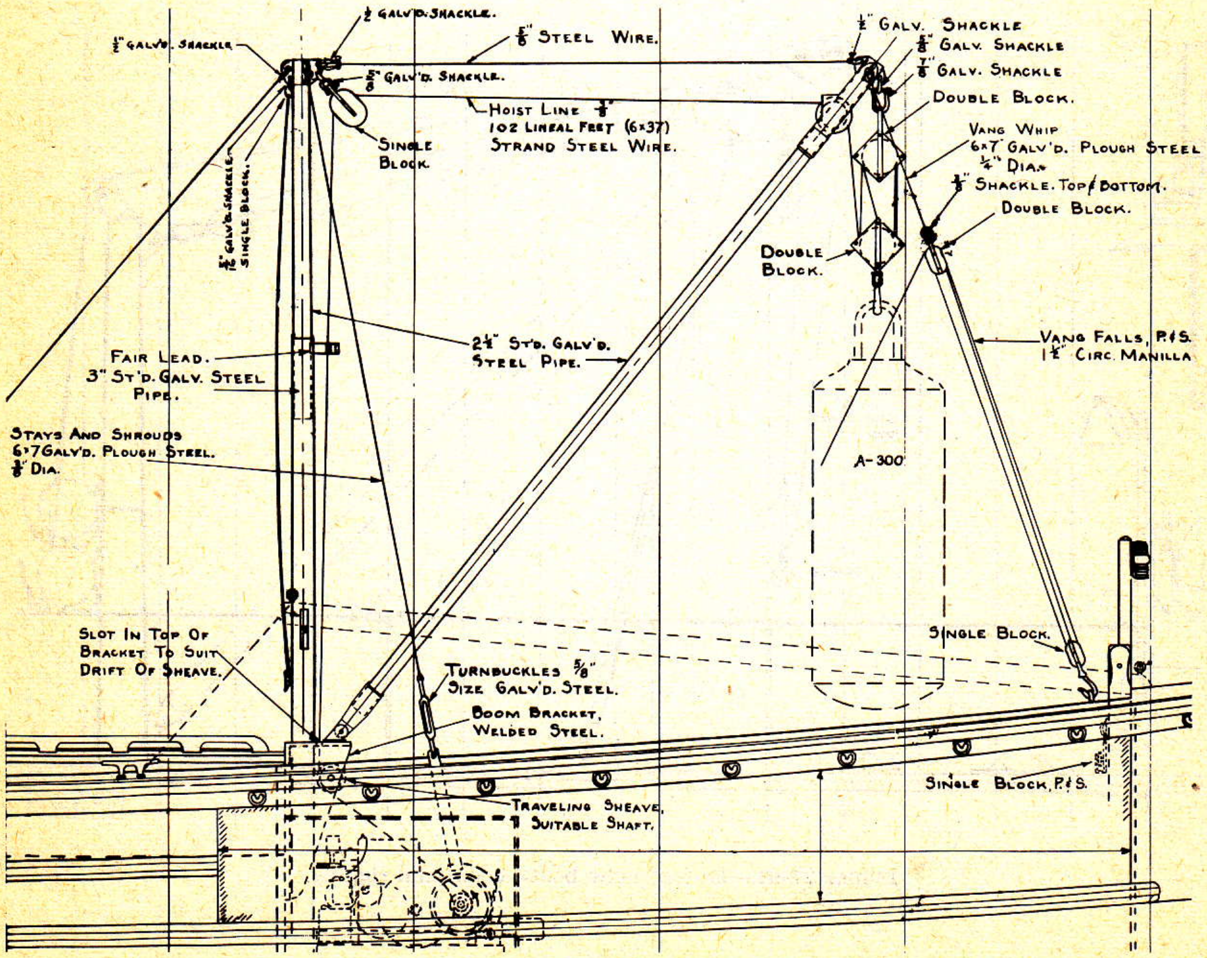


FIGURE 27–96.—40-foot buoy boat—boom and rigging.

Following is a summary of hoisting capacities of representative types of tenders and buoy boats.

Table of capacity of power-driven weight-handling gear

Class or name of vessel	Power	Size of hoist line (inch)	Number of parts	Capacity in short tons
189-foot tender	Steam	¾	5	20
			1	4.5
180-foot A tender	Electric	⅞	5	20
			3	15
			1	5
180-foot B and C tenders	do	⅞	5	20
			3	15
			1	5
175-foot (*Fir*)	Hydraulic	⅞	5	20
			3	15
			1	5.5
173-foot (*Mistletoe*)	Steam	¾	5	20
			1	4.5
133-foot tender	Electric	⅝	3	5.6
			1	2
122-foot (*Narcissus*)	do	⅝	6	10
			1	2
121-foot (*Linden*)	do	⅝	5	10
			1	2.25
114-foot (*Sycamore*)	do	½	3	3
			1	1
114-foot (*Forsythia*)	do	7/16	3	3
			1	1
100-foot (*Cosmos*)	Air	7/16	5	5
			3	3
			1	1
72-foot (*Birch*)	Electric	⅜	4	3
			1	1
65-foot buoy boat	Gasoline	½	3	2
	Electric	⅜	3	2
52-foot buoy boat	Air	⅜	2	1.5
40-foot buoy boat	Hydraulic	⅜	1	.75
	Gasoline	⅜	5	1.5
			1	.35

P. *Daily inspections and lubrication.*—The primary purpose of the daily inspection of rigging is to make certain that the equipment is safe for use. At the beginning of each work day, a visual inspection shall be made of all the rigging. The padeyes and hooks shall be examined at close range, a careful search being made for any cracks that might have developed. The hook shall, in all cases, be examined immediately before lifting a full-rated load. The lubrication of boom seats, and the pins and blocks in the rigging should be daily routine when the equipment is in use, and, if properly accomplished, will greatly increase the life of the equipment. Wire rope should be lubricated as needed, and in all cases should be slushed adequately to prevent rusting when not in use. Lubrication of wire rope is discussed under section 27–2–55.

Caution.—In no case shall the hoisting tackles, hook, etc., be tested by jerking on a weight. While this method might expose a failure on a part of the gear, it may also start a failure which does not become evident at the time. Complete failure may then occur during actual operations with possibly disastrous results.

Q. *The weekly inspection* of rigging shall be more thorough than time will normally permit for the daily inspection. Routine maintenance, including painting, necessary for keeping equipment in good condition, should be performed at this time. The weekly inspection shall include the following:

All manila and wire rope, padeyes, hooks, booms, and other fittings, shall be carefully inspected for accumulated wear and distortion. Wire rope shall be cleaned and lubricated, as needed, and renewed if the condition warrants. The conditions under which wire rope should be renewed are discussed in paragraph 27–2–55. Examine the interior of all manila line for mildew and other indications of deterioration. The amount of weathering, wear, and elongation permissible before replacement depends upon the use. Line should not be discarded needlessly, and when no longer suitable for one usage, should, if practicable, be shifted to a less severe one.

R. *Annual inspection.*—Complete inspection and overhaul of the boom (derrick) and all running rigging of tender-class vessels shall be made by the ship's force, assisted by bases or yards, as necessary, at least once each year. Component parts subject to extensive wear and deterioration should be inspected and overhauled as indicated by the extent of use. It is the intention that during these inspections, all moving parts shall be thoroughly inspected, and, where applicable, lubricated. To this end, the inspection and overhaul period should follow a period of dry weather, to insure that the least possible amount of moisture is present in the wire rope. The annual inspection and overhaul shall include the following:

(1) *Inspection of wire rigging.*—Cradle the boom, unship all wires from hoister and topping lift drums. Unreeve all blocks. Inspect all wire for broken ends, kinks, and external damage. Carefully inspect all wire rope splices and fittings, and all splices in manila line. Three different methods have been extensively used on Coast Guard vessels for securing wire rope to sockets. A common method is the use of tapered sockets poured with zinc. These fittings should be checked to see that the socket is completely filled, and for indications of loosening of the zinc in the socket, or of pulling of the wire from the zinc. See section 27–2–65 for instructions for attaching a poured-zinc type wire rope socket. A second commonly used type of fitting for the ends of wire rope is the patented screwed feige-type fitting using a tapered wedge plug. The end of the wire rope should completely fill the socket, and this requirement can be checked by the inspection hole provided in the fitting. All, or nearly all, of the threads on the sleeve and socket should be engaged to secure the maximum clamping power on the wire and to prevent failure by stripping of the threads. The instructions listed under section 27–2–65 should be followed closely in installing these fittings. Cable sockets now installed shall not be replaced by other types without the approval of Headquarters. The third type of socket in use is the swaged socket, the installation of which requires the use of heavy swaging equipment, which at present is available only at certain naval shipyards, and a few larger commercial repair yards. These fittings should be inspected for cracks and for loosening of the wire.

(2) *Hooks and chain slings.*—All hooks and chain slings regularly used on the "main" tackle, "relief" tackle, and the "whip," shall be tested annually, or more often if the condition warrants, by magnetic particle or other nondestructive methods. Hooks and chain slings shall be annealed, or other-

wise heat-treated, only when the hook shows evidence of severe work-hardening, and then *only when the original heat treatment is known* and can be repeated. If serious cracks and severe work-hardening are present and the original heat treatment is not known, the hook shall be discarded and replaced with a new hook of known chemical and physical properties and known heat treatment. Chain slings of the Herc-Alloy type, or similar heat-treated high-tensile steel chains shall never be annealed. Take and record caliper measurements of hooks so that at future inspections they may be checked for elongation.

(3) *Blocks, pins, etc.*—Disassemble all blocks, swivels, pins, sheaves, etc., for inspection and greasing. Check all grease fittings and grease passages while disassembled. Inspect pins and bushings for wear. If found worn, and replacements are not immediately available, take measurements and make sketches for manufacture of replacement pins and bushings for installation and spares. Wear greater than normal is usually the result of inadequate lubrication or misalignment. If such wear exists and the remedy is not apparent, the matter should be called to the attention of Headquarters.

(4) *Boom and fittings.*—Unship boom foot from boom seat. Inspect boom foot pin. On vessels having electric hoisting equipment, it will be necessary to disconnect the flexible power leads at junction box located near boom base. Lift boom seat from boom base, inspecting boom seat and bushings for wear or adequacy of lubrication. Upon completion of inspection, assemble all parts properly lubricated.

(5) *Lubrication of wire rope.*—After reinstalling wire rope on hoisting drums, thoroughly lubricate the entire length of rope with approved wire rope lubricant.

S. *Unauthorized alterations.*—There is sometimes a tendency among operating personnel to attempt to modify or alter hoisting rigs from the designed standards to suit their own concept of operational need. The placement of various connections on a boom or the size, etc., of the tackles have been carefully considered by the designer to minimize the strains involved. A seemingly slight alteration may unknowingly weaken the boom to a dangerous extent. A recent example of this was the change in location of the hoisting tackles (made because the tackles fouled each other when the boom was topped high) on a 189-foot tender without changing the location of the topping lift connections to compensate accordingly. Any departure from the intention of the designer either through alteration of the boom structure or rigging, or unorthodox operation, should be avoided. The following rules should be observed to avoid dangerous operation of any cargo boom:

(1) Do not handle any hook loads above the rated capacity of the boom.

(2) Do not alter the location or details of the boom fittings or install jury rigs of any kind.

(3) Do not reduce the number of parts in the topping lift, or the size and quality of standing or running rigging. It is sometimes advantageous to reduce the number of parts in the lifting purchases to gain greater speed, but capacity must be proportionally reduced.

(4) Do not neglect to rig preventer lines to control boom at all times during sudden changes in wind, current, and position.

(5) Do not neglect lubrication of gooseneck swivel, footpins, or other rotating bearing surfaces.

T. Figure 27–97 illustrates Standard Hoisting Signals. In the interest of uniformity of training, these signals should be used exclusively.

U. *Training of boom operators.*—Boom operators for aids to navigation tenders must be selected with care. Young alert men with ample experience on the buoy deck, having a keen sense of orientation and judgment of distance, cool nerves in an emergency, and foresight, make good boom operators. The boom operator should be able to move a load from one point to another without the need for specific orders for each individual movement, yet he must instantly obey a movement order when given by the officer in charge on deck. He should be alert for emergencies, and should check to see that personnel are clear before lowering a load. Few boom operators know that if a big buoy breaks loose when the ship is rolling, the boom may be instantly lowered on to the buoy, and the buoy pinned up against the bulwark or another buoy and held there until secured. It is desirable to maintain a complement of at least two qualified boom operators at all times. This makes it advisable that two additional men be under training. Boom operators are trained first by observation of the functions over a period of time, during which time the various controls and their associated functions are carefully studied, then they handle individual tackles one at a time to achieve the "feel" of the gear, and as time goes on they take over the remaining operations until they can manipulate the boom in any direction. The new boom operator is allowed to take over the handling of light loads such as may occur when loading, and gradually takes over more complicated operations as he progresses in skill. A boom operator must have a healthy respect for the potentialities of the machinery under his charge and must fully realize the consequences of a mistake. Many ships let the man operate the boom during a practice period with a small sinker on the tackle and place it in designated spots marked out on deck or as directed by a petty officer on deck.

(1) Boom operators must take care not to jam a hoisting tackle in two-blocked position, even if the officer in charge fails to stop the hoisting. When topping a boom straight up, the main or relief tackle, if hooked into the deck, must be slacked off. Conversely, when topping straight down, the slack must be picked up. When topping up or down on booms having a whip led through the boom, remember to slack the whip if it is made fast on deck. When topping up and holding a power vang, the boom will trim in-board toward the vang. This fact is often used to advantage, likewise conversely when topping down. Take care not to top a boom too high. The old type will jackknife up against the mast and must be hauled down by a power tackle, or if on a 180-foot class tender, the topping lift gear will be overstrained. Do not top the 180-foot class A boom

STANDARD SIGNALS

FOR THE OPERATION OF LIFTING GEAR

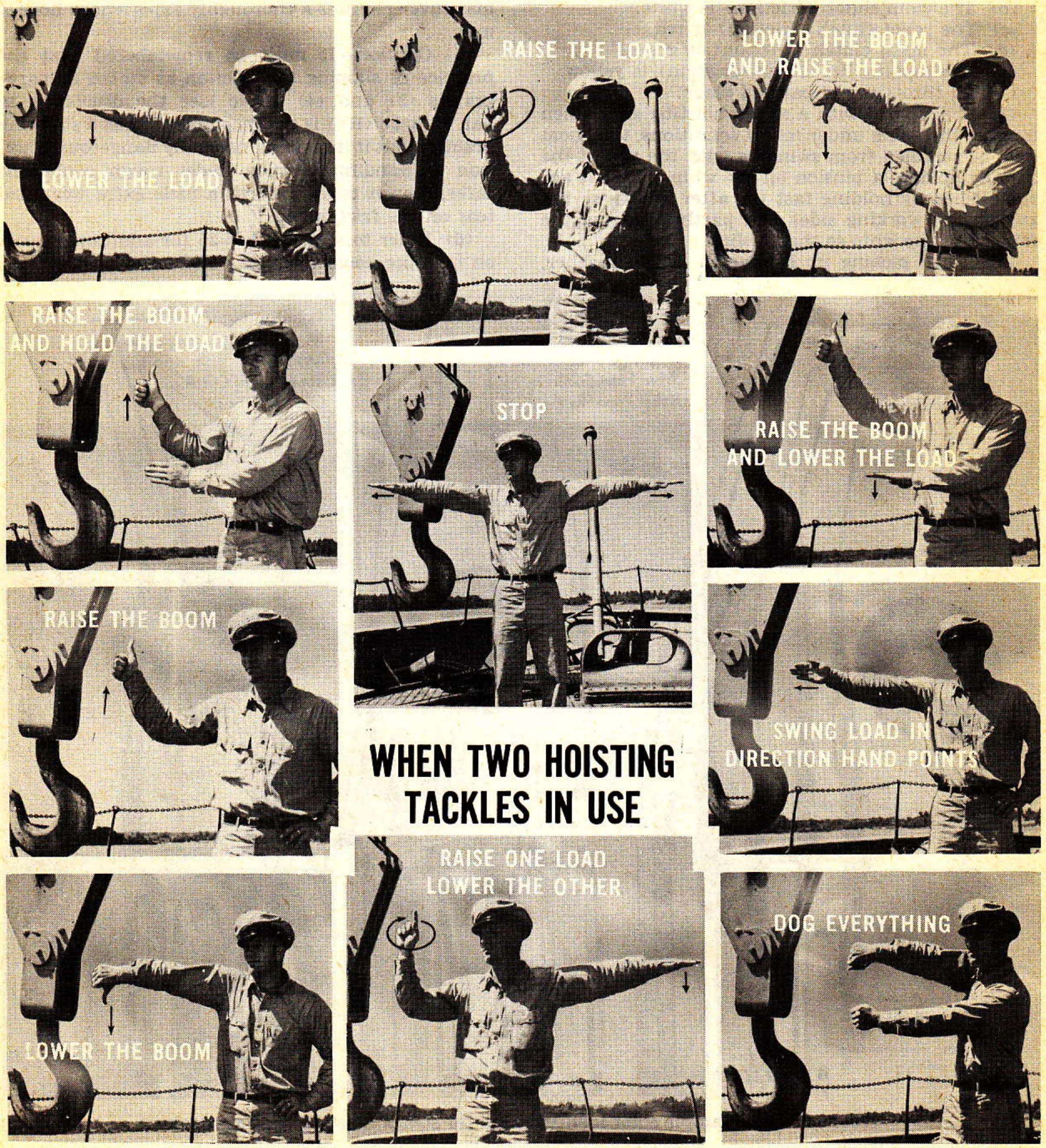


FIGURE 27–97.—Standard hoisting signals.

down too far when trimmed well outboard; the motor housings will strike the boat deck coaming.

(2) Following is a color scheme used for identifying the numerous controls of steam hoisters on some 189-foot west coast tenders (see fig. 27–98): The handles of the controls are painted as follows:

(*a*) All brakes have black lever handles with the grip release painted the same color as the corresponding clutch to carry though the color scheme.

(*b*) The whip clutch (friction) is white.

(*c*) The relief clutch (friction) is red.

(*d*) The main clutch (friction) is green.

(*e*) The topping lift clutch (friction) is yellow.

(*f*) All throttles are painted black.

(3) If equipped with a steam hoisting gear when topping the boom under rough conditions, the boom may be steadied from swinging with the roll of the ship by holding a tension on the whip. This is accomplished by holding fast the after guy (i. e., the guy on the working side) and partly engaging the friction of the whip so that it slips.

(4) When picking up a buoy in rough weather, slipping the friction of the hoist is used to advantage as follows. Have the engine running at a good speed and the hoisting friction partly engaged. This keeps the hook secure in the lifting lug of the buoy as it rises and falls in a sea. By doing this, no sudden jerks or strains are put on the rigging, and then when a break comes with a calmer spell making it safe to hoist, the buoy may be quickly raised out of the water by fully engaging the friction. This maneuver requires a thoroughly experienced hoister man.

(5) *Caution*—It must be remembered that the practice of slipping the friction as stated in paragraphs (3) and (4) above (see the discussion in par. 27–3–50 (H)) is not recommended as a standing practice, but if it makes a normally dangerous situation of handling a buoy under rough conditions safer, then it may be worth a little extra wear and tear on the friction.

(6) Refer to section 27–9–25 for additional notes on training boom operators and hoisting practices.

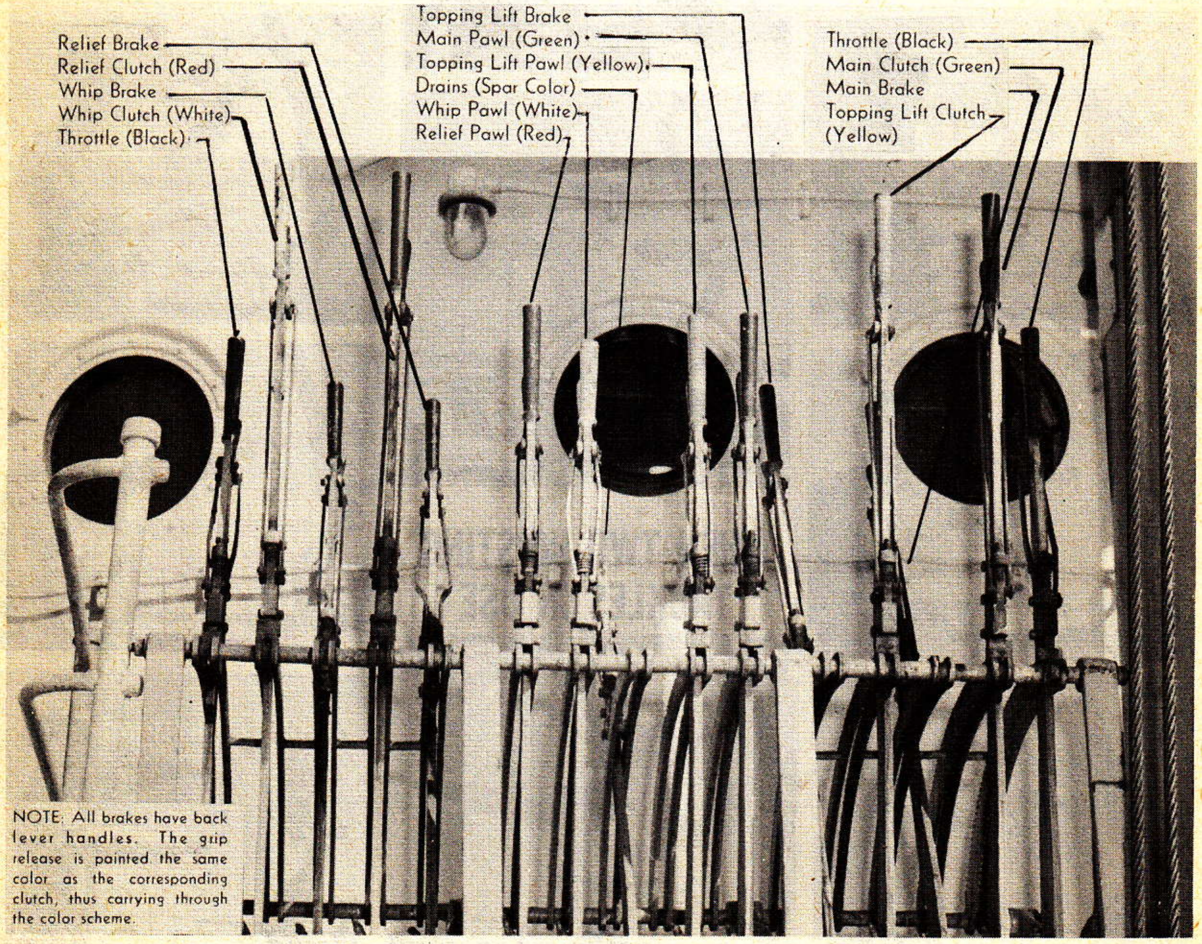


Figure 27–98.—Sample color identification for steam hoisting gear controls.

27–3–60 Padeyes—

A. Inspection of padeyes and associated links should be a part of the inspections made of all buoy handling gear, performed routinely and after every particularly heavy load.

B. Many of the older tenders are equipped with ring-type padeyes which, when overloaded, will elongate and take a permanent set. Padeyes in this condition should be replaced by installing links of suitable size. The practice of overloading padeyes to such an extent should be avoided.

C. Some units have ordered replacements, in the past, without reference to technical information. This resulted in their recommending stock sizes of rings involving an actual reduction of strength for the fitting. In ordering material of this nature, specifications should always be stipulated, rather than mere reference to physical dimensions or stock numbers.

Wrought iron elongated and circular links for attachment of manila or wire rope falls to padeyes

Link type: Stock diameter x Inside width	Ring type: Stock diameter x Inside width	Minimum break load [1]	3-strand manila rope												6 by 19 plow steel hoisting wire rope											
			Circumference (inches)												Diameter (inches)											
			1¾	2	2¼	2½	3	3½	4	5	6	7	8	10	¼	5/16	3/8	7/16	½	9/16	5/8	¾	7/8	1	1⅛	1¼
			Breaking strength (pounds)												Breaking strength (pounds)											
			4,450	4,400	5,400	6,500	9,000	12,000	15,000	22,500	31,000	41,000	52,000	77,000	5,000	7,800	11,000	14,600	18,800	23,400	28,800	41,200	56,000	73,000	92,000	113,000
			Number of parts												Number of parts											
Inches	*Inches*	*Pounds*																								
¼	½ x 3	3,535	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5/16	½ x 3	5,520	1	1	1	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
3/8 x 9/16	¾ x 4	7,950	2	1	1	1	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	--
7/16 x 5/8	¾ x 4	10,830	3	2	2	1	1	--	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	--
½ x 11/16	7/8 x 4	14,145	4	3	2	2	1	1	--	--	--	--	--	--	2	1	1	--	--	--	--	--	--	--	--	--
9/16 x ¾	1 x 5	17,895	5	4	3	2	2	1	1	--	--	--	--	--	3	2	1	1	--	--	--	--	--	--	--	--
5/8 x 15/16	1⅛ x 5	22,095	6	5	4	3	2	1	1	--	--	--	--	--	4	2	2	1	1	--	--	--	--	--	--	--
¾ x 1 1/16	1⅜ x 6	31,800	--	6	5	4	3	2	2	1	1	--	--	--	5	3	2	2	1	1	1	--	--	--	--	--
7/8 x 1 3/16	1½ x 6	43,245	--	--	6	6	4	3	2	1	1	1	--	--	6	4	3	3	2	1	1	1	--	--	--	--
1 x 1¼	1¾ x 7	56,550	--	--	--	--	6	4	3	2	1	1	1	--	--	6	5	3	2	2	1	1	1	--	--	--
1⅛ x 1⅜	1⅞ x 8	66,800	--	--	--	--	--	5	4	2	2	1	1	--	--	--	5	4	3	2	2	1	1	--	--	--
1¼ x 1¾	2⅛ x 9	82,500	--	--	--	--	--	6	5	3	2	2	1	1	--	--	--	5	4	3	2	2	1	1	--	--
1⅜ x 1 13/16	2⅜ x 10	99,800	--	--	--	--	--	--	6	4	3	2	1	1	--	-	--	6	5	4	3	2	1	1	1	--
1½ x 1⅞	2¾ x 12	118,700	--	--	--	--	--	-	--	5	3	2	2	1	--	--	--	--	6	5	3	2	2	1	1	1
1⅝ x 2⅛	----------	139,500	--	--	--	--	--	--	--	6	4	3	2	1	--	--	--	--	--	6	4	3	2	1	1	1
1¾ x 2¼	----------	161,600	--	--	--	--	--	--	--	--	5	3	3	2	--	--	--	--	--	--	5	3	2	2	1	1
1⅞ x 2½	----------	185,500	--	--	--	--	--	--	--	--	6	4	3	2	--	--	--	--	--	--	6	4	3	2	2	1
2 x 2⅝	----------	211,100	--	--	--	--	--	--	--	--	--	5	4	2	--	--	--	--	--	--	--	5	3	2	2	1

[1] Break test load American Society for Testing Materials, Specifications A56–30.

EXAMPLE NO. 1—

Problem: Determine size of ring pad necessary for 10-inch snatch block.
Solution: 10-inch snatch block requires 3½-inch manila. In column for circumference equal to 3½ inches and opposite number of parts equal to 2, link type size is ¾ by 1 1/16 inches, and ring type size is 1⅜ by 6 inches.

EXAMPLE NO. 2—

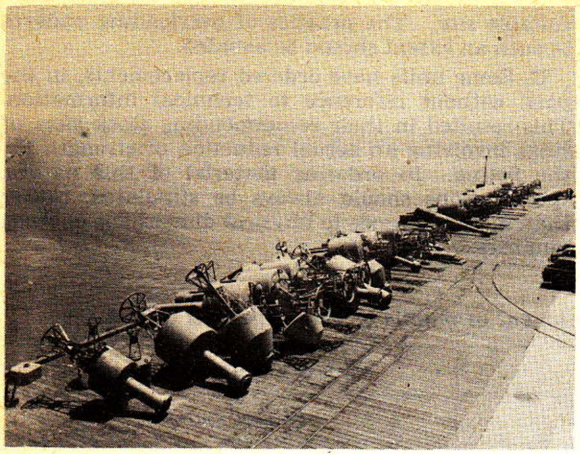
Problem: Determine size of ring pad for 7/8-inch wire rope, single block with becket.
Solution: In column for rope diameter equal to 7/8 inch and opposite number of parts equal to 3, elongated link type size is 1⅞ by 2½ inches.

27–4 AIDS TO NAVIGATION WORK AT DEPOTS

27–4–1 General—

A. Coordination of the work of the buoy yard and aids to navigation shop (or whatever other division or differentiation is in effect at the unit for the yard preparation of the actual buoy bodies and appendages, as against the shop forces who prepare and install the lighting apparatus) is essential. Such minor items as knowing exactly when and where the tender desires to load buoys or equipment should be furnished to both components, in order that an efficient working schedule may be maintained.

B. Certain depots consider that better segregation of responsibility for proper installation of lighted buoys occurs when delivery of the buoy body and component lighting apparatus is made to the tender separately for assembly during or prior to loading. Other depots furnish the buoy completely assembled and ready to light, others do everything except charge the buoy. In any event, it is incumbent on the tender personnel to check and recheck all lighting apparatus for proper operation and characteristic, gas lines, wiring, mooring eyes or shackles, etc. for any possible chance of failure. This should be done before leaving the dock. Reduction of outages is a proven fact in cases where thorough checking of lighted buoys is concientiously observed.



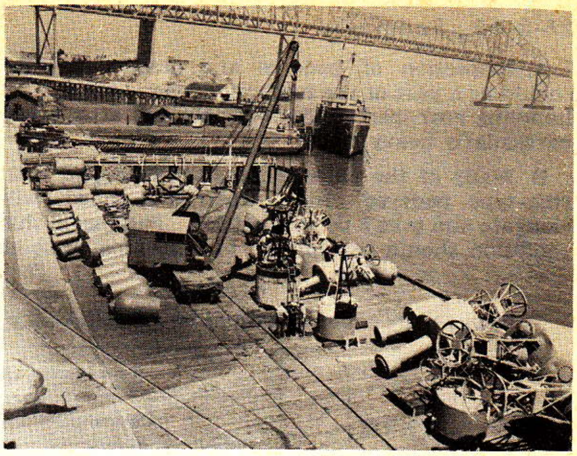


FIGURE 27–99.—Dockside views, buoy depot.

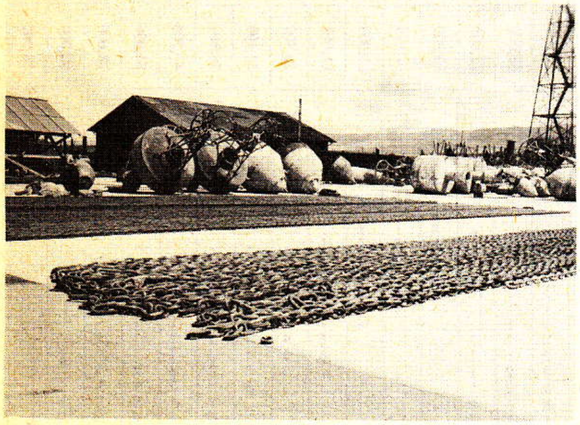


FIGURE 27–100.—Stowage of chain.

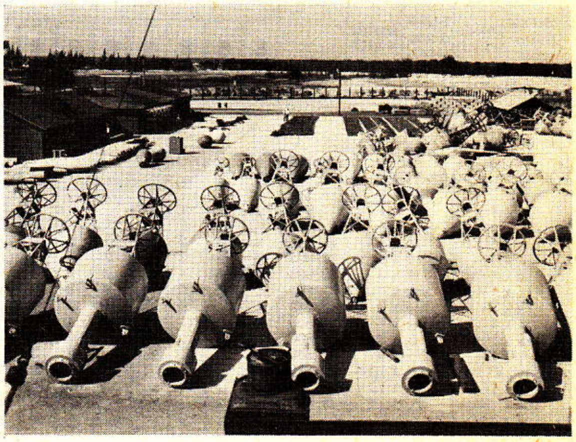
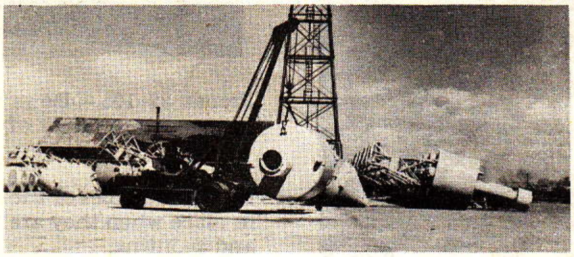


FIGURE 27–101.—Storage area for lighted buoys.

C. *Arrangement of a depot.*—Buoys are arranged on the dock (buoy slab) at depots with the object in view of keeping the heavier lighted buoys available to the tenders with the least amount of movement, at the same time taking into consideration the equal distribution of weight to prevent excessive concentration thereof. The lighter buoys that are more easily moved are stowed at a greater distance from loading points in accordance with space requirements. Chain is separated according to size and stored at convenient places in lengths of 15-fathom shots each. Sinkers and ballast balls are arranged according to size and the consideration for distribution of weight. Other buoy appendages such as shackles, pins, swivels, bridles, etc., are stored at convenient points and are separated according to size. Certain depots have a rack built for the storage of pilings of different lengths. Acetylene gas cylinders are generally stored in covered racks and are separated, full from empty. In the case of depots having sand-blasting equipment, an area is reserved for cleaning and sand-blasting. The buoys are then removed to another area reserved for painting, storing, and minor repairs. If a buoy is in need of major repairs, it may be deposited near the ship area where the necessary work can be accomplished without interfering with sandblasting and painting in progress. After repairs have been accomplished on the buoy body, it must be hydrostatically tested for leaks before it is moved out on the wharf for cleaning and painting.

D. *The equipment of a depot* includes one or more Krane Kars with a capacity of up to 10 tons, for moving unlighted, and the smaller lighted, buoys and other heavy objects around the yard. When operating the Krane Kar, two men work together. One handles the controls and drives, while the other hooks and unhooks and acts as a safety guard, keeping everyone clear, and guiding the driver. Certain large depots may also have a mobile crane mounted on a truck body. The largest lighted buoys are generally moved by the tenders. Hand cars (dollies) are used for handling cylinders, batteries, chain, etc., although these may often be handled by sling from the Krane Kar. Piping is laid throughout the yard and docks to furnish water and air where needed. Electric conduit is provided likewise. One depot has a fresh-water dipping tank with sufficient capacity to accommodate an A–300

Krane Kar preparing to lift 3½ x 10E lighted buoy.



Another type of Krane Kar hoisting an 8 x 26 lighted buoy.

FIGURE 27–102.—Handling buoys at a depot.

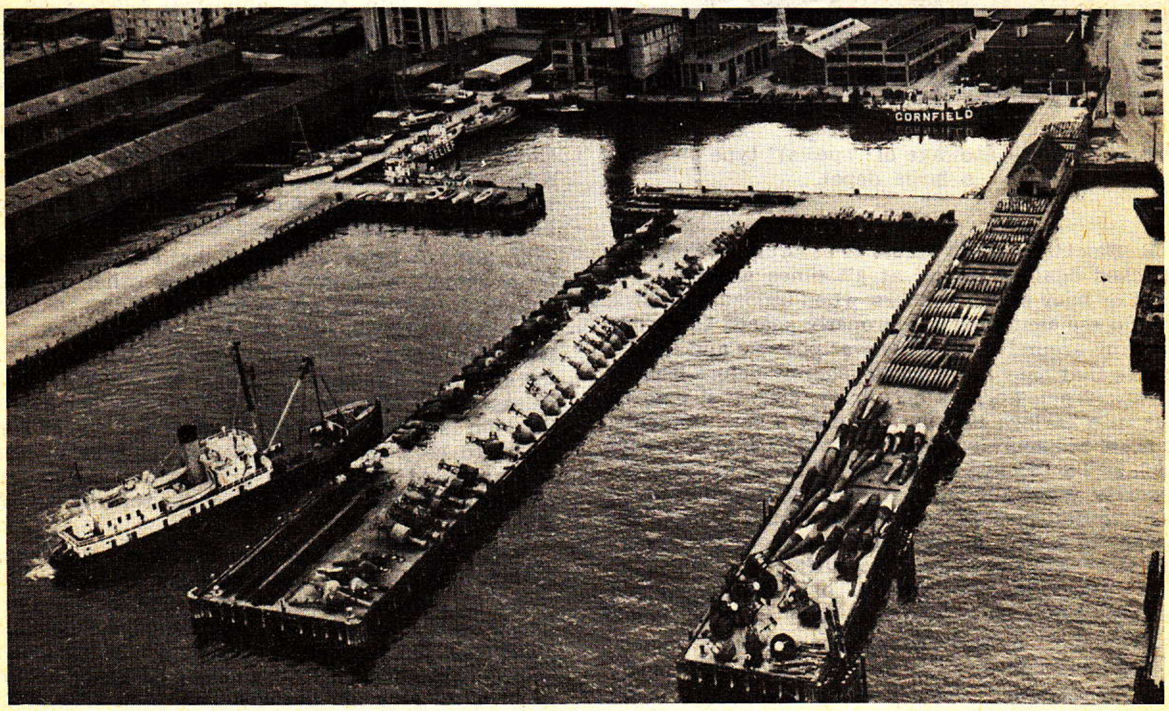


FIGURE 27–103.—A tender coming in to the depot for a load of newly overhauled buoys.

acetylene cylinder, adjacent to the storage racks. Any minute leak in the valve or body of the cylinder is found more easily by dipping than by visual inspection or by using soapsuds. Sandblasting equipment, power-driven wire brushes, chipping hammers, and sanders are furnished for cleaning the buoys preparatory to painting. Large depots have various separate shops, namely, blacksmith, machine, painting, carpenter, lamp, and electronics repair shops. Smaller depots may have many of the above facilities combined. Each shop is completely equipped with the necessary tools. Depots providing freight-handling facilities may have motor driven fork trucks, etc., to assist in handling miscellaneous objects.

FIGURE 27–104.—Stowage of "special" type buoys at a large depot.

E. *Blocking*.—Buoys must be securely blocked and chocked against rolling at all times when on the dock or buoy slab. Tenders, when unloading buoys, should see that they are properly spaced to permit working around them whenever possible and should insure that they are blocked securely before leaving them. When working on a buoy, even if it is to be left in a certain position for only a few moments, it must be securely blocked. Conical-bottom buoys such as 7 x 18's and 8 x 20's are difficult to chock up securely, especially when the cage is tipped down to a horizontal position. Block up a buoy so that the weight of a man or two climbing about the superstructure will not cause it to shift.

(1) Blocking may consist of wooden tapered wedges (4 by 4 by 12 inches or 12 by 12 by 30 inches for example) or rectangular blocks (4 by 4 inches, 6 by 6 inches, or 12 by 12 inches, of suitable length) or large rectangular blocks with one concave side cut out to fit the curvature of the buoy body. One depot uses a steel support made in the shape of a sawhorse

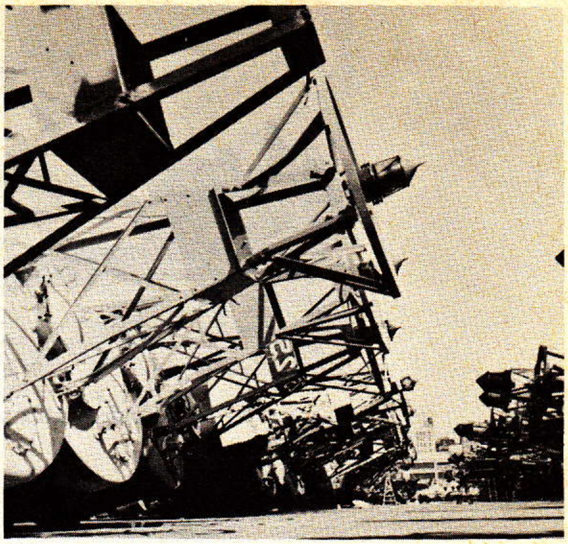


FIGURE 27–105.—Rows of large lighted buoys on the dock of a large depot.

to rest the tubes of the larger buoys on, to keep them in place when they are being rolled over for cleaning and painting.

(2) In the case of heavy buoys, place the blocking under the buoys just before their weight is sustained by the ground, so that the weight contributes to the tenacity of the wedges. Drums, saw benches, etc., are also used to support or block up buoys for repairing, cleaning, and painting.

(3) In certain areas, abnormal tides, such as caused by storms, may require that the buoys be chained to sinkers on the dock to prevent their loss.

F. *Shipping buoys to depots*.—Unless it is known that suitable lifting apparatus is available for heavy buoys, or that tracks are laid to the depot, buoys should always be shipped to a depot for tidewater delivery subject to a tender's tackle. Smaller buoys are handled with depot crane facilities, using suitable slings, hooks and shackles, etc.

G. *Slings*.—Rope, wire, and chain slings are used by workmen in handling buoys and other weights. Although rope slings are generally handier for handling light weights such as the smaller buoys, batteries, cylinders, etc., since chain is often heavy for workmen in awkward positions to attach, rig, or release, with the added danger of pinched fingers between links, do not underestimate the size of rope slings to be used. Rope deteriorates rapidly from such exposed hard usage and its actual strength may be far below its rated strength for any specific size.

H. *Handling low discharge batteries*.—Care must be taken in loading and storing low discharge batteries to prevent spilling and breakage. Carrying handles which clamp into each top edge of DH and DHB low discharge-type batteries are extremely useful in decreasing the amount of manhandling required in carrying the batteries, both around the depot and when servicing a light ashore. The sharp edges of the battery cans of the DHB type cut into the hands otherwise. The practice of placing batteries over the shoulder when carrying is dangerous; even the DHB type has been known to slosh a drop or two of electrolyte near the eyes, in spite of the nonspillable-type vent installed. Carrying hooks can be made of ⅛- by ⅞- by 5½-inch metal with lugs to clamp the battery and having a wood handle grip 6 inches long. The distance between the lugs is 8 inches. A rubber-wheeled cart with a guard can be used to transport the batteries from the tender to the charging racks.

I. *Salvaging low discharge battery cans.*—A considerable savings in cost of new low discharge batteries can be effected by buying batteries not in cans, it being a simple matter to insert a new battery and pour melted paraffin along the sides to seal it in the can. The metal can affords much protection to the fragile case and provides a more convenient means of handling. To provide a replacement supply of these protective cans, it is necessary that a means of salvaging them be instituted.

(1) One method is as follows: Remove all loose fittings from the battery, break the rubber top of the case, and remove the lead. Then immerse can in boiling water and leave it until all the paraffin has melted. Wire brush the can and paint it with acid-resistant paint.

(2) Following is another method using hot water. An advantage of this method is that the cell is undamaged. This is important should it ever be desirable or necessary to remove the cell for repairs. Figure 27-106 shows the apparatus used in this connection. It may be constructed from scrap material available almost everywhere. The cell is placed in the tank upon an inner pan or baffle. The tank measures about 18 inches by 24 inches, the inner pan measures about 13 inches in diameter, and about 1 inch high, and is mounted on 1-inch high studs, providing a water space for circulation. This is considered desirable since the heat is applied directly to the bottom of the tank. The tank is held in place by rods on either side. The battery is held in place or down, by rods attached to the inner pan which carry adjustable lugs that fit over the battery case. The cell is lifted by means of a yoke-like arrangement consisting of a crossbar made of hardwood to which are attached a pair of lifting lugs. These lugs were designed to provide a lift in line with the center of the terminal post so as to prevent bending of the same.

(3) In operation, the packing nut on each terminal post is loosened and the lifting lugs attached. A sufficient strain is taken to lift the plates up to a point where they hit under the cell cover. The packing nuts are then retightened. The cell is now placed in the tank and clamped into position, and water added to a point about one-fourth of an inch below the battery cell top. The water is heated to 160° F., at which point the cell will lift out by taking a strain on the lifting device. This description is for the first battery only. Succeeding batteries which are set in water already heated to 160° F. will require soaking for about 3 minutes before they will lift out.

(4) Temperatures above 160° F. of course may be used, but the lower temperature permits the withdrawal without too much melting of wax and allows its removal in 1 piece by merely slitting down one side and peeling the entire blanket off. During the process the temperature of the electrolyte does not exceed 80° F. Cells of the DH-5-1 type may be removed from the square cans equally as well.

J. *Acetylene cylinders* should be examined whenever handled, and missing caps replaced before placing cylinders on storage racks. Cylinders should be cleaned and painted before shipment to the recharging plant. Full cylinders should be checked for quantity before delivery to a tender. Never strike a cylinder with a hammer to remove rust so as to read the serial number. Do not use a steel wire brush on a cylinder. The section showing the serial number, tare weight, etc., is painted with aluminum paint. Store A-50 and A-300 cylinders, full and empty, separately. Observe all precautions when handling acetylene. See Chapter 20, part 20-5, for further details regarding acetylene cylinders.

K. *Overhauling buoys, typical procedure.*—The following practice is followed at one depot when receiving buoys from tenders for cleaning and repair:

(1) Before depositing buoys on the dock, tender crews always clean off as much marine growth as possible, since it comes off much more easily when wet. (In most areas, tenders remove the batteries or cylinders before unloading. If cleaning the buoy and removing cylinders or batteries is left for the depot force to do, unnecessary labor costs and a refuse disposal problem are created.) Inspection is made for any structural repairs necessary, and if required, the tender will deposit the buoy near the shop area.

(2) When the buoy is placed on the dock, securely blocked up, the lantern is removed (unless already done by the tender) and the pocket covers, swing bolts, gas tubing, wiring, vents, etc., are overhauled as necessary. *Extreme care must be exercised when pockets and buoy bodies are opened. Use only nonsparking tools. Refer to the latest Engineering Memoranda and Chapters 20 and 24 of this manual for instructions for opening acetylene buoys. If flooding a buoy, consider the effect of added weight on the dock. Always assume that an acetylene buoy is NOT gas-free and handle it accordingly until proven otherwise. Never flood the pockets of an electric buoy. Exercise care, however, in opening pockets of electric buoys as well as acetylene, since there is a possibility of an accumulation of highly explosive hydrogen gas.* Welding, burning, or other spark-making work should never be permitted adjacent to or even in reasonably close proximity when opening an acetylene buoy. Sparks may carry many feet and cause an accident.

(3) The buoy body, if opened for inspection, will be prepared for repairs if necessary. Plugs are placed in the tubing connections to prevent sand from entering. Pocket covers are taken to the blacksmith's shop for flange straightening by the

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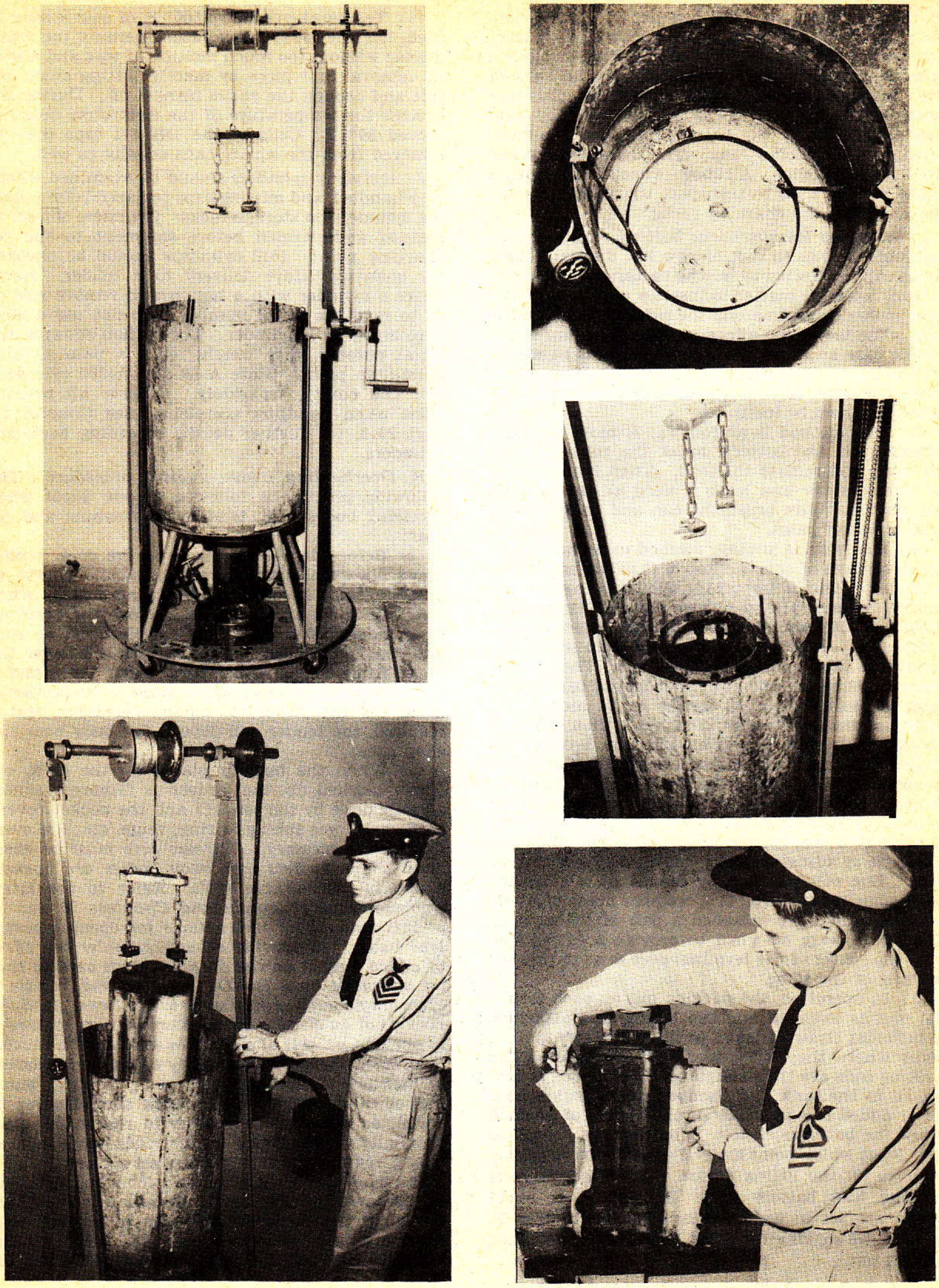

FIGURE 27–106.—A device for salvaging low discharge battery metal containers.

welder. The swing bolts are cleaned, rethreaded, and nuts tapped out in the machine shop, if necessary.

(4) If structural repairs have been made to the buoy body, a hydrostatic test must be made (see Ch. 24, sec. 24–7–11) before cleaning and painting.

(5) The buoy is now sandblasted to bare metal. When cleaning tubes on large buoys, a long wooden handle is used to guide the sandblasting nozzle. About halfway in the tube a block of wood or a bar is used to support the weight of the handle and sandblasting gear.

(6) When the buoy is clean and ready for painting (if other than a large lighted buoy), it is removed inboard, away from the sandblasting area to a spot reserved for painting, storing, and minor repairs. Consult the latest Painting Instructions for procedures for applying paint on buoys, including the new vinyl-plastic type. When the paint is dry, all fittings previously removed are now replaced. Gaskets are replaced on the pockets and the covers secured.

NOTE: Procedures at the several depots may vary slightly from the above. Some units use chipping hammers and wire brushes in lieu of sandblasting, and do the cleaning and painting of the buoys in the same location. Some depots maintain a check-off list so that all necessary inspections and repairs are definitely made on each buoy.

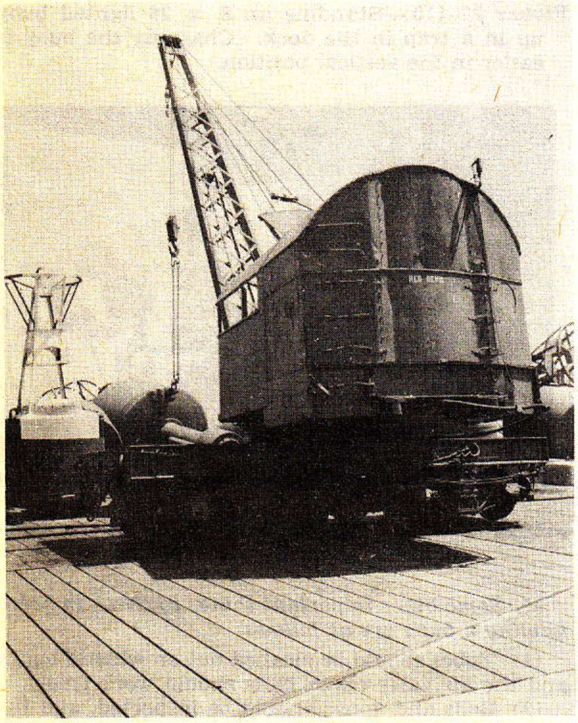

FIGURE 27–107.—Compressed air-driven railroad crane hoisting an 8 x 26 lighted buoy.

L. *Some of the common mistakes in handling acetylene apparatus around a depot are as follows:*

(1) The chain plugs not kept on valves, lanterns, junction boxes, and cylinders.

(2) Cylinders not securely wedged in buoy pockets. Wooden pad not placed in bottom of

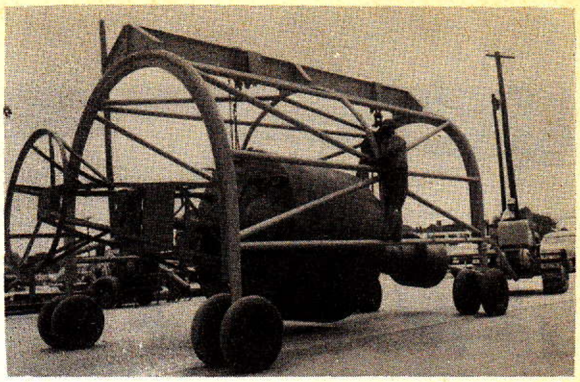

FIGURE 27–107A.—Moving a large lighted buoy with a "buoy carrier" at a large base.

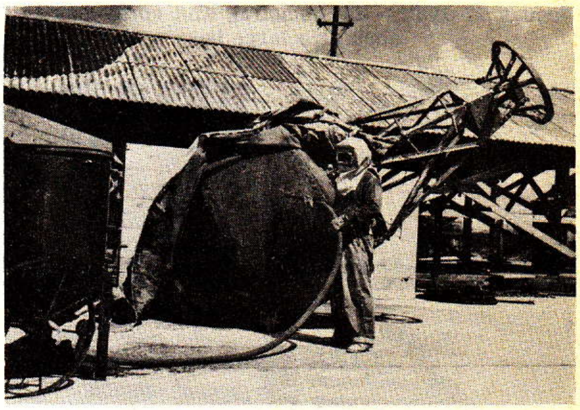

FIGURE 27–108.—Sandblasting a buoy.

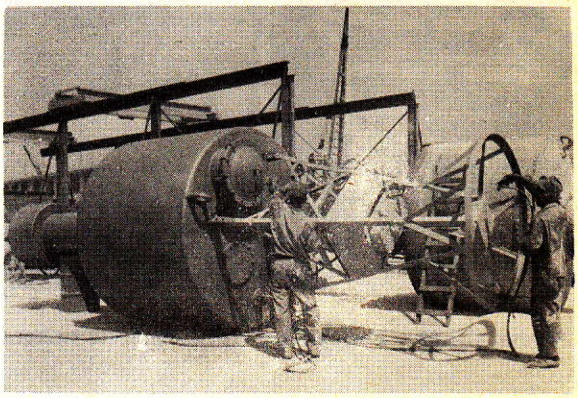

FIGURE 27–108A.—Spray-painting a lighted buoy at a large base.

pocket. New aluminum washers not used EVERY time a connection is made.

(3) Protection caps for adjusting screws not kept on flashers. These protection caps help to prevent leakage of gas around the screws which could result in an explosion.

(4) Water is allowed to get in connections and piping.

(5) Improper care of pocket covers, gaskets, and swing-bolts (dogs). Using improper type wrench on nuts.

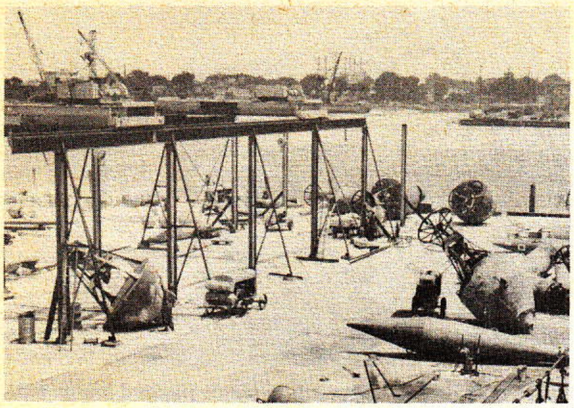

FIGURE 27–108B.—Sandblasting and spray-painting dock at a large base.

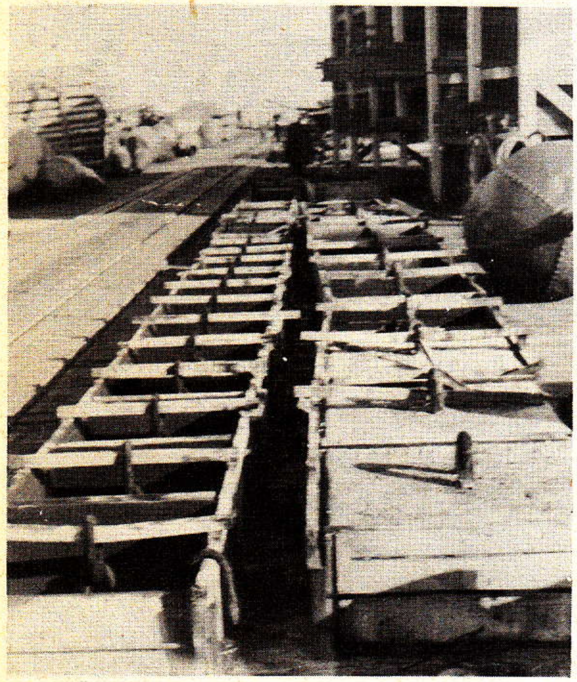

FIGURE 27–109.—Forms for pouring concrete sinkers.

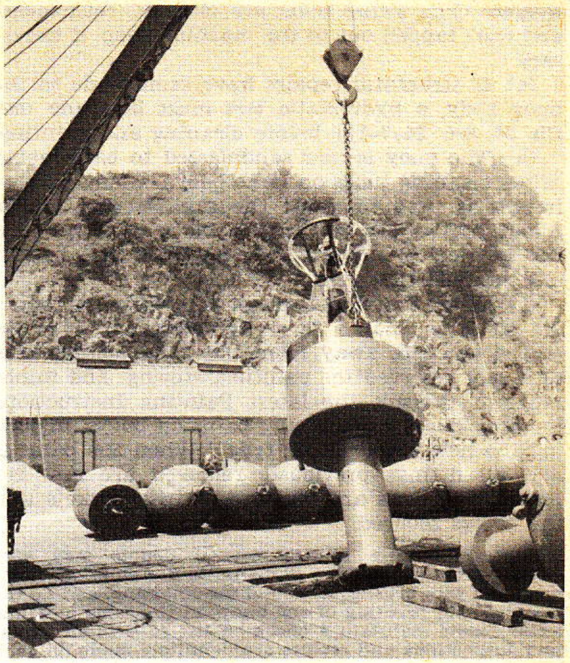

FIGURE 27–110.—Standing an 8 x 26 lighted buoy up in a trap in the dock. Charging the buoy is easier in the vertical position.

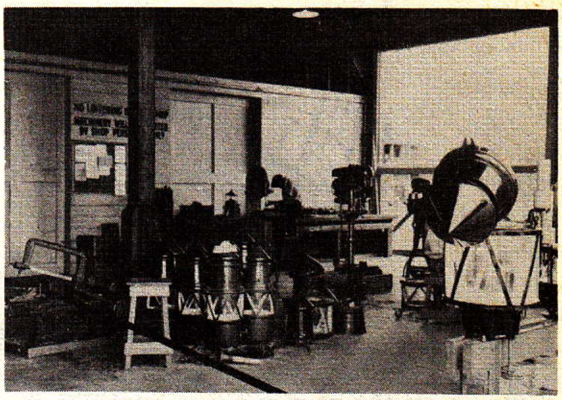

FIGURE 27–111.—Typical lamp shop where buoy lighting apparatus is repaired.

(6) Insufficient time taken for checking flashers before using. Not permitting all the air to work out of the lines and flasher.

(7) The valve stems on the lantern, junction box, and cylinder valves are made of steel and rust easily when exposed to salt air. They soon get into a condition where the valve key will strip the corners off, making it necessary to renew them. The threads on the stem of cylinder valves rust and give trouble. The threads of connections on cylinders and pocket staybolts deteriorate when exposed, and cause stripping of connections, requiring renewal. All threads and valve stems should be coated with graphite grease, and blind plugs and caps kept on all connections, including the lantern connection.

M. *Some other important things to check in overhauling a buoy are as follows:*

(1) Tubes should be cleaned out on whistle buoys and the air valve check balls should work freely.

(2) Bells and gongs should be inspected, and renewed if cracked. Clappers and clapper guards should be renewed if necessary.

(3) Inspect the threads of staybolt fittings leading from inside the pockets to the buoy head. Freshen the threads with the proper tap if necessary. Free up the inspection plugs in the pocket covers. Inspect all piping, connections, junction boxes, etc., and overhaul as necessary.

(4) Check lanterns for cracked and broken storm panes.

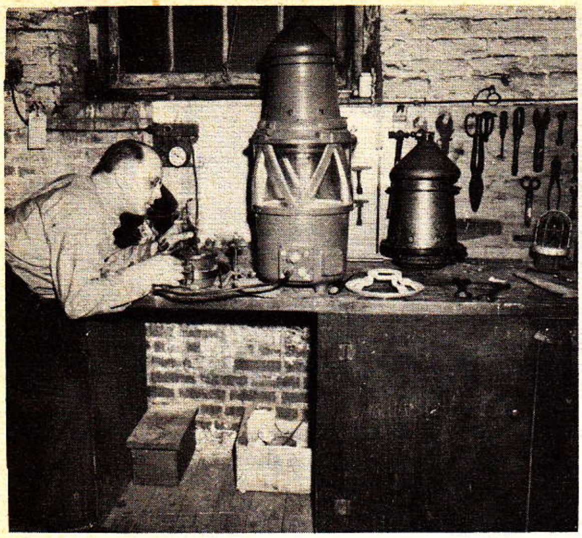

FIGURE 27–112.—Repairing an acetylene flasher.

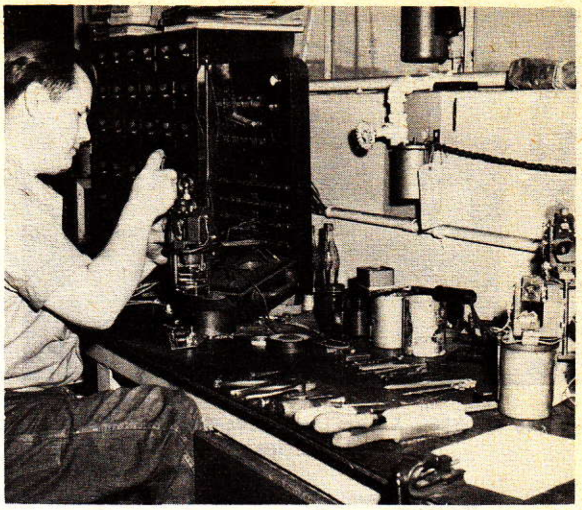

FIGURE 27–114.—Repairing an electric lampchanger and flasher mechanism.

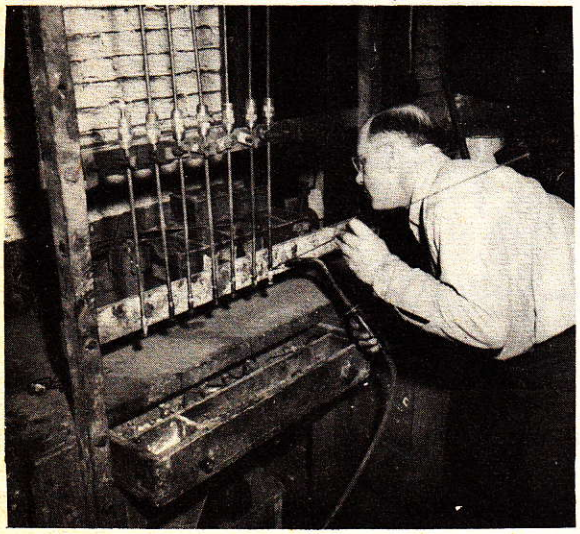

FIGURE 27–113.—Brazing acetylene tubing connections.

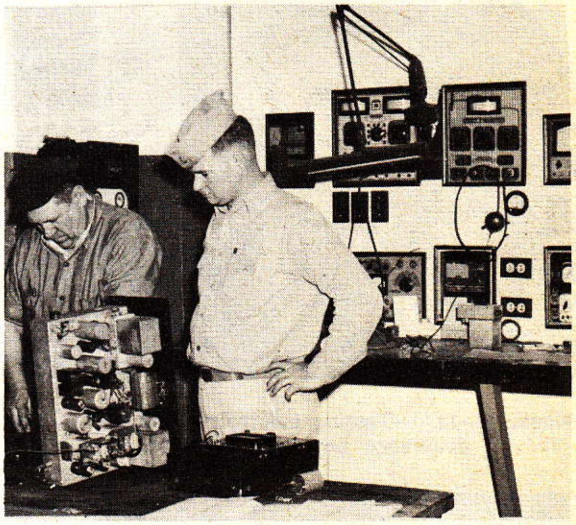

FIGURE 27–115.—Repairing electronic equipment.

(5) Flasher mechanisms should be carefully tested before leaving the lamp shop, and proper characteristic set. (See Chapter 20.)

(6) Renew wooden chafing strips on buoy tubes if necessary.

(7) Renew mooring shackles, or build up with weld or insert steel bushings in worn mooring eyes of buoys.

(8) When removing lanterns and cylinders from buoys, screw blind plugs in the end of all piping to keep water out. A small amount of water in a gas line will rust the valve seat and cause trouble in the flasher, which has several steel parts.

N. *Lamp and battery shops.*—The lamp shop is a very important part of the depot. Here acetylene and electric lighting apparatus are overhauled and stored. Flashers are tested for more than 24 hours before being issued. The battery charging apparatus may be in a separate place or in a part of another shop. Care must be taken in handling batteries of all types. See Chapter 21 for details of batteries, handling, and charging.

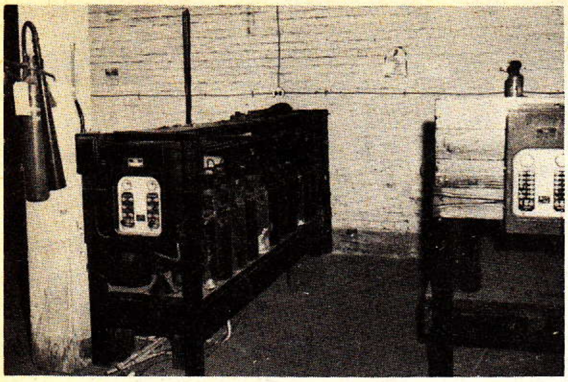

FIGURE 27–116.—Charging racks for low discharge batteries.

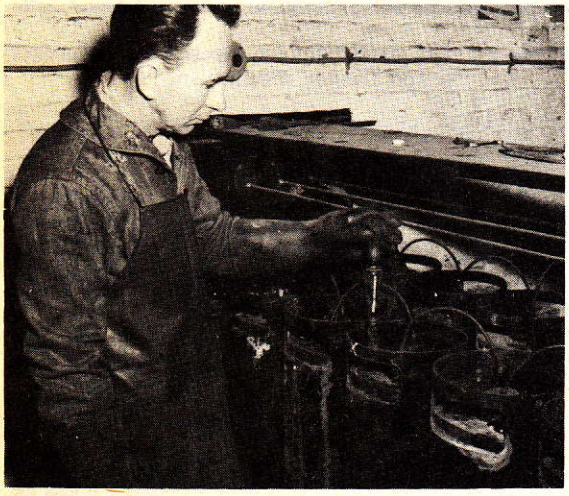

FIGURE 27–117.—Testing electrolyte solution of low discharge batteries on charge.

FIGURE 27–118.—Repairing a low discharge battery.

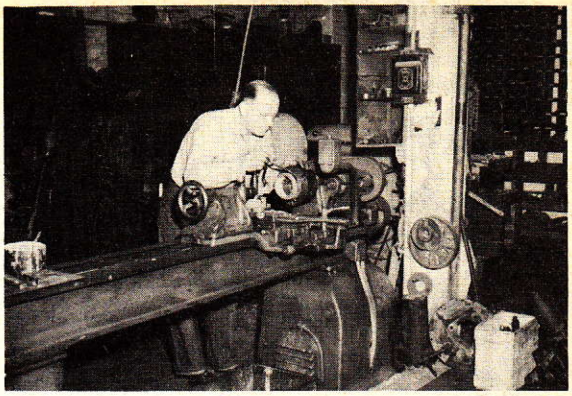

FIGURE 27–119.—Most depots have a complete machine shop.

FIGURE 27–120.—Welding a patch on an unlighted buoy.

FIGURE 27–121.—Storage racks for acetylene cylinders.

FIGURE 27–122.—Fitting the mooring bail on a spar buoy. (Some depots manufacture their own spars).

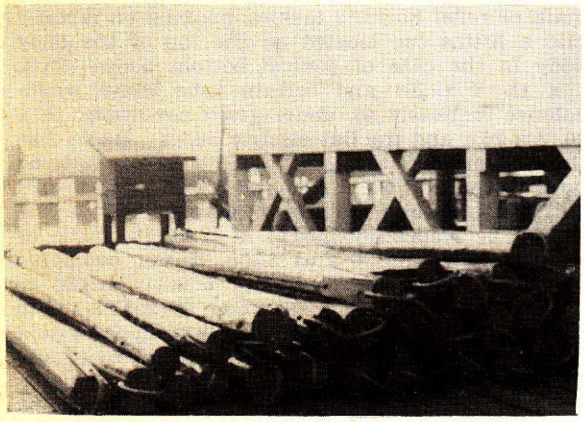

FIGURE 27–123.—Pile of completed spar buoys.

27–5 AIDS TO NAVIGATION WORK AFLOAT, GREAT LAKES AND COASTAL WATERS

27–5–1 Loading and Stowing Aboard Tenders—

A. *Planning.*—In certain areas, the Commanding Officer of the tender has considerable latitude in planning his work, not only for the particular trip, but for the entire buoy relief season. Careful planning is often necessary so that sufficient buoys of the required type are on hand at the depot, ready for loading, in time to finish the areas being worked. Sometimes areas have to be split up due to the lack of buoys. Buoys in exposed locations are scheduled for relief during the good weather months, with a few of the inside buoys left for relief at other times. In certain areas, acetylene lighted buoys perform better if relieved in the summertime or early fall, thus insuring a good gas pressure in the cold winter months.

(1) Upon receipt of operational orders, make up a list of buoys, chain, sinkers, shackles, swivels, batteries, lanterns, paint, spare equipment, and other gear that will be required for the trip. Plan with officers and men where the load is to be placed on board, to facilitate the work in the field.

(2) Some tenders carry a spare second-class can and nun in addition to spare sinker(s) and chain. Always have plenty of spare shackles and keys on hand. The amount of chain and sinkers necessary to accomplish the reliefs for the trip may be found from the buoy cards or file copies of Form 2555 maintained on board, which list the size and weight of the moorings. Data are also available as to the past condition of the chain, time it was last renewed (if not done every time), character of the bottom, etc. In most cases it is not necessary to carry all new chain and sinkers for all buoys to be worked. Worn sections of chain are cut out on the scene and the chain reused for another buoy.

(3) Check all buoys and equipment thoroughly before leaving the dock. Some ships use a standard check-off list. When possible, prepare lighted buoys before sailing, so that the light can be tested over a reasonable period to insure reliability.

B. *The stowage* of buoys on board a tender requires careful attention when a large load of buoys is to be carried. Generally, the last buoys to be loaded will be the first ones worked. Stow each item with a minimum of handling, and such that it may remain secured until actually ready to use. Detail men to secure the load as it comes aboard so that the listing of the ship under the next hoist does not cause the deck load to shift. When loading commences, order all unnecessary men clear, and put out the smoking lamp.

C. *Preparation for loading.*—In preparing to load buoys, appendages, and equipment, inspect carefully the hoisting tackles, chain slings, manila and wire rope straps and slings, snatch blocks, tools, etc., and lay them out for use. "A place for everything and everything in its place" is a phrase particularly adaptable to aids to navigation work. Keep the deck clear of stray lines, loose tools, and other gear. Lay out the blocking, chocks, or saddles for the buoys in the positions in which it is planned to secure the buoys, having regard for the location of available padeyes for passing lashings. Remove the main hatch for receiving small buoys, sinkers, or chain as necessary. Wire slings of appropriate size for the various types of unlighted buoys are made up and kept on hand.

D. *Precautions to be observed in loading* are the same as used in handling heavy weights in general. Keep the load low and move it slowly. Keep personnel out from under and between weights. Not infrequently, even experienced personnel will duck under the head of a buoy to shift the blocking when lowering the buoy into place. This is a dangerous practice. Keep head and tail lines attached to weights; be prepared to snub them around a cleat, bitts, or padeye to keep the buoy under control. Make sure that the strap or bridle is adequate before using it. When hooking on buoys, check carefully before hoisting, that the hook is properly secured. Shackles are better than hooks on slings for hoisting buoys aboard, especially the unlighted ones. Straps that have been used for lifting battery racks may be damaged from contact with acid. When loading a class A 180-foot tender, take care not to top the boom down and out too far so as to damage the motor housings.

E. *Loading of unlighted buoys* may be accomplished as follows:

(1) *Special class.*—A double branch or two-legged wire, manila, or light chain sling is used for loading special-class buoys in a horizontal position. The legs of the sling are spliced to a lifting ring; the other ends have an eye for a shackle or have hooks spliced in. One leg of the sling is generally shorter than the other. This short end is hooked in the mooring eye on the heavy (counterweight) end of the buoy. Slings may be 3½-inch manila, ⅝- or ¾-inch wire, or ½-inch chain. A suggested length of a sling for use with second- and third-class specials is 6½ feet for one leg and 7½ feet for the other. A sling with two 10-foot lengths is useful for loading first class specials, and also for hoisting small lighted buoys alongside for recharging. Two special buoys may be hoisted at one time by passing one leg of the sling through the lifting bail of one buoy and hooking or shackling on to the lifting bail of the other, the other leg of the sling being hooked into a strap passed through the mooring eyes of the two buoys. Special-class buoys are loaded aboard with the whip. A 2-inch head line should be secured to the load to steady and guide the buoy.

(*a*) When loading buoys for stowing in the hold, pick them up at one end only, using a short strap or shackle rather than hooking directly into the lifting bail. If a short strap is not used, the sling may be passed completely through the lifting bail and hooked back into its own lifting ring. A buoy hooked directly is liable to become unhooked should the strain be eased, as when the buoy rests momentarily on the deck or on top of another buoy. When stowing buoys in the hold, a light tackle can be clapped on to haul the buoy over to any desired position while the boom still holds most of the weight, slacking off on the whip as appropriate. Often a couple of men pulling on a head line will accomplish the same thing.

(*b*) Screw-pin shackles inserted in the eyes spliced in the ends of the slings may be used in lieu of hooks and are considered safer, since they lessen the chances of the buoy accidentally becoming unhooked from the sling.

(*c*) Special-class buoys may also be hoisted abroad in a horizontal position, using a 3½- or 4-inch manila strap passed around the body of the buoy at the balance point. The approximate point of balance of special-class buoys is at the welded seam in the lower part of the buoy body where tapering to counterweight begins.

(2) *Standard-class buoys* are loaded with the whip, and may be picked up by the double sling, or the whip alone, hooked into a short strap through the mooring or lifting eye of the buoy. When picking up a standard can by the mooring eye, pull the head to one side when landing the buoy on deck, otherwise it may stand on end momentarily and the whip come unhooked.

(3) *Tall-type buoys* may be hoisted on board by hooking the hoisting tackle directly into a balancing lifting lug located just below the middle of the buoy. Use a steadying line on at least one end of the buoy.

(4) *Bell or gong buoys* may be hoisted aboard by hooking the hoisting tackle directly into a lifting lug or ring located on top of the buoy body. Secure a steadying line to the framework. A bell buoy with a fixed counterweight should be handled on the main or relief.

(5) *Spar buoys* are loaded one or more at a time, using a double sling, spread 6 to 8 feet apart for balance. Larger spars are loaded one at a time with a single chain sling passed around the middle of the spar at the balance point.

F. *Lighted buoys (other than 9-foot types)*.—Prior to lifting a lighted buoy clear of the dock, a head line should be rove through the side of the cage opposite the tackle. Men on the dock tend the head line to prevent the buoy from swinging and damaging the lantern or other objects. The ends of the head line may be passed to men on deck so that when the buoy is hoisted over the side, control of the buoy may be smoothly transferred to the men on deck. In the case of a large lighted buoy, tail lines are also passed around the tube of the buoy to assist in controlling it.

(1) Lighted buoys are loaded by means of the main or relief hoisting tackles, hooking on directly into a lifting lug located on the top of the buoy body in the case of conical bottom buoys (BIII, 7 x 18, 8 x 20) and certain tube buoys which balance or nearly so, under given conditions (6 x 20, 8 x 26), and the flat electric buoys. Buoys like the Converted C type and the 8 x 23W which do not balance, and the 6 x 20 and 8 x 26 when loaded with batteries and lantern or equipped with a bell, should be loaded by means of a chain bridle or double chain sling. This sling, if not composed of special chain (Herc-alloy or equal), should be of not less than 1-inch diameter open-link chain for smaller buoys, and 1¼-inch chain for the 8-foot buoys. An improvised sling can be made by shackling a length of chain between the lifting lugs on the top and bottom of the buoy body and hooking the tackle into a shackle in about the middle of the chain. Wire rope slings, ⅞- or 1-inch diameter, may also be used in loading lighted buoys of less than 9 feet diameter. Many vessels use a special double-branch chain sling having one leg shorter than the other, and use this sling for picking up all their tube buoys.

(2) Flat electric buoys, especially the larger 7FE type, are better handled by means of a double chain sling having two legs of equal length. Electric tube buoys should not be picked up in the horizontal position, suspended from only one lifting lug, if there is any tendency for the lantern end to tip downwards. Although buoy batteries are designed to retain their electrolyte when tipped past the horizontal, they have been known to leak.

G. *Nine-foot lighted buoys*.—A 9 x 32 lighted buoy without batteries, bell or lantern will balance when hoisted by the lower lifting lug, otherwise it will not. The 9 x 38W buoy without batteries and lantern will balance, and will nearly balance when loaded, such that men on a tail line could hold the buoy level. However, if it is an electric buoy, it is better to use the bridle or double branch sling on the 9 x 38 as well as the 9 x 32 buoy; it will be steadier for loading. The chain sling used for loading 9-foot buoys consists of two legs, one shorter than the other, of appropriate strength chain having a hook in each end and a lifting ring in the middle. Some vessels use improvised rigs as follows: shackle a 12-foot length of 1½-inch chain between the lifting lugs at the top and bottom of the buoy body and hook the main into the chain about 2 feet from the lower end; or hook the main into the lower lifting lug and shackle a length of chain from the upper lifting lug of the buoy to the shackle on the main block. One tender uses a three-legged chain sling having two short legs and one long one. The long leg is hooked into a lifting lug at the top of the buoy body and the other two legs are shackled into the mooring lugs at the bottom of the buoy body. This arrangement permits a vertical lift on the two short legs and a diagonal lift on the long one. The buoy is picked up horizontally and is very steady.

(1) When loading 9-foot buoys on a class A 180-foot tender, have the man tending the dockside boom guy shift his position to the boat deck and tend the guy from a cleat on the A-frame.

(2) When loading more than one 9-foot buoy, it is considered a safer practice to turn the ship around at the dock for loading a second buoy, although it is possible to hoist the buoy over the one already on deck. It is also possible to load the first buoy on the outboard side first. However, swinging the buoy around on deck renders it liable to damage to the lantern.

H. *Loading a 9-foot buoy.*—Following is a suggested procedure for loading a 9-foot lighted buoy:

(1) Moor the ship alongside the dock where the buoy is to be loaded so that the after end of the buoy port is about 8 feet or so ahead of the buoy to be hoisted. Take care to make the vessel fast in such a way that no damage will result to the side of the ship or to the dock. The vessel will take a sharp list and such things as boat davits, life rails, etc., might be bent. This danger can be overcome by working the ship ahead on a springline and controlling the distance of the afterpart of the ship from the dock by the rudder. Have chocks ready on deck.

NOTE.—The remainder of the procedure is described for a class A 180-foot tender. Older tenders not having the double topping lift arrangement of the boom will proceed in a similar manner to that described. The class B and C 180-foot tenders will handle the buoy in much the same manner except that there will be no need for tackle hooked in the deck or in the bulwarks to trim the boom.

(2) Hook the relief in a padeye across the deck opposite to the working side for a power vang, and hook the whip in a ringpad well aft on the bulwarks on the working side for hauling the boom outboard. Swing the boom out over the buoy, topping as necessary so that the main purchase hangs about 3 feet shipward from the lifting lug located at the bottom of the body of the buoy. The boom should be at about 60° from the fore-and-aft centerline of the ship. The position of the boom in relation to the buoy is important, because when the strain is taken on the hoist, the ship will list, thus moving the tackle further outboard. If allowance is not made for this, the buoy will shift when it is picked up, possibly doing some damage.

(3) On a bare (stripped of cylinders, etc.) 9 x 38 buoy, hook directly into the lifting lug. If fully equipped, or if a 9 x 32 buoy, use the bridle or chain sling described above. Rig head and tail lines and have several men tend each line. Take a strain on the hoisting tackle slowly, until the buoy is clear of the dock, then hoist away, lifting no further than necessary to clear all obstacles. (The buoy will nearly always be lying on the dock with the tube end closest to the ship, therefore, depending on whether the buoy is to be carried athwartships or fore-and-aft on deck, swing the buoy around with the head and tail lines so as to lead fair while trimming the boom in across the deck. Most ships prefer to carry the buoy fore-and-aft with the lantern end aft.) Make sure that all hands stand clear, and that the men on the steadying lines stand back far enough to get a good lead.

(4) Trim the boom inboard and swing the lantern end of the buoy in the appropriate direction. It will be necessary to top the boom up before the buoy can be landed in the fore-and-aft position on deck, and in fact on some tenders, before the buoy can be brought in over the bulwarks. Therefore, when the boom has been trimmed in to about a 45° angle with the fore-and-aft centerline of the ship, hold the relief (power vang) and top the boom up. (Note that topping the boom while holding the relief causes the boom to trim in as well as rise.) When the buoy has been topped far enough to land in the desired spot, trim the boom further inboard with the relief (don't forget to slack the whip when trimming in) until the buoy is over the chocks or cradle. Top up or down as necessary for the final adjustment and lower the buoy into the chocks. When carried fore-and-aft, the outside of the buoy body should just touch the bulwarks, and the lower end of the body should be about even with the after end of the buoy port.

I. *Loading equipment and appendages.*—Following is data on the loading of equipment and appendages:

(1) Acetylene cylinders are generally loaded by the whip, using a manila strap passed around the body of the cylinder(s) at the balance point. The strap should be well spread to insure against the load's tipping. A–300 cylinders are loaded one to a strap. They may also be hoisted by passing the strap through the bail at the upper end of the cylinder. A–50 and A–25 cylinders are loaded in groups of up to six to the load. Take care not to drop or bang the cylinders. See that a protection cap is on all A–50's and A–25's, and that blind and chain plugs are installed on all cylinders.

(2) Battery racks are generally hoisted by the whip, using a short wire strap through the lifting eye on the top of the rack. If manila straps are used in handling batteries, take care that acid does not weaken the strap. Many vessels do not reuse a manila strap used in handling batteries.

(3) Lanterns are hoisted aboard with the whip and a manila strap arranged in conventional manner. Lanterns are fragile and must be handled carefully.

(4) One tender has suggested the use of cargo pallets (see fig. 27–283) for loading cylinders, lanterns, supplies, etc. For handling cylinders, the pallet is fitted with 2- by 2-inch strips on both ends to prevent the cylinders from rolling off. Ten A–50's have been successfully carried on one pallet load.

(5) Sinkers are loaded by hooking the whip directly into the bail of the sinker. The heaviest sinkers are generally loaded with the main.

(6) Chain is loaded in bundles of one or more shots secured in a manila or wire strap and handled on the whip. Chain may also be hauled aboard singly in bights; however, care must be taken not to let even a small bight get over the side of the ship. Even a few links of chain over the side can start the chain running, after which there is no stopping it, once it takes charge. Bridles are handled similarly to chain, as above.

(7) Ballast balls are loaded in groups secured by a wire strap passed through their bails.

J. *Fundamentals of stowage.*—Because of the variety of sizes, shapes, and weight of buoys, each presents a slightly different stowage problem. The important factor in securing the load is to use sufficient lashings of ample size and lead them in the proper directions to prevent movement. A comparatively light preventer can generally keep a heavy weight from shifting on deck or from swinging when suspended, but once the weight begins to move, it is difficult, if not impossible, to stop it. Therefore, secure such weights well. Never overload the buoy deck. Leave sufficient space on deck for working personnel and equipment. Buoys should be blocked and lashed even in calm weather, since the list of the ship under a heavy load may start the deck load shifting. Never land lighted buoys or sinkers directly on steel decks. Sinkers may be landed on battens, boxwood, or other light dunnage, or spaced on wedges. Dunnage prevents sliding and facilitates washing down the decks. Always block buoys clear of bitts, cleats, and scuppers. With the exception of special-type buoys, place dunnage under the buoys just before their weight is sustained by the deck so that the weight contributes to the tenacity of the wedges.

(1) When only a short distance is involved between the dock and the working area, buoys are often stowed in the way of the buoy ports, ready for setting. Here again, however, it is necessary to secure the buoy including bights of mooring chain that may have been ranged out, well enough for all sea conditions because of the possibility of unexpected rough weather, or as frequently happens, a change of itinerary after the ship is underway, i. e., a sudden search and rescue mission.

(2) It is necessary to inspect the lashings of buoys periodically when underway to insure no change in tautness. If underway at night, have cargo lights rigged to illuminate the deck and turn them on during the inspections.

(3) It is important, particularly with a new crew or boatswain's mate being trained, to see that the buoys are secured in such a manner that they are prevented from moving, both athwartships and fore-and-aft. With inexperienced personnel, there is a tendency to be content with only securing the buoy downward to the deck, with the result that the lines or chains lead almost vertically from the buoy and there is only frictional resistance to movement of the buoy along the plane of the deck, which is, of course, inadequate in a seaway. It is better to spend time for adequate securing before going to sea than to have to break out men in the mid-watch to attempt the dangerous job of securing a shifting deck load.

K. *No set rule of stowage.*—Various tenders stow buoys and appendages in different places on deck, commensurate with the space available, the working plan, type of buoys carried for the trip, trim of the vessel, etc. No set rule of stowage can be laid down for such a heterogeneous cargo. However, suggested procedures are given in the following paragraphs.

L. *Stowing unlighted buoy.*—Small unlighted buoys such as second- and third-class specials and standards are often stowed in the main hold where they are blocked and wedged securely against stanchions, cargo battens, bulkheads, etc., and are lashed with 2- or 3-inch line as required. Line is used for lashing small unlighted buoys in the holds and on deck. It is not satisfactory for lashing tall-type unlighted buoys or lighted buoys.

(1) Standard-type unlighted buoys cannot be safely tiered. They are stowed on deck or in the hold, placed alternately head to foot alongside each other so as to make the maximum use of the space available.

(2) Since as many as 30 or more special-type unlighted buoys may be carried, it is convenient to stow these buoys on their sides in layers or tiers up to three high. The bottom layer is started on one side of the deck against something solid such as the bulwark, and may then extend across the deck to against something equally solid. A timber such as a 4- by 4-inch is first placed on deck a little aft of the fixed counterweight of the bottom tier of buoys for the heavy end of the buoys to rest on. Take care that the entire buoy rests firmly on the deck and on the timber. Then another 4- by 4-inch timber is laid across the counterweight end on top of the first tier but a little further away from the end than the first-mentioned timber. This second cross-timber is securely lashed in place and the second tier of buoys is laid on top of the first tier, nesting each buoy between two buoys of the bottom tier. The third tier is similarly placed. After all tiers have been stowed, the buoys are lashed securely and an overall chain is griped down over the pile and secured by a turnbuckle. If the buoys are not wedged in between two solid objects, such as when only half the deck is used for storage, the end buoys must be lashed together so that the load will not separate.

Some vessels follow the practice of stowing the counterweights of each tier opposite to the counterweights of the tier below.

(3) When stowing unlighted buoys, it is often found convenient to place red buoys on the starboard side of the deck and black buoys to port, since

it is common to work up rivers and bays. Spar buoys are generally stowed with the bails forward.

(4) Bell and gong buoys should be placed on deck so that it is only necessary to move them again to put them over the side and then place the relieved buoy in the same chocks. These buoys are awkward to secure.

(5) Tall-type unlighted buoys are large and heavy, and should be chocked up and secured similarly to lighted buoys as described below.

M. *Stowing lighted buoys.*—Lighted buoys are landed on deck on wooden cradle blocks, wooden saddles, or other appropriate dunnage. The body of the buoy should not rest entirely on the steel deck but should be supported by the dunnage so that the weight of the buoy biting into the wood tends to increase the friction of the blocking. Lighted buoys are lashed with chain and turnbuckles of size appropriate to the size of buoy being secured. For example, for a 7 x 18 buoy, ¾- to ⅞-inch chain would be sufficient, but for a 9 x 38 buoy, 1- to 1⅛-inch chain would be used. Flat-bottomed electric buoys are stowed flat on deck on thin planking or on equally spaced wedges and are lashed with chain and turnbuckles. Six- and eight-foot counterweighted tube buoys are stowed with the tube down on deck and cage up in the air, being braced against tipping down by additional blocking directly under the middle of the buoy's upper body. Care must be taken in stowing 8 x 23W buoys as they are unstable in this position due to the short counterweight tube. They are more safely stowed flat on their sides. Space does not always permit this, as the lanterns of lighted buoys must often be nested over and against each other in order to get them all on board. Chain for lashing is secured to a padeye, led through the lifting lug at the top of the buoy, or given a round turn around a pocket casting and secured to the deck again with a turnbuckle, the over-all lead resembling an inverted vee whose legs must not be vertical. Lashing chains are often just passed directly from the top of the buoy

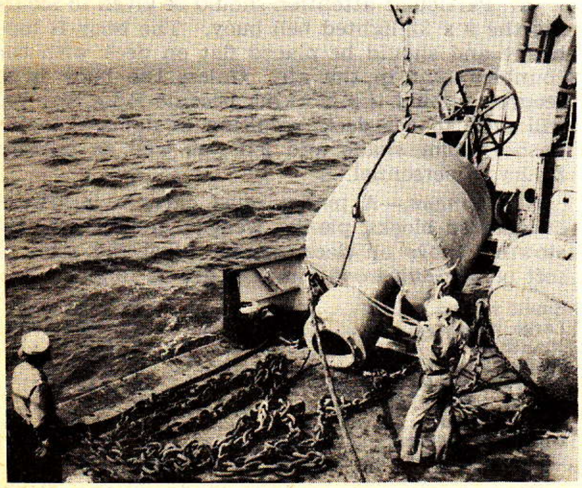

FIGURE 27–124.—Shifting an 8 x 23W buoy around on deck.

to the deck and secured by a turnbuckle. When securing conical-bottomed buoys such as an 8–20-type, in addition to the lashings from the top of the buoy, wire straps or chains are led in opposite directions from the bottom lug of the buoy to prevent twisting.

(1) Wherever chain is mentioned in the above as used for lashings, wire straps of comparative strength may be used. Most ships, however, do not favor using wire since it is hard on the hands and is difficult to adjust to the proper lengths.

(2) Lighted buoys, other than 9-foot types, are often stowed with the lantern end forward. However, the particular arrangement of the deck of the tender or the number of buoys aboard may necessitate other arrangements. Conical-bottomed buoys are headed in any direction, wherever there is room for them.

(3) Wherever the 9-foot lighted buoy is discussed herein, the description and procedure is applicable to the 10 x 39 buoy as well. Nine-foot buoys require particular care in blocking and securing due to their size and weight. Two of these buoys are all that can be carried for working, although three can be squeezed aboard for transportation purposes.

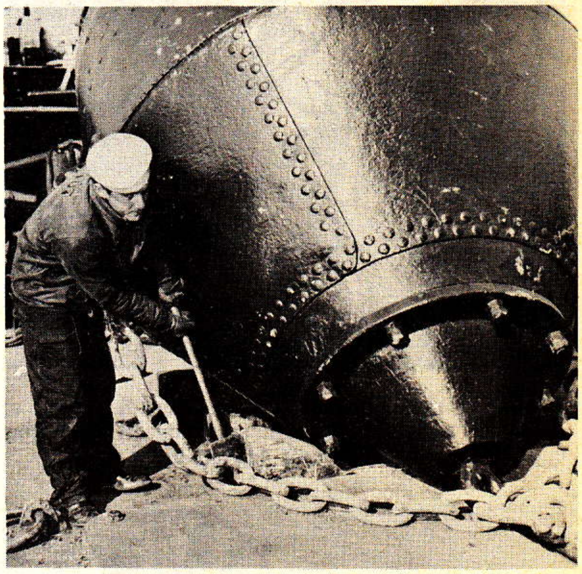

FIGURE 27–125.—Driving home a wedge under an 8 x 20 lighted buoy.

The majority of tenders stow and work these buoys from a fore-and-aft position alongside the bulwarks with the lantern headed aft. From this position they may be put over the side without further handling or shifting around at sea. A few tenders carry the buoys athwartships in the way of the buoy-ports. However, when the buoys are in this position, working deck space is lost to other purposes, hook line leads are not as fair when working the buoy, and securing the buoy is more difficult. One tender carries the buoy in a cross-deck diagonal position when cruising and shifts it to the athwartships position for working. Nine-foot buoys are lowered onto

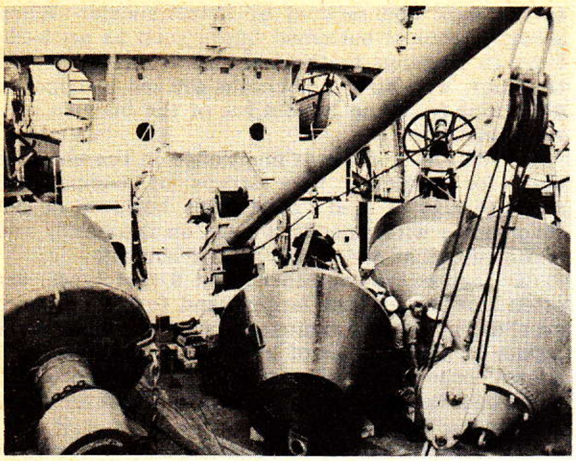

FIGURE 27–126.—Miscellaneous buoys stowed on deck.

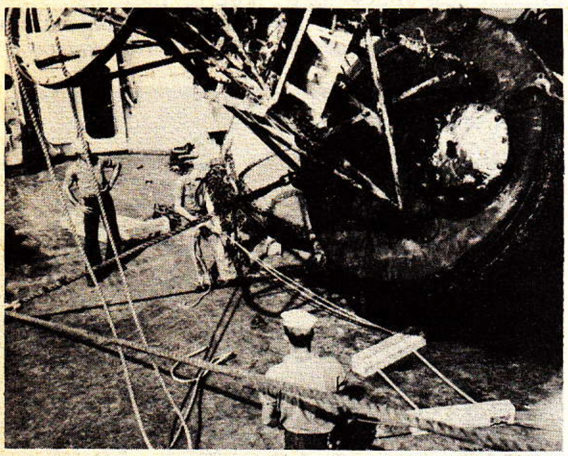

FIGURE 27–127.—Placing a wooden cradle under an 8 x 20 buoy. Note man standing in dangerous position inside bight of snatch block.

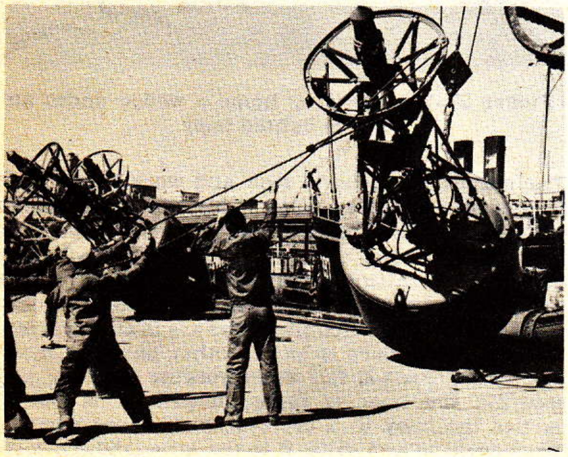

FIGURE 27–128.—Picking up an 8 x 20B lighted buoy from the dock.

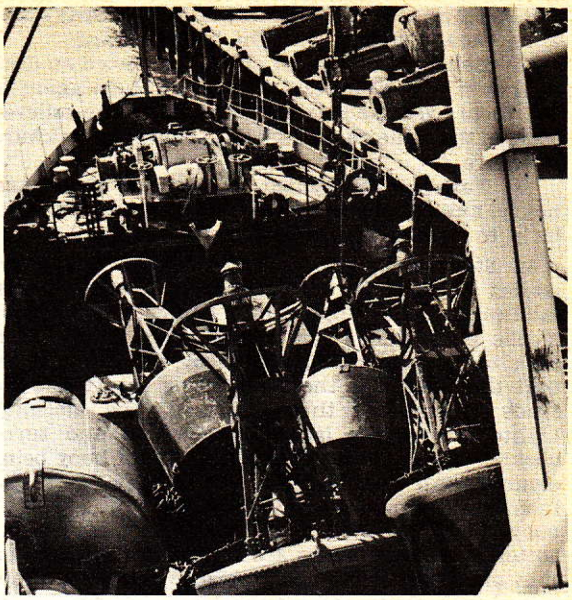

FIGURE 27–129.—A deck load of large and small lighted buoys.

a large wooden chock 12 by 12 inches by 9 or 11 feet, one side of which is cut out to conform to the curvature of the buoy's body. The counterweight is lowered onto a 2 by 12 inches by 4 foot plank. Blocks and wedges are tightly jammed in under the remainder of the body to prevent the buoy from tipping the lantern end down. Four or six chain and turnbuckle lashings are passed to the body of the buoy and a half hitch or round turn lashing is passed around the tube.

(4) Moorings for 9-foot buoys are often ranged out on deck before loading the buoy, since once the buoy is in position, the buoy port area is largely blocked.

(5) Particular attention should be given to securing the 9 x 32 lighted bell buoy. The buoy is top-heavy and should be placed flat on deck with the counterweight in the air. Unless the buoy is so secured, should the blocking become loose, the top will drop to the deck, resulting in damage to the flasher, color shade and lens, as well as possible injury to personnel.

N. *Dunnage.*—A tender must carry a multitude of assorted blocks, planks, wedges, chocks, etc., for stowing buoys on deck. Some suggested sizes of soft or medium wood dunnage are as follows:

Small wedges	4″ x 4″ x 12″
Large wedges	12″ x 12″ x 30″
Planks	3″ x 12″ x 11′
Planks	2″ x 10″ x 4′
Blocks, concave one side	12″ x 12″ x 11′
Blocks, square	12″ x 12″ x 11′
Blocks, square	4″ x 4″ x 4′
Chocks, tri-corner	6″ x 6″ x 12″

Other sizes as required under the circumstances.

Some tenders use saddles made of two blocks 12 x 12 inches x 4 feet or 6 feet with tapered inboard edges along their length and separated on an angle by pieces of pipe. Handles can be fastened to the outside edges for attaching guide lines. One

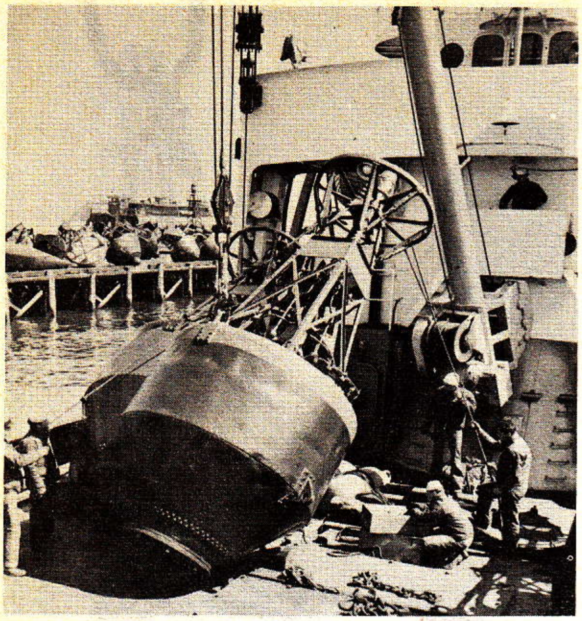

FIGURE 27–130.—Setting an 8 x 20B lighted buoy down on wedges on deck. Note that men stay well clear.

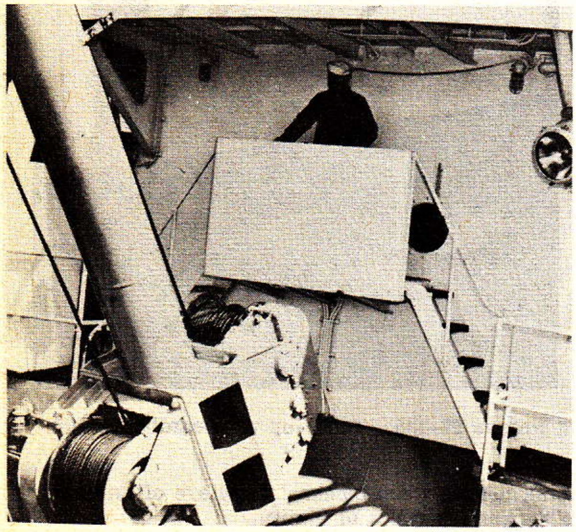

FIGURE 27–131.—Operating a boom is serious business. There should be no visitors or miscellaneous conversation.

vessel suggests using a length of 2 x 12 inch planking with two 4 x 4's spiked to one side, one piece at each end. A 5 x 15 buoy would require a distance of 2 feet 6 inches between the blocks; a 6 x 20 buoy, 2 feet 10 inches; 7 x 18 and BIII buoys, 3 feet 1 inch; 8 x 26 buoy, 3 feet 5 inches between blocks. A cradle for 9-foot buoys is sometimes made by bolting two 12x12's together and cutting out a concave section on one side for the body of the buoy.

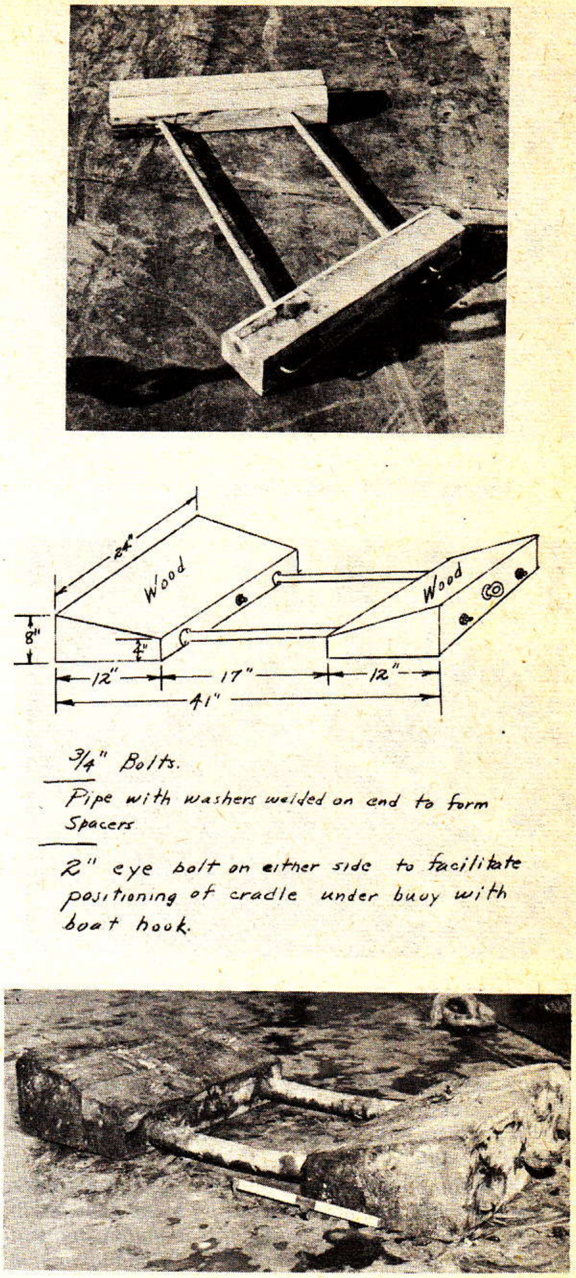

FIGURE 27–132.—Wooden buoy saddles (cradles).

O. *Sinkers and chain* are generally stowed forward on deck on most vessels, in spaces not adaptable for placing buoys, so as to utilize every available space on deck. They can also be stowed in the hold. Chain is stowed in bundles secured by manila or wire straps, or is ranged out on a wooden platform. Sinkers are landed on small equally-spaced wedges, battens, or on strips of boxwood. Both sinkers and chain should be appropriately lashed. When carrying an unequal number of

FIGURE 27–133.—Saddle for ballast ball.

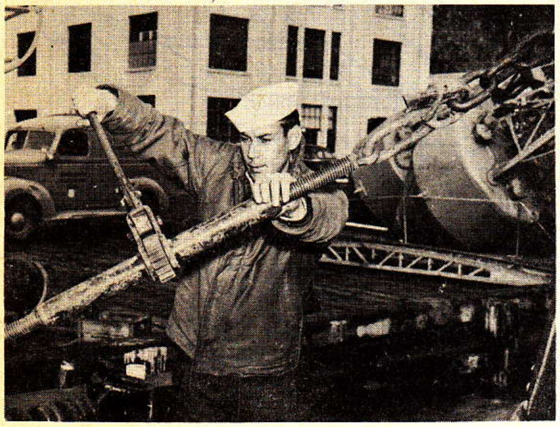

FIGURE 27–134.—Steamboat-type ratchet jack. A quick means of tightening a buoy lashing.

lighted buoys, sinkers may be placed to trim ship. When slings are placed around bundles of chain, they should be left in place so as to expedite further handling later.

P. *Acetylene cylinders* should be stowed on deck where they will not be damaged by loose gear, such as near the after bulkhead. It is generally not feasible to stand them vertically, although it is better for the cylinder. Lash them securely and drive wedges to tauten the lashings. See that the blind plugs and protection caps are in place. Wooden 4 x 4's, cut with half rounds shaped to fit the cylinders, may be placed on deck, and then subsequently between each tier of cylinders. A chain lashing may be cinched across the top of all the cylinders. Never stow acetylene cylinders below decks.

Q. *Battery racks* should be stowed vertically in a place free from exposure and away from loose gear. If stowed in the forward hold, a small hatch should be open for ventilation, if possible.

R. *Ballast balls* are awkward to secure. They may be fastened directly to the buoy, or may be set on a plank between two blocks. They are often dumped in between bundles of chain.

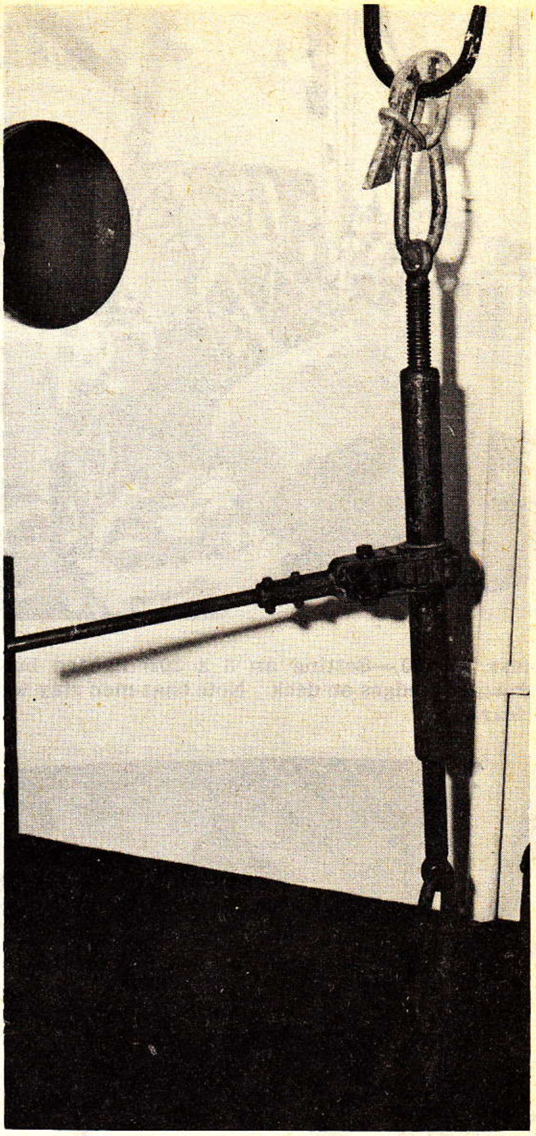

FIGURE 27–135.—Close-up of Steamboat Jack.

S. *Turnbuckles.*—In addition to the conventional-type turnbuckles, ratchet-type steamboat pulling jacks have been found useful for securing loads positively and quickly. (See fig. 27–134.)

27–5–5 Preparing Buoys for Service—

A. Assuming that the buoy has been loaded and secured, the next step is to complete preparations for service. Buoys are generally furnished to the tender completely painted as to final color coat, except in the Great Lakes and certain other areas where tender forces clean and paint many of the buoys. The tender force often paints the number or identifying letter. All painting, color coats, number, etc., should be done well in advance of the time of placing the buoy in service whenever possible, to permit the paint to dry and to preclude a hasty, sloppy last-minute job. Most tenders try to schedule the preparation of buoys alongside the dock if possible, so that should a substitution of equipment or other change be indicated, it may be accomplished more easily. Also, it allows more time for the light to be test-operated to insure reliable performance.

(1) Unlighted buoys require no preparation other than painting, numbering, and connecting the mooring (which is usually done just before arriving on station). All buoys should be inspected to see that mooring lugs and lifting eyes are in good condition.

(2) Several vessels have found that the sheet or roll-type reflecting material used on spar buoys can be made to last longer and perform better if the strips are cemented on thin pieces of sheet metal which are then tacked to the wooden spar, rather than cemented directly to the buoy. The reflecting material adheres better to metal than to wood. A supply of strips of required size and color can be made up and kept on hand.

(3) Lighted buoys require a great deal of additional preparation which is discussed below.

B. *Lighted buoys.*—Some depots furnish the lighted buoys to the tender completely charged with lantern installed, ready for service. In this case, the tender should still make its own check to see that there are no leaks in acetylene gas lines; that pocket covers are on tight; inspect electric wiring; gage acetylene pressure or check voltage of batteries; check operation and characteristic of light apparatus; check color and number of buoy; check for missing or loose bell clappers or pocket cover lugs; clear vents, etc. Other depots furnish the bare buoy and equipment separately, and the tender force installs the cylinders or batteries, lantern, etc. Many tenders prefer to do this work of assembling the buoy, since the final responsibility of insuring reliable operation is theirs anyway, and if the buoy requires premature servicing, they are the ones who must usually make the extra trip to relight the buoy.

C. *Acetylene buoy.*—The following paragraphs describe the charging and assembling of a large acetylene lighted buoy as performed by tender force. The procedure would be much the same if performed by the depot:

(1) Gage the cylinders before loading and record the serial numbers. Remove the pocket covers of the buoy, securing a small line to the hoisting eye of the cover for lowering it to the deck. The covers of a large buoy pocket are heavy and require two men for handling, one to lower on the line, the other to guide it free.

(2) Some tenders place the buoy over the side of the ship, either floating or hung on the boom, before inserting the A-300 cylinders. This permits easy insertion of the cylinder by passing a 3 or 3½-inch short manila strap through the bail of the cylinder and hoisting with the whip. The cylinders are lowered onto wooden pads in the bottom of the pocket and must be securely wedged in place by four equally-spaced tapered wooden wedges driven snugly around the cylinder in the pocket by a bar of *nonsparking material.* Do not use a steel bar or hammer for this purpose.

(3) If the cylinders are to be inserted while the buoy is lying on deck, as is generally the case, pass a good manila strap (3 or 3½ inch) around the middle of the cylinder and hoist it up in front of the buoy pocket, positioning the boom as necessary. It has been suggested that to make the cylinder easier to start into the pocket, the strap be arranged so as to make the butt of the cylinder slightly heavier in balance. However, if this is done, extreme care must be used, since, should the cylinder slip out of the strap, a catastrophe might result.

FIGURE 27–136.—Gaging a cylinder before installing it in a buoy.

FIGURE 27–137.—Removing pocket covers of an 8 x 20B buoy.

(4) When the cylinder has been hoisted up to the buoy pocket, the butt end is inserted as far as the lifting strap will permit. (Be sure that the wooden block is properly positioned in the bottom of the pocket.) Secure a 3-inch lowering line to the bail of the cylinder and lead it through the cage of the buoy to a padeye or cleat on deck. The steadying line used in hoisting (a weight should never be hoisted without one or more steadying lines secured) will serve for this purpose if heavy enough line. Ease the strain of the lifting tackle and slack away on the lowering line to slide the cylinder into the pocket. Take care that the cylinder is inserted far enough in the pocket before slackening or shifting the lifting tackle. Should the pocket be nearly horizontal, the cylinder may be difficult to slide. Shifting the strap to the upper end and taking a slight strain will ease the situation. Soaping the pocket of 9-foot buoys will aid in sliding the cylinder in. Do not attempt to insert a cylinder into a pocket without a lowering line to prevent its sliding too fast.

(5) Before the cylinder is completely inserted into the pocket, the valve connection must be lined up fair with the staybolt connection in the side of the pocket. Insert a wooden or nonsparking bar through the bail of the cylinder and twist it into alinement. When inserting cylinders in buoy pockets (buoy lying horizontal on deck), be sure that the cylinders are inserted all the way to the bottom of the pocket. Otherwise, when the buoy is raised vertically, the cylinders will drop and the wedges loosen, resulting in an eventually fractured gas line. It is difficult to get the cylinders all the way into the pockets of a 9 x 38 buoy.

(6) Install the other cylinders as above. Close the shut-off valve at the junction box located inside the daymark of the buoy tower. Connect the cylinders to the pocket staybolts, using new aluminum washers in every connection. Set up all connections taut and gas-tight, but not unnecessarily tight, turn on the gas at the cylinders and check the lines to the junction box for leaks with soap solution. Here is where a little extra time spent in careful checking will pay dividends, perhaps eliminating an extra tender trip on a week-end to recharge the buoy in midseason

(7) Crack the shut-off valve at the junction box to blow out the line to the lantern. (Some tenders blow out each pocket line individually.) Acetylene tubing which has been unused for a period of time may collect deposits of carbon which must be blown clear before connecting the lantern. Also, during the course of the buoy's overhaul, foreign matter may have accumulated in the tubing.

D. *Installing lantern.*—While the cylinders are being wedged and connected, the lantern may be hoisted into place and bolted on. Use a manila strap slung in the conventional manner. One or two starting studs (headless bolts with rounded ends) are screwed into any of the holes on the base of the lantern. The lantern is brought into a position slightly aft and above the mounting plate. It is then lowered away slowly while two men on the ring of the cage guide the starting studs into the mounting plate. The remaining bolts are started, but not tightened until the starting studs have been removed and replaced with bolts. All bolts are then tightened together. A socket wrench is useful for this purpose. In placing some lanterns in position, care must be taken to insure that the gage block does not line up with the bracing of the buoy cage. It would be impossible to gage the buoy, if this happened, without some kind of extension. Make sure that the lantern is well secured. Many buoys have been found minus a lantern entirely, or with it hanging by one loose bolt or on the gas piping. The bolts, when loosened by the continuous motion of the buoy, may crystallize and snap off, or just work themselves out.

E. Connect the tubing leading from the shut-off valve in the junction box to the lantern and turn on the gas. Check the remainder of the system for leaks. Some tenders have a check performed by two separate individuals as an added precaution. If satisfied that the entire system is free of leaks, replace the pocket covers. (See paragraph (K) below relative to gaskets and sealing compounds, etc.) When replacing the covers, set up on the lugs (dogs) gradually and evenly so that the cover will seat properly on the gasket to make a watertight seal.

F. *Light flasher.*—Allow 15 to 20 minutes for the air to work out of the flasher, ventilate the lantern thoroughly, and light the pilot. Adjust it as necessary. (See Chapter 20, section 20–9–20.) Watch pilot lights of acetylene buoys closely as they have a tendency to creep brighter from the original adjustment. Check the flasher characteristic and adjust as necessary (Chapter 20, part 20–7). Flashers lit or adjusted in the heat of the day may slow down somewhat later. Check the focal height of the burner. An improper focal height will result in a considerable decrease of candlepower. If the buoy is to be located near breakers in the open sea or at any other place exposed to considerable flying spray, fit a drip shield under the lantern top over the pilot to keep the water from extinguishing the pilot.

G. *Gauge buoy.*—When the buoy has been completely installed, tested, and the flasher allowed to operate over a period of time, the buoy should be gauged before being placed on station. This pressure is recorded for computing service time.

H. *Buoys using A–50 cylinders.*—Buoys such as the 7 x 18, 6 x 20, etc., which use the A–50-type cylinders are prepared in a similar manner to the larger buoys described above. Great care must be exercised in checking for gas leaks in the 7 x 18 buoy since there are many more connections than in most acetylene buoys.

I. *Great Lakes area procedure.*—When preparing buoys for commissioning in the spring on the Great Lakes, the buoys showing 4½ or more atmospheres at the end of the previous season are often commissioned without recharging, since the change of temperature in the spring will increase the atmospheres to about 7. They are then recharged as necessary during the navigation season. This procedure has been found to save labor and expense in the handling, refilling, and transportation of the cylinders.

J. *Electric buoys.*—Battery racks may be installed more easily in electric-lighted buoys if the buoy is slung vertically over the side, or in the case of small tube buoys, with the tube down the hatch into the main hold. Check the voltage of the bank of batteries before loading and test the nonspillable vent by laying the battery rack horizontally on the dock and rolling it over several times. The vent in each

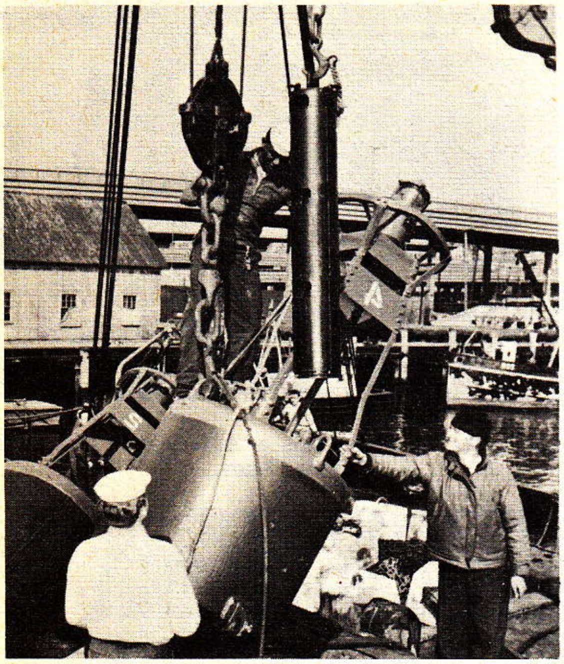

FIGURE 27–138.—Installing battery rack in 3½ x 10E lighted buoy. Note that the buoy has been picked up slightly to permit easier insertion of the batteries.

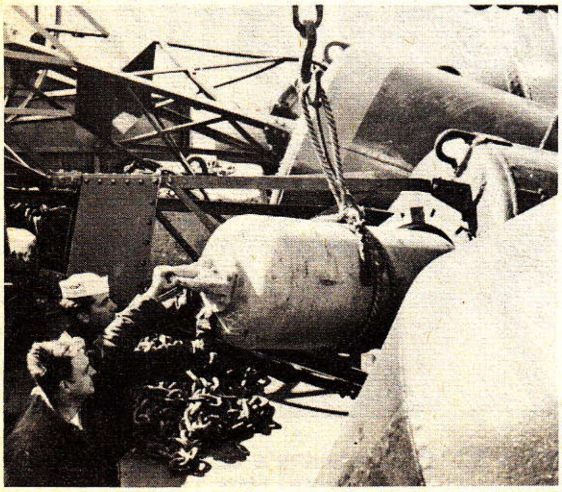

FIGURE 27–139.—Installing an A–300 acetylene cylinder in buoy pocket. A line is generally led from the bail of the cylinder to the buoy cage to prevent it from sliding down into the pocket too hard.

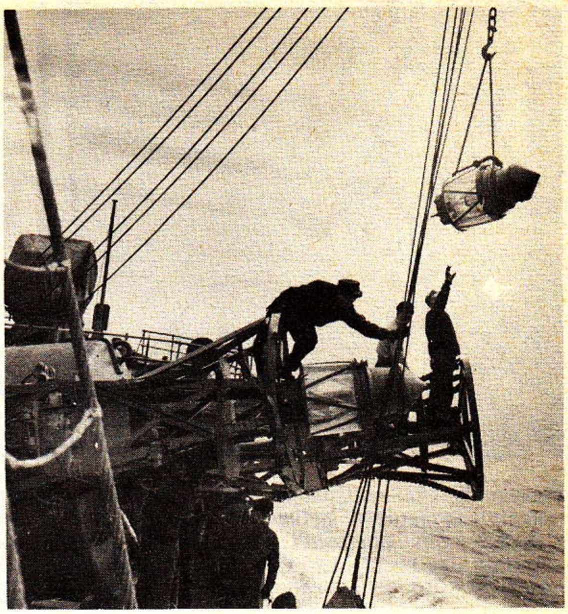

FIGURE 27–140.—Hoisting a 375-mm. acetylene lantern in place on a large lighted buoy. Lantern should have a steadying line attached and men on buoy should be wearing life jackets.

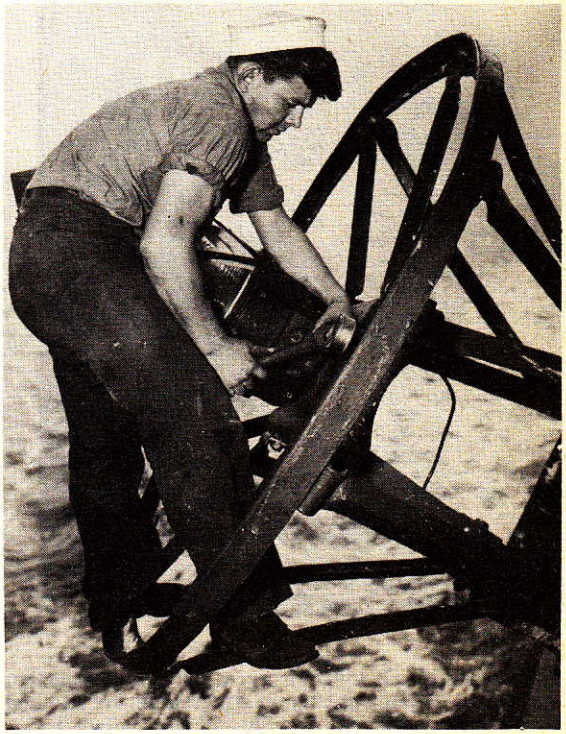

FIGURE 27–141.—Installing a test gage on a 200-mm. acetylene lantern. Man should be wearing life jacket and should have one leg hooked around cage structure to better brace himself. (See man in fig. 27–143.)

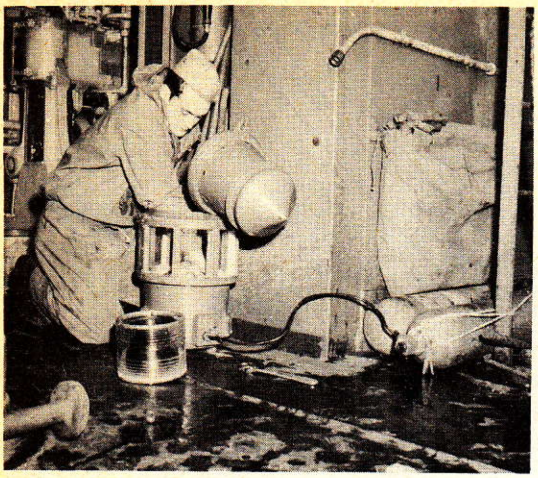

FIGURE 27–142.—Adjusting flasher of a 200-mm. acetylene lantern before installation. Note test cylinder in horizontal position—acetylene gas should not be drawn off when cylinders are lying horizontally, as acetone may get in the flasher.

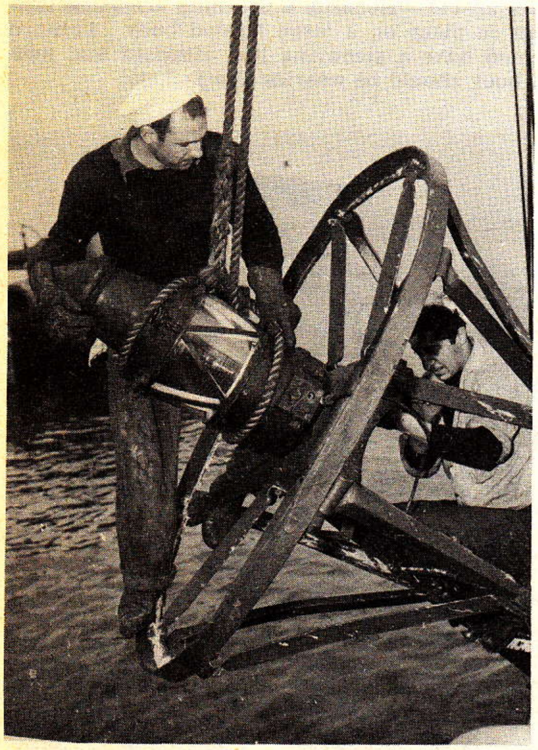

FIGURE 27–143.—Bolting on a 200-mm. acetylene lantern. Men working on superstructure of buoys on deck when near the side of the vessel should wear lifejackets.

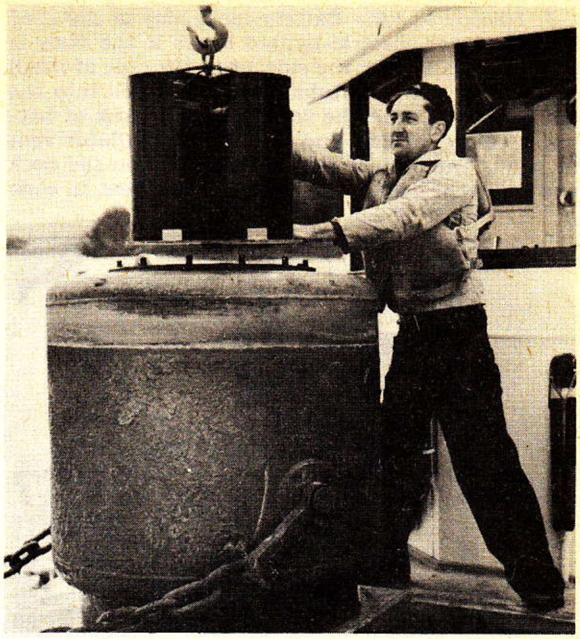

FIGURE 27–144.—Installing a battery rack in 3½FE lighted buoy.

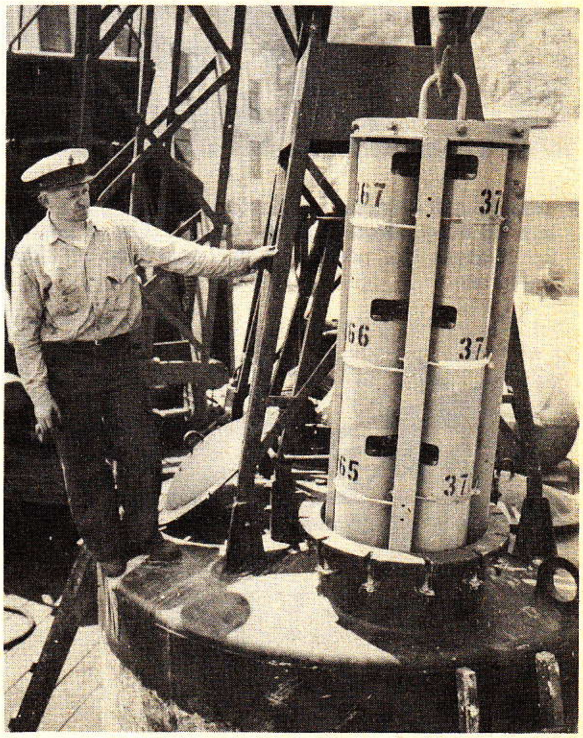

FIGURE 27–145.—Installing a battery rack in a 7FE lighted buoy.

FIGURE 27–146.—Spreading graphite grease on old-type pocket cover gasket prior to installing cover. New-type neoprene gaskets require no grease or other sealing compound.

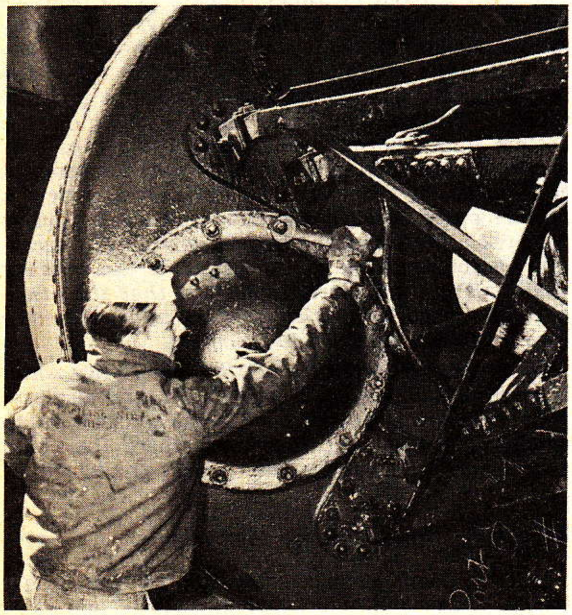

FIGURE 27–147.—Tightening pocket cover hold-down bolts. They should be tightened alternately and by opposites, evenly to avoid bending the cover plate. Use only nonsparking tools to open or close a pocket cover.

battery must revolve freely. Do not leave the batteries in a horizontal position. Remove the pocket covers and tuck the battery leads back into the recess in the pocket so that the rack will not pinch or cut them as it slides in. Hoist the battery rack up over the pocket and lower it gently. Batteries are fragile and should be treated with the same respect shown acetylene cylinders. Set up on the wedging setscrews or lugs located in the top of the battery rack. Use additional wooden wedges if necessary, to insure that the rack will be secure in the pocket. Connect the wire leads to the proper terminals and coat the connections with grease. Be sure when connecting the battery leads that they are not accidentally reversed. Check the wiring at the lantern for grounds and proper voltage. (The lantern is installed in a manner similar to acetylene lanterns described above.) Check the lighting equipment for proper operation and characteristic (see Chapter 21). Make sure a 6-volt flasher is not installed in a 12-volt buoy installation, etc. Secure the pocket covers, taking great care to obtain a water-tight fit. This is vitally important in the case of electric buoys. Inspect the pocket vents to make sure they are free. Explosions have occurred due to the accumulation of hydrogen gas given off by the batteries. Allow the buoy to remain lighted as long as possible before placing into service, the same as for an acetylene buoy, as a check to insure reliability.

K. *Gaskets.*—A number of methods of sealing buoy pockets are in use on various ships. As of July 1, 1951, cork neoprene gaskets were available on term contract. As rapidly as existing buoys are converted to the use of this gasket (a depot job), no other gasket should be used. Too much emphasis cannot be placed on the maintenance of watertight buoy pockets, especially in the case of electric buoys. See Chapter 24 for instructions on installation of gaskets.

L. When the buoys have been prepared and lighted, and are to be left burning on the dock or aboard ship overnight, cover the lantern with canvas or burlap.

M. *Bridles and moorings,* etc. may be connected as described in section 27–5–15.

27–5–10 Selection of Mooring—

A. The amount and size of chain, and size and weight of sinker to be used in a buoy mooring, is a variable factor governed largely by local conditions peculiar to the specific buoy station. The condition and nature of the bottom (is it good or poor holding ground; is it abrasive on the chain?), the range and strength of tide or current, the degree of exposure to rough weather, and of course, the size and weight of the buoy, are all factors to be considered by the commanding officer of the tender in determining the size of mooring to make up. Buoy cards and file copies of form 2555 maintained on board the tender and in the district office will show a history of what moorings have been used, including pertinent remarks concerning them. Until an officer has achieved considerable experience, the past action of others, if found satisfactory, will serve as a competent guide. The tables shown in Chapter 24 indicate an average recommendation for moorings, disregarding special circumstances. It is seldom advisable to use less than, and may sometimes be better to use more than, that specified in the tables.

(1) In extreme locations or poor holding ground, several sinkers may be used. Along river channels, large sinkers are used even on small buoys, to lessen the chances of the buoy being dragged when fouled by passing craft.

(2) Certain locations have proven extremely difficult for maintaining lighted buoys on station due to the presence of circular currents causing the chain to become balled up in spite of swivels. The twisting of the chain brings the buoy to short stay, and due to its buoyancy, the chain will either part, pull out the sinker bail, or lift the sinker so that the buoy drifts into shallower water.

(3) Sometimes it is necessary to allow the buoy to drag a little rather than to use a large sinker and hold the buoy until it parts the chain. This condition exists in the First District where several buoys are located in rocky bottom. Under extremely rough conditions, it has been found that by hooking a smaller sinker in the mooring between the main sinker and the buoy, dragging may be prevented.

(4) If difficulty is experienced in keeping buoys on station in channels with steep banks and strong currents, this can be overcome in most cases by using a smaller concrete sinker and making up the difference in weight by shackling a 15-fathom shot of 1½-inch chain in 6- or 8-foot bights. This chain will have a tendency to bury itself in the mud. Use more chain if necessary.

(5) In areas where a buoy will not hold station because of strong current and silt in the river, this condition may be overcome by dropping the sinker a couple of hundred feet from station and dragging it over to its location. The sinker thus breaks through the crust of the silt and buries itself in the softer mud below.

(6) Extra weight should be placed on buoys that set close to surf to prevent dragging in the event of rough weather or a heavy ground swell.

(7) Nine-foot buoys in exposed areas generally require 8,000- to 12,000-pound sinkers and 1⅝- to 2-inch chain. Eight-foot buoys use 5,000- to 8,000-pound sinkers, etc. See tables for average conditions in Chapter 24.

(8) Buoys marking a dredged channel which are plotted on the chart in a straight line should be given the same scope of chain. This makes it easier to check the alignment.

B. *The scope of chain* used on large outside buoys is generally a ratio to the depth of water of 4 or 5 to 1. In less exposed locations with no strong current, 3 to 1 may be sufficient if an adequate size of chain and sinker is used. In restricted waters such as channels, the scope must be as short as practicable to insure that the buoy watches close to its charted station and to prevent its drifting off the channel line at slack water or during cross-tides. Sufficient chain should be added to prevent buoys set on ledges with surrounding deep water from being pulled under if dragged off station.

C. *Inspection.*—Mooring chain should be carefully inspected throughout at the time of annual servicing (also when setting the buoy initially). Any sign of general wear is sufficient reason to move the chain to another buoy located in calmer water. It is false economy to reuse a chain which *might* serve another year. Mooring chain will wear most at the *chafe*, that point where the chain first touches the bottom, and which is continually rubbing with the rise and fall of the buoy in the seas. These dozen or so links can be cut out, the chain joined with a riveted-pin shackle, and the mooring is ready for another season. After a number of years the chain will show wear in several places, or will generally be worn so thin throughout that it must be surveyed. Moorings used on buoys in locations where the bottom is of a very abrasive nature should be of the best chain available in the wearing sections; stud link or die lock, if available, is best to use for outside buoys.

Do not use split-key type shackles for connecting sections of the chain that rub along the bottom or may chafe on the buoy tube.

D. *West Coast procedure.*—Following is an example of procedure followed by a district on the West Coast where conditions are often severe:

The bridle spans the underside of the buoy, but is short enough to ride on only one side of the tube, protected by wooden chafing strips. Below the bridle, a short length of chain called the pendant is fastened. Because this chain is comparatively light (depending on the size of the buoy), it must be of such length that it does not hang to within 2 fathoms of the bottom at the buoy location. Below this pendant is a section of heavy chain called the *chafe* which carries the heaviest wear at the point where the chain first touches the bottom. The chafe is about 1½ times as heavy as the pendant chain, but where the bottom is rocky, or sea conditions severe, the chafe may be even heavier. Below the chafe section, a length of chain called the bottom chain is used between the chafe and the sinker. The bottom chain usually rests on the bottom under normal conditions, and serves only to provide sufficient catenary to protect the pendant from shock in the event of extreme seas where a greater scope between the buoy and the bottom is required. In placing the buoy, a sounding is necessary to double check on the length of the pendant chain. *It is particularly important that the pendant not be too long, otherwise the wear will come on a chain too small for the purpose.*

E. Chain, used in sandy bottoms where fast water is present, can be made to last longer, and also prevent fouling, if a piece of manila line is rove through the links of chain at that part where the chain experiences its most friction, i. e. at the chafe.

27–5–15 Preparing the Mooring—

A. The buoy mooring consists of the bridle, swivel, lengths of chain, sinker, and connecting shackles (also a ballast ball on certain buoys). The bridle is generally connected to the mooring lugs of the lighted buoy after it is loaded on deck but before proceeding to sea, so as to obviate the need for excessive moving of the boom to prepare the buoy for setting when at sea.

(1) *Shackles.*—Special $2\frac{1}{2}$-inch riveted-pin shackles are used at the mooring lugs of 9-foot buoys, into the bow of which the bridle is connected with 2-inch (first class) shackles. Some tenders use split-key shackles at this point; others use riveted-pin type. The riveted-pin shackle is the most secure if the buoy is to be placed in an exposed position. A few tenders split the end of the pin of the split-key-type shackle down to the slot with an oxyacetylene cutting torch, then heat and spread over the two sections of the pin. This achieves the same effect as the standard riveted-pin type. If split-key-type shackles are used at the junction of the bridle ring and the swivel and mooring chain, care must be taken to so insert the shackle that the key will not rub on the chafing strips on the buoy tube. The ring of the bridle reaches to about two-thirds the length of the tube.

(2) Some vessels use a 5- or 6-foot length of $1\frac{1}{2}$-inch or $1\frac{5}{8}$-inch chain between the bridle and the swivel, thus placing the swivel clear below the buoy. If this is used, it is connected with a riveted-pin shackle to the bridle, and with a split-key shackle to the swivel.

(3) For 9-foot buoys, with the exception of the special $2\frac{1}{2}$-inch shackles, the remainder of the mooring uses 2-inch shackles. Smaller buoys use smaller shackles. See the tables in Chapter 24. Note that the shackle size is always larger than the chain.

B. *Connecting lighted buoys.*—When loading a sinker for a 9-foot buoy, set it on deck as close to the side of the ship as possible at the place where it is to be stopped off, to eliminate the necessity for swinging the boom at sea. The chain is shackled into the sinker with the bight or bow of the shackle in the bail of the sinker (this gives a rope stopper (if used) more clearance to slide through the bail of the sinker). The buoy bridle is raised with the whip until the ends are suspended high enough to allow shackling into the buoy. This eliminates manual straining, since the lugs on 9-foot buoys are too high to be handled easily by hand. Raising the bridle gives a good opportunity to see that it is clear, with no turns in it. On 8-foot buoys, the bridle may be hooked on by hand.

C. *Range out the chain* in thwartships rows, each bight running from just inside the lip of the deck at the edge of the buoy port, to as far across the deck as necessary, depending on the length of the chain and number of bights. Do not have the chain piled or bunched upon top of itself—make the rows even. In the case of large buoys, if they are to be worked first, it is often advisable to range out the chain on deck before loading the buoy.

Stopper chain.—Most ships run a length of large open-link chain or a buoy bridle fore-and-aft between two padeyes about midships on deck, or at the edge of the opposite buoy port, depending on the length of bights of chain across the deck. This is a stopper chain, and is used for lashing the bights of the mooring with safety stoppers, or "rottenstops." "Rottenstops" are lashings light enough to part, and are intended only to check the speed of the chain as it runs over the side when the sinker is tripped. The safety stopper is placed about four fathoms from the bridle end of the chain to absorb the shock of the chain, and to hold it fast to prevent the strain from coming on the buoy. It is placed far enough from the bridle to allow the buoy to be swung over the side before the stopper is released.

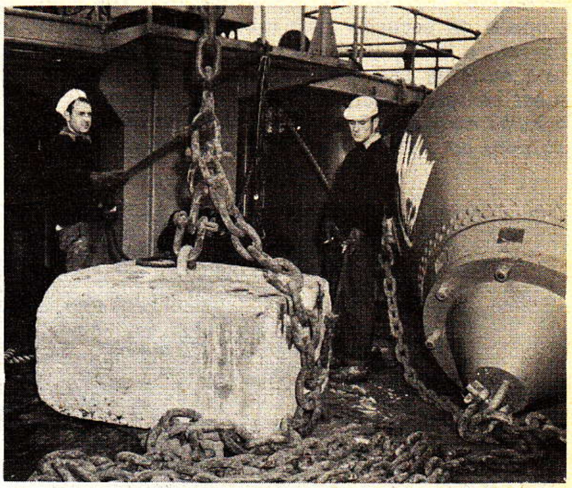

FIGURE 27–148.—Preparing to hoist a sinker by means of the hook inserted in a shackle in the chain. Note split-key type shackle used to join chain to sinker.

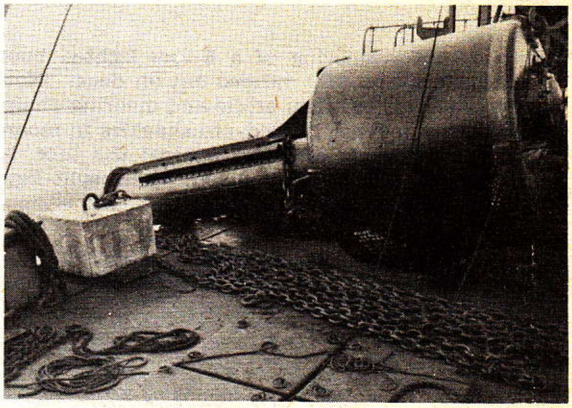

FIGURE 27–149.—Mooring of a 9 x 38W lighted buoy (laying athwartships) ranged out on deck. Note that the bridle should be pulled down on top of the chaffing strips on the tube before setting the buoy over the side. In its present position, the bridle can hang up and cause the buoy to list.

D. *Stopper lashings.*—The size of the stopper lashing and the number of turns taken is determined by the size of the mooring, having in mind the purpose of the stopper, i. e., whether it is intended to part or to hold fast. Discarded boat falls make excellent "rottenstops" for heavy chain. Heavier line, or more turns of lighter line, or preferably a pelican hook, is used for the safety stopper. A man should always be stationed with a sharp ax to cut any stopper that fails to part at the proper time. *He must be alert to stay out of the way of the chain.* Slip knots may be used on stoppers on small chain to permit the stopper to be reused.

E. *Caution.*—When hoisting out the sinker for hanging over the side on a pelican hook, wire strap, or manila slip stopper, BE SURE that the chain is stopped off securely just inboard of the sinker, to prevent a bight of chain from getting over the side and starting the chain running out. *One of the most common mistakes in handling chain is to let a bight accidentally get over the side without being stopped off. It can lead to disastrous results.*

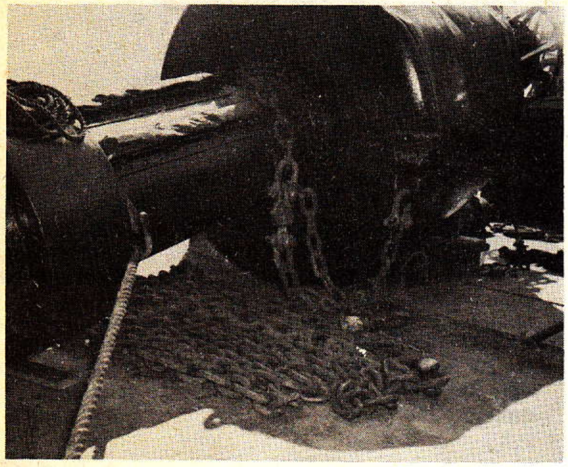

FIGURE 27–150.—Mooring of a 9-foot lighted buoy (laying fore-and-aft) ranged out on deck. Note swivel inserted between bridle and mooring chain. Most ships now use riveted-pin shackles in mooring lugs, where bridle rides against the tube, in the "chafe," and in other places where split-keys are apt to wear through.

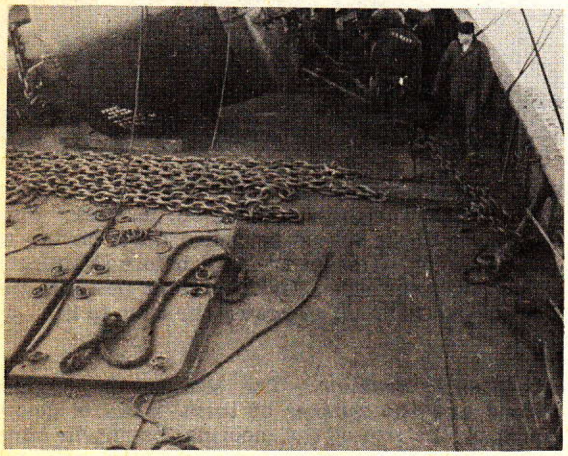

FIGURE 27–151.—Chain ranged out across the deck and stopped off to a buoy bridle stretched fore-and-aft in the way of the buoy port on the non-working side.

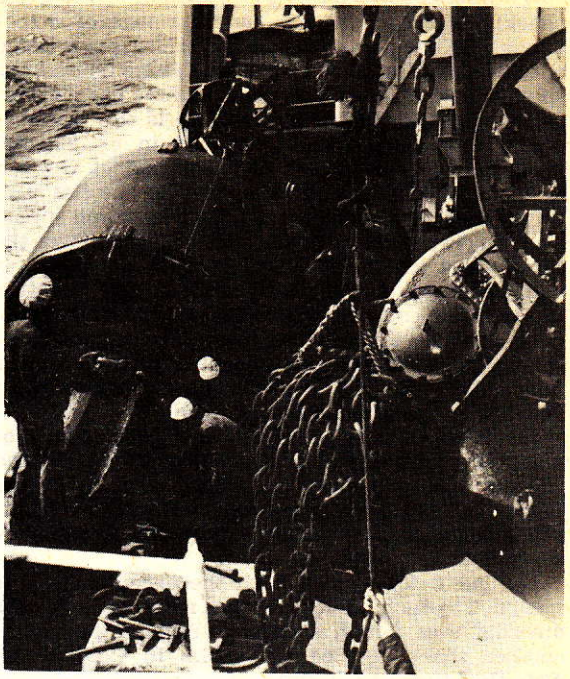

FIGURE 27–152.—A bundle of chain being moved around on deck in a manila strap.

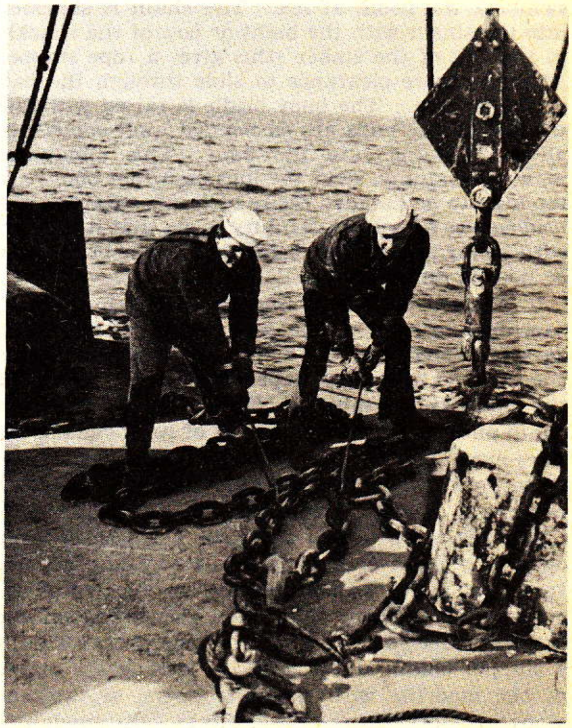

FIGURE 27–153.—Ranging mooring chain out on deck. Note pelican hook stopper in foreground.

FIGURE 27–154.—Using a "Swede" wrench for holding a split-key shackle steady for spreading the key.

FIGURE 27–155.—Flaring over a split-key unnecessarily far. Keys bent in this manner are difficult to remove.

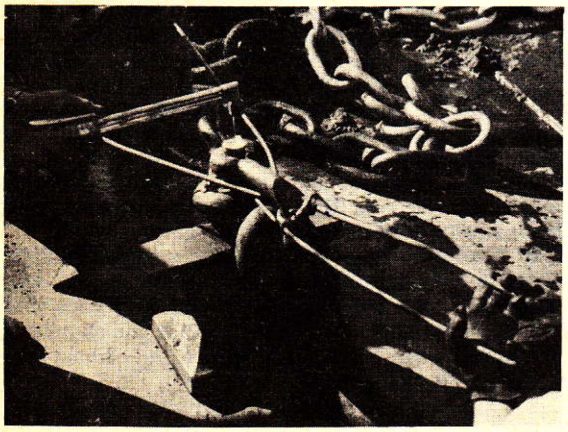

FIGURE 27–156.—Heating the head of a rivet-pin-type shackle pin with an oxyacetylene torch before peening.

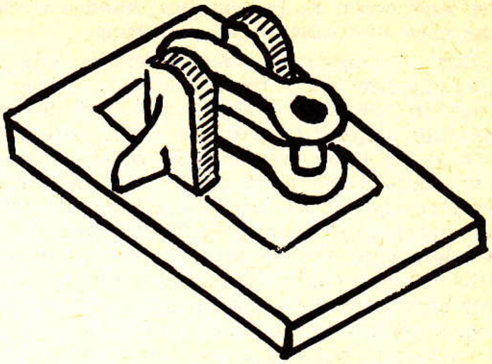

FIGURE 27–157.—A special shackle anvil for use in peening rivet-pin-type shackles.

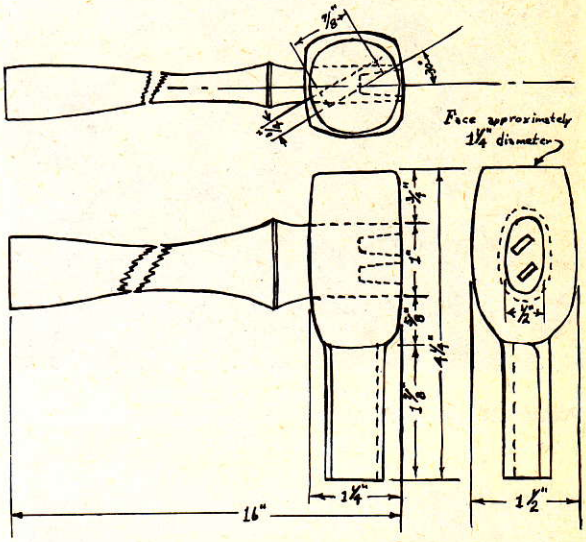

FIGURE 27–158.—A special drift used for driving out split-keys.

F. *Numbers of stoppers.*—Stoppers are not necessarily placed on each bight of chain, unless needed for keeping the chain aboard under rough conditions. The number of stoppers to use is commensurate with the need indicated by the circumstances to keep the chain running out under control, and to prevent it from whipping and lashing about, and taking charge. In the case of small unlighted buoys with not much chain, a stopper near each end is usually sufficient.

It is advisable when passing manila lashings on big chains, especially on the safety stopper at the bridle end, to use more than one link. Too much lashing in one link may cause it to snap under the sudden strain. In deep water it is advisable to back up the safety lashing or stopper with a shackle from a pad eye on deck into the chain. If the stopper holds, then the shackle can be removed before putting the buoy over the side. In very deep water, using heavy chain, it may be advisable to lower the sinker and chain to the bottom, hand-over-hand on the main and relief tackles (fleeting).

G. *Extra heavy chain.*—When working with long lengths of extra-heavy chain, such as the 2½-inch size used in Navy fleet moorings, the chain has been successfully stopped off with the bights (about half a shot or so) hung over the side of the ship, and just the ends of the bights on deck stopped off to a heavy fore and aft stopper chain. This, of course, is only practical in water of sufficient depth in protected locations. It permits the laying of great lengths of heavy chain which would otherwise completely crowd the deck, constituting a hazard, and necessitating more stoppers and lashings.

H. *Caution.*—Take care that the pelican hooks used have a positive safety pin or lock which cannot accidentally come loose from a sudden snap or surge as the chain comes taut.

FIGURE 27–159.—Heading over (peening) a rivet-pin-type shackle.

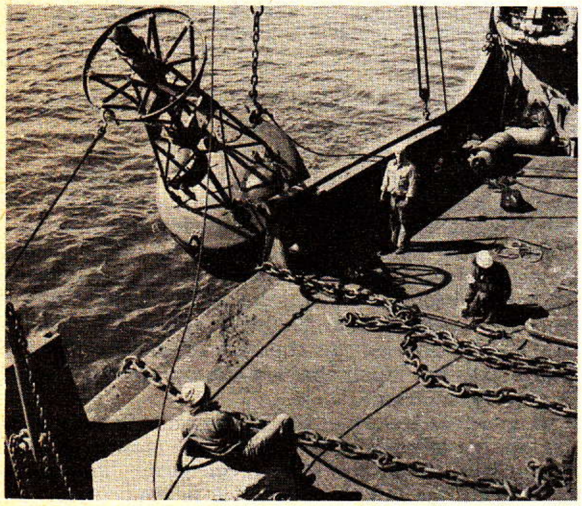

FIGURE 27–160.—Standing by to cut the mooring-chain stopper next to the buoy. The chain should have been ranged out more neatly in bights for running out. Twisted bights constitute a hazard.

I. *Miscellaneous notes.*—Following are miscellaneous notes on connecting shackles:

(1) In connecting shots of chain together with split-key-type shackles, instead of keying the pin in the shackle, the shots may be shackled together, pin inserted in the shackle, and then split down the center to the key slot with an oxyacetylene cutting torch. The split portions are heated and riveted over in opposite directions. Many failures occur when only a split-key is used under extreme conditions.

(2) If a split-key shackle is used to connect the swivel and mooring chain to the bridle, see that when the bridle lays against the wooden chafing strips on the tube of the buoy, the head of the shackle pin, not the split key, rubs against the chafing strips.

(3) When shackling the swivel into the chain, the shackles can be prevented from turning by always inserting the pins through the chain. This applies also to the bridle. The bow of the shackle is put into the large ring, and the pin in the small end of the swivel.

(4) In the case of smaller lighted buoys using split-key shackles, when shackling the bridle into the buoy, insert the pins from under the shackles so as to allow splitting of the keys on top of the shackle.

(5) Arrange the mooring chain so that a split-key shackle will not be in the "chafe" (the section first rubbing on the bottom).

(6) Use riveted-pin shackles at points where the chain touches the bottom or chafes against the buoy.

(7) Care should be used when riveting shackles, so as not to drive the end of the shackle together when pounding the pin. Iron wedges with handle, for first- or second-class shackles, are used by one tender to keep the shackle in original shape, and prevent cracking the U. Both end links of chain should be in the U of the shackle so as to permit the wedge to enter alongside the shackle pin. Be careful not to overheat riveted shackle pins and introduce brittleness. When peening over riveted-pin shackles on an anvil, place the anvil over a frame of the deck to give a more solid foundation for sledging. When riveting a shackle pin, the men using the hammers should stand with feet spread well apart and use a straight up and down stroke of the hammer. This gives better balance and control than if the hammer is used with a side stroke, and cuts down the possibility of an accident. The time-honored means of steadying the shackle on an anvil with chain hooks is not altogether satisfactory.

(8) One ship has constructed a special "holding anvil" for use with riveted-pin shackles. It is constructed of a 2-inch steel plate 12 by 14 inches with 2 short pieces of T iron welded so that the shackle is held upright while the pin is heated and peened over with sledges. (See fig. 27–157.)

(9) Another unit has fabricated a special drift for driving stubborn split keys out of a buoy shackle pin. The drift is handled, and the blade is shaped like a split key except that it is square at the end. (See fig. 27–158.)

(10) For a description of how to flare out keys of split-key shackles so that they may be easily removed later, see Chapter 24, paragraph 24–9–15 (C). Inspect all moorings before buoys are set. See that riveted shackles are properly headed over and that split keys are made up tightly.

J. *Preventer for bell buoys.*—Where bell and gong buoys are subject to icing, a "preventer" of ⅞- or 1-inch chain is run through the bridle ring, with both ends secured to the bottom of the buoy or to the end of the ballast ball. The chain is adjusted to permit the buoy to rock on its bridle up to a certain point. Past that point, the full strain of the mooring shifts to the bottom of the buoy and prevents the buoy from capsizing when it becomes iced up. When these types of buoys capsize under the weight of ice, they remain inverted until the tender turns them over. (See fig. 27–161.)

K. *Anti-rolling preventer for 8 x 20, etc.*—Conical bottom buoys such as the 8 x 20 type, when located in places where ground swells are encountered, can be reduced to a minimum of rolling and pitching by using a short length of chain from the middle ring of the bridle to the eye on the bottom of the counterweight of the buoy. Some tenders attach an 850- or 1,260-pound ballast ball to the counterweight, to minimize the motion of the buoy.

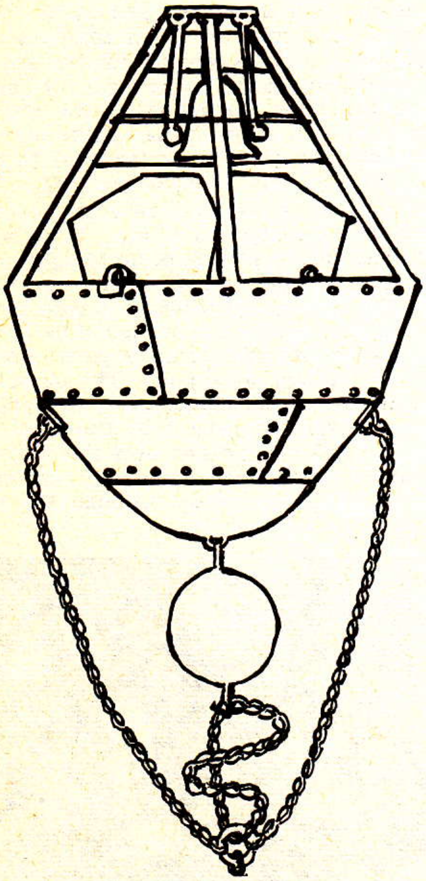

FIGURE 27–161.—"Preventer" for bell buoys to overcome a tendency to capsize under heavy ice conditions.

27–5–20 Preparing a Sinker for Tripping—

A. Assuming that the mooring chain has been ranged out on deck and shackled to the buoy and sinker, just before the tender reaches the buoy station or while maneuvering to check angles, etc., the sinker is prepared for tripping. There are several methods of tripping a sinker, some old and one new. Certain methods are better adapted to certain conditions, also taking into consideration the size and weight of the sinker, etc. The various methods of stopping off a sinker, or otherwise preparing it for going overboard will be discussed in turn in the following paragraphs. For example, in rough weather it is not advisable to have a sinker hanging low over the side, free to bump the ship with every roll. If the ship is rolling, keep lashings on the sinker until actually ready to hoist it over the side, or trip it with the dumping sling or "teeter" board, or whatever other method is to be used. In protected waters where a large number of buoys are to be worked, it is desirable to have a quick and easy method of dumping the sinker to save time and labor. Each method has been developed through experience to meet the particular conditions involved.

B. *Mechanical chain stopper.*—The recently developed mechanical chain stopper provides a quick, easy, and safe means of stopping off the sinker, clear of the deck, yet away from the water so as not to pound the ship's side in rough weather. There are no manila lines or wire straps to jam, wear out or

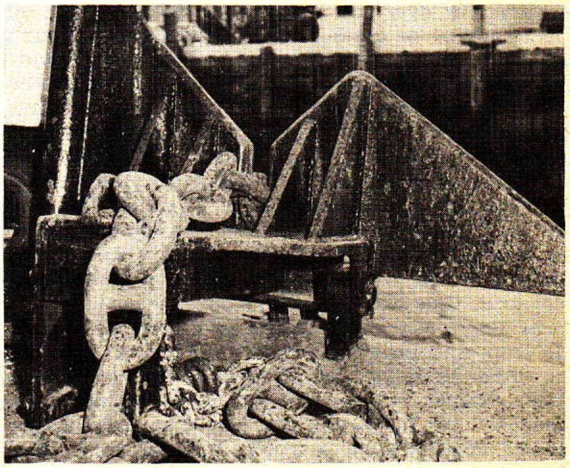

FIGURE 27–162.—Mechanical chain stopper (looking outboard).

entangle personnel, or pelican hooks, dumping slings, tripping boards, etc., necessary if the mechanical chain stopper is installed. See section 27–3–40 for a description of this device.

(1) To hang a sinker in the mechanical chain stopper, proceed as follows: If the bail of the sinker is large enough to allow the hoisting hook to be inserted freely, hook the whip (if a small sinker) or the main in, and hoist the sinker just high enough off the deck to clear the stopper.

FIGURE 27–163.—Mechanical chain stopper (looking forward).

If the ship is rolling even slightly, use steadying lines or a cross-deck hook line on the sinker. By having the boom trimmed a bit outboard instead of vertically over the sinker, and holding back on the steadying or cross-deck hook line (led through a snatch block in the deck and thence to the windlass), the sinker rides in a slight vee caused by the leads of the tackle and the steadying line, and thus its tendency to swing is retarded. A sinker can also be steadied as follows: pass a hook line out through the forward chock of the bulwark on the side of the ship where the sinker is to be hung, bringing the hook line up over the bulwark and securing to the sinker. Heave taut on the windlass, and as the sinker is raised to clear the bulwark the hook line is kept taut, thus steadying the sinker.

(2) Boom out until the sinker clears the side of the ship, and insert the mooring chain as close to the sinker as possible in the jaws of the mechanical chain stopper. Lower the sinker gently until the chain fetches up in the stopper, then unhook the tackle. A large shackle can be inserted in the bail of the sinker or in the chain to accommodate the hook of the hoisting tackle if desired, or a sling (nipper) chain may be passed around the chain either close to the sinker or a fathom or two back and the sinker hoisted thusly. If a sling chain is used, it is better to pass it a fathom or so away from the sinker to preclude any possibility of its jamming below the stopper. When a sinker is hoisted out in this manner, the boom must be trimmed sharply inboard once the sinker is outside and below the stopper, in order to break the chain over into the jaws of the stopper.

(3) When ready to drop the sinker on station, strike the tripping latch, and the jaw section of the stopper falls outboard releasing the chain and thus dumping the sinker.

C. *Stopping off on a pelican hook.*—A widely used method of stopping off a sinker is to insert the mooring chain in a pelican hook shackled to a padeye on deck, either directly or by means of a short length of chain, to permit adjustment of the pelican hook. The sinker is hoisted over the side as described in paragraph (B) above, the chain being adjusted in the pelican hook to make the sinker hang at the desired height above the water. If using a sling chain to pick up the sinker and mooring chain, take care that it does not jam against the side of the ship, making it difficult to cast off when the sinker is hung. Be sure that the pelican hook has a safety pin, *and use it.* Hinge-pin-type pelican hooks are better than the hinge-link-type, there being no chance for the bill of the hook to twist and possibly come loose. When tripping a pelican hook, do not strike the trip latch on the top; when it opens, it may strike your hammer and send it flying. Ears or tabs may be welded on the side of the trip latch for striking.

D. *Stopping off on manila line.*—Another common method is to use a manila slip line. This may be a 6-inch line for heavy sinkers of up to 6,500 pounds, a 5-inch line for up to 5,000-pound sinkers, etc. Even for the lightest 1,000-pound sinker, however, no line smaller than three-inch should be used. An eye is spliced in one end which is secured on deck near the edge of the buoy port. The other end is whipped and is led out through a chock and back aboard ready for inserting into the bail of the sinker. The sinker is hoisted over the side as described under paragraph (B) above, and the end of the stopper line is passed through the bail of

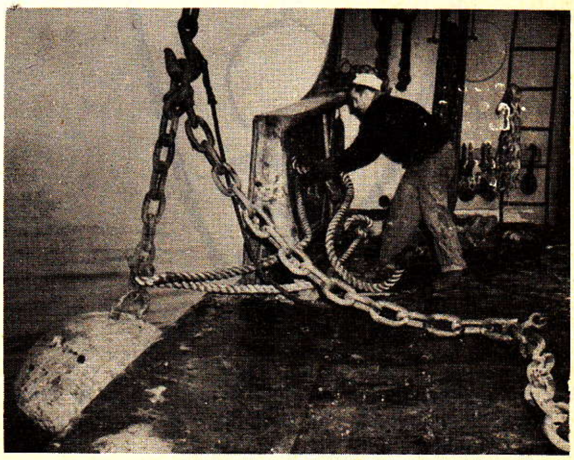

FIGURE 27–164.—Stopping off sinker with manila line.

the sinker or a link of the chain. (A shackle may be inserted in the bail or in one of the links, and the stopper line passed through this to insure that the stopper will not jam on release. The shackle is recovered at the time of the next relief.) The end of the stopper line is led back aboard over the bulwarks or through the buoy port and is secured to a cleat on deck. When a sinker has been hung, the stopper should be tended by an experienced seaman. The stopper should be only just long enough for the job intended. Too long a stopper is hazardous to personnel, as the end whips about violently when it is released.

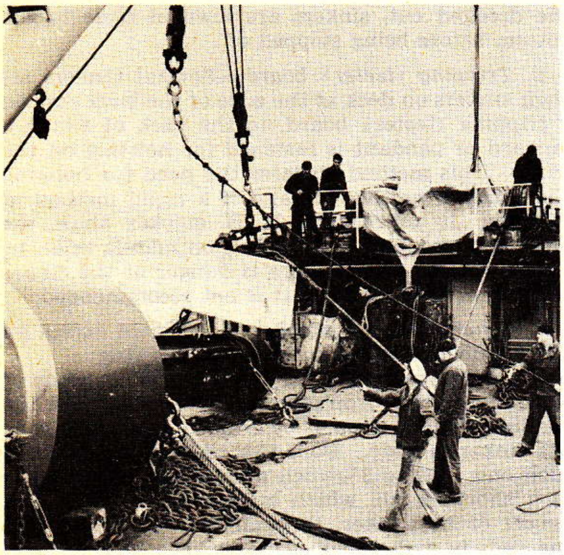

FIGURE 27–165.—Hoisting out sinker for 9 x 38 lighted buoy. Note use of steadying line on sinker holding back against slight outboard trim of hoisting tackle.

(1) *Caution.*—When hanging a sinker over the side, be sure that a bight of chain does not get over the side. The weight of a single small bight can cause the entire chain to run out. The only sure way to prevent this is to stop off the chain.

(2) *Check before letting go.*—When the order is passed to "let go the sinker," the man tending the line should check to see that the deck is clear of personnel before letting go. Although the manila stopper is widely used in buoy work, it can be a dangerous practice if not properly executed.

(3) *If stopper jams.*—Occasionally the slip line may foul in the sinker and the mooring will not fall clear. Always have a sharp axe ready, and expend the stopper if necessary by cutting it at the eye which is secured on deck. A man's hands or leg might get caught in trying to free the jam otherwise.

(4) *Use of hookline.*—Some older tenders, when hanging a sinker over the side, are unable to top the boom down far enough to hang the sinker forward of the buoy port. In this case, a hookline is led outboard from the capstan to haul the sinker forward.

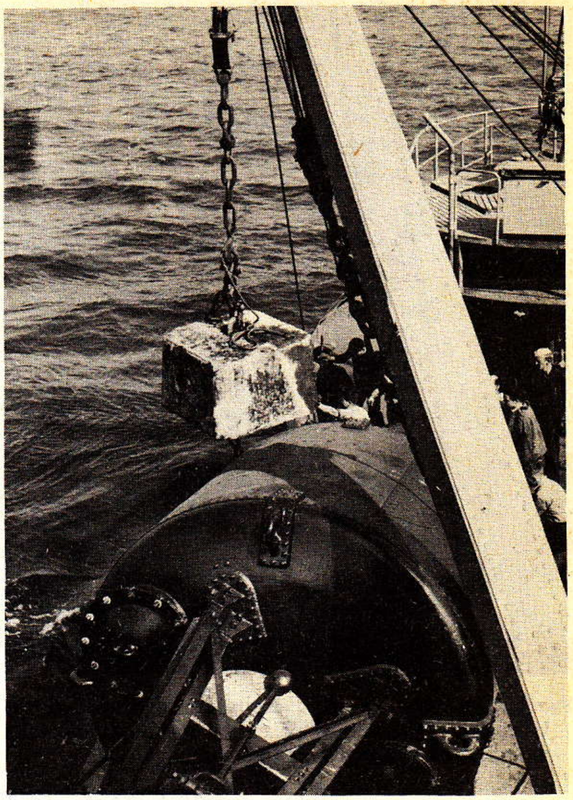

FIGURE 27–166.—Swinging sinker over the side. If sea were choppy, steadying lines should be attached to the sinker.

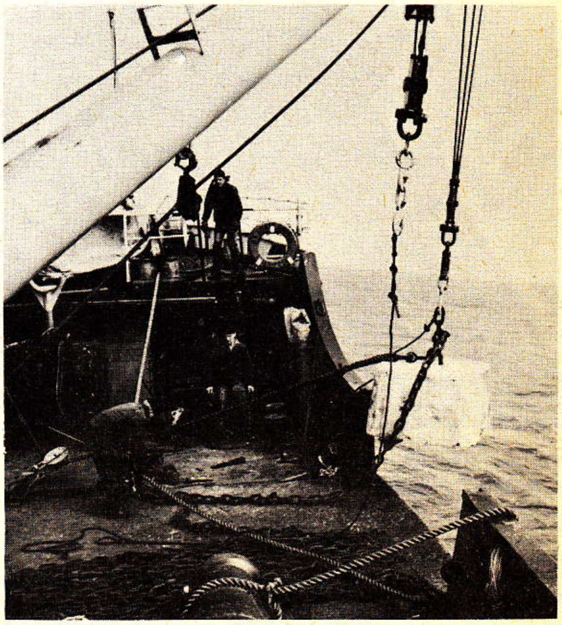

FIGURE 27–167.—Hoisting out sinker and stopping off mooring chain in pelican hook preparatory to setting a tall-type nun buoy.

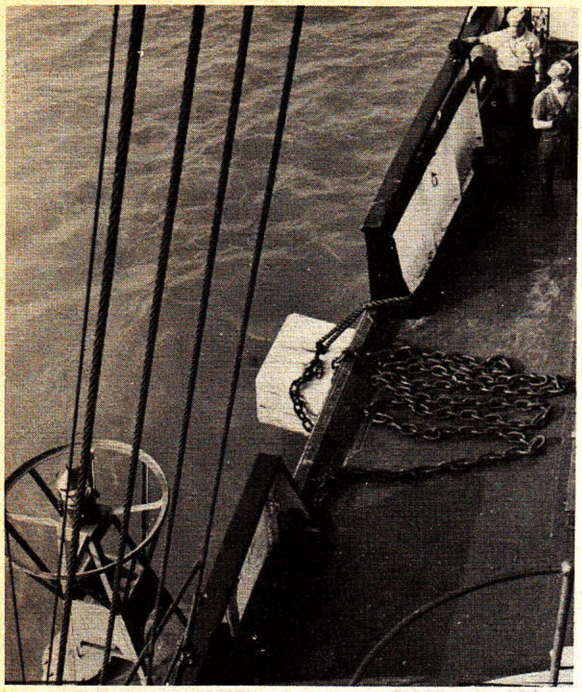

FIGURE 27–168.—Mooring improperly prepared for tripping. Note bight of chain hanging over the side and no stoppers on the chain on deck.

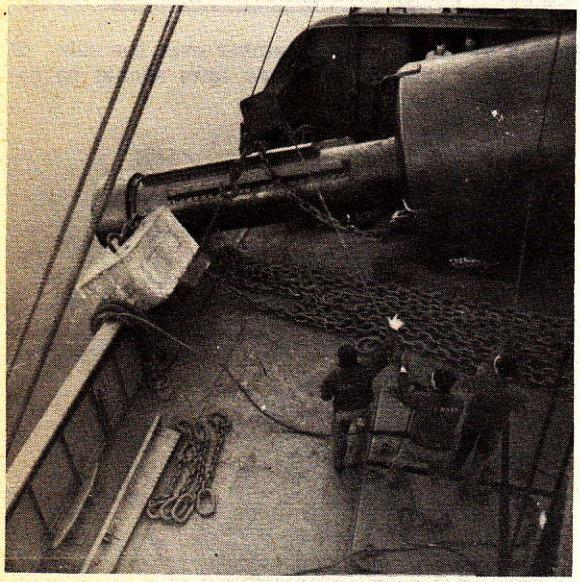

FIGURE 27–169.—Sinker being tripped on "teeter board." Dumping sling works in a similar manner.

(5) *Use of guard rail.*—Older tenders, equipped with guard rails around the vessel forward and aft of the buoy port, rest one edge of the sinker on the guard rail. This eases the strain on the stopper and prevents the sinker from swinging against the side.

(6) *Casting off stopper.*—Only an experienced and trustworthy seaman should tend the sinker stopper, and he should have no other duties at the time. When letting go a manila slip-stopper, throw all but the last few turns off the cleat, and let the weight of the sinker pull the remaining turn or so around the cleat. Do not attempt to throw off all the turns, as the heavy weight may cause the line to run out faster than you can cast the turns off, and it may foul your clothing, or an arm or leg. When the line starts to run, *throw the end clear and step back out of range quickly.*

(7) When setting buoys in inland waterways where close tolerance of accuracy is required and it is necessary to get the sinker exactly on the line of the dredged cut, sinkers are lowered close to the bottom before being stopped off.

E. *Tripping (teeter) board.*—Several tenders set their sinkers on deck at the edge of the buoy port on a tripping (teeter) board, to the back of which a lanyard or pendant is fastened for hoisting on the whip. This method obviates the need for hanging the sinker over the side and is a rapid method of dumping it overboard. It is quicker than the method of stopping a sinker off on manila line. In rough weather where there is danger of the sinker shifting around on deck, it is not recommended.

F. *Other various methods,* seldom used except on a few individual ships, include the following:

(1) *A dumping sling* for small sinkers is made of wood and rope, or iron pipe and wire cable. For the smallest sinkers, use a 4- by 4-inch almost as long as the sinker is wide. Bore two holes 4 inches from each end. Using 3½-inch manila, reeve both ends of a short length, which is double the width and height of the sinker, through the holes, and join the ends in a short splice. Seize the rope to form an eye in the bight. To use the dumping sling, lay the 4 by 4-inch just over the edge of the buoy port; holding the eye, lay the rope on deck, vee shaped; then set the sinker on deck on top of the rope, flush with the outer edge of the 4 by 4-inch. Lash the sinker, if necessary, until ready for letting go. When ready to let go, hook the main or whip into the eye of the sling and heave the sinker over the side. The pipe and cable sling is made and used in a similar manner for larger sinkers.

(2) *Lever device.*—One ship uses a lever tripping arrangement in which a wire strap is passed through the bail of the sinker, one eye secured to a padeye on deck, and the other eye hooked over the tripping lug. (See fig. 27–171.)

(3) *Set sinker on deck edge.*—Some vessels, in rough weather, place the sinker with about one-third of its bottom resting on the edge of the buoy port and the remainder of the sinker tilting out and down over the side. The sinker is held in this position by the mooring chain secured in a pelican hook. When placed in this fashion the chain may be easily secured in the pelican hook and the sinker is not liable to shift from the vessel's rolling. However, the sinker must be placed carefully and the pelican hook secured in the proper link of the chain to balance the weight correctly; otherwise, the sinker might slip out of position.

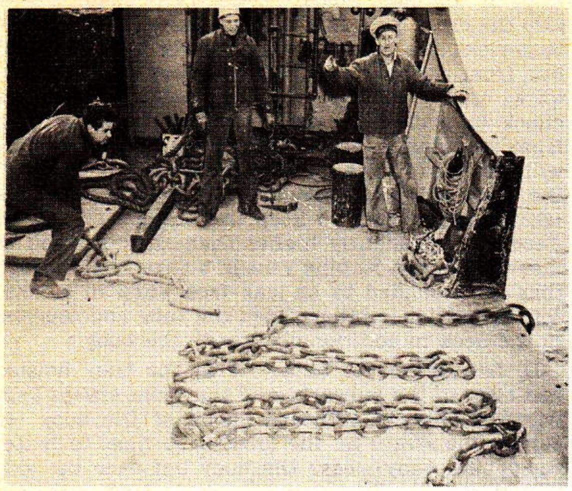

FIGURE 27–170.—Sinker has just been tripped free. Note that men stand well clear of the chain whipping over the side.

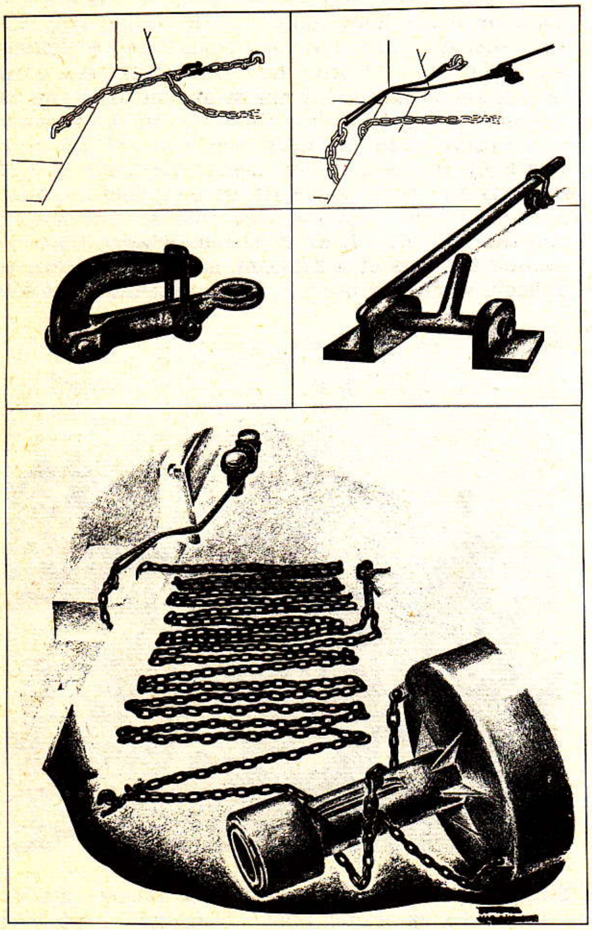

FIGURE 27–171.—A partial summary of devices used for tripping sinkers: Pelican hook, wire strap and tripping lever, and a manila slip stopper.

(4) *Heaving overboard by line.*—Another method of tripping a sinker overboard is to set it on the edge of the deck in the buoy port and lead a 5- or 6-inch line from the windlass cut through the forward chock of the buoy deck, back through the buoy port inboard around the sinker, back out the buoy port and in through the after chock and secured. Heave the line on the windlass and the sinker is pushed overboard. Be sure to lead the heaving line so that the mooring chain will not be fouled as it runs out. Some tenders use a length of wire rope for that end of the line which crosses the buoy port behind the sinker. This gives added strength and resistance to wear from the mooring chain as it runs overboard.

27–5–25 Setting Large Lighted Buoys Overboard—

A. The handling of the 9- and 10-foot lighted buoys at sea is difficult, and potentially hazardous when done under rough conditions. It requires more careful planning and quick thinking than any other type of buoy work when working in a seaway. Extreme care must be exercised to keep the buoy under control at all times. There are a number of methods of placing large lighted buoys over the side and recovering them aboard in use in various areas. Most of the tenders in a certain area usually handle the buoys in much the same manner, because of local conditions and other factors which influence the work. Several of the methods will be described below. Large lighted buoys (9- and 10-foot types) may be carried fore and aft on deck, one on each side of the tender, with the lanterns heading forward or aft. The majority of ships prefer to carry the lanterns aft. The available space and arrangements on deck may govern this choice. In certain areas where conditions are severe, only one large buoy is carried at a time, so as to permit the maximum use of deck space.

(1) Several tenders carry the buoy athwartships in-between the buoy ports. Although the buoy is easier to slide overboard from this position, much valuable deck and working space is lost, and a large load of other buoys cannot be carried.

(2) Use ample steadying lines when moving a buoy around on deck. It is not recommended to move large buoys around the deck at sea in rough weather. Should a buoy get out of control at sea, and all means of getting restraining lines on it fail, the boom may be dropped onto it to wedge it over to one side or up against another buoy until lashings can be passed.

Note: The following description is made from the point of view of a tender having whip, main, and relief hoisting tackles, one of which must be used for a power vang. The class B and C 180-foot tenders need no power vang, and will be considered for discussion purposes to have a main (forward purchase) and a relief (after purchase).

B. *Procedure, buoy lying fore and aft.*—To place a large lighted buoy overboard while in the fore-and-aft (lantern end aft) position on deck, proceed as described below:

(1) Assume that the mooring has been made up, bridle attached, chain ranged out on deck and stopped off, and the sinker hung or otherwise prepared for tripping. Some ships drop the sinker on station before hoisting the buoy out over the side. (The buoy end of the mooring must be securely stopped off with sufficient slack remaining to permit the buoy to be hoisted overboard.) Others hoist the buoy out and hold it griped in tightly against the ship's side, but not water-borne, before dropping the sinker. Bring the ship's head around to the seas, or put her on the easiest riding heading, in order to minimize rolling. Have all cross-deck lines and other gear broken out and ready for use. Do not remove the chain and turnbuckle lashings from the buoy until actually ready to hoist it over the side.

(2) Top the boom up over the buoy so that the main tackle hangs over the lower lifting lug on the buoy body. Hook the main in and take only the slightest strain, just enough to keep the hook from coming free. Be careful not to raise the weight of the buoy at this time, thus disturbing it in its chocks. Hook the relief into the lifting lug at the top of the buoy body (the words top and bottom as used in this connection apply to the buoy body as viewed when in a floating position. (Some tenders have found that using a short ⅞- or 1-inch wire strap with an eye in each end, passed through the lifting lugs, between the buoy and the hoisting tackles, makes it much easier to unhook the heavy blocks when the buoy is water borne. See figure 27–175.

(3) Pass a 3½- or 4-inch manila headline through the cage of the buoy and tend both ends on deck around a cleat, the men being ready to surge or pick up slack as necessary. The reason for tending both ends on deck is to make it easier to cast off when the buoy is finally launched. Some tenders use a single heavier line made fast to the cage. If using a single line, be sure to tie a large bight so that the knot can be easily reached from the deck for casting loose.

(4) Rig a 6-inch cross-deck line from the windlass through a snatch block on deck to the tube, shackling it to its own part around the tube. This line is removed after the buoy is griped in alongside the ship after being hoisted out.

(5) Rig another cross-deck line to a lug, other than the one used for hoisting, on the top of the buoy body. These cross-deck lines should be led at angles that will best restrain the fore-and-aft surge as well as the 'thwartships roll of the buoy when it is hoisted. Crossing the leads of these lines will help to achieve this; also, leading them in opposite directions. Trim the boom outboard (3 feet or so), so that a slight angle exists between the main and the vertical above the lifting lug. This is so that when the buoy is hoisted, the slight outboard pull, in addition to the upward lift, will keep the buoy taut against the cross-deck lines which will be holding back. Be sure that the hoisting tackle does not lead forward or aft, however, as otherwise the buoy will slide forward or aft when it is raised from the deck.

C. *Hoisting the buoy.*—Cast off the lashings and hoist the buoy slowly on the main and relief together. The relief would ordinarily tend to pull the head of the buoy inboard toward the boom, therefore the cross-deck line on the tube must be tended to prevent this. Some tenders prefer to have a stout line from the cage led from the buoy over the bulwarks on the working side, and back in through a chock to a cleat on deck, to prevent the lantern from swinging in against the boom. The headline will also steady the lantern end of the buoy. Lift the buoy only high enough to clear the bulwarks. (Some ships prefer to keep the lantern end of an electric buoy slightly higher than the tube end to insure against a leaking vent in a battery (although they are designed to be leak-free when in a horizontal position); others keep the tube end touched to the deck to additionally steady the buoy.)

D. *Launching the buoy.*—With the buoy hoisted just clear of the bulwarks and the boom always kept trimmed slightly outboard ahead of the buoy (to permit the strain on the cross-deck lines to better steady the buoy), ease the buoy out over the side and as soon as clear, lower away on both tackles a few feet, immediately trimming the boom well inboard so as to gripe the buoy in against the side of the ship. Do not lower the buoy so as to be water-borne at this time. If the buoy is sufficiently griped in, the cross-deck lines may be removed. Lower the main until the buoy hangs on the relief, still not water-borne. Clear the main from the lower lifting lug. The whip (if any) has meanwhile been used as a power vang, to take the strain on the boom as the buoy is eased out over the side. Hook the main in a padeye in the deck to keep it out of the way. The buoy is now hanging nearly vertically and if the lens and color shade (if an acetylene lantern) have not already been installed, they are put in now, and the buoy lit. It must be remembered that installing the lens of a 375-mm. acetylene lantern is difficult when the buoy is in a horizontal position

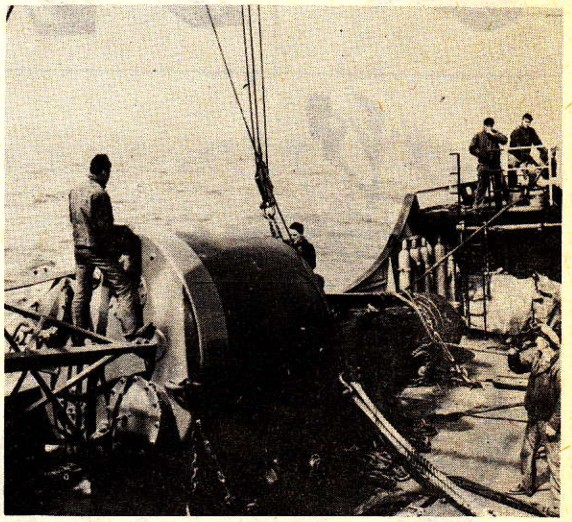

FIGURE 27–172.—Hook one lifting tackle (main) into a 9 x 38 lighted buoy. Note that turnbuckle lashings have not been removed yet. Note also that two tube lines are going to be used to steady the buoy.

(small wedges can be used to help hold it in place while the top is closed), therefore most tenders wait until the buoy is over the side before installing the lens. In the case of a 9 x 38 buoy hanging overboard on the relief after the main has been removed, due to its length, the counterweight on the end of the tube may be directly under the sinker. It is therefore necessary to top the boom up until the sinker is clear to drop freely.

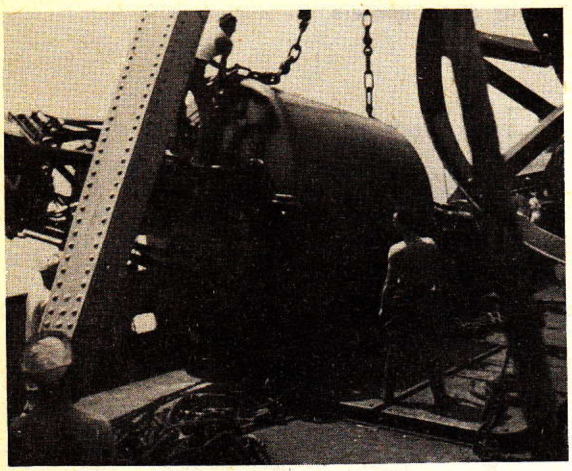

FIGURE 27–173.—Hooking in relief, preparatory to lifting buoy over the side on the main and relief. Note mooring chain ranged out under the buoy tube.

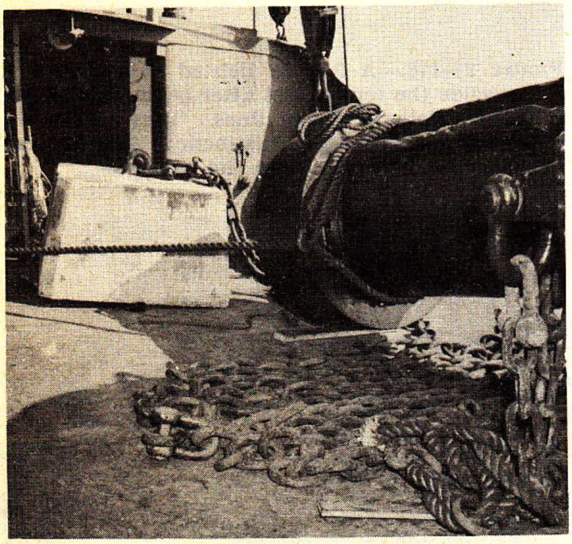

FIGURE 27–174.—Cross-deck line shackled around buoy tube.

E. *Clearing away the buoy.*—If the sinker has not already been dropped, maneuver the ship on station and drop the sinker. Take care that when the last bight of chain goes flying over the side it doesn't strike the buoy. A bight of chain can tear the hold-down bolts off the pocket cover. If the boom is topped up so that the buoy hangs abaft the buoy port, there will be no danger of this. Lower the relief and clear it from the buoy. Lower rapidly, but just as the buoy becomes water-borne, slow the lowering momentarily so that the buoy will not rise up sharply and strike the ship. A jar may extinguish the light, if not break the lens or color shade. Cast off one end of the headline and haul it aboard, reeving through the cage. Some vessels actually float the buoy and clear the hoisting tackle before dropping the sinker, holding the buoy alongside with the headline. Just before the buoy is cleared, the ship should be put on the most favorable heading for backing away quickly. This is particularly important in rough weather, since during every second the ship remains alongside once the buoy is loose, there is potential danger of striking the buoy and doing damage. A buoy should not be released while the chain tends under the ship, as the buoy may be crowded forward along the hull with danger of bumping or fouling the anchor.

F. *Following are some miscellaneous notes:*

(1) *Balancing pendant.*—Some vessels pick up the buoy with the main only in the lower lifting lug, using a balancing pendant hooked into the block

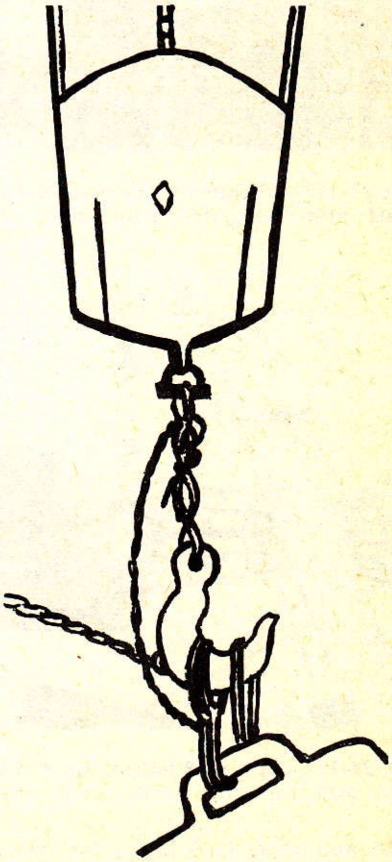

FIGURE 27–175.—A wire strap used for hoisting a large lighted buoy.

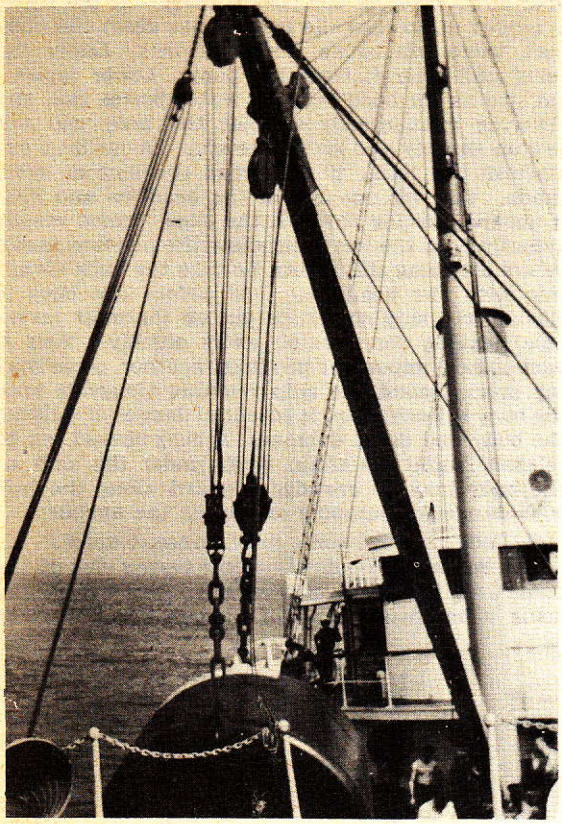

FIGURE 27–176.—Picking up the buoy on the main and relief, preparatory to placing it over the side.

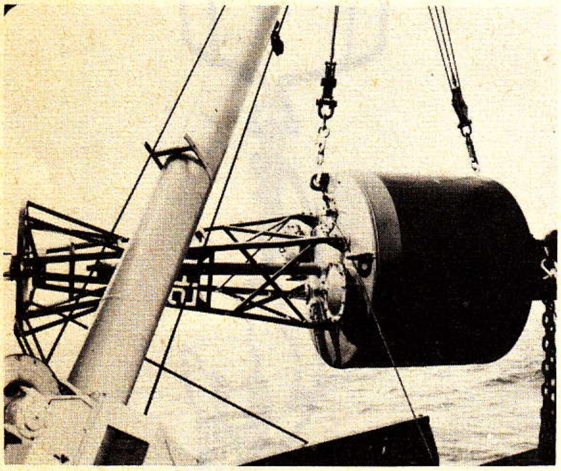

FIGURE 27–177.—A 9 x 38 lighted buoy being hoisted out over the side. Note stout headlines.

shackles and upper buoy lifting lug (9 x 32B buoys, when picked up on one tackle only, must have a balancing pendant; 9 x 38's may or may not have it). When the buoy is lowered into the water, the balancing pendant comes slack and can be easily unhooked. When the main is hooked in this manner, the use of a large shackle between the hook and the bottom lifting lug will make the unhooking easier (some later-type buoys have lifting lugs sufficiently large enough to make the shackle unnecessary). However, unhooking the main block from the lower lifting lug of the buoy when water-borne, can be unwieldy, and the use of a wire strap as discussed in paragraph (2) below, or holding the buoy by the upper lifting lug on the relief as described in paragraph (D) above, is considered a better practice by many tenders.

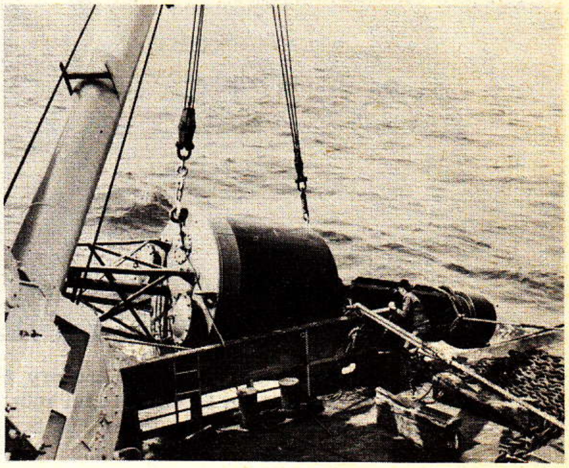

FIGURE 27–178.—A 9 x 38 lighted buoy griped in alongside the tender just after being hoisted outboard. Note steadying lines. They will be removed before the buoy is launched. Man is clearing section of bridle from the bulwarks.

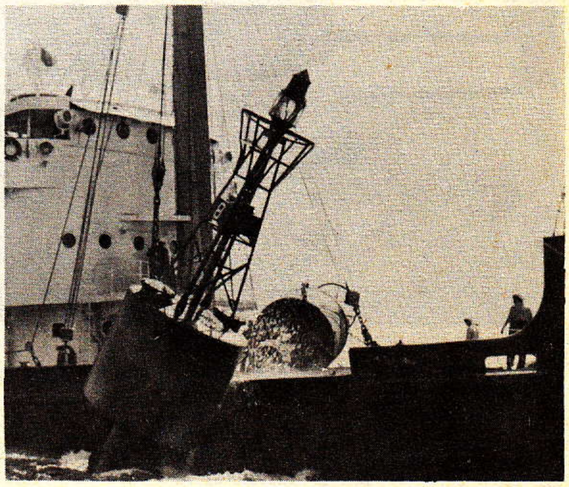

FIGURE 27–179.—A 9 x 38 lighted buoy held alongside a 189-foot tender just before being set on station.

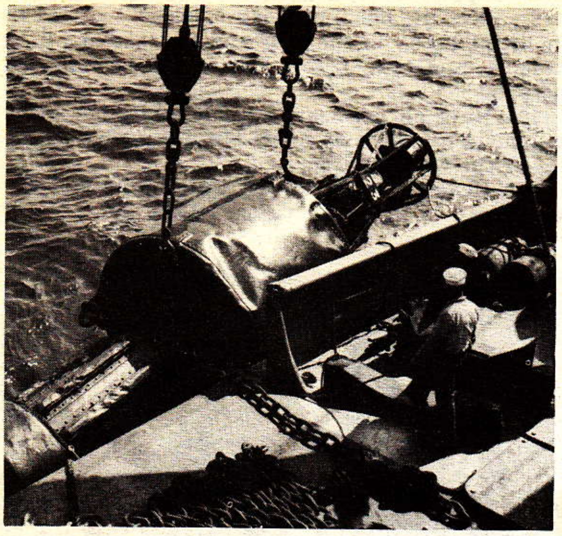

FIGURE 27–180.—Another view of a large lighted buoy hung alongside on the main and relief, just before lowering and clearing the main. The buoy will then be held alongside on the relief until the tender maneuvers on station.

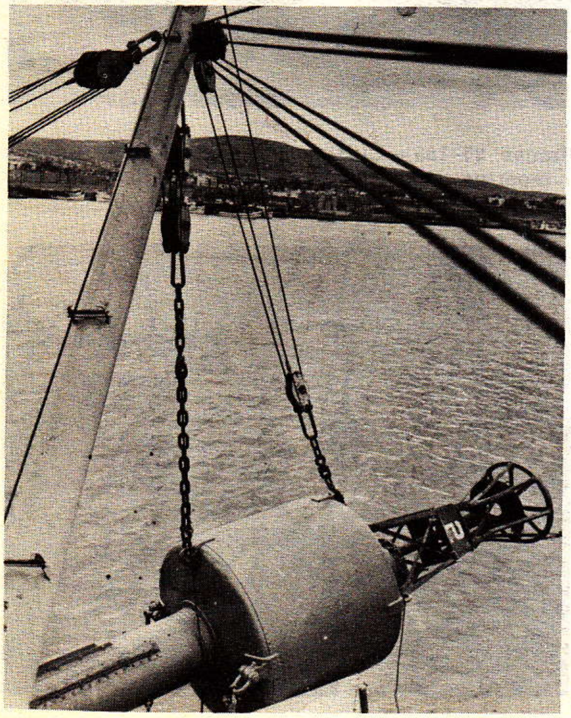

FIGURE 27–181.—A 9 x 38 lighted buoy hung, lantern end forward, over the side on the main and relief, preparatory to lowering and holding on main only. Most tenders prefer to work with the lantern aft. It is unnecessary to use a length of chain between the relief and the lower lifting lug such as in this photograph.

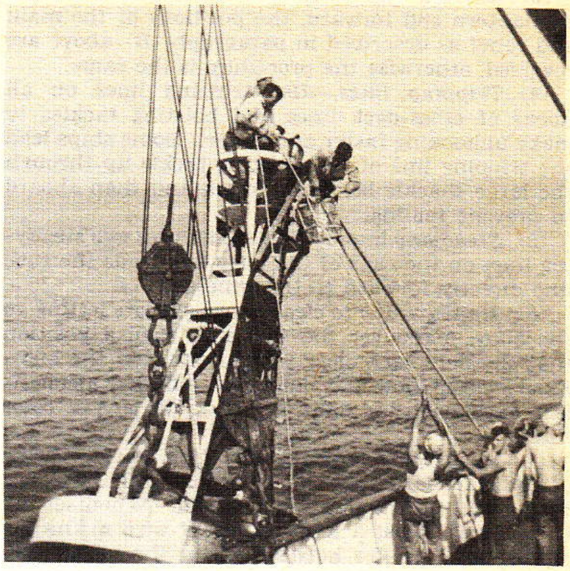

FIGURE 27–182.—Buoy hanging on relief. Installing lens and color shade.

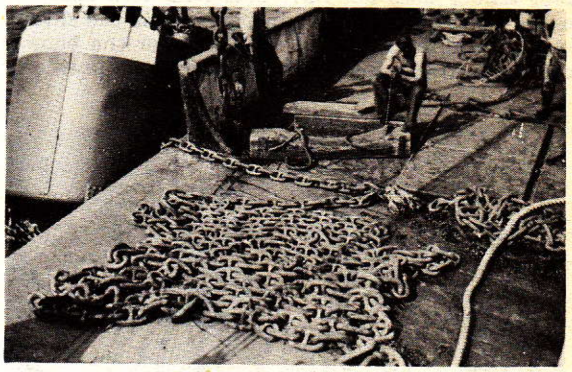

FIGURE 27–183.—Mooring chain ranged out on deck. Buoy hanging on relief. Generally, this amount of chain should be stopped off somewhere along the middle as well as at both ends.

(2) *Wire strap for easier unhooking.*—Some tenders use a heavy wire strap in the lower lifting lug, and pick up 9 x 38 buoys on the main only, keeping the relief hooked across the deck for a power vang. The strap may be ⅞- or 1-inch diameter plow steel wire rope, 8 feet long with a 1-foot eye in each end. A 2-inch manila line is spliced through the eyes and secured to the chain above the hook, enabling the strap to be recovered after use. The bight is then passed through the buoy lug and looped over the end of the hook. Because the wire is stiff and springy, the bight disengages when the strain is released as the buoy becomes water-borne. A 9 x 32 buoy cannot be handled in this manner. Vessels not having the double topping lift, and requiring the whip as a power vang, must use manila guys to back up the whip, and should let the cross-deck lines help ease the athwartships strain off the whip.

(3) *Lantern end forward.*—When working with the lantern end forward, the positions of the main and relief as described in paragraph (B) above are reversed, otherwise the procedure is the same.

(4) *Tripping lines.*—Use tripping lines on all hooks of cross-deck lines and hoisting tackles to make unhooking faster and easier. Some ships lead the tripping line of the hoisting tackle up through the large shackle below the block and then aboard to prevent fouling.

(5) *Steadying lines.*—One tender uses two steadying lines on the cage of the buoy and leads the tube line directly forward to the windlass.

(6) *Maneuvering to clear buoy.*—Before letting go the buoy. maneuver the ship into such a position that she may back clear without striking the buoy. Even a slight blow may damage the flasher mechanism, extinguish the light, or break the lens or color shade.

(7) *Identifying lugs on older type buoys.*—Some of the older large lighted buoys may only have two lifting lugs on the upper buoy head. When setting these buoys, twist a few strands of wire in the lug you want to use for hoisting out at the next relief. This will be on the side which has chafing battens on the tube.

(8) *Nine-foot buoy on 189-foot tender.*—The 189-foot tender does not have sufficient deck space to carry a 9 x 38 buoy fore and aft unless the shroud on the working side is disconnected, or the buoy is canted with the tower outboard of the gunwale or the tube projecting along the outboard passageway.

(9) Have the hoisting tackle hook(s) inserted in the lifting lug(s) of the buoy and all steadying lines attached and taut, before taking the lashings off the buoy.

(10) Have all necessary or potentially necessary equipment and gear at hand, but not strewn in the way of the working area.

(11) Have the buoy almost waterborne and the vessel dead in the water before letting go.

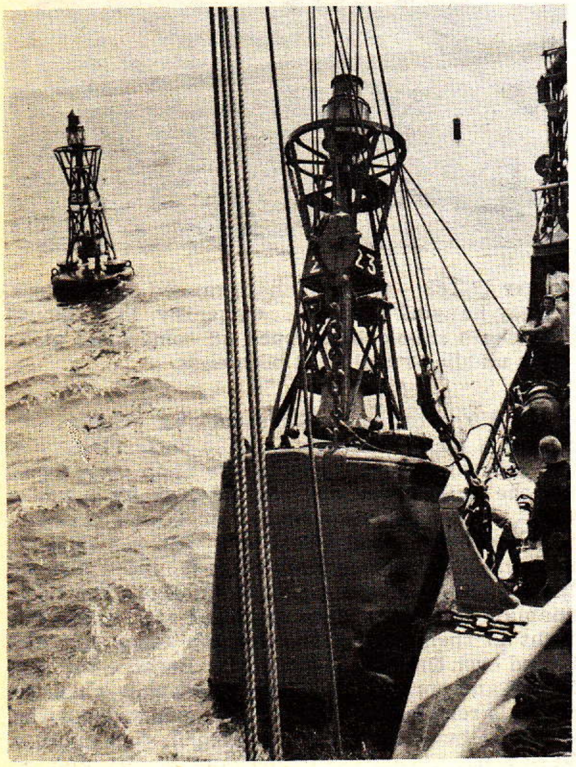

Figure 27–184.—A 9 x 32B lighted buoy held alongside on the relief just prior to releasing sinker and mooring chain.

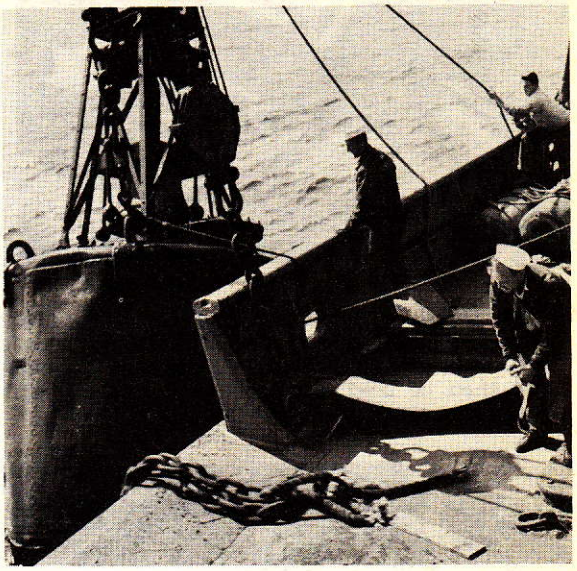

Figure 27–185.—Cutting the last stopper on the mooring just before lowering the buoy in the water.

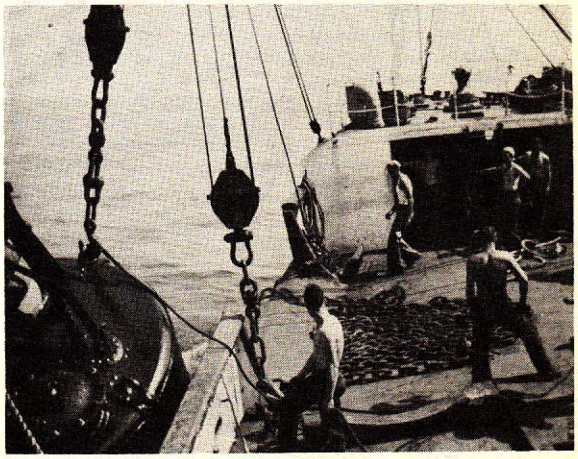

Figure 27–186.—Tender on station, sinker tripped and chain running overboard. When chain is clear, buoy will be lowered, tackle unhooked, and ship backed away. This amount of chain on deck should not be permitted to run off without restraint of stoppers along the middle as well as at both ends. Men should stand back well clear of the chain.

(12) Make sure that all gear is free to run without fouling, and keep a minimum of personnel on the buoy deck.

(13) Check the characteristic of lighted buoys again immediately before setting them.

G. *Procedure, buoy lying athwartships.*—Large lighted buoys may also be carried and worked athwartships in the way of the buoy ports, or they may be swung from a fore-and-aft stowage position around to a working position athwartships. When the buoy is secured in the working area in the way of the buoy ports, the tube is at or just over the edge of the buoy port and the buoy is securely griped down in chocks or a cradle by lashings and steadied by cross-deck lines. Launching procedure is given in the following paragraphs.

H. *Preparation.*—When ready for launching, the main is hooked into the upper lifting lug of the buoy. The boom operator must be careful, when picking up the slack of the hoisting tackle, not to disturb the buoy in its cradle. Set the boom so that the lead of the main is slightly outboard of the vertical over the lifting lug but not forward or aft of the buoy. This will cause the buoy to slide outboard through the buoy port when lifted. The cross-deck line will hold back on the buoy, thus steadying it.

I. *Launching.*—When the word is passed to set the buoy over the side, cast off the lashings and hoist handsomely on the main until the buoy body clears the chocks. Do not raise the buoy high. Let the tube slide along the edge of the deck. Once the end of the tube is outside the buoy port, lower the buoy body closer to the deck, *but never allow it to touch the deck, as the hoisting tackle might accidentally unhook.* Have 6-inch cross-deck lines rigged somewhat as follows: One line leading from a padeye on the top of the buoy body opposite the lifting lug (a chain sling may be passed around a tower leg if there is no padeye available) athwartships through a snatch block hooked into a length of chain stretched across the opposite buoy port and then secured to mooring bitts. This line is paid out as the buoy slides overboard. The other two hook lines are secured to the tube, and one led forward and the other aft. Steadying lines (3½- or 4-inch) are rove through the cage and tended on deck at a cleat or padeye. As the buoy is slid overboard by trimming the boom outboard, the steadying lines are eased off until the buoy is out over the side. Lower the buoy a few feet (but not water-borne), and trim the boom in immediately to gripe the buoy in to the side of the ship. Cast off all steadying lines except the headline in the cage. Lower into the water at the proper time, unhook the hoisting tackle, cast off the headline, and back the ship clear.

Some tenders may use the relief instead of the main to hoist the buoy out.

J. *Power vang.*—In all cases of vessels not equipped with double topping lift-type booms, one of the hoisting tackles must be hooked into a padeye across the deck to serve as a power vang. This is generally one of the multiple purchases, unless they are both needed for hoisting, such as when fleeting in heavy chain, in which case the whip is used. It must be remembered not to overload the whip when used as a power vang. Keep the manila guys set up taut to back up the whip. Remember to tend the manila guys when trimming and topping the boom. Working heavy loads using the whip as a power vang may be made safer by doubling the whip, running it through a snatch block and securing it back to the upper end of the boom.

K. *Alternate method of leading cross-deck lines.*—It has been suggested, to help keep any tube-type buoy lying athwartships under control in rough weather, that the following method of leading cross-deck lines be used:

(1) Rig a 6-inch line to the buoy body leading athwartships to a snatch block in the usual manner. Make this line fast to the mooring bitts.

(2) Lead a 6-inch line with a whipped end from the anchor windlass down under the tube of the buoy (buoy is lying athwartships) through a snatch block secured to a padeye at the side of the main hatch, then back over the tube of the buoy and make fast to the mooring bitts forward on the working side.

(3) Set the boom as usual and hoist the buoy, setting taut the line over the tube. Slack the athwartships and the tube lines as the buoy slides overboard. When the buoy is over the side, heave taut the tube line, thus hogging the buoy tight alongside.

(4) Remove the athwartships line, work the ship around so that she will blow clear, and unhook the lifting purchase. When the ship is in a good position, let the whipped end of the tube line go and heave it clear with the windlass, backing the ship away.

L. *Method of clearing buoy in rough weather.*—In cases of rough weather, when there is danger of the ship's striking the buoy while getting clear, the following has been suggested: While the buoy is griped in to the side of the ship before lowering, run the end of a 6-inch line from the windlass out through a chock forward of the buoy port, outside of the buoy and under the flanges of the pocket or through one of the lifting eyes, back aboard through a chock aft of the buoy port, securing the end on deck. Then remove the cross-deck lines. If the sinker has not already been let go, work the ship into position and drop the sinker, at the same time turning the ship off the wind so that she will be set away from the buoy. The line can now be slacked off, and the buoy held at any desired distance away from the ship until the hoisting gear is unhooked. Slack the buoy away from the ship until well clear, then throw the turns off the bitts and slip the line. This same method can be used when servicing or relighting buoys in bad weather. The ship's anchor method of approaching buoys (see sec. 27–10–30) may be used in conjunction with the above.

M. When placing a buoy over the side from the athwartships position, or when holding it on one tackle, griped in alongside after being hoisted over from a fore-and-aft position on deck, the lantern may be swung either forward or aft as the buoy is griped in to the ship's side. Most tenders prefer to have the lantern aft, although on some vessels the lantern must go forward to prevent its striking the boom. If the tender is making way through the water, it is better to have the tube of the buoy leading aft (lantern forward).

N. *Under emergent conditions.*—There have been occasions where it was necessary for a tender to hang the sinker and buoy over the side while in protected waters, lashing it securely to the side, and then proceed to sea and drop it on station. This should be done only in emergencies, under extremely rough conditions, where it would be impossible to get the buoy safely over the side at sea, and where there is no other buoy to pick up.

27–5–30 Bringing Large Lighted Buoys Aboard—

A. The following paragraphs discuss the recovery of the relieved buoy by means of several methods, depending mainly on whether the buoy is to be stowed athwartships or fore-and-aft. Buoys may often be set overboard in weather too rough to safely pick them up, therefore buoy work should be undertaken with this thought in mind. Buoys will move during the course of a year's service and sea buoys are usually found far enough off station so that the new one can be set before relieving the old buoy. If the old buoy happens to be so close to station that there is danger of fouling, then it may be dragged off station sufficiently to permit safe setting of the new buoy. In many areas, buoys must be worked in the early morning hours before the prevailing winds make up.

NOTE.—In the following, vessels of the class B and C 180-foot tenders, not having three purchases (main, relief and whip), will be considered for discussion purposes as having a main (forward tackle) and a relief (after tackle). The description below will generally be from the standpoint of a boom equipped with three hoisting tackles, one of which must be used as a power vang.

B. *Preparation.*—The boom should be trimmed and topped so that the relief hangs in the buoy port at, or just inboard of, the deck's edge. The whip is generally hooked well aft on the gunwale of the working side to haul the boom over into position. The main is hooked into the deck to steady the boom. When the boom has been trimmed into position, the whip is shifted back across the deck to act as a power vang during the operation of hoisting the buoy. It must be remembered that when the buoy is hoisted out of the water, the ship will list, therefore the hoisting tackle should not be trimmed too far outboard, or the buoy will be allowed to bang against the side of the ship as she rolls in the seaway. It is assumed that all necessary deck gear, lines, etc., have been broken out ready for use.

C. *Hooking on.*—The buoy is approached by the ship (see sec. 27–10–35) and when close enough, a long boathook (pike pole) is used to haul the buoy close. Pass one or more 3½- or 4-inch headlines through the cage and tend both ends aboard. If the weather is such that this is insufficient to steady the buoy alongside, some vessels pass a heavy manila strap through the superstructure of the buoy and hook the whip into it to temporarily steady the buoy. The main is used for a power vang for the moment. Vessels not having a whip use the main. Other tenders use a wire strap or chain sling passed in the same manner; still others use a wire lasso over the tower of the buoy. In every case of steadying the buoy with a tackle, extreme care must be taken not to overstrain the whip or strap. The cage or tower is easily bent. When the ship is rolling, the boom operator must ever be alert to slack away to prevent the weight of the buoy from coming on the gear.

(1) When the buoy has been steadied alongside, and not before, some tenders put a man aboard to hook the relief into the center lifting lug on the buoy head. The man must be strong, agile, and experienced, and should wear a life jacket. He should be cautioned to keep his eyes open and remain on the outside of the buoy, away from the side of the ship at all times. Slack away the relief and have men tend it on deck to help the man on the buoy hook on. Take a slight strain to keep it hooked in and hold fast until the man has been safely removed from the buoy.

(*a*) *Caution.—Many experienced officers consider that the placing of a man aboard a buoy to hook on is unnecessarily hazardous under all conditions.* It is certainly not recommended when there are inexperienced personnel either on deck or on the bridge. The handling of the ship is very important at this time and any error of judgment can be disastrous.

(*b*) Often the hoisting tackle may be hooked in from the ship, using a tripping line made fast to the back of the hook to control the tackle, thus obviating the need for sending a man into a potentially dangerous position.

(*c*) *Pendant.*—A short heavy wire pendant, having a hook in one end and a thimbled eye in the other, is used by many tenders to fish the lifting lug of the buoy. The relief is then hooked into the pendant. However, some tenders do not have sufficient hoisting height available to permit hoisting the buoy over the bulwarks when hooked on in this manner.

(2) *Boathook.*—When a buoy is being approached by the tender, men are often overeager to pull the buoy alongside, and attempt to hook a boathook into the cage of the buoy before the ship has been steadied up and stopped. Should the ship be too far off the buoy for the man or two tending the boathook to pull it alongside, the men must be alert to get the boathook clear of the buoy in time, before it is pulled out of their hands. If you find that you cannot pull the buoy alongside, *push outward and twist* the boathook while you still have some of it left to push. This is the only way you can free it from the buoy and prevent seeing it float off, usually into shoal water where you cannot follow to retrieve it. It should be remembered that a number of men tailing on to a long boathook (pike pole) can often bring a buoy alongside where one or two men could do nothing. The main thing to remember is not to wait too long before getting it free.

D. *Hoisting the buoy.*—Hoist away on the relief, hauling on the headline to swing the lantern aft, until the lower lifting lug is within reach of the deck. Hook the main into the lower lifting lug, take a strain and hold it; lower the relief until the buoy is horizontal. If the main is raised instead, to bring the buoy horizontal, it may be too high and the lantern might tend inboard, making it difficult to adjust and secure the hook line on the counterweight end. Now the buoy may be brought aboard in either of the following manners:

(1) Any 9-foot buoy may be brought aboard horizontally, using both main and relief. The whip, if any, is used as the power vang and must be backed up by manila guys and cross-deck hook lines (described below). Under certain conditions, the

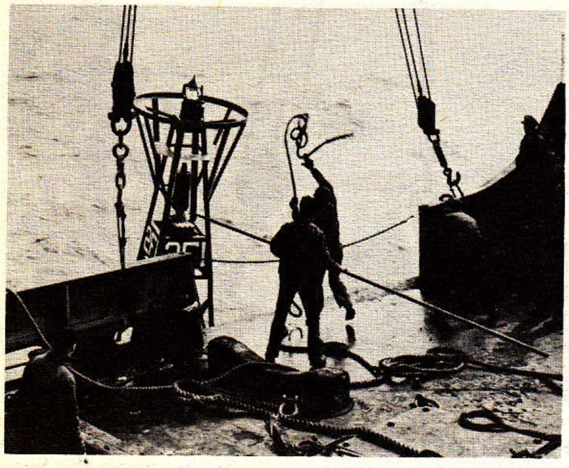

FIGURE 27–187.—Passing a head line into the cage of a lighted buoy, preparatory to hooking on the lifting tackle.

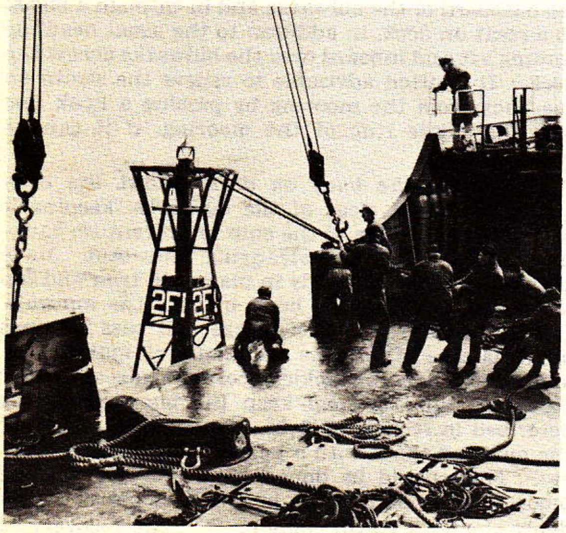

FIGURE 27–188.—Holding a 9 x 38 lighted buoy alongside with the cage line while attempting to pass a chain sling around a tower leg for hooking on a tackle to steady the buoy, while the lifting tackle is hooked into one of the lifting lugs. The chain sling can be easily lost overboard. (See text for other methods of steadying a buoy while hooking on the lifting tackle.)

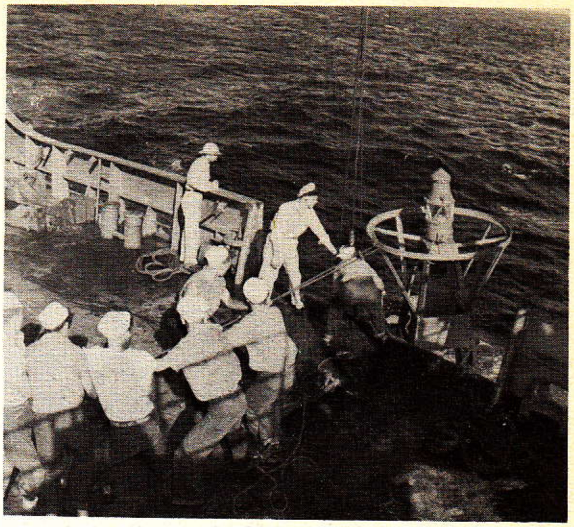

FIGURE 27–189.—Steadying a buoy alongside while man on buoy hooks the hoisting tackle in a lifting lug. There are not generally as many men available for work on the buoy deck as shown in this photo. Placing a man on a buoy is not recommended if the buoy can be hooked otherwise.

FIGURE 27–190.—Steadying the buoy with a strap passed through the cage and hooked onto the whip. This method can bend the cage if too much strain is permitted.

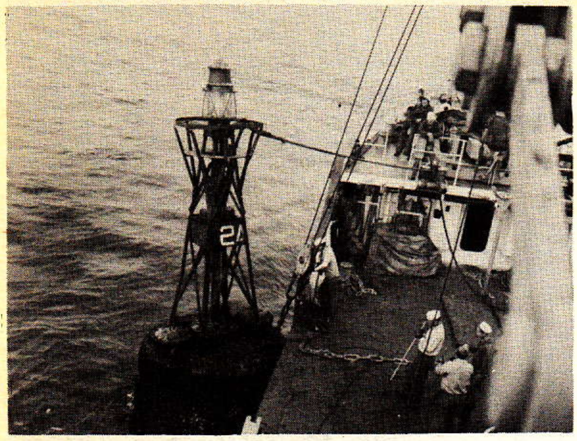

FIGURE 27–191.—A 9 x 38 lighted buoy just after being hooked on with the main. Note steadying line from the cage led to the windlass. A pelican hook for stopping off the mooring lies on deck in lower center. Cross-deck hook line has not yet been secured to the buoy.

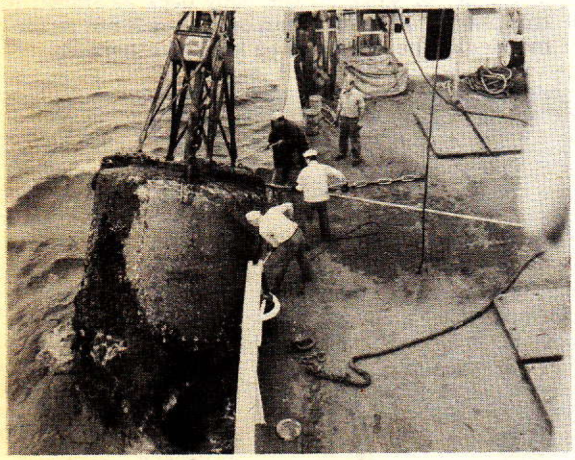

FIGURE 27–192.—A 9 x 38 lighted buoy held alongside while sea growth is cleaned off. Note cross-deck hook line holding buoy steady.

strain may be too great for the whip to heave the boom in. Take care not to overload the whip.

(2) If a 9 x 38 buoy, the relief may be unhooked once the main has the strain, and led back across the deck for a power vang. The whip may be led aft on the working side outboard of the main and relief to steady the boom, or it may stand by to hook into the mooring later.

(3) If a 9 x 32B buoy, a balancing pendant or sling must be used between the top and bottom lifting lugs, and the main hooked in at the balance.

E. *Steadying lines.*—In either event, when bringing a buoy aboard horizontally, lying fore-and-aft, a 6-inch cross-deck hook line is passed around the tube and led through a snatch block across the deck to the windlass. Another 6-inch cross-deck line may also be led to a lug on the upper buoy head for steadying. Some ships use an additional headline led outboard of the bulwarks and in through a chock to a cleat on deck, in addition to the usual headline leading aft and inboard over the bulwarks across the deck. It is often advisable to relieve the strain on the buoy from the mooring by passing a hook line into the bridle ring of the mooring, if it can be reached.

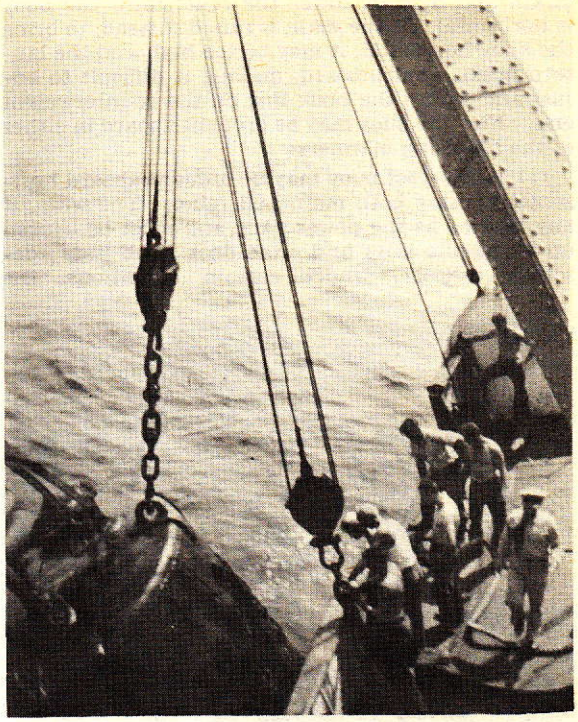

FIGURE 27–193.—Initial hoisting on the relief. Main will be hooked into lower lifting lug when the buoy has been raised higher.

F. *Landing the buoy on deck.*—Hoist the buoy slowly until just clear of the bulwarks, keeping it griped in to the side of the ship to prevent its banging around. Keep the steadying lines taut. Have the cradle or chocks ready in place and trim and top the boom to bring the buoy in over the gunwale. Lower the buoy into the chocks and pass lashings immediately. The same technique of making the angle of the hoisting tackle oppose the tube and other steadying lines to help keep the buoy steady, as described in section 27–5–25, can be used. Stop off the mooring chain with a pelican hook, or the whip, etc. This should be done at once to prevent the mooring from pulling the buoy out of position suddenly should a strain come on it. The recovery of the mooring chain will be treated in section 27–5–45.

G. *Caution.*—During the time of hooking on and hoisting aboard, the conning officer must maneuver the ship to keep the mooring chain up and down, or leading slightly under the ship with a minimum of strain. Keep the ship on the easiest possible course to minimize rolling, especially while the buoy is being brought in over the gunwale. A man should be stationed well forward out of the way to watch and report the tend of the chain. He should be trained to volunteer the information frequently without having to be asked each time.

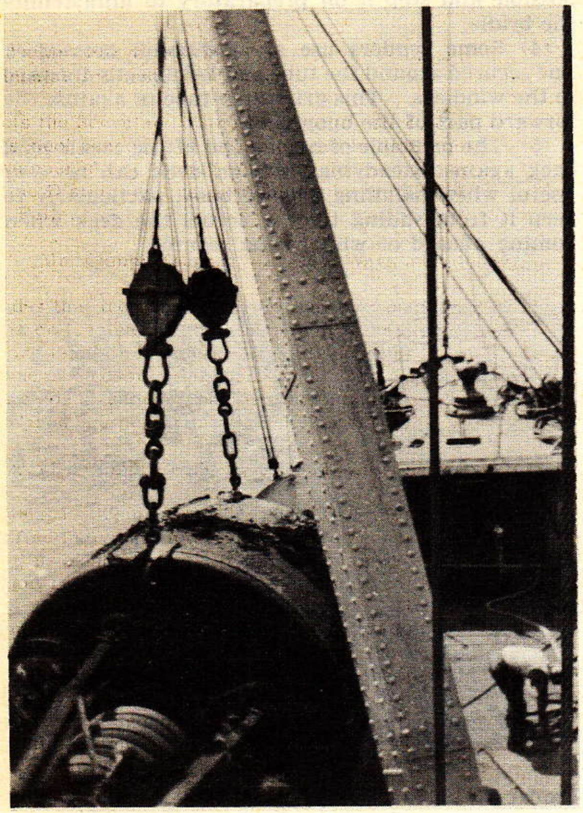

Figure 27–194.—Main and relief lowering the buoy into chocks on deck.

H. *Large lighted buoys may also be picked up and brought aboard athwartships.*—If the ship is rolling severely, this may be the safer method. When calmer water is reached, the buoy may then be shifted fore-and-aft to give more room on deck. Buoys are approached and steadied alongside in the manner as described in paragraph (C) above. The main is used for lifting the buoy, and is hooked into one of the side padeyes instead of the center of the three lifting lugs on the buoy head. This is so that the opposite padeye will be available for hooking in a cross-deck steadying line when the buoy comes up on deck. Some tenders lift from the center padeye and use hooklines in both side padeyes. This practice does have an advantage of having both upper and lower lifting lugs on top of the buoy. The boom is trimmed inboard sufficiently to keep the buoy griped in against the ship.

(1) As soon as the buoy is hooked and the man (if any) clear, hoist smartly until the buoy is clear of the water and the buoy head level with the deck. Hook in a 6-inch cross-deck line to the padeye opposite the one used for hoisting. Lead this line on the forward side of the hoisting tackle, so that when the line is hove taut, the lantern will swing around forward to avoid striking the boom. The cross-deck line is led to a snatch block directly athwartships and thence to the windlass.

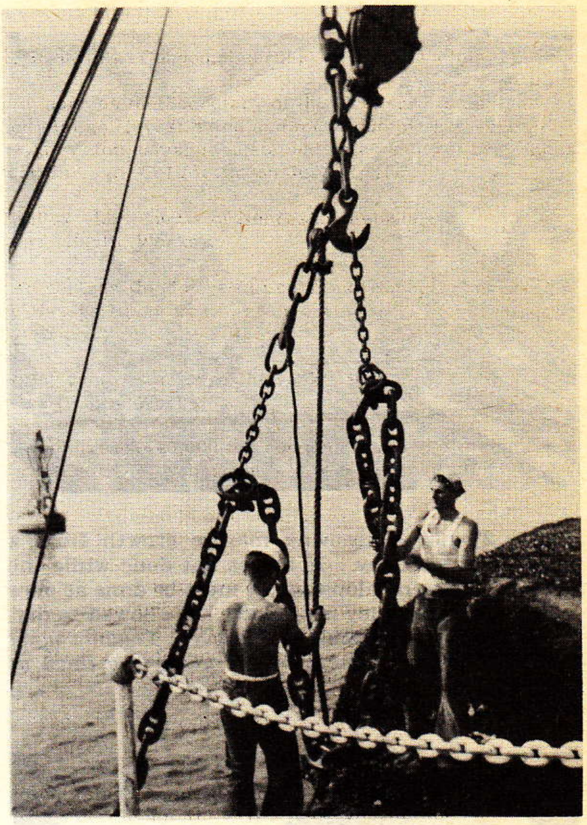

Figure 27–195.—Overhauling mooring chain hand over hand, using sling chains (old style) on the main and relief.

Figure 27–196.—Ranging out the mooring chain in neat bights and shackling into a padeye on deck as an extra safety measure is a good practice.

(2) Hoist the buoy until the lower part of the body rests on the edge of the deck, keeping the buoy steady with the cross-deck line and headlines which

were rove through the cage. Using the relief for a power vang (class B and C tenders need no vangs), trim the boom in, dragging the buoy athwartships across the deck through the buoy port. Keep all steadying lines taut.

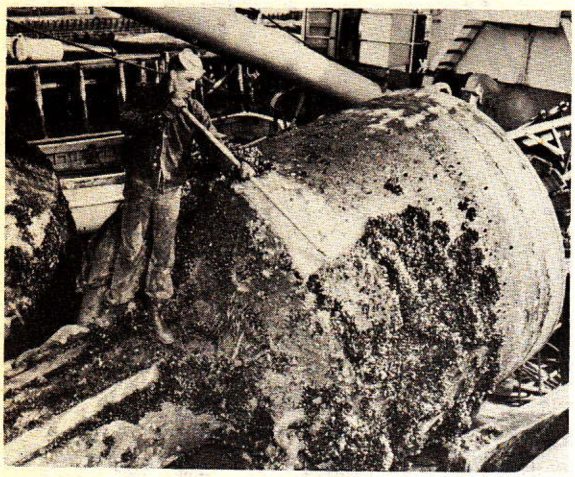

FIGURE 27–197.—Removing marine growth from a large lighted buoy. If this is not done while the buoy is hanging alongside, it must be done at once as soon as the buoy is on deck. If allowed to dry, the growth is difficult to remove. *Tenders must always clean off buoys before unloading them at a depot.*

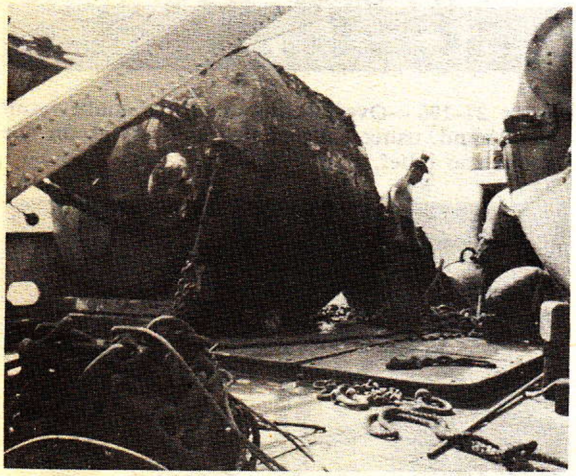

FIGURE 27–198.—Buoy stowed in chocks on deck and lashed down: End of relieving operation.

(3) Do not raise the buoy too high. The tube drags over the edge of the buoy port and helps to keep the buoy steady. Lower the buoy on to wooden chocks and secure immediately with lashings of suitable size led in four directions. Keep the main hooked into the buoy until it is safely lashed. Keep the hook line taut but do not depend on it alone to prevent the buoy from slipping back over the side. When passing lashings, do not assume that the lip of the tube projecting over the edge of the buoy port will prevent the buoy from sliding further inboard should the ship take a heavy roll. Secure the buoy in all directions. Hook into the mooring as soon as possible and stop it off preparatory to unfastening the bridle.

(4) Some tenders use an additional cross-deck line secured around the tube and led directly forward to the windlass. This gripes the tube in against the forward part of the buoy port.

(5) The principle of having the lifting tackle hold back against steadying lines on deck can be very useful when handling a large buoy, particularly to keep it from sliding too far across the deck when coming aboard or while being secured.

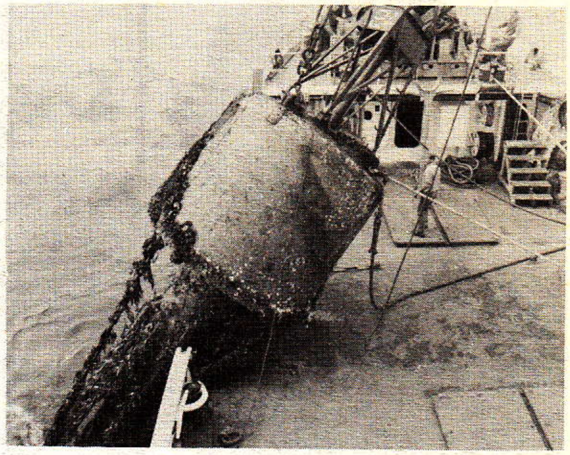

FIGURE 27–199.—A 9 x 38 lighted buoy is being broken in over the edge of the buoy port, hoisted on the main, steadied by two hook lines. The slack forward hook line should be kept taut.

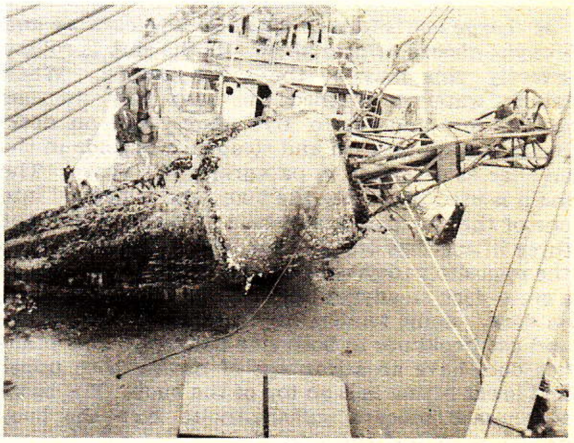

FIGURE 27–200.—The buoy has been hauled in on deck and is ready for lowering onto chocks and securing with chain lashings. Buoy tubes are often left hanging over the side until the chain is brought up.

I. *Following are some miscellaneous notes:*

(1) When unhooking a hoisting tackle from a padeye across the deck to bring it over to use on the buoy, be sure that it does not get loose and swing wildly around the deck, due to the angle of the boom and heel of the ship.

(2) Many ships mark the heel of the boom to indicate when a large buoy has been topped high enough to be in proper position for lowering onto the chocks on deck.

(3) As much of the sea growth as possible should be removed while the buoy is hanging alongside. Use long-handled scrapers. When cleaning a buoy before putting it ashore, do not forget to scrape out the inside of the tube as well as the outside of the buoy. A hoe with a curved blade to fit the contour of the tube could be made for this purpose. If an acetylene buoy is to be washed off with water to assist in cleaning off the marine growth, extinguish the light to prevent damage to the lens.

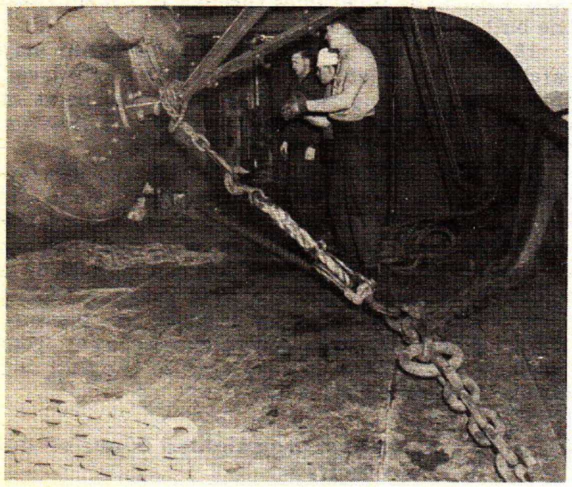

FIGURE 27–201.—When no padeye is available on the buoy, the hook line may be secured to the buoy by passing a chain sling around a tower leg. The snatch block is secured to a buoy bridle stretched across the buoy port.

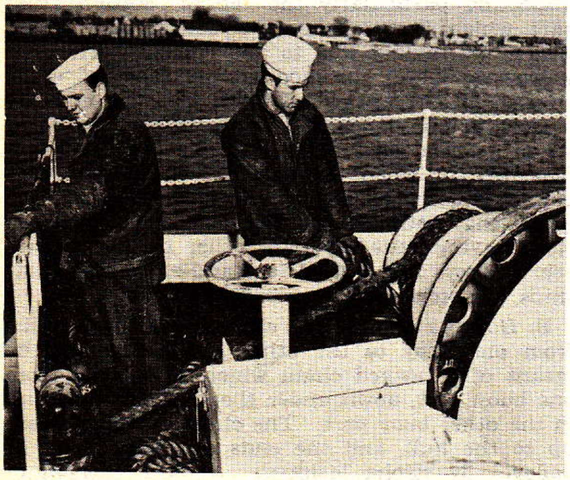

FIGURE 27–202.—Taking turns of a hook line on the gypsy-head of the windlass. Remember to alternate the direction periodically to prevent unraveling of the rope.

(4) The bridle should be cleared from the wooden chafing strips on the tube while the buoy is hanging alongside. A hookline may be tossed into the chain for this purpose, or passed on the end of a boat hook.

(5) When the whip is used as a power vang, heaving in on the tube or cross-deck line will ease the strain on the whip. The headline must be held to prevent the lantern end from swinging outboard.

(6) When the buoy has been lowered into the chocks on deck, with the buoy lying fore and aft, the tube line may be hove in to haul the tube inboard to clear more space in the buoy port for overhauling the mooring.

(7) The lens and color shade are generally removed while the buoy is hanging nearly vertically alongside.

(8) In rough weather, as an added precaution, another hook line may be passed into the chain below the bridle to keep the strain off the buoy while placing it in position on deck.

(9) Some tenders are so rigged, that when using the relief as a power vang while working one side of the ship, it will foul if used similarly when working the other side. In this case the main must be substituted for the power vang. Care must be taken to see that all leads of hoisting tackles are free and clear at all times.

(10) When possible, the headlines are rove through the cage opposite to the side where the lifting tackle is hooked in.

(11) Before sending a man on a buoy to hook on, be sure the man is wearing a life jacket, that the buoy is steadied, and the ship under control and not in danger of setting down on the buoy. Have men on deck tend the cables of the hoisting tackle to help the man on the buoy as much as possible.

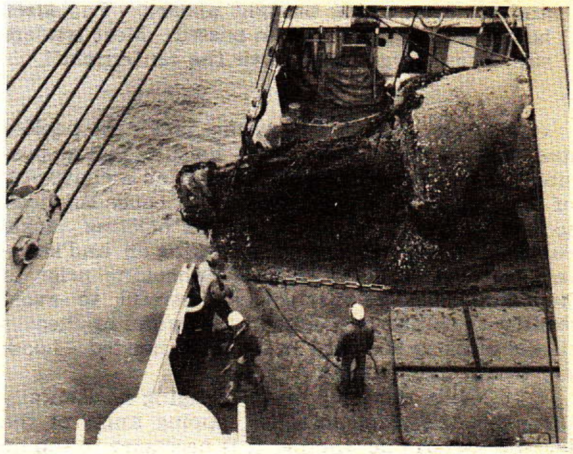

FIGURE 27–203.—Picking up the first bight of chain, preparatory to unshackling the bridle.

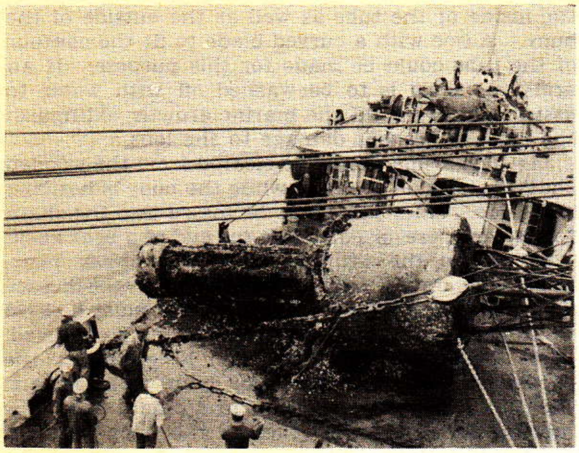

FIGURE 27–204.—The boom has been trimmed well across the deck to get as much lift on the first bight of mooring chain as possible, preparatory to unshackling the bridle. Note pelican hook secured to cross-deck chain to stop off the mooring.

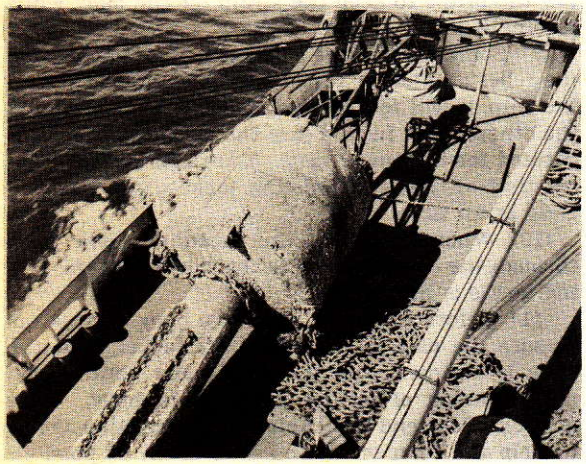

FIGURE 27–205.—A 9 x 38 lighted buoy stowed fore-and-aft after being brought aboard. The after lashings have not yet been passed. Most tenders stow these large buoys with the lanterns aft.

(12) When the first hoisting tackle is hooked *and the man clear of the buoy,* hoist as fast as possible until the buoy is out of water, as a sharp roll of the ship at the wrong time might cause the hook to jump free. Men holding the hoisting tackle cables to steady the tackle for hooking on, and keeping a strain on it to prevent unhooking prior to hoisting, must be particularly careful to avoid getting their hands caught in the cables or sheaves of the block as the buoy is suddenly hoisted. Loose gloves are dangerous.

(13) While the buoy is still hanging horizontally alongside the ship, note the topping angle of the boom to determine whether it is necessary to top up or down to have the buoy in proper position for setting down onto the chocks on deck. It is safer to top the boom while the buoy is hanging alongside.

(14) Keep the hoisting tackle(s) hooked into the buoy on deck until all the lashings have been passed. When unhooking the tackles, take care that they do not swing wildly around on deck.

(15) One method of passing the headline through the cage is to have someone on the forecastle head drop the end through the framework as the buoy comes alongside. The end is fished with a boathook when the buoy reaches the buoy port.

(16) If there is a station buoy (an unlighted buoy), it is generally relieved before the lighted buoy is picked up.

(17) When the buoy is being brought aboard athwartships, a 6-inch line may be passed around the tube and secured to the bitts foreward of the buoy port. The tube slides through this bight until the butt is aboard.

(18) There may be cases where the whip may safely hold loads which it cannot hoist. However, this circumstance closely approaches the point of overstraining the whip. When in doubt, use heavier tackle.

(19) When handling lighted buoys under ice conditions, pass a wire strap or chain lasso around the tower of the buoy to steady it alongside until the lifting lug can be chopped free of ice for hooking on the hoisting tackle. The lasso can be held by a 6-inch hookline on deck, or by a hoisting tackle. This procedure is necessary because the pressure of the ice field may often push the vessel away from the buoy, or cause it to heel over so far that the lifting lug cannot be reached.

27–5–35 Relieving Large Lighted Buoys on the West Coast—

A. Conditions on the West Coast bars are generally severe, and require the utmost caution in handling large buoys. The moorings are generally sanded in beyond recovery, making it necessary to shackle the new buoy to the old mooring, provided the mooring is in good condition. This is determined by hauling up the chain to short stay, and inspecting particularly the "chafe" section (that part which first touches the bottom and which wears out rapidly due to the constant friction). Worn sections of the mooring are renewed, using riveted-pin connecting shackles, and the mooring is used for another year. The complete mooring is set or relieved only when the buoy is established, relocated, or when the mooring has deteriorated beyond effective repair. For routine relief, this requires that both buoys be on deck for a short period, leaving little room for other buoys or spare gear. Buoys are carried fore-and-aft or athwartships, as described in a preceding section.

B. *Hogging chain.*—The exchange of the mooring from one buoy to the other is accomplished by means of a hogged chain which is run out from one buoy port, down under the ship, and back up in the other buoy port. The chain is hogged close up to the hull, and the ends are stopped off at padeyes by strong lashings. Allow a fathom of chain at either end for shackling to the bridle and to the old mooring. It is advisable to back up the lashings with a loosely placed shackle which can be removed later. The hogging chain consists of one shot of the same size chain as the mooring.

C. *Hooking on.*—The buoy is approached as described before, a steadying line rove through the cage, and a wire pendant with hook in one end and eye in the other is used to fish the middle lifting lug. The hoisting tackle (main or relief) is hooked into the pendant and the buoy is hoisted to the deck level. In calm seas, the buoy may be brought aboard by any of the methods described above for handling large lighted buoys. In rough weather however, or with a heavy swell running, the buoy is lifted until the bottom of the body rests on the edge of the deck. A fender is placed under the body to hold the buoy off the lower lug, and the buoy is set vertically in the forward part of the buoy port with the tube still in the water. This is called "standing the buoy in the buoy port."

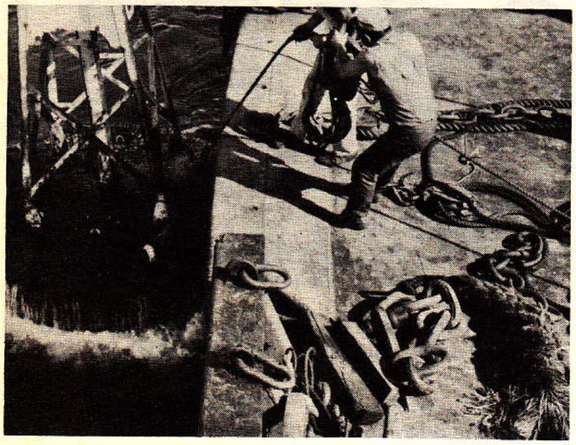

FIGURE 27–206.—Fishing a wire pendant into the lifting lug of the buoy. This obviates the need for a man to board the buoy.

D. A hookline is placed in the inboard upper lug, steadying lines are led forward and aft (if the buoy is jammed against the forward bulwark, there is no need for a steadying line aft, which incidentally would be in the way of handling the mooring chain), and a turnbuckle or tackle is secured in the lower lug to gripe the buoy tube in against the side of the ship. Some tenders use a wire pendant passed around the tube and secured on deck with a doubled 6-inch hookline or three-fold purchase. Some keep the main on the buoy to hold the strain. The fore-and-aft guy or steadying lines rigged to the buoy should be heavy enough to withstand considerable strain (6-inch) when the buoy is standing in the buoy port. The old buoy is left in this position until the new one is overboard. Then it is broken down on deck with the cross-deck hookline without further lifting, and is left secured athwartships until the ship reaches calmer water. Then the buoy can be safely picked up, shifted around, and cradled.

(1) This system of standing the buoy in the buoy port has also been used in reverse for setting buoys under heavy swell conditions. Before going out on to the bar, the buoy is stood in the buoy port, secured with a pelican hook turnbuckled to the bottom lug, and has steadying lines fore, aft, and athwartships. The sinker(s) are set in the opposite buoy port and the mooring chain hogged. When on station, the sinkers are dropped, the boom is over the buoy and tending slightly outboard with a slight strain on the hoisting tackle, the pelican hook is tripped, the buoy lifted clear and set in the water.

(2) One tender is experimenting with a modified version of this method for recharging buoys instead of bringing them entirely aboard.

(3) It has been found that a buoy "standing in the buoy port" has no tendency to tip inboard under all normal conditions of heavy swell in which a buoy may be safely worked.

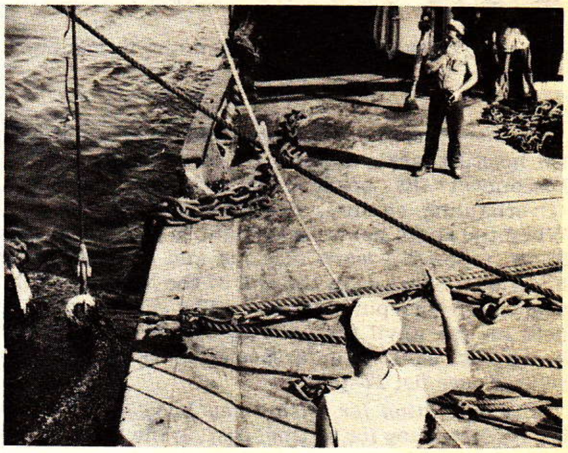

FIGURE 27–207.—Buoy is hoisted to deck level by the lifting pendant on the main. A double cross-deck hookline is secured by a wire strap to gripe the buoy in to the side of the ship.

FIGURE 27–208.—Buoy brought athwartships on deck. Note leads of two double cross-deck hook lines.

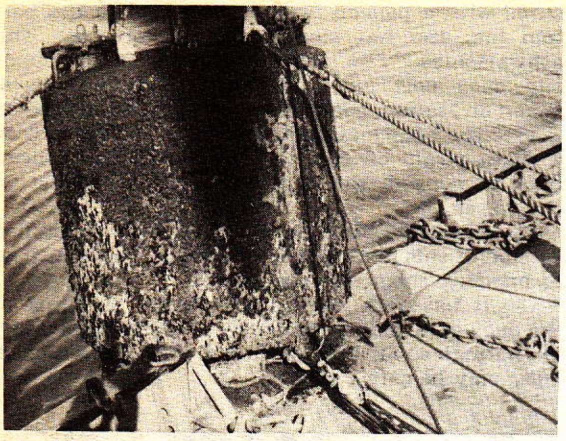

FIGURE 27–209.—Buoy is left standing in the buoy port.

E. *Disconnecting mooring.*—Fish the bridle with the hoisting tackle and stop off the mooring on deck. Disconnect the bridle and pick up the chain. (Overhauling chain is described in sec. 27–5–45.) When the chain has been brought to short stay, stop it off, renew all worn sections and unshackle the top shot. Shackle on the end of the hogging chain, using a riveted-pin shackle. (The shackle may be held on the anvil for peening by the use of chain hooks (fig. 27–156) or a special shackle anvil may be used (see fig. 27–157).)

F. *Preparation for setting new buoy.*—In preparing the new buoy for setting, postion the boom as described before. One ship uses a heavy wire strap rove through both upper and lower lugs and hooked on the main, which is centered over the body of the buoy. Both eyes of the strap are hooked on to the main with a retrieving line bent on to one eye of the strap. A cross-deck line is run through a lug on the buoy head and secured with one end fixed,

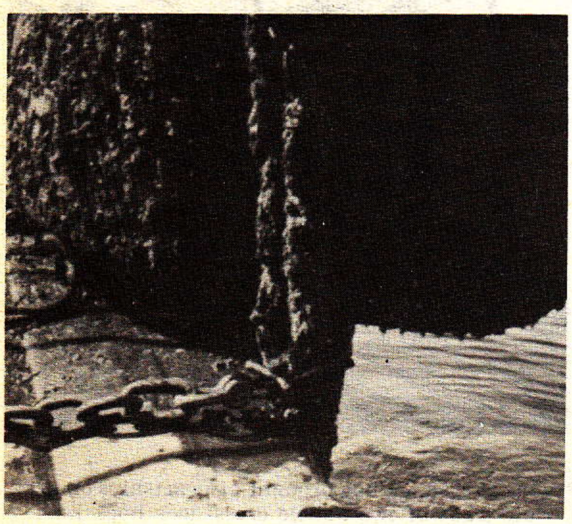

FIGURE 27–210.—Buoy standing in the buoy port, chain stopped off in a pelican hook.

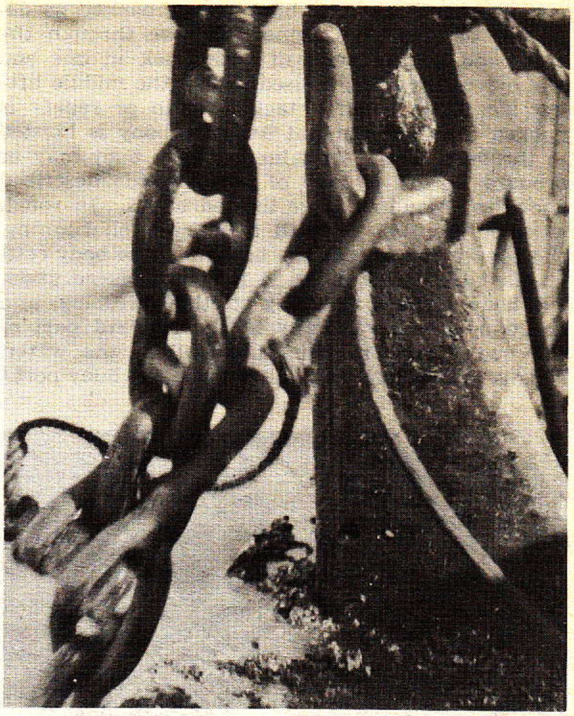

FIGURE 27–211.—Chain being hoisted by a special Modeer-type shackle. (See also Fig. 27–222.)

the other with turns for surging. A line is passed around the buoy tube and secured in a like manner. The headline is passed through the cage and both ends are tended on deck. Some tenders prefer to secure the cageline and have only one end to tend on deck. If so, be sure to tie a large enough bight so as to be able to reach it easily from the deck for casting loose later. A special fore-and-aft line is passed through a lug on the bottom of the buoy to prevent fore-and-aft surge.

G. *Setting the buoy overboard.*—Continuing the operation described in paragraph (F) above, the

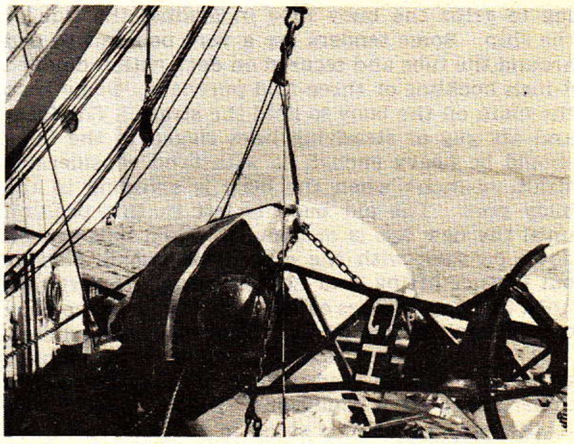

FIGURE 27–212.—A 9 x 38 lighted buoy on deck of an 189-foot tender, setting strap rigged.

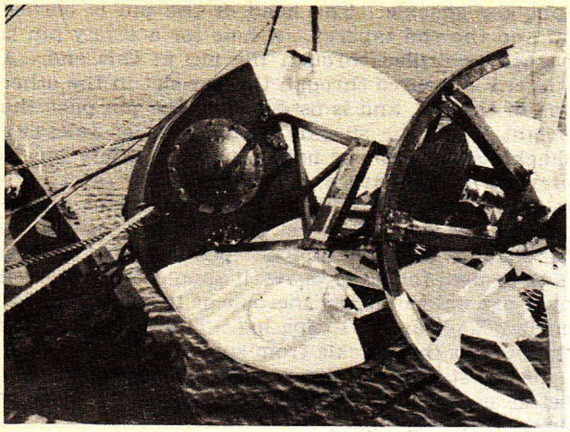

FIGURE 27–213.—Buoy being hoisted over the side. Note head, body, and tube steadying lines.

buoy is lifted with the main until above the rail, then boomed out and down, surging all lines until outboard of the gunwale. The buoy is then lowered on the main (with body and tube lines thrown off) until waterborne. As soon as the weight is off the setting strap, one eye is lifted off the hook, the main is run up, and the strap is pulled clear. The lines are allowed to reeve through and are retrieved. The pelican hook stopper on the mooring chain is released, the manila stopper on the hogged shot on the far side is cut, and when in all respects ready, the stopper on the working side is cut, and the buoy is free.

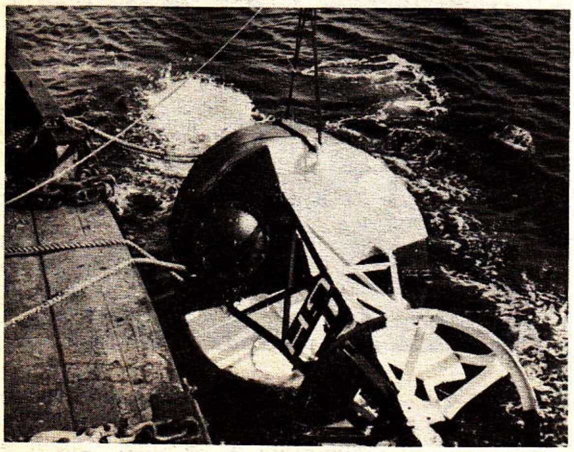

FIGURE 27–214.—Buoy alongside just prior to lowering into the water.

H. *Heavingout line.*—Some ships use a heaving-out line to assist in hauling the buoy outboard and to help steady it. The line is led from the windlass through a snatch block on deck, out through a chock, up over the bulwarks, through the inboard lifting lug of the buoy, back over the bulwarks, in through a chock, and made fast so as to be able to let go readily. Heave the line taut. When the buoy is lifted, heave taut again. Keep on heaving until the lug of the buoy is parallel to the chock, then slack away. Let go the bitter end, and heave the line aboard as soon as the buoy is unhooked from the lifting tackle.

I. When working on exposed bars, most West Coast tenders only work one 9-foot buoy at a time. If two are carried, one is usually left moored inside the adjacent harbor while the outside buoy is being relieved.

It has been found that single 6-inch crossdeck steadying lines are inadequate for working under many conditions, and an additional snatch block secured to the buoy is used to double up the steadying line.

27–5–40 Relieving Eight-foot and Smaller Lighted Buoys—

A. Although the handling of 8-foot and smaller lighted buoys is not as difficult as the handling of large buoys, it must not be assumed that the work is free from potential danger, or that the precautions emphasized in the foregoing sections should be modified or forgotten entirely. There are still very heavy weights involved. Eight-foot and smaller buoys are lifted by one tackle only, usually the main (except in the case of very small buoys such as the 5- and 3½-foot lighted buoys), and are handled by the athwartship's method already described. A single cross-deck hookline leading atwartships is generally sufficient, although in rough weather additional cross-deck lines should be laid out and used if indicated. Many ships use a short wire pendant (⅞- to 1⅛-inch diameter, or braided wire of equal strength) with a hook in one end and a thimble in the other for hooking on to the lifting lug of the buoy. It is much easier to "fish" the lug with a pendant than with the main hook directly, and often obviates the need for a man to board the buoy.

B. *Shifting buoys around on deck.*—Tenders generally carry a number of the smaller lighted buoys, and therefore working these buoys necessitates shifting them around on deck at sea from a stowage position at any place on the deck to a working position in the way of the buoy ports. Shifting heavy weights at sea requires skillful work on the bridge as well as on the buoy deck. The vessel must be brought to the easiest heading, and under certain conditions the officer-in-charge on deck should be advised from the bridge when to hoist, and when to wait and hold everything fast for a moment. Plenty of cross-deck hooklines and head and tail steadying lines should be used. *It is better to keep the buoy from taking charge rather than to try to stop it once it gets out of control.* When topping up and down and trimming the boom, keep the guys (vangs) taut but do not forget to slack them when necessary. Use power tackles hooked in the deck to steady the boom when at sea. Keep weights low and touched to the deck whenever possible. When topping the boom down to shift a buoy forward, do not forget to pick up the slack in the hoisting tackle to prevent its becoming unhooked. Always have a few extra wedges ready to throw under the buoy should it start to shift.

C. *Preparations for launching the buoy.*—Whether to set the new buoy first and then pick up the old buoy, or vice versa, depends on how close the old buoy is on station, whether there would be danger of fouling if the new mooring is dropped close aboard the old one, or whether the old mooring is to be reused (such as where sanded in), etc. Most tenders prefer to set the new one first if possible, so as to have more room on deck. The relative strength of the current and wind must be considered, together with the drift of chain on the old mooring, as it is desirable to place the new buoy and mooring on the weather or upstream side in order to have it ahead and clear of the ship when the old buoy is being taken aboard.

(1) Assuming this to be the case, top the boom up over the relieving buoy, which has been shifted to a working position in the way of the buoy port and lashed down if necessary. The main should hang over the lifting lug on the top of the buoy body. Some hook the main directly into the buoy, others use a wire pendant.

(2) The lugs of smaller buoys are not always of ample size to insure quick unhooking of the large hooks of the main and relief. One tender uses a releasing shackle made from a first class (2-inch) split key shackle. The head of the pin is burned off and the end tapered. A hole for a safety pin is burned or drilled through the pin at this end. A lanyard is secured through the key slot in the other end of the pin, and is used to trip the pin once the weight is off the shackle. This type of releasing shackle should not be used without a safety pin to prevent its premature unhooking. The safety pin may be withdrawn once the buoy is hanging alongside, and as long as the weight of the buoy is held on the shackle, it cannot unhook. If this type of shackle is to be used for large buoys, it should be reinforced by a bar welded across the bow of the shackle high enough to clear the lifting lug. This bar is to keep the jaws of the shackle from spreading apart under a heavy strain. A slip-pin shackle thus fitted is better used with a wire lifting sling than directly inserted into the buoy lug.

(3) Whatever method of unhooking is used, it is essential that it work quickly and surely, since the

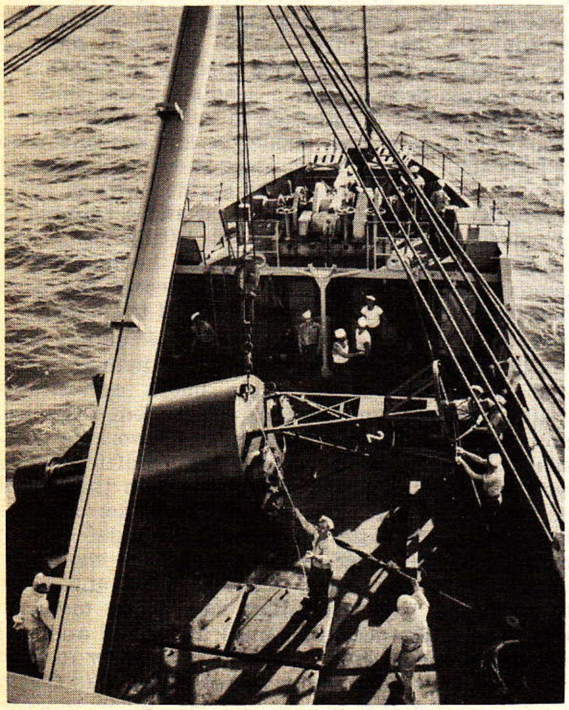

FIGURE 27–215.—An 8 x 26 lighted buoy on a tender's deck, ready to be put in the water. Boom is swung directly over buoy. Main tackle is hooked to lifting eye and hauled taut in preparation for raising buoy. The headline, tended by several seamen, is run through the lantern cage. The tail line attached to the main hook is being tended by one seaman.

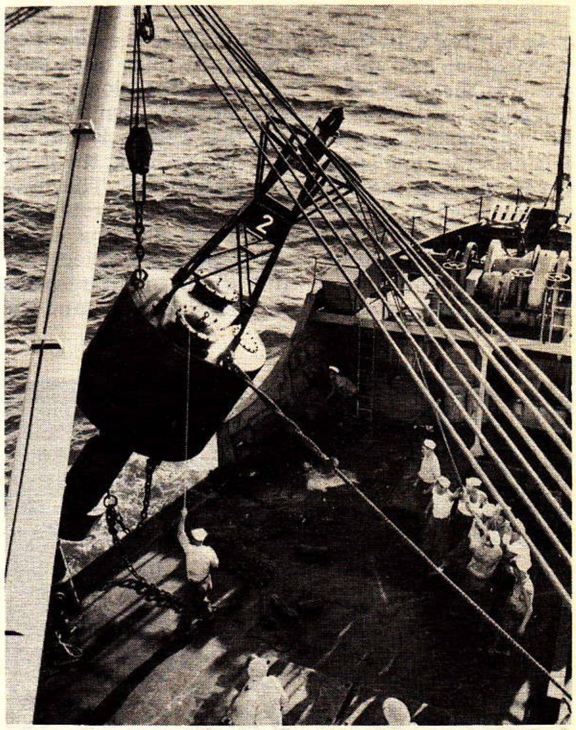

FIGURE 27–216.—An 8 x 26 lighted buoy suspended in air by the main and being swung through the buoy port in preparation for setting. Chain is ranged out on deck and stopped off to a padeye. Six-inch manila stopper holding sinker over the side is secured to bitts and is being closely tended by an experienced seaman. Buoy is steadied by headline run through cage of the buoy. The cross-deck line attached to lifting eye runs through a snatch block on starboard side to windlass on forecastle. Tail line attached to main hook is being tended by one seaman. NOTE: *in rough weather, buoy should never be hoisted high in the air like this.*

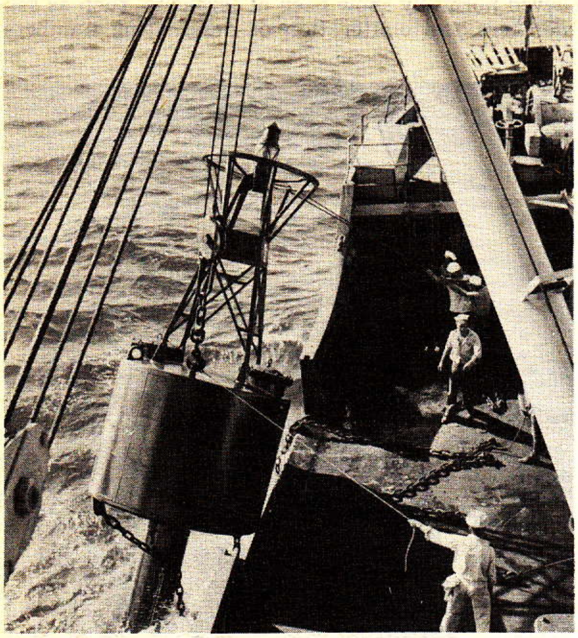

FIGURE 27–217.—An 8 x 26 lighted buoy being lowered over the side. Buoy is steadied by headline run through cage. Tripline stopping off chain is being tended by one seaman. Tail line is being tended by BMC.

tender is often in a tight spot and must clear the buoy at once. Be sure, when hooking a tackle or pendant into a buoy, that it is facing in the right direction to have the back of the hook inboard or nearly so, when the buoy is swung out alongside. This permits a better lead for the tripping line. Reeve a headline through the cage to steady it and, if conditions indicate, rig a cross-deck hookline leading athwartships to steady the body of the buoy.

D. *Launching the buoy.*—It is assumed that the mooring has been ranged out, connected, and stopped off, and the sinker hung ready for tripping, as described in sections 27–5–15 and 27–5–20. Pick up the buoy on the main. If no cross-deck line is being used, have the main directly over the lifting lug. If a cross-deck line is being used, trim the boom outboard a bit and hold back on the hookline to steady the buoy, as described in section 27–5–25. Steady the lantern end of the buoy and swing the boom out until the buoy clears the edge of the buoy port. Turn the cage forward or aft with the steadying line, lower the buoy a few feet, and trim the boom in to gripe the buoy alongside. Insert the lens and color shade if not already done, and light the buoy. When on station, let go the sinker and lower away the buoy. To prevent the chain from striking the buoy as it runs overboard, it is advisable to top the boom up when the buoy is hanging alongside so that it hangs clear, aft of the buoy port. When the buoy is waterborne, clear the hoisting tackle, cast off the headline, and back the ship clear.

(1) Some tenders, when carrying an 8 x 26 fore-and-aft in the same position as the 9-foot buoys, hoist it over the side with the same procedure as described under section 27–5–25.

(2) When placing an 8-foot buoy over the side from athwartships in rough weather, let the tube slide along the deck and over the edge. This harms nothing but the paint on deck and helps to steady the buoy.

(3) Keep a line fast to the hoisting block at all times so that it won't swing around when the ship rolls.

(4) Some tenders release the buoy, holding it alongside with the headline, before dropping the sinker to insure that the hoisting hook will not foul in the lifting lug and drag the buoy off station.

(5) Whenever using a pendant, having a retrieving line secured to it.

(6) Some vessels may use the relief, in lieu of the main as described in the foregoing. The procedure is the same in either case.

(7) In very rough weather, it may be necessary to pass a hookline to the buoy to grip it alongside in addition to trimming the boom well inboard. This line is removed just before the buoy is lowered.

(8) When handling "C" type lighted buoys, pick them up on both the main and relief the same as described for 9-foot buoys in section 27–5–25. If the buoy is to be handled with a single hoisting tackle, the method of reeving a tube preventer hookline described in a foregoing section can be used. The "C" type buoy is awkward to handle.

E. *Hoisting aboard.*—The old buoy is approached as described in section 27–10–35 and when close aboard, a long boat hook (pike pole) is used to pull the cage close enough to reeve a headline (3 inches) through it for steadying. (One tender took a piece of ⅜ inch bar stock bent in a half circle about 8 inches diameter with a straight 6-inch length on one end, and inserted this in the end of the staff to make a more effective boat hook.) In rough weather a strap can be passed into the tower of the buoy, and a hoisting tackle or cross-deck line hooked into it to steady the buoy alongside for hooking on. Any one of the lifting lugs is hooked with the short pendant or by the hook of the tackle, and the buoy is hoisted clear of the water.

(1) When handling a pendant to fish the lifting lug of a buoy, the man must keep a strain on it in order to keep the hook engaged until the hoisting tackle is hooked on and the slack taken up.

(2) When hoisting the buoy aboard, the boom is kept trimmed so that the hoisting tackle hangs just inboard of the center of the buoy port. This is to offset further list of the ship and to keep the buoy close aboard. It is often necessary to trim the boom further inboard once the buoy is raised out of the water, in order to keep it griped in tight alongside.

(3) Except in the case of small lighted buoys (3½- and 5-foot), a 6-inch hookline is passed forward of the hoisting tackle to the outboard lifting lug on the body of the buoy (opposite the one used for hoisting) and led athwartships through a snatch block and thence to the windlass. Heaving taut this line as the buoy is hoisted clear of the side breaks the buoy around, lantern forward, to lead fair

These are specially posed pictures. Buoys to be relieved normally show need of servicing, such as sea growth on the underwater parts, lack of paint on cage members, and obliteration of designating numbers and letters due to rust or bird deposits.

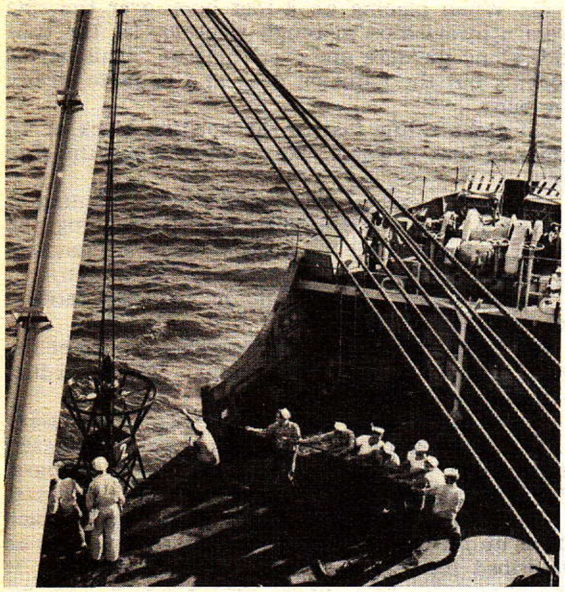

FIGURE 27–218.—An 8 x 26 lighted buoy alongside, about to be hoisted aboard. Boom is swung to port directly over the buoy, main tackle is being hooked into the lifting lug. Buoy is held steady by men on head line. Cross-deck line is laid out but has not yet been attached to the buoy.

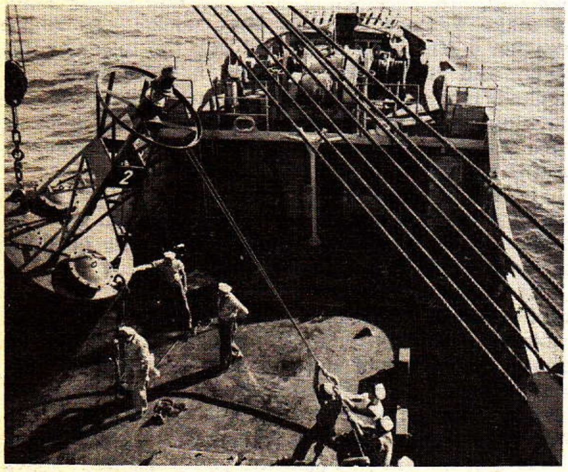

FIGURE 27–219.—Lighted buoy partially suspended by the main. Buoy is held steady by the head line. Cross-deck line has just been attached to the inboard lifting lug and will soon assist in steadying the buoy and dragging it inboard.

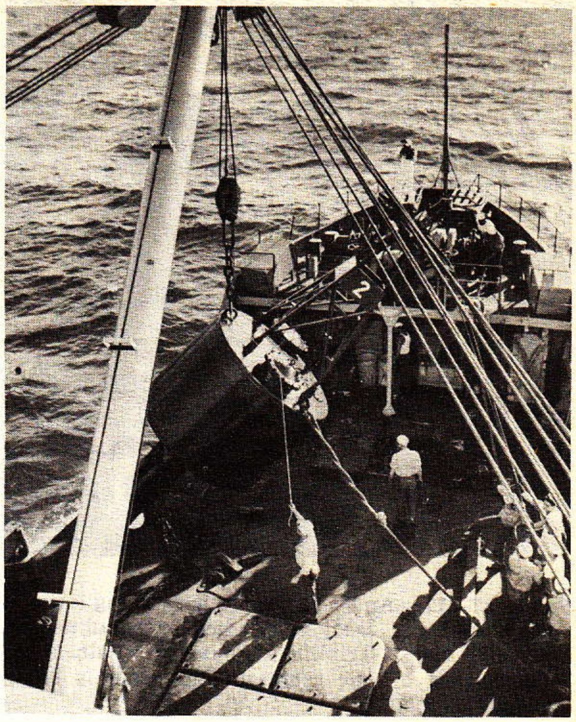

FIGURE 27–220.—Buoy is suspended above the deck. Cross-deck line attached to the lower lifting lug leads through a snatch block on starboard side to the windlass on forecastle. The buoy is still steadied by the head line run through the lantern cage. The tail line attached to the main hook is being tended by a seaman. NOTE: *It is not necessary to hoist the body of the buoy so high, and in rough weather this should never be done.*

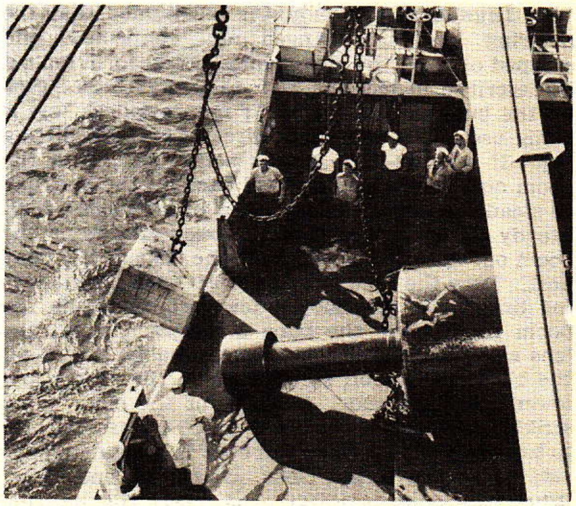

FIGURE 27–221.—The 8 x 26 lighted buoy is now lying on deck. Its concrete sinker and chain are being hoisted aboard.

across the deck as the boom is trimmed in. The buoy is hauled across the deck far enough to leave plenty of room at the buoy port for the men to hoist the chain. When bringing buoys aboard, keep the buoy close to or touching the deck. It is better to trim the buoy further across the deck in order to get sufficient slack in the chain, than to hoist it aloft and make it necessary for a man to get under the weight in order to hook on for the bight of chain.

(4) The chain is stopped off by the whip, hookline, pelican hook, or the mechanical chain stopper, as described elsewhere in this chapter, and the mooring recovered as described in section 27-5-45.

(5) When handling small lighted buoys it is often not necessary to disturb the position of the boom. Using a cross-deck hookline, hoist the buoy clear of the deck, and pull across. This saves time in that the boom is ready in position for overhauling the chain.

(6) If the vessel is rolling ever so slightly, even small buoys should be lashed down just as soon as they are set down on chocks, cradle, or wedges on deck.

(7) In rough weather, it is good practice to back up the mooring stopper by shackling the chain to a padeye in the deck. The mooring chain should be unshackled from the buoy bridle before hoisting up the mooring.

(8) Buoys should be cleaned of as much sea growth as possible while still over the side. In any event, clean it off while the buoy is still wet. Once dry, the buoy will be very difficult to clean. Take time to get them as clean as possible. It will ease the depot's job tremendously.

(9) Improper handling of the cross-deck hookline may result in a smashed lantern. It is a good practice on single-screw vessels to pass a stout hookline into the mooring chain as the buoy is raised out of the water, and snub it alongside before bringing the buoy aboard. Then, should the ship fall off, there will be no undue strain placed on the buoy.

(10) Keep the cross-deck hookline fast to the buoy as long as the mooring is still connected to it, and until it is lashed securely.

(11) When the bail on old-type buoys does not permit the use of a proper size hoisting hook, never substitute a smaller hook of doubtful strength. Insert a shackle which will hold the load safely and which will accommodate the larger hoisting hook.

F. *Relieving buoys, West Coast.*—When relieving the smaller lighted buoys (other than 8 x 26) on the West Coast where the same mooring is to be reused, no hogging chain is required, since there is room on deck to bring the old buoy aboard. Stop off the mooring and shift it to the new buoy after pulling it up to short stay for examination. The 8 x 26 buoy can be handled as described in section 27-5-35.

G. *Hoisting buoys aboard, using mechanical chain stopper.*—When hoisting small lighted buoys aboard vessels equipped with the mechanical chain stopper, hoist the buoy alongside as usual, with the lantern trimmed forward. As the boom is trimmed inboard, haul the lantern end of the buoy athwartships by means of the headline rove through the cage. Bring the boom amidships and top up or down, or maneuver the ship so as to cause the chain to lead fair into the stopper. Should this be difficult to accomplish, pass a hookline into the chain at the deck's edge and lead it directly to the windlass. The chain may thus be hauled up into the stopper jaws easily. When the chain has been engaged in the jaws of the stopper, trim the boom back outboard to slack the chain. Lower the buoy and secure in chocks on deck. Disconnect the bridle from the mooring chain. Hook the hoisting tackle (main or whip) into the chain just inboard of the stopper. With the boom now trimmed well inboard so as to break the chain over into the stopper, hoist the tackle, pulling the chain through the stopper. When the tackle is two-blocks, slack away to engage the chain in the stopper, then lower smartly and hook in just inboard of the stopper for another bight. Repeat this procedure until the sinker is at the water's edge. With the chain engaged in the stopper, the boom is trimmed outboard, hook engaged in the chain and the boom topped up until the chain is abaft the stopper and the sinker clear for lifting aboard. If the sinker appears while there is still enough lift available to bring it aboard, the boom is topped up without bothering to engage the chain in the stopper.

When hoisting a buoy aboard for gauging, recharging, etc., the same procedure is followed to the point where the buoy is disconnected from the mooring chain. After hoisting aboard, setting on deck in a cradle or on chocks, and disconnecting the chain, the buoy is tested or serviced as necessary. (Although the chain is securely held in the stopper it is wise to get in the habit of always disconnecting a buoy from its mooring while on deck and before starting to work on it.) The ship remains anchored by the buoy sinker with its chain engaged in the stopper. When the buoy is ready to be reset, haul about 10 feet of mooring chain aboard and stop off. Reconnect the buoy to the chain, hoist it out over the side, and lower into the water. Trip the chain stopper, lower and clear away the main, and back the tender clear.

H. When placing buoys in winter storage in the Great Lakes area, it has been found useful to paint the Light List name of the buoy in abbreviated form on the bottom of the buoy to aid in identifying it the following spring. Moorings are also marked, all chain examined and renewed where necessary. Chain is often end-for-ended.

I. *Handling battery racks.*—In relieving an electric buoy, if the battery racks are removed from the pockets, care should be taken in swinging the racks aboard ship or on the dock so as not to strike the rack against stationary objects. The batteries, properly racked, are well protected and are not too fragile, but it is necessary to handle them with even greater precaution than acetylene cylinders. The batteries are protected with steel cans, and the nested cans are held in heavy steel racks. This affords ample protection to the cells when properly handled. Battery racks should be hoisted by the lifting eye on the top, or by the large hole in one of the sections just above the center of gravity when lifting from a side position. Avoid lifting with chain slings wrapped around the rack as this may

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incur damage to the batteries. The Willard low discharge battery is so designed to properly vent the cell without spilling the electrolyte. The vent and filler plugs on the top of the cell must be screwed down tight, and the post seal nuts and post washer around the terminals must be watertight. The surfaces upon which the gasket rings seat must be clean and smooth to assure even pressure on the gasket and proper expansion around the terminal. These precautions are to be followed when the batteries are charged, and before they are placed in racks and connected.

27–5–45 Hoisting Mooring Aboard—

A. *Sling chains.*—The work of hoisting mooring chain aboard, or "fleeting" or "overhauling" the chain, may be accomplished in several ways. The most commonly used method is to pass a short single chain sling (nipper chain) of appropriate size and strength, having a pear link in each end, around the mooring chain, then pass one end link of the chain sling through the other and hook it on to a hoisting tackle and heave away. Two hoisting tackles may be used to heave the chain up hand over hand, lowering one as the other is raised. Three chain slings are used so that one can be passed while one is holding the load high, while the third is being taken off. An experienced man can flip a chain out around the mooring chain and back aboard without having to reach out with both hands around the chain. Passing a chain sling places a man in a hazardous position. It should be done as expeditiously as possible, and the man should step back out of the way quickly. Do not allow too many men to cluster about the chain, attempting to help pass the sling. One man is sufficient to pass the sling, and a few others can push the hoisting block over to him for hooking on.

A common fault in passing a chain sling is to get the pear link, through which the other end is passed, backward. The chain of the sling should lead from the small end of the pear link so that the chain, after passing around the mooring, leads through the large end of the pear link to the hoisting hook. This permits the large end of the link to bear more firmly on the mooring being hoisted and does not overstrain the pear link. When hooking into the upper pear link with the hoisting tackle, see that the large bight of the link bears in the hook. Do not take a strain until the link is all the way into the hook.

B. *Hooking directly into the chain.*—Another method of hooking on to hoist chain is to place the hoisting hook of the tackle directly into the links of the mooring chain. This can only be done when the chain is large enough to accomodate the hook. The large hooks of the main and relief will generally not fit directly into links of less than 1⅜-inch open-link chain. Care must be taken that the hook does not jam in the links of the chain. If so, do not strike the hook to free it; strike the links of the chain.

C. *Modeer shackle.*—In deep water or with very heavy chain, either heavy chain slings or special lifting shackles are used. A 1½-inch and 2-inch U-shaped shackle, having a locking bar-type pin and known as a Modeer shackle, is widely used on the West Coast. Light chain may be hoisted with an ordinary buoy shackle inserted in the links and the hoisting tackle into the shackle.

D. *Mechanical chain stopper.*—The mechanical chain stopper (see section 27–3–40) is a very useful device for stopping off mooring chain which is being hoisted. It provides a safe and secure stopper while the chain sling is being passed or the hoisting tackle being hooked in. It permits the use of a

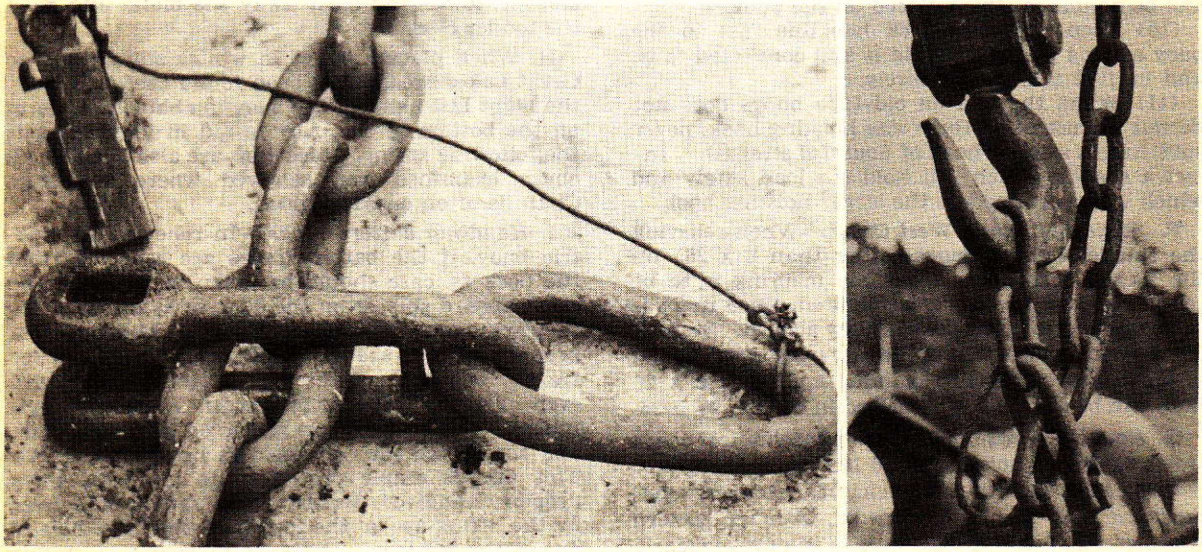

FIGURE 27–222.—A Modeer-type shackle widely used on the West Coast for hoisting heavy mooring chain, in lieu of chain slings.

single tackle for hoisting, thus speeding up the recovery of the mooring and releasing the other tackles for steadying the boom or holding other loads. The safety feature of not requiring personnel to approach the chain until it is securely held should not be overlooked.

E. *Hoisting chain aboard.*—As stated before, chain may be hoisted aboard (on vessels not equipped with the mechanical chain stopper) hand over hand, using two tackles, the whip and main if the load is light, or main and relief for heavy loads, or the mooring may be hoisted in single lifts on one tackle and stopped off at the deck's edge while the same tackle is run down for another lift. Hook the relief abaft and outside of the chain on the main when hoisting hand over hand with both falls. Hooking otherwise will tangle the two falls together. The multiple purchases of the relief or main are slow and cumbersome, and often more time is saved by using just the whip for hoisting, passing a chain sling to the main, and holding it fast instead of hoisting it in turn, or, a cross-deck hookline may be passed into the chain at the deck's edge to stop it off while the whip is being lowered for a fresh bight. This latter practice is only suitable for light loads, and when there is no danger of the weight of the ship coming on the mooring.

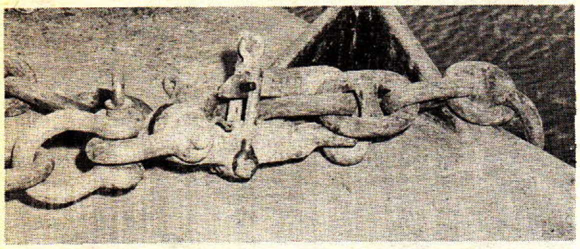

FIGURE 27–223.—Mooring chain stopped off in a pelican hook.

(1) Many ships use a preventer line (up to 10 inches), wire, or chain stretched across the buoy port outboard of the mooring to keep it alongside. Some tenders use a freely-working shackle secured to a heavy line for a deck stopper, or a pelican hook shackled to the deck by a short length of chain.

(2) In retrieving chain, it is important to keep personnel as clear of the overhanging bights as possible. In placing chain slings around the mooring chain, the men should work so that the strain is outboard and away from them.

F. *Position of the boom.*—The boom should be topped up over the buoy port and trimmed so that the hoisting tackle hangs inboard of the edge of the ship, so that the chain when lowered will not pile up dangerously close to the edge of the buoy port. Men passing chain slings must have plenty of room to work. Also, should a bight of the chain accidentally slip over the side, the entire chain could run off the deck in a flash.

When using the mechanical chain stopper, top the boom down until the hoisting tackle is in line with the jaws of the chain stopper and hangs well inboard. It may be necessary when handling large buoys with long bridles, to pass a hookline into the bridle or mooring chain below, if it can be reached, and leading the hookline directly to the windlass, heave the chain up into the jaws of the stopper. When handling small buoys, the chain can be made to lead up into the stopper by judiciously backing or going ahead on the ship slightly. (Take care not to gather any way.)

G. *Disconnect mooring from buoy.*—When the buoy is on deck, hook the whip or other tackle into the bridle, or the chain below it if possible, and hoist. Be careful not to disturb the buoy by hoisting the bridle too high. If sufficient slack can be obtained by the first hoist, stop off the chain by any of the methods described herein, i. e., mechanical chain stopper, pelican hook, etc. Lower the bridle and disconnect it from the mooring chain. *Always* disconnect the mooring chain from the bridle before attempting to hoist the mooring aboard. This is to prevent the buoy from being pulled adrift, or even overboard, should excessive strain come on the gear, or something part. If the shackle key at the swivel does not come out freely, do not waste time. Burn it off with the oxyacetylene cutting torch. Always have this torch handy for use when working buoys.

H. *When picking up a long length of heavy chain,* shackle it to the deck at the end, and if necessary, at several places along its length as it comes aboard, to prevent loss of the entire mooring should something part. The preventor shackle may be shifted as the chain comes aboard so as to always be as close as possible to the part being hoisted. If the chain is to be reused, such as when overhauling part of the mooring for inspection, the chain should be flaked down in even rows and stopped off the same as for a new mooring. Do this as the chain comes aboard, instead of letting it pile up and trying to straighten it out afterwards. If the chain is not to be reused, spread a suitable strap on deck and pile the chain up on it so that the entire bunch of chain may be handled about the deck and unloaded easily later.

Know the depth of water and how many shots of chain are in a mooring, and keep track of them as they come aboard.

I. *Caution.*—When a mooring chain is leading over the edge of the deck, secured in a stopper, or when held on a tackle, be ever alert for a sudden movement of the chain fore or aft due to the ship's accidentally gathering way through the water. Even the most alert conning officer cannot always hold the ship motionless, and a strain may come on the chain which cannot be anticipated. Do not allow any part of the body to protrude over the side of the ship adjacent to the chain. For example, do not peer down over the side close alongside the chain to see how it tends. At just that moment it may slide up against the bulwark with sparks a-flying. Although it may be necessary at times to reach around the chain to pass a chain sling (an experienced man need not do this), do so quickly and always be alert to a possible movement of the chain.

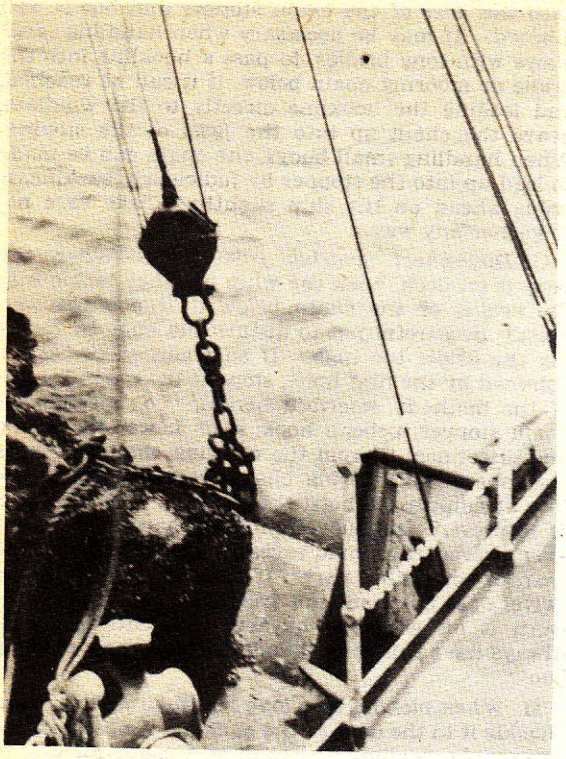

FIGURE 27–224.—Sinker coming aboard.

FIGURE 27–225.—Sinker raised to deck edge just before coming aboard. If the weather were rough, sinker should have steadying lines.

Do not permit loiterers to peer or reach over the bulwark anywhere along the buoy deck. The chain may not be confined to the buoy port area; there have been occasions where a poorly handled ship caused the chain to rake the entire foc's'le head. Make sure that all men keep clear of the chain on deck as it comes aboard. When bringing chain to short stay in areas where moorings are sanded in, care must be taken not to bring too severe a strain on the rigging when swells might cause rolling or pitching.

J. *When chain piles up on deck.*—When large amounts of chain are to be hoisted on deck, it may be necessary to use a cross-deck hookline to heave some of the chain clear of the working space to make room for the remainder as mentioned before. Never allow chain to pile up to such an extent that there is a possibility of a bight getting overboard, or that it crowds the men hooking on the hoisting tackles.

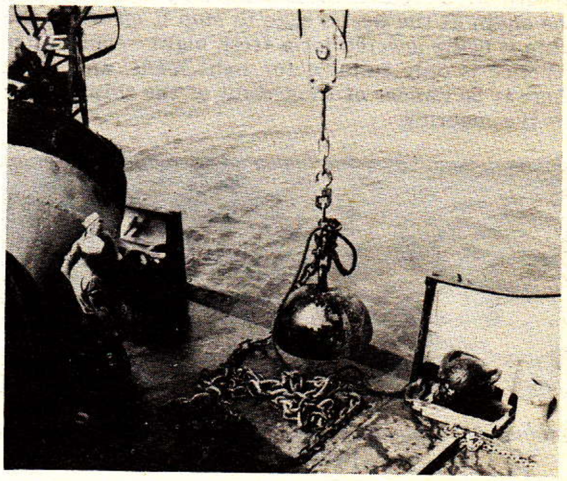

FIGURE 27–226.—Sinker coming aboard. Note wooden strips ready for sinker to be set down on. Steadying line of sinker should be tended.

K. *Breaking out sinker.*—When the chain has been hoisted up and down (at short stay), it is generally advisable, except in the case of very small sinkers, to break out the sinker with the main or relief. In certain locations, sinkers will be sanded in beyond recovery. In others, they will be recovered only after a considerable struggle. Take care not to overstrain the rigging when breaking out a sinker. If the sinker fails to respond to a moderate pull, it will be necessary to shackle the mooring into the deck and break it out with the ship. The mechanical chain stopper is fine for this purpose. Keeping the chain leading slightly under the ship tends to cushion the shock on the chain, and may prevent the chain from parting when at short stay. The boom operator should hoist very easy when breaking out a sinker. Often a strain is taken causing the ship to list, and then hoisting is stopped. A wait of a few moments may allow the stability of the ship to break out the sinker. If the sinker fails to break out and it becomes necessary for the ship to pull on the mooring, shackle the chain directly to a heavy padeye or mooring bitts on deck, and steam in several directions to work the sinker free. Some ships have a specially reinforced padeye located on deck with a short length of 2¼-inch chain and shackle for this purpose. (See fig. 27–206.)

Following is the procedure for breaking out a sinker used by a tender on the West Coast:

When the sanded-in mooring is shackled on, the deck is cleared of personnel. (The buoy has already been disconnected.) Strain is put on the mooring by going either ahead or astern with the ship's engines. The vessel will generally circle the mooring slowly. This circle should be reversed at intervals to avoid twisting off the chain. If the mooring is not too deeply sanded, it may break loose in 15 to 30 minutes. When heavily sanded, the chain will usually break somewhere near the sanded-in section where the chain is the oldest. If all efforts with the engines fail to break out the sinker or part the chain, which is very rarely, the mooring must be cut off with an oxyacetylene torch outboard of the breaking-out shackle. Not more than 10 percent of the sinkers are recovered in this area. The remainder of the times the chain will part.

L. *Caution when hoisting "chafe" section.*—If the "chafe" of the chain is badly worn, use extra care when hoisting. Get the chain stopped off or hooked on below the chafed section as quickly as possible, and always be alert for a sudden parting.

M. *Caution when chain is at short stay.*—Many times the chain reaches short stay or the sinker is just off the bottom when the tackle is two-blocked. If the ship is rolling or pitching it is dangerous for the men hooking on for the next bight, as they are apt to be struck by the chain as it alternately slacks and snaps taut. When this condition occurs, it is better to lower away on the two-blocked purchase a few feet to set the sinker back on the bottom, or to give sufficient slack to stop the snapping of the chain. Then hook on the other purchase and get a full lift on the chain in order to get the sinker well clear of the bottom. If hoisting with the main and whip, when approaching short stay, vary the lifts so as to have the main hooked on when breaking out the sinker. If the ship is rolling heavily, secure preventer lines on the blocks of the main and relief to prevent them from swinging around while being hooked on.

N. *Kinked mooring chain.*—Hoisting a kinked or fouled chain aboard can be a very dangerous procedure, and one which requires ingenuity in placing the chain slings in order to get the balled-up chain aboard. Sometimes wire straps must be passed into various parts of the knots of chain to stop them off while passing a chain sling for a fresh bight. Always be on the alert for a sudden slipping or unravelling of the balled-up chain. Watch out for a sudden twisting and swinging of a loose end. A chain which is found to be kinked may be shackled to the deck

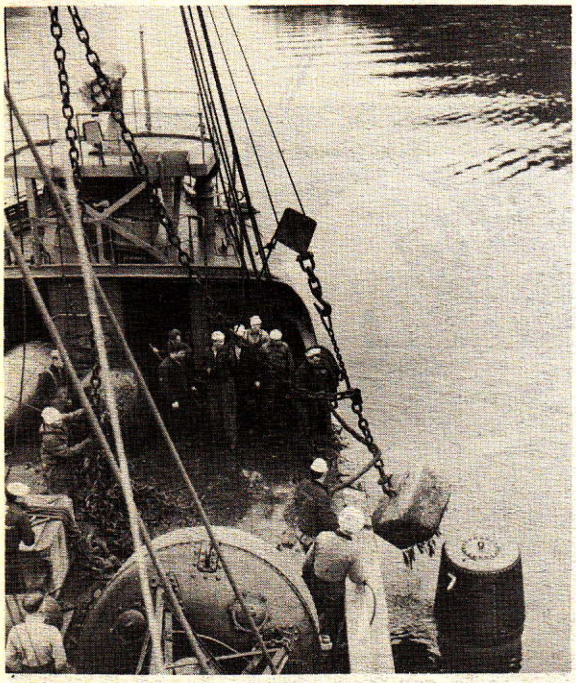

FIGURE 27–227.—Sinker coming aboard. Note manila preventer line outside of chain to keep the chain from surging outboard. Note also that the boom is trimmed too far in-board—sinker will slide way in on deck. This could be dangerous.

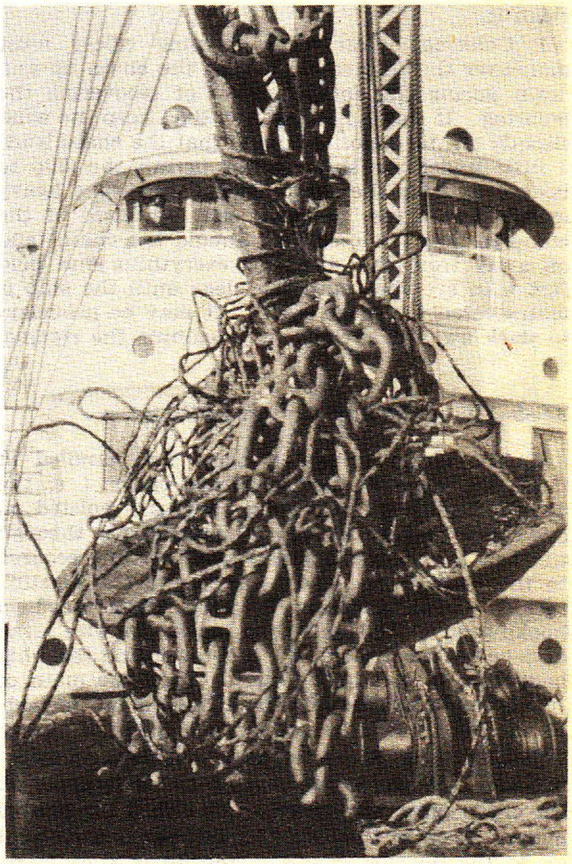

FIGURE 27–228.—How a fouled mooring sometimes looks.

and a strain taken by the ship, dragging the mooring for a short distance, sea room permitting. This should either clear it or bind it so tight that it can be raised on deck without suddenly clearing itself and jerking the boom and hoisting gear and thereby causing damage. Usually it clears itself. In some areas, where the current is swift, the moorings will inevitably come up full of turns. If the mooring is dragged enough, the turns will work out. Care must be taken not to drag over cable or restricted areas. Use only moderate power for this operation, increasing speed as the sinker breaks out and the turns in the chain unravel.

O. *Bringing sinker aboard.*—When the sinker is in sight and clear, wash it off if muddy and trim the boom back over the side. If the sinker is pulled aboard when the boom is trimmed inboard, it will swing and may strike a buoy or personnel. If the vessel is rolling, even slightly, rig a preventer line rove out through a chock and secured to the sinker. When hoisting the sinker in rough weather, keep it griped into the side of the ship to prevent banging. A cross-deck hookline may also be led to the sinker and the sinker hove aboard, holding back with the boom, using the same principle as described in section 27–5–25 for setting large buoys overboard. Land the sinker on wooden strips or wedges. Recovered sinkers are often muddy and are prone to slip around on deck. A sinker covered with mud may be dragged in the water at the surface to clean it.

P. *Conning officer.*—The conning officer must maneuver the ship so as to keep the chain up and down during the entire process of recovering the mooring. If this is not possible, then keep the wind slightly on the opposite bow so that the chain leads a little under the ship. Never permit the ship to bear away from the chain. Some ships rig a heavy manila line across the buoy port outboard of the chain to hold it alongside. Should the chain tend off away from the ship, dog everything and hold fast with everyone standing clear until the ship is maneuvered alongside again. It may be necessary to slack away to prevent overstraining the rigging.

27–5–50 Relieving Unlighted Buoys—

A. The larger unlighted buoys are handled in much the same manner as lighted buoys; i. e., the 8- and 9-foot bell and gong buoys are hoisted on one tackle and steadied by a headline rove through the bell tower, and a cross-deck hookline secured to the body of the buoy opposite to the hoisting tackle. Great difficulty is often experienced in hooking on to bell and gong buoys. A wire strap may be passed through the bell tower and the whip hooked in to steady the buoy. Then the main or relief may be hooked into the lifting lug on the body of the buoy (with or without a pendant). Large unlighted buoys may have heavy chains for a mooring, and if so, the same precautions for stopping off the chain must be applied as described for lighted buoys. Even in the case of small buoys with light chain, the mooring should be stopped off at each end to insure that a bight of chain does not get over the side unintentionally.

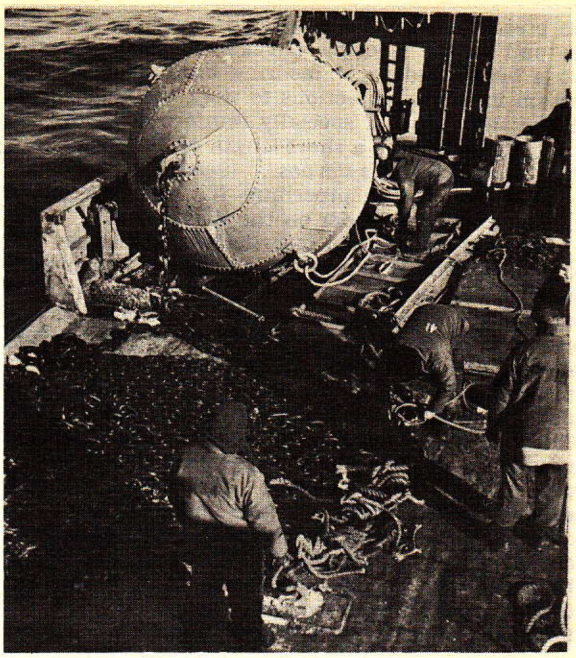

FIGURE 27–229.—Bell buoy on deck, preparatory to setting.

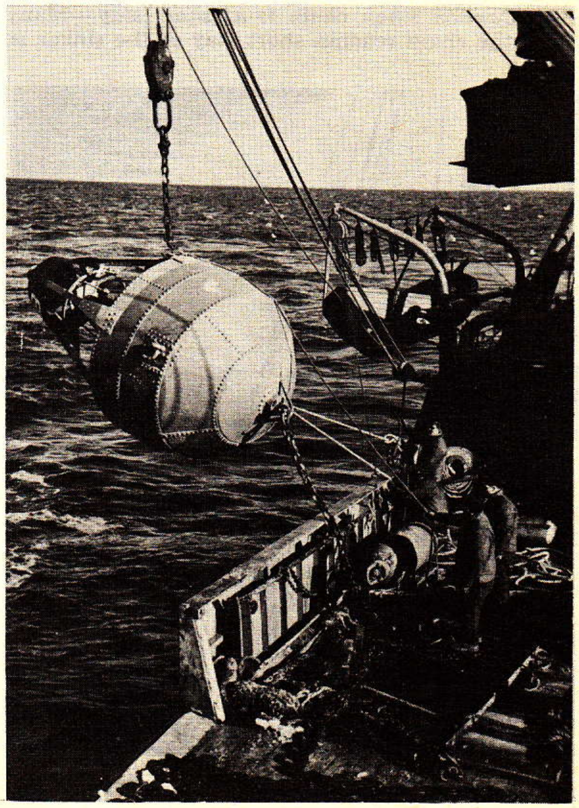

FIGURE 27–230.—Bell buoy hoisted over the side.

B. *Tall-type buoys* are handled by both the main and relief (or main and whip) being hooked, one into the lower (balancing) lug, and the other into the upper lifting lug, depending upon which direction the buoy is lying in on deck. In rough weather it is wise to use hook lines for steadying. A headline is rove from the buoy in all cases. When the buoy has been picked up and boomed out over the side, the tackle in the lower lug is cleared, and the buoy lowered when on station by the tackle in the upper lug. Tall-type buoys may also be handled by hooking the main only into the balancing lug (the lower one), and when the buoy is hanging over the side, hooking the whip into the upper lug, take a strain and clearing the main. When on station, lower the buoy on the whip. In some cases, a tall-type buoy will be found that has no lower lifting lug. In this case the main is hooked into the upper lifting lug, and the boom topped and trimmed sufficiently to drag the buoy across the deck and over the side. A steadying line should be attached to the butt end of the buoy in this case.

C. *Launching standard type.*—The larger standard-type unlighted buoys are hoisted over the side on the whip (main, if vessel has no whip) with the mooring and sinker stopped off as described for lighted buoys. The tripping line in the back of the hoisting hook serves as a headline. Cross-deck lines are not used except when hoisting aboard as described below. Standard nuns and cans may also be hung over the bulwark aft of the buoy port by passing a line, with an eye splice looped over a cleat, through the buoy's lifting lug, and back around the cleat. When on station, the mooring and the buoy line are tripped simultaneously. If reflectors are to be installed, a separate headline must be rove through the lifting eye to hold the buoy alongside after launching.

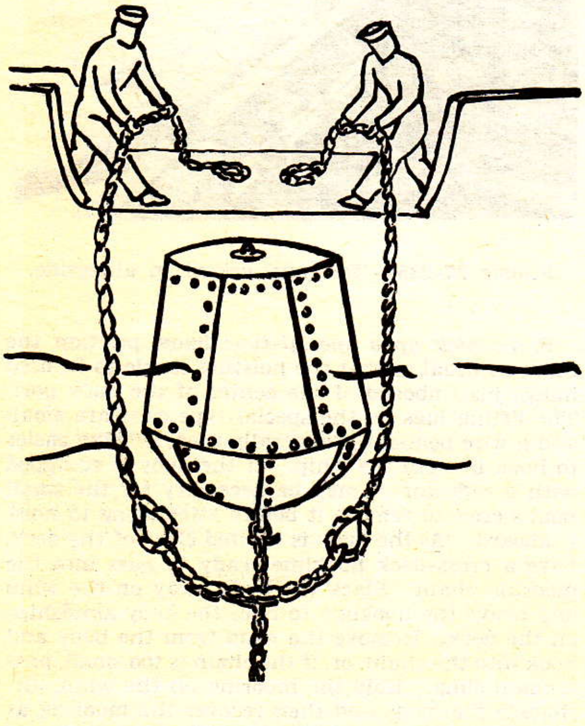

FIGURE 27–231.—A typical lariat used for picking up standard-type unlighted buoys.

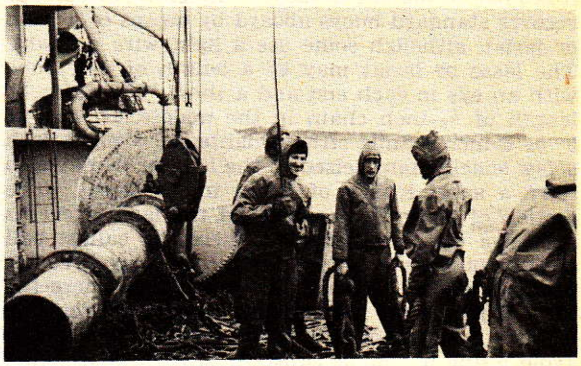

FIGURE 27–232.—Standing by with lariat (lasso) to pick up unlighted buoy.

Third-class standard buoys may be set on deck at the edge of the buoy port (providing the weather is good), and when the mooring runs off the deck, if the buoy does not fall over the side, a hearty push by a few of the men will clear the buoy. *The men must stay clear until the chain is all off the deck.* This is sometimes resorted to in a tight place when the old buoy has to be picked up quickly on the whip and it is not desired to have the boom tied up in handling the new buoy. Also, the buoy may be pushed overboard before the sinker is dropped. However in this case, the mooring must be well stopped off and the men must take care to keep clear of the chain. When time and conditions permit, it is always safer to hoist the buoy over with the boom.

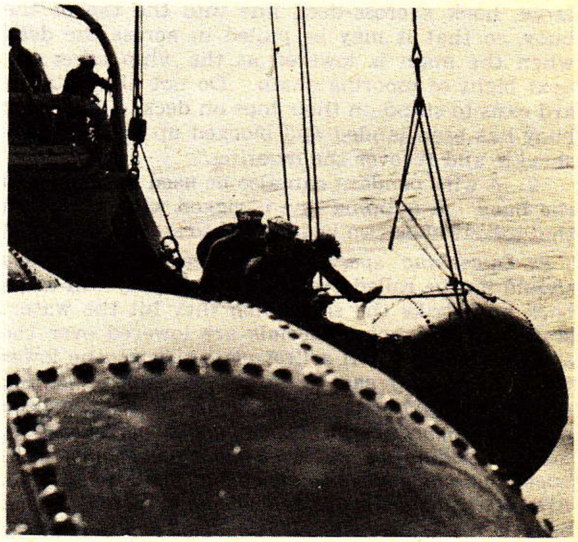

FIGURE 27–233.—Hanging first-class standard can buoy over the side on a stopper.

D. *Hoisting standard type aboard.*—Many old standard-type buoys have lifting eyes or bails too small to accommodate the hook of the whip, and a fourth-class (1 inch) split-key-type shackle must be inserted. This shackle is left on the buoy. However, even this shackle is difficult to hook into, since it lies flat on top of the buoy. Therefore, most ships recover standard buoys aboard by means of a lasso or lariat, although some use a light wire pendant. The lasso or lariat may be a length of wire rope with an eye in each end and a short (6- to 8-foot) length of ⅝-inch chain in the middle, an endless 5- or 6-inch manila strap weighted in a bight with a few shackle pins seized to the line, or it may also have a short length of chain in the bight. The section of chain in the bight of the lasso prevents excessive wear at that part where the ballast ball usually pinches the sling when the buoy becomes inverted during hoisting. In rough seas where the buoy is in violent motion the lariat is particularly useful. A line should be made fast to the lariat to avoid losing it. Some ships use a short chain sling with a 6-inch line spliced into each end (see fig. 27–231).

(1) When approaching the buoy, 2 men tend the lariat, 1 at each end of the length of chain. Another man tends the tail line and a fourth, the whip. As the buoy comes alongside, the lariat is swung out and dropped over the buoy, and allowed to sink below it so as to catch the chain. The whip is hooked into the upper bight of the lariat, or the eyes at each end, and hoisted away. Should the weather be rough, a man tends a boat hook passed through the lariat. Thus he can hook on to the buoy and hold it steady while the sling is dropped down around the buoy. Men tending a lariat must take care not to be pulled over the side should the ship set away from the buoy before the whip can be hooked on. The buoy comes up capsized when hoisted in this manner, and as soon as the mooring chain can be reached from the deck, the whip is stopped, a chain sling passed around the mooring, and the main hoisted away to take the strain. Never raise a buoy up high on the lariat. If the buoy is large, hook a cross-deck line into the top of the buoy, so that it may be pulled in across the deck when the main is lowered as the whip takes the next bight of mooring chain. Do not allow standard cans to stand on their tops on deck. When the buoy has been landed and blocked up on deck, unshackle and recover the mooring.

(2) A wire pendant can also be used to hook onto the buoy. A tripping line is rigged with an eye so that a boat hook can be inserted to steady the hook.

E. *Launching special type.*—Special-type buoys should not be rolled overboard since they will come back and strike the ship when they hit the water; standards will not. Specials are lowered over the side on the whip. If a first-class special, the lower end of the buoy can be lashed to prevent sliding while the whip hoists it off the deck; then the lashing is let go. Special-type buoys may also be hoisted out over the side on a strap at the balance, and parbuckled at the gunwale until time for letting go. Always attach a steadying headline to a special-type buoy if hoisted horizontally, otherwise the tripping hookline will suffice.

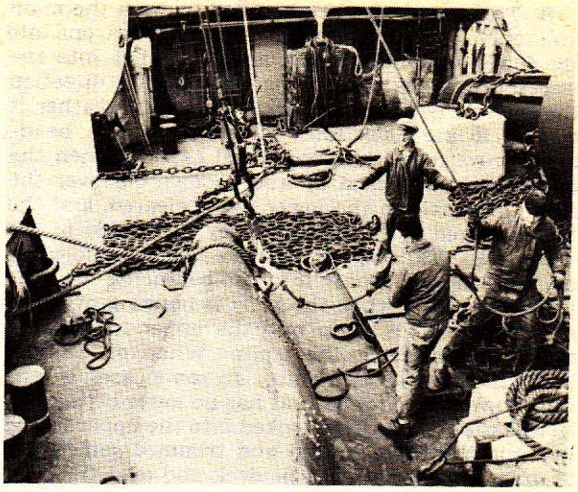

FIGURE 27–234.—Picking up a tall-type nun buoy at the balancing lug. Note use of cross-deck steadying line leading outboard.

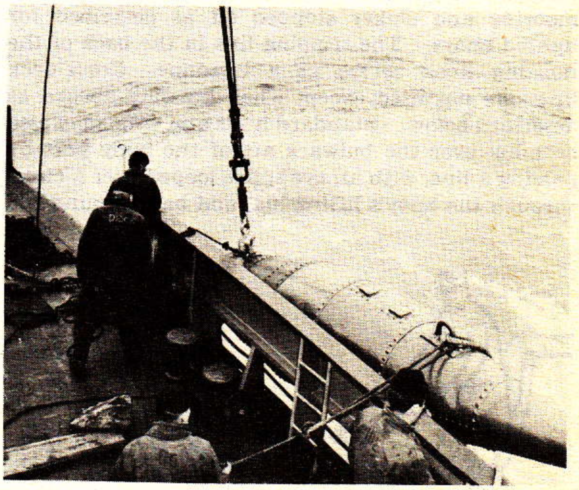

FIGURE 27–235.—Tall nun griped in alongside.

F. *To pick up a special-type buoy,* position the boom as usual so that the hoisting tackle to be used hangs just inboard of the center of the buoy port. The lifting lugs on the special-type cans are small and a wire pendant is generally used, it being easier to hook in than the whip. If the buoy is equipped with a reflector, it may be necessary for the small boat's crew to remove it before attempting to hoist it aboard. As the buoy is hoisted clear of the deck, have a cross-deck hookline ready to pass into the mooring chain. Slack the buoy away on the whip and heave the hookline to haul the buoy amidships on the deck. Remove the whip from the buoy and hook into the chain, or, if the chain is too small, pass a chain sling. Hold the mooring on the whip, unshackle the buoy, and then recover the mooring as described elsewhere in this chapter.

27–5–55 Recharging Buoys on Station—

A. Lighted buoys are often recharged on station one or more times between their annual relief. Recharging may become necessary because of a short service period due to an oversize burner or lamp being used to give a high candlepower, or due to failure of the lighting apparatus through a gas leak or electric short circuit. Buoys to be recharged may be hoisted and brought entirely aboard the tender, or may be suspended from the boom, griped in alongside the ship. Small lighted buoys are often recharged in the water from a cargo or buoy boat. (See sec. 27–7–5.) Large 8- and 9-foot buoys are generally recharged alongside if the weather permits, since handling the A-300 cylinders is easier when the buoy is in a vertical position, and less handling of the buoy is required. Smaller buoys such as the 7 x 18 and 6 x 20, etc., are brought up on deck.

(1) If the buoy is brought on deck, *be sure* that the mooring chain is securely stopped off. Under certain conditions, the handling of the ship to prevent undue strain on the mooring while working on the buoy will be difficult. If the mooring will safely hold the ship without dragging off station, it is better to allow the ship to lay quietly to the mooring rather than to use the engines constantly in an attempt to keep the ship in position by maneuvering. In strong winds or current, judicious use of the ships engines will be necessary. Bearings and angles should be checked to make sure that the buoy has not been dragged off station. Buoys in certain hazardous locations may have to be purposely dragged off station in order to permit the tender to work them safely. The mechanical-chain stopper is useful for this purpose. In many instances, dropping an anchor (described in sec. 27–10–30) will hold the ship from dragging the mooring while laying alongside the buoy. Also, the buoy may be brought alongside in rough weather more safely when using the anchor.

(2) It has been suggested, when men are working over the side such as when recharging a buoy alongside, that a jacob's ladder be left hanging over the rail to leeward of the buoy. A life ring with lanyard of suitable length should always be kept handy on deck when working buoys.

B. *Hoisting a large buoy for recharging.*—A large lighted buoy to be recharged is generally hoisted by means of a double-branch chain sling about 14 feet long, having a 10-ton hook in the end of each branch and a common ring or pear link in the other end. This sling is hooked to the main or relief, and the ends hooked into the opposite lifting lugs on the top of the buoy body as it comes alongside. Under rough conditions, it is necessary to steady the buoy before hooking on the lifting tackle. This may be accomplished by passing a 3½- or 4-inch line through the cage and having several men tail on the line on deck, or a rope or wire strap may be passed around a reinforced part of the buoy superstructure, or thrown as a lasso over the tower and a strain taken on the whip to steady the buoy. In any case of attempting to steady a buoy on the whip, do not permit the weight of the buoy to overstrain the tackle or strap. A rolling ship may easily do this. It is dangerous to allow a man to board a buoy for hooking on tackles or for any other purpose until the buoy is steady and completely under control alongside the ship. The man must be cautioned to always be alert for twisting or turning of the buoy and must keep himself on the outside of the buoy at all times. Whenever possible, attempt to hook the tackles or slings in without putting a man aboard the buoy.

Note that there are three lifting lugs on a nine-foot buoy. The center one is for hauling the buoy up by a single tackle, such as when bringing it aboard. The other two lugs, which are opposite each other, are for hoisting the buoy alongside for recharging.

C. *Another method of hoisting.*—Another good method of hoisting, used by many tenders, is to hook both the main and the relief on the buoy, one in each of the lifting lugs. This is made easier if a 1- or 1⅛-inch wire pendant about 7 feet long or more, with a suitable hook in one end and an eye in the other, is used between the hook of the tackle and the buoy. This pendant is easier to hook into the buoy-lifting lug, and eliminates the need for dragging the heavy main and relief around on the buoy. It also helps to keep the hoisting cables from fouling the buoy tower.

D. *Griping buoy in to ship's side.*—The buoy is hoisted (in either manner) evenly, so that it hangs vertically far enough out of the water that the seas will not affect it. Trimming the boom inboard immediately after, or while hoisting, will help to gripe the buoy alongside until it may be secured as described below. When the buoy body has been hoisted sufficiently high, cross-deck hooklines are led from cleats on deck, or from the windlass through snatch blocks on deck, to the buoy, in directions that securely gripe the buoy in alongside. They may be led as follows:

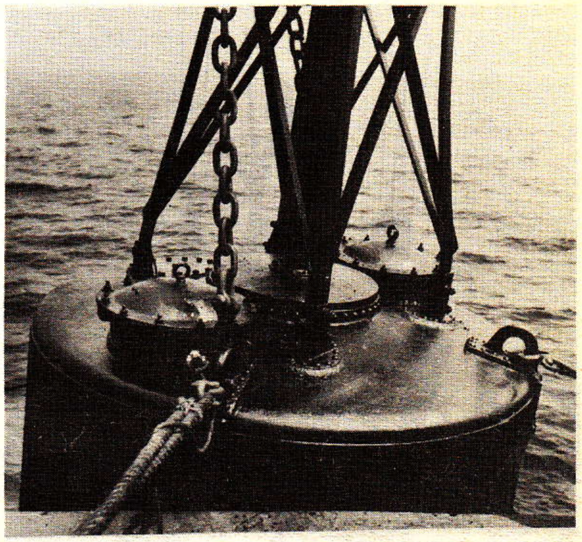

FIGURE 27–236.—An 8 x 26 buoy hung alongside on chain bridle on main. Wire pendant leads forward, hook line leads athwartships and slightly aft. If the weather were rough, another line should lead aft.

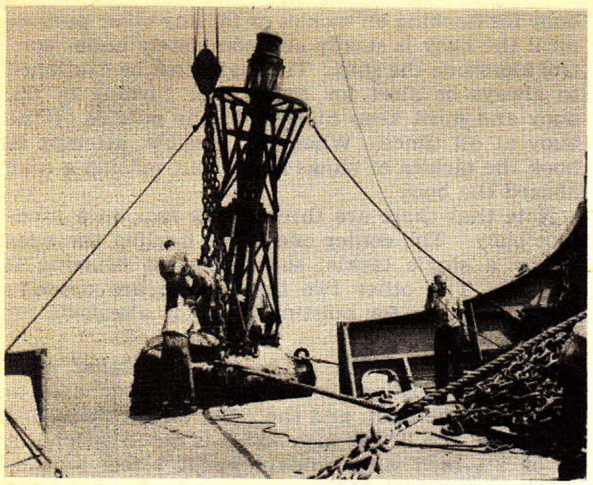

FIGURE 27–237.—A 9 x 38 lighted buoy being recharged. Note lack of hook line leading aft. Man is standing in dangerous position in bight of hook line. Note how chain bridle keeps hoisting cables clear of tower. Men working on buoys should be wearing life jackets.

(1) Lead one hookline out through the chock aft of the buoy port and hook into the buoy at or near the after lifting lug. Take up the slack and secure. Lead the other hookline out through the chock forward of the buoy port and hook on to the other lifting lug. Haul taut on the windlass and secure. The windlass may be required for other purposes, so the line is often shifted to a cleat or mooring bits. (The lines may be hooked into the neck of the lifting hooks or other suitable place on the buoy. There is generally not enough room to pass two hooks directly into the lifting lug.) Use at least 6-inch manila lines for the cross-deck hooklines. If possible, keep the mooring chain leading straight up and down or slightly under the ship to avoid putting too much strain on the griping-in hooklines.

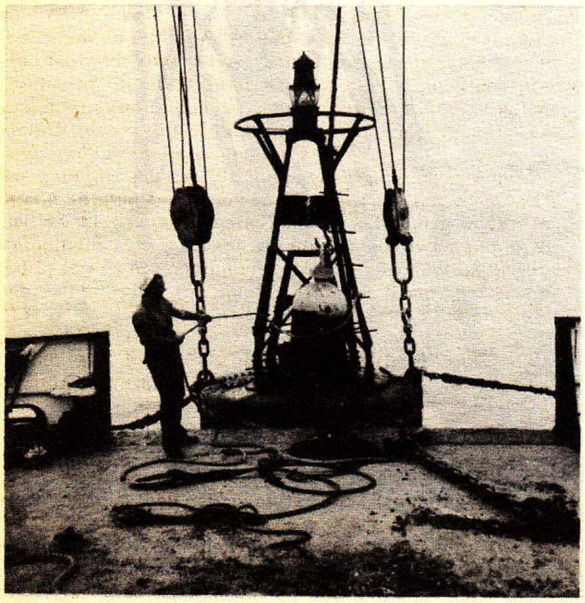

FIGURE 27–238.—An 8 x 26 buoy hoisted by the main and relief.

(2) Some ships lash the buoy in to the buoy port with wire pendants; some use a single cross-deck line leading to the center lifting lug, with fore-and-aft steadying guys. Some use a third cross-deck line leading directly athwartships in addition to the fore-and-aft lines described in (1) above.

(3) Another method is to lead a hookline out through the forward chock, out around the body of the buoy and back aboard, and hook into a padeye on deck further aft. Hauling taut the line will gripe the buoy alongside.

(4) In rough weather it is particularly important to use sufficient lines of adequate size to insure that the buoy will remain safely alongside.

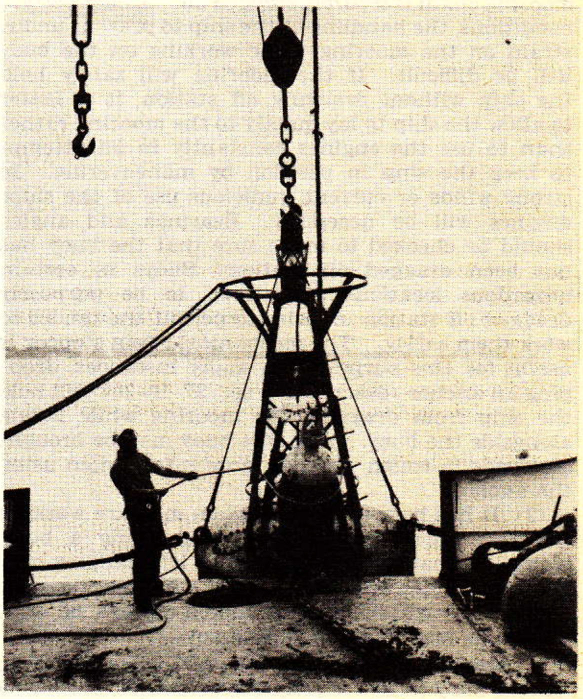

FIGURE 27–239.—An 8 x 26 buoy hoisted by a wire sling on the main. Note the preventer around the A–300 cylinder. Steadying hook lines lead properly but should be kept taut. Reverse the hook lines to turn the buoy around to work on the other pocket.

E. *Rigging hoisting-out gear for cylinders or batteries.*—On vessels equipped with a single whip in addition to the two heavy hoisting tackles, the buoy may be held on these two tackles, and the whip used for lifting out the cylinders or battery racks. Vessels not so equipped must either use a chain bridle and hoist the buoy on a single tackle, using the other one for handling cylinders, or hook a snatch block under the boom between the hoisting tackles, and use a manila line led from the windlass for hoisting the cylinders out. Have the new cylinders or battery racks ready on deck adjacent to the working area before hoisting the buoy, so that the boom will not have to be moved or the cylinders dragged over the deck. Be sure that the listing of the ship under the load of the buoy will neither topple over an unlashed battery rack nor start the cylinders rolling or sliding.

F. *Opening the pockets.*—Using only nonsparking tools, loosen the hold-down bolts on the buoy pocket covers. *Caution:* Follow instructions contained in the latest Engineering Memoranda when opening acetylene buoys. (NOTE.—The general procedures described herein, although stated for acetylene buoys, are applicable to electric buoys as well.) When loosening the hold-down nuts, do not turn the swing-bolts down until all the nuts have been loosened and the pocket cover seal broken by inserting a nonsparking wedge, etc., if necessary. Pocket gaskets properly prepared should not stick. Even in good weather, secure a steadying line to the pocket cover before removing it aboard with the whip or gantline. When the cover is landed on deck, use this steadying line to secure it there. When a large buoy is held alongside, the tender will have a list, large or small, depending on the condition of loading of the ship. Pocket covers can slide overboard while on deck.

Pockets found flooded may be easily pumped out, using a fire hose and mechanical foam pick-up (eductor principle).

FIGURE 27–240.—Lifting an A–300 cylinder out of a buoy pocket. A screw-pin shackle in the eye of the whip is safer than a hook. Men working on buoy should be wearing life jackets.

G. *Removing the cylinders.*—Close the valves of the cylinders and disconnect the tubing, using only nonsparking tools. Remove the wedges. Hook the lifting gantline or whip into the bail ofthe cylinder (a shackle is safer than the bare hook) and hoist slowly until the cylinder is nearly out of the pocket. Before hoisting clear, pass a steadying line around the lower part of the cylinder, take a round turn around the buoy tower and lead the end back on

FIGURE 27–241.—Opening a buoy pocket improperly. Note the stillson and monkey wrenches. Use only nonsparking wrenches of a type which will not burr the nuts.

deck to be tended and slowly paid out as the cylinder is hoisted clear. Use this steadying line even in good weather, since the boom's being trimmed inboard slightly from the vertical causes the lead of the gantline or whip to also be at an angle, and thus the cylinder, if unrestrained, would swing in a large arc once free from the pocket. Use at least a 3-inch steadying line. If water is found in the pocket, it must be removed, the pocket dried out, cleaned, rust removed, and painted.

H. *Installing new cylinder.*—When the old cylinder has been lowered to the deck and securely chocked or wedged in place, hook on to a fresh cylinder (many ships use a screw-pin shackle in lieu of the hook as a safety precaution when handling cylinders; it prevents the whip from coming loose when the cylinder touches the deck). Hoist it clear of the deck, steadying it with a line led out around the buoy as before. Two men then push the cylinder outboard while men on the steadying line pick up the slack. When the cylinder is aligned above the pocket, the gantline is surged, permitting the cylinder to slide in.

(1) A white chalk mark should be placed in the pocket before removing the old cylinder to indicate the alignment of the cylinder valve, otherwise making the connection may be difficult. This is more critical in the case of small buoys using A–50 cylinders, since the smaller circle of connecting tubing is stiff and more difficult to align. A new stainless steel tubing of great flexibility is now used. If necessary, a wooden or non-sparking metal bar may be inserted through the bail for turning the cylinder into correct alignment.

(2) The cylinder is lowered completely, wedges are driven tight, and the tubing connections are fitted with new washers and hooked up. Test carefully for leaks with soap solution. If using old-type gaskets, coat the pocket gasket generously with

wet or dry graphite, or sealing compound, as indicated. Buoys using the new type neoprene gasket need no grease or sealing compound. Any defective hold-down bolts (dogs) and poor gaskets should be replaced. When reinstalling the pocket covers, use the same procedure as in removing.

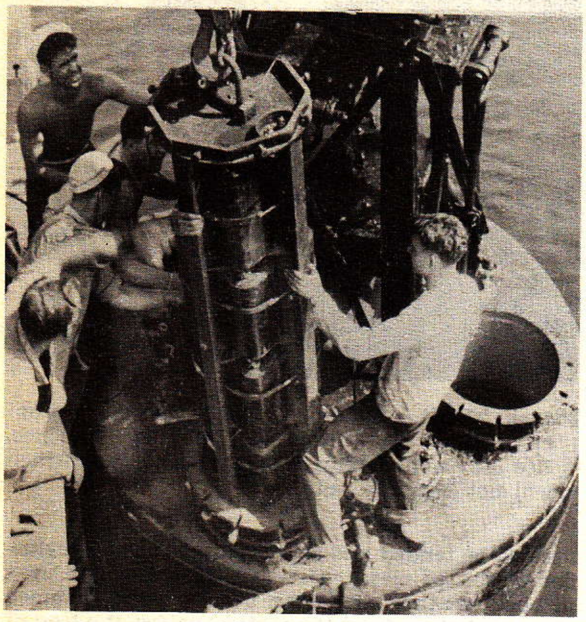

FIGURE 27–242.—Installing a battery rack in a large lighted buoy. Men working on buoy should be wearing life jackets.

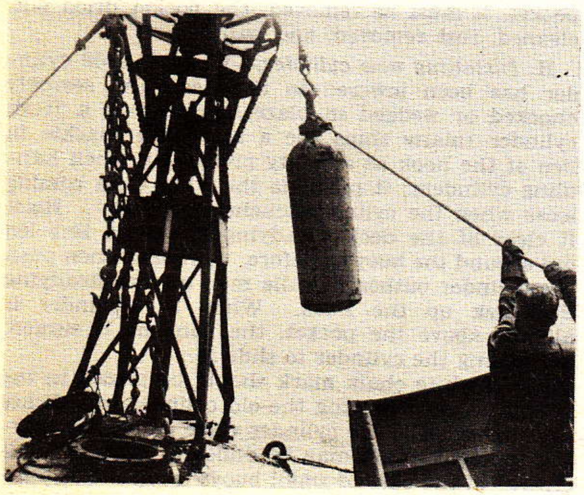

FIGURE 27–243.—An A–300 cylinder has been hoisted clear of the pocket and is being hauled aboard. Note that the steadying line does not keep the cylinder from swinging. In anything other than a flat calm, a line should be fast around the body of the cylinder and led out around the buoy and tended from the deck. See figure 27–239 for another suitable method. In very rough weather, use a steadying line in the bail of the cylinder as well.

(3) If the buoy is hanging on two tackles, one of the pockets may be outside of either tackle. If the opposite tackle is lowered a bit, the cylinder can be pushed through the opening thus made in order to reach the pocket.

(4) On 8 x 20 buoys there are only two lifting lugs, and one pocket will be on the outboard or opposite side. Thus, in order to pull the cylinder from the outboard pocket, the buoy must be turned by reversing the steadying lines and heaving the buoy around. In this case it is better to hoist the buoy on one tackle, using a double-branch sling.

(5) Flat-electric buoys are usually taken on deck for recharging.

(6) Recharging small buoys alongside is done in a similar manner to the large buoys described above. If taken up on deck, the cylinders are handled as described in section 27–5–5 for preparing buoys for service.

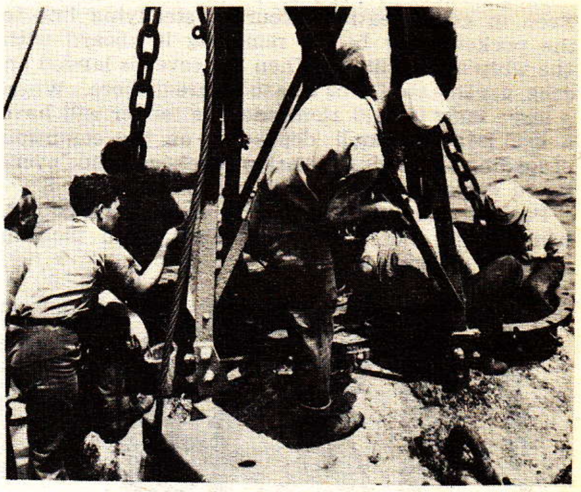

FIGURE 27–244.—Cleaning and touch-up painting goes on while cylinders are being exchanged. Men working on buoy should be wearing life jackets.

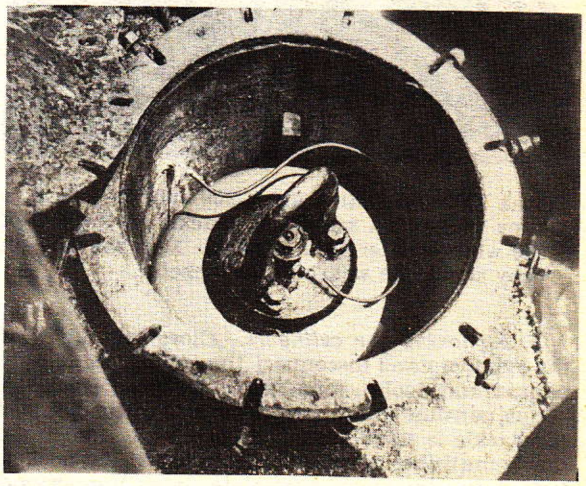

FIGURE 27–245.—An A–300 cylinder connected in a buoy pocket.

I. *Overhauling lantern.*—While the cylinders are being replaced, one man is aloft on the buoy inspecting and servicing the lantern and flashing mechanism. When the buoy has been recharged, the gas is turned on, the entire system checked for leaks, and the flasher permitted to operate for about 20 minutes before relighting to insure that all the air is worked out of the system. The buoy is then gaged, the pressure and temperature recorded, the pilot lighted (adjusted if necessary) and the characteristic checked. Be sure that the lantern top is properly secured. Always take plenty of time to insure that the light is functioning properly before leaving the buoy. Having to make an extra trip to relight a buoy is a chore to personnel and an expense to the Service.

J. *Cleaning and painting buoy.*—While being recharged, buoys are cleaned of sea growth and the paint is touched up where necessary.

K. *Lowering and releasing buoy.*—Before releasing the steadying hooklines and lowering the buoy upon completion of the operations, the ship should be swung to a favorable heading for withdrawing from the buoy. Then the hooklines and hoisting tackle(s) may be quickly released and the vessel set away from the buoy. If the buoy is held on a bridle on one tackle, it may be well to hook the other tackle into the buoy and take a strain to permit easier recovery of the chain bridle. The use of wire pendants in hoisting the buoy permits quicker and surer release of the buoy than when the large hooks of the hoisting tackles are hooked directly into the lifting lugs on the buoy. When the buoy is hooked on two tackles, one of them is held to take the strain while the other is unhooked. Then the buoy is lowered on the remaining tackle and cast loose.

Under ideal conditions, casting off the buoy is no problem. However, in rough weather it is necessary to lower and unhook quickly and swing the ship away before the buoy has time to bang against the side of the ship. It does not take much of a jar to extinguish the light or break a color shade or lens.

L. *Verifying position.*—The position of the buoy should be verified before completing the recharging operations. Local ranges can be observed during the operations to indicate dragging.

M. *At every recharging.*—In every instance when an acetylene buoy is recharged, a sounding is taken, lantern, pilot, burner, lens, etc., checked and cleaned, the light checked for proper characteristic, and the buoy gauged and the pressure recorded.

N. *Electric buoys are handled in much the same manner as described for acetylene buoys in the foregoing paragraphs, with the exception of the different apparatus involved, i. e., batteries, flashers, lamps and lampchangers in lieu of cylinders, flasher-regulators, burners, etc.*

O. *When relighting an acetylene buoy,* a similar procedure to that described for recharging may be followed, except that the cylinders are not exchanged. The position of the buoy is checked, lens, burner, pilot, etc., inspected and cleaned, characteristic of the light checked and adjusted if necessary, and the buoy gauged. If less than four atmospheres, the buoy is generally recharged. If the weather is favorable, a man may be placed aboard the buoy for relighting. Otherwise the buoy is brought aboard or held alongside the tender. The following method of securing a buoy alongside for relighting is in use aboard one 180-foot class tender:

"Rig a system of fairleads from the deep-sea anchor drum (180-foot class tender only) on the windlass so that a bight is formed by the wire cable on the port side. (The lead is taken from the starboard side to prevent any chance of injury to the windlass operator should the wire or fairleads part.) The bitter end of the deep-sea anchor wire cable is secured on deck and rigged with a pelican hook for quick release. The buoy is then snared in the bight and the wire taken up taut with the windlass. Thus held alongside, the buoy is steady and it is relatively simple to work on the lantern. This method is especially advantageous in the case of heavily iced buoys which cannot be worked by small boat.

P. *De-icing a lighted buoy.*—Lighted buoys sometime accumulate large amounts of ice above the water line, and in the case of acetylene buoys, ice is sometimes found inside the lantern. This is due to the buoy being run under the water.

One method of de-icing a buoy is as follows: The buoy is brought alongside, and a chain or wire rope lasso is passed over the tower and hoisted on the whip until the lifting lug may be cleared for hooking in the main or relief. If there is little strain, the buoy may be held alongside on the lasso by trimming the boom well inboard. A 1½-inch rubber-covered hose is led out ready to spray hot salt water (approx. 140° F.) on the portion of the buoy to be de-iced. (Older-type steam-powered tenders use a steam line for de-icing purposes.) On acetylene buoys, the lantern top is opened and the drainage hole in the bottom of the lantern pot is cleared. The hose is then played directly on the flasher and other parts of the lantern necessary to de-ice. This procedure does not harm the flasher. Hot fresh water is used to flush away the salt, and the parts are then thoroughly cleaned with alcohol.

27–5–60 Handling Spar Buoys—

A. Spar buoys are handled in a somewhat different manner from other unlighted buoys. Working with wooden spars is often difficult, and may be hazardous due to danger of splintering or breaking the spars. The buoys are not pulled across the deck as other buoys are, nor are there any lifting eyes to hook the hoisting tackle in. A table in chapter 24 (fig. 24–35) shows recommended sizes of spars for certain depths. That length spar should be selected which watches fairly vertically in slack water.

If the water is too deep and less than one-third of the spar will be out of water, a short length of chain must be connected between the bail of the spar and the sinker. Usually it is best to always use a short length of chain between spar and mooring. Then if a ship's propeller strikes the spar, there is some give, and not as much chance of the mooring eye on the spar being torn out. Also a short length of the end of the chain can be left free to stop off in the pelican hook or mechanical chain stopper, instead of running a tripping or slip line through the shackle or bail for a stopper. Even if the spar is shackled directly to the sinker, a short length of chain will be useful for stopping off.

B. *Preparing the spar.*—If the spars are not painted when delivered to the tender, they should be given two coats of copper-bottom paint and two coats of color enamel on the bottom and top halves respectively, and numbered as appropriate. The size of the numbers should be 14 inches on first-class 10 inches on second- and third-class, and 6 inches on fourth-class spars. Various tenders load spars in different directions, some with the bails forward, some aft. It is largely dependent on the general arrangement of the buoy deck and what other deck load is aboard.

C. *Procedure for setting the spar.*—When approaching a buoy to be relieved, the new spar may be prepared for setting as follows: (*Described for a tender having whip, main, and relief hoisting tackles; other boom types may adapt procedures as pertinent*). Top the boom up so that the whip hangs over the spar at about the upper one-third of the buoy as it lies on deck. Pass a sling chain around the spar, passing one end of the chain through the other to cinch it down on to the buoy. A length of 2-inch manila is secured to the lower eye of the sling chain as a recovery line. Hook the whip into the chain sling and hoist the spar vertically. Swing it over to the buoy port and connect the chain (if any to be used) and sinker. Then lifting the spar and sinker clear of the deck, hoist them over the side and when on station, lower away. When the sinker is on the bottom, the chain sling is loosened by pulling on the recovery line. Should the spar or the chain be too long to be lifted in one hoist of the whip, pick up the sinker on the main and put it over the side, slacking away until the entire weight is back on the whip. Clear the main and proceed as above.

D. *Another method of setting a spar is as follows:* Pick up the spar on the whip with a chain sling at the balance and bring it fore and aft with the butt end at the sinker in the buoy port. Shackle the spar to the sinker and meanwhile pass a line around the top end of the buoy, securing it on a cleat to prevent the spar from rolling overboard. Clap on a chain sling and pick up the butt end of the spar and the sinker and hang them over the side on a stopper, holding the top end of the buoy fast in the light stopper. The butt of the spar can rest on the sinker. When on station, trip the sinker stopper, and at the same time cast off the line holding the head of the spar at the gunwale. Maneuver the ship clear of the buoy. Most tenders work with the butt end of the spar and sinker forward, although, some ships stop the sinker off aft. Either way is satisfactory. Some tenders pass an additional light manila stopper line around the lower part of the spar, although if the butt end is resting securely on the sinker, this additional stopper should not be necessary. A steadying line may be passed to the top of the spar while moving it around on the deck. It should be removed before setting.

E. *Parbuckling spars over the side.*—If there are many spars to be worked, to save time they may be parbuckled two to a side, one on top of the other, and secured separately. The moorings are then attached. Set the top buoy first.

F. *Procedure with mechanical chain stopper.*—If the tender is equipped with the mechanical chain stopper, the following procedure is used: The spar is hoisted by the butt, and after being connected to the sinker so as to balance with the sinker attached, it is hoisted over the side and the end of a short length of 1⅛-inch chain (at least 8 links) which was secured to the sinker or spar, or left over if a connecting chain was used, is placed in the jaws of the chain stopper. The butt of the spar rests on the sinker. The top of the spar is supported by a stopper line, or on one ship, a metal arm ("spar rest"), located about 25 feet abaft the stopper, which swings out over the bulwarks to hold the top of the spar. With the "spar rest" there is no need for stopper lines of any sort, and tripping the mechanical chain stopper automatically sets the spar with maximum speed, accuracy, and safety to personnel.

G. *Handling iron spars.*—Iron spars are worked in a similar manner to wooden spars. Use a good short strap on the top of the buoy and lift the end with the relief so as to be able to pass a heavy rope endless sling around the balance point. Pass one bight of this sling through the other and hoist the buoy with the main. Then handle the buoy as described in paragraph (D) above.

H. *To recover the old spar buoy,* proceed as follows: As the buoy comes alongside, pass a long sling chain around the spar or drop a chain lasso over the top. Hook the whip into the chain while sliding the bight down the buoy as far as possible so as to be able to get the most lift. Meanwhile, secure a steadying line around the top of the spar with a timber hitch. Hoist the buoy. When the spar is two-blocked, pass another sling chain around the buoy at the deck level, and either secure it in a pelican hook or hook on the main and set up taut. Then, if on the main, lower the whip and main together until the upper sling chain can be removed, then hoist again with the main. If held on the stopper, lower the whip and pull the sling chain down for a fresh bight; hoist again with the whip. While the buoy is being hoisted, clean the sea growth off. When the buoy is clean, hoist it so that the mooring comes up on deck. Trim the boom in to bring the sinker aboard. Lower the spar to the deck before unshackling, since it may be unbalanced when loose from the sinker. Short spars generally can be picked up in one hoist.

(1) When the spar and mooring are aboard, with the spar held vertically on the whip, the boom is swung in and the whip lowered enough to put the sinker on deck and allow the men to disconnect the chain from the buoy. As stated above, sometimes it is better to lower the spar to the deck before disconnecting the mooring, since it may be unbalanced when loosened from the sinker. A hookline is then attached to the bail of the spar (the hookline runs from the forecastle deck to a snatch block at the aft end of the buoy deck and then forward to the

spar buoy). The boom is brought inboard to the position over which it is desired to stow the old buoy. A strain is taken on the hookline hauling the bail end of the spar aft, and the whip is lowered until the buoy is fore and aft and horizontal with the deck. Then the buoy is lowered to the deck, whip unhooked, sling chain removed, and the hookline cast off.

(2) It is easier and better if spar buoys can be worked exclusively on one load without mixing them up with other types of buoys. Rings and keys are used on the buoy shackles connecting the spar buoy to the mooring and the mooring to the sinker, because they are faster and easier to connect or remove.

I. *Procedure with mechanical chain stopper.*—For ships equipped with the mechanical chain stopper, the following procedure is suggested: Pass a long chain sling around the spar as low as possible and hoist on the whip or main. When two-blocked, pass a short chain sling around the spar and place the end into the jaws of the stopper. Lower the spar slowly until the stopper sling takes hold. Then pass another short sling around the spar just above the stopper, lower the tackle, remove the long sling and hook into the second short sling. Hoist away, leaving the stopper sling to slide along the spar as it rises. Clean off the sea growth as it comes up. Should the second hoist be insufficient, the stopper sling chain is already in place ready to grab the spar as soon as the weight slacks. For the average buoy, one or two hoists will be enough to bring the sinker to the deck. If the sinker is to be reused, it may be stopped off directly in the mechanical stopper without being brought aboard. However, if the spar is to be unshackled while held vertically, be sure to secure a preventer line to the butt in case the spar is unbalanced when freed from the sinker. It is always better to lower the spar to the deck before unshackling. Then pick up the buoy with a strap or sling at the balance for shifting around on deck. If the sinker is to be brought in on deck, hoist until the sinker is just below the stopper, then top the boom up to bring the sinker up on deck abaft the stopper.

J. *Other methods.*—As with any type of buoy, there are other methods of handling which may be just as adequate. However, the majority of tenders handle spars in much the manner described.

27–5–65 Recovering Buoys Sunken or Washed Ashore—

A. *Sunken buoys.*—All tenders are called upon from time to time to drag for sunken buoys. Most vessels are equipped with large cumbersome grapnels weighing 400 to 500 pounds. The weight of the grapnel makes it necessary that the ship itself tow and handle the grapnel in combing the area. This is a slow and tedious process, many times ineffective because of the presence of a shoal area nearby, thus restricting the movements of the ship. In the case of 6 x 20 lighted buoys or smaller, a specially designed grapnel weighing about 100 pounds has been used, handled entirely from a small boat, which because of its maneuverability, can comb in minutes an area that would take the larger vessel hours.

B. *Towing the grapnel.*—At times, dragging for sunken buoys is performed in a perfunctory manner with only a half-hearted belief that the buoy will be recovered. No doubt of its recovery should exist, providing the buoy has sunk on station and the work is carried out systematically and thoroughly. The most common fault is that the grapnel is towed too fast, thus causing it to hop along over the bottom only touching occasionally. When towing from a small boat, this can be determined by a person placing or keeping a hand on the towline and feeling the continual tugging of the grapnel as it scrapes the bottom. If towing with the ship, make fast a line to the dragging chain a few feet away from where the end is shackled to the deck. With a few turns of this line around the gypsyhead of the windlass, a sudden strain will readily be indicated by the surging of the line. Towing too fast can be dangerous in the case of a small boat, for if the grapnel should hook into something suddenly, it may pull the stern of the small boat down and swamp it.

C. In dragging for a sunken buoy, place a few marker buoys to outline the area. In addition to confining the dragging to the desired area, they aid in insuring that the various passes back and forth are parallel and relatively close together. If no results are obtained, the areas should be criss-crossed.

D. *Procedure.*—When using the heavy grapnel, proceed as follows: Use ¾- to 1½-inch chain, depending on the size of the buoy to be recovered, shackled to the grapnel. The scope of the chain should be at least three times the depth of the water. Shackle the inboard end of the chain to a padeye on deck and drop the grapnel over the side. Have way on the ship, otherwise the chain will pile up on top of the grapnel and thus fouled, it will not hook anything. With the grapnel on the bottom and the ship going ahead slowly, hook a cross-deck line into the bight of the chain at the edge of the buoy port and heave it forward with the anchor windlass. Keep three or four turns of the line on the gypsyhead of the windlass until such time as the sunken buoy or chain is hooked. This will be immediately noticeable as the additional strain will cause the line to surge on the gypsyhead. Stop the engine but keep a forward strain on the chain with the ship until sure that the grapnel is securely hooked in. Haul the chain aboard. Do not let the chain lead exactly vertically.

E. Figures 27–245A and 27–245B illustrate a new type of grapnel successfully used under difficult conditions. The grapnel was used as follows:

"The main lifting tackle cable was removed from the drum on the boom and about 300 feet of ⅞-inch wire rope was installed on same, to be used as drag cable. A fairlead block was secured on deck just forward of the main hatch. The cable was rove through this fairlead block and secured to a length of 1½-inch chain which was in turn secured to the grapnel. The bight of the cable was passed through a snatch block just forward of the fairlead block. A 6-inch line was made fast to the snatch block and led to the starboard gipsy on the anchor windlass, being hove in until the snatch block was up against the fairlead on the for'c'sle head. The drag cable led out the port buoy port. This arrangement gave about a 35-foot bight in the cable which could be slacked should the grapnel became hung up on a rock, thus giving sufficient time for the ship to be stopped before the cable parted. Since the dragging in this case was done in 11 to 13 fathoms of water, 15 fathoms of chain was used to permit hoisting directly on the chain when the grapnel caught something." Although armor plate was used to fabricate the grapnel in this case, it is believed that mild steel of similar dimensions would be adequate.

F. *Fouled grapnel.*—Take care not to drag over cable or restricted areas. If a cable comes up fouled in the grapnel, there will usually be a tremendous strain, and the cable must be securely stopped off, preferably on both sides of the grapnel, before attempting to clear it. Strong wire straps in pelican hooks can be used for stoppers.

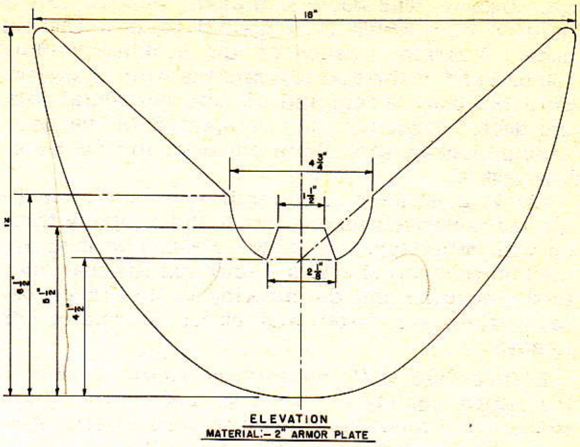

FIGURE 27–245B.—Hook for grapnel.

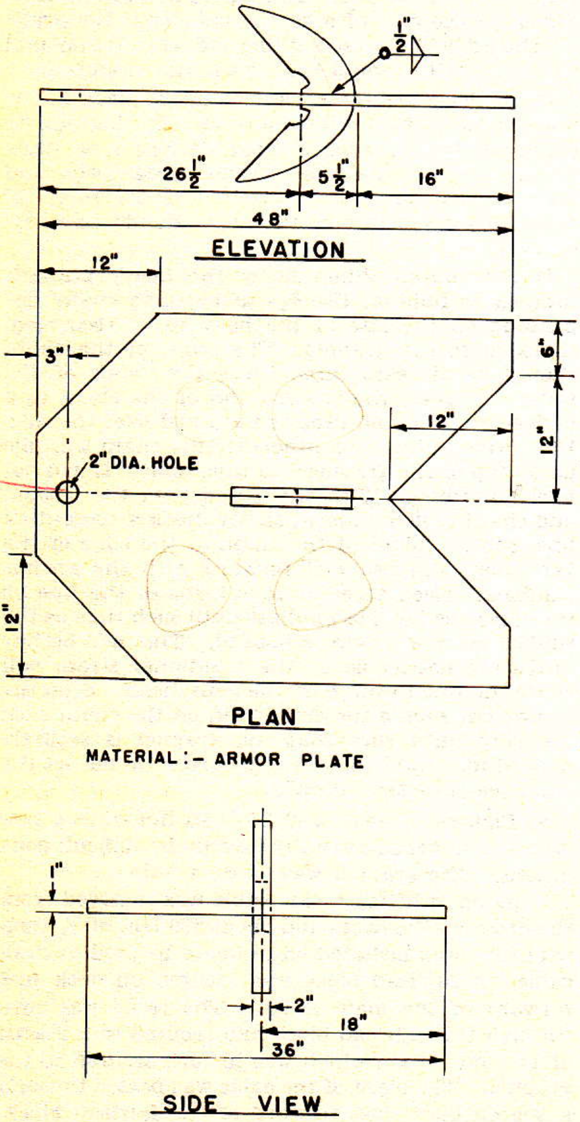

FIGURE 27–245A.—Detail of chain grapnel.

G. *Caution.*—Take care to ventilate the lantern of a sunken acetylene buoy thoroughly, and flush it out with fresh water.

H. *Buoy washed ashore.*—To salvage a large buoy washed ashore, the tender may have to send a party ashore to disconnect the mooring before attempting to pull it off the beach. There is a possibility of parting even a 10-inch manila hawser if an attempt is made to drag a buoy which is attached to a mooring sunk deep in mud or sand. If the buoy is in the surf with mooring attached, at low water it could be dragged clear of the water by running a hawser through a snatch block attached to a sand anchor or a "dead-man" ashore. By pulling in this fashion the working party may have a chance to disconnect the mooring, and then throw the hawser out of the snatch block and pull the buoy into the water. The hawser is always attached to one of the hoisting pads on the buoy except when the buoy is towed through shallow water by a small boat. The towline of a small boat is attached to the crown of the cage, and thus the buoy is tipped down when pulled and there is less chance of the tube snagging on the bottom.

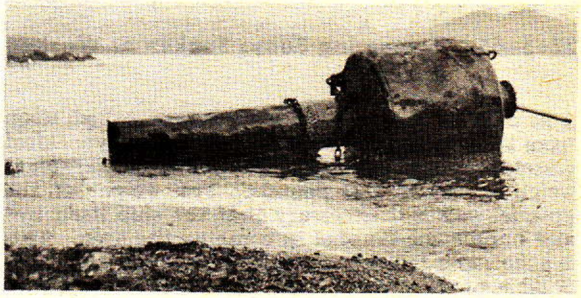

FIGURE 27–246.—Typical remains of a buoy washed ashore.

27–5–70 Towing Buoys Back on Station—

A. Buoys are frequently found off station and must be towed back by the tender. In good weather there is little difficulty in hooking on a ⅞- or 1-inch wire pendant or a short length of chain leading from a padeye on the buoy deck to a hook in the lifting lug of the buoy.

Some tenders make the towing line fast from the bow to keep the buoy from having a tendency to drag under.

B. Undue strain must not be placed on either piece of equipment. The slack must be taken up slowly and with strain taken, the engine power slowly increased until the mooring chain is felt to be fully stretched. Greater power is then applied to break out the sinker. To increase power too rapidly once slack is taken out of the drag chain or pendant may cause undue stress on the mooring if secured to a well-sanded-in sinker, thereby parting the mooring chain with the resultant loss of chain and sinker. If there is any difficulty in breaking out the sinker, it may be worked free by taking a strain in various directions.

C. *Towing with the boom.*—Towing buoys by hooking on the hoisting tackle of the boom is not recommended except in cases of very small buoys where the strain would be negligible. Attempting to tow from the boom of a 180-foot B or C class (double topping lift) tender could easily jackknife the boom back over the bridge with disastrous results, unless one of the boom tackles was hooked into the deck.

D. *Towing buoys in rough weather.*—The following method of towing large lighted buoys under unfavorable conditions has been suggested:

"When lighted buoys have been dragged off station as a result of a strong gale, there will generally be a confused sea for some time after the gale has subsided, which makes it difficult and dangerous to pick up the buoy or tow it alongside back to station. However, if the sea is not too rough for a motor cargo boat, the buoy can be towed back on station. First, place a marker buoy on station as a guide. Then lower the small boat and put two capable men on board the buoy to secure the towing hawser. The men will secure a snatch block to the cage of the buoy. Anchor the tender to windward so that when sufficient chain has been veered to insure against dragging, the buoy will be 50 to 75 feet astern. Pass the bight of a 4-inch messenger to the buoy and secure it in the snatch block. Bend the messenger to a 10-inch hawser, a couple of fathoms from the end, and heave it back to the buoy, holding it two-blocked at the snatch block until the men have secured the end to one of the lifting lugs of the buoy. Remove the men from the buoy. Heave in the anchor and pay out on the hawser until the anchor is aweigh. If difficulty in unshackling the hawser is anticipated, leave the messenger rigged so that slack may be given the men on the buoy for unshackling.

"Tow the buoy back on to station, approaching from exactly down-wind so that the buoy will be directly astern of the ship, and the ship will not be making leeway. Estimate in advance the distance that it will be necessary to tow the buoy past the marker in order for the sinker to arrive on station. Pass this information to the boat crew and have them stand by to signal when this point is reached. When the buoy is on station, heave to and unshackle the hawser and recover the snatch block."

27–5–75 Unloading Buoys and Appendages—

A. Many of the same procedures described under section 27–5–1 can be followed in unloading. Before buoys are unloaded they should be inspected, and defects noted and marked for repairs. Move the ship as necessary to properly place the buoys on the dock and take care not to swing the boom too far aft, particularly in the case of 180-foot class A tenders when it is topped down low. Space the large buoys on the dock to permit sufficient working room around them if possible, to decrease the need for future handling when being overhauled. *See that the buoys are safely and securely blocked before leaving them.* Maintain a close liaison with the depot as to the placement of buoys ashore. Take care not to damage the wharf when unloading nine-foot buoys. As the buoy touches the dock, release the hoisting tackle immediately (if an electric hoister, lower away at full speed) allowing plenty of slack for the ship to roll back from the list.

B. When a buoy has been relieved at sea, after the mooring is aboard and the buoy cleaned of sea growth, the batteries or cylinders are removed. *Take all usual precautions when opening the pockets of either acetylene or electric buoys. Impress on the crew that opening a buoy pocket is one of the most important functions of buoy work and is potentially hazardous.* If the buoy is lying on deck, cylinders (or batteries) cannot be hoisted out by directly hooking a hoisting tackle into the cylinder because of the poor lead out of the buoy pocket. A handy-billy tackle can be rigged from the cage of the buoy to the cylinder, and when the cylinder is hoisted about halfway out of the pocket, a strap can be passed around the middle and a strain taken on the power tackle.

Another method is to secure a heavy line on deck and pass the end (with an eye in it) through the ring of the cage on the buoy, down through the bail of the A–300 cylinder, and lead the end back out of the pocket to a power hoisting tackle (the whip or main). Hoist handsomely, and when the cylinder is halfway out of the pocket, stop and pass a strap around the midsection and hook on another power hoisting tackle to take a slight strain. Now heave the cylinder the rest of the way out of the pocket and lower it to the deck on the other tackle.

C. Many depots will not accept buoys from tenders unless they are cleaned of marine growth, bridle and mooring totally unshackled, and cylinders or batteries removed. When a depot is required to perform this work, unnecessary labor costs mount and a refuse disposal problem is created.

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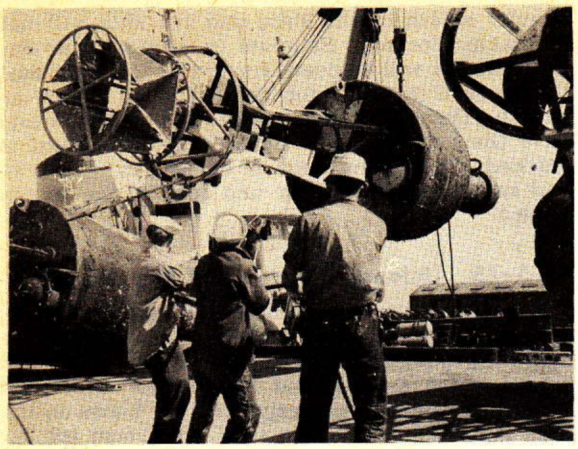


FIGURE 27–246A.—Unloading a 9 x 38 buoy (with radar reflector) on the dock of a depot.

27–5–80 Removal of Wreckage of an Aid to Navigation—

A. Whenever a tender removes the wreckage of a damaged or destroyed aid to navigation, the site should be inspected to determine that no wreckage constituting a menace to navigation remains. Every reasonable means should be employed to insure this fact.

(1) This can best be done by sweeping with a rope, wire, or chain drag stretched between two vessels or between the tender and her motorboat. The drag should be weighted in the center sufficiently to keep it on the bottom as it is towed slowly. If the motorboat is not available, the site can be dragged by attaching the drag to a sinker and circling the site with the sinker at the center of the circle. Any obstructions found should be removed. Even though the obstructions are under water, if ingenuity and good seamanship are used, it will generally be possible to remove most of them.

(2) Use of a lead line, dragging a grapnel astern, fathometer soundings, etc., are not satisfactory methods of locating wreckage inasmuch as it can easily be missed.

B. When a tender rebuilds an aid which has been destroyed with no wreckage visible, the same procedure should be followed to find the wreckage prior to rebuilding so that the new structure can be built upon the site or immediately next to it. A larger area may have to be dragged.

C. These instructions do not include removal of any piles which will be used in the new structure. In the work of dragging, it will be useful to have a small buoy or marker prepared for immediate placement if the obstruction is found and the drag slips over.

D. In all cases of the removal of wreckage or the rebuilding of wrecked structures, tenders will report whether the site was dragged and whether obstructions remain. Only in those cases where after diligent effort it has been found impossible to remove the wreckage will it be allowed to remain. In such cases it shall be buoyed with whatever equipment is on hand and report made as to type, color, and number of buoy and location in yards and degrees from the wreckage. Such a buoy shall be as close to the wreckage as possible on the channelward side.

27–6 AIDS TO NAVIGATION WORK ASHORE, COASTAL WATERS

27–6–1 General—

A. Where aids are located on outlying islands or at shore locations inaccessible to vehicles, and where no docking facilities are available, the problem of landing maintenance gear, batteries or cylinders sometimes requires sheer ingenuity. Personnel servicing shore aids in steep rocky areas must be trained to be alert, sure-footed, strong, and in good physical condition. On precipitous cliffs, it is common to erect an A-frame or sheer legs, sink a "deadman" in the ground, or secure tackle or snatch block directly to a tree or to the structure, in order to hoist gear from the beach or boat below. The motorboat is often used as a source of power for hoisting. Gear is carried ashore in various types of craft; motor cargo boats, rubber liferafts, dories, skiffs, landing barges, etc., the particular unit being chosen to meet the specific need. In areas where landing is impossible with a dinghy, skiff, or motorboat, or where there is extreme rise and fall of tide, where mud flats extend for long distances from shore, aids are worked by means of a rubber liferaft. Paddles are used for propulsion. The rubber boat has also been found useful for work in heavy surf and rocky landings. When servicing aids by means of a skiff, use a flat-bottomed one; it is more stable for carrying heavy gear than a round-bottomed boat.

B. *Preparation.*—Careful planning will eliminate needless trips by the workboat. Explain to the officer in charge of the working party exactly what is expected to be accomplished and check carefully to see that some essential item of equipment is not left behind. Portable radio equipment is widely used in this work. Maintain a check list for servicing parties to insure optimum performance of the aid. Carry small tools ashore in a canvas bag. Additional gear such as roofing material, hinges, boards, etc., are taken shore when needed for repairs. Lay out the work, when possible, for a time when the prevailing winds are off-shore.

C. *Tide.*—Know the state of the tide when working a shore aid. Certain aids may be worked only at certain stages of tide. In areas with a large tidal range, the handling of cylinders and batteries is easier at high water. Plan to begin the work before the tide starts ebbing. If the water is falling fast, the boat may have to stand off clear.

D. *Motorboat.*—Maintain a continuous watch in a boat laying to while the working party is ashore. A boat can easily be hung up on the riprap with a change of tide or wind. Watch out for projecting bolts or sharp ends of timbers sticking out from marine structures. When in an area with rapidly rising tide such as Cook Inlet, Alaska, the motorboat should be kept close at hand until the men are safely above the high water mark. Watch out for quicksand areas such as are present in Bristol Bay, Alaska.

E. *Approaching the aid.*—It is better to approach a marine site from leeward and, if possible, land on the side of the structure that has ready access to the door of the tank or battery house, if not on the weather side. Stem the current, if strong. Avoid colliding with the foundation of the aid. Except under ideal conditions, it is better to drop an anchor offshore and approach cautiously. If an anchor is used, a tripping line should be provided. See section 27–10–50 for further details regarding landing small boats. When servicing a light on a breakwater, an anchor may be dropped as the small boat approaches bow on to the riprap to land the men. Then, weather permitting, bow and stern fasts are passed ashore and the anchor line shifted to lead from amidships to breast the boat off the breakwater. Use long leads on the bow and stern fasts.

F. *Inland waterways.*—When operating motorboats in inland waterways, slow down if you must leave the channel and when going close aboard bridge fenders, wharfs, etc., to avoid striking tree limbs and other debris that may jammed between the piling beneath the surface. Be cautious, even if you knew it was clear the last time you were there. Take advantage of the current when making a long trip in a small boat, to reduce the time of operations.

G. *Slippery conditions.*—When servicing aids ashore in winter under icy conditions, or when landing on slippery kelp-covered rocks, take along a bucket of sand to spread in the way of the working area.

H. *Ladders.*—Many structures which are located in exposed areas have ladders on the side sheltered from the prevailing winds. In the case of round or nearly so structures, this ladder is at the point where the waves rounding each side of the structure meet, and in winter will form considerable ice as the spray rises in the air. Personnel must use extreme care. Before climbing any ladder, check it for rotten or missing steps.

I. *Landing data notebook.*—Certain vessels maintain landing information notebooks which contain local data and photographs. An example of a typical entry is as follows:

"Mitrofania Island Light, LL#2550, Pacific Coast Light List, is perhaps one of the most difficult lights to service in the entire Alaska area. It must be worked near high water and in a calm sea. A rubber liferaft is extremely useful for ferrying personnel and material ashore from the small boat. In order for personnel to scale the cliff, a line is lead around the southeast side along a crevice. The danger to personnel handling material is magnified by slippery rocks and loose shale. This vessel has been delayed for many days awaiting favorable weather conditions to work the light. Attached are four photographs taken of the landing operation and position of the light. The landing conditions were considered good at the time; the sea was comparatively calm."

J. *Hoisting acetylene cylinders or batteries.*—Various methods are used to haul acetylene cylinders or batteries up to the structure of shore aids. Luff tackles of 21-thread line are used at many structures where the tank house is above the ground or on a marine foundation. Round bar davits are installed at some aids; at others the tackle must be secured as best one can. Carefully check the frame of the structure, or wherever the tackle is to be made fast, before hoisting. A common place of making fast is at the intersection of the tower cross-braces.

(1) When hoisting A–25 cylinders up a sheer cliff with a hauling line rove through a snatch block, the cylinders can be made fast as follows; put a clove hitch over the cap end, then a half hitch with one of the lines around the butt end about 10 inches from the butt; make a half hitch with the other line close to the first one; then a second half hitch with the first line, placing it close to the first one. This gives two half hitches with one line and one with the other, which is in the middle. When lowering, an additional half hitch is placed over the cap end using the line leading into the boat. Never apply a sling directly to the neck of an acetylene cylinder valve.

(2) Cylinders can also be hoisted by the special lifting cap (if not using the adjustable cap, check the threads carefully; see Ch. 20), or by a sling. One method of slinging is to take a line with a loop in the end, place the loop over the neck of the cylinder and then pass several half hitches around the body, well spaced apart, and hoist the cylinder upside down. Be careful, if slinging cylinders by means of an endless strap in the conventional manner, that the strap is well spread. A dropped cylinder can lead to a catastrophe. Cylinders should generally be hoisted one at a time and an empty one sent down with each trip. Keep a tail line on cylinders to slack away or hold as needed, to prevent cylinder from striking the foundation or rocks. A heavy thrummed canvas sling, similar to a collision mat, has been used for hoisting cylinders. Cylinders may also be hoisted in a cargo net.

(3) Take care when transferring a heavy A–50 cylinder into a small skiff or dory, when the motorboat cannot land. One cylinder in the boat at a time should be sufficient. When hoisting cylinders directly from the boat to the light, move the boat immediately out from under until the cylinder is clear. The same applies when lowering. Wait until the last minute before moving the boat under to receive the cylinder.

(4) The cargo boats of one tender have been equipped with small davits and a step hold on one side of the thwart forward of the engine compartment for use in hoisting A–50 cylinders in and out of the boat.

K. *Other methods of handling cylinders.*—In the case of shore lights easily approached, cylinders are carried from the boat to the light. An experienced husky man can carry an A–25 cylinder alone. However, whenever possible, and especially in rocky or slippery areas, use two men. When carrying cylinders over a boulder-strewn beach or slippery ledge, take care not to drop them.

(1) In certain instances where the only convenient landing point is some distance from the aid and the approaches to the light are fairly smooth and level, a small two-wheeled cart has been successfully employed in carrying as many as four A–50 cylinders at a time.

(2) The following method of handling cylinders is in use on board one tender; make a carrying bar, ¾-inch diameter, 42 inches long with a circular half bend in the middle to fit the contour of an A–50 cylinder. Use a section of rubber hose to fit over the iron bar to prevent slipping. Three men handle the cylinder, one on each handle of the bar and the other carrying the valve end of the cylinder.

(3) Short manila toggle straps can be made for four men to carry an A–50.

(4) A two-wheeled hand truck made of angle iron and thin wall conduit with pneumatic 14-inch tires, having a two-pronged fork instead of the conventional halfmoon-shaped bibb, has been useful in moving A–25's over soft sandy levees and over rough uneven ground.

(5) In transporting cylinders in small boats, removable wooden racks, notched to hold the cylinders, are useful. When cylinders are stacked in tiers, burlap bags placed between them will help to prevent slippage in the event of excessive rolling of the small boat. Keep protection caps on at all times.

(6) An acetylene cylinder skid rack for sliding them ashore can be made from two pieces of oak, 3 inches x 4 inches x 18 feet, bolted together so as to form a track. Space the pieces and cut a bevel on the inner sides to form a race that will fit the perimeter of an A–50 cylinder. Blocks on one end may be attached to clasp the gunwale of the boat so that the skid will serve double duty as a fend-off. Short battens fastened to the underside of the skid opposite the race will serve as steps for a gangway.

(7) The following method has been used for loading and unloading cylinders from a boat; provide a quantity of 21-thread manila straps 8 feet long with an eye spliced in each end. Spot the boom so that the hoisting tackle hangs just clear of the center of the buoy port. Arrange all the cylinders, each with its strap rigged by passing one eye over the neck of the cylinder and making two half hitches around the cylinder near the other end, and lay them out in the way of the buoy port. Hook the free end of the straps onto the hoisting hook, and when the boat is alongside, place them in the boat. In rough weather, the small boat can ride alongside on a seapainter and receive the cylinders safely. Cylinders may be unloaded similarly. This method obviates the hazards incident to balancing the cylinders around the middle with the conventional endless strap.

L. *Examples of servicing procedures.*—The following examples illustrate some of the procedures required for servicing shore aids. (These were furnished by a West Coast tender.) Many variations of procedure will exist.

(1) "Servicing Newport Bay East Jetty, a 50-foot boom of telescoping 2½-inch iron pipe is rigged with a topping lift, two manila guy lines, and a permanent hook line. A 20-foot dinghy lands personnel on the jetty and then lays to about 30 feet off the jetty. The boom is swung out over the dinghy and one A–50 cylinder with wire strap (10 feet of ⅜-inch wire with an 8-inch eye in each end) is hooked on; then the boom is swung around to the jetty. A twofold tackle is used to hoist the cylinders up to the stowage platform. The boom is telescoped and left chained to the tower, and all rigging is removed after the light is serviced."

(2) "Newport Bay Channel Light 4 is serviced in the following manner: At the top of the pile structure, a base for a 2½-inch round bar davit is permanently installed. The motor launch delivers personnel and A–50 cylinders to the light. A 4-foot davit is rigged on the structure and a 21-thread twofold tackle clapped on. Cylinders are hoisted from the motor launch with wire straps. After servicing, all rigging except the permanent davit base is removed.

(3) "At Catalina East End Light, the shore party is landed in a 15-man rubber boat having a 2½-inch line leading to the motor launch anchored outside the surf. After the initial landing, the rubber boat is hauled to and from the beach by lines. Six A–25 cylinders are placed in the rubber boat at a time. A ⅜-inch wire rope hangs down from an A-frame at the top of the hill to assist personel in climbing. A wire strap is made fast to the A-frame and a wooden block for 3-inch line is moused on the strap. Eight hundred feet of line is rove through the block and down to the bottom of the hill. The other end is passed to the motor launch. A special metal strap with clamping hinge bolt and lifting eye is made fast to the cylinder. At a signal from the bottom of the hill, the motor launch hauls away by running to seaward. When the cylinder nears the top, a signal is given to stop hauling. The cylinder is removed from the metal strap and exchanged for an empty one. The empty cylinder is slacked down the hill. After the aid has been serviced, the working party is hauled off the beach in the rubber boat."

(4) "At Ship Rock Light, the working party is landed in the dinghy on a rock at the base of the light. A breeches-buoy rig is used at this light. The hawser (2½-inch manila) is made fast at the top of the rock and the other end is taken by dinghy to a tidal rock about 150 feet from the light. A wire strap is passed around the tidal rock and a two-fold tackle is clapped on the strap. A small length of chain is attached to the hawser as a stopper; the other end of the tackle is hooked into the chain, and the crew of the dinghy tighten the hawser by hauling on the tackle. During the operation, slack may be taken out of the hawser by this tackle. A 500-foot length of 2½-inch line is passed through a block secured on the light and the end lowered to the dinghy. The motor launch has the other end. A riding block is placed on the hawser and the A–25 cylinder metal strap is put on the block. The end of the hauling line is made fast to the metal strap. When the cylinder has been secured in the strap, the signal is given for the motor launch to haul away. Empty cylinders are slacked down the hawser by the working party at the top. After the light has been serviced, all rigging is removed."

(5) A special tool for towing (hauling) with the motor launch, as mentioned above, consists of two eyebolts bolted into the bulwark and a ⅜-inch wire rope spliced between them. A 6-inch hook is clamped in the center of the bridle thus formed to provide a towing fulcrum forward of the rudder.

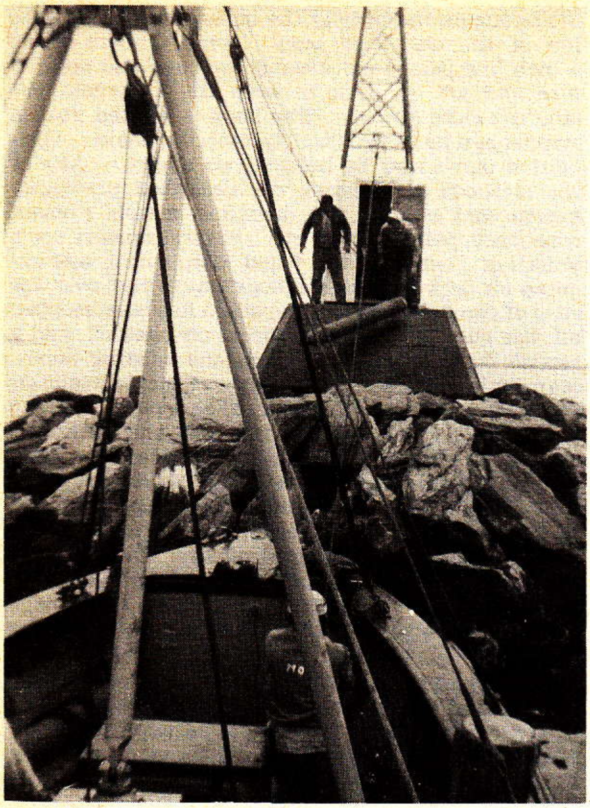


FIGURE 27–246B.—Acetylene cylinders being hoisted ashore to a minor light from a buoy boat by means of two tackles. Boat has nose up against the riprap of the light.

M. *Check for presence of gas.*—The officer in charge of the working party should personally open the door of the tank house of an acetylene light and check for the presence of gas. Sufficient time should be allowed for the interior of the house to ventilate thoroughly before starting work.

N. *General servicing procedure, acetylene light.*—When an acetylene shore aid is serviced, the following (as appropriate) is accomplished: all cylinders are gaged, serial numbers recorded, and cylinders replaced with full ones if necessary. All fittings and connections are tested for leaks with soap solution. Only new aluminum washers are used whenever a connection is broken and remade. The flasher, burner, pilot, and lantern are checked, cleaned, and repaired as necessary. Shut off pressure to the atmosphere gage (if one is permanently installed) located in the tank house, and bleed out the gas remaining in the gage. The sunvalve is checked, and the characteristic of the light observed and checked against the light list for correctness. The structure is repaired and painted as necessary and any brush or trees obscuring the light cleared away. For complete details concerning acetylene apparatus, see Chapter 20.

O. *Handling batteries.*—Air cells may be carried ashore in canvas pack-sacks slung over the back by 12-thread line shoulder straps, two T–2600-type batteries in each pack-sack. The sacks allow full use of the hands and arms in scaling the steep and rough ascents to the lights, holding on to rocks, lines, branches, etc. Air cells may be filled with water on board the tender, breather tabs left on and caps replaced. When the batteries have been landed at the light, they are removed from their cartons, water level checked and adjusted, and breather tabs removed.

(1) Primary (Edison) cells are often made up before being taken to the light and are carried in the boat in a box containing a number of separate spaces, one for each battery. Exercise extreme caution to avoid contact with the electrolyte.

(2) Batteries should be hoisted in a bucket or box on a line; never by the carrying handles. The line used for hoisting batteries should be frequently checked for weak places caused by contact with the acid.

(3) Check the battery house to see if there are any leaks from weather. Air cells must be kept perfectly dry to operate properly. If air cells have not been filled aboard the tender, carry a large supply of fresh water for charging them. In any event, carry water for topping them off.

(4) When air cells are installed, it is often necessary to add to the water level after a few days of service. However, if the batteries are filled on board the night before, and are topped off when installed at the light, there should be no further difficulty. Do not remove the breather tabs until actually installed.

(5) Batteries should always be placed as far as possible from the door to prevent rain and snow that may be driven in through a warped section of the door from "shorting out" the batteries.

(6) Be careful in disposing of used electrolyte or exhausted air cells; discard them where present or future damage will not be caused to persons or animals, or a water supply will not be polluted.

P. *General servicing procedure, electric light.*—When an electric shore aid is serviced, the following is accomplished as appropriate; check voltage of batteries, take hydrometer readings, recharge cells as needed, check wiring throughout the structure, check flasher, lampchanger, and clean the lantern. Check sun relay or timeclock. Inspect the structure for leaks or needed repairs; make repairs if possible. Check the light characteristic for correctness with the light list. Clean away brush or trees obscuring the light and daymark.

(1) When servicing electric range lights controlled by a time clock, reset the clocks at each service period so as to synchronize the time of lighting and extinguishment. This will eliminate many reports of apparent failure caused by one light of a range burning when the other is extinguished.

(2) For complete details relative to servicing electric apparatus, see Chapter 21.

Q. *Safety sling.*—When painting large daymarks on range lights, a safety belt can be made from an 18-inch length of 2- x 4-inch lumber, with a 2-inch manila sling spliced through a hole in the lumber, making the sling to fit the waist. The 2 x 4 is inserted through the daymark slats in a vertical position, and when turned across the slats, holds personnel securely.

R. A small level is useful to carry in the tool bag for truing up the lantern.

S. *Inspection for repairs.*—When visiting a minor shore aid, make a thorough inspection of the building, structure, and accessories. Take any necessary action to correct defects within the capabilities of the forces at hand, and if beyond capabilities, make a full and detailed report including a list of materials required, sizes, dimensions, etc.

27–7 AIDS TO NAVIGATION WORK, INLAND WATERS

27–7–1 General—

A. Rules of seamanship, as described in foregoing sections for large tenders, apply as well on a limited scale to smaller tenders working in inland waters. Although buoys and other weights to be handled are smaller and lighter, the fundamentals of handling are much the same with regard to the proportionate relative size, and the safety precautions and rules stressed throughout this chapter should not be ignored. In addition to the usual work of handling lighted and unlighted buoys and servicing minor lights ashore, inland tenders are called upon to perform certain types of construction work such as driving piles, erecting minor structures of a variety of types, both ashore and on marine sites, and pulling out damaged or broken piling which might constitute a menace to navigation. Although most of the work of inland tenders is done in protected waters, they are sometimes called upon to work aids located in inlets or large inland bays where extremely rough conditions can prevail.

B. *Relieving a buoy.*—When working buoys in inlets where conditions are generally severe, handle buoys with much the same caution as described for working large buoys at sea. Do as much as possible of the preliminary arrangement of buoy, sinker and mooring before leaving sheltered waters. Take all possible precaution against permitting weights to swing when the tender is rolling in the inlet. Small unlighted buoys are often rolled over the side to avoid having to hoist them out. Upon occasion, a relieved buoy is left hanging on the boom with its butt end secured by preventer lines until the tender reaches calm water where the buoy may safely be lowered to the deck.

C. *Inlets.*—When working small buoys in sheltered waters, the tender approaches the buoy so as to bring it close aboard at the buoy port. The same rules regarding stemming the wind or current hold good as described in section 27–10–35 for the larger tenders. The buoy is pulled close aboard with a boat hook, and the hoisting tackle is hooked into the lifting lug on the body of the lighted buoy, or on the top of the unlighted buoy. Some tenders use a 4-inch line passed out around the buoy and secured fore and aft on deck to keep the buoy and the mooring close aboard. The buoy is hoisted until a stopper can be passed into the mooring chain. (Unlighted buoys may be hoisted two blocks.) Any of the methods of stopping off, described previously herein, may be used, i. e., hookline, manila stopper, wire strap, pelican hook, etc. Several tenders use a length of ⅞-inch chain, fitted with a hook and secured on deck so that the hook hangs just over the edge of the deck. When the chain has been stopped off, the buoy is lowered on deck, unshackled, and a second bight of chain taken by the hoisting tackle. Many inland tenders have only one tackle available for hoisting, the whip being used as a power vang to the deck, or vice versa. In this case, the method of "hoist and stop off," such as is practiced in a buoy boat, is the only way to hoist a buoy aboard. Moorings are generally short since most buoys handled by inland tenders lie in shallow water. If the sinker is to be reused, it is stopped off over the side on a manila line or pelican hook. The mooring chain is inspected for wear, repaired if necessary, and ranged out on deck and stopped off, ready for setting the next buoy.

(1) In picking up a lighted buoy in choppy water, the whip is often hooked into the superstructure to steady the buoy. This must be carefully done. Headlines are used for all lighted buoys. In putting lighted buoys over the side, a similar procedure to that described under section 27–5–40 is followed. The buoy is hoisted out over the side and is let go usually simultaneously with the sinker. Small unlighted buoys are often rolled over the side.

(2) When installing batteries in a 3½ x 10E lighted buoy, pick the buoy up on the main or relief, and then hoist the battery rack into the pocket with the whip. If the rack is installed in the pocket while the buoy is lying on deck, it will be difficult to get it in and will necessitate additional handling, which thus increases the possibility of damaging the batteries.

(3) Preparing buoys for setting in inland waters entails much the same preparation, charging, inspection, tests, etc. as described for larger buoys in section 27–5–5.

(4) When allowing men to board buoys, be sure that the buoy will not become top-heavy and fail to support the men safely. A 7 x 18 buoy, for example, will support one man, but not two. A 3½-foot buoy will not support a heavy man.

(5) When hooking the whip into a lighted buoy for steadying, on vessels having air-driven hoisters, do not hold the load on the brake; just crack the throttle and tend the hoist to maintain a slight strain for steadying purposes, but not enough to bend the superstructure.

(6) Buoys are hooked on and lifted in much the same manner as described for lifting aboard athwartships in section 27–5–30, except that hooklines or steadying lines, other than a headline passed through the cage, are seldom used. Many inland tenders have no means for heaving a cross-deck line under power.

(7) Buoys should be scraped as clean as possible while still hanging over the side. This has a safety application in that it keeps the deck cleaner and less slippery.

(8) Several tenders recommend approaching somewhat wide of the buoy so as to keep it in view and not scraping the side; then, when nearly abreast the buoy port, work the vessel over closer and pull the buoy alongside with a boat hook. If men are to be landed, take care to have the bow of the tender swinging away, rather than down onto the buoy.

(9) When buoys are in locations necessitating short scope such as narrow channels, etc., if it is known that the mooring will sand-in, take the precaution of having the mooring long enough so that at high water the buoy can be hoisted sufficiently to get a chain sling on the mooring for hoisting on the main or relief.

(10) When buoys are to be set in shallow water and only short lengths of chain are involved, the chain ranged out on deck need not be stopped off except at the ends. *Caution all hands to keep clear of chain, no matter how small or how short a length.*

D. *Recharging a small lighted buoy.*—Following is a description of the procedure for recharging a small electric buoy followed on one inland tender:

(1) The tender approaches the buoy up against the tide or wind, depending on which is the stronger.

(2) The boom is spotted over the center of the buoy port, and slightly inboard of the edge of the deck, with a double-branch sling hanging on the relief purchase. One man stands by with the whip to hook into the cage of the buoy.

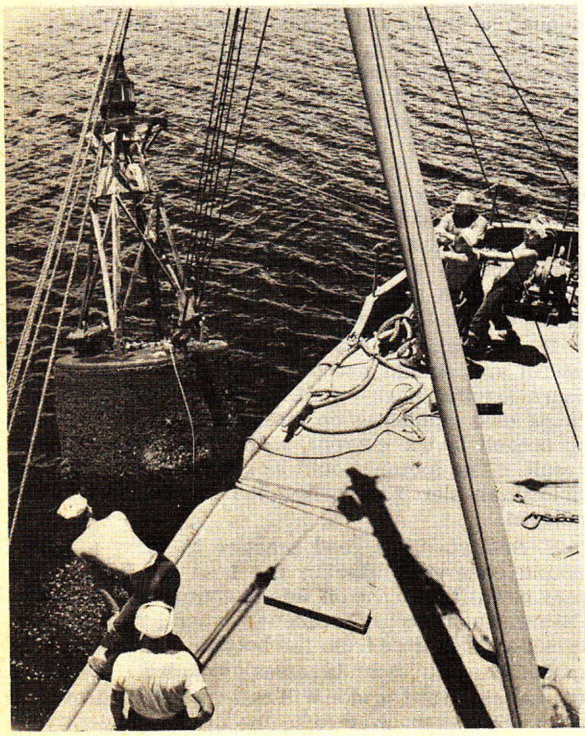


FIGURE 27–247.—Hoisting a small lighted buoy aboard an inland tender.

(3) After the tender is alongside of the buoy, the whip is hooked into the cage and raises it high enough to pass steadying lines around the fore and aft legs of the lantern tower. When this has been done, the sling is hooked into the lifting bails, and the buoy is raised until the battery pocket is level with the deck. The pocket cover is removed, the wires disconnected, and the battery hoisted out with the whip.

(4) A new battery is inserted, connected, and the complete wiring system checked for correct voltage before replacing cover. The lantern is also checked for flasher and lampchanger operation and proper characteristic.

(5) The whip is hooked into the cage of the buoy, the slings removed, and the stoppers cast loose. The buoy is then lowered into the water.

(6) Caution must be exercised in hoisting a buoy by means of the whip hooked directly into the cage. Heavy buoys must not be hoisted in this manner, as the cage structure is easily bent.

27–7–5 Buoy Boat Operations—

A. Buoy boats are designed primarily to service buoys in shallow water or restricted areas where vessels of the tender class cannot navigate. Buoy boats are small motor boats of various sizes, from 38 to 65 feet in length, having a boom and hoister capable of handling second and third class unlighted buoys (except tall-type), river buoys, and 3½-foot lighted buoys. The larger 5- and 7-foot lighted buoys may be recharged from a buoy boat (or motor cargo boat) but cannot be hoisted. First class special buoys may be worked occasionally, and a procedure for doing so is given below. In many areas where a large number of buoys are to be

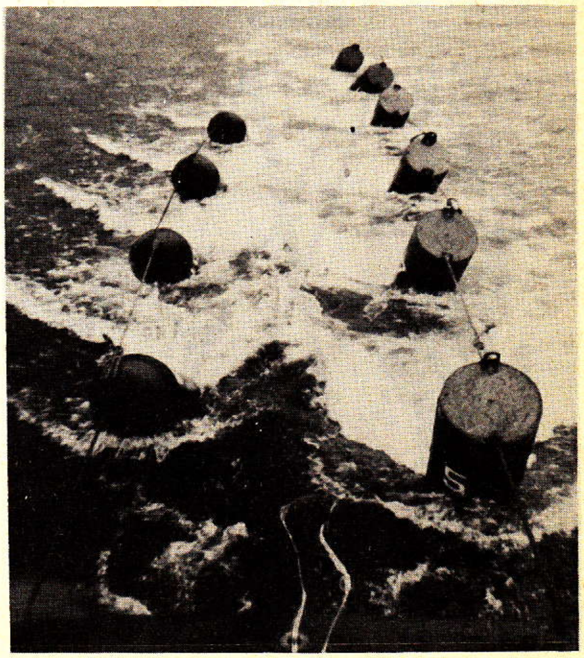


FIGURE 27–248.—Towing buoys astern enroute to working area.

worked, the buoy boat works from a shore unit, or in conjunction with a tender. If the latter, the tender carries the buoys and appendages, paints the numbers, cuts mooring chain to the proper length, etc., and loads the buoys in the buoy boat or alongside in the water. If the buoys are to be towed astern they should be arranged in the order in which they are to be worked. When working buoys by buoy boat, do as much preliminary work as possible

FIGURE 27–249.—Buoy boat hoisting a second class can buoy.

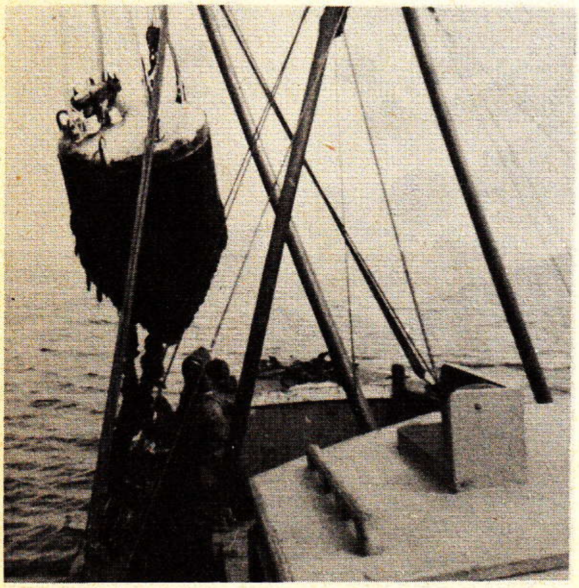


FIGURE 27–250.—Stopping off the mooring of a 3½ x 10 lighted buoy.

at the depot or on board the tender prior to loading the boat.

B. *Tools/equipment.*—A typical assortment of tools and equipment peculiar to aids to navigation work used by a buoy boat is as follows:

Hammers, blacksmiths, cross peen/straight peen	4
Chisels, cold, assorted sizes	3
Hacksaw, with extra blades	1
Hatchets	2
Mauls, top, tapered point, short handled	2
Marlinespikes	2
Kit of tools, acetylene/electric apparatus	1
Nonsparking wrenches, hammers, bars, etc	1 set
Hooks, spare hoisting	2
Leadlines	2
Sextant	1 or 2
Protractor, 3 arm	1
Shackles, screw pin, assorted sizes	1 doz.
Tackles, luff, 3-inch/21 thread	2
Stoppers, manila, assorted sizes.	
Stoppers, chain with grab hook	2
Rope, manila, assorted sizes for lashings.	
Marker buoys, with 6-thread line	2
Chart of the area.	
Spare lighting apparatus as necessary, gaskets, graphite, etc.	
Spare chain, shackles, keys, sinker, etc.	

C. *Boom.*—Buoy boats are generally equipped with only one hoisting tackle, which means that after each lift the chain must be stopped off and the tackle lowered for a fresh bight. Manila or chain stoppers of appropriate size are used for this purpose. Inspect the boom, fittings, riggings, and all working gear before beginning the day's work. Safety is just as important in a buoy boat as on board the tender or at the depot. The weights handled may not be as heavy but they can crush just as effectively. The boom should be set so that it will not be necessary to top it up or trim it in or out while handling buoys or sinkers over the side. It should be topped high enough so that a third-class buoy can be picked up well clear of the gunwale, and should be trimmed inboard so that when a sinker is picked up off the bottom the top of the boom will not extend over the gunwale. To permit a boom to pay out while supporting a heavy load is very dangerous. With the boom trimmed inboard of the gunwale, the list of the boat under a load will be sufficient to provide the proper lead for the falls. Some buoy boats are equipped with a wire preventer the same length as the boom guy when in working position. This preventer, when rigged, will keep the boat from capsizing should the manila guy part under a load.

D. *Current.*—In extreme currents, an anchor is useful and should not be neglected because of the extra rigging work entailed. Since the buoys are being held amidships on most buoy boats, it is easy to broach to the current, with capsizing a possible result. The motor should be kept running, and the helmsman alert to keep the boat headed fair to the current.

E. *Ballast.*—It is good practice to carry a 2,000-pound concrete sinker in the boat for ballast. It may be shifted to the off side to counteract excessive listing, which occurs frequently when attempting to break a sinker free from the bottom. Ballast is also useful when the boat becomes grounded. Swinging the ballast over the side will cause a list, or dropping it on the bottom may raise the draft sufficiently to free the boat, after which the sinker may be dragged into deeper water for recovery.

F. *Loading.*—A three- or four-man crew is generally used in handling buoys. If many buoys are to be worked, an extra man or two is assigned. One operates the hoisting winch, one tends the helm and motor, and the other(s) hooks on and stops off, etc. Third-class special buoys may be loaded in the boat, stacked up against the gunwale and each other with counterweights down. Other buoys are stowed in the bottom of the boat, as much to one side to keep a working space clear as possible, commensurate with the permissible list of the boat. A square sinker, chain, ballast ball, shackles, etc., comprise the appendages. Buoys must be securely lashed and wedged at all times to prevent shifting. When a considerable number of buoys are to be worked in one area they are often towed astern. Buoy boats have handled as many as 20 buoys in this manner.

G. *Setting a buoy.*—Following is a description of how a buoy may be set from a buoy boat:

(1) The mooring should be made up in the proper length with one end of the chain shackled to the sinker. The ballast ball, if used, should be shackled to the mooring eye of the buoy. Split-key shackles are used at these two points. The buoy and appendages are then loaded into the boat by a mobile crane on shore or by the tender's boom (the buoy may be put overboard alongside).

(2) On arrival at the location where the buoy is to be established, the sinker is hoisted out over the side of the boat and secured just below the gunwale with a manila slip-stopper. With the boom properly trimmed, it will be necessary to push the sinker out over the gunwale when hoisted clear. The inboard tend of the falls will help to keep the sinker close aboard the boat and minimize banging the side in rough water. (If the weather is not too favorable, the sinker may be slung overside beforehand, when the boat is in sheltered waters.) If the sinker is heavy, it may be well to dip the chain under the boat and stop it off at the other gunwale, so that when the buoy is hoisted on the other side for shackling on the end of the mooring chain, the boat will not list excessively. The buoy, after connecting, may be lowered into the water and kept alongside with a light head line passed through the lifting eye, or cage (if a lighted buoy). One end of this line may be secured in the boat, but the other should be tended by one of the men.

(3) Determine the position of the buoy in accordance with any of the methods described under part 27–11. When nearing the exact position of the buoy, put the rest of the mooring chain over the side so that no chain remains in the boat except where it is stopped off at the gunwales. If it is a long mooring, it must be stopped off with line every 10 or 15 feet, and each stopper cut or slipped as the chain runs out. Chain must never be permitted to "take charge" and run out wildly.

(4) When "on-station," cut or slip the rope stopper holding the chain at the gunwale on the buoy side and when all clear, slip the sinker stopper and cast off the buoy. If the sinker is not so heavy but that both the weight of the sinker and buoy can be borne by the boat on one side, dipping the mooring chain is not restorted to, and the chain at the buoy end is not stopped off.

(5) If desired, the buoy may be secured to the chain first and placed over the side before the sinker is hung.

(6) Always stop off the chain before hoisting either buoy or sinker out over the side, to prevent it from suddenly running out. A small bight of chain permitted to slip over the side can gather momentum with terrific speed and often disastrous results.

(7) Be sure all the chain is allowed to run out of the boat *before* tripping the sinker. If this is not done, the chain will whip around in the bottom of the boat, injuring personnel or fouling other gear which might capsize the boat.

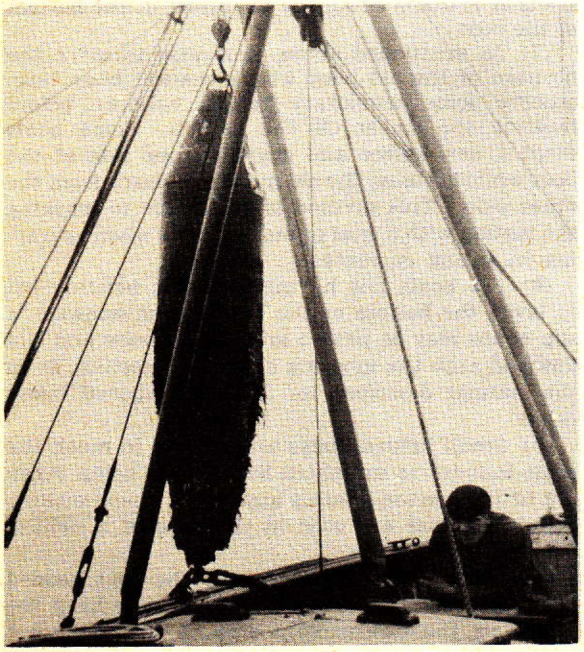


FIGURE 27–251.—Third class special nun two-blocked and mooring stopped off.

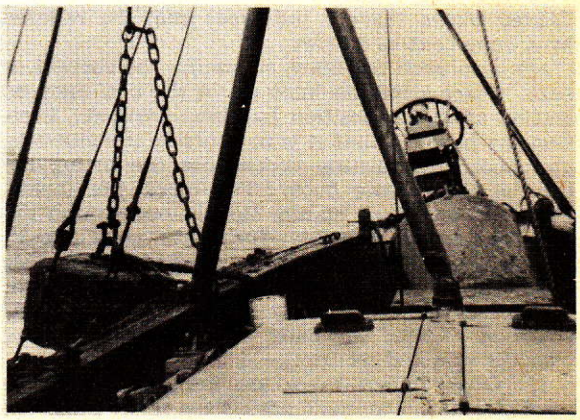


FIGURE 27–252.—Hanging a sinker over the side on a manila stopper.

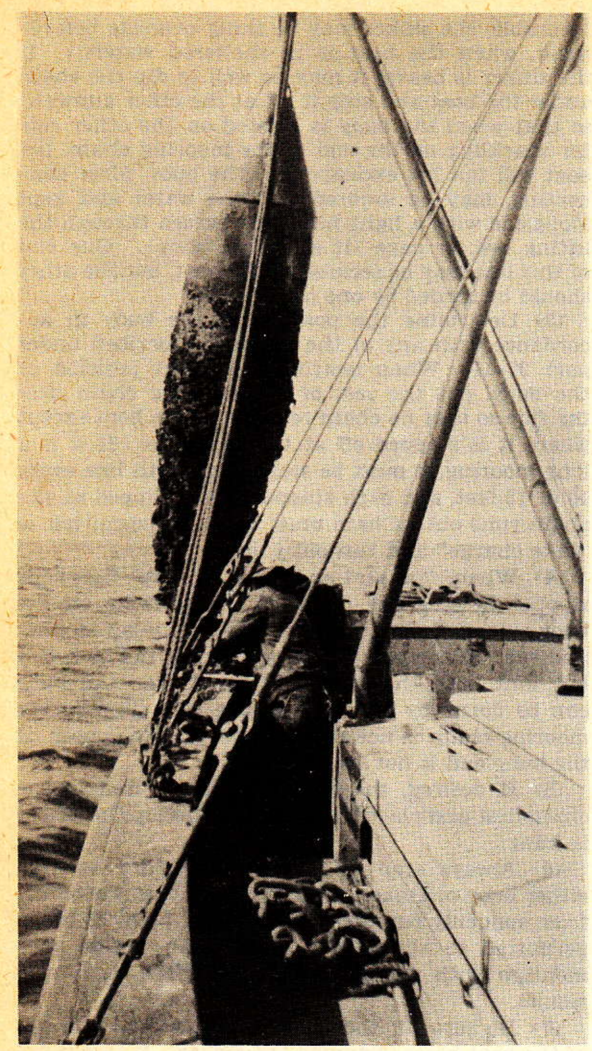


FIGURE 27–253.—Stopping off the mooring of a third class special nun.

H. *Relieving a buoy.*—Second and third class unlighted buoys (except tall-type) may be relieved by a buoy boat as follows:

(1) Approach the buoy, stemming the current or seas. Place a marker buoy or set the new buoy on station after the position has been verified. Position the boom so that it is not outside the gunwale, and hook the hoisting tackle into the lifting lug on the top of the buoy. Two-block the tackle. Pass a 3- or 4-inch manila stopper out around the buoy to keep it, and later the chain, close aboard as it is being hoisted. Hold the buoy at the gunwale while the chain is stopped off below the shackle with an appropriate size manila or chain stopper, and unshackled. Lower the buoy into the boat or back over the side and secure it.

(2) Often, when there are many buoys to be worked, it is not brought aboard but is towed astern or left tied up temporarily to the new buoy until the remaining buoys have been relieved. A toggle line 10 feet long (1½-inch or 2-inch line) may be used for securing the old buoy to the new one while waiting to be picked up on the return trip. Form a grommet 18 inches from end of line by making a throat seizing. Make a toggle in the other end using a one-half-inch iron rod about 8 inches long. Serve the line between the toggle and grommet to prevent chafe.

(3) Unhook the falls from the buoy, hook into the mooring chain as low down as possible and two-block the tackle, casting off the stopper as the strain is eased. Again stop off the chain at the gunwale. (When a chain stopper is used, it consists of a length of chain secured in the boat and having a grab hook on the other end extending about 6 inches beyond the gunwale.) It is a good practice to secure the bitter end of the mooring chain somewhere in the boat while hoisting the remainder of the mooring, particularly in the case of long lengths of chain. Lower the bight of chain into the boat and again hook into the chain over the side. Hoist and stop off until the sinker is in sight, if it is planned to bring the sinker aboard or to inspect it.

(4) Often moorings, especially in soft bottoms or in inlets where the sinker is sanded in beyond possible recovery, are hoisted only far enough to inspect the "chafe" (that short length of the chain that rubs along the bottom as the buoy rises and falls in the swells). In this case, the worn section of chain is replaced if necessary and the new buoy hoisted out, shackled on to the old mooring and lowered away.

(5) When picking up a long mooring, it is good practice to stop off the chain in the boat at frequent intervals, so that in case the rigging parts, the chain will not run out. In most cases this is not necessary since, as a general rule, buoy boats are used to work buoys only in waters too shallow for the regular tender.

(6) If the new chain is to be bent on to the sinker, see that it doesn't foul the old chain in the bottom of the boat.

(7) As mentioned above, it is wise to mark the position of the old buoy with a marker buoy (also observe some temporary ranges ashore) before hoisting the sinker off the bottom. Some boats plant a new sinker and chain off one side of the boat while bringing the old mooring aboard from the other side. This method is preferable to marking the station with a trial or marker buoy when operating in strong currents.

(8) For boats not having sufficient hoisting lift to bring the bottom of the buoy to the gunwale, a slip chain may be passed around the buoy and slid down to grab the mooring chain for hoisting, as in the manner described for first-class special buoys below.

(9) Small lighted buoys are relieved in much the same manner as unlighted buoys, care being taken not to damage the lighting apparatus when hoisting. Steadying lines are used in the cage of a lighted buoy.

(10) If it is impossible to keep the boat headed into the current, it is generally better to keep the chain on the downstream side of the boat, but extreme caution must be observed when making a heavy lift if the boat is not headed fair to the current.

(11) When working spar buoys, chain slings are used to secure the buoy for hoisting and for stopping off. Several lifts are required before bringing a spar aboard.

I. *Relieving first class special buoy.*—Although buoy boats cannot lift a first-class special buoy clear of the water by hooking onto the top lifting lug, they may be relieved as follows:

(1) Using a piece of ¾-inch open link chain formed in a loop by a freely running shackle over the standing part (i. e., a lasso), pass it over the buoy and lower the chain loop to the bottom of the buoy. Heave in and stop off the standing part of the chain lasso in the usual manner until the mooring eye of the buoy is flush with the gunwale. Stop off *both* the mooring eye of the buoy and the mooring chain below the shackle, and disconnect the buoy. Holding the stopper on the mooring eye of the buoy, pass a manila strap around the buoy at the balance point and take it aboard if desired, otherwise secure a line to the bottom of the buoy so as to be able to lower it slowly to permit the buoy to resume an upright position. Heave the mooring chain aboard for inspection or replacement in the usual manner. In setting a first-class special buoy, it is hoisted overboard with a sling at the balance and is shackled to the mooring chain. A manila stopper is passed around the bottom of the buoy to be slipped after the sinker or mooring chain is dropped.

(2) Another method is as follows: Hook the hoisting tackle into the lifting lug on top of the buoy. Two-block the buoy and hold it fast while the boat moves ahead slowly. As a strain comes on the chain, the buoy trails aft and the bottom rises to the surface where stoppers can be passed to the mooring eye of the buoy and the chain. Continue as above.

J. *Sinker sanded in.*—When a sinker is sanded in and cannot be raised with the boom, heave it short and secure. Then take a few turns around the sinker with the boat, keeping the chain taut. This may help to break the sinker free. It is also often possible to free a sinker by surging back and forth on a taut chain.

K. *Dragging buoy back on station.*—When a buoy is found off station a short distance, it may usually be dragged back by the buoy boat. When in a strong current, the following method has been suggested:

(1) Flake plenty of heavy line back and forth over the gunwale just abaft the working cleat to keep the buoy from chafing the side. Take a strain on the chain by going ahead against the current at slow speed, then put the rudder over slightly so that the boat comes about toward the side on which the buoy is secured (i. e. buoy on port side, turn to port). This must necessarily be toward the channel so as to keep the boat out of shallow water, therefore, approach the buoy accordingly when making fast. When the boat has swung stern to the current, speed up the engine to break out the sinker. The force of the current is thus added to the power of the engine. Once the sinker is loose, the boat will again have steerageway and may be headed in any desired direction. It should be noted that precaution is taken to go ahead into the current to tauten the chain and keep it so, before turning with the current to break out the sinker. If the boat is turned while it and the buoy are riding down with the current, the towing gunwale will, at the moment the boat is broadside to the current, suddenly dip down, either causing the boat to ship water and possibly capsize, or putting an undue strain on the towing cleat. Never tow a lighted buoy by making fast to the cage. It will bend and the lantern may strike the side of the boat.

(2) When trying to relocate a spar buoy which is off station, and being unable to do so because of lack of power, it is sometimes possible to drag it, using a chain. Make one end fast to one of the towing bits on the stern, then take a couple of round turns around the spar and work them down to the sinker chain, if any, and make fast to the other towing bit.

L. *To recharge an electric lighted buoy,* the boat should be secured alongside the buoy with bow and stern fasts in such a position that, with the boom well topped up and swung out, the falls are directly over one of the battery pockets. Place a heavy fender between the buoy and the boat. A two-leg sling consisting of two 6-foot lengths of manila line of suitable size, having hooks in one end and joined to a ring at the other, is used by some boats to hoist the buoy so that the battery pocket is level with the gunwale of the boat. If the water is choppy it is better to hoist the buoy and gripe it in to the boat's side with lines.

(1) Remove the covers from the battery pockets and disconnect the battery wires. Always secure a preventer line to the pocket cover before removing it. Tape the ends of the wires to prevent short circuiting during the process of installing new batteries. Also break the connections at the lantern and leave disconnected until after the new batteries have been installed. Loosen the setscrews located around the top of the battery rack to hold the rack secure in the buoy pocket.

(2) Now hook the falls (if they are in use for hoisting the buoy, use one of the manila guys for a tackle or have a luff tackle suspended from the boom just below the main block) into the lifting eye located at the top of the battery rack and hoist the rack of batteries out. Lower them into the boat and secure them so as to prevent movement when the boat rocks in the swells or lists under the weight on the boom. Hoist the new rack of batteries and install them in the buoy. (The new rack was made up at the depot or on board the tender.) If there is water or electrolyte in the bottom of the battery pocket, swab it out before installing new batteries. Take care not to drag the swab over manila lines, and rinse it out over the side after using.

(3) When the rack of batteries has been installed in the pocket, using a voltmeter, take a reading of the voltage of the bank of batteries just installed, to insure that the voltage is still the desired amount and that no grounds have developed during the process of placing the batteries in the buoy. If the proper readings are obtained, connect the wires to the battery rack and secure the rack in the pocket by setting up evenly on all setscrews located around the top of the battery rack.

(4) If the buoy is to operate under severe conditions such as in an inlet, it has been found that the setscrews for holding the rack secure are insufficient and the placing of three wooden wedges midway between the screws has been recommended. Wedges are made as follows: rip a 2-inch x 4-inch in half and cut into blocks 4 inches in length. Bisect the blocks diagonally to get suitable wedges. Be sure that the wedges are driven down around the battery rack far enough so as not to prevent the pocket cover from seating properly. Check all work carefully and when satisfied that all is in order, apply graphite to the gasket (if old-type) and replace the cover, tightening the hold-down nuts evenly and alternately.

(5) Now, turn the buoy around so that the other pocket is in working position. Recharge the other pocket(s) as above. Make the necessary tests for correct voltage and grounds at the lantern and if found correct, connect the lantern and check it for proper operation and characteristic. If the wiring from the battery pocket to the lantern seems to be in doubtful condition, it is better to check the voltage at the lantern before closing the pockets, in case the wiring must be checked or renewed. Touch up paint wherever necessary before casting off from the buoy.

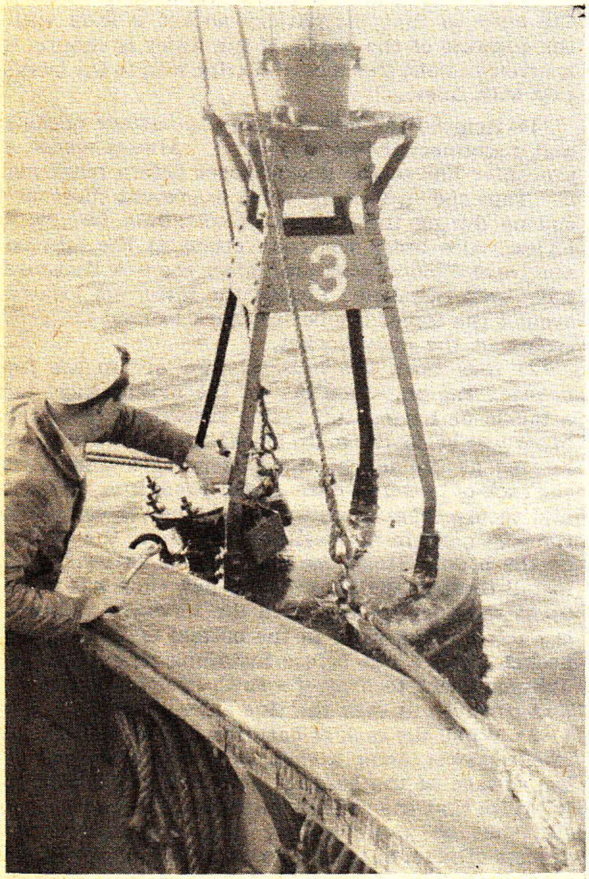


FIGURE 27–253A.—Removing battery pocket cover of 3½ x 10 E lighted buoy.

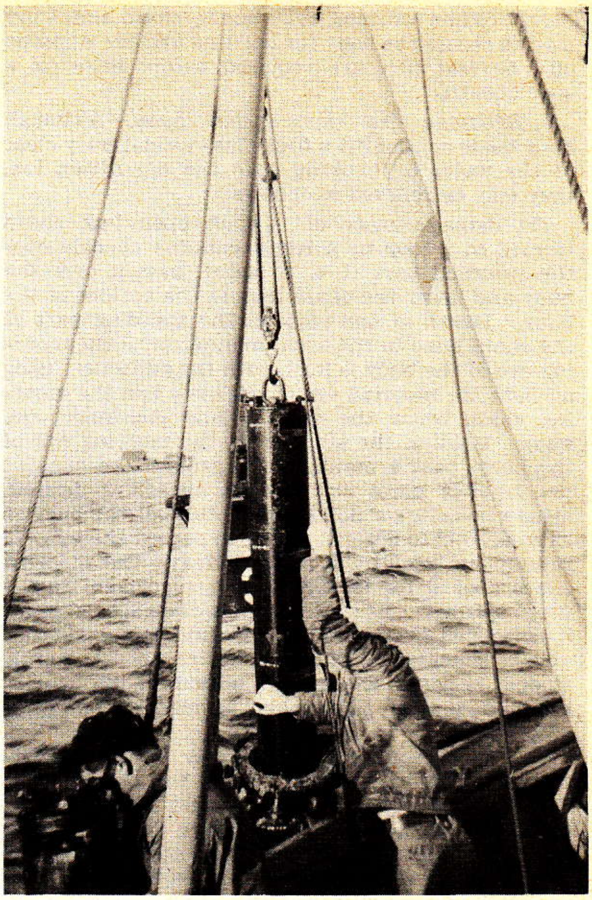


FIGURE 27–253B.—Lowering new battery rack into pocket of 3½ x 10 E buoy.

(6) *3½ x 10 E.*—When picking up 3½ x 10 E's without a two-leg sling, hook on to the padeye nearest the battery pocket. When hoisting with a sling, take care that the battery pocket swing bolts do not catch on the guard rail or gunwale of the boat.

(7) *3½ FE.*—To recharge a 3½ FE lighted buoy, moor the boat fore and aft alongside the buoy. Secure a preventer line from the pocket cover to the superstructure of the buoy before removing the hold-down nuts. Exchange the battery rack as described above.

(8) *Emergency light.*—In an emergency, when any electric buoy becomes inoperative and recharging is impractical at the moment, a "Hotshot" dry battery of proper voltage may be temporarily connected to the lantern. Another method of emergency procedure is as follows: Install an emergency light consisting of: one A–25 acetylene cylinder in a rack, secured to the buoy superstructure, and one 150 mm. lantern connected with 8 mm. acetylene tubing. On the smaller buoys such as a 7 FE, the 200 mm. electric lantern is removed and the acetylene lantern installed in its place. On larger buoys, the 150 mm. lantern may be secured to a board,

2 inches x 12 inches x 36 inches, which is in turn secured on top of the daymark of the buoy by means of through bolts and large washers. It has been found that this type of emergency light is easy to install and will greatly outlast the smaller electric emergency lights, and is more dependable.

(9) See Chapter 21 for further details regarding electric apparatus.

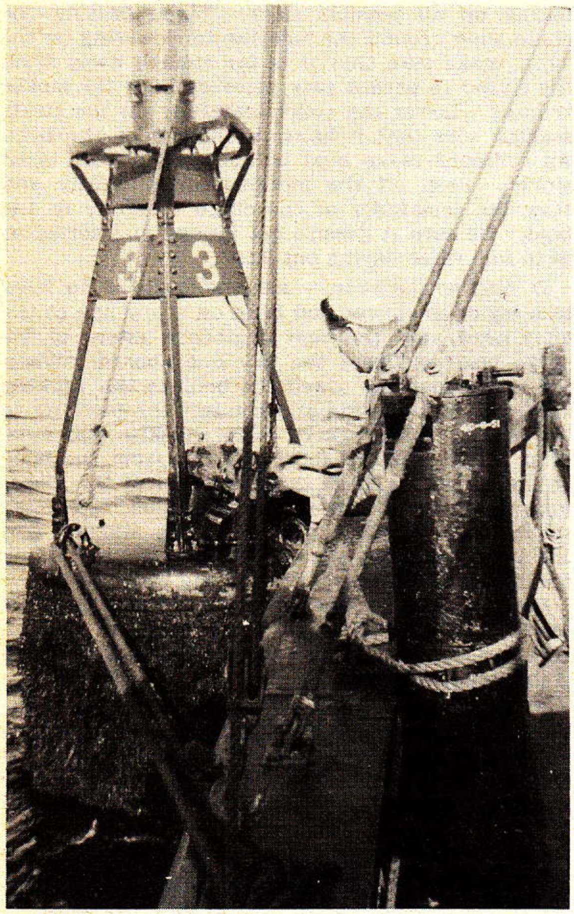


FIGURE 27–253C.—Securing battery pocket cover. Remember to tighten hold-down bolts alternately and evenly. Note that old battery rack is securely lashed.

M. *To recharge an acetylene lighted buoy,* secure the buoy boat alongside as described in paragraph (L) above. Use extreme caution when working with acetylene buoys and use only nonsparking tools. (See Ch. 20, "Acetylene Apparatus" for details relative to acetylene gas. See also latest Engineering Memorandums for additional instructions on opening buoys.)

(1) Now, remove the cover, using a preventer line to keep it from falling overboard. Close the shutoff valve on the cylinder and loosen a connection at the manifold or remove the pressure gauge plug to relieve pressure. Mark the position of the valve on the side of the pocket wall and remove the tubing between the cylinder and the staybolt fitting in the pocket wall. Lift out the cylinder with the special lifting cap (see Ch. 20, sec. 20–5–20). When lifting out the cylinder, pry out the wedges with a nonsparking bar.

(2) Cylinders are handled in the same manner as battery racks described in paragraph (L) above. When wedging in the new cylinders, do not use a steel bar or ordinary metal hammer. *Use only nonsparking tools in and around buoy pockets.* Connect the cylinder to the staybolt fitting, using NEW aluminum washers. Do not turn on the gas at this time—leave it closed until all the tanks have been replaced. Now, turn the buoy so that the next pocket is in position and repeat the above procedure. When all empty cylinders have been replaced by full ones, open the valve of one cylinder and test all connections throughout the buoy for leaks with soapsuds solution, using a brush or a sponge. When satisfied that no leaks exist, open all cylinder valves and replace chain plugs over the valve stems.

(3) Close the pockets, tightening the covers down alternately and evenly all around. Open the lantern, *ventilate it thoroughly* and light the pilot. Allow ample time for the air to work out of the system, check characteristic and touch up paintwork where necessary, before leaving buoy.

(4) When recharging a buoy such as the 7 x 18 which has four pockets, it is possible to become confused and recharge a pocket twice. Throw a wedge down on top of each full cylinder until all have been installed.

(5) *Caution.*—When recharging a 5 x 15A or 7 x 18A lighted buoy from a motor cargo boat, rig a luff tackle from the cage to handle the cylinder. If there is a strong current, use the motor and rudder to keep the boat headed fair. Otherwise the boat may swing broadside to the current and partially capsize the buoy, filling the pockets with water when

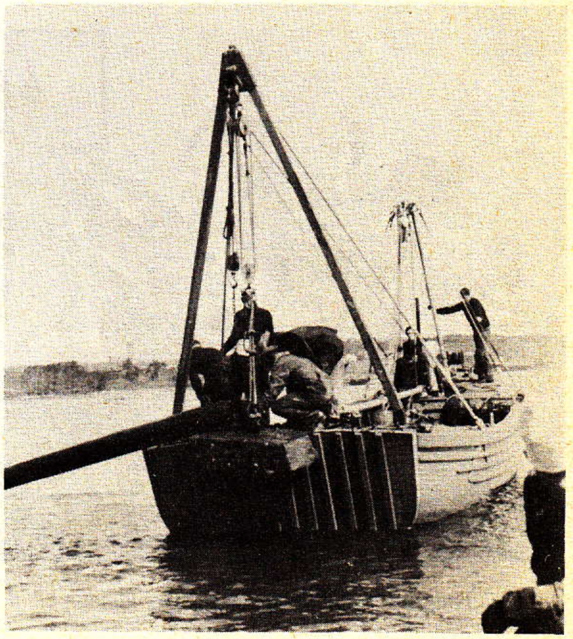


FIGURE 27–254.—Working a spar buoy from a buoy boat.

the cylinders are suspended from the cage. Remember that the conical bottom buoys such as the 7 x 18 are unstable if more than one man climbs aboard. Never permit a man to board a buoy unless he wears a life jacket.

(6) *Emergency procedure for acetylene buoys.*—Lash an A–25 cylinder to the superstructure of the buoy and pipe it directly to the lantern.

(7) See Chapter 20 for further details regarding acetylene apparatus.

N. *83-foot patrol boat.*—When servicing a buoy from an 83-foot patrol boat, the following procedure has been suggested:

It has been found that a better approach may be made stern-to into the wind or current. The stern life line is removed and the man has a large, steady platform from which to jump onto the buoy. If the buoy requires recharging, lines are passed from each lifting lug to the quarters of the boat and a large truck tire is hung over the stern as a fender.

O. *Records.*—Keep accurate records of all servicing operations.

27–7–10 Relieving Lighted Buoys in Inlets (With Ship's Boats)—

A. It is sometimes necessary for a tender to establish or relieve lighted buoys in inlets or shallow water where the tender cannot operate, and no specially fitted shallow draft buoy boat is available. In this case the ship's boat may be used as described below.

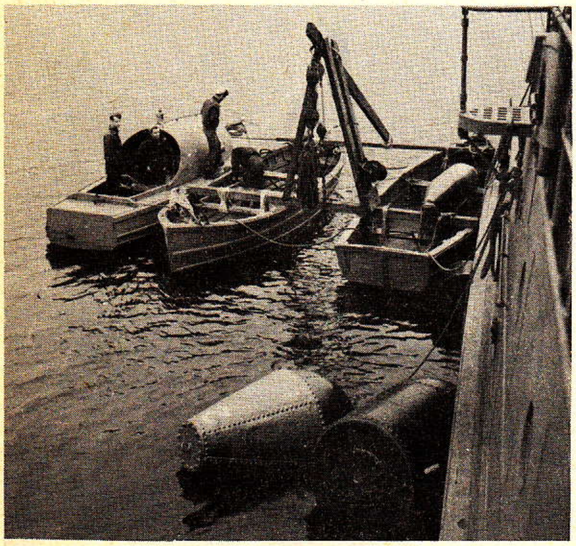
B. *Selecting mooring chain.*—To establish a buoy, determine the depth of water and select the proper length and size of mooring. Select a heavier chain than would ordinarily be used, preferably die-lock chain; the length to be several times more than the depth of the water. Shackle a length of lighter chain somewhat longer than the depth of water to this heavier chain. This will be the wearing length which will be renewed annually, as necessary. The heavy bottom chain should last for years.

C. *Hanging sinker on boat.*—Select a sinker of appropriate weight, connect the heavy chain and lower it overboard alongside the cargo boat. Pass a heavy rope sling around the boat and through the bail of the sinker. Knot both ends together, taking up all possible slack. When passing the chain sling around the mooring for lowering on the whip, make sure that it is far enough away from the sinker to permit easy recovery once the sinker is hung. Lower the sinker carefully on the strap, making sure that it hangs evenly under the boat. An ordinary cargo boat will support a good sized sinker. Stop off the mooring chain lightly and stow the remainder of the chain carefully in the boat. Be sure it doesn't get kinked or knotted so as to foul when paying out later.

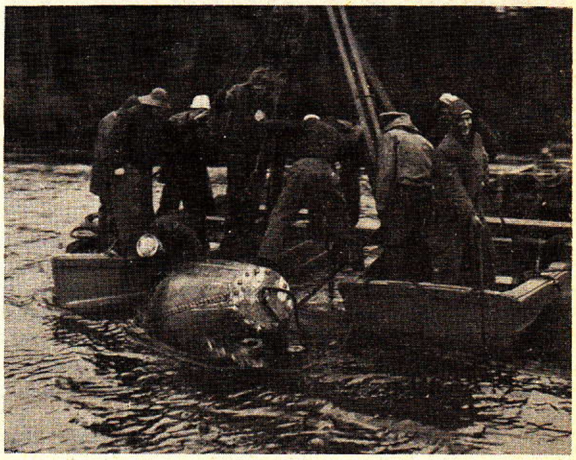
D. *Setting the buoy.*—Lash the bridle of the buoy to a leg of the tower and bend on a tow line to the buoy head. Set the buoy overboard astern of the cargo boat and pass the tow line aboard. When the cargo boat has towed the buoy to the working area, pull it alongside and connect the mooring to the bridle. Always carry extra shackles and keys. Stop off the chain a short distance from the buoy at the gunwale. Allow the remainder of the mooring to run overboard when on station, and clear the stopper holding chain near the sinker. Cut the stopper holding the sinker, then the remaining chain stopper at the buoy, and the buoy is set.

Some shackle the buoy to the mooring aboard the tender and then tow it to the area all connected. However, the boat is more maneuverable if the buoy is just towed freely.

E. *Relieving the buoy.*—When relieving, secure the bridle of the new buoy to the tower as described above, put a length of new light chain in the boat and tow the buoy to the location. Rig a single sheave ginpole in the bow of the boat, extending



Rigging a temporary hoisting gear.



Working a 3d class standard nun.

FIGURE 27–255.—Jury rig for working small buoys with ship's boats.

several feet over the water. Reeve a single hook line through the sheave and clap a jigger tackle on the inboard end. If possible, have a man or two climb on the buoy to heel it over to expose the bridle. Pass the hook line into the bridle as low as possible and haul in a bight; stop off and repeat the procedure until all of the light mooring chain is hove aboard and the heavy mooring chain is exposed. Remove the worn light chain, replace with the new chain, connect the new buoy, and tow the old buoy back to the ship.

F. *Replacing mooring.*—When the old mooring needs to be replaced, it will have to be scuttled and a complete new outfit used, as the small boat cannot retrieve the heavy chain and sinker. If it is found possible to hoist any of the heavy chain aboard, before scuttling the mooring, do so and burn off the chain with a portable oxyacetylene torch. This will leave less chain to foul the bottom for the new mooring, in addition to recovering some expensive chain.

G. The above method is not used with buoys larger than 5–FE.

27–7–15 Relieving Small Buoys (Special Case)—

A. In some cases it is not possible to relieve small buoys located in shoal water directly from the buoy deck of the tender. In such cases the procedure may be as follows:

(1) A marker buoy may be used to locate the buoy station, this being placed from the motorboat.

(2) The buoy, chain, and sinker are shackled together and the sinker is suspended from the bow of the motorboat by stopping off the chain as near the sinker as possible on the bow cleat and allowing the remainder of chain and the buoy to trail astern. (A heavy sinker is sometimes better slung under the middle of the boat.) The rope stopper holding the sinker may be cut with an axe or cast loose when on station.

(3) A long hook line may be carried out from the ship by the boat and hooked to the buoy, whereupon the buoy, chain, and sinker are dragged off station and to the ship's side. This may be done before or after setting the new buoy, depending on how close the old buoy was on station.

27–7–20 Construction of Single- and Three-Pile Minor Structures by Tenders—

A. *Work order data.*—The order from the district office will specify the type of structure (accompanied by drawing), the size of lantern, the voltage and amperage of the lamps, the characteristic of the light, type of daymarks with identification markings if required, and data pertaining to location of the structure such as bearings and distances to reference points, etc. The drawing will show all details of construction pertaining to that type of structure, and will also show the desired amount of penetration for the piles, the depth of water to mean low water level, and the distance from mean low water level to the focal plane of the lantern.

B. *Site location.*—If the site of the structure has not already been located and indicated by a marker buoy, this work is accomplished immediately upon arrival at the site, by the use of sextant angles or other standard method. See part 27–11 of this chapter.

C. *Depth of water.*—Carefully sound the depth of water at the site and determine the mean low water datum plane, making all usual corrections for height of tide at that moment, correction for site location in respect to reference station, the piling effect of wind if any, etc. The mean low water level is shown on the drawing furnished by the district.

D. *Preparation of piles.*—The required length for either vertical or sloping piles is determined by the summation of the various pile dimensions as shown on the drawings, except that when the depth of water to mean low water as indicated on the drawing differs from that as actually measured at the site, the latter shall be used. Having determined the required length of piles, the butt ends are sawed squarely with the pile axis to the determined length. The squarely sawed butt facilitates driving since it permits the delivery of maximum energy from the hammer blows. The bottom tip of the pile is usually chamfered slightly and uniformly to facilitate driving, but a very sharp point should be avoided because of the possibility of brooming of the point, with consequent increased difficulties in driving. Whenever a pile is expected to be driven in an exceptionally hard gravel bottom, the bottom tip of the pile is often provided with a metal shoe of conical or wedge shape to prevent brooming of the pile point.

In order that it may be readily ascertained, during the driving operations, when the pile has reached its required penetration, each pile should be marked by a line (waterproof yellow crayon suggested) indicating the distance from the pile tip to mean low water level. An additional line (waterproof red crayon suggested), representing the actual level of the water at time of driving, should also be placed on each pile immediately before driving. Thus, during high water conditions, the red line should be above the yellow line; and during extreme low water conditions the red line should be below the yellow line. During the pile driving operations, the pile is sunk until the red line just touches the surface of the water, after which driving operations cease. Thus, the tip of the pile will have its required penetration, the yellow line representing mean low water will be at its proper elevation irrespective of fluctuations in tide or river level; and the pile head will be at its proper elevation to receive the platform and lantern with focal plane of lantern at its required elevation. In cases where the pile cannot be driven to its required penetration because of an exceptionally hard bottom or because of an obstruction encountered, if the penetration obtained is reasonably close to that required, the pile is left in place, and the top is sawed off by an amount corresponding to the distance that the red line remains above the surface of the water.

E. *Anchoring.*—Since many of the inland tenders required to drive pile are not equipped with spuds, it is necessary to lay out anchors from each bow and from the stern in order to hold the ship steady for pile driving. Even so, unless wind and current are moderate to light, piling cannot ordinarily be driven. At some locations, the bow can be grounded out and the ship thus held steady. The flying moor (described in any standard work on seamanship) is sometimes used in connection with anchoring the tender for driving pile. A heavy sinker lowered at short stay will help steady the moor. Accomplish the maneuver so that the bow or stern is headed into the wind or current, if possible. A lot of time and effort will be saved in the long run if the vessel is completely steadied before attempting to drive piling.

F. *Standard pile-driving equipment.*—The use of standard pile-driving equipment facilitates speed and accuracy in the driving of piles, and the initial cost of such equipment is soon repaid by the resulting savings in time and effort. This standard equipment comprises an A-frame, hammer, and hoisting equipment. For a drop hammer, the A-frame should be about 10 feet higher than the maximum length of piles to be driven. The A-frame is provided with leads for guiding the hammer. The leads should preferably be arranged for tilting, so as to permit the driving of sloping piles. The hammer may be either drop, steam, or air type, and should obviously be furnished with the requisite type of equipment for operation of same. The hoisting engine should have at least two drums; one for the hammer line, and one for the pile line. An additional drum for the use of a jet line is desirable. The A-frame and hoisting equipment should preferably be mounted on a barge, preferably about 30 x 70 feet with a square end where the driving equipment is mounted.

Although the pile-driving equipment may be (and frequently is) arranged for use from the deck of a tender or other vessel, this arrangement is inconvenient on account of frequent need for assembling and disassembling of this equipment aboard. Also, tenders mounting pile-driving equipment are unwieldly and difficult to handle in moderate to strong winds. The mounting of pile-driving equipment on a barge permits the pile driver to be in a constant state of readiness for immediate use, and creates less wear and tear on the vessel.

G. *Improvised pile-driving methods.*—When standard pile-driving equipment is lacking, piles may be driven by improvised methods as follows: A standard pile hammer may be suspended from a boom on the whip with or without guide leads for the hammer. The use of guide leads is preferable as glancing blows on the pile head are thus avoided, and plumb driving of piles is thus better assured. Another improvised method for driving piles is by using a buoy sinker for a hammer suspended from the whip as explained above. In either of these cases, means must be provided for handling the pile as well as means for hoisting and dropping the hammer or sinker. Another method is to place the pile in vertical position at the site of structure and apply a downward pull by means of a line from the pile head run vertically to a snatch block on deck and thence to a winch drum. A steady pull in such manner will bring a pile down to required penetration in mud or clay, but care must be taken to hold the vessel in such position as to keep the pile vertical.

H. *Jetting* (the use of water pressure through a pipe alongside the pile) is useful in sinking piles when pile-driving equipment is lacking, in which case it may be used alone or in conjunction with a weighted pile (i. e. a sinker swung out to rest on top of the pile). Jetting is also useful in assisting the driving of piles with standard pile-driving equipment in hard ground conditions, and is especially valuable in sand, gravel, or hard packed clay. The purpose of jetting is to loosen the ground under the point by water delivered under pressure. The jet water should be delivered to the pile point in sufficient volume and pressure to wash away the soil from under the point and to reduce the friction of the soil around the pile body. After the pile has been sunk, the earth settles naturally around the pile to retain the pile permanently in position. When jetting is used in conjunction with pile-driving equipment, jetting is usually discontinued a few feet before final penetration is reached, and the pile is driven the remainder of the distance with the hammer alone. Fire pumps delivering 150 g. p. m. make excellent jet pumps.

The jet pipe is sometimes secured to the wood pile by means of staples, straps, or nails in such a manner that the pipe can be pulled free when driving is completed. Some operators find it preferable to keep the jet pipe free, and in constant motion up, down, and around the pile. In such case the jet pipe should be suspended from an overhead rig permitting free movement of the pipe.

I. *Sloping piles.*—To slope piles for dolphins where tilting pile-driving equipment is not available, they may be driven or jetted in a vertical position along the circumference of a large circle, after which the tops are drawn together. This method is easier in relatively soft ground. However, where the ground is hard, there is danger of breaking the piles near the bottom, in which case the process of drawing together the tops of the piles is assisted by jetting the ground near the pile on the side facing the interior of the circle. The drawing together of the pile tops is accomplished by means of a sling hooked around the tops, and by tightening the sling with a block and tackle. If the pile tops do not move uniformly together towards the center of the circle, the resisting pile is assisted by further jetting at the ground. Wood cleats should be nailed temporarily near the top of the piles to prevent the displacement of the sling while being tightened. The use of the block and tackle, if maintained constantly in the same relative position, may cause all pile tops to move together as a group toward the direction of pull of the running line. To avoid this, the block and tackle may be occasionally shifted in location with respect to the various piles; or the block and tackle may be substituted by a turnbuckle arrangement to pull on the sling ends.

J. *Pile-driving hints.*—When a drop hammer is used, the heads of wood piles may be protected with a steel ring fitted over the pile head, the cross section of the ring metal being approximately ⅞ x 2½ inches. The purpose of the ring is to avoid brooming and splitting of the pile head during driving, since a broomed or split pile head results in unnecessary length of cutoff due to damaged pile top, and reduces the transfer of energy from the hammer blows to the pile.

(1) If, during the driving, the pile head begins to broom excessively, even with the use of the metal ring, it indicates that the pile has been driven to refusal. If the penetration must be continued under these conditions, the pile must be assisted by jetting.

(2) If, during the driving, the pile begins to stagger and the hammer bounces, it indicates that a boulder has been encountered, or that the pile point has been damaged, or that the pile has split somewhere in the ground. In such cases the pile should be pulled and a new sound pile should be driven in an adjoining location.

(3) To aid in the construction of a three-pile structure, a jig for properly placing the piles in a triangular position may be built out of 2- x 4-inch lumber. To construct such a jig, place three pieces of 2'' x 4'' x 12 feet in a triangle with the ends overlapping. Using a deck bucket (it is about the same diameter as a pile), place it in the vee formed by these overlapping ends, and adjust the pieces of lumber to give equilateral sides according to the distance specified between the pilings, if any. Nail the 2 x 4s together and cut off the ends, leaving a small vee at each corner of the triangle. After the first pile has been established, the jig is used for positioning the remaining piles. Remember that the apex of the triangle should be at right angles to the channel, so that when the daymarks are secured to the finished structure they will be clearly visible both upstream and downstream.

(4) After a pile has been jetted, it should be allowed a period for "stiffening up," i. e. to permit the mud and sand to settle around the pile. Twenty minutes or so is usually sufficient.

K. *Sawing pile tops.*—After the piles have been driven in place, or drawn into position, as the case may be, the tops of the piles are sawed off at the required level. In order to saw the piles properly, wood cleats may be used to guide the saw. The cleats are placed on opposite pile faces. It is preferable to use top and bottom cleats with just sufficient space between to permit clearance of the saw blade.

L. *Completion of the structure.*—Since there is a large variety of types of structures in use in the several districts due to particular local requirements, no discussion of the construction of platforms, daymarks, battery or tankhouses, and lantern supports, etc., will be made. Sufficient information is furnished by the District's drawing, work order and specifications.

M. *Pulling piling.*—Tenders in inland waters are often called upon to remove old piling from destroyed or unused aids. These pilings are sometimes pulled without much effort, using a heavy chain or wire sling passed around the pile and hooked onto the main. Generally, the pilings are more stubborn and other means must be devised to get them out. (A few downward blows with the hammer may loosen the pile sufficiently to facilitate pulling.) If the piling is located in sand and refuses to come out, jetting may be resorted to as follows: Set taut on the pile with the main hoisting tackle and hold fast. Rig a jet pipe, 1½-inch diameter, with a fire hose and pump secured to one end, and hoist it on the whip alongside the piling to jet the sand away. Use all pressure available and keep the jet pipe in motion, i. e. lower it, raise it slightly, then lower it a little below where it was before until the jet reaches the bottom of the pile. If the jet pipe is not kept in constant motion, it will stick tightly in one place and another jet must be rigged to free the first one. First one side, then the other of the piling is loosened until the main can pull it up. In hard mud and clay bottoms water jets will not work. In this event, set taut on the pile with the main and pass a length of ¾-inch chain around the pile at the deck level. Secure this chain on deck so as to steady the piling fore and aft. Work the ship slowly ahead and astern to loosen the pile. Stubborn pilings require patience and perseverance but nearly all of them can be pulled eventually.

N. *Handling pilings.*—The use of tongs or snap hooks in loading piling has been common practice for a number of years. However, several accidents and many narrow escapes have resulted from their use. Whenever possible, it is better to pass a chain sling around the pile. This requires a little more time and the piles must be wedged in order to be able to pass the round turn of the chain. In some cases, such as floating piling, this procedure may not be feasible, but whenever possible in hazardous work, the safest method should be employed. Also, the penetration of the hooks through the protective coating tends to destroy the effectiveness of the expensive protective treatment. Men handling piling should wear gloves. A splinter from creosoted piling can become a serious injury.

27–7–25 Aids to Navigation Work Ashore, on Rivers—

A. The procedure of servicing shore aids presents different problems on different rivers. For instance, brush and tree cutting on the lower Mississippi is a major item in servicing aids ashore, while on the upper Mississippi the problem is relatively simple. This is due to the difference in stability of the shore line. Painting structures is another item which should be deferred until later in the season on rivers likely to have a major flood every year. Shore structures should be checked for soundness, any rotten portions replaced, and checked for appearance, all in addition to routine servicing of the light apparatus (as described elsewhere in this manual). The outstanding feature of handling shore aids on the lower Mississippi River is the fact of the impermanence of the structures. The structures have to be constantly moved back and reset due either to channel changes of active caving banks caused by the constant, and at times rapid, change in water levels. Many structures are lost in this manner. During high water stages when the banks are overflowed, the structures are dismantled, moved a safe

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distance back from the river, and wired to trees for safekeeping until such time as the stage of the river recedes sufficiently to replace them. During this time a temporary light is exhibited from a "Little Giant" hand lantern or similar device.

B. *Building shore structures.*—Constructing shore structures along rivers is a job requiring some ingenuity at times, and good common sense. In most cases, river-type shore structures are elevated as much as possible to prevent being carried away during high river stage. To construct and maintain them generally requires either a ladder, linesman's spikes, or where the structure is to be secured to a tree, the ladder staps may be nailed directly to the tree. Before climbing a ladder, be sure that it is well anchored at the top and bottom, and that it is given enough angle. Do not attempt to climb a structure or steps that appear rotten or weak. If working around under someone on a structure, watch out for dropping tools and materials. When clearing brush and trees from around shore aids, do not work too close to each other and take care that all is clear before a tree is permitted to fall. Make sure of your footing and see that brush, vines, etc., are clear from overhead, before swinging an axe or brush hook.

(1) All structural parts and materials are precut and painted, ready to be assembled on the spot. Many structures have wingboards fitted with sheets of reflecting material. In preparing precut sections of structures, if it is known where the nail holes will come, undersize holes may be drilled in the proper places.

(2) When painting structures, scribe in the outline of the number or letter with a nail or other sharp tool to make repainting easier. To prevent smearing of paint on reflector buttons, place a short length of rubber hose of suitable size over each button as you paint.

C. *Servicing shore structures.*—The servicing of lighting apparatus at shore structures is similar to the procedures described for other structures elsewhere in this manual.

(1) Wasp's nests are often found inside of battery boxes, etc., on shore structures. Take care in opening these boxes, as a sudden wasp sting might cause you to lose your balance and fall from the structure.

(2) Following are some effective methods of fabricating bird guards suggested by a light attendant on the Intracoastal Waterway: "Piling and Pointer—Take a piece of lumber 12 inches square and drill about 22 holes 3 inches apart. Take nine 12 to 14-inch lengths of stiff wire and bend them into a U. Thread the points of the wires through adjacent holes, continuing until all but four holes are filled. Nail the board to the top of the piling. Use a length of 1- x 1-inch lumber fitted with wires sticking through as above and secure it to the pointer and top edge of the daymark. Five-pile Dolphin Lights—Drive nails in each corner of the top of the battery box and one on each side between them. Secure a wire around the pot of the lantern just below the swing bolts. Now zigzag the wire from the nails to the wire around the lantern. Drive a nail in each corner and on each side of the battery box platform, and drive eight nails in the side of the battery box about 18 inches from the bottom, one in each corner and one in the middle. Zigzag wires from the battery box platform to the battery box. If there is a daymark, a length of 1 x 1-inch fitted with wires as above will help."

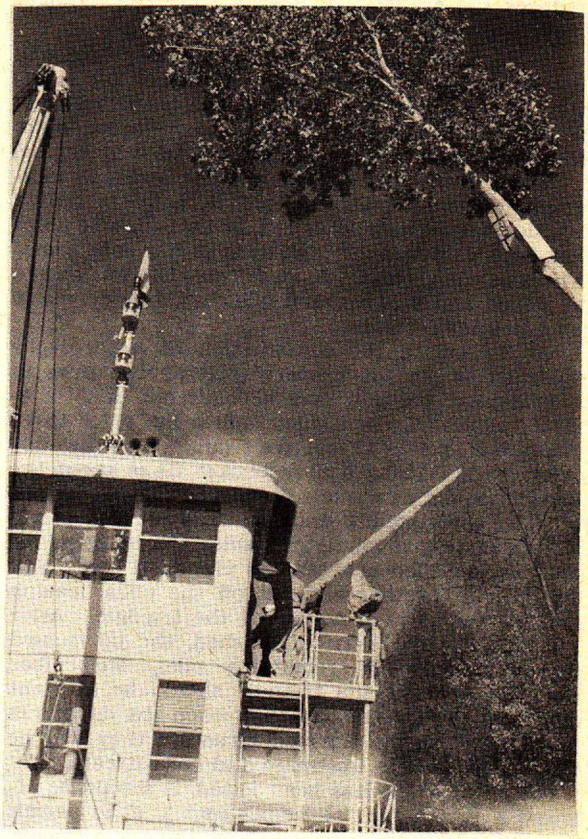


FIGURE 27–256.—Servicing a daymark located high in a tree.

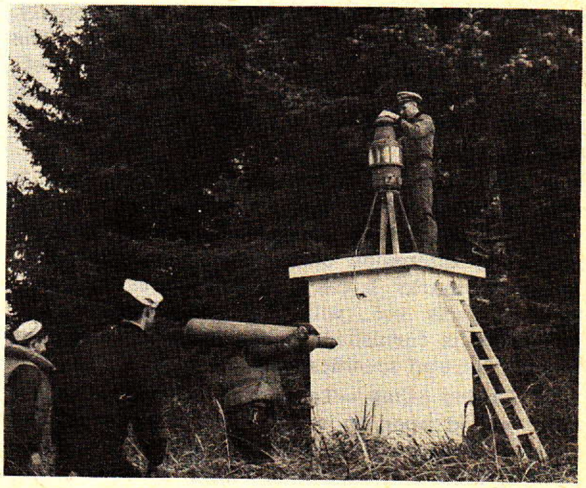


FIGURE 27–257.—Servicing a light on the bank of a river.

27–7–30 Aids to Navigation Work Afloat, on Rivers—

A. Satisfactory buoying and lighting a certain section of river calls for a knowledge of the eccentricities of the section in question plus a knowledge of the types of vessels and equipment, their limitations and methods of navigation. First of all, the gage above and below a section to be buoyed must be known, i. e., the present reading, the low-water reading, and the project depth for the section. For example, to properly place a buoy at mile 223.0 Upper Mississippi River, the Dixon Landing gage at mile 228.3 Upper Mississippi River and the Grafton gage at mile 218.0 Upper Mississippi River must be known. The project depth for this section of river is 9 feet. The present gage reading at Dixon Landing is 8.3 feet, low water reading 7.58 feet. Grafton gage present is 15.0 feet, low water 14.2 feet. With this information the slope is computed on graph paper. Reading from the grap thus constructed, at mile 223.0 it is found that the buoy in question must be placed in 9.6 feet of water in order to maintain project depth.

(1) In low water season in certain sections it is not always possible to maintain the desirable width of three or four hundred feet between buoys, and sometimes the channel must be narrowed to 200 feet. Anything under 200 feet presents a problem. In a straight crossing it can be narrowed a little more, but in a crooked channel or at a turning buoy this is not practicable because the larger tows are unable to navigate in such a narrow space. It is better to leave 200 feet width and notify navigation that one side of the channel is less than project depth. This should be on the upstream side, due to the fact that a downbound tow would be sliding away from the shallow side and upbound tows will "run from it" (the tendency of a vessel or tow to sheer away from a shoal in some cases). Also, should a vessel ground, it is much easier to free it from an upstream reef.

(2) The above example is given to show some of the knowledge required to perform buoy work on certain inland rivers. Perhaps more than in any other type of aids to navigation work, intimate piloting details must be thoroughly learned through years of experience.

(3) On the Mississippi and Missouri Rivers, the commanding officer of the tender prepares sailing directions for the guidance of navigation based upon information gained from his regular patrols of the area. These sailing directions include, in addition to directions for navigation, gauge readings which tell the pilot how much water depth is available and indicate how closely he must adhere to the marks in all directions. Also least sounding depths along the section are shown. These sailing directions are written in a jargon peculiar to the river and understandable by pilots. They should be written from the point of view of a large tow. If he can navigate the section, then anybody can.

B. *Working buoys.*—Many river tenders work their buoys from a barge pushed ahead of the vessel. On one tender, unlighted buoys (15 and 18 river types) are stowed in a pen amidships on the barge. Wire rope for moorings is placed forward, sinkers along the side, chain for moorings aft, and lighting apparatus inside the barge workshop. To load, the barge is maneuvered under a boom ashore at the depot. Following is a description of how 15 and 18 river buoys may be handled:

The 250-pound sinkers are placed on the edge of the barge near the bow with about 50 feet of mooring wire stretched outboard down the side of the barge. The buoy is resting on the deck at the stern of the barge. On whistle signal, the sinker and buoy are pushed overboard by hand, one man to each. When picking up the buoy, the vessel maneuvers the barge alongside, stemming the current. The buoy and the attached mooring wire are manhandled aboard with a boathook and the wire is secured to a cleat on deck. The hook of the whip is then passed under the wire outboard of the cleat and run up, thus hauling the sinker aboard. The success of this method depends on obtaining enough slack in the mooring wire to secure it around a cleat. When slack cannot be obtained, the buoy must then be hoisted by the whip, stopping off, etc. as with any single hoist.

C. *Sinker sanded-in.*—Complete sanding-in of the sinker almost always results in its loss. If believed only partially sanded-in, stop off the wire and then maneuver the tender and barge until the wire tends upstream. Slowly apply a steady strain. Do not jerk on the mooring, and keep all hands clear while pulling.

D. *Miscellaneous notes.*—Following are some miscellaneous notes on working buoys:

(1) In the case of larger sinkers, i. e. 2,000 to 4,000 pounds, a dumping board is used for tripping, being hoisted on the whip. The usual precautions in connection with ranging out chain, etc., must be observed.

(2) In picking up buoys equipped with mooring chain, a 6-foot length of ⅝-inch chain, having a grab-hook on one end and shackled to a padeye on deck at the other end, is used for stopping off the chain, either while getting a second bight for hoisting, or for holding the mooring while the new buoy is exchanged for the old.

(3) One tender, having a number of 3½ FE's in its area, carries two complete spare buoys aboard, one red and the other black, so that should a buoy require servicing, recharging, etc., the entire buoy is relieved and the old buoy then safely overhauled while on deck en route to the next buoy. This saves time and obviates the need for keeping the tender alongside the buoy in strong current, etc.

(4) A chain stopper consisting of a slotted piece of 1-inch steel plate has been developed by one river tender. This plate is welded in an upright position on its edge on the outboard topside of the deck at a favorable location of handling buoys. Suitable gusset plates are used for reinforcement. The depth and width of the chain slot are governed by the size chain to be used. This is a variation of the mechanical chain stopper described elsewhere in this manual.

(5) When loading heavy materials on inland tenders which may cause considerable listing, check to see that all portholes located near the waterline are closed.

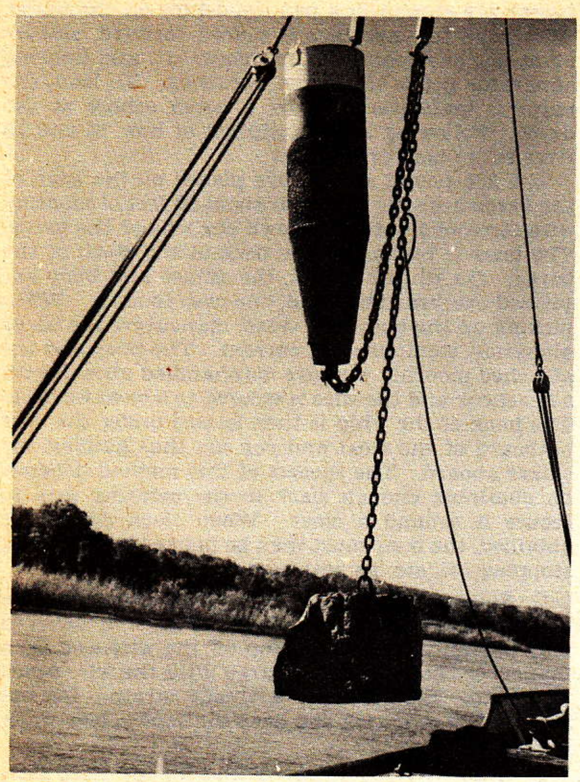


FIGURE 27–258.—A river-type can buoy and mooring being hoisted aboard for relief.

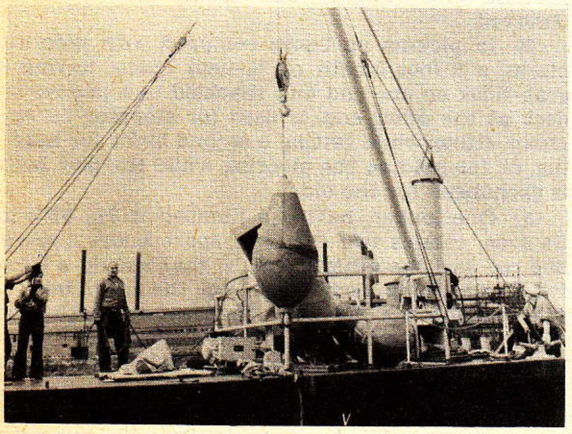


FIGURE 27–259.—Picking up a third-class standard nun buoy.

E. *Dragging buoys.*—Sometimes it is necessary to drag a buoy a short distance to cover the tip or finger of a bar making out or down. This is accomplished by maneuvering the bow of the barge alongside the buoy at the point of rake and dead flat. The barge should be on the side in which direction the buoy is to be dragged. Bring the buoy aboard and stop off the mooring wire to a cleat. The new location having previously been found by sounding, take

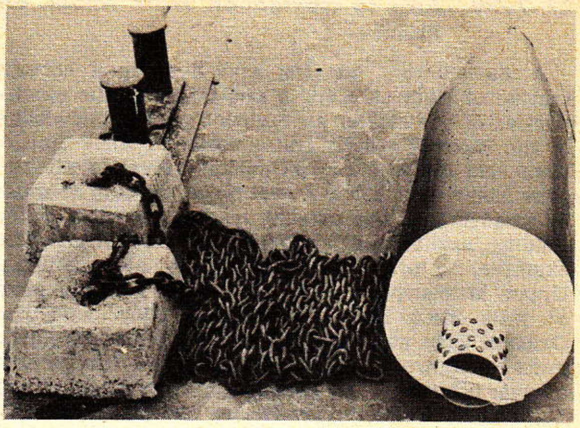


FIGURE 27–260.—A small can buoy, mooring chain and sinkers laid out on the barge.

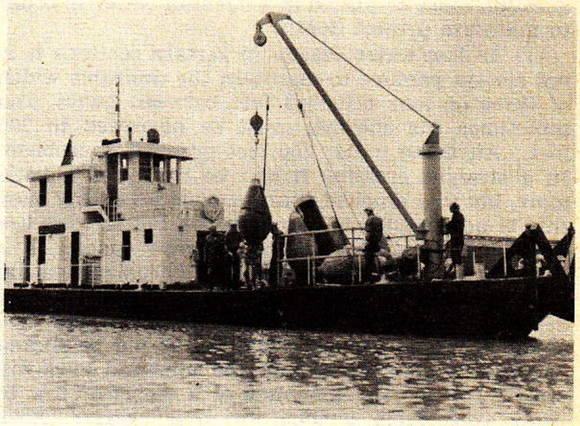


FIGURE 27–261.—A typical river tender working a small nun buoy.

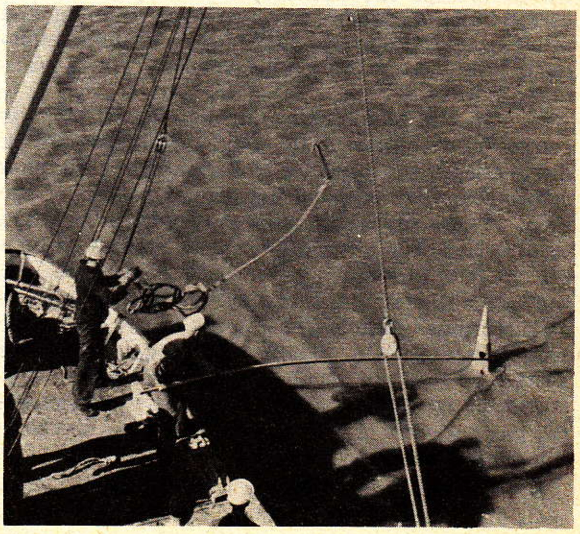


FIGURE 27–262.—Fishing a small buoy alongside with boathook and grapnel.

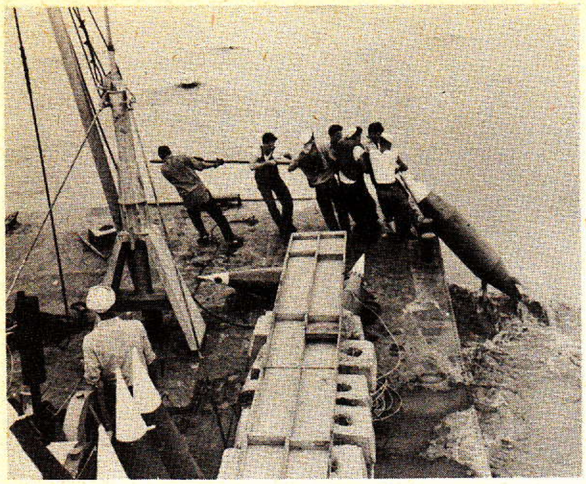


FIGURE 27–263.—Pulling a river-type buoy aboard the tender's barge. Men on barge should all be wearing lifejackets.

a slow strain and drag the buoy over to the new station. At the signal, one man casts off the mooring wire from the cleat and another pushes the buoy overboard. Be sure that the strain is off the mooring wire before signaling the man to cast off. Always have a stand-by buoy and mooring ready in case the wire should part. Have a range picked out previously to determine the new location quickly and easily, and allow for the length of cable to the sinker in computing station. *Always check your results with a sounding.*

27–7–35 Building and Repairing Daybeacons—

A. The maintenance of daybeacons often involves the erection of metal spindles, and installation of heavy cage-type structures on top of the poles. Each presents its own problem of rigging as the following photographs illustrate. In some cases, a flat working platform and gin pole are hoisted into place and secured at the top of the pole. The gin pole is generally only used when the cage or daymark structure is heavy.

B. Figure 27–269 shows a method employed for painting a 68-foot tower daybeacon, using a portable fire pump and 1½-inch hose with a small spray nozzle. This method obviated the need for elaborate staging and rigging, and shortened the painting time to about 4 hours. The carbide sludge solution mixed with salt water was prepared in 55–gallon drums.

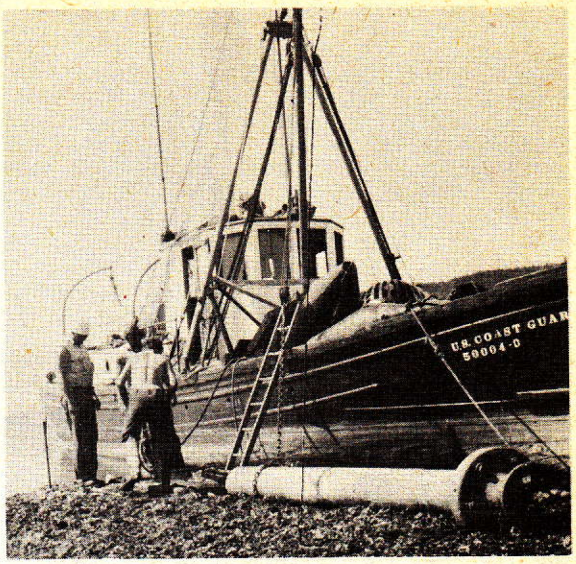


FIGURE 27–264.—Digging a hole in a shoal for a daybeacon.

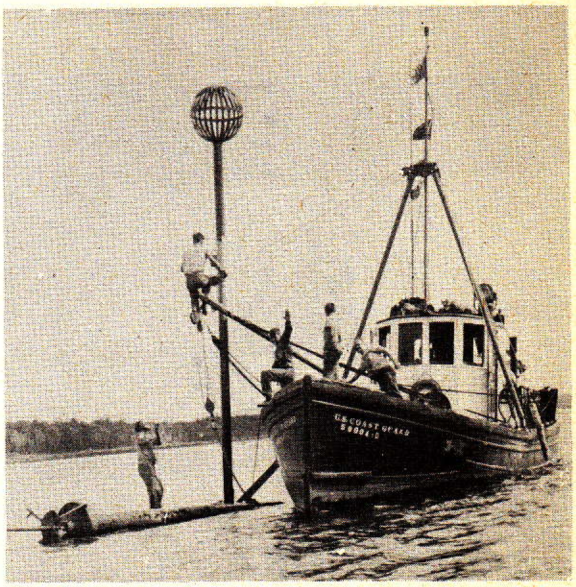


FIGURE 27–265.—Painting a daybeacon.

27–8 LIGHTSHIP AND LIGHT STATION LOGISTICS

27–8–1 General—

A. Because of the geographical locations of many lightships and light stations, the maintenance of the stations and their crews presents a difficult year-round logistics problem. Food, fuel, water, gasoline, kerosene, mail, liberty parties, medical relief, and scheduled repairs all have to be provided by water transportation and, in the great majority of cases, under hazardous conditions of weather and sea, frequently exposing the servicing vessel in tenuous anchorages. The difficulties of supplying light stations and lightships are generally the same, although the details of execution differ to such an extent that in the First District, for example, it is a fortunate coincidence that, geographically, isolated stations are fairly well concentrated along the coast of Maine, while the lightships are stationed along

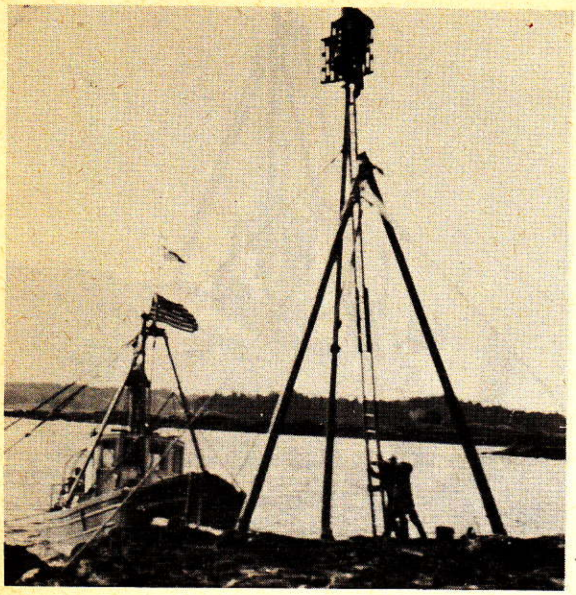


FIGURE 27–266.—Erecting a spindle-type daybeacon by use of shear legs.

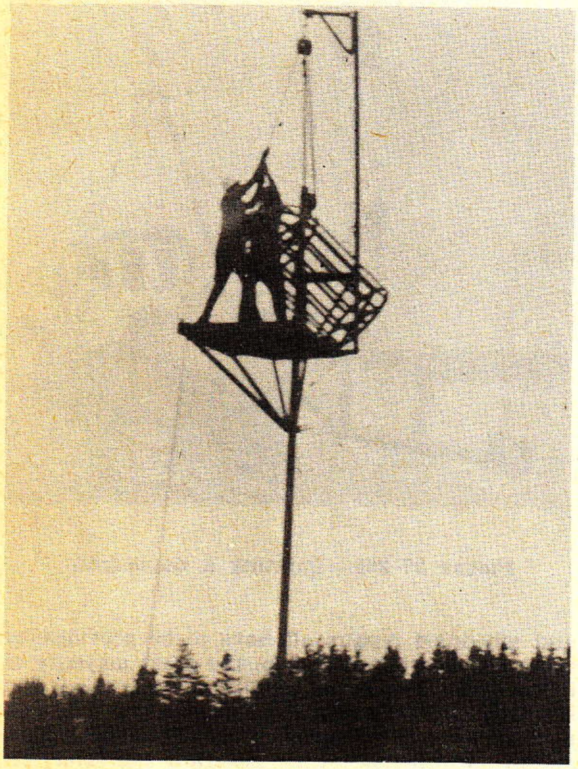


FIGURE 27–267.—Hoisting a cage daymark by use of ginpole and temporary working platform.

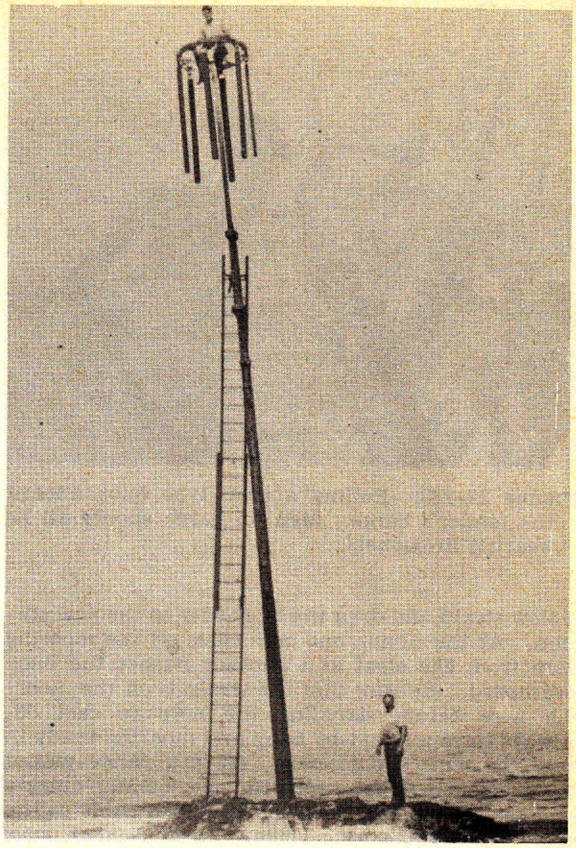


FIGURE 27–268.—Replacing daymark pendants on an isolated daybeacon.

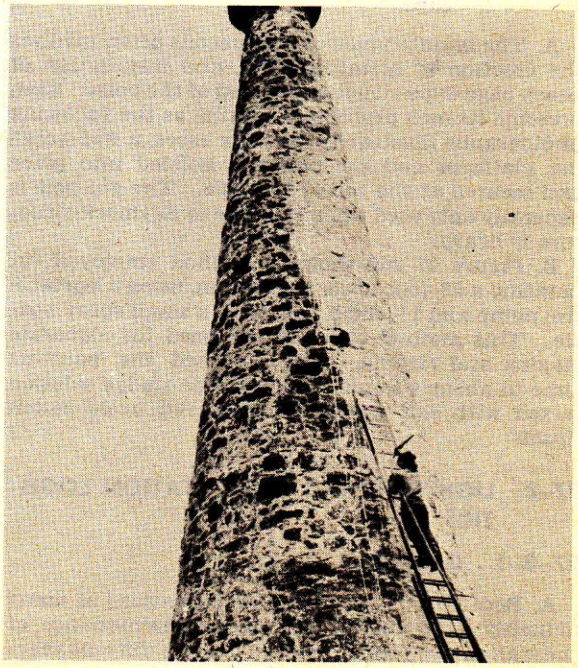


FIGURE 27–269.—Spray painting a daybeacon tower.

the coast of southern New England and are concentrated in the waters of Cape Cod. This situation makes it possible for the tenders and other servicing vessels to specialize and become expert in the techniques necessary to the solution of the particular problems of their respective areas, thus reducing unit servicing time to a minimum, consistent with safe procedure.

B. *Supplying coal.*—Many of the light stations in the First District, for example, still depend upon coal as a source of heat for quarters and other station dwellings. The coal is bagged at the depot or is delivered by the contractor in bags of about 70 pounds. The coal in bags is loaded onto the deck of the tender by means of the cargo boom, and the vessel proceeds and anchors close by the station to be serviced. The loaded boats are sent ashore to land at the boat slip or ramp, if any. If the station has a ramp, the boat is run up the greased rails at full speed. As the boat comes to a stop, a hoisting whip is hooked into the stem ringbolt and the boat is then hauled clear of the water. From this point on, all hands form a human conveyor belt and carry the coal to the station.

C. *Fuel oil and water.*—The delivery of fuel oil, kerosene and water to light stations and lightships may be accomplished by means of a hose line and either pump or compressed air. The hose is floated ashore from the tender and run up to the tanks. The tender may take suction from the ship's tanks, or from a special tank which is kept at the depot for the purpose, and which is carried on deck during fueling trips. If the ship's tanks are used, this means running the low-capacity fuel-transfer pump—and the job seems to last forever. If the deck tank is used, an air compressor is hooked up to the tank and air pressure forces the fuel ashore. Most of the time this is a very satisfactory method because of the great length of hose required (producing a large line loss due to friction) and the unusual head pressure caused by the high elevation of the light station in many cases. The ship's small transfer pump was never designed to work against such odds. When the delivery of oil is completed, using this method, the hose is blown clear with compressed air (each length of the hose contains about four gallons), and the hose is taken in. By keeping the air passing through the hose, it will float and at the same time will be propelled by jet action through the water, thereby simplifying the work of hauling it aboard.

(1) *Caution.*—The procedure of forcing fuel ashore under air pressure can be *dangerous* if proper precautions in the use of high pressure air are not observed. Tanks must be inspected and tested as safe to withstand the pressure. Pumping oil and water ashore is considered to be a safer procedure.

(2) A variation of the use of the ship's transfer pump or the compressed air methods is the use of a booster pump, when a long hose line is involved. Water can be delivered by use of a Hale skid pump as a booster on either a 1½- or 2½-inch hose. With a Y fitting in the line it is possible to deliver as much as 15,00 gallons per hour, depending, of course, upon the ability of the receiving unit to take

FIGURE 27–270.—Launchway and boat house at Libby Island Light Station, Maine

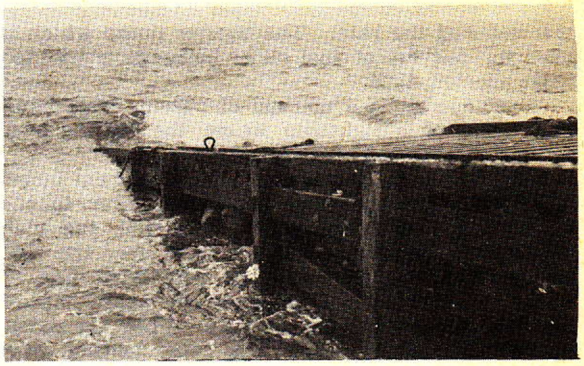


FIGURE 27–271—Ramp at Cape Ann Light Station, Mass.

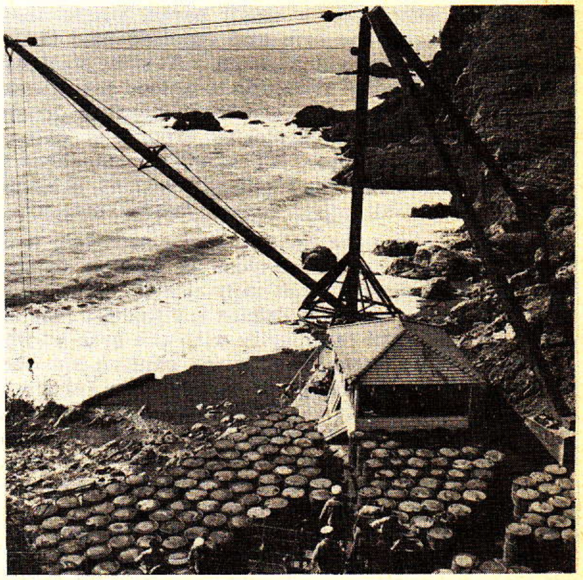


FIGURE 27–272.—Landing area of an Alaska light station.

FIGURE 27–273.—Fueling operations in Alaska.

the water at the rate. The booster pump which is used for delivery of fuel oil or kerosene is the no-spark electric type.

(3) Following is a method of passing water and fuel hoses to a lightship where the fueling vessel has compressed air available:

Using 1½-inch hoses, cap them, put them under a light air pressure and float them over to the lightship. After pumping is completed, the men aboard the lightship hold the hose over the side where it can be seen and the remaining fuel or water is blown out. The hoses are again capped and put under light air pressure. They are easily pulled back to the ship. The same method may be used at light stations to make the hose easier to pull across.

(4) Many light stations in the Great Lakes area are fueled by means of drums of gasoline, kerosene, etc., taken ashore on a small barge, where they are hoisted onto the crib and emptied into tanks by pouring each individual drum. At some stations, the tender may come alongside to unload the drums. *Extreme care* must be taken when pouring drums in this manner, since explosive vapor will gather around the structure. All auxiliary machinery should be secured during fueling operations, in addition to taking all other normal safety measures.

D. *Approaching the light station.*—Although it is highly desirable to get as close as possible to the unit to be serviced to not only use the minimum amount of hose but to maintain the highest rate of flow possible, until familiarity with the area of the individual light station is acquired, caution must be exercised in approaching. If the area is unfamiliar, sound out thoroughly with the small boat and lead line for the best anchorage. If possible, observe local ranges so that the same spot may be located the next time. The approaches of some stations are such that they can be visited under most, if not all, stages of current and wind conditions. Others can be visited only on certain specific bearings, and such visits are conditioned by the wind and current. The eddy currents developed about stations located in open water are important in the consideration of where to anchor in respect to a station. However, proper evaluation is the result of numerous carefully observed experiences at the unit.

(1) The change in current, and the eddies produced therefrom, must necessarily guide the time and manner in which the hose is passed from the ship to the station. The swinging of the vessel at anchor may foul the hose in the anchor chain, or even part it.

(2) If the bottom is soft and the shore is steep, a tender may sometimes nose in slowly and touch the bow ashore. This is frequently done at stations on the Great Lakes. In tidal waters this should never be attempted on an ebb tide.

(3) In some locations, tenders can anchor close to the landing and pass a stern line to the beach, thereby warping the stern in as close to the beach as is safe and practicable.

E. *Approaching the lightship.*—The normal method of fueling and watering lightships is to approach from directly astern (unless a considerable sea exists) sufficiently close to pass heaving lines, whereby a 6-, 8- or 10-inch hawser (depending on weather conditions) and fuel and water hoses are run across. A man can pass a heaving line further if he stands at the break of the forecastle head so that he can swing the line in a big arc along the side of the ship. Although this requires practice, a good man can pass a heaving line for a remarkable distance in this manner. It is well to favor the starboard quarter of the lightship if approaching in a single screw vessel, so that if it becomes necessary to back off suddenly, the bow will swing clear. In a heavy sea with the lightship veering, it is not advisable to approach too closely. In this case the lightship can trail a line astern to be picked up by the tender. Lay on 150 to 300 or more feet of hawser, depending on the weather. The length of the hawser should be such as to allow the bow of the tender to rise on the swell at the same time that the stern of the lightship goes up. This will prevent sudden jerks and resultant overstraining of the line. When paying out hawser, do not forget to pay out fuel and water hoses as well, as you drop back.

F. *Making a lee for the boats.*—In several instances, with a slight to moderate swell running, it has been found advantageous to the boats lowered for transferring supplies and personnel, to create a lee by taking a strain on the mooring line to haul the stern of the lightship to windward, and by proper maneuvering of the tender, hold the lightship there until boat operations are completed. See that the boat has plenty of fenders and long bow and stern painters.

G. *Laying stern-to.*—It has been found that in the case of certain twin-screw vessels in rough weather, less yawing is experienced by laying stern-to while fueling the lightship. In the cases where there is a tendency for the tender to creep up on the stern of the lightship, such as in calm weather, the engine(s) may be turned over slowly to keep the ships apart. A single-screw vessel would maintain a steady heading more easily under these conditions if laying stern-to.

H. *Delivery of miscellaneous material.*—In addition to the routine servicing of stations with fuel, water and stores, there often are construction materials to be transported ashore—lumber, cement, brick, well-drilling equipment, sanitation gear, and other materials used in connection with improvement projects. All this equipment requires special handling because, in most instances, it is not service-owned, but belongs to some private concern. Naturally, this equipment must be delivered in the same condition as when received, so that the work scheduled involving the use of this special equipment can be performed. When the improvement or repair job is completed, the equipment has to be removed from the station and transported back to the depot. Some special cases require floating gear, rafts (towed by the ship's boats) and the need of the most ideal weather conditions.

I. *Pea-pod dinghy.*—The development of the pea-pod dinghy is one part of the solution to the problem of landing a small boat at an island station which is exposed to the almost ever-present ocean swell. This development is complemented by the improved design in hoisting gear and launchways which are used in launching and hauling out the dinghy. The pea-pod is a 15-foot double-ended carvel-planked boat with a beam of about 5 feet and a draft of about 2 feet. The boatman rows from a standing position, facing forward, in order that he can watch the swell, timing his dash for the launchway so that he arrives at the top of a swell and can hook the hoisting whip into the ring bolt in the stem of the dinghy. As soon as the hook is secured, the winch operator in the boathouse heaves around and hauls the boat up the launchway.

J. *Fueling Alaskan stations.*—The following procedure has been used in fueling some isolated stations in the Alaskan area:

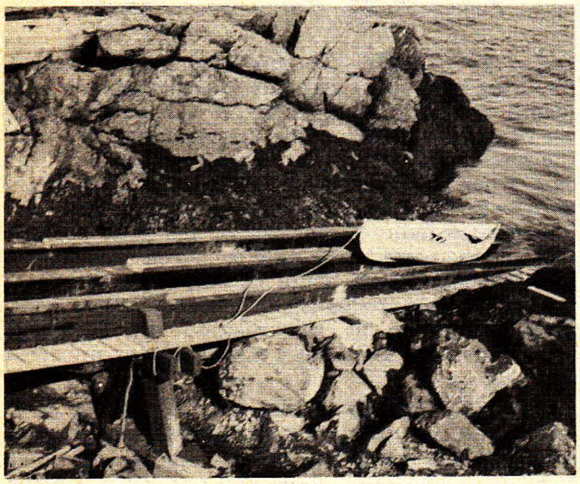


FIGURE 27–274.—Boat launchway showing pea-pod dinghy. Libby Island Light Station, Maine.

"Ship's landing craft, an LCM and two LCVP's, were used. The LCM was loaded with four 1,000-gallon pontoons and had a Chrysler Marine fire pump unit mounted on the stern, connected by a 4-inch rubber suction hose to a manifold which in turn was connected to the pontoons. Another manifold was used to fill the pontoons from the ship. The first (emptying) manifold consisted of 3-inch pipe leading from each pontoon into a 4-inch cross pipe, each being provided with a gate valve. The second (filling) manifold consisted of a 3-inch cross pipe with four 1½-inch outlets, each equipped with a plug cock. Two 25-foot lengths of rubber filling hose were led from each outlet to a pontoon, and a 4-inch main filling line led from the ship.

(1) Fifty-gallon drums were lined up on shore, emptied of water and bungs removed by station personnel. The LCVP made a preliminary trip ashore with hose, extra bungs, manifold seals, valves, couplings, and nozzles. Two and one-half-inch water hose in 50-foot lengths was led from the drums to the water's edge. A manifold consisting of 2½-inch pipe with four 1½-inch outlets was fitted to the 2½-inch water hose. Enough sections of 1½-inch rubber or canvas hose led from the manifold to the drums and a quick closing nozzle was fitted on the end of each hose.

(2) The LCM and the beach party were equipped with portable radio so that emergencies such as a broken hose or low pressure, etc., could be remedied. Water hose is generally unsatisfactory for fueling purposes as it soon develops leaks."

27–9 CARGO HANDLING

27–9–1 General—

A. Tender-class cutters are frequently required to carry cargo of a nondescript heterogeneous nature, which may be difficult to stow and secure for that very reason. Certain tenders, engaged in loran and light station logistic runs, carry cargos which include crated electronic parts which must be kept dry and handled gently; drums of kerosene, gasoline, and fuel oil which are usually stowed on deck; vehicles and construction equipment, also stowed on deck; and miscellaneous crates, cases, and packages which complete the below-decks stowage. Just as each buoy trip presents a new stowage problem for handling and securing, so does every logistics trip. Proper application of the fundamentals of cargo handling as varied to meet the conditions present will enable the commanding officer to feel secure, when his vessel puts to sea, that the cargo will arrive undamaged, and that the ship's safety will not be jeopardized enroute. The following sections and paragraphs describe some of the principles of cargo handling which are applicable and adaptable to vessels of the tender class.

27–9–5 Planning and Distribution of Cargo—

A. One of the important phases of cargo handling is planning the loading and proper distribution of cargo in a vessel. It may be well to point out at this time that the practical side of loading a vessel does not always conform to the theoretical. Usually, the cargo is planned in advance. It is possible, with experience, to make the segregations as to the various types of cargo for suitable hold, deck, or on-deck stowage, as shown. This, however, can be completely upset by a last-minute change in plans—canceling part of the weight cargo, making substitutions and additions—necessitating the immediate revision of the preliminary planning set up for the vessel. Trim and stability influence the planning of stowage, with full consideration given to the individual type of vessel. Care must be exercised in distribution of weight fore and aft to keep the ship in proper trim. Stability is discussed under section 27–9–65 briefly.

B. *Stowing aboard the vessel.*—Stowing of cargo in a vessel requires skill and experience. Stowing is more than just placing cases in position to keep them protected from damage. The theory of stowage of a ship's cargo is based on the same principles as packing a crate—the idea being to get the greatest possible goods properly and safely into the crate, and so packed that they will not be damaged in transit.

C. *Separation of cargo.*—Separation of cargo is vitally important. Consideration must be given to contamination, dust, moisture, leakage, crushing, and chafing before deciding where the cargo is to be placed in the vessel. Restrictions and regulations are placed on the stowage of explosives, ammunition, inflammables, and labeled cargo.

D. *Stowage factor.*—Problems in stowage involve the use of the stowage factor of the commodities to be loaded and the cubic capacity of the compartment in which the cargo is to be stowed. The stowage factor denotes the amount of cubic feet required to stow a ton of any specific commodity. The long ton (2,240 pounds) is always used in these calculations.

Example	*Factor*
Drum lubricating oil	52
Steel	10

A weight ton (2,240 lbs.) of drum oil measures 52 cubic feet.

Usually the term "measurement cargo" describes goods having a stowage factor of more than 40, while those stowing at or below 40 are termed "deadweight cargo."

E. *Computing cubic measurements.*—The standard practice in computing cubic measurement is to take the over-all outside dimensions of the container or its contents, whichever is greater. The cubic measurement is obtained by multiplying the over-all length by the over-all width by the over-all height. In considering over-all dimensions, bottoms and ends of containers are included, as well as greatest projections for irregular-shaped objects. Drums or rounds, such as tires, are considered as rectangular solids, the diameter being used as the length and width. The following examples illustrate correct dimensions used in determining cube (see fig. 27–275):

Weight

Gross—weight of contents and container.
Tare—weight of container.
Net—weight of contents.

To measure

L×W×H equals cubic.
3 feet × 2 feet × 2 feet equals 12 cubic feet.

Discrepancies between package markings and actual measurement can be determined by a check on the pier or at the ship's side. Measurements of vehicles taken from standard published measurements should be carefully noted to include condition of vehicle shipped as to whether extending parts have been removed, tops down, etc.

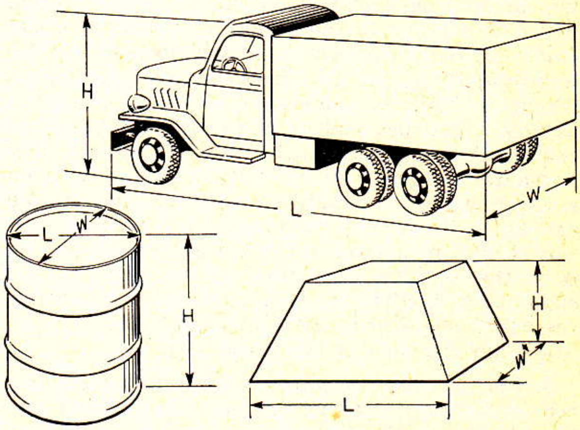


FIGURE 27–275.—Cargo measurements.

F. *Tipping angle.*—The problem of loading cases, requiring hoisting at an angle to reduce the over-all length, is one that can easily be calculated by the use of a scale profile of the vessel's hatch in which the piece is to be loaded. A scale facsimile of the case, when placed in the desired position for clearance, will show the tipping angle necessary, and also clearly indicate whether or not it is possible to place the piece in the hold or 'tween deck, as the case may be. When doubt exists as to whether or not unusually large items can be carried below deck, predetermination by this method will eliminate speculation and save many man hours of unnecessary labor.

G. *"Full and down"*.—Ideal planning would be to load the vessel "full and down." This term is used to define the condition wherein the ship's cubic capacity is completely filled and the vessel is down to its allowed maximum draft. It is difficult to accomplish "full and down" loading because of the nature of cargo and priorities involved.

H. *General cargo*, for purposes of stowage, usually includes miscellaneous case goods, bale goods, and cardboard containers of all sizes and descriptions.

DETERMINING TIPPING ANGLE NECESSARY WHEN PIECE EXCEEDS THE LENGTH OF THE HATCH

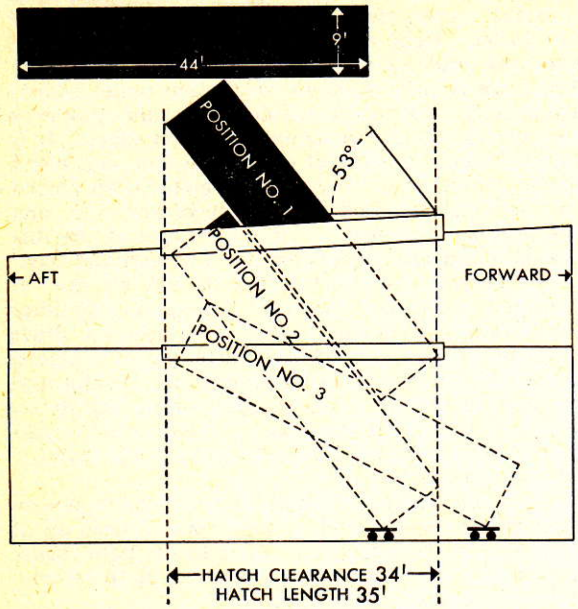


FIGURE 27–276.—Tipping angle.

General cargo requires the fitting of small cases with large packages, and bales with cartons, to minimize the amount of lost space, and to maintain a level upon which dunnage is placed to provide an even floor for overstowage with other cargo when necessary. Hooks may be used on most general cargo, excluding bales, bags, and fiberboard containers.

27–9–10 Cargo Accounting—

A. *Tallying and checking*.—Tallying is the act of recording the amount of cargo when counted by the checker. Accurate checking and tallying are essential for efficient transportation.

B. *Receiving cargo*.—Cargo is received at the warehouse, wharf, or pier by rail, barge, lighter, truck, express, and parcel post. A shipment goes through many hands before it is loaded aboard ship for its destination. Every time the cargo changes hands, a physical count must be taken by a checker and a proper record must be made. Various systems of checking and tallying may be used, but in content they are substantially the same. Checkers must know the nomenclature used in checking cargo, such as commodity or content, units, location, marks, numbers, weights, cubic measurement, consignor, and consignee. They should also be familiar with the abbreviations used in cargo checking, both in the receipt of cargo and in stowage aboard ship, as well as code and markings. In checking, there are a number of methods of recording the amount of cargo loaded or discharged; by units, block system or straight check.

C. *Manifest*.—A manifest is a complete listing of all cargo aboard a vessel.

D. *Stowage plan*.—A stowage plan is a form on which is shown the location of all cargo on board a vessel. When a vessel is loading for several discharge ports, colors are used on the stowage plan to distinguish the various ports.

27–9–15 Measurement Standards—

A. Following is a group of definitions relating to measurement standards of ships.

(1) *Gross tons*.—The entire internal cubic capacity of the ship expressed in tons of 100 cubic feet to the ton, excluding certain exempted spaces such as the peak and other tanks for water ballast, wheelhouse, galley, excess of hatchways, open forecastle, bridge, poop, domes and skylights, etc.

(2) *Net tons*.—The tonnage of the ship remaining after certain deductions have been made from the gross tonnage expressed in tons of 100 cubic feet per ton, such as crew and navigation spaces, master's cabin, percentage of propelling machinery spaces, and other items.

(3) *Deadweight tons*.—The carrying capacity of the ship in tons of 2,240 pounds. It is the difference between the "displacement, light" and the "displacement, loaded."

(4) *Displacement, light*.—The weight of the ship *excluding* cargo, passengers, fuel, water, stores, dunnage, and other items necessary for a voyage.

(5) *Displacement, loaded*.—The weight of the ship *including* cargo, fuel, water, stores, etc., which bring the vessel down to her load draft.

(6) *Cargo dead-weight tons*.—The number of tons (2,240 pounds) which remain after deducting fuel, water, stores, dunnage, etc., from the dead-weight of the vessel.

(7) *Bale cubic*.—The space available for cargo measured in cubic feet to the inside of the cargo battens, on the frames, and to the underside of the beams.

(8) *Measurement or ship ton*.—Calculated as 40 cubic feet volumetric or space measurement.

(9) *Weight ton*.—Calculated as a long ton of 2,240 pounds.

B. The vessel's dead-weight scale will show the displacement, dead-weight tons, and tons-per-inch immersion for any draft.

C. When reading the draft of a vessel, the numbers are 6 inches high, the bottom of the number is the mark, and the mean draft is the sum of the draft forward and the draft aft divided by two.

27–9–20 Cargo Handling Gear—

A. Proper use of cargo handling gear—essential to prevent unnecessary damage to cargo or injury to men—means selecting the right gear for the job and using it correctly. After the right type of gear has been selected, it must be checked for defects. If defective, it must be replaced or repaired. Listed in the following paragraphs are some of the various types of cargo handling gear together with methods of their use.

B. *A wire sling or strap* is a length of wire rope with an eye in each end. Slings vary in length and are used for heavy lifts. A sling that just reaches around a load has a greater crushing effect than one that goes around 1½ times; therefore, to prevent crushing, a longer sling should be used.

(1) The diameter of the wire used in the sling and the individual length of the legs, depend upon the size and weight of the load to be handled. After determining the requirements as to weight and measurement, further consideration must also be given to pressure, abrasion, and slipping. In most instances, wires are used in bridles, but there are many cases requiring only the use of a single leg. This will vary from a small 3-foot strap with a wire splice in each end, to the single wire leg of 50 feet.

(2) Particular care must be exercised when using bridle wire slings on such things as unboxed trucks, boats, automobiles, etc., to relieve pressure by the use of suitable spreaders of sufficient strength to keep the leg of the bridle sling from compressing the load being lifted. The angle of each leg of the sling above the spreaders should not exceed 45° from the vertical.

(3) Wire abrasion is caused by the movement of the wire leg over a sharp or abrasive surface without sufficient protection of wood or padding at the sharp corners usually found on the bottom edges of the pieces being hoisted. In some instances it is also necessary to provide longitudinal stiffness both at the bottom and at the top of a case to act as protection and reinforcement.

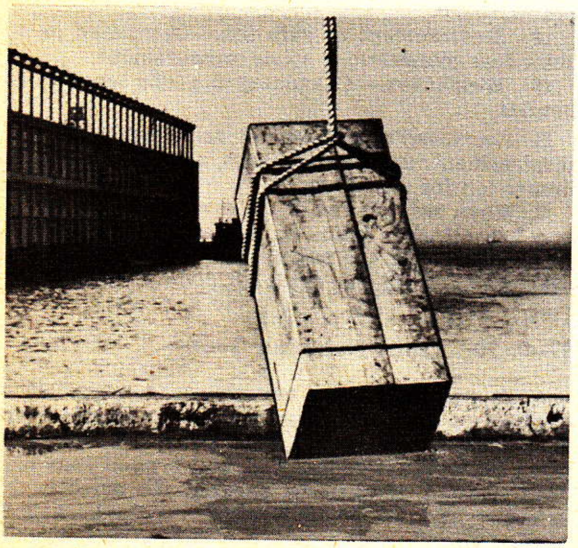
(4) Wire on steel, such as pipe, structural steel, etc., will slip unless the cargo is properly slung and provided with some protection between the wire and the steel in the form of manila rope, wood, or matting. This is particularly true when a single wire leg is used and the cargo slung at an angle in order to reduce the length of the draft to enable it to be lowered into the hatch.

C. *Rope sling.*—This type of sling, made of line spliced to form an endless strap, was used prior to the more specialized gear recently developed, such as pallets and platform slings. Although this type of sling is used for certain types of bag cargo such as sugar, coffee, etc., it is rapidly being replaced by the pallet. Rope slings have a tendency to crush packages and also tear bags if improperly used. Their use is only recommended when pallet boards are unsuitable or unobtainable. The rope sling may become frayed and weakened by sharp edges. It is passed around a draft of cargo, the long end being passed through the short end or bight, then placed on the hoisting hook. When necessary, the long end may be shortened by taking a bight of the line in each hand and tying them into an overhand knot.

(1) *Snorter.*—A short strap, having an eye on each end, is called a snorter. It helps to eliminate overcrowding a hoisting hook with eyes of draft slings or straps. One of the snorter's eyes is placed in the hook shackle; its other eye is then led through the eyes of the slings or straps holding the draft, and then placed on the hook. The snorter is also used to secure snatch blocks to stanchions, rails, or other fittings.

(2) *A rope strap* is a length of rope with an eye or hook spliced in each end. The hook is spliced on to make its use more flexible. Used to lift light loads, it may also be utilized as a dragline, or to remove single pieces of large lumber.

D. *The chain sling* has a definite place in cargo handling. It does, however, require much more care than the average wire or rope sling. Until recent years, chain was seriously affected by extreme cold and many accidents have been caused as a result of this physical change. Certain types of chain, under strain, change their normal shape and give some warning before breaking. Some chain defects, such as elongation of links, fractures, and stretching or opening of hooks, can be detected by a superficial examination.



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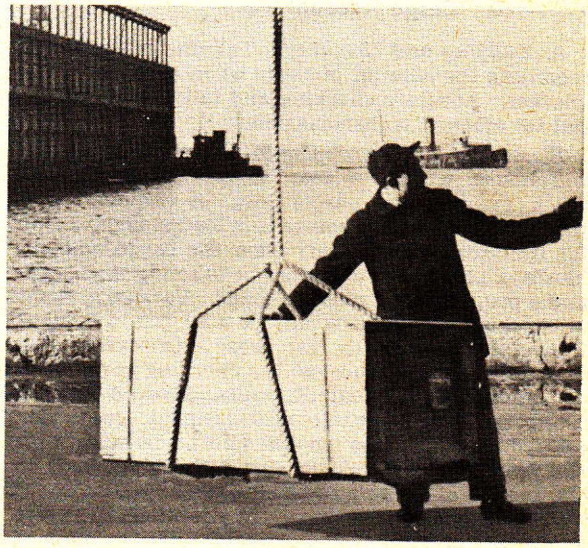

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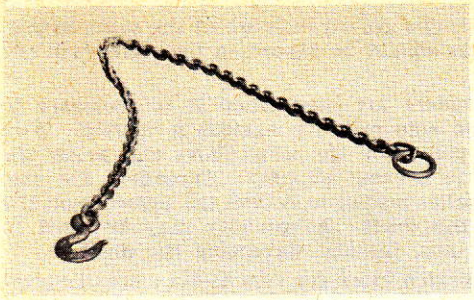
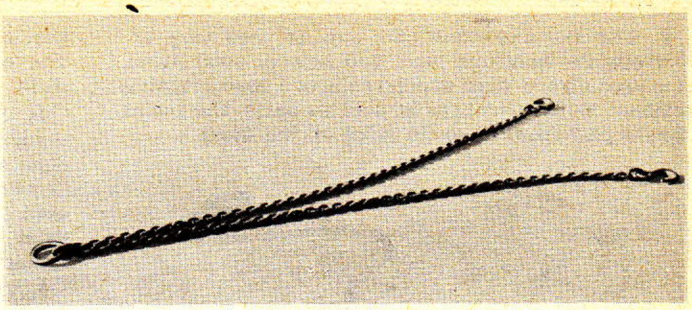
FIGURE 27–277.—Methods of securing a rope sling.



Single chain sling.



Bridle chain sling.

FIGURE 27–278.

(1) Chain slings are used in bridles or single legs. Bridle chains are used for bar copper, steel, and other hard-surfaced metals. Single chains are used mostly for rails, heavy pipe, steel rods, etc.

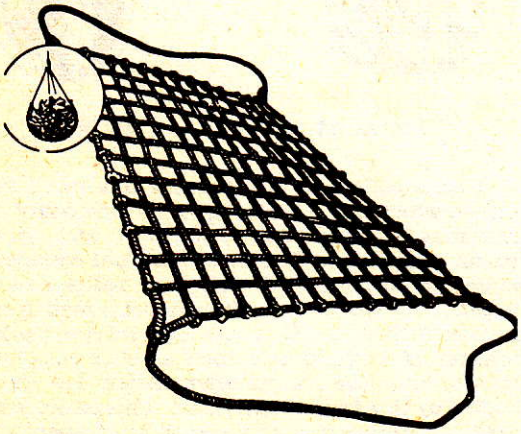
(2) When using this type of equipment, protection must be provided between the chain sling and the draft by the use of wood, old rope, or mats. Such protection also should be used between the individual pieces in the draft to prevent slipping. The rule should also be established in the hoisting of the above-mentioned cargo, to place a complete round turn with the chain around the draft.

(3) See section 27–3–20 for further data concerning the special type of chain slings used in handling buoys aboard tenders.

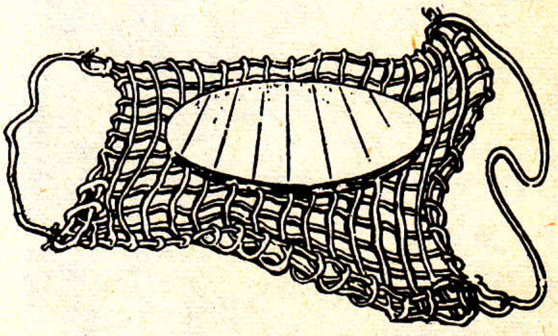
E. *Net cargo sling (wire or rope).*—This type of sling is used to handle cargo such as mail, ship's stores, small packages, etc., strong enough to withstand pressure. It has a particular use in operations where cargo is discharged into small floating equipment, such as landing boats, etc., where the safety of the men working below, confined to a small area, is a prime consideration. This type of sling has also the same characteristics as a rope sling since the breakage of cargo improperly piled in the sling is exceedingly high. It is also used in many instances by inexperienced men who are unfamiliar with orthodox slinging methods, as a safety precaution. Its use, however, should be confined to conditions outlined above and made to augment the pallet rather than to replace it.

(1) *"Pie-plate" net sling.*—A new cross-type cargo net has been developed which is particularly adaptable to Dukw operations. It provides greater capacity, requires less material for construction, and gives a considerable increase in safety of operations over the old type cargo net. Corner draw strings close corner gaps, and make it difficult for boxes or other cargo items to drop from the loaded pie plate inclosed in the net. The securing of bridles over the top of the draft keeps each load intact. The pie-plate is about 5 feet across.

(2) *Wheel nets* are used for wheeled vehicles when use of straps might result in damage.



Cargo net.



Cargo net and pie plate.

FIGURE 27–279.

F. *The running hook wire* can be used very effectively for handling pipe, dunnage, or steel items. It is used on any item which requires a good gripping action. When this gear is used in pairs, the hooks should pull from opposite sides of the draft.

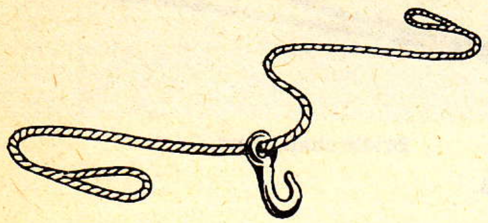


FIGURE 27–280.—Running hook wire.

G. *Barrel slings (drumhooks)* are used to hoist drums or barrels of standard size by hooks placed over each end. They are particularly adapted to the hoisting of drums. Barrels constructed similarly to oil and glucose barrels have a chime and a chime hoop of sufficient strength to withstand the pressure exerted by the hook. This type of sling is not recommended for barrels of the sugar or flour type, as such barrels are not intended for this method of hoisting. A spreader bar or frame used in connection with six sets of hooks will increase the draft capacity to six drums. When used in multiple, the barrel hooks should be adjusted so that the drums are all hanging at the same height. The drums should be placed so that they will not shift.

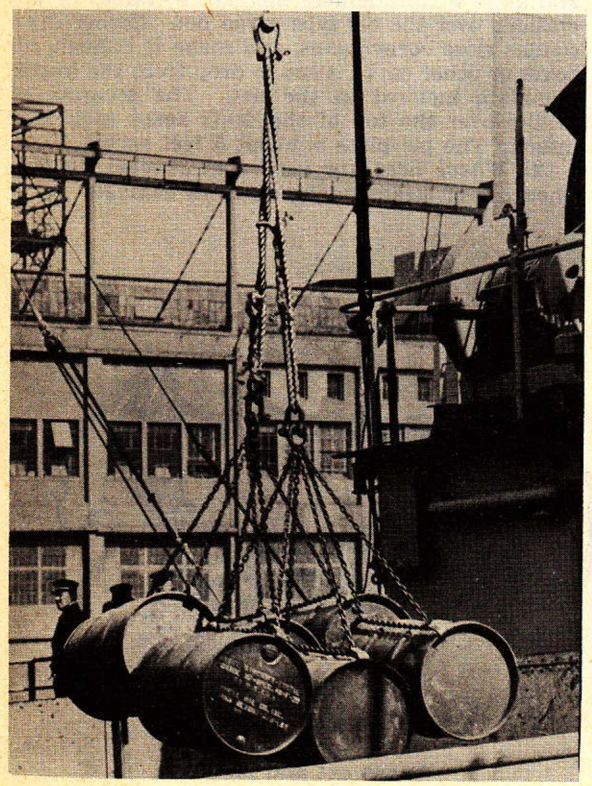


FIGURE 27–281.—Chain barrel sling hoisting six drums.

H. *Spreaders* are used when it is necessary to reduce the side pressure against a vehicle. Wire clips are placed on the sling above and below the spreader to prevent slipping. Spreaders are also used on pallet bridles to relieve the pressure on the sides of the draft. A spreader may be used to spread drums, thereby stabilizing the draft.

I. *The snatch block* is a very useful piece of equipment because of its flexibility. It is used as a lead block, usually in the compartment in which heavy or bulky pieces of machinery and similar cargo are being stowed. There is a unique coupling arrangement on the side of the block through which the hauling part of the wire or rope can be passed quickly. The hook may be fastened to the vessel with a strap or into a pad eye.

This type of block comes in several forms. The hook arrangement is the most widely used. But the shackle arrangement instead of the hook serves a very useful purpose under certain conditions. From a safety standpoint, the shackle is the safer of the two. However, the hook, when used, should have a mousing or seizing by rope yarns across the mouth of the hook to keep it from becoming unsecured. This type of gear should be used and made part of the equipment in the handling of heavy lifts.

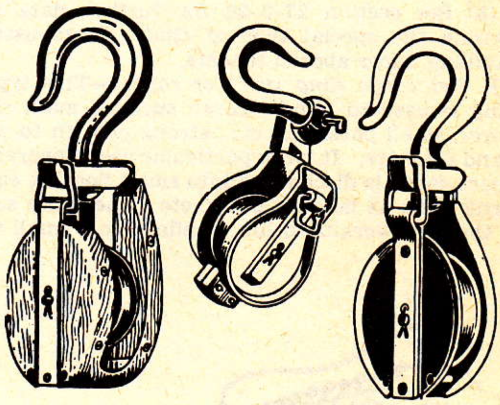


FIGURE 27–282.—Snatch blocks.

J. *Cargo pallet.*—A pallet board is a small platform on which cargo is placed so that the board and cargo may be moved easily as a unit, and stacked without rehandling. The three principal designs are the *double platform pallet, the skid pallet, and the box pallet*. The double platform pallet is used in conjunction with fork-lift trucks and tractor-trailers. Packages of uniform size such as blitz cans, subsistence, and small arms ammunition are ideally handled by this type of operation. This pallet is best suited for stevedoring and transit shed operations. Round commodities, such as gas cylinders, may be palletized by the use of specially constructed chocks. These chocks are made up and spaced to fit the particular commodity. They are tied together by two narrow strips which lay into the space between, and

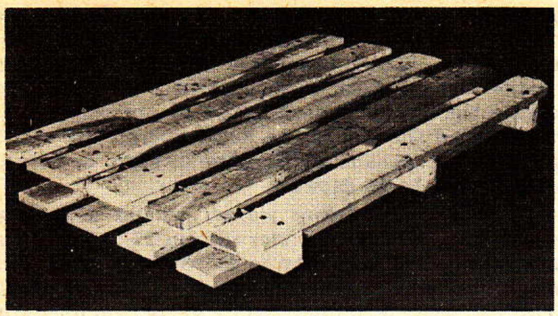


FIGURE 27–283.—Standard pallet used for cargo handling.

flush with, the top of the boards of the pallet's platform. The second tier lies in the cantlines of the first.

(1) When loading a pallet board, two things should be remembered: Maximum load in the minimum of space, and the stability of the load. Attaining the maximum load not only requires the selection of the proper size pallet for the cargo being handled, but also requires the development of a pattern or key. Figure 27–285 demonstrates this point. To have a well-stacked pallet, the entire pallet should

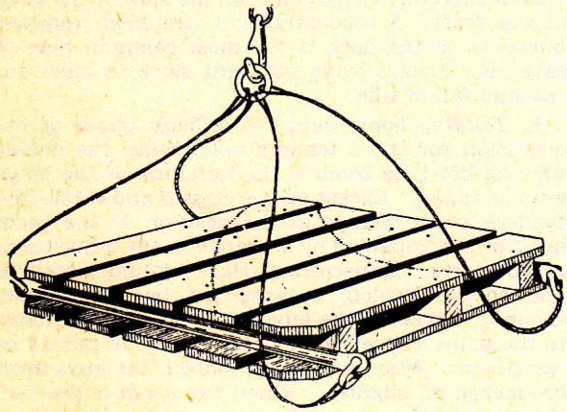


FIGURE 27–284.—Pallet board and bridle.

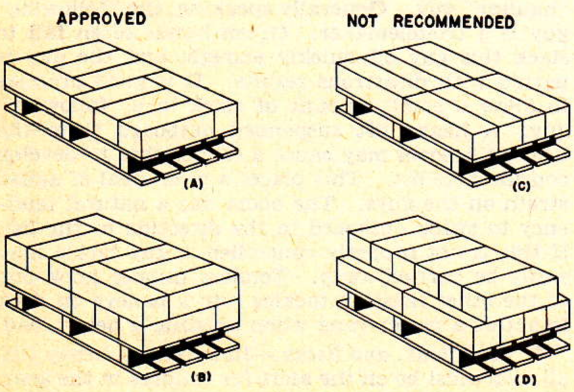


FIGURE 27–285.—Pallet loading.

be used—tying in the boxes on the pallet. Figure 27–285 (*a*) and (*c*) show two methods of arranging the same number of cases for the first tier. The entire pallet area is fully utilized in each case. However, in the second tier, figure 27–285 (*b*) and (*d*), it is evident that the tiering done in (*a*) and (*b*) will allow more flat surfaced boxes per pallet, permitting another pallet load to be stacked more safely on top than does the tiering illustrated in (*c*) and (*d*). Time required to develop a good "key" tier for a commodity is well spent. In addition to maximum space utilization and stability of tiering, checking can be done more accurately and quickly when every pallet load of the same commodity bears the same number of boxes. Proper selection of pallet board will assist in developing the most efficient key. The easiest way to develop a key on the correct sized pallet is to make a template of your pallet boards.

(2) When loading a pallet with cases of uneven size, the highest and strongest cases should be placed at each end of the pallet with the smaller and more fragile cases in the center. Thus when one pallet is piled on top of another, a stronger and more level bearing surface is obtained.

K. *Gravity roller conveyors* are made in various lengths and are fitted with a series of steel rollers of sufficient strength to handle the weight desired. When set on an incline, packages move over the rollers by gravity. Conveyors can be set up with curved pieces and other adjuncts, which can be pieced together to provide a continuous flow in the desired direction. The normal gradient required varies from 2 to 5 percent, according to the weight of packages being handled. Particular care must be given to the support placed under the conveyors as to rigidity, strength, and bearing surface.

L. *Crowbars and rollers* properly used save many hours of hard work. The rollers, placed under cases of boxed vehicles, cases of machinery, pipe, and many types of steel, allow flexibility of motion and direction. Bars and rollers in most instances are used simultaneously and should be kept together.

M. *Dunnage* is any material used to protect both the ship and her cargo. Ordinarily, the term dunnage is used to refer to rough-finished boards and other pieces of wood, but a number of other materials are also used, including battens, cardboard, heavy paper, burlap, etc. Boards used for dunnage are usually 1-inch thick, 4 to 7 inches wide, and 6 to 16 feet long. Dunnage is used to prevent chafing, movement, separation of cargo, equalize pressure, obtain ventilation, protect from sweating, and for chocking and bracing.

(1) *Sufficient, and proper type.*—The most important consideration in the use of dunnage is that it be *sufficient* to protect the cargo. Equal to this consideration is the requirement that dunnage be of the *proper type* and *suitable* for the purpose for which it is used. Bear in mind that dunnage is not only for the protection of cargo under ordinary conditions, but must be selected and used to provide protection under extreme conditions of ship operation.

(2) *Cargo can be damaged by the dunnage itself.* Wet dunnage placed in the hold of a ship will cause evaporation due to the heat in the hold, thereby

damaging the cargo. Take care to see that dunnage which has become dirty, greasy, or oily is not reused. An actual case involved dunnage which had been used for a shipload of potash and then reused for a cargo of wire spools, with the result that the wire was pitted.

(3) If removed from the ship, dunnage should be properly washed, dried, and assorted for future use. If not removed from the ship, it should be dried and assorated according to its usage.

(4) There is no definite set of rules applicable to dunnaging other than the use of good common sense and forethought. The dunnage must be sufficient, and suitable to protect both cargo and ship.

27–9–25 Cargo Hoisting—

A. *Cargo boom.*—An important factor in cargo handling is the boom and hoisting machinery. Description of some of the representative types is given under section 27–3–50. Tenders equipped with a single whip enjoy an advantage of speed and ease of handling in loading and unloading. A disadvantage of vessels equipped with the tender-type boom is that the boom must be swung in and outboard for each draft, similarly to the jumbo boom on a merchant vessel. This is time-consuming and is wearing on the rigging.

B. *Handling the draft.*—When cargo is being hoisted or lowered, swinging should be avoided if possible. Usually, swinging can be prevented in the hold or on the dock by dragging or "touching" the draft until it is directly under the upper block of the hoisting tackle, or by positioning the boom directly over the load before hoisting. Occasionally a draft will start to swing athwartships while being carried across the deck. This swinging must be stopped before the draft can be landed. A wildly swinging draft often results in damaged cargo and endangers the men working in the hold or on deck. Tag or steadying lines should be attached to the heavier drafts.

(1) Coordination is essential for good boom operation. During the early stages of training boom operators, the draft should be handled with three distinct movements—hoisting, racking (athwartships motion), and lowering. A well-trained boom operator can combine these movements to deposit the draft ashore or aboard smoothly and quickly. Always bear in mind the safe working capacity of the single whip, and never overload it. Avoid violent stops and starts in handling cargo. When two-blocking a tackle, the boom operator is responsible for watching and insuring that the hook and blocks are never hoisted high enough to jam, even though the person in charge fails to order "stop" in time. Fatal accidents have been caused by jamming a hook too hard up against the upper sheave, with the hook subsequently letting go and striking a man on deck.

(2) *Petty officer in charge.*—The boatswain's mate or other petty officer in charge on deck is the safety engineer in handling cargo. He is the director, or quarterback, in any loading or discharging operations, and all eyes look to him for cues. He must be level-headed, unexcitable, and able to foresee and avoid trouble. A conscientious, alert boatswain's mate and a capable boom operator instill confidence in the men working cargo and help greatly to increase the safety and efficiency of operations. To understand the job of the boom operator to whom he is giving signals, the signalman must be able to operate the boom capably.

C. *Standard hoisting signals* should always be used. They are given under section 27–3–55. Boom operators have authority to move the load at their discretion only when the signal to rack is given. This authority terminates when the person in charge gives the hoist or lower signal. This is necessary for safety and for quick control of the draft. Sometimes it is necessary for the person in charge on deck to take signals from men in the hold, or on the pier. To avoid confusion, one man in the hold or on the pier should be designated to give these signals. The boom operator should take orders only from the person in charge. Complete coordination of every man in the gang is a prerequisite for safe working and fast handling of cargo.

D. *Preventive measures.*—When the cargo consists of numerous small packages of odd sizes, it is not uncommon for individual packages, or even an entire draft, to be accidentally dumped overboard during the course of the operation. A save-all should therefore be rigged over the side in the path of the draft. A rope cargo net stretched from the bulwarks to the dock is the most common type of save-all. Always leave sufficient slack to allow for rise and fall of tide.

E. *Tending boom guys.*—A difficult phase of the operation for those tenders not having the double topping lift-type boom is the handling of the boom guys or vangs. Except on the class B and C 180-foot tenders, every change in the position of the boom must be accompanied by a change in the adjustment of the guys. Unnecessary slack should never be allowed to develop, because the boom will slap around. Likewise, the guys must never be tightened to the point where the guy tackle may be parted by the strain. When a boom is topped, the guys must be slacked off slightly. When the boom is lowered, the guys must be taken in. Swinging or racking a boom requires special coordination between the men tending the guy lines. When the boom is swung outboard or inboard, one guy may be considered as a "hauling" guy. Generally speaking, the "following" guy is a troublemaker. Green hands often fail to slack this guy off quickly enough, and the guy is parted with disastrous results. It is good practice to allow a small amount of slack in a "following" guy. A heavy lift suspended outboard from the head of a boom may cause a tender ship to develop considerable list. This places a great deal of added strain on the guys. The boom has a natural tendency to swing outboard in the direction of the list. If this is not properly controlled, a guy tackle may easily be carried away. Tenders usually hook one of the other hoisting tackles into a padeye on deck to act as a power vang when hoisting a heavy load.

F. *Stop, look, and listen.*—In making a heavy lift, all men must be on the alert for failures in the gear, and other possible hazards. Before a heavy lift is finally hoisted, it should be picked up a few inches and thoroughly inspected. The slings should be checked for adjustments and chafing. If necessary, the load should be lowered and the sling readjusted or blocked out with dunnage. While the load is suspended off the deck, the rigging (including the boom, topping lift, hoisting and guy tackles) should be carefully observed for indication of unusual strain. When it has been ascertained that everything is in order, the load should be hoisted in one continuous, smooth operation. All blocks should be running free with no chafing of lines against the cheeks of the blocks. Much can be determined by listening to the gear as the lift is being made. A faulty block or wire or rope under strain generally squeaks and groans loud enough to give warning to the alert man. When operating heavy lift gear—Stop, Look, and Listen.

27–9–30 Stowage of Small Cargo—

A. *Small boxes of uniform size and commodity.*—In figure 27–286, the hold has been prepared for stowage of small cases of uniform size that should be kept top side up. Each tier of boxes of similar size and shape should be kept perfectly level. In some ships, the deck of the lower hold may rise a little in the wing as the deck approaches the turn of the bilge. Avoid stowing boxes on this rise as the next tier above will put extra pressure on the tilted edge of these wing boxes. The space left vacant should be filled in or bilged over with dunnage. When stowing a number of boxes of the same dimensions, if possible, arrange the tiers as bricks are laid in a wall; that is, each box should rest on two boxes beneath it. Figure 27–286 shows the first tier of boxes with dunnage along one side against the bulkhead. Depending on the construction of the box, dunnage between tiers is used whenever necessary to spread weight. When the contents and construction of boxes permit stowage on the end or sides, a more economical use of space is possible by working from the sides of the ship to the centerline of the hatch. Boxes can be turned up on ends or sides to fit into spaces too small for stowage in the usual manner.

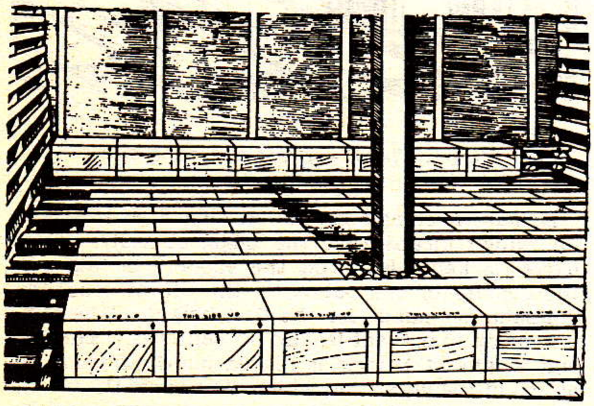


FIGURE 27–286.—Stowage of small boxes.

B. *Block stowage.*—At times it may be advisable to depart from the method of keeping a level floor and to segregate cargo into blocks; however, the principles are the same, level floor and brickwork fashion. This makes a solid pile, and distributes weight. A bulkhead is constructed of wood to secure cargo by bracing from stanchion, deck, and ship's side. (See fig. 27–287.)

C. *Level floor.*—Normally, every effort should be made to keep a level floor as the stowage proceeds. This may be achieved by filling the empty spaces with small boxes or other filler cargo. If necessary, small pieces of dunnage can be used for this purpose. Care should be used to properly dunnage canned goods used as filler cargo. Every effort should be made to keep canned goods of the same type together in a block. Delays have occurred at overseas ports because different commodities were mixed in the same hatch. When stowing subsequent tiers, no box should be placed so that it rests directly on the top and inside of the four corners of the box beneath it unless dunnage is placed across the top of the lower box to take the weight, because the combined weight of a number of tiers may crush the lower box.

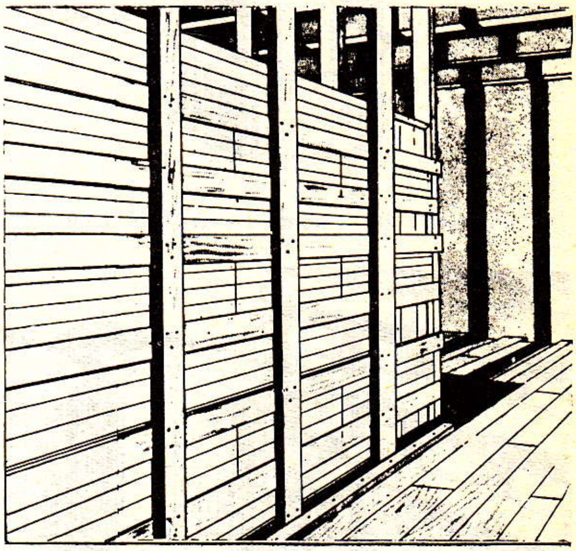


FIGURE 27–287.—Bulkheading off a block of small boxes.

D. *Use of conveyors.*—Small cases may be handled with a gravity roller conveyor in the conventional manner, when the place of stowage is some distance from the square of the hatch. For some cargo, finished lumber or waxed dunnage used as slides will serve as a substitute for roller conveyors. Water-proofed, tough, paper bags used for protecting some commodities work very well on these slides. For some operations, one or more sections of roller conveyors can be placed, inverted, or tracks running from where the draft is to be landed to the place of stowage can be made from one or two pieces of dunnage. Pallet loads may be landed on these reversed conveyors and rolled to place of

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stowage. This method allows the entire draft to be moved at one time and reduces handling. Large cases may also be handled in a like manner. When cases are too wide to balance well on one section of roller conveyor, two sections laid parallel may be used, with the case landed on both.

27–9–35 Miscellaneous Stowage—

A. *Drums* for liquids are usually made of steel (see fig. 27–288). Preparation of a hold requires that stripping be laid about 4 inches apart with added dunnage and cribbing of cordwood on bilge or flare (see fig. 27–289), or a shell may be built over the bilge or flare. When making up a bilge or flare with cordwood, the cross-stacking method shown in figure 27–289 saves dunnage and permits make-up in advance of stowage.

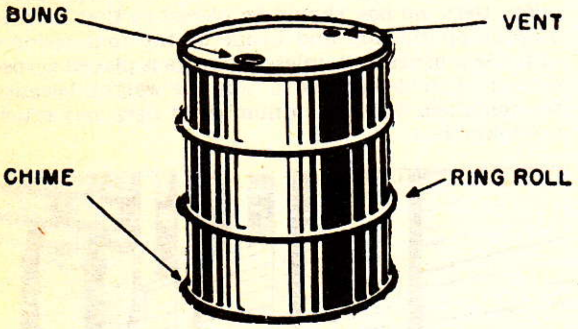


FIGURE 27–288.—Nomenclature of a drum.

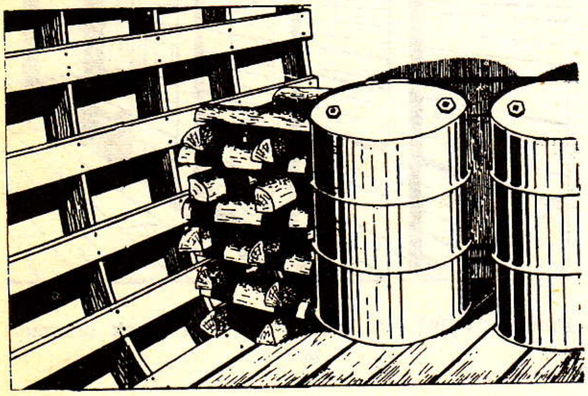


FIGURE 27–289.—Make-up of bilge using cordwood.

(1) When starting a key for drum stowage, place dunnage between the drums and the steel bulkhead. The first draft is landed so that the drums can be rolled in the direction of the stowage, then worked from the wings to the centerline of the ship with one gang working each side. (See fig. 27–290 for "key" row.) The bungs are always placed up, and the chime must rest squarely on the dunnage. The succeeding rows are stowed in the cantlines of the first row. If the first row of drums does not fit securely across the bulkhead, you can save space by spreading out the first row so that the second row is placed deeper in the cantlines of the first. Remember that the sum of the spaces between the drums is less than the diameter of one drum.

(2) In stowing the second tier of drums, the top of the first tier should be stripped with dunnage (see fig. 27–291). Care should be taken to cover chimes. Succeeding tiers are stowed in like manner.

(3) Petroleum cargos must be well ventilated, as petroleum vapors are heavier than air. Heavy oils such as lubricating, fuel, and gas oils should never be stowed over cases of refined oils.

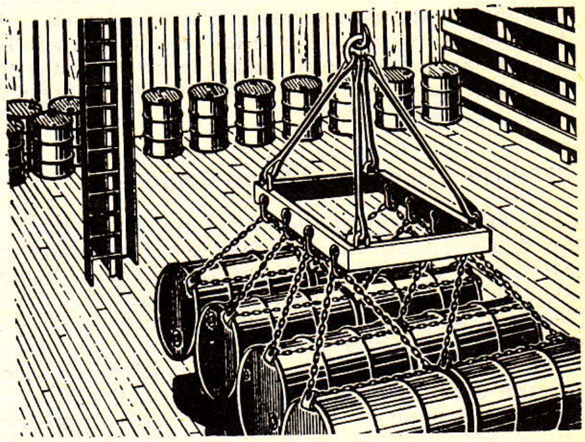


FIGURE 27–290.—First row of drums.

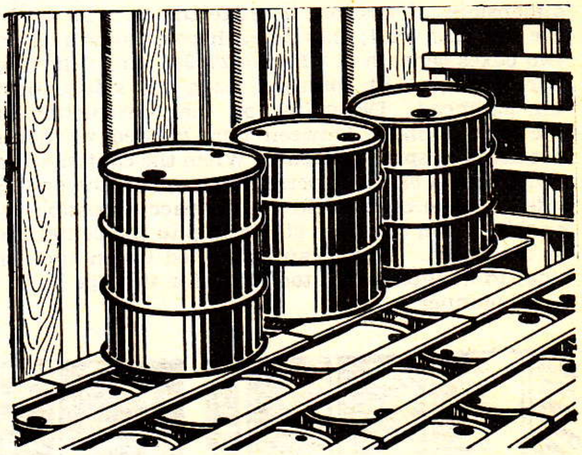


FIGURE 27–291.—Start of second tier.

B. *Barrels* should be stowed bilge free and bung up, which means that the bilge, or belly, of the barrel is kept clear and the support is taken by the quarter of the barrel by the use of scantling, dunnage, or quoins for the first height. The bung is kept up to prevent leakage of contents. The second height of barrels is placed one-half barrel in on top of the lower tier, which distributes the weight on four barrels, and is known as bilge and cantline. The most important thing to remember in the stowing of barrels is that, unless a proper floor is made with the first height, difficulty will be experienced in stowing additional heights. The lost space against the bulkheads and in the wings is usually taken up by the use of cordwood and dunnage. Cordwood is also used between the barrels to make a chock.

C. *Bagged cargo.*—Many commodities are carried in bags of different sizes and materials: flour, in some cases, in white cotton bags; cement, usually in heavy paper bags; coffee, in burlap and grass bags. All containers of this nature are subject to damage by sweat, moisture, rust, and tearing. In the case of cement bags, improper placing of dunnage will break the bag open. White bags of flour quite naturally will show dirt, footprints, and sling marks, and it is important that proper care be taken in this respect. Bagged cargo conforms, more or less, to the irregular sections of the vessel and is suitable for stowage in such places. This can be effected with a minimum amount of lost space.

D. *Vehicles* are of many types, shapes, and sizes. Each vehicle must be considered as an individual item, whether it be a ¼-ton jeep or a 6 x 6 truck. effected with a minimum amount of lost space. The former, for example, can be stowed in the body of the latter. Vehicles require the use of wire slings with spreaders sufficiently long to keep the wires from damaging the truck.

One method for lashing vehicles on deck is pictured in figure 27–292. Dunnage must be placed on deck under the wheels, then the wheels are chocked securely and the chocks braced. Two lashings are required on the front, and two on the rear of such vehicles as trucks and construction equipment. These lashings may be either crossed or led outboard from the vehicle. The chassis should be blocked up to take the weight off the body, and compression applied by lashings off the spring. Lashings may be made fast to front and rear axles in lieu of chassis lashing. In this case, it is not necessary to block under the springs.

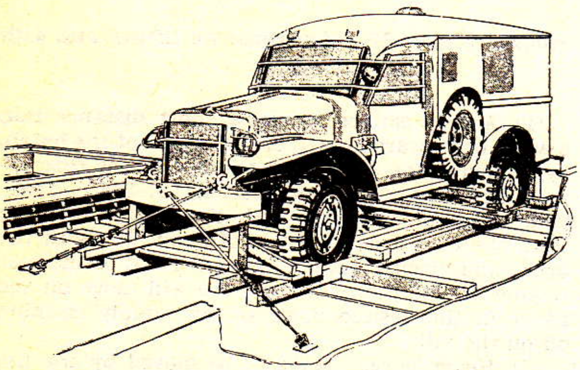


FIGURE 27–292.—Stowage of vehicle on deck.

E. *Timber.*—The American unit of measurement for timber is generally 1,000 board feet, equal in bulk to 83⅓ cubic feet. To calculate board measure or the number of square feet of planking 1 inch in thickness, multiply the thickness by the width (in inches) by the length (in feet) and divide by 12.

F. *Procedure in the hold.*—To allow bridles and slings to swing wildly when being hoisted is dangerous. Drafts should be landed as near to the place of stowage as possible. A sufficient number of men should get behind the draft before it is landed, pushing it over to the desired spot. Boom operators should lower away carefully to avoid dumping or damaging the cargo. Unless boom operators are exceptionally skillful, drafts should not be swung into the wings.

To facilitate removal of slings from heavy cases, the cases should be landed on rollers, or dunnage, as shown in figure 27–293. Also, the slings should be kept clear in order that they may be removed from the ends of the case. If rollers or dunnage are placed under extreme ends of the case with the slings between, one end of each strap must be removed from the hook. The slings can be pulled out by hand, or by taking up on the hook. Extreme care must be exercised if the slings are pulled out by the winches, since, when the slings come from under the case, they may snap and swing or whip around the hatch. This is particularly dangerous when the sling is made of wire rope; therefore it is an undesirable practice. Under certain conditions, this method may be necessary, but the straps should be held at the point of breaking-out to prevent snap. Using a shackle to fasten one eye of each strap to the cargo falls, then placing the other ends on the hook, will provide a faster and surer method of removing the proper sling-eyes from the hook.

27–9–40 Stowage of Heavy Cargo—

A. *Location of stowage.*—Heavy cargo should not be stowed in the ends of a ship. A vessel so loaded will steer badly and will ship excessive water over the bow. In addition to the usual precautions taken to safely lift and stow heavy pieces of cargo, care must be taken to spread out the bearing surface. Stout timbers laid fore-and-aft, and long enough to distribute the weight over at least two floors, should be prepared to take the bearing points of such weights. When local stresses due to a heavy weight stowed in a 'tween deck are set up, the deck beams should be shored up from the deck below. As a rule, stowing heavy cargo amidships and in the wings will result in a more comfortable ship in a seaway. Since the raising and lowering of weights in a ship's hold has a direct effect on the vessel's stability, the distribution of cargo should be consistent with her "tender" or "stiff" qualities. See 27–9–65 for data on stability.

B. *Preparing the hold.*—Heavy cargo will often be placed on skids, or cased. A hold should be floored off with dunnage in preparation for the cargo below. This will aid in the moving of cargo from the point of landing to the point of final stowage. Should the bottom of a case be not sufficiently strong to be directly landed on rollers, specially constructed skids of heavy timbers may be used with rollers, or the cargo may be landed on greased dunnage and moved without the aid of rollers. The point of landing should be as near as possible to the place of stowage, and in such position that the minimum amount of turning will be required.

C. *Use of manpower.*—After landing, cases can be moved into place either by hand or by use of ship's power. Men can push or bar cases into position. Crowbars (as shown in figure 27–294) are used by placing the pointed end of the bar under the end of the case, then lifting upward and forward. A load being moved on rollers may be turned by cutting the front roller in the direction desired and the rear roller in the oposite direction. This may be accomplished by striking the rollers while under the load with a heavy maul, or by cutting them one at a time as they are placed under the forward end of the case. To remove rollers from under the case, the heel of the bar may be used (as shown in fig. 27–294) to raise the load sufficiently to slide the rollers out to the side. Never straddle rollers when removing them in this manner. Should the case drop, the end of the roller, which is still under the case, may be pinched, causing its free end to spring suddenly upward, injuring the person handling it. To remove a roller from beneath extremely heavy cases, a jack may be required. A railroad track jack may be used. After removal of rollers, the jack is slacked all the way down. It may be removed then with the aid of a crowbar. Heavy cases such as those discussed in this paragraph should not be landed flat on the dunnage floor, but should be set up on blocks to facilitate discharge.

D. *Final shifting.*—To accomplish final shifting of a few inches for tight stowage, crowbars again may be used. One or more bars are placed with the toe of the bar under the case, lifting it sufficiently to allow a good bite for the pointed ends of other bars used as explained in paragraph (C) above.

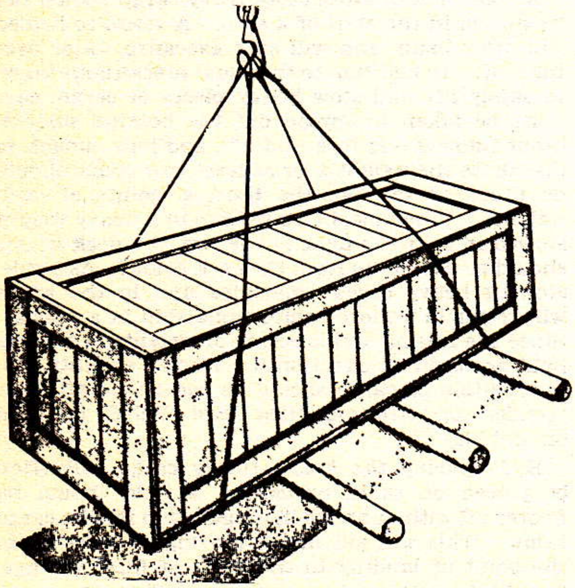


FIGURE 27–293.—Landing cases on rollers.

E. *Final stowage.*—When it is not possible to stow with its end against other heavy cases, the case being stowed must be securely braced or chocked to prevent any movement. Every consideration should be given to make the job as easy as practicable for the hold men handling heavy cargo. There are ways by which the ship's power can be utilized to save manpower. A few will be mentioned:

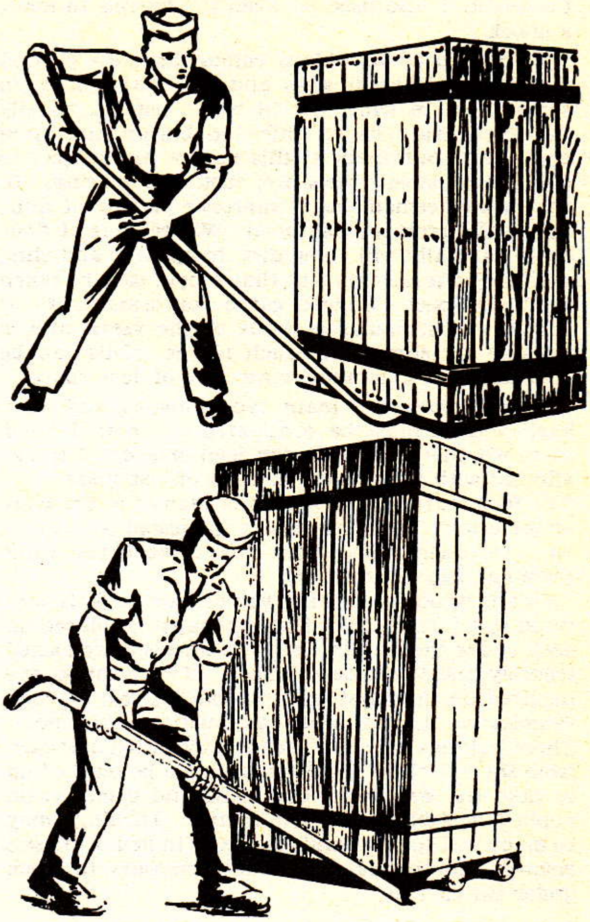


FIGURE 27–294.—Use of crowbar for lifting, and with rollers.

(1) A case can be moved a short distance into a wing, or forward, or aft, of the square of the hatch, by removing the sling from the end of the case toward direction of storage. (See fig. 27–295.) Then, picking up on the load with the remaining sling until the case is at an angle of about 30° with the deck; and placing a roller under the end of the case resting on the dunnage, the case will move on the roller in the desired direction by rapidly slacking off on the fall.

(2) Heavy cargo may also be moved by the use of a dragline or hookline. When using a dragline in the hold or in the 'tween deck of a vessel, care must be taken so that there will be no danger to the men stowing these lifts. Lead the dragline to the windlass to avoid having to use the ship's fall, except in the case of light leads being hoisted on the whip. The dragline should be clear and should not rub or chafe on any part of the ship's construction. A fairlead can be obtained by using snatch blocks (see fig. 27–297). The dragline may be made

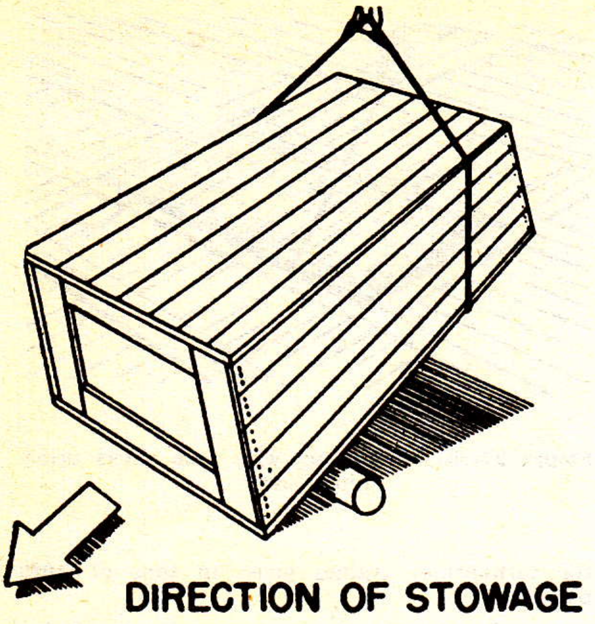


FIGURE 27–295.—Moving case using cargo runner and roller.

of wire rope in lieu of manila or sisal. The leads on which the snatch blocks are hung should be of chain or wire rope. Dunnage should surround stanchions where the leads are made fast. Keep men clear of all lines. If possible, rollers should be used under cases to reduce strain on the dragline. If the case is too heavy, a tackle may be rigged. If necessary, improvise a tackle by using additional snatch blocks. See figure 27–296 for a method of rigging a single or double purchase using beam clamp and snatch blocks. When overhead clearance is sufficient, beam clamps can be used to hang a snatch block to a deck beam, permitting the case to be lifted into place under the wings, or fore or aft of the square of the hatch.

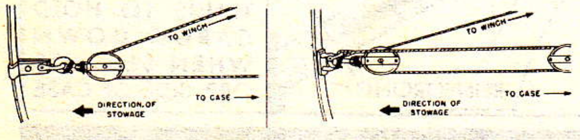


FIGURE 27–296.—Rigging single and double purchase using snatch blocks and beam clamps.

(3) To save time and work, heavy cargo, cases, or vehicles should be headed in the direction in which they will be rolled or dragged when they are landed in the hold. (See fig. 27–298.)

(4) To remove wire rope slings from closely packed cases by ship's power, unhook opposite ends of each sling and hoist as shown in figure 27–299.

F. *Slinging.*—Extreme care is urged in slinging heavy lifts. Sling should be blocked out with dunnage to prevent chafing and possible cutting; dunnage should be placed between wire slings and metal

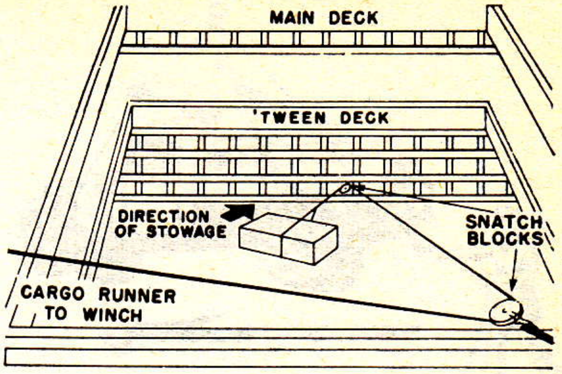


FIGURE 27–297.—Fairleading dragline.

to prevent slipping. In slinging heavy lifts, remember—shackles are stronger than hooks.

27–9–45 Stowage of Deck Cargoes—

A. Deck cargo usually consists of miscellaneous cargo for which there is no space under deck, dangerous articles which cannot be safely carried below, and articles which, because of their size, nature, or shape cannot be readily stowed underdeck. Because of the varying sizes and shapes of commodities stowed on deck, few specific rules for their stowage can be stated. When stowing a large amount of cargo on deck, care must be taken to avoid blocking off bitts and chocks, sounding pipes to bilges and ballast tanks, handles of valves of piping systems, or any other pieces of equipment essential to the operation or safety of the vessel. To outline the spaces to be kept clear in chalk is good practise.

B. *Cases on deck.*—Deck cargo (cases) should be stowed so that it can be lashed in separate blocks (one on the square of the hatch, and one on each side, for example). If the nature of the load warrants, additional over-all lashings can be used. (Rods or straps may be substituted for wire or chain.) Turnbuckles must be fitted in each lashing to permit further tightening, irrespective of the type of lashing employed. In this connection, hook turnbuckles (except regular deck lashing turnbuckles with slip hooks) are not to be used. When using wire or chain, round-turn lashings are used on each end of each block of cases. Other lashings can be over-all.

(1) The edges of the cases underneath the lashings must be protected by wooden capping and sometimes by angle iron.

(2) When lashing deck cargo, care must be exercised so as to obtain the utmost value from the lashing by proper leads and angles of stress, and by equal-value material in the component parts thereof.

(3) Angle iron may be used along the edge of the case under the lashing to prevent the wire or chain from cutting through the edges of the case. End lashing may be given a round turn and drawn up tight by taking a bight of the lashing where it comes from under the case, and placing a black-

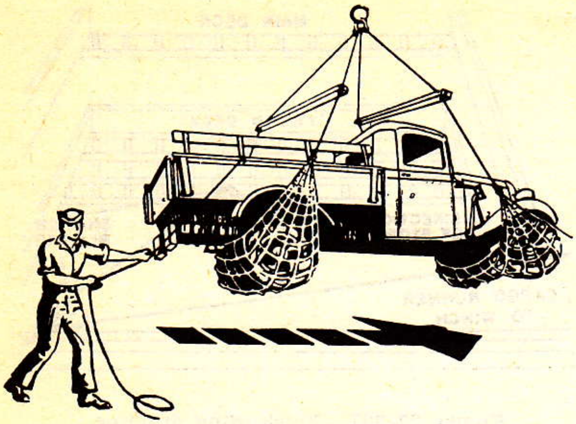


FIGURE 27–298.—Heading vehicle in direction of stowage before landing.

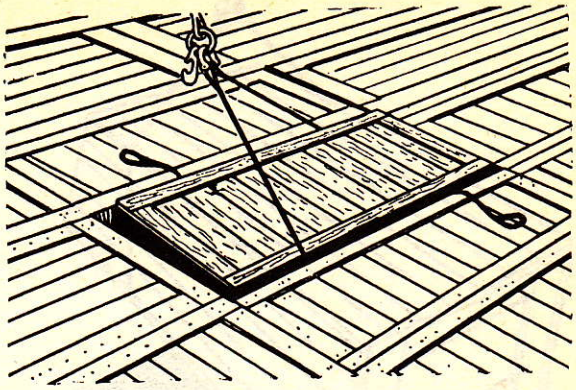


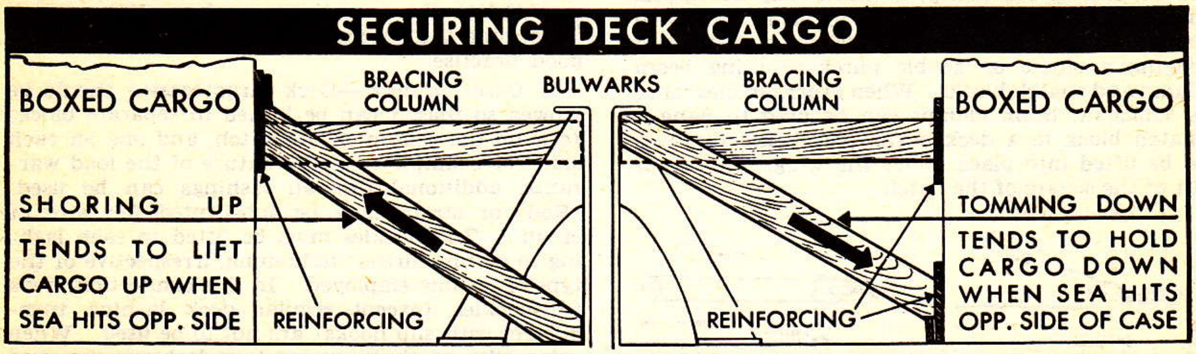
FIGURE 27–299.—Removing wire rope slings using ship's power.

wall hitch on the hoisting hook; then "taking up." Turnbuckles should have space left for further tightening enroute. Lumber sheathing and 2-inch x 6-inch wood angles along the edges serve to spread the pressure of shores and braces.

C. *Turnbuckles* play an important part in securing deck cargo and are useful in other operations. When they are exposed to the elements they should be well oiled or coated with grease to prevent corrosion. To determine the safe load for turnbuckles, the diameter of the threaded rod is measured. The following table gives the safe load for turnbuckles (values given in tons of 2,000 pounds).

Diameter in inches	*Safe load*
½	.9
⅝	1.5
¾	2.2
⅞	3.1
1	4.1
1⅛	5.1
1¼	6.6

D. Too much stress cannot be placed upon the proper securing of deck cargo, if it is to arrive at its destination in usable condition.



VALUES OF COMMON EASTERN PINE AS A COLUMN OR BRACE

2" x 4"	1.7 TONS UP TO	1.3 FT. LENGTH	8" x 8"	16.9 TONS UP TO	6.2 FT. LENGTH	6" x 6"	9. TONS UP TO	4.5 FT. LENGTH
"	1.5 "	2.7 "	"	15. "	12.5 "	"	8. "	9.1 "
"	.8 "	3.4 "	"	8.5 "	18.5 "	"	4.6 "	13.7 "
4" x 4"	3.9 TONS UP TO	3. FT. LENGTH	2" x 8"	3.6 TONS UP TO	1.3 FT. LENGTH	10" x 10"	27. TONS UP TO	8. FT. LENGTH
"	3.5 "	6. "	"	3.2 "	2.7 "	"	25. "	15. "
"	2. "	9. "	"	1.8 "	3.4 "	"	13.7 "	23.7 "

IN BRACING OR CHOCKING DECK CARGO TOMMING IS OF MORE VALUE THAN SHORING EXCEPT WHERE CARGO IS PACKED HIGH THEN A COMBINATION OF BOTH SHOULD BE USED AT ALL TIMES. USE LASHINGS IN CONJUNCTION WITH TIMBER AND STRONGLY REINFORCE WHERE PRESSURE WILL BE EXERTED

FIGURE 27–300.—Securing deck cargo.

27–9–50 Cargo Damage—

A. The knowledge of what may happen to a cargo during loading, transportation, and discharge, and of the means of averting such losses, is a great portion of the requirements of proper cargo handling and protection. The various kinds of damage most commonly met with are noted in the paragraphs below.

B. *Before loading.*—All packages showing signs of breakage, pilferage, or leakage should be rejected until repaired and put into their original condition by the shipper or responsible parties receiving goods for shipment.

C. *By handling.*—Careless boom work must be avoided; as in lowering drafts heavily upon other cargo in the hold, or in swinging goods against the ship's side or hatch coamings; dragging cargo along the dock, or to and from remote places in the holds; dropping packages from trucks, cars, tops of tiers, or from slings; careless sorting and piling; slinging fragile and heavy packages together.

D. *By use of improper appliances.*—Damage is caused by hoisting cargo in slings or nets not suitable for packages, and the lack of landing platforms or chutes when working over cargo already stowed.

E. *Leakage and drainage.*—Wet goods should be stowed in compartments set apart for their exclusive use, and drainage and odors from same kept clear of dry cargo.

F. *Condensation and sweating.*—During sudden temperature changes, moisture will condense on cool surfaces and cause sweating. Ventilation should be arranged to equalize the inside and outside temperatures gradually. When leaving warmer latitudes, vigorous ventilation should be the aim in order to equalize the temperatures as soon as possible, but, upon a sudden drop in temperature, check the ventilation so that condensation caused by the ingress of cold air will be reduced to a minimum.

G. *Crushing damage* is caused by subjecting packages to more pressure than they can stand. Crushing is further aggravated by the ship's motion in a seaway, as when goods stowed near the ends of a vessel are subjected to the effects of pitching in a head sea, or during heavy rolling when cargo in the wings is under extra pressure due to the "scend" of the vessels roll. This class of damage is often due to frail packing; often to bad stowage. Weighty packages should be stowed next to the floor when possible, with lighter cargo over them. Stow light goods in the 'tween decks where top weight would be at a minimum. Stow strong packages in the wings. The necessity for compact stowage is obvious here.

H. *Chafing damage* is caused by the to-and-fro motion arising from the vessel's movement in a seaway. It is mostly found in bale or roll goods such as cloth, rugs, paper, linoleum, and coils of cordage, copper piping, etc. Keep such goods away from projecting structural parts of the ship's holds, and avoid stowage of same over lively or springy cargo. Compactness of stowage is of first importance here. Chafing is sometimes caused by the improper chocking of cargo within the vessel, railroad car, or lighter. Chafing can be serious in connection with inflammable cargo in metal containers, particularly if a spark is produced by static electricity. Chafing can also be caused by dragging cargo-handling equipment, such as pallet boards and lift boards, across the top of unprotected containers and fragile cases. If the cargo is properly dunnaged and chocked, there is slight possibility that chafing will occur.

I. *Tainting.*—Careful consideration must be given to segregation of cargo in the various compartments of a vessel to avoid contamination and tainting. Many foodstuffs can easily be tainted by being in close proximity to such things as gasoline, rubber, certain types of asphalt, etc. Fresh eggs, for example, due to their porous nature, will absorb taint very quickly. Flour can be tainted by fruit. A noted source of taint damage is a leaky fuel oil tank top just below the cargo. Obnoxious odors left by such commodities as barreled fish, copra, fertilizers, strong liquid chemicals, or oils of many kinds may be eliminated by freely sprinkling common slaked lime upon the hold ceiling and in the bilges. The lime should stand for a few hours before sweeping up the hold; if necessary, repeat the process.

J. *Spontaneous heating.*—Many vegetable or animal-originated commodities are susceptible to spontaneous heating, especially during long voyages in warm weather.

K. *Cargo mixture.*—Prevention of the annoyance caused by mixing cargo can only be effected by carefully placing separation marks or "separation cloths" where different lots are shipped, and by arranging the stowage so that no mixture can possibly occur. Consignments for different ports or lots of general cargo may be separated by boards, mats, or rope yarns between tiers of bags or cases, or by wire stretched across metal rails, rods, piping, etc.

L. *Broaching and pilferage,* although prevalent in some general cargo trades, is not generally encountered on board vessels of this Service.

M. *Inherent vice.*—Some cargos are damaged by their very nature of inherent vice, which is a quality or change in some cargos which damages the commodity itself. This kind of damage allies itself to that of spontaneous heating in that goods in the vicinity of those subject to inherent vice may share in the damage from said cause.

27–9–55 Safety—

A. *Securing shackles, hooks, etc.*—Shackles, hooks and gates of snatch blocks used in rigging should be secured with rope yarn (mousing) or wire. Various methods of securing these items are pictured in figure 27–301. In mousing a shackle, the pin should be tightened, then secured with rope yarn or wire as illustrated. In all cases where rigging is aloft, use wire for mousing. Care should be exercised to place the mousing where it may not be cut by the wire rope made fast to the shackle. Hooks are moused for two principal reasons: to strengthen the hook, and to prevent the slings from slipping off the hook. Hooks may be moused with rope yarn, wire, or a shackle as shown. The gate of snatch blocks, unless firmly moused, may open, allowing the line to jump out. Before any operation, check all shackles, hooks, and blocks to see that they have been secured.

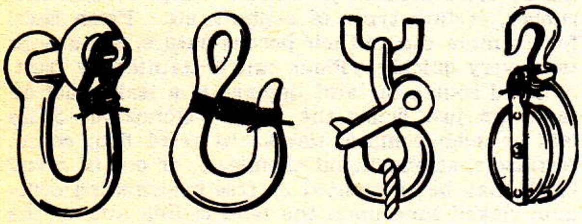


FIGURE 27–301.—Methods of mousing.

B. *Clear square of hatch.*—The square of the hatch should always be kept clear and free of any debris to reduce hazards that interfere with quick handling of cargo. After a tier of cargo that does not provide sound footing for hold men, or which requires protection from cargo being landed, has been stowed in the square of the hatch, a solid level floor of dunnage must be placed.

C. *Do not stand under draft.*—Men working in the hold should never stand in the square of the hatch when a draft is overhead, because the tendency of the draft is to swing athwartship. For greater safety, they must stand fore or aft of the square of the hatch.

D. *Steady draft when lowering.*—When a draft is lowered into the hold, it should be stopped about 1 foot above the spot where it is to be landed. The hold men then come out from under the deck and steady it while it is landed. They must never reach up for a draft.

E. *Dangers exist constantly while working cargo. You must be on the alert at all times:*

(1) Be sure the draft is properly slung before hoisting.

(2) Do not cover a hatch with tarpaulins unless the hatch covers are in place.

(3) Do not have "drift" too long on the draft. Shorten sling or top up boom if necessary.

(4) Do not tow freight cars with the ship's cargo gear.

(5) Do not use worn-out gear.

(6) Never reach up for a draft. Wait until it is even with your shoulders.

(7) Never ride a draft or sling.

(8) Never stand in the bight of a line or wire.

(9) Never stand under a draft.

(10) Never throw or drop anything below decks without shouting "Look out below," *and being sure the space is clear.*

(11) Remember that shackles are stronger than hooks.

(12) Stretch a life line around 'tween deck hatches when not working cargo.

(13) Walk behind a draft—never in front. Wait until it is being lowered. Better yet, use the other side of the deck.

(14) Watch out for swinging hooks, slings, and gear.

(15) When hoisting heavy lifts, stand clear of whip action of ropes, etc.

(16) When landing a draft, never pull. Always push it in the desired direction.

27–9–60 List of Stowage Factors—

Following is a list of stowage factors of various representative types of articles which may comprise a ship's cargo:

Commodity	Packing	Stowage Factor	Remarks
Acetylene gas	Cylinder	28	Do not stow below decks; keep away from heat.
Acids	Carboys	65	Stow on deck.
Asbestos	Bags	55	
Asphalt	Barrels/bags	65/55	Stow away from heat.
Bacon	Boxes	60	Keep cool, dry.
Baking powder	do	65	Keep cool, dry, away from odors.
Barbed wire	Coils	105	
Batteries	Crates/cases	50/70	Keep dry.
Beer	Cases	52–60	Watch out for pilferage.
Blankets	Bale	85	
Books	Cases	65	
Bricks	Uncrated/crates	17/25	Stow carefully on edge with straw.
Brooms	Bundles	245	Weak packing, stow on top of cargo.
Butter	Boxes	56	Keep cool.
Cable, chain		13–21	Stow 'thwartships in bottom of hold.
Candies	Boxes	60	Keep cool, dry, away from odors.
Canned Food	Cases/cartons	60/var.	Handle with care, avoid denting cans.
Canvas	Bales	70–115	Protect from soiling, use no hooks.
Carbon dioxide gas	Cylinders	45	Stow away from heat.
Cement	Bags	35	Keep dry; dust may harden with dampness.
Chain	Barrels	38	Packing generally insufficient for weight.
Charcoal	Bags	110	Keep dry; dust may explode under certain conditions.
Cigarettes	Cases	120	
Clothing accessories	do	70–105	Weak packing.
Coffee	Bags	56–66	Keep away from odors.
Condensed milk	Cases	45	Light packing.
Cots	Bales	97	
Dried fruits	Bags/cases	52/var.	Keep cool, dry.
Dry goods	Boxes	100	
Dried vegetables	Bags	45–70	Have good ventilation.
Eggs	Cases	100	Easily tainted, weak packing.
Electric light bulbs	do	315	Weak packing; stow on top.
Electric wire cable	Reels	28	Stow on end, handle carefully.
Fish, salted	Barrels	50–65	Keep cool, dry; leakage.
Fish, canned	Cases	66	
Fish, frozen	do	52–77	
Flour	Bags/barrels	52/63	Keep dry, protect from odors.
Fuel oil	Barrels	56–60	
Furniture	Unpacked/crated/lt. pkg	155/var.	Handle carefully.
Gasoline	Drums	65	Dangerous cargo; handle carefully.
Glassware	Cases/crates	85–240	Handle carefully; stow on top.
Graphite	Cases	45	Keep dry; dust may stain other goods.
Grease	Drums	45	
Hardware goods	Bulk	35 and up	
Hydrogen gas	Cylinders	59	Dangerous cargo; handle carefully.
Iron, pigs		10	
Iron, steel bars, angles	Unpacked	10–20	Use double sling; stow flat.
Jackets	Bales	128	
Landing mats		47	
Linoleum	Rolls	65–75	Stow flat; handle carefully.
Lubricating oil	Barrel	43	
Lumber, heavy		42	Stow flat; select lengths to avoid losing space.
Lumber, light/very light		63/126	
Machinery	Boxes/cases	30–48	
Mails	Bags	85–105	Keep dry in special compartment.
Meat, canned	Cases	50–63	
Medicines	do	77	
Nails	Cases/barrels	28	Packing often insufficient for wt.
Oil	Cases	50	
Onions	Bags	77–90	Easily damaged by insufficient ventilation and dampness.
Oranges	Cases	84–90	Check for overripe fruit.
Oxygen gas	Cylinders	50	Keep away from oil and grease.
Paints (mixed with oil)	Drums/cans	28–42	Leakage; stow away from food, etc.
Pipes, cast iron	Unprotected	42–87	Handle and stow with care; no overstowage.
Potatoes	Bags	60	Keep cool and dry.
Raincoats	Cartons	112	
Rags	Bales	144	
Rope	Coils	133	Protect from stains; gives out odors.
Sand	Bags	25	
Shirts	Boxes	97	
Shoes	Cases	102	Protect from heat, dampness and pilferage.
Sleepers (railroad ties)		50–77	If creosoted, stow on deck.
Soap	Case	45–63	Packing often too weak for weight.
Steel beams, angles	Unprotected	14	Stow flat to avoid bending.
Tarred paper	Rolls	63–84	Stow flat; no overload.
Tin	Sheet	7	
Tires	Paper wrapped	100	Stow flat; away from foodstuffs.
Vehicles, carryall		265	
Vehicles, command car		247	
Vehicles, compressor		117	
Vehicles, mixer		400	
Vehicles, sedan		390	
Vehicles, truck, ¼-ton 4 x 4		238	
Vehicles, truck, ¾-ton 4 x 4		214	
Waste, cotton	Bale	150–180	
Wire, copper	Coil/barrel	38/30	Stow flat to avoid crushing.

27–9–65 Stability—

A. The condition in which a vessel is loaded is of utmost importance because it involves the safety of the ship, cargo, and personnel. Stability, with all it ramifications, is a technical study, of which vessel loading is only a small part. There are, however, certain fundamentals used in connection with the loading of vessels with which all those responsible for or engaged in such loadings should be familiar. The information supplied by the designer or builder of the vessel, coupled with the vessel planning, such as the distribution of weight in various compartments in and on the deck of the vessel, will result in a definite value for the GM, which is the determining factor as to whether the ship is properly loaded and seaworthy.

B. *Definitions.*—Stability is defined as the measure of the inherent ability of the ship to right itself when rolled or heeled to one side by some external force. In discussing this subject, terms will be used that are defined as follows:

(1) *Center of Gravity* (*G*) is that point in the ship through which acts the resultant force due to all the weights of the hull and its contents.

(2) *Center of Buoyancy* (*B*) is that point through which acts the resultant force due to buoyancy. It is the center of gravity of the water displaced by the shape of the vessel's hull.

(3) *Metacenter* (*M*) is the point of intersection between the centerline of the ship in an upright position and the line of action through the center of buoyancy at its various positions due to slight heel of the ship.

(4) *Metacentric Height* (*GM*) is the height of the metacenter above the center of gravity. This is expressed as a negative distance when the center of gravity is above the metacenter.

(5) *Vertical Center of Gravity* (*VCG*) denotes the point at which all the individual items making up a weight may be considered as concentrated, and is measured as a vertical distance above the keel. The *VCG* may refer to the load in one compartment or to any individual item on board. If a homogeneous cargo fills an entire compartment, the *VCG* will be the geometrical center of that compartment.

(6) *Moment* is the product of the weight multiplied by its distance from a designated point. The vertical moment (weight multiplied by *VCG*) will give "the moment of weight" for each individual compartment of the vessel.

(7) *Displacement* (*total weight of vessel plus cargo, fuel, water, stores, etc.*) is the total of all the weight items, including the weight of the vessel when light.

(8) *KG* (*measurement from the keel to the center of gravity*) is the *VCG* of the entire ship, including any of the load that might be aboard, and is calculated by dividing the total moment by the total displacement. *KG* is given for a definite light condition of the ship and must be corrected, when cargo or fuel is taken aboard, to give the *KG* for the whole system of weights, or the distance from the center of gravity above the keel of the entire floating mass.

(9) *KM* (*the distance from the keel to the metacenter*) is furnished by the builder of the vessel to correspond to the total displacement of the ship as indicated. Values of *KM* are shown by a curve, or may be tabulated, for any draft of the vessel.

(10) *GM* (*the distance from the center of gravity to the metacenter*) is *KM* minus *KG*.

(11) *Free-surface Correction* is the allowance made for slack or full conditions within the water and fuel tanks.

(12) *GM Available* is (10 minus (11) above.

(13) *GM Required* is usually drawn as a curve of minimum *GM* necessary for safety under normal operating conditions (including damaged ship conditions). Under normal operating conditions, consideration is taken of deck loads, crowding of passengers to one side, effects of high beam winds, high speed turning, and weights to be handled by booms over the side. *GM available must always be greater than GM required;* if not, ballast must be taken in.

(14) *Tons-Per-Inch-Immersion* (*TPI*) is the figure denoting the number of tons weight required to be taken on board to increase the ship's mean draft one inch.

(15) *Inch-Trim-Moment* (*ITM*) is the value in foot-tons of the moment about the transverse axis passing through the center of gravity of the water-plane which will cause a change of one inch in the difference between the forward and after drafts. Such a change is indicated by a ½-inch increase at one end and a similar decrease at the other, where, as is usually the case, the center of gravity of the water-plane is roughly amidships.

(16) *The Righting Arm or Lever,* generally referred to as *GZ* in the transverse stability diagram, is found from the curves drawn through a set of values for each 10 degrees of heel. Since the curve is based on an assumed value of *GM*, a correction must be made to the righting levers given thereon where the existing *GM* differs from that used in laying down the curve. The righting moments for the ship may be calculated by multiplying the righting arm by the displacement.

C. *Trim* is a term used to describe the position of a ship in relation to the still-water level when viewed from broadside. The technical meaning of the term is the difference between the drafts of water at the forward and after perpendiculars. The trim is a very important factor entering into the seaworthiness of a ship. After the fuel, water and stores are taken aboard, the trim of the vessel is usually governed by the distribution of cargo. In many instances, due to late arrival of cargo, it is difficult to keep the vessel in proper trim. In such cases it may be necessary to carry water ballast in the fore or aft peak, whichever the case might be. It is essential, therefore, that during loading operations a frequent check be made of the vessel's draft in order to alter distribution of weight before the ship gets completely out of trim. The draft should be checked after the fuel oil, ballast, or water is taken aboard. It should also be the practice to fuel and store the vessel as quickly as possible upon arrival on berth in order to properly plan the cargo distribution. "Down by the head" means that the vessel is deeper forward than aft. "Down by the stern" means the reverse.

D. *List*—A vessel has a list when it is not floating in an upright position. The amount of list is expressed in degrees measured from the vertical. The reasons for a vessel listing, while loading or discharging, should be known to the ship's officers and those in charge of the cargo activities. This knowledge will enable immediate corrective steps to be initiated if such are needed. In many instances the list is due to the unequal distribution of fuel oil or water while being loaded. The most serious cause of list is the uneven distribution of cargo. Care should, therefore, be exercised by those in charge of loading the vessel to see that the distribution of cargo in the vessel is not responsible for the list. The list of a vessel is described as either port or starboard.

E. *Required information.*—Before the *GM* of a vessel can be determined, information regarding the characteristics of the vessel must be available. In view of the fixed nature of the data there is slight chance of error until it is used in connection with the estimated weight distribution in the vessel's compartments.

(1) The following information should be available to the ship's officers:

(*a*) A scale or table showing the displacement and dead-weight tonnage, freeboard, *TPI*, and *ITM* for any draft.

(*b*) A curve or table of metacenters, showing the height of the metacenter above the keel at any draft.

(*c*) A curve of righting levers (*GZ*), the so-called stability curve, for two or three different conditions of loading, or *GM* values.

(*d*) Height of the center of gravity above the keel (*KG*) of the ship in light condition. Light condition defines the ship as complete and ready for service, but with no cargo, liquids, stores, ammunition, or men and their effects on board.

(*e*) Dimensions—length, breadth, depth of hold, etc., and the docking plan, the general arrangement and capacity plans.

(2) Extreme care must be exercised in compiling the total tonnage in the compartments, and when considering the liquid conditions of the various fuel oil, water, and cargo oil tanks. It is also highly important to note the weight and height of the deck cargo. All figures and computations must be accurate if the final result is to be a true picture.

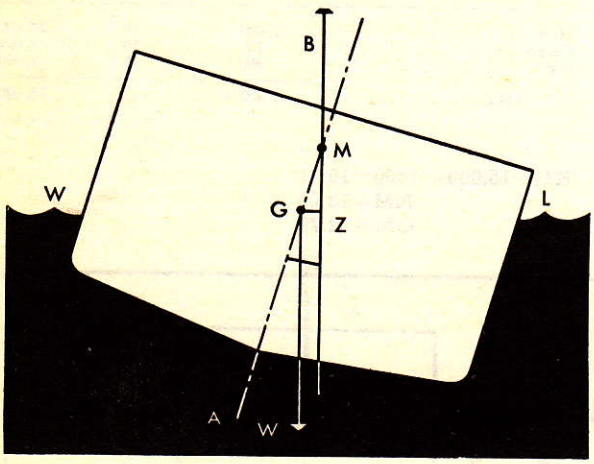
F. *Measure of stability.*—The stability of a ship as previously mentioned is its ability to right itself when rolled to one side. This power depends upon the relation of the center of gravity of the vessel and the center of buoyancy. The unusual measure of stability is the metacentric height (*GM*); that is, the distance of the center of gravity (*CG*) from the metacenter (*M*). The location of the center of gravity depends on how the ship is loaded. The location of the metacenter depends on the form of the ship, and for a given ship, on the mean draft.

GM controls the stability of the ship up to about 7 degrees of heel, for at these small angles, *GZ* is equal to *GM* multiplied by the $\sin \theta$, or the sine of the angle of heel. At larger angles of heel the freeboard becomes a determining factor for the length of the righting arm.

G. *Considerations for a given value of GM.*—For a given value of *GM* the following considerations must be noted:

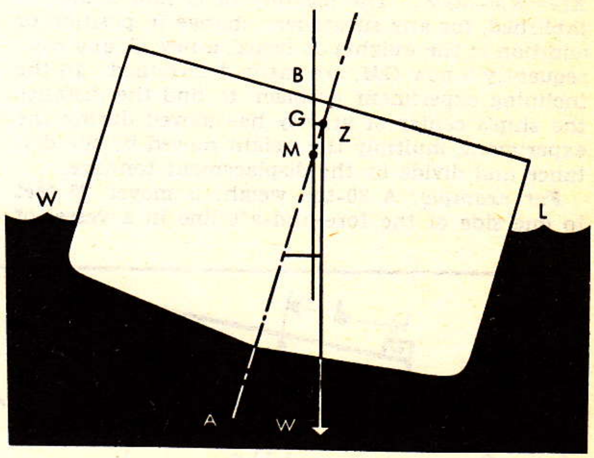
(1) At small angles of heel, increase of beam produces greater *GM* and therefore greater *GZ*, or righting power.

(2) The limiting angle to which a vessel may heel and still possess righting power is governed by the amount of freeboard.



Vessel in stable condition.

Vessel in a stable condition with the center of gravity (*G*) *below* the metacenter (*M*). The righting lever (*GZ*) shows buoyance (line B) and weight (line W) exerting force to right the vessel.



Vessel in unstable condition.

Vessel in an unstable condition with the center of gravity (*G*) *above* the metacenter (*M*). The righting lever (*GZ*) shows buoyancy (line B) and weight line W) exerting force to continue turning the vessel.

FIGURE 27–302.

(3) The point M, the metacenter, limits the position of G if the ship is to possess stability, and it will be noted that the distance GM, the height of the metacenter *above* the center of gravity, is actually the measure of the vessel's initial stability.

(4) At small angles of heel, a fine-lined vessel has a shorter GZ, or righting arm, than a full-lined ship.

(5) GM affects most the behavior of the ship at sea, particularly the period and violence of rolling. GZ, the length of the righting arm, governs and determines the resistance of the ship to capsizing, and hence is the element of greatest interest in assuring survival of the ship after underwater damage. A vessel with a comparatively low center of gravity and great length of GM will be a "stiff" vessel. This condition is accompanied by short, sharp rolling in a seaway, is uncomfortable, and may damage the vessel and cargo. On the other hand, a "tender" vessel has a long easy roll. Here the center of gravity is comparatively high, the GM short; and if a high freeboard value (which affects GZ) is wanting, the danger of capsizing in a heavy sea is always present. However, such a vessel, possessing a high freeboard, might actually have a greater range of stability than had she been in the "stiff" condition with less freeboard. The value of GM may, in most cases of loading and ballasting, be controlled by the proper vertical distribution of weight aboard ship. An otherwise "stiff" vessel may be changed into an easy one, and vice versa.

H. *Inclining experiment.*—Since the location of G by computation involving the weights of all structural parts, ballast, fuel, etc. on board is a huge calculation easily fraught with error, the inclining experiment is made on a vessel in which the angle of heel caused by placing a known weight a known distance from the fore-and-aft mid-ships line is found. A simple calculation derives the GM, and $KG=KM-GM$. The location of G now being established, for any subsequent change in position or addition to the weights on board, a new G, and consequently a new GM, are easily determined. In the inclining experiment problem, to find the distance the ship's center of gravity has moved during the experiment, multiply the weight moved by the distance and divide by the displacement tonnage.

For example: A 30-ton weight is moved 25 feet to one side of the fore-and-aft line in a vessel of 2,500 tons displacement. Length of the plumb line (used to measure the angle of heel) is 20 feet, mean deflection (measured along a batten) is 24 inches. Required the GM:

Since G moves to G_1, we have $GG_1=(w\times d)$ divided by W. Let PL equal the length of the plumb line and LL_1 equal the deflection, then PL divided by LL_1 equals GM divided by GG_1, from which $GM=(PL\times GG_1)\div LL_1$.

Therefore, shift of $CG=GG_1=(30\times 25)\div 2500=$ 3.6 inches.

$GM=(240\times 3.6)\div 24=$ 36 inches or 3 feet

(1) The inclining experiment booklet furnished to the ship will give a light condition for the vessel and one or more assumed conditions of loading. These conditions can be used as a basis for estimating or calculating the stability under actual load conditions.

(2) The above description is given for general information purposes only. To conduct an inclining experiment, refer to more complete details and instructions given in standard texts on stability.

I. *Finding GM for a load condition.*—Computation of KG is simply an application of the principles of moments about the basic point K, in order to find the CG of a vertical system of weights.

(1) For example: A ship in light condition displaces 1,000 tons, the KG being 10 feet; and the KM in loaded condition being 13 feet. Two hundred tons of cargo are loaded 10 feet above the keel and 200 tons of fuel 15 feet above the keel. Find the GM.

Solution: (Sum of moments about K÷total weight or displacement) equals KG.

	Weight (tons)	Height above K (feet)	Moment (feet per ton)
Ship	1,000	10	10,000
Cargo	200	10	2,000
Fuel	200	15	3,000
Total	1,400		15,000

Feet
KG=15,000÷1400=10.71
KM=13.00
GM= 2.29

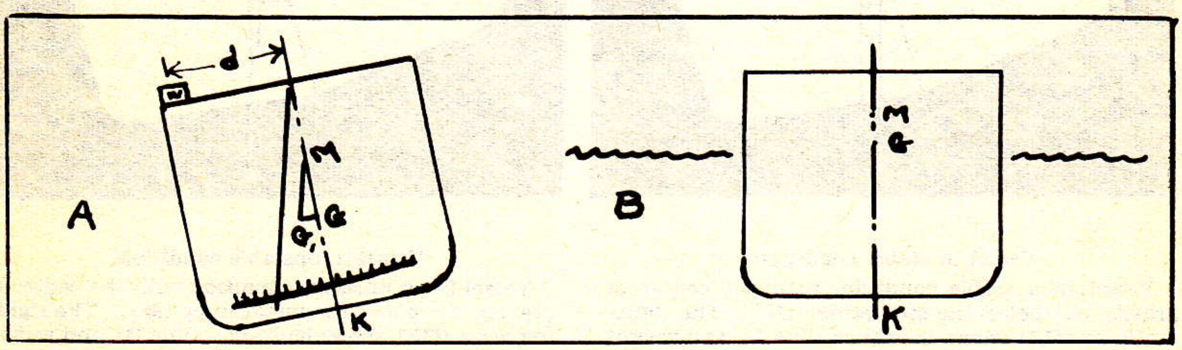


FIGURE 27–303.—(A) Measuring effect of shift of weight. (B) $KM-KG=GM$.
(Reprinted from Merchant Marine Officer's Handbook by permission of Cornell Maritime Press.)

(2) Assuming that the above example is a trial by computation for a proposed loading, it is now proposed to shorten the *GM* by .25 foot. How many feet must 50 tons of cargo be raised to effect this?

Solution: Here it is required to raise the *CG* .25 foot. By the principle of moments, the weight moved times the distance moved divided by the total weight is equal to the shift of the center of gravity (*CG*) of the system.

.25 foot rise of $G = (50 \times \text{distance raised}) \div 1400$

$$\text{Then distance raised} \frac{.25 \times 1400}{50} = 7 \text{ feet}$$

Therefore 50 tons of the 200 tons of cargo aboard must be placed 10 plus 7 or 17 feet above the keel. Note that 25 tons raised 7×2 or 14 feet would give the same result; or 100 tons raised 7÷2 or 3.5 feet gives a third choice in the matter.

(3) Taking another example, assume a vessel of 2,000 tons displacement is to fill a ballast tank whose *CG* is 1½ feet above the keel. *GM* equals 2.0 feet and *KG* equals 14 feet. The capacity of the tank is 50 tons. What will be the effect on the GM?

Solution: Distance of *CG* of tank from *G* is 14−1½ or 12½ feet. Shift of *G* (50×12½)÷(2,000+50)=625÷2,050=.304.

Therefore KG=14−.304=13.696
GM= 2+.304= 2.3 feet

J. *Stability curves.*—The value of *GM*, as previously noted, must be considered in connection with the curve of righting arms, which is generally called the stability curve. Usually, curves are drawn giving the righting arms for a ship in three estimated conditions; light, normal or cruising, and full load. For practical purposes, if the *GM* of the ship can be estimated for an existing condition, the righting arm curve may be selected which most closely resembles the existing condition. The curve can be corrected by multiplying the difference between the *GM* from which the curve is drawn and the *GM* of the existing condition, by the sine of the angle of heel: (*GM* actual—*GM* for the curve) × Sine of the angle equals the correction. If the actual *GM* is larger than curve *GM*, the correction will be added to the values of the curve; subtracted if the actual *GM* is smaller.

While a satisfactory stability condition may be apparent through the information shown on the curve, a later experience may prove the vessel's behavior at sea to be poor. The ship's rolling period is usually the key to this. If the wave period and the vessel's period of roll are nearly in agreement when the sea is near the beam, excessive rolling is the consequence. The most satisfactory rolling period is one which is greater than the half wave period, and not coincident with the full wave period.

K. *BM or metacentric radius.*—We have seen that the vector representing the upward force of buoyancy meets the point *M*, the metacenter, on the mid-ship vertical line. The total buoyancy force concentrated at *B*, the center of buoyancy, has its origin at this point. We accept the values of *BM* for any given floating position or draft condition as beyond our control. A desired location of *G* may be affected by means at our disposal, but *M* and *B*, and consequently the distance *BM*, are laid down by the inexorable laws of nature. *BM* (feet) equals (moment of inertia of water plane) divided by volume of displacement (feet³), or $\frac{I}{V}$, the numerator *I* being considered relative to the longitudinal axis. It will be observed from this formula that the value of *BM* depends almost wholly upon the volume of displacement, since an ordinary vessel's water plane area changes comparatively little throughout her range of working drafts. This accounts for the high position of the metacenter at the lighter draft, so that a given *KG* results in a greater *GM* at the light draft than at the load draft. Also, for a given displacement, the vessel having the greater beam will have the greater *BM*, since the moment of inertia of the water plane about the fore-and-aft line varies as the breadth cubed, and only directly as the length. We therefore note that the broad-beamed shallow-draft vessel is characterized by her great metacentric height (*GM*) because of the comparatively great height of *M* (*KM*). This is a "stiff" vessel with a short rolling period. Considering a narrow-beamed ship, the formula shows that the *BM* will be seriously affected by a heavy draft, or increase in displacement. We have here the naturally "tender" vessel in the load condition, and particular care must be taken to keep G well down.

(1) In ordinary cargo-type steamers the *BM* approximately varies inversely as the draft. Thus a vessel of 12,500 tons displacement, 400 feet in length, and 55 feet beam, at 12 feet draft with a *BM* of 21 feet, has at 26 feet draft a *BM* of 10 feet. In such a steamer the location of the center of buoyancy, or *KB* (ship upright), is approximately .55 of the draft above the keel.

(2) The moment of inertia of the water plane (*I*), as used in the formula above, is equal to the length times the breadth cubed, divided by 12.

L. *The longitudinal BM*, which is required in trim calculations, is computed on the same principle. The moment of inertia of the water plane is considered as about the transverse axis passing through the center of gravity of that area.

M. *Pitching.*—A vessel of light draft as compared to her load condition will react to a head sea with a much more lively motion, due to the fact that the longitudinal BM corresponds to a shorter pitching period, just as we have seen that the greater transverse *BM* (unless counteracted by a raised center of gravity) produces the shorter rolling period. The pitching period has been found to agree closely with the result given by the formula: $t = 0.554\, k \div \sqrt{LGM}$, *k* being the radius of gyration about the transverse axis passing through the center of gravity. The

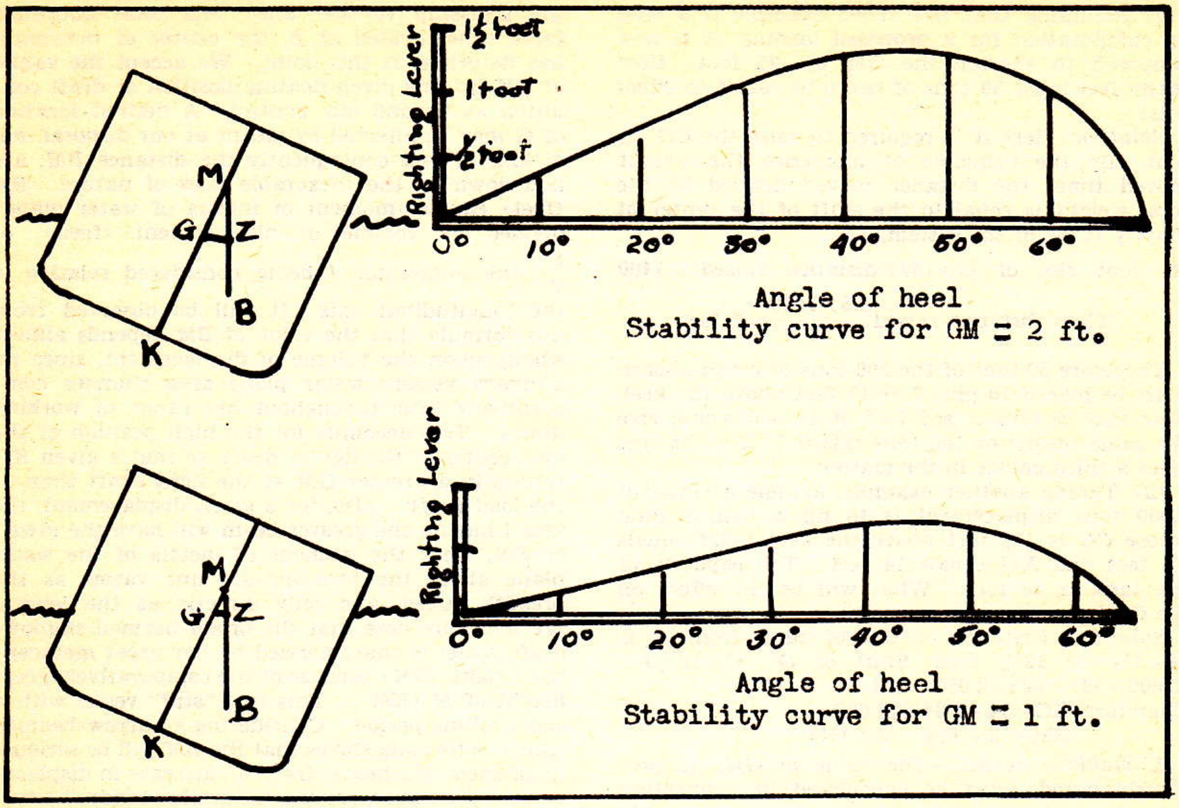


FIGURE 37-304.—Stability curves for different values of *GM*. (Reprinted from Merchant Marine Officer's Handbook by permission of Cornell Maritime Press.)

value of t (in seconds), of course, depends upon the moment of inertia of the mass about the center of gravity, so that greater weight toward the vessel's ends, and a consequent increase in the numerator k, will result in a longer pitching period for a given *LGM* (longitudinal metacentric height). The same effect on the period of roll is produced by stowing heavy cargo in the wings of the holds, but, due to the comparatively small distance from the mid-ship line to the center of the weight, such effect would, in most cases, be negligible. Unusual weight placed near the ends of a vessel produces sluggishness in a head sea, which causes the shipping of heavy water over the bows, a consequent loss of speed, and undue longitudinal stresses on the vessel's structure.

N. *Ballasting.*—From one-fourth to one-third of the deadweight carrying capacity is, in general, a suitable amount of water ballast to be carried in double bottom and deep tanks of a ship in light condition. Double bottom tanks alone are seldom adequate for efficient ballasting, considering the difficulties of navigation and wear and tear on the structure in a heavy seaway. Deep tanks, or wing tanks are almost a necessity in most trades, and absolutely so in stormy waters. The obvious advantages of supplying the needed deadweight as well as a raised center of gravity need hardly be commented on. Slack water ballast should particularly be guarded against, as it has a damaging effect on tank tops and causes stresses in the tank structure and vicinity.

(1) *Filling ballast tanks at sea.*—Loss of *GM* due to consumption of fuel or water may sometimes require filling a ballast tank at sea. It is not good seamanship to wait until the vessel is in a tender condition, especially so if rough weather is encountered, before taking such action; and particularly should the tanks be of the undivided type, i. e. a free surface extending from side to side of the entire tank. *GM* is reduced in the case of a free liquid by an amount equal to the moment of inertia of the surface of the liquid divided by the displacement of the vessel: Reduction of $GM = i \div V$, i being the moment of inertia of the free surface and V the displacement (in feet^3). It should be noted that i in the formula is independent of the volume of the free liquid, being, for a tank of rectangular form: $i = (l \times b^3) \div 12$, l and b being the length and breadth of the free surface, respectively.

(2) As an example of the effect on the *GM* of the free liquid surface in a vessel's tanks, consider a double bottom 4 feet deep, filled to a depth of 3 feet with sea water: The tank is 50 feet wide and 52 feet long, and the water is free to flow in any direction. Assume that the height of the *CG* before running water into the tank is 22.8 feet and the ships displacement is 13,000 tons. Weight of water in the tank is 220 tons.

Change in *KG* due to water in tank:

$$\frac{(228-1.5)\times 220}{13220}=.35$$

Reduction in *GM* due to slack water:

$$\frac{i}{v} \text{ or, } \frac{(50\times 50\times 50\times 52)}{(12\times 13220\times 35)}=1.7 \text{ feet.}$$

Fall in *CG* due to taking in water	= .35 foot
Reduction in *GM* due to slack water	=1.17 feet
Total reduction in *GM*	= .82 foot

(3) Instances of such large free surfaces of liquid, of course, would be rare in any vessel. It is worthy of note that, since the value of the moment of inertia of the free surface varies as the cube of the breadth, a watertight centerline division in the tank would result in one-fourth of the *GM* reduction due to free surface in the through tank. The centerline division would appear, then, as follows;

Fall in *CG* due to taking in water	=.35-foot
Reduction in *GM* due to slack water	=.29-foot
Increase in *GM*	=.06-foot

The presence of slack oil or water in subdivided tanks, therefore, is not generally a serious condition in ship stability consideration. However, the probably perilous case of a tender vessel having her lower hold full of water is realized when considering the effect on the *GM* of comparatively large free liquid surfaces as given in the example.

O. *Change of trim.*—When a given weight is placed in a vessel at a given distance forward or abaft the tipping center, or center of flotation, the change of trim due to the moment about that point (expressed by the weight × the distance) is found by the formula $C=\frac{(w\times d)}{ITM}$ where *C* is the change of trim in inches; *w*, the weight in tons; *d*, the distance from the tipping center; *ITM*, the inch trim moment. The *ITM* may be found by $\frac{(k\times t^2)}{b}$ where *t* is the tons per inch immersion; *b*, the breadth of the vessel; *k*, a constant depending on the block coefficient.

For coefficient of .65, value of k is 28.

For coefficient of .70, value of k is 30.

For coefficient of .85, value of k is 32.

Another name for the center of flotation is the center of gravity of the waterplane. This curve is usually found in the "Displacement and Other Curves" or "Curves of Form."

For example: 100 tons of cargo are loaded in a vessel 50 feet forward of the tipping center; tons per inch are 12; breadth of the ship 40 feet; a block coefficient of .65. Draft before loading, 11 feet forward and 12 feet 6 inches aft. Find the draft after loading.

For the *ITM* (28×12×12)÷40=100.8 foot/ton.

For the change of trim (100×50)÷100.8=50-inches or 4 feet 2 inches.

For the increase in mean draft 100÷12=8 inches.

	F.	*A.*
Draft before loading	11′00″	12′06″
½ trim	+ 2′01″	− 2′01″
Increase	+ 08″	+ 08″
Draft after loading	13′09″	11′01″

Since the change of trim is equal to the sum of the increase of draft at one end of the ship and decrease at the opposite end, due to the "tipping" effect, we apply only half-trim in the manner required.

(1) The location of the tipping center is at the center of the water plane area, or is approximately at the mid-distance between perpendiculars.

(2) When weights are shifted in the fore-and-aft line, the moment found by multiplying the weight by the distance moved is that which causes the change of trim. Therefore, it is not necessary to know the position of the weight moved relative to the tipping center. For example: 100 tons of fuel oil are shifted from No. 3 to No. 6 tank, a distance of 110 feet. The ITM is 550 foot/tons. Draft before shifting fuel is 15 feet F. and 14 feet A. Find the new draft.

(100×110)÷550=20″ change of trim (by the stern).

	F.	*A.*
Draft before shifting fuel	15′00″	14′00″
½ trim	−10″	+10″
New draft	14′02″	14′10″

Note that in this case we have not added or taken away any weight so that the tons per inch (*TPI*) value does not enter the calculations.

(3) Tabulated information on the draft and trim effect due to loading, discharging, shifting cargo or ballast, etc., is of much practical value aboard ship. Such information may be computed for light and load drafts, the neecssary correction for intermediate drafts being estimated and properly applied. A convenient form of tabulating this data in the case of ships ballast or bunker tanks might be as follows:

Fore peak sinks 10 inches forward; rises 3 inches aft.

Number 1 D. B. sinks 8 inches forward; rises 2 inches aft.

Number 8 D. B. rises 3 inches forward; sinks 6 inches aft., etc.

Similarly, the effect due to loading 10, 25, or 50 tons of cargo in the center of the hold might be arranged as a table.

P. *Following are some useful formulae for use in stability computations.*

(1) $GM=KM-KG$ (ship upright); KM=height of metacenter above keel.

(2) $\sqrt{GM}=.22b\div t$; b=breadth of vessel, and t=single period of roll in seconds.

(3) $KB=.55d$ (ship upright); KB=center of buoyancy above keel, and d=mean draft (a close approximation in cargo steamers).

(4) $BM=I\div V$; I=moment of inertia of waterplane about fore-and-aft axis, and V=volume of displacement.

(5) $BM=.08\ b^2\div d$; b=moulded breadth of vessel, and d=mean draft (a close approximation for cargo steamers).

(6) $KM=KB+BM$

(7) $LGM=(LBM+KB)-KG$

(8) $LBM=I \div V$; I and V, *see* (4) above.

(9) $ITM=(LGM \times W) \div (12 \times Length)$; W = displacement in tons, and *Length*=that between perpendiculars.

(10) TPI=(Area of water-plane) : (12×35).

(11) Area of water-plane=Length×breadth×coefficient of fineness.

(12) $GG_1=(w \times d) \div W$; GG_1=shift of center of gravity (in feet); w=weight shifted; d=distance weight is shifted; and W=displacement (in tons).

Q. Stability data for several representative types of tenders is given below; (some values are approximate).

Tender	Displacement tons	Mean draft (feet)	Trim by stern (feet)	GM (feet)	Maximum rtg. arm (feet)	Range (degree)	KG (feet)	ITM foot/tons	TPI
189-foot class (*Jonquil*):									
Light	868	9.3	3.67	2.63	1.3	50	15.99	101.0	11.03
Full load	1,239	12.0		3.72	1.5	65	13.34	116.5	11.83
180-foot classes (A, B & C):									
Light	694	9.85	4.75	.87	1.56	81	15.4	66.8	8.8
Normal	984	12.4		2.62				96.26	10.5
Full load	1,025	12.67	2.75	3.36	2.04	88	14.1	100.9	10.55
175-foot class (*Walnut*):									
Light	706	9.58		1.79			13.49	83.0	9.2
Full load	902	11.5		2.58			12.83	97.0	10.03
173-foot class (*Mistletoe*):									
Light	670	7.79	2.25	5.15			11.55	85.0	
Full load	725	8.25		5.35			10.83	88.3	
133-foot class (*White Heath*):									
Light	348	5.73	3.04	8.13	2.85	62	11.04	45.35	7.08
Full load	476	7.19		6.35	2.42	64	10.08	51.45	7.45

NOTE.—The above data for *Walnut* and *Mistletoe* is based on inclining experiments made in 1939 and is therefore somewhat out of date. It is included only to show a representation of several types of tenders, comparing the old with the new.

(1) Taking the 180-foot class tender for example, at normal load the table below shows the effect on the transverse metacentric height (*GM*), of adding 15 tons additional weight at various heights. Weights up to three times this amount will have approximately proportional effects on the *GM*.

Center of gravity of added weight above base line (feet)	Location	Change in GM (feet)
5	Main hold	+0.15
12	Second deck	+0.04
20	Main deck	−0.08
27	Upper deck	−0.18

(2) A rough method of determining metacentric height (*GM*) of a vessel at any time when the ship is rolling, may be used by observing the period of roll with a stop watch. The relation connecting the period of roll with the *GM* is as follows: $GM \frac{K}{t^2}$, where K is a contant, with a value for the 180-foot-class tenders of about 64, and t is the time of the half-roll, that is, the time in seconds between the maximum roll from one side to the maximum roll on the other. The value of the constant K may be more accurately established by observing the roll period at a time when the *GM* is approximately known, such as when the ship is about in a normal condition. By placing the time of the half-roll so obtained, and the *GM*, in the formula, the value of K may be checked. In observing t, it is best to get the total time of a number of successive half-rolls, such as 10, rather than to use only a single cycle; then divide the total time by the number, in order to average out inaccuracies. This method is valid, theoretically, only for free and unrestricted rolling; that is, the natural roll of the ship without outside influences tending to change the time of the roll. Consequently, the time should preferably be taken during fairly calm weather, when the roll is not appreciably affected by deep waves.

(3) It must be remembered that the above method of determining *GM* gives only approximate results, and it should be used only with a thorough understanding of the principles involved, so that its limitations may be understood.

R. The description of stability in this section has been but briefly touched, and the interested reader is invited to pursue this subject further in any of the well-known texts dealing with cargo-handling or damage control.

S. For information, a few statistics of various classes of tenders are given below (some values are approximate):

(1) 189-foot *Jonquil*-class tender:

Hatch size, 9 feet 3 inches x 9 feet 3 inches.
Hold capacity, lower, 9,056 cubic feet.
'tween decks, 6,375 cubic feet.
Tank capacity:

Fresh water:		*Gallons*	*Tons*
Frs. 16-24 C/L		4,787	17.78
25-42 S		5,820	21.61
25-42 P		5,820	21.61
78-87 C/L		14,041	52.14
Diesel oil or ballast:	*Gallons*	*Oil (tons)*	*Water (tons)*
Frs. 6-16 C/L	5,877	18.25	22.45
6-16 S	5,477	17.01	20.92
6-16 P	5,477	17.01	20.92
56-77 S	5,498	17.07	21.00
56-77 P	5,244	16.29	20.03
Fuel oil:		*Gallons*	*Tons*
Frs. 49-55 S		11,697	42.2
49-55 P		12,208	44.1
43-49 S		11,989	43.3
43-49 P		12,237	44.8

(2) 180-foot class tender:

Hatch size, fwd., 7 feet x 7 feet; main 9 feet x 9 feet.
Hold cap., fwd., 4,000 cubic feet; main 11,000 cubic feet.
Tank capacities:

	Gallons	*Tons*
Fresh water:		
Fore peak	7,000	26.0
Fwd. C/L	19,680	73.2
Fwd. S	11,476	42.7
Fwd. P	11,476	42.7
Aft. C/L	7,250	27.0
Aft. S	3,060	11.4
Aft. P	3,060	11.4
After peak	~~7,000~~ 3,005	~~26.0~~ 10.0
Fuel oil:		
CL	12,800	41.3
S	8,705	28.1
P	8,705	28.1

(3) 173-foot class (*Mistletoe*):

Hatch size, 8 feet, 7 inches x 9 feet, 3 inches.
Hold cap., 12,090 cubic feet.
Tank capacities:

	Gallons	*Tons*
Fresh water (potable)	11,000	40.89
Fresh water (res. feed)	11,000	40.89
Fresh water (trimming F & A)	[1] 3,500	13.0
Fuel oil	29,000	104.0

[1] Each.

(4) 133-foot class (*White Heath*):

Hatch size, 10 feet x 10 feet.
Capacity of holds:
Number 1, 7,280 cubic feet.
Number 2, 3,780 cubic feet.
Number 3, 1,140 cubic feet.
Tank capacities:

	Gallons	*Tons*
Fresh water:		
Fore peak	3,216	11.9
After peak	3,500	13.0
Fr. 11-12 S	1,675	6.2
Fr. 11-12 P	1,675	6.2
Fuel oil:		
S	6,110	19.7
P	6,110	19.7

T. *Stabilogauge*.—An instrument known as Stabilogauge has been issued to the 180-foot class tenders. This is a calculating device which instantly determines the mean draft, displacement, deadweight, and stability which a ship will have under any condition of loading or at any time during a voyage. The indicator in the left hand window gives the metacentric height (*GM*) of the ship for any condition, based on information set into the instrument by micrometer-type thimbles, according to the actual condition of loading. Complete instructions for the use of Stabilogauge are furnished with the instrument. A Stabilogauge prepared for a certain vessel or class of vessels may not be used to compute values for any other type vessel.

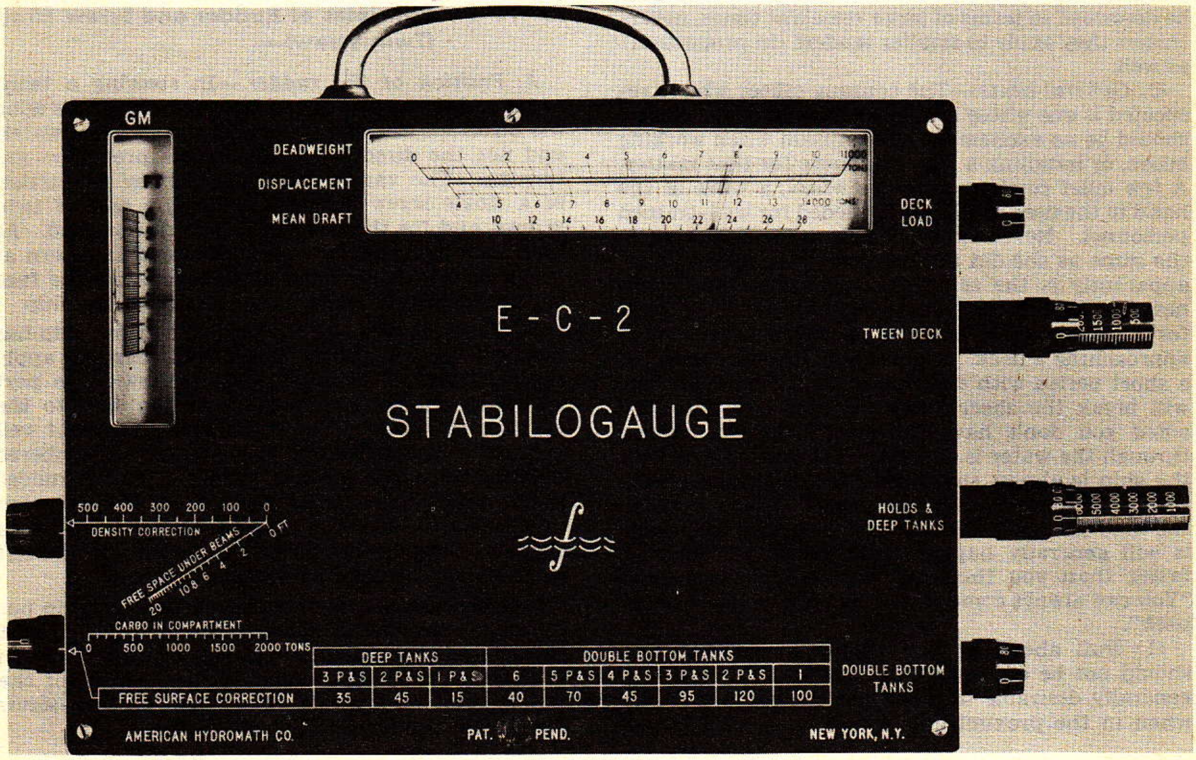


FIGURE 27–305.—Stabilogauge.

27–10 SHIPHANDLING

27–10–1 General—

A. *Purpose of this section.*—The phrase "different ships, different long splices" holds good in shiphandling as well as in other seafaring functions. A more controversial subject may not be found. However, it is the intent of this section to set forth for informative purposes some of the fundamental principles involved in maneuvering single and twin screw vessels, along with some practical hints developed through the experience of many capable shipmasters.

B. *Good shiphandling essential to aids to navigation work.*—Although shiphandling, especially in aids to navigation work, is an art which can be learned only by constant study, analysis, experiment, and practice (or in other words, experience), nevertheless a thorough understanding of the fundamental effects of a vessel's rudder and propeller(s) and general characteristics of certain types of vessels will enable the conning officer to profit more readily from his experience. Good shiphandling is absolutely essential in aids to navigation work from a standpoint of safety and operational efficiency. When setting buoys, one is often required to put a ship in places where no prudent seaman would voluntarily go. Constant vigilance is the watchword when working buoys. The slightest inattention on the part of the shiphandler when a buoy is alongside or is being hoisted—allowing the ship to fall off for a moment or gather way—and the damage is done. A man is injured, gear damaged, etc. Since aids to navigation tenders may be either single or twin screw, the principles involving each will be discussed in turn. Although these principles may be described in terms of large vessels at times, nevertheless they apply to smaller tenders (in proportion) as well.

C. *General hints.*—The conning officer who is respected is one whose bridge is taut and quiet. There should be no excitement or confusion when working buoys, or handling a ship anywhere for that matter. A few quiet commands to the wheel, a wave of the hand to the deck is all that is needed for well-trained personnel. Never expect a ship to handle exactly the same as she did the last time you were in what apparently is the same situation. Conditions will never be exactly the same. Always be on the alert for a sudden sheer when in a confined channel or approaching a dock. A quick full ahead or back for a short period with the engine, as the case may be, will break the sheer and straighten her out, *provided* you don't have too much way on. Speed through the water is deceptive. It may appear that the ship is almost stopped, in fact you may be deciding to work the engine ahead, but as soon as the buoy gets past the bow and is coming alongside, it will generally happen that the ship is moving faster than you thought. Remember the phrase "You can always come ahead, but you cannot always back".

(1) Full ahead on the engine in maneuvering should not be confused with speed. Although it is generally desirable to maneuver the engines gently when in the proximity of a dock or a buoy, there will be times when a quick cant one way or another is desirable, yet without increasing the headway. Using full rudder and two-thirds or full speed ahead for a *brief* interval will be much more satisfactory than prolonged use of the engine under less power which permits a greater distance to be covered ahead and towards the dock or buoy before the desired turn is achieved. This is especially true when dead in the water or moving slowly in the direction you wish to turn the engine. It is always the strong initial thrust that has the greatest turning effect.

(2) Another good reason for going slowly is the chance of mechanical or human failure. The pilothouse control may suddenly go dead, a circuit breaker cut out if you have moved the control too quickly from ahead to astern, an engineroom telegraph signal misread, a man on deck may hold the spring when you want it veered, etc. In any of these events, if your headway is what it should be, you will probably have time and space to counteract what has happened.

(3) If, when approaching the dock or buoy, you find that the ship has too much headway, don't hesitate to back and stop her, even if it spoils the approach and it becomes necessary to turn around and come in again.

D. *The principal factors* in connection with the handling of any ship are the size of the vessel (length, displacement), her speed (power), the depth of water under her, the force and direction of the wind and current, space available for maneuvering, and principles of the effect of rudder and engines. The latter is the most important and will be discussed first.

27–10–5 Principles of Rudder and Screw Effect (Twin-screw)—

A. *Position of the rudder.*—In steering a twin-screw vessel, the position of the rudder depends upon the direction the ship is moving through the water, and not the direction in which the propellers are turning. The various forces set up by the action of a single screw balance out in the case of twin screws, and for that reason can be disregarded. As long as both screws are working ahead or astern at the same speed, the force of water against the face of the rudder will control the steering of the ship.

B. *Headway and the rudder.*—When the ship has headway, and a turn to the right is desired, apply right rudder. The ship's stern will swing to port and thus change the heading of the ship to the right, or starboard. The ship pivots on a point well forward of amidship and it should be remembered that the stern, not the bow, swings when the rudder is put over. This swing, away from the direction to which the rudder is applied, causes the ship to change to the desired heading. To turn to the left when going ahead, left rudder is applied.

C. *Sternway and the rudder.*—When the ship has sternway, the rudder effect is the opposite. Right rudder when the ship is going astern causes the stern to move to the right, changing the heading of the ship to port. Left rudder, vice versa. A twin-screw ship steers similarly to an automobile.

D. *Effect of screws.*—When both screws are turning ahead or astern at the same speed, the ship, if not influenced by external factors of wind and current and with the rudder amidships, will move straight ahead or back. If either screw is working singly, a turning moment is created which will swing the ship away from the side on which the screw is acting. For example, if the starboard screw is turning ahead alone, the ship will swing to port. If backing, then the ship's bow swings to starboard as the stern goes to port. When the screws are turning at different speeds in the same direction, i. e., one turning ahead one third, the other ahead full, the bow will turn toward the side which has the engine turning at the slower speed, and the greater the difference in speed, the sharper the turn. When the screws are opposed, the ship's bow will turn towards the side that is backing; i. e., port screw ahead, starboard screw backing, and the bow will turn to starboard. Whether the ship will have headway or sternway will depend on the difference between the relative speed and power of the two engines and the amount of way that was on the ship when the operation was begun.

In order to turn a twin-screw ship in place, the relative speed of the respective engines must be adjusted until they balance each other (not turning at the same number of revolutions necessarily), discounting of course the external effects of wind and current. In screws working opposed, it should be remembered that the screw backing must turn faster than the screw going ahead in order to balance the thrust. In turning a ship in place, it may be necessary to alternately stop and start the engine. Under some conditions, one screw backing two-thirds will about balance the other screw going ahead one third.

E. *Rudder and screws.*—As stated before, the rudder is used in relation to the direction of motion of the ship through the water rather than in relation to the direction of rotation of the propellers. For example, when going ahead on both screws and it is desired to turn to starboard sharply, stop and back the starboard screw and apply full right rudder. However, when having sternway and desiring to turn the ship to starboard (stern to port), go ahead on the port engine, back on the starboard engine and full left rudder. When the ship is being swung in place with no way on, the rudder should be left amidships.

F. *Steerage.*—When the ship is dead in the water, or nearly so, the ship lacks steerageway and the rudder will have little or no effect. This is true as the ship loses her way when coming to a stop or when starting to make way after being stopped. Control must then be accomplished with the engines until steerageway is gained.

G. *Know your ship.*—The officer handling the ship should know certain individual characteristics of his ship: for example, how much power to expect when certain speeds are ordered, how long it takes the engine room to reverse the engines, how far the ship will travel if the engines are reversed at various speeds ahead, what turning effect certain degrees of rudder angle will have, the diameter of the ship's turning circle, etc. This paragraph applies to single-screw vessels as well.

H. *Standard orders to the wheel.*—Since the standard orders to the helmsman should be familiar to all (they may be found in any standard text on seamanship) they will not be repeated here. However, it is emphasized that only standard terminology should be employed. A confused helmsman can easily cause an accident.

27–10–10 Principles of Rudder and Screw Effect (Single-screw)—

A. In the following discussion a right hand propeller is assumed.

B. *When going ahead,* the effect of the rudder is the same as described for a twin-screw vessel. Right rudder turns the ship's head to the right and the ship pivots in a similar manner to a twin-screw vessel.

C. *When backing,* a different problem is involved. The sidewise thrust of the backing screw has a tendency to swing the ship's stern to port. Conversely, when going ahead, if there is no countering effect of the rudder, the sidewise thrust of the screw going ahead tends to swing the stern to starboard. The screw when going ahead has its greatest turning effect on the ship when turning over slowly. However, when the screw is backing, its greatest turning effect is at full speed. When backing, the rudder has little effect until the vessel has gained considerable sternway, in which case if the sidewise thrust of the screw to port is not too strong, the vessel may mind her helm and back to the rudder the same as a twin-screw vessel. A single-screw vessel is more easily affected by current and wind when backing. It is a tendency of most vessels to back into the wind and away from the current. This is true, to a lesser degree, in twin-screw vessels also.

D. The following illustrations show the effect of screw and rudder on a powerboat. The principle is the same for ships.

E. The following four cases illustrate the effects of various combinations of screw and vessel motion, and are explanations of some of the following illustrations.

(1) *Ship and screw going ahead*—If the ship is stopped and the screw starts turning ahead, the screw current striking the rudder causes the ship to turn in the direction the rudder is put over. As the vessel gathers way, the effect of the screw current is lessened and the normal action of the rudder takes control. This is why a short application of full power ahead when the ship is stopped has a great turning effect without causing much advance. This is a most useful maneuver, but one which many shiphandlers are apparently hesitant to use. When the ship is proceeding normally and the rudder is suddenly put hard over, the stern will first move away from the direction of the turn. The ship then "crabs" off in the same direction as it slowly begins to turn. Due to her momentum along her original course, the ship will range ahead along that course for a length or two before beginning to gain ground in the desired direction.

(2) *Ship and screw going astern.*—In this case the steering effect of the rudder is negligible until the ship gathers sufficient sternway; meanwhile the screw current has started to swing the vessel's stern

to port. As the sternway increases, the rudder, if put hard right, will take increasing effect and if the screw is backed slowly so as to minimize its thrust, the stern will swing to starboard. If the rudder is put full left, the stern will swing rapidly to port. This tendency can be useful when turning in a short narrow space, provided the ship is turned to the right. By alternating full ahead on right rudder and full astern on left rudder, a ship may be turned quickly in a small area. The wind generally has quite an effect on vessels going astern. If there is much wind, the ship will back its stern up into it regardless of rudder or screw. Therefore, when turning in a narrow space with wind on one bow, make the turn away from the wind, backing the engine when the wind is well abaft the beam.

(3) *Ship going ahead, screw going astern.*—It must not be assumed that the rudder will still affect the ship's head while the ship has headway. As soon as the screw is reversed, new forces are brought into effect. If the rudder is left amidships, the ship's head will fall off to starboard. If the rudder is put full right at the instant the screw starts astern, the ships head will swing to starboard at first. The bow may continue going to the right but usually will stop, then slowly swing to port, the stern swinging to starboard as the ship gathers sternway and minds her helm. If the rudder is put full left at the instant the screw starts astern, the bow will swing slightly to the left at first, but as the speed decreases it will fall off to starboard, since all forces are acting together to swing the stern to port.

(4) *Ship going astern, screw going ahead.*—If the rudder is amidships, the sidewise pressure of the screw blades counterbalances the discharge current striking the rudder, and it is impossible to predict in which direction the ship will swing. If the rudder is put full right, the stern will go rapidly to port; if put full left, the stern goes rapidly to starboard. However, if the ship is making considerable sternway and full power is not being used, the steering effect of the rudder may cause the ship to back to her rudder until the sternway has decreased, when the discharge current of the screw takes effect and causes the ship to react as described above.

(5) In the two cases described above of a ship going ahead with screw backing and a ship going astern with screw going ahead, the predictions of the ship's action are predicated on the use of full power on the screw under average conditions. Should speed through the water be high and only half power used, some of the tendencies noted may be reversed.

F. *A swinging ship* carries considerable momentum and tends to continue to swing in the direction in which it started. Therefore if conditions permit, start the swing with the rudder before using the engine to change the direction of the ship's movement. In this manner the swing can be started in the right direction and the rudder and engines used to best advantage to continue the swing. When maneuvering a single-screw ship, remember that the position of the rudder depends on what the propeller is doing rather than on the direction of the motion of the ship through the water.

G. *Different conditions.*—It must be remembered in the foregoing that differences in trim, wind, sea, current, suction of the bottom, size of rudder and propeller, etc., all produce new forces, or modify existing forces, and the vessel may at times act in a manner other than predicted herein.

27–10–15 Alongside a Pier—

A. Bringing a ship alongside a pier requires action with the rudder, engines, and mooring lines. The extent to which each of the foregoing is used depends on the existing conditions of wind and current and the individual characteristics of the ship. A landing should not be attempted without observing the set to be expected. Check the tide and current tables and note the wind condition. Ships swinging at anchor may not always be a reliable indication of the current along the shore because of counter-currents and eddies. When approaching a pier, it is a good practice to use various fixed objects on shore as temporary ranges to ascertain the direction of the set.

B. *Going alongside with no set—twin-screw.*—Under these conditions the vessel may be docked equally well on either side. Lines and fenders are made ready, and the berth approached at an angle of 10 to 20 degrees, maintaining only sufficient speed for steerageway. Engines should be stopped and the bow allowed to approach fairly close to the dock, at which point the rudder is put over in the direction away from the pier. This latter action will bring the stern in so the ship is parallel with the wharf. Headway is then stopped by backing the outboard engine, or, if the ship has reached a parallel position before she loses her headway, it will be better to back both engines to prevent the stern from swinging into the pier.

C. *Going alongside with no set—single-screw.*—A single-screw vessel can be easily handled when going alongside a dock to port, as the stern will go in when the screw is backed. Approach the dock at a small angle as described above for twin-screw vessels. When the bow is close, back the engine. Too much headway will require the engine to go astern for too long a period, in order to stop the ship. This may force the stern in too close to the dock, necessitating a short kick ahead on full left rudder to throw the stern out away from the pier. It is better to come in slowly. Most single-screw vessels put a springline ashore first, leading aft on the dock from some point forward of amidships on the vessel, and by judiciously working the engine ahead slow, the vessel can be sprung alongside, after which the remaining lines may be put out, i. e. bow, stern, quarter spring, and breasts. When a vessel is working ahead slow on a spring line, she may be steered at the dock with the rudder, and the bow steered in or out as desired. This is useful when taking up slack in the lines.

When a single-screw vessel is making a dock to starboard, the approach must be made as parallel as possible to the face of the dock, since the screw when backed will throw the bow in toward the dock, and the stern out. If left rudder is given while the ship still has steerageway and before the screw

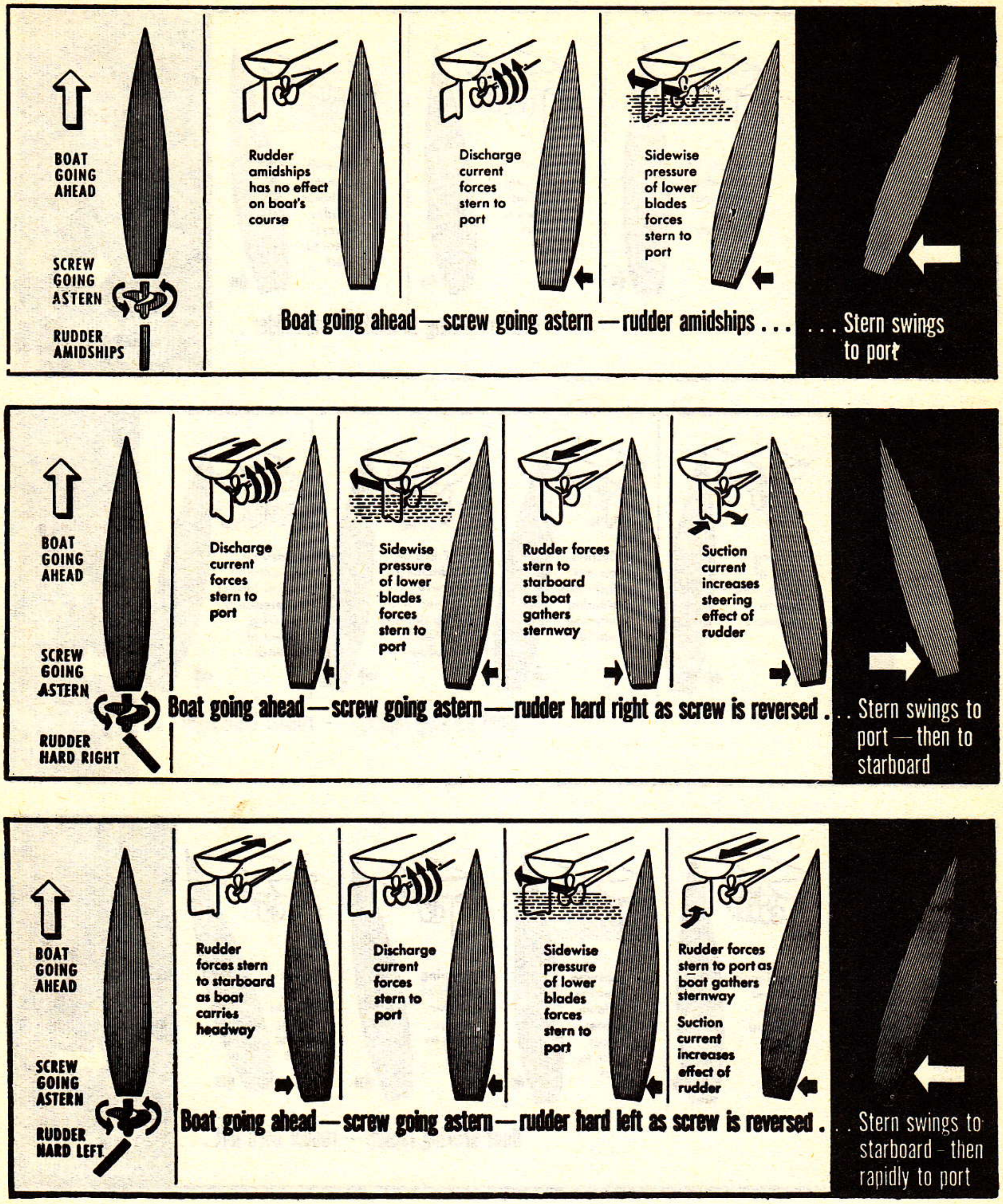


FIGURE 27–306.—Maneuvering diagrams.

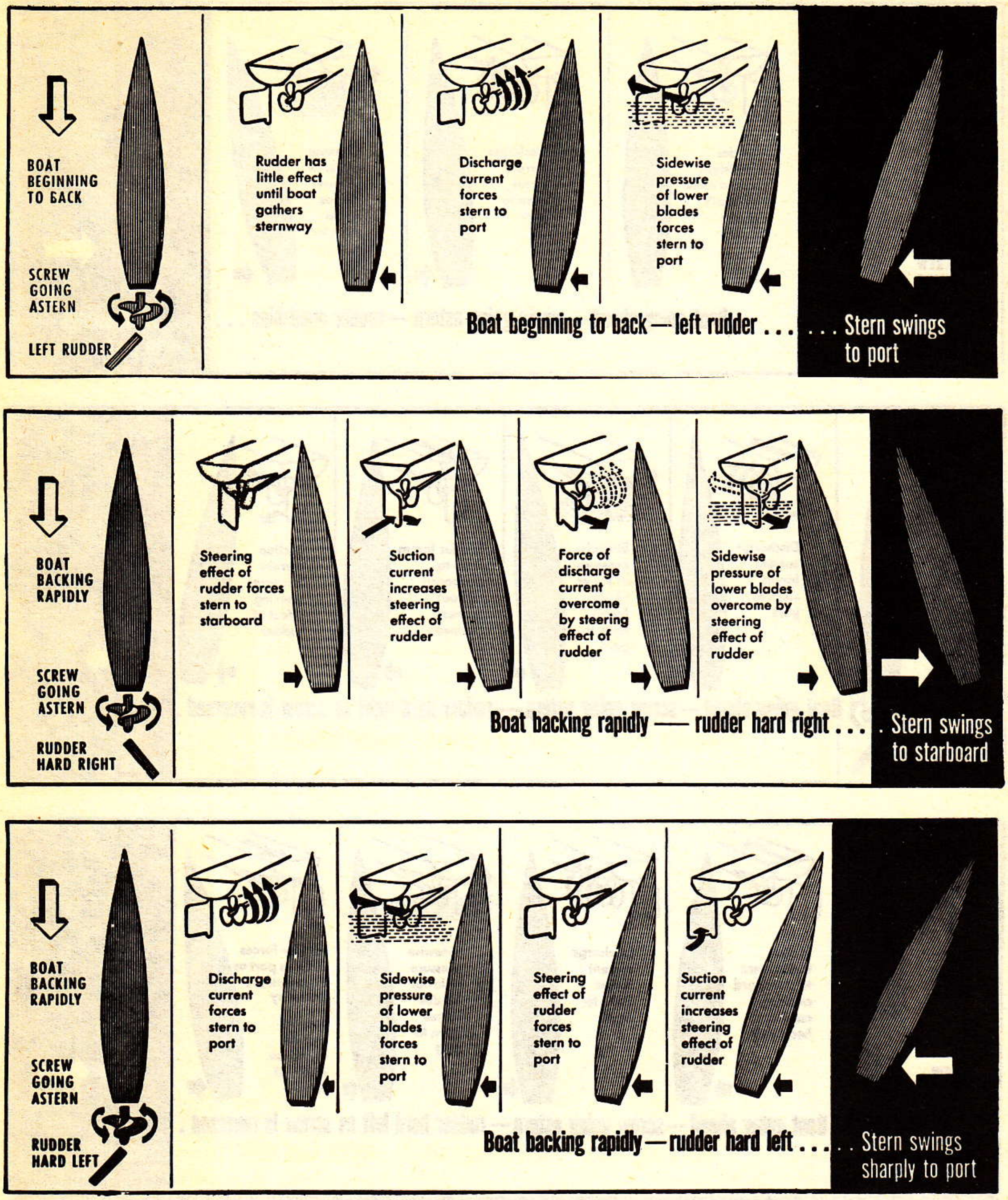


FIGURE 27–306A.—Maneuvering diagrams.

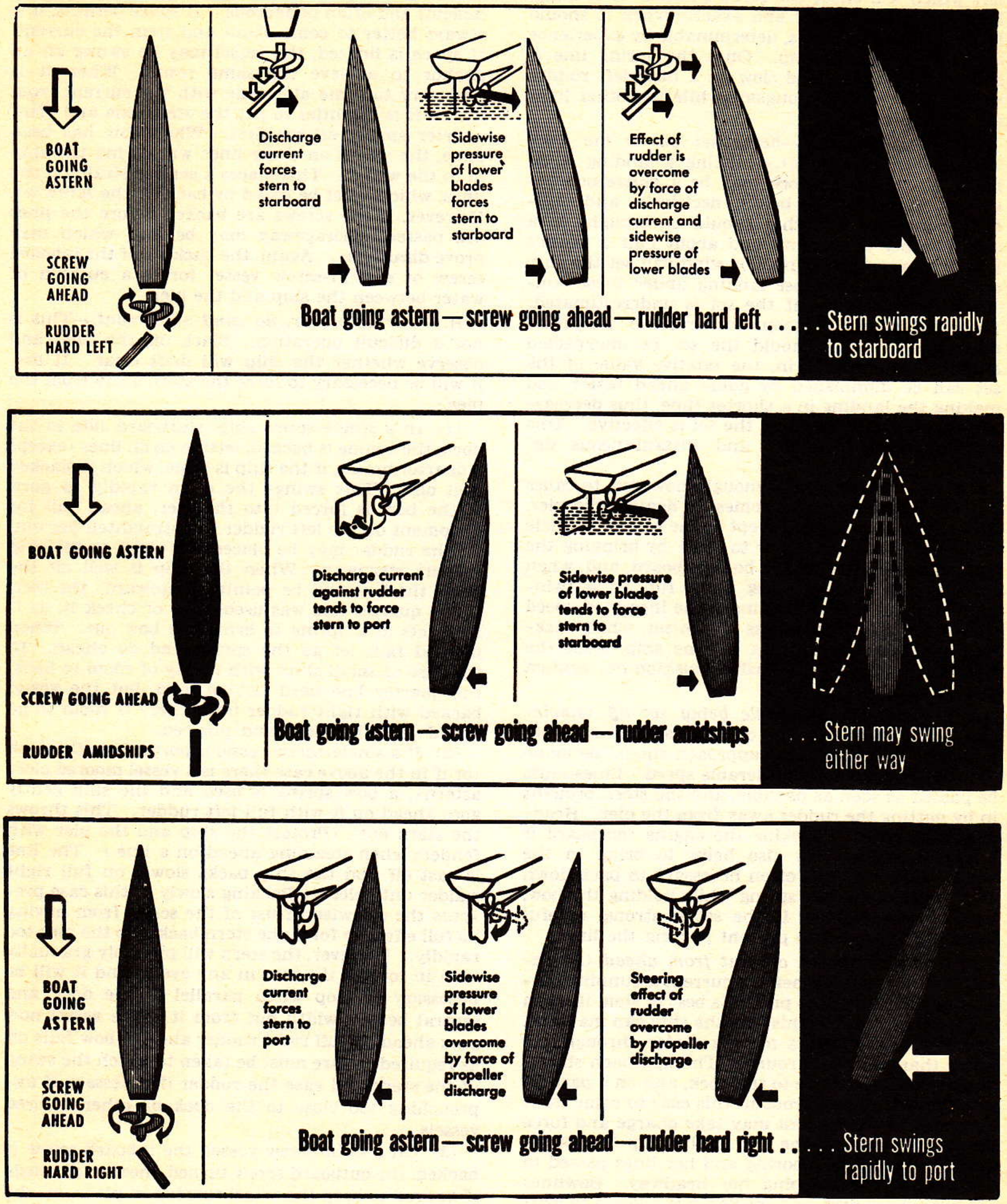


FIGURE 27–306B.—Maneuvering diagrams.

is backed, the vessel will be given a sheer to the left which will offset the screw's action in backing. How much left rudder and exactly when it should be applied are variables, determinable by experience and the individual ship. Once the spring line is ashore, steaming ahead slow on a little left rudder will breast the ship alongside while the other lines are being run out.

D. *Going alongside—being set on to the dock (single- and twin-screw)*.—Making a landing when being set on to the dock may be a dangerous operation that must be boldly, decisively, and skillfully handled. The ship should be brought to a stop parallel to the pier and about half a beam's length away. The current or wind will set the ship on to the pier. A close landing under these conditions is dangerous, if the set is underestimated. Therefore plenty of room for error of judgment must be allowed. Should the set be unexpected and the ship too far in, the relative value of the set can be diminished by going ahead faster and making the landing in a shorter time, thus decreasing the time during which the set is effective. This requires good judgment and instantaneous decision.

The set may be strong enough, however, to cause damage when the vessel comes up against the pier. This can be overcome (except in the case of a single screw vessel making a pier to port) by bringing the ship in faster, canting the bow outboard, and, when close to the dock, backing down full (if a twin-screw) on the inboard engine. The increased speed cuts down the effectiveness of the set, while backing the engine straightens out the ship, stops the headway, and creates a wash to cushion her against the pier.

E. *Going alongside while being set off (single- and twin-screw)*.—If the current is such as to set the ship off the dock, the approach should be made at a fair angle with considerable speed. Lines must be passed as soon as possible, and the stern brought in by putting the rudder away from the pier. Headway is stopped by backing the engine (outboard if a twin-screw). This also helps to bring in the stern. However, it is often necessary to back down on a forward quarter spring while holding the bow, breast, or bow line. If the set is strong, careful handling is needed to prevent parting the lines.

F. *Going alongside, current from ahead (single- and twin-screw)*.—When the current is running parallel to the face of the pier, it is best to stem it when going alongside. In this way the ship can maintain steerageway, as she is moving faster through the water than over the ground. The approach should be slow with reference to the dock, and on a parallel heading. It is dangerous in this case to come in at an angle, as the current may take charge and force the bow in against the pier. The ship is brought above the point of mooring and her lines passed to the pier before stopping her headway. Bowlines are put ashore first, and the vessel is allowed to drift in on her springlines leading forward on the dock. The rudder is used to swing the stern, and undue strain on the lines is prevented by an occasional kick ahead on the engine(s). A large ship may drop the outboard anchor upstream and spring in on a line while veering chain.

G. *Going alongside with current from astern*.—Bringing a ship alongside with a fair tide is always difficult and often dangerous. If space permits, it is always better to come about and stem the current. If space is limited, the vessel may be swung on an anchor to achieve the same result. When it is necessary to come alongside with the current from astern it is essential to get the stern line and after quarter spring ashore first. When this has been done, the strain on these lines will spring the ship in to the wharf. This places a serious strain on the lines, which must be eased by backing the screw(s). However, if the screws are backed before the lines are passed, steerageway may be lost, which may prove disastrous. Again, the backing of the inboard screw of a twin-screw vessel forces a cushion of water between the ship and the pier.

H. *Clearing a pier, no wind or current*.—This is not a difficult operation. Slack off the lines and observe whether the ship will drift clear. If not, it will be necessary to force the stern away from the pier.

(1) In a single-screw ship, starboard side to the dock, the engine is backed, letting go all lines (except a quarter breast, if the ship is large, which is slacked well off). This swings the stern rapidly to port. If the bow is forced into the pier, ahead full for a moment on the left rudder will straighten her out, or, the rudder may be placed full right as the ship gathers sternway. When the ship is well off the dock, the bow will be pointed in towards the pier. If the quarter line was used, hold or check it, as it now acts as a spring to bring the bow out. When pointed fair, let go the spring and go ahead. In the case of small ships with plenty of room to back, the quarter line need not be used, but the vessel backed with right rudder until there is room to go ahead on left rudder and proceed.

(2) If a single-screw vessel is port side to the dock (or if in the above case there is a vessel moored close astern), a bow spring is used and the ship gently goes ahead on it with full left rudder. This throws the stern out (Protect the ship and the pier with fenders when steaming ahead on a line.) The line is cast off and the ship backs slowly on full right rudder until clear. Backing slowly in this case prevents the sidewise thrust of the screw from having its full effect to force the stern back into the pier too rapidly. However, the stern will probably gradually turn in toward the pier in any event, and it will be necessary to stop when parallel to the dock and several beam's width out from it. The vessel now goes ahead on full right rudder and the bow falls off as required. Care must be taken to watch the swing of the stern and ease the rudder if necessary if approaching too close to the dock or other moored vessels.

(3) On a twin-screw vessel, the inboard screw is backed, the outboard screw turned ahead judiciously if desired to keep the vessel turning in place, or, the outboard screw alone may be turned ahead against a spring, to force the stern out. However, the bow comes in against the dock and fenders must be tended. If there is plenty of room astern, by backing the inboard screw, and later as the bow swings in, by backing the outboard screw to stop the swing

of the bow, the vessel may be backed away without the bow touching the pier. The discharge current of the inboard screw also will tend to keep the bow off when it reaches the bow. As soon as the stern is well clear, the vessel may be steered by the engines until astern steerageway is obtained.

I. *Clearing a pier while being set on.*—This is a difficult situation. To go out ahead without the use of a tug or outlying anchor is dangerous.

(1) A single-screw ship lying starboard side to the dock should go ahead slow on a spring line with full right rudder, tending fenders at the bow. When the stern is well clear, cast off and go astern full.

(2) A single-screw vessel laying port side to the dock should wait for more favorable conditions, if possible. However, if she must go out, the stern must be worked out as far as possible to allow for the sidewise thrust of the screw, which will combine with the set of the current or wind to force the stern back alongside the dock. If the wind is strong and the stern can be worked off far enough, then the ship may back to the wind and thus offset the thrust of the screw. In working the stern off, it is better to lead a spring aft from the bow and protect the pier with adequate fenders. With a spring leading from the bow in this fashion, providing the construction of the bow of the ship and the pier permits, the vessel may be turned to a full perpendicular to the pier (providing the wind or current is not too strong) and then backed off quickly.

(3) A twin-screw vessel should first go ahead on a spring with the outboard screw, tending fenders at the bow. This will throw the stern out against the set. The ship should then be backed immediately with plenty of power on the inboard engine, casting off the spring. The wash of the inboard engine should tend to keep her off. The outboard screw should now be backed to get the ship away as quickly as possible.

J. *Clearing a pier, being set off.*—This is the easiest situation. Cast off all lines, and when the ship has drifted away from the pier, proceed.

K. *Clearing a pier, current from ahead.*—If a ship is headed into the current, hold a spring leading forward from the quarter. This allows the bow to cant off into the current. Go ahead slow on the screw (outboard if twin-screw) to keep the stern away from the wharf. The bow will continue to swing. When far enough off, cast off and proceed. If the stern is not clear to go ahead on the engine, a bow breast should be kept under a light strain and when the ship is headed correctly, check the bow breast and slack the quarter spring. The stern will then swing out and clear. Then cast off all lines and proceed. To use the bow breast in this manner, the bow must be further out than the stern, otherwise the ship will fall back alongside. Should the wind prevent the bow from falling off, it will be necessary to go out astern as described above for a ship being set on the pier.

L. *Clearing a pier, current from astern.*—Hold a spring leading aft from the bow and ease out on a quarter breast. When pointed correctly, cast off all lines and go out astern.

M. *Winding ship.*—It is occasionally necessary to turn a small ship from one side to the other at the same berth at a dock. This may be accomplished by making use of the current or wind. It is safer to let the stern swing outboard than it is the bow, as there is a chance of damaging the rudder and propellers when the stern is toward the dock.

(1) When the current is feeble and from astern, all lines are slacked except a spring led aft from the bow. If the stern fails to drift out into the current, back the inboard screw of a twin-screw ship, back the screw of a single-screw ship starboard-side-to, or go ahead slow if a single-screw ship port-side-to. As the stern swings out, the current will catch it and swing it rapidly around. All after lines are let go, and by backing a bit the bow is kept clear of the pier. As the vessel swings around, a spring is led out forward from a point well aft on the forecastle of the opposite bow in order to increase the effectiveness of the rudder in controlling the swing of the vessel. When the line has a clear lead, a strain is taken and the original spring is cast off. The ship then goes ahead slowly with the engine, and the rudder is used to ease her into the berth.

(2) If the engine is not available, winches may be used, in which case a long line is run from the off quarter, well forward to the dock. This forward spring is an aid in completing the swing should the current be insufficient. Fenders or a camel are placed at the bow and the ship allowed to take up on the after bow spring. The inboard lines are slacked up and finally cast off.

N. *Loading at a pier.*—When it is necessary to move a tender up and down a pier to load various items, much time can be saved by handling the ship on one line. This line is the spring leading aft from a point forward or aft on the buoy deck, depending on which point is most suitable for keeping the vessel alongside the wharf. The line is passed ashore with the end lead aft on the pier, and a turn or two taken on the cleat on deck. The engine is turned over slowly ahead and the ship fetches up on the line and is breasted snugly in against the pier. Judicious use of the rudder will swing the bow in or out as desired or will hold the ship steady for loading. When one item has been loaded, the line is slacked or shifted to another bollard and the vessel ranges ahead to the new position. Should the current be strong, additional lines may be necessary. The side of the vessel in respect to the dock should be considered in that the vessel, listing as the load is raised, may not be damaged by any dock structure.

27–10–20 Miscellaneous Notes—

A. *To stop a single-screw ship without a sheer.*—To stop a single-screw vessel without sheering off too far to starboard, proceed as follows, providing there is sufficient space. Give the vessel left rudder to begin a sheer to port. Back the engine full. As the vessel slows down and begins to swing back to starboard, kick the engine ahead full on full left rudder to break the sheer, then back full again, alternately backing and coming ahead until the vessel is stopped. In small ships proceeding slowly, one sheer to the left at the beginning is usually sufficient.

B. *To turn a single screw ship short around,* put the rudder full right, engine full ahead. When headway is acquired, back the engine full. As the ship gathers sternway, shift the rudder to full left. When the vessel has gone far enough astern, go ahead full on full right rudder. Repeat the maneuver until the ship comes around to the desired heading. If no sternway is acquired, there is no need to shift the rudder.

(1) If there is not enough room to go ahead and astern, drop the anchor and steam around it with the helm hard over, paying out just enough cable for the anchor to hold.

(2) If there is not enough room to anchor, place the bow against the bank or wharf (be cautious, wharves are usually crumbly and rotten and damage easily), and heave the ship around, utilizing wind and current if possible.

(3) If coming upstream with a flood tide or down river with the current, sheer toward the starboard bank, so bringing the bow into slack water and stern into the current. Continue as for turning short around with the helm and engines.

C. *To turn around to port (single screw)*.—It is difficult to turn a single-screw ship to port in a narrow channel. What is gained by going ahead on left rudder is lost when it becomes necessary to back. Therefore, when it becomes necessary to turn to port, give left full rudder and when you have gone as far as prudent, let go the port anchor and veer to 10 or 15 fathoms of chain (the amount depends on the depth and nature of the bottom). Go full astern. If there is much way on the vessel, let the engine help to check her, not allowing all the strain to come on the anchor windlass and cable. As the ship swings around to port under the drag of the chain, stop her way and let her bring up on the chain. Heave in and proceed.

D. *Turning against a strong current.*—To turn a single-screw vessel against a strong current, steam over to the port side of the channel and stem the current. Go full right rudder and full ahead, until the bow starts swinging to starboard, then stop the engine. Let the current swing the vessel athwart the river. When the ship has reached ahead as far as prudent, go full astern and shift the rudder to full left. This will have a tendency to hold her stern up against the current and she will come around more quickly than had you gone over to the starboard shore and turned to the left.

E. *Effect of current and wind.*—The effect of current will be greater on a deep draft vessel with low freeboard, while a high freeboard vessel is more influenced by the wind. When steaming with the current, backing with either a twin screw, or particularly with a single-screw ship, will result in loss of steerageway which, with the current acting against the quarter, may cause the ship to swing exactly opposite to the direction to be expected from the action of the screw(s). Loss of steerageway can be dangerous. It gives one a helpless feeling to be coming up on a delayed-opening bridge with a fair wind and tide.

(1) A single-screw vessel light in the water with a slight breeze on the starboard beam will generally back dead astern. Some ships are so unpredictable, however, that they will do anything anytime.

(2) In a moderate or strong wind, the stern of single-screw ships will swing rapidly into the wind when backing. Twin-screw ships will do so to a lesser extent.

F. *Dredging with the anchor.*—Dropping an anchor and steaming ahead while holding it at short stay is an effective means of controlling vessels (especially single-screw). It is useful when there is a need to hold the bow up against an offshore wind at the dock. The use of the anchor permits the application of greater power to offset the ship's normal slowness to answer her rudder in shallow water and her tendency to sheer. The speed of the ship may also be controlled by paying out or heaving the chain as desired. This maneuver is known as dredging with the anchor.

G. *Working the engine around a dock.*—Avoid working the engine strongly around docks. When in shallow water, the propeller in turning over will create water currents, eddies, whirlpools, and suction that may throw the ship out of position. For example; when making a landing at a solid bulkhead, the propeller in backing will force a wedge of water between the ship and the berth, and the stronger you have to back, the farther this cushion of water will force you away from the wharf.

H. *Ships do not always obey the rules.*—Although a single-screw ship with right-hand propeller will normally back to port, learn the idiosyncracies of your own ship. All ships do not handle alike. Some will straighten out with only the slightest touch ahead on left rudder as they should, others make it necessary to work ahead full for a moment in order to straighten them out. Some low-powered deep draft vessels with little or no drag will take a long time to swing and will be hard to stop once they get going. Some ships may swing their bow to port on backing. This occurs when they are trimmed by the head and have a starboard list, such as a heavily loaded tender returning from a day's work.

I. *The following are a few rules worth remembering:*

(1) The diameter of a ship's turning circle is least at slow speed.

(2) Ships have a tendency to fall into a trough when going ahead at an angle with the sea. Backing tends to throw the stern up to the sea.

(3) A ship cants best with full rudder and engines full ahead.

(4) Steering is usually bad at full speed in shallow water. When steering by twin screws alone, set one screw at two-thirds speed and vary the other accordingly.

(5) A vessel having no way upon her and not affected by the wind will lie broadside on the flow or set of the current.

(6) When turning a twin-screw vessel by opposing the screws, the ship will swing faster if given a little head or stern way.

(7) When dredging with the current, have just enough cable out to check the ship's way. Sheer with the helm. If there is too much way over the ground, pay out more chain.

(8) In taking way off most ships, the backwash of the screw reaches amidships when the vessel's headway is stopped. On some ships, the backwash may reach the bridge before they are dead in the water.

(9) The pivoting point of a ship going ahead and swinging is generally from one quarter to one third the length of the ship from the bow.

(10) Ships turn more slowly into the wind and sea than away from them.

(11) The stern swings first when the rudder is put over. Keep it clear for swinging either way as long as possible. Don't turn your bow away and in doing so slam your stern into the dock.

(12) Alongside a wharf with a twin-screw ship, bank suction is caused by screws turning ahead, bank cushion is caused by screws turning astern.

(13) When about to touch in making a landing, have no fore or aft motion on the ship.

(14) Do not veer lines under a strain unless absolutely necessary. Use the engine to ease the strain. A man veering a line under a heavy strain may easily get caught in a bight.

(15) Remember the side suction when coming alongside a solid pier or bulkhead. Keep a little further away from the pier and approach at a greater angle than usual.

(16) The effect of bottom suction is to sheer the bow away and suck the stern in.

(17) Keep your eye open to detect any change in the situation; that is, watch ranges on shore to detect being set off or on. When backing, watch your mast or stern flagstaff to detect the stern's falling off to either side.

(18) Use plenty of power when needed but keep the speed to a minimum. When in doubt, stop!

27–10–25 In Restricted Waters—

A. In addition to the various principles of rudder and screw effect discussed in the foregoing sections, certain other factors are involved in maneuvering vessels within the confines of restricted waters such as dredged channels with abrupt shallow water outside the channel limits, canals or narrow rivers. Although this discussion is stated in terms relative to a large single-screw vessel, the principles involved are applicable to somewhat lesser extent to vessels of the tender class. Handling a ship in a narrow channel is an inexact science and no text can cover precisely the myriad of conditions that must be coped with. Therefore, it is intended that these comments should only be used as a corollary to experience and judgment.

B. *Effect of suction.*—One of the foremost of the factors to be considered in handling vessels in restricted waters is suction. This force is made manifest when a vessel's stern approaches the bank of a channel too closely. The bow tends to sheer away and the stern will suck in towards the edge of the channel. Often, in the case of a large ship, this force is stronger than can be overcome even by full rudder and full ahead on the engine. Some ships go completely out of control when approaching shoal water; others can be induced to remain near it if properly handled.

(1) A dependable ship running a straight narrow channel with shoal water on both sides in fog or darkness will give a definite indication when approaching too close to either bank by carrying extra rudder toward the bank. If it becomes necessary to keep her close to the bank, she can be made to stay there in spite of the fact that the ship itself would prefer not to do so and if left alone would sheer away. If it is desired to stay in the center of the channel, this can be accomplished by heeding her warning and by altering course slightly—1° or 2°. The ship will signify when she has gotten further away from the bank by carrying less rudder and will indicate when she has reached the center of the channel by ceasing entirely to carry extra rudder.

(2) When the vessel is cranky and hard to steer and has a tendency to sheer from side to side, work over toward one bank and then when she wants to sheer constantly away from that bank, the rudder can be used to hold her steady against the tendency to sheer. This method was used to handle a cranky lightship in a narrow channel when she refused to steady up when in the middle of the channel.

C. *Cutting the point.*—This fact of carrying extra rudder is useful when coming to a bend in the channel in obscured visibility. Assuming the channel to change from North to East; while on the straight reach, run parallel with and close enough to the starboard bank (the side the point of the bend will be on in this case) so as to cause the ship to be "afraid of the bank" and therefore want to run away from it. This will cause her to carry considerable rudder. As soon as she begins to require less rudder to hold her steady, it is an indication that the bend has been reached. At this moment alter course to the right sufficiently to bring the ship in toward the point. Keep her on this heading until she again begins to lose suction (or in other words, carries less rudder) at which time again alter course to the right. Continue this procedure until the ship is heading East.

Although under normal conditions when full speed or at least considerable headway can be maintained, it is almost always preferable to "keep in the bend" when making a turn, only when it becomes necessary "to cut the point" such as in poor visibiilty, can the effect of suction and the carrying of extra rudder be used to indicate the ships position. If this method were used when the ship was near the bend side of the channel, the fact of carrying extra rudder to denote that the bend had been reached, since she would already be carrying some rudder, would be difficult if not impossible to detect in time to prevent the bow from grounding. Therefore, when using the effect of suction to impart information in working around a bend, keep the ship on the point side only.

D. *Keeping in the bend.*—Under normal conditions of good visibility with the vessel making good headway, a ship should keep in the bend of a turn. There is a natural tendency to begin the turn too soon and should the vessel feel the effect of suction from the point, it will require, besides the normal amount of rudder for the swing, whatever additional amount of rudder is necessary to counteract the retarding effect of the suction from the point. For example; 20° rudder is assumed to be the normal amount required for negotiating the bend. If it takes 10° rudder to offset the effect of suction from the point, then this would mean that 30° rudder would be required to get the ship around.

A pilot who is not suction conscious may feel that he is being cautious in turning early, but ironically, he is placing the ship into more danger because, when making a turn in this manner, to have a little stronger head tide or heavier head wind might cause the ship to fail to answer even with full rudder. Criticism of this comment may be that the ship should be slowed down beforehand so as to be able to give her full speed when ready to make the turn and thereby do it more safely. It will be agreed that this is a proper precaution whenever it is expected that much rudder will be required to make a turn. However, here is how the turn can be made with very little rudder: Before coming to the turn, work the ship over to the bend side of the channel so as to require 10° of rudder to hold her parallel with the bank. When reaching the turn and in making it, she will be kept this distance out of the bend and will thereby get the benefit of an amount of suction that will cause as much swing as 10° of rudder would. So to make the turn (assuming 20° rudder is required were there no suction), only 10° of rudder will be required instead of 30° as in the previous example; and by keeping still closer to the bank, she might not need any assistance at all from the rudder.

E. *Caution.*—The illustration cited in paragraph (D) above requires something to counteract it emphatically, because not only do the proper way to make a bend and the proper way to pass a ship in a narrow channel seem like reckless indifference to those unfamiliar with close work, but very unfortunately indeed, after one does become accustomed to keeping close to the bank, or passing close to another vessel, then the reaction almost invariably is to go to the other extreme and want to keep too deep in a bend or to crowd a passing vessel too closely. When about to meet another ship in a narrow channel, do not get over too far, or if the channel is very narrow, do not give way too soon; but it is essential to guard against the mistake of not giving way enough at the proper time. These comments would be incomplete if the other important precaution were not, at least, mentioned: Reduce headway.

F. *Meeting and passing another vessel.*—Suction in this case is caused by two different things; the ship's headway (or the action of the water passing by a moored or anchored ship) and the turning over of the ship's propeller. In the case of the latter, it is abreast the quarter, where the water apparently has the least motion, that the suction is the most powerful and dangerous. The effect of the ship's bow wave is slight when the ship is going slowly, but can be very pronounced in confined waters—especially from a loaded ship making much headway.

(1) Assuming a problem of two ships meeting in a narrow canal such that with each ship giving way the maximum amount possible without getting too close to the bank, there will be about 50 feet between them when abreast of each other. The ships will pass port to port. (Both ships should follow the action described; however, the actual handling of only one will be discussed.) The ship should be slowed down in ample time without sacrificing good control over her. Presume conditions are such that she handles well on slow ahead. In approaching the other ship, she is kept far enough away from the starboard bank to make certain that the suction from the bank will not prevent her from readily answering her right rudder at the necessary time. Now, just before the bows get close, both ships give considerable right rudder with the result that each heads decidedly toward her own starboard bank; and then shortly afterward each reverses the rudder so as to throw their respective sterns clear; then each steadies up. At the completion of this combination of maneuvers the position of each ship is parallel with and close to her starboard bank. (From now on the other ship's maneuvers will not be noted.)

(2) When the ship gets parallel to the bank, she will require a great deal of right rudder to hold her steady. Shortly after being steadied up, her bow will be abreast the quarter of the other ship and the suction coming from the other ship's quarter will pull the bow out to port. It would seem to be the logical thing now to apply more right rudder. Assuming that this were done to stop the swing, the bow would soon get beyond the influence of the other ship and the rudder would be eased. Meanwhile the stern has gotten to where it is feeling the pull—which is much stronger than the suction from the bank, so she heads in still closer. However, the other ship's suction is soon lost and, when it is, our ship is so close to the bank that the combined effect of full right rudder and full speed ahead is insufficient to overcome the bank's suction, and much to our dismay, the ship goes across the canal and strikes the other side.

(3) Now, consider what could have been done to prevent the above mishap. It should be remembered that an object directly astern will be forced further astern by the engine working ahead on a ship with headway, but an object on either side of astern will be forced farther off to the side. Therefore, immediately after passing, our ship in the illustration above came under an influence that forced her stern towards the bank, thereby aggravating the already unfavorable condition. A ship, immediately after passing another ship, will continue to go contrary to full rudder although at any other time she might answer her rudder in spite of being equally close to the bank. It takes more rudder to counteract bank suction immediately after passing another ship than at any other time. Returning to the illustration above, we will proceed with our ship just the same as in the foregoing account up to the time the ships were abreast of each other. Then, although the bow does take a rank sheer toward the other ship's quarter (and here begins the knack of keeping control) it will be allowed to go quite a bit in that direction, because there is very little likelihood of its striking the other ship's quarter since the other ship's stern is moving out of the way. So we let our ship's head swing out to about the middle of the canal. Shortly after the bow heads out, the stern of our ship feels the effect of the suction from the other ship's

quarter. When this happens (and here is the remainder of the knack), let the other ship's suction pull our own ship's stern away from the bank. At this time she should be given full speed to overcome the lateral effect of the other ship's wheelwater, or wake. The ship will be near enough to the middle of the canal to make it quite certain that rudder power will predominate over bank suction.

(4) If a canal is so narrow that there is very limited space between the ships when they are abreast, then there is serious danger of each ship's bow being sucked into the other ship's quarter. In such cases this method of passing must not be resorted to.) In this case, the anchor may be dropped, held and dragged at short stay to steady the ship.

G. *Contour vs. suction.*—The contour of a bank governs the strength of suction. A sloping bank will give greater suction effect than a perfectly vertical bank, such as the wall of a lock.

H. *Passing moored vessels.*—Vessels should always be slowed down early when approaching moored vessels in a narrow channel. The disturbance that goes ahead can be felt for quite a distance and should be allowed to subside. Stop the propeller shortly before getting abreast of the moored vessel, and headreach by.

I. *Ship's own swell may float her when grounded.*—A vessel aground may be floated by another vessel passing with considerable headway. However, as a precaution, the vessel aground should have her propeller motionless while the ship underway is approaching and until she is sufficiently past. A ship may sometimes use her own swell to lift herself over a shoal. Suppose when going full speed down a narrow channel, she suddenly fetches up on a lump, causing her to come to a complete stop. Just a trifle later the swell, that has been following astern, will overtake her and frequently has enough lifting power to float the ship—with the assistance of full speed ahead on the engine.

J. *To determine the direction of current.*—It is often desirable to know the direction in which the current is running in a canal, or whether it is slack. In some inland waterways the direction of the current is subject to sudden change and is generally unpredictable. If no other means is available to indicate the direction of the current, it can be judged by noticing how the ship acts at the turns. If she sets toward the point, it is an indication of a head tide. With a strong head tide, the swinging should be delayed the longest; with a slack tide, begin swinging a little sooner; and when the tide is strong fair, commence swinging very early.

K. *Effect of head and fair tide.*—A head tide is preferable because a ship can be easily stopped if necessary; and if she takes a rank enough sheer to cause her bow to ground out, she will not get "jacked" athwart the channel. However, a ship will steer much better with a fair tide. A poor handling ship can be kept under control and will get over the bottom with a strong fair tide because she needs to make very little, if any, headway. Thus the effect of suction would be lessened, whereas with the same strength of head tide, the speed she would have to make to get over the bottom would cause her to go wild. The more speed, the more suction.

L. *Making a bend with a strong fair tide.*—As a rule, the current runs most strongly on the bend side of a channel, whereas "under the point" there is apt to be an eddy. In making a sharp turn, if the full force of the current strikes the ship on the quarter and at the same time the bow runs into slack water or opposite current, the vessel may sheer completely around. Therefore, the bend must be approached in a manner that will minimize and most nearly neutralize suction as well as avoid getting into these contracurrents. Minimize the suction by proceeding slowly through the water and stay in the middle of the channel instead of "keeping in the bend" as is most generally advisable and sometimes necessary. Although starting to swing from this position, the ship will set quite a bit toward the bend side of the channel before the turn is completed. As soon as she gets a little nearer to the bend side of the channel she will commence feeling suction to help her swing, and in addition to this (since she will be set toward the bend) she will have to be headed, at least slightly, diagonally to the direction of the channel. This position will cause the current, also, to help in swinging.

Had the ship approached the turn near the bend side of the channel, when arriving at the turn, she would have to head decidedly toward the opposite (or point) side of the channel to avoid having the current set her against the bank. This diagonal heading will cause the after part of the ship to be struck by fair current where it is running most strongly, forcing the ship to swing. Bank suction will aggravate this swing still more. Then, in addition, the bow will be in, or close to, slack water or opposite current. The ship would now be in an extremely vulnerable position.

M. *Passing a tow.*—When a tug with a tow astern is being passed, the two should decrease speed in order that the passing ship will not require too much headway to pass, with the resulting forces of suction being increased to the extent that the tug may not be able to control the tow. This same reasoning should be applied to any overtaking situation. If you are being overtaken in a narrow channel and intend to permit the other vessel to pass, slow down and make it easier and safer for both vessels.

N. In summarizing, it can be said that suction is generally thought of only as a handicap or as a source of trouble; but by taking proper precautions, its harmful effects can be satisfactorily offset. Furthermore, suction can (1) give invaluable information on occasion, when navigating a narrow channel; (2) help in making a bend; (3) frequently, by utilizing a passing vessel's suction, prevent a ship from getting out of control after the passing is completed; (4) often be a most effective means of getting a vessel afloat; (5) in various situations be made to act as an auxiliary to the rudder.

27–10–30 Use of the Anchor in Maneuvering—

A. There have been several references in the foregoing sections to the use of the anchor in shiphandling; for example, dragging an anchor at short stay (dredging) to steady a ship's head in narrow channels or when docking under unfavorable conditions. There is a tendency for many shiphandlers to be reluctant to use an anchor in maneuvering. On these ships, elaborate measures are taken to insure that the anchors are ready for letting go, yet seldom if ever are they used. On a single-screw ship, an anchor can, when properly used, aid in the successful and safe completion of a maneuver that would normally be almost impossible under the conditions present. This section will not be concerned with the normal anchoring of a ship, which procedure is set forth in any standard book of seamanship, nor will the material already discussed in the foregoing sections relative to the use of anchors in maneuvering be repeated. However, some additional methods and "wrinkles" are given below.

B. *To make a lee for boat alongside.*—When anchored in a strong wind, to make a lee for a boat or lighter, bend a hawser (a cross-deck hook line may be used) to the anchor cable outside the hawsepipe and lead it along to bits on the after end of the fore deck. Haul taut and secure. Slack away on the cable until the hawser straightens out. The vessel will now cant away from the anchor and provide the necessary lee.

C. *To come alongside a buoy when close to the bank, or in rough weather.*—When necessary to come alongside a buoy located on the abrupt edge of a channel where there is danger of the tender setting up on the bank by wind or current while working the buoy, the anchor may be dropped upstream such that the ship sets back abreast of and a beam's width or so away from the buoy. By using the rudder, and the engines if necessary, or by bending a hawser as described in paragraph (B) above, the vessel may be sheered over alongside the buoy as necessary. A rapid method of bending the hawser on a tender is to use the cross-deck hook line in the chain. This maneuver is useful in rough weather when it is necessary to bring a buoy alongside the tender when the buoy is rocking violently in the seas. The vessel may be sheered over close aboard the buoy and kept under control while awaiting a lull in the seas to get the buoy quickly hooked on.

D. *Anchoring along the bank of a canal.*—When anchoring a ship alongside the bank of a canal, use two anchors, laying the outboard anchor out ahead, veering sufficient chain to drop the inboard anchor so that when the ship is heaved ahead to normal riding scope to the outboard anchor, the inboard anchor leads aft with about one-third the scope of the other. Thus when the tide turns, the vessel will swing without danger of crossing the cables. When the ship has swung to the new direction of current, reverse the scope of the anchors.

E. *Flukes fouled with mud.*—When dragging an anchor in maneuvering, the flukes may become balled up with mud and will fail to take hold. This can be readily detected as the ship surges ahead. If this takes place, and the anchor cannot be hauled up to free it from the mud, pay out more scope of chain and hold it, then, as the ship fetches up with a jerk, the mud will usually come off.

F. *Making a sharp turn.*—To use the anchor in making a sharp turn, assuming a right angle turn to the left, drop the port anchor when approaching the turn and pay out enough chain to almost stop the ship's headway with the engine slow ahead. The anchor must be dropped soon enough to get the necessary amount of chain out and have the ship all but stopped just before she is at the point where the swing must be made. Now go slow ahead on full left rudder, and the anchor chain serves to spring the ship around as if she were working on a spring line around the corner of a dock and into a slip.

G. *Amount of scope.*—When an anchor is dropped, the chain should not be slacked out so fast as to make it pile up on top of the anchor. A rule to remember in working a ship on an anchor is to use the minimum amount of scope that will accomplish the maneuver. A light ship in a strong beam wind in docking should use the lee anchor, as the lead under the bow will enable less scope to be used and will help to hold the entire ship up to the wind instead of just the bow as would be the case when using the weather anchor.

27–10–35 Maneuvering Around Buoys—

A. The maneuvering of a buoy tender into the exact spot where a buoy is to be moored is not an easy task except under the most favorable conditions of wind and current. Generally twin-screw tenders, being more maneuverable than single-screw ships, can be brought "on station" more readily. However, with a thorough understanding of the foregoing principles of handling ships in general, and a knowledge gained from experience concerning the peculiarities of the individual ship, and what is very important, a pilot's knowledge of the local conditions that may be expected in that particular spot, a tender may be maneuvered so as to drop the buoy's mooring with a close tolerance of accuracy.

B. *Approaching the buoy.*—Before approaching a buoy to be serviced, consider the wind, current, swells, location of foul ground, and channel traffic. Unless local conditions make it inadvisable, it has generally been found that a buoy may best be approached with the ship heading into the wind, seas, or current; whichever is the controlling or strongest factor. This permits the vessel to approach slowly, be stopped and straightened out if necessary, and when alongside the buoy, allows a quick application of rudder and engine when necessary to correct a cant of the bow to either side or to prevent drifting astern. Control the tender so that no quick water rises near a buoy about to be picked up. Never hook on to a buoy while the vessel is in motion.

(1) When approaching the buoy, the wind or current may be brought a little on the opposite side to insure that the ship will set alongside the buoy, however, once the buoy is hooked on, the bow of the tender must be turned back into or towards the wind or current so as not to unduly strain the gear or drag the mooring. Experience is most important

in this respect; to keep the buoy or chain close aboard so that hooking on and hoisting will be safer and easier, yet not to allow the weight of the ship to set down on the buoy or mooring, is a knack of shiphandling not easily acquired by some. At no time should the bow be permitted to swing off away from the current or wind so that the ship sets away from the mooring. Should this happen, however (it does once in a while, even to the best), hold everything and stand well clear on deck until the ship can be brought back under control by judicious backing and filling. Many ships use a preventer line rigged across the buoy port outboard of the mooring chain to hold it close aboard.

(2) In the case of large buoys with heavy moorings, many tenders work with the wind a point or two on the opposite bow to insure that the chain will lay alongside. However, if the weight of the ship is permitted to set down on top of a small lighted buoy, it may be dragged under the vessel with damage to lantern and superstructure resulting

(3) If the buoy is located close to a shoal, rocks or other obstruction, do not assume that it is "on station" and proceed blindly. Take bearings, angles, soundings, etc., and approach carefully in every case. Remember that you are being called upon by virtue of the job to be accomplished to take your ship into situations the ordinary mariner would avoid.

(4) It is often difficult to judge the speed of advance of the tender due to the presence of current. Watch the shore, if close enough, for an indication.

(5) It has been found that under certain conditions it is better to give courses to the helmsman to steer, rather than to give numerous rudder orders. This is especially true in strong currents. This procedure can be used alongside the buoy to some extent, as well as when approaching it.

(6) It has been found that when approaching 9 x 38 buoys with the 189-foot class tender, the buoy should be brought further off the bow, and when abeam the buoy port, the ship should then be allowed to set down on the buoy. This prevents the lantern from being struck by the flair of the bow.

C. *Approaching in rough weather (not using anchor).*—Unless local conditions preclude, a buoy may best be approached with the ship heading into the wind, seas, or current. This permits the vessel to approach slowly, be stopped and straightened out if necessary, and when alongside the buoy, allows a touch ahead on appropriate rudder when necessary to correct a cant of the bow or to prevent drifting astern.

D. *Approaching in rough weather (using anchor).*—In approaching buoys in rough weather, whether to hook on for hoisting or to recover a man aboard, the use of an anchor by single-screw ships has been suggested as a procedure safely and efficiently accomplished many times, particularly on the Great Lakes. There is a danger in connection with using an anchor in the manner described below, however, that the anchor might drag and foul the mooring of the buoy. The shiphandler must make sure that sufficient chain is out to hold the vessel and that the character of the bottom is such that the anchor will not drag.

(1) An example of approaching a buoy using the anchor is as follows: assume that the buoy sets on the edge of the channel and you wish to pick it up on the port side. Head into the wind and leave the buoy 50 to 75 feet off to port. When the stern of the ship is abreast of the buoy or nearly so, stop, drop the starboard anchor and set back, taking care to lay the chain out straight, not bunched up on top of the anchor, yet making sure that it doesn't drag. Have an experienced man tend the windlass brake. Allow the ship to settle back until she lays fair to the anchor with the buoy 50 to 75 feet abreast of the buoy port. Put the rudder full left and leave it so. Work the engine slow ahead, starting and stopping as necessary to cause the ship to work over toward the buoy. It will be found that with the wind coming over the starboard bow, a lee of sorts will be created at the port buoy port. It will probably be necessary to pay out some additional chain to bring the buoy within boat-hook reach of the buoy port. Note that the stern stays out in the clear channel all during the maneuver. If not too much chain is paid out, the buoy and the ship will not collide and the lee created will allow hooking on in weather much too rough to come alongside in normal fashion. It will be necessary to give a few short kicks ahead on the engine from time to time to keep the ship in position (backing is seldom necessary).

(2) The above maneuver is useful in working buoys when located along the edge of a shoal with the wind slightly on the bank, or such that the ship cannot safely lay alongside normally without danger of grounding.

(3) The above method may also be used in putting men aboard or taking them off a buoy under conditions which would otherwise be dangerous. The tender can lay to her anchor out in the channel while the man completes his work, and then swing over to pick him up with very little danger of the ship ever touching the buoy if the maneuver is properly executed.

(4) When heaving around on the anchor after working the buoy, pay particular attention to the ship to avoid being set over onto the buoy or getting the propeller fouled in the mooring.

(5) In restricted waters, twin-screw tenders have found it advantageous to use the anchor in a manner similar to that described above for single-screw vessels.

E. *Approaching the buoy down-wind.*—Often local conditions require that a buoy be approached down-wind or with a fair current. In this case it must be remembered to approach the buoy with less headway as the ship is moving faster over the ground; also it is better to have more time to observe the set of the ship and apply corrective action. It was found, while working on some West Coast bars with a twin-screw tender, that holding the vessel's stern to the sea made somewhat of a lee at the buoy port. The 133-foot *White Heath* class tender has also been found to work well stern to the sea. In working offshore, in a moderate swell, the greatest stability of a vessel such as the 180-foot class is usually obtained by holding the stern to the sea. The buoys may then be prepared with the least difficulty and danger.

(1) The vessel may be positioned so as to permit her to proceed on the desired heading while the buoy is being prepared, and be at the correct position just as the buoy is readied for letting go.

(2) When working with the wind astern with a single screw ship, take care not to get the wind too far on the starboard quarter, especially when working alongside a bold reef with an onshore wind. Should the wind get too far around on the quarter, when the ship is backed to clear the buoy she may not back to the wind but may back to her natural tendency to go to port through the action of the screw, and thus end up broadside on the reef. Should the tackle become fouled and the buoy not be unhooked in time, the same end result may occur. The mechanical chain stopper described elsewhere in this chapter is useful in such a case in providing a quick and positive means of stopping off a mooring when it is necessary to back clear at once.

(3) As stated above, it has been found that some ships lay more quietly stern to the sea and in some cases, buoys, unapproachable in rough weather in normal fashion (i. e. ship stemming the wind and sea), may be worked with the sea astern.

F. *Approaching a marker buoy.*—Section 27–11 of this chapter deals comprehensively with the various methods of locating the position of a buoy. Assuming that the exact station of the buoy has been located and marked with the usual small marker buoy, the problem remains to bring the ship to that spot so that the buoy sinker may be dropped exactly "on station." Care must be taken in approaching the small marker buoy. The slightest setting down of the ship on the marker will generally drag it off position. Once a ship has touched a marker buoy, do not trust its position further. Take new angles and recheck. If a ship approaches a marker buoy with too much headway and has to back down furiously to prevent overreaching, the backwash of the screw may often shift the marker out of position.

G. *Handling tender alongside buoy.*—Working portside to with a single-screw ship provides the advantage of being able to throw the bow away from the buoy when backing if approaching too fast or too close, and turning the bow more easily to port by going ahead if being set down away from the buoy. It is wise to keep the buoy forward of the vessel's pivot point, particularly in the case of single-screw ships. In this manner, the shiphandler can always move the bow quickly toward or away from the buoy. With the buoy abaft the pivot point, appreciable time is consumed before the ship will move in the desired direction. In handling buoys alongside as well as in approaching them, wind and current must be kept constantly in mind. In approaching, the stronger of the two, if opposed, is determined, and the vessel stemmed in that direction. However, eddies near the buoy can change conditions observed a few yards away. Sometimes a heading which is a compromise between the two forces will serve best to keep the ship steady alongside the buoy.

The importance of not permitting the weight of the ship to bear heavily against or away from the mooring, as mentioned before, cannot be overemphasized. This problem plagues the shiphandler not only in approaching and initially hooking on, but remains as long as the vessel has the buoy alongside. Even when the buoy has been hoisted and griped in alongside for recharging, the conning officer must remain alert and be ready to maneuver to keep strain off the buoy and mooring all during the recharging process, which may take some time. Take care not to build up way on the vessel, while maneuvering to hold the ship steady alongside the buoy, that will require vigorous corrective action to counteract. This can be built up into a vicious cycle with disastrous results.

H. *Working in narrow channels.*—If the wind is on one side of the channel and the vessel is to relieve a series of buoys, relieve the buoys on the windward side first. If the wind has not changed when it comes time to work the leeward buoys, use an anchor to help keep the tender off the bank or shoal, or, if the channel is wide enough to permit the tender to work athwart the channel, work the buoys, stern to the wind. If it is necessary for a tender to go up a narrow channel to relieve buoys and there is insufficient room to turn around, go up with the flood tide, drop an anchor to swing on, and work the buoys on the way out, stemming the current.

I. *Placing a man aboard a buoy.*—The placing of a man aboard a buoy from the tender to perform routine gauging, relighting, or other servicing is a hazardous operation under almost any circumstances and *should be avoided whenever possible.* The maneuver requires the highest degree of skill on the part of the conning officer, and unless conditions are extremely favorable, the practice is not recommended. Only men who can swim and who have had experience on the buoy deck should be allowed on buoys.

(1) When in an emergency, due to a sudden change in weather, etc., it becomes necessary to approach the buoy with the ship to recover a man, the buoy should be brought abreast the buoy port, not too close aboard, and the ship steadied up and stopped. A line is passed to the man on the buoy, rove through the cage and the end brought back aboard. The buoy should not be pulled alongside until the ship is under control and is not sheering off under the influence of a backing screw or the wind and sea. Use plenty of manpower to haul the buoy alongside. In almost every case there is sufficient slack in the mooring to permit this; however, one or two men cannot do it. When the man is aboard, let go one end of the line and the buoy will spring away from the side of the ship, pulled by the weight of the mooring. Do not permit the wind to get on the opposite bow and cause the ship to fall down on top of the buoy, nor should the buoy be approached so close that it rubs alongside while the ship still has headway. In the case of a large lighted buoy, a man is safer inside the cage should the ship strike the buoy. The use of the anchor as described in Paragraph (D) above permits a safer approach to a buoy under adverse conditions such as a sudden squall, etc. It is worth taking the extra time to rig the anchor if an accident can be avoided.

(2) When it is necessary to put a man aboard a buoy, and conditions permit, it is generally better to use one of the ship's boats for this purpose. The tender can steam in circles around the buoy at full speed to knock down the seas and thus permit the boat to approach the buoy even in quite rough weather.

(3) If conditions are such that the ship may not bring the buoy alongside under any circumstances, and there is no other means of getting the man off, he may be recovered by passing him a bowline while the buoy is still several feet off and pulling him aboard through the water. A wet seaman is better than a crushed one.

J. *In shallow waters.*—Often it is thought best to enter waters of doubtful depths during high tide. In some places this may be necessary, nevertheless, there are times when this does not hold true. A thought to consider; should the vessel become grounded, it would suffer less damage and be easier to refloat if grounded during or near low water. When working buoys when there is insufficient water to float the ship at low tide or 1 or 2 hours before low tide, it is best to go in and leave promptly between half and high tide to avoid being caught and laying aground over a full tide interval. Certain types of hull form may safely rest aground without capsizing. The ship should rise to the following tide if maintained absolutely watertight, and there is not excessive mud suction.

Working buoys with the anchor at short stay is not recommended on rocky bottom or when working near a dangerous rock in tidal waters, as it may catch and delay the prompt departure of the vessel long enough for damage to be sustained.

K. *Following are some miscellaneous notes on this subject contributed by experienced tender personnel.*

(1) Remember to work with the elements rather than to try to force the ship against them.

(2) When working in swells with contrary wind or current, stem the swells if possible to minimize rolling.

(3) Single-screw tenders, when there is a choice, generally work buoys from the port side because of the tendency of the bow to swing clear of the buoy as the ship is backed away.

(4) When working buoys in shoal areas, take advantage of any stage of the tide or current that will tend to keep you off the shoal. Similarly take advantage of wind conditions.

(5) When relieving buoys, bear in mind that it is possible to set a buoy under sea and weather conditions which would make it dangerous to pick up the buoy being relieved.

(6) In clear water, if there is any difficulty in maintaining the proper position of the vessel toward wind, current, or sea, and staying on station, then forget the latter. The buoy can always be dragged back on station.

(7) After the vessel is made fast to the buoy, take a side range on shore so as to detect any dragging. Once a ship fetches up on the mooring and does not drag, it is good practice to allow the ship (if not too large) to set on the mooring and not work the engines unless necessary.

(8) When backing away from a buoy, take care that the cage of a lighted buoy does not foul the anchor. This is why single-screw vessels usually work their buoys on the port side.

(9) When setting a buoy, it is well to bring the wind or current a bit on the working side just at the last minute as the buoy goes overboard, so that when backing clear, the wind or current will help to keep the ship off.

(10) When working in close quarters, it may become necessary to back the ship away from the danger before getting the mooring aboard. If not, equipped with a mechanical chain stopper, the mooring may be quickly shackled into the deck, or cut with an oxyacetylene torch in an emergency. A cutting torch should always be immediately available on deck when working buoys, and more than one crewman should be trained in its use.

When a vessel is equipped with a mechanical chain stopper and is in a tight place, the chain may be quickly secured in the stopper and the vessel backed away to safety dragging the mooring along. Whenever possible, however, in any case of dragging a mooring, unshackle the buoy beforehand if time permits, as an added precaution.

(11) The conning officer generally starts to maneuver the bow of the ship away from the buoy (so as not to damage the lantern) just after it is set, while the crew is clearing the hoisting tackle from the lifting lug on the buoy. This maneuver should not be premature or too drastic until it is sure that the hoisting tackle is completely unhooked and clear of the buoy. Otherwise the conning officer may find himself dragging a buoy on the tackle with the ship drifting rapidly away.

(12) When working outside areas, head the ship on the easiest course, to minimize rolling when buoys are being hoisted or moved around in preparation for working. In rough weather, await a quiet interval when the ship is fairly steady before making any hazardous lift. Should a buoy start to swing wildly, a quick boom operator will touch it to the deck just enough to steady it but taking care not to give it enough slack so as to become unhooked. A couple of blocks or wedges can be thrown under the buoy. The best practice is to use plenty of steadying cross-deck lines of ample size and never give the buoy a chance to get started. Should a buoy break loose and take charge, it is possible to lower the boom right down on top of it and wedge it over against the bulwarks or up against another buoy until it can be secured. This may be a little hard on the gear but is nothing to what the buoy could do if permitted to take charge.

(13) In the case of the double topping lift (180 foot B & C) class tenders, there is danger in permitting the ship to range ahead too far with a buoy or mooring over the side suspended from the boom. If the boom happens to be topped high and the buoy or chain starts moving aft alongside the ship abaft the buoyport, the boom may jacknife back over the bridge, resulting in possible extensive damage and injury.

(14) In the case of a high-sided single-screw tender which tends to back easily to the wind, the ship is swung first until the wind is on the quarter in which direction it is desired to back; then the engine is backed.

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(15) Twin-screw tenders are noted for their different handling characteristics. Some can be easily turned in their own lengths, others need plenty of headway or sternboard even in little wind. Nearly all twin-screw tenders require way through the water before being able to turn in high winds.

(16) The 180-foot-class tender has been found to handle well with good rudder action and sufficient power. In confined spaces, it is necessary upon frequent occasion to handle this type of vessel with hard-over rudder and full power. Whereas no single-screw tender can be expected to maneuver as easily in tight places as a twin-screw ship, nevertheless if handled in the light of making the most of the good maneuvering qualities of this class of vessel as compared to most single-screw ships and not expecting to accomplish the impossible, the 180-foot tender can show an excellent record of performance.

(17) When outside buoys need relighting in a heavy chop and there is too much sea for the buoy to lay alongside the ship, a motorboat is put over on the lee side and run in close to the buoy. The ship is then run at full speed around the buoy, making a circle the turning radius of the ship. After one turn, the chop is knocked flat and the boat can lay alongside in somewhat of a slick calm. The ship has to continue this operation as long as the boat is required to lay alongside the buoy.

27–10–40 Towing—

A. *Towing qualities of tenders.*—Aids to navigation tenders are frequently called upon to tow other vessels in connection with rendering assistance. The 180-foot class single-screw tenders are particularly adapted for this duty, being fitted with towing bits, a winch or capstan for handling the line, and having the taffrail designed for manila rope towing. Towing with wire is difficult with the class A 180-foot tender, as there is no provision for handling the wire. The class B and C tenders have a small winch aft which will accommodate wire up to 1 inch diameter, however, for heavy strains the wire must be stopped off to the towing bits rather than to permit the strain to come on the winch. On all classes of 180-foot tenders no provision is made for preventing chafe of a wire hawser over the taffrail, such as roller chocks, etc. Eight- and ten-inch manila hawsers are standard towing equipment on large tenders. The capstan on the class A 180-foot tender will handle 12-inch manila, but the gypsy heads on the winch of the class B and C 180-footers will only handle up to 10-inch, and that not too well. Towing with the 180-foot class tenders is less difficult than with older twin-screw tenders since these vessels are extremely maneuverable and are better equipped. Some general facts relative to towing are given in the paragraphs below.

B. *Towing hawser.*—A vessel may be towed with manila or wire rope, a combination of both, or either of the above plus the vessel's anchor chain. Most tenders tow with manila rope. Although wire is very satisfactory if the vessel's handling facilities permit, manila affords more spring and is more easily handled. Where a combination of manila and wire rope is used, the wire rope is usually secured to the tow. As a rule, towing is made easier if a long and heavy towline is used. Variations in tension are taken up by the elasticity or spring of the sagging bight, thereby decreasing sudden jerks.

C. *Length of line.*—Two hundred fathoms of 10-inch manila or 1½-inch wire rope should be used for ideal towing of a vessel of 2,000 tons, for example. In towing in a seaway, it is important that the two ships involved keep "in step", that is, use a length of towline such that the ships will meet the waves and ride over them together. If one vessel is in the trough of the sea as the other is on a crest, the line will first become taut and then suddenly slack, thereby producing a jerky motion. Wave lengths are usually approximately the same, so it is a simple matter to adjust the length of the towline by heaving in or veering hawser.

D. *Preparing for emergent letting-go.*—In securing a towline, consideration should be given to the possibility of a sudden need for letting go in an emergency, and preparations made appropriately. When towing with wire, a pelican hook is desirable. If it is impossible to rig a pelican hook, have an oxyacetylene cutting torch handy. An ax should always be kept close by a manila hawser.

E. *Steering.*—Vessels, such as the 180-foot class, fitted with towing bits located well forward of the rudder, and a towing rail, may be easily steered when towing. All personnel must be kept clear of the path of the hawser as it is free to sweep from quarter to quarter. Vessels not so equipped but with plenty of power may tow through a stern chock, but small ships will find that they handle poorly when so rigged. Steering can be made easier by rigging a span consisting of two lines brought in through the quarter chocks. Ample chafing gear must be used in the way of the chock or over the towing rail.

F. *Maneuvers for passing towline.*—The method of passing the towline from the towing vessel to the towed vessel is dependent upon the condition of the vessel being towed and the weather. The method to be used should be determined by the commanding officer of the towing vessel, giving consideration to the factors involved, and communicated to the Commanding Officer of the disabled ship before the beginning of any operations. The following methods are recommended under the conditions indicated:

(1) *Towed vessel disabled, sea condition favorable.*

(*a*) Towing vessel stands to weather side of disabled vessel and in passing, shoots line across the bow of the disabled ship.

(*b*) Disabled ship hauls in shot line, manila messenger, and hauling line, and bends the manila hauling line onto her towline.

(*c*) The towing vessel hauls in the messenger, hauling line and disabled vessel's towline, connects her own and disabled vessel's towline together and veers line to the necessary towing distance.

(2) *Towed vessel disabled, sea conditions unfavorable.*

(*a*) If the use of line-throwing facilities is impracticable, the towing vessel stands down the leeward side of the disabled ship, passes under her stern, fouling the disabled ship with buoyed manila messenger line. This line is picked up by means of a grapnel.

(*b*) The same procedure as outlined in (1) above is then applicable.

(3) *Towed vessel not completely disabled, any sea condition.*

(*a*) Vessel to be towed comes close aboard under lee counter of towing vessel. Towing vessel passes shot-line and messenger, etc.

(*b*) The same procedure as outlined under (1) above is then applicable.

(4) *Alternate method, towed vessel disabled.*

(*a*) Disabled vessel puts overboard a buoyed line which floats aft and to windward. The towing vessel cruises slowly up and retrieves this line with a grapnel.

(*b*) The same procedure as outlined under (1) above is then applicable.

G. *Getting underway with the tow.*—After the towline has been made secure to both ships, and chafing gear rigged as necessary, full instructions are given the chief engineer about starting, if necessary. When all is in readiness, the engine(s) is started ahead as slowly as possible and stopped the instant the line begins to tauten out; then a few more turns are made until the inertia of the tow is overcome, and both ships are moving slowly with constant tension on the line. Speed is increased little by little and the course changed gradually as necessary. When the tow is straightened out and moving steadily, the speed is worked up to that at which it is considered wise to continue. This speed is governed by weather conditions, the size and condition of the hawser, and the size of the ship being towed. The primary factor to be considered is the towing hawser, and the speed should be adjusted to a point where the towing hawser will not be overstressed. Recovering a parted hawser and passing a new one (which you might not have) is a dangerous and difficult operation under bad weather conditions. Many a towing hawser has parted unnecessarily because of ignored fundamental principles.

H. *Wire and manila combination.*—When towing with a combination of wire and manila rope, be sure that the length of the wire is not less than the manila rope if leading through a chock, since the accumulation of twisting (greater in manila than in wire), due to the vessel's surging in a seaway, must be dissipated throughout the wire's length.

I. *Towing with anchor cable.*—If necessary to tow with anchor cables, get up such chain from the locker as will reach the stern of your ship. Stretch the chain aft and place a couple of heavy planks between the anchor flukes and the shell plating. Having maneuvered your vessel so the stern will be as close as possible to the disabled vessel's bow, heave over the end of her chain on board and shackle it to your own cable. The towed vessel will regulate the length of cable by her windlass. Your cable is toggled by the anchor in the hawsepipe.

J. *Letting go.*—When letting go a tow, if a wire rope or chain cable has been used, do not allow the towed vessel to cast off without bending a line to the end so that the towline may be veered slowly. If a heavy wire or chain towline is cast off loose, it will hang as a deadweight from the other vessel, constituting a hazard to maneuvering, and possibly placing too great a strain on the vessel's winch or capstan when heaving in. Ordinarily, when casting off, the vessel towing slows down and the towline is hove up short, and when the two vessels are reasonably close (do not get dangerously close), the line is cast off. Take care not to foul the propeller(s). A long length of manila may easily drift into the propeller if the ship is stopped.

K. *Towing aircraft.*—Rendering assistance to aircraft requires a special knowledge of towing which must be used in order to prevent damage to the plane. Consult a standard work on seamanship.

L. *Storm oil.*—The use of storm oil in towing during heavy weather cannot be too strongly recommended. Here the towing vessel is in a position to protect her charge and generally make better time on a passage. In maneuvering to pick up a tow in bad weather, it is well to remember that a vessel will drift to leeward faster than the oil will spread in that direction. Therefore, spread oil well to leeward of the disabled vessel, so that both ships, during the operation of connecting a towline, will be protected by the oil slick, and a less arduous job will be the result.

For storm oil, animal and vegetable oils are the best. Fuel oil thinned out with kerosene has given good results. About 2 gallons per hour is the rate reported by many vessels hove-to in heavy weather. A slow drip from canvas oakum-filled bags, or from rags kept soaked with the oil and placed in waste pipes will be found effective, but the quantity required will be governed by the effect produced, as observed in any particular case.

M. *Following are some general notes on offshore towing:*

(1) When towing with a heavy line having a deep sag, shoal water must be avoided.

(2) Before attempting to take another vessel in tow, reach a clear understanding between the two ships as to procedure.

(3) Be sure the towed vessel uses plenty of chafing gear in the way of the bow chocks. It has been found that many nonservice vessels either have little or are reluctant to use it.

(4) When getting ready to pay out a manila hawser, coil it down in large figure-of-eight coils, or if necessary, fake down, lapping the coils to avoid fouling. Pass out the hawser on a hauling line which will allow the end to revolve and take out turns.

N. *Towing alongside.*—When towing in port or in confined waters, the towing vessel should be made fast alongside if possible, as this gives greater ease and certainty in handling. When used in this way, the towing vessel is usually placed on the quarter, where its rudder acts with that of the tow for steering. As the power is applied at a distance from the midship line, there is here a considerable turning moment, which will throw the ship's head to one side or the other, according to whether the towing vessel goes ahead or back; the effect being exactly as if the tow had twin screws and was using only one of them. In going straight ahead, the turning effect is neutralized by a small amount of rudder. The towing vessel should be secured well aft alongside of the tow with her bow snubbed in towards the tow with a line from aft for going ahead, and one from forward for backing. These lines are usually made fast at the bow of the towing vessel, her stern being held from swinging out by an after breast leading to the tow, figure 27–307 (1).

(1) If the towing vessel has a right-handed screw, she will be able to make a straighter sternboard if secured on the port side of the tow, since in backing, the tendency of her screw is to throw her stern out to port, while the tendency due to her position on the port side of the tow is to throw the stern of the tow the other way. When secured on the starboard side, both these elements will act together to throw the stern off to port.

(2) If there is a sharp and difficult turn to be made, the tug should be made up on the inboard quarter, that is to say, on the side toward which the turn is to be made. Here she will be properly placed for backing to assist the turn. So long as she is going ahead, the outboard side would place her more favorably for turning; but if her turning effect when so placed should prove insufficient for the turn she would then be helpless. To back, under these circumstances, even for keeping clear of the beach, would only make matters worse. It is the practice of tug masters to place themselves on that side of the tow toward which they wish to turn, if the turn is one which involves some difficulty.

(3) It frequently becomes necessary to turn a large vessel on a pivot. Suppose the tug is on the starboard quarter and wishes to slew the stern of the tow to port. She lets go her after breast and goes ahead with left rudder, holding the "go ahead" line. This throws the tug's stern out and she puts her bow (invariably well protected by fenders) against the stern of the tow and pushes it around. If it is desired to pull the stern to starboard, she lets go her line from the bow, slacks the after line, and swings off clear, going ahead as in figure 27–307 (8). Observe that for this maneuver it is necessary that the line used for towing should lead from a point far enough forward of the rudder to allow the tug's stern to swing freely. She will then be able to head in any direction desired, even though there be a current setting her down.

(4) A tug towing a vessel alongside often has occasion to "wind" the tow for putting her alongside in a particular way, or for getting on the offside in landing, to avoid being jammed between the tow and the dock. In figure 27–307 the tug first gives the tow a sheer with the rudder (3). She then backs, slacking all lines except the backing line (4), then a little later, slacks everything and puts her stem against the stern of the tow and goes ahead, pushing the stern around (5), and ends by making fast alongside with her bow toward the stern of the tow (6), and with her port side to the tow instead of the starboard side, as in the beginning.

O. It has been suggested that the below listed "emergency" method of towing or pulling on large vessels with the 180-foot C-class tender has proven to be very successful and particularly so in that it obviates the almost impossible task of handling a 10- or 12-inch hawser with the small gypsy heads on the existing towing winch.

The deep sea anchor cable is disconnected from the fair-lead at the bow and run aft across the buoy deck and boat deck through a series of snatch blocks then over the towing rail. After the desired amount of cable is payed out, it is stopped off with a chain stopper at the towing rail and some slack reeled off the drum and used to take the necessary turns around the towing bit. It is necessary to place chafing gear around the cable where it rides the towing rail. Further, some method of putting an eye in the bitter end of the cable is necessary; cable clamps have been successfully used for this purpose. This method permits the towing tender to pay out as well as take in the cable with ease by use of the level winding deep sea anchor winch. Moreover the 1¼" diameter cable with a length of 300 fathoms which is installed on this class tender permits the towing vessel to take a tremendous strain and allows for an ample catenary in the cable.

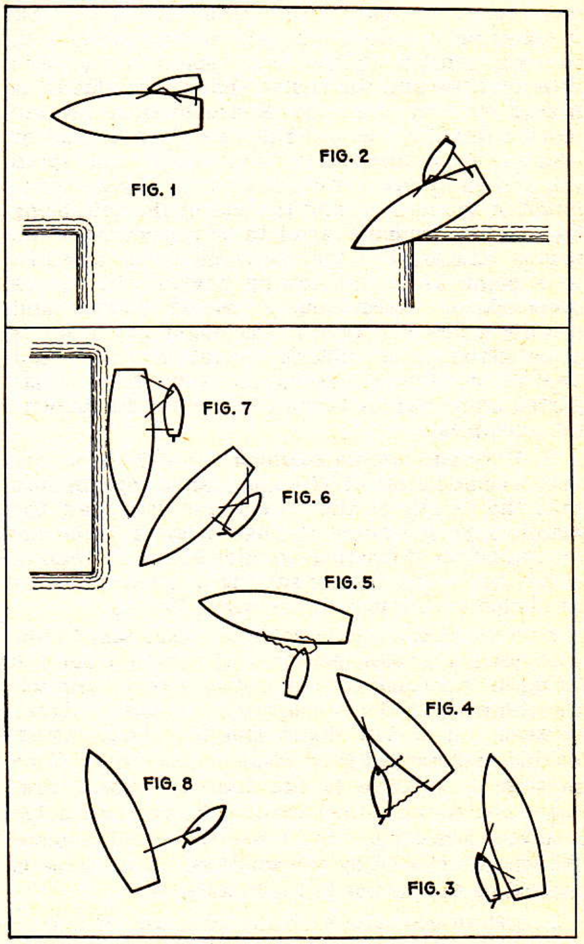

FIGURE 27–307.—Towing alongside—turning a tow. (Reprinted from Knight's Modern Seamanship by permission of D. Van Nostrand Co.)

27–10–45 Stranding—

A. Practically every seaman, at some time or other, puts his vessel aground, or at least is aboard such unfortunate craft. The danger of grounding is particularly pertinent to aids to navigation tenders since the very nature of their duties requires that the ships be sometimes placed in hazardous positions where no ordinarily prudent navigator would take his ship.

B. *Natural impulse is to back off.*—When your vessel strands, resist the first impulse to put the engine(s) full speed astern. This is a natural tendency, but should the vessel be ashore on rocks, she may have a hole in the bottom and to back off may result in sinking her without leaving time even for saving life. If aground in soft bottom, to work the engines in either direction may result in disabling them by filling the condensers or strainers with sand or mud. Again, when a single-screw vessel is aground forward, backing the screw may slew her stern around and put her broadside on the beach.

C. *Lay out anchor.*—Know the state of the tide —if falling, act without hesitation and at once. Assuming that there is reason for not backing off at once, it is imperative that an anchor be laid out astern to keep the ship from slewing around broadside to the seas or from working further up the beach. Such a line, kept well taut, will sometimes start a ship off quite unexpectedly by the steady pull which it exerts; a slight rise of tide or a little working of the ship by the wind or sea contributing toward the same end. If there is current setting along the coast, as frequently happens, the anchor should be laid out a little off the quarter to keep the stern from being swept around. A buoy with a good recovery line should be made fast to the anchor.

While the anchor is being laid out, soundings should be taken all around the ship. If there is a chance that help will be needed, it should be requested promptly.

D. *Examine ship.*—Make a thorough examination of the ship and isolate watertight compartments found holed or leaking. Brace bulkheads and start pumps. If the hole is large, there may be danger in hauling off before it is at least partially stopped. When measures have been taken to prevent the ship from working further inshore, and not until then, the work of lightening ship may be begun—ballast tanks pumped out, cargo shifted, lightered, thrown overboard. If the ship is aground forward, something may be gained by filling the after tanks or otherwise adding weight aft. If the vessel is pounding hard from the sea, and it appears that it may be some time before a successful effort can be made to get her off, it may be well to flood her double bottom tanks or even her holds, to prevent smashing in the bottom from the pounding or working further inshore.

E. *Obtain local information.*—It is generally assumed that a vessel will come off most easily the way she went ashore. This is not always the case, however, and the reason why not will probably be obtained from those having local knowledge of the area. Do not hesitate to seek information as to the nature of the bottom, peculiarities of wind and current, etc., from local fishermen, and others who may be available.

F. *The assisting vessel* should, as a rule, anchor to seaward with a good scope of chain, get good lines from the stern of the wreck, and keep them taut. When the time comes for a combined effort, she steams ahead with her engine and heaves on the anchor windlass as well. It is often good for the assisting vessel to lay out her own spare anchors well off shore with good lines bent to them and send the ends of these lines aboard the wreck. In bad weather, passing lines to the vessel ashore is a difficult job. However, by the use of line throwing apparatus and small boats, messenger lines may be run and if the stranded ship has power available, she can heave the heaviest hawser aboard. If no power is available, the assisting vessel can heave the line over using a whip and tail block, or it can be coiled down in a small boat and run over. Heavy wire hawsers can be buoyed at intervals to prevent fouling on the bottom. It is not satisfactory to attempt to float a hawser in to a stranded vessel on an open beach.

G. In cases where a strong current runs along the beach at certain stages of the tide, if lines are hove taut at slack water, the current, when it makes, will be on the beam of the anchored vessel and will exert tremendous force, with all the advantage from the span formed by the anchor cable and the towline. It would be well here for the assisting vessel to heave two anchors down.

It is imperative that the assisting vessel be prepared to cast off or cut the line between the ships instantly in case she finds that her anchors are dragging and that she is being set down on the beach. In the case described above, and where the assisting vessel cannot anchor, it is better to lead the hauling line from a chock well forward of the stern to permit using the rudder for holding her head up against the current. Also, she will thus always be pointed toward safety should she start to drag. The assisting vessel should always be alert to the potential danger of herself becoming stranded while attempting to render assistance.

H. *Danger of collision.*—When pulling off a stranded vessel, there is always the danger of collision if she comes off suddenly; therefore, the assisting vessel should always be ready to slip everything and get out of the way.

I. *Towing vessel underway.*—An advantage of having the towing vessel underway is that if the wreck does not come off from pulling directly astern, she can place herself on either quarter alternately and may thus be enabled to slew the stern of the wreck around and so loosen her up in her bed. However, the difficulties are often increased when the assisting vessel cannot anchor. It is difficult to maintain a steady tension on the line; and if the wind or current is across, there is great danger that she will swing around on the towline and end by going ashore herself. In any case, when the assisting vessel cannot anchor, she must not take the line from her stern chocks under any circumstances.

J. *Taking a line forward.*—Sometimes the assisting vessel can approach bows-on to the wreck, receive a line forward and back her engine to pull off. The time saved in not having to maneuver to receive lines astern might in some cases be enough to make the difference between "just in time" and "just too late". Here again the importance of retaining pivoting maneuverability is emphasized, and the line should lead in through a chock some distance abaft the stem (fig. 27–308 (3)).

K. *Attempt to back off immediately.*—There are cases when the effort should be made to back off immediately; as, for example, when the ship is on a hard, steep sandy beach. Here she is aground forward, and if steps are not taken immediately she may swing around broadside and ground throughout her length. On this kind of a beach an anchor should be gotten out at once if backing does not bring her free. On a steep beach, if the stern is free, steaming ahead dead slow to keep the stern from broaching may be necessary while anchors are run out, etc.

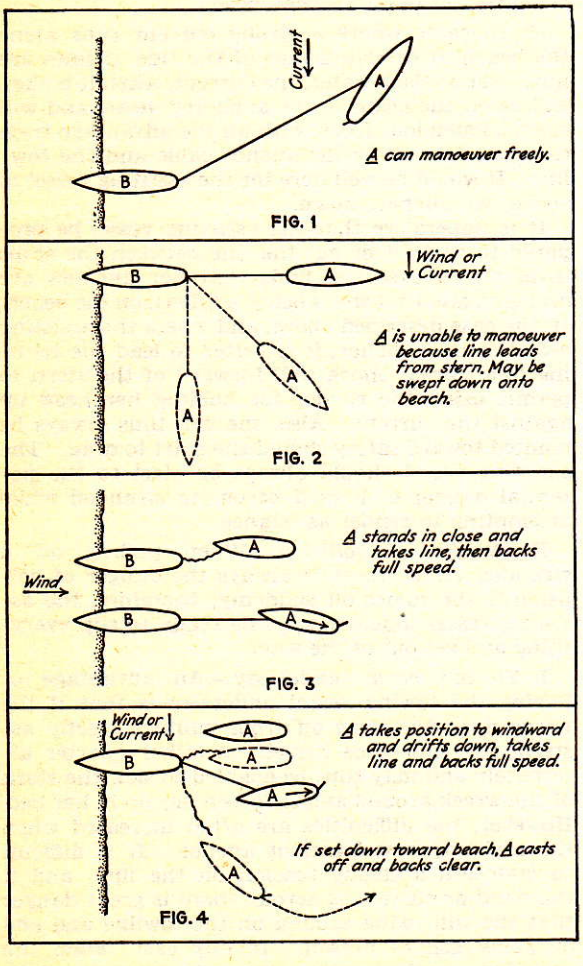

FIGURE 27–308.—Assisting a stranded vessel. (Reprinted from Knight's Modern Seamanship by permission of D. Van Nostrand & Co.)

L. *Jetting.*—When a vessel grounds on sand, it frequently "packs" up around the hull. The presence of packed up sand can be determined by use of the lead line. In this case, water jets (pipes over the side) can be rigged from the ship's fire pumps to "liven" up the sand.

M. *Jumping on a line.*—The practice of "jumping on a line" is generally futile in the case of a large stranded vessel, unless she is hung up on one spot, which is easy to determine as she will swing. It is also dangerous and hard on the gear.

N. *When laying out anchors,* carry out a kedge a little beyond the spot where your heavy anchor is to be dropped and bend a 3-inch line to it for a "guess warp." For the heavy anchor, use two boats, catamaran fashion. Hang the anchor (the spare or regular bower) between the boats from a spar or timber lashed amidships. If there is a swell, lash a spar across the after ends of the boats also, so that the two will take the swell as one boat. Buoy each anchor as laid down.

O. *Following are a few notes on procedure:*

(1) Secure the running line about 6 to 8 fathoms from the end of the hawser with a rolling hitch, and then at frequent intervals stop the running line to the hawser with sail twine or small stuff that may easily be cut adrift. About 2 fathoms from the end of the hawser take a marline or clove hitch with the running line around the hawser and again stop the running line to the hawser with small stuff beyond this hitch. This prevents jamming when being taken on board, and gives plenty of drift to make fast before casting off the running line.

(2) No precautions are too great to prevent a hawser from getting into the propeller. An officer should be stationed where he can direct and supervise the paying out and handling of the hawser while it is being run.

(3) Never turn over the engines until the officer in charge aft reports all clear of the propeller.

(4) Have a reliable man stationed with a sharp ax where he can cut the hawser promptly.

(5) Except in an extreme emergency, never start or stop the engines suddenly with a hawser made fast to another vessel.

(6) To prevent a vessel's charging into the assisting vessel, have a thorough understanding with the master of the stranded ship as to just what to do if she comes off with a rush.

(7) If the vessel comes off, or if it is found that she cannot be floated on the tide that you are working on, decrease speed by slowing down a few revolutions at a time until the stop order is given. Thus you will have full control of the situation and avoid any danger of fouling the propellers with the hawser.

(8) When assisting a vessel stranded on a lee shore, proceed as above in getting a strain on the hawser. Both vessels heave in on their anchor chains at the same time. If you have anchored with a greater scope of chain than she has, she will break out her anchors first, and should immediately get one ready for letting go. By the time you break yours out you will have taken the necessary strain to tow her off shore and probably to a safe anchorage. If anything goes wrong, she can let go her anchors and probably be in no worse position than before.

P. *In summary, remember the following:*
(1) Know the state of tide.
(2) Sound all around.
(3) Form a plan—be careful.
(4) Lay out anchors if it can be done—at once.
(5) If bow on, try to keep the stern free.
(6) When wind and tide are right, trim tanks, drop weights, work all freeing agencies together.

27–10–50 Small Boat Handling—

A. An important phase of aids to navigation work involves the servicing of unattended aids and light stations on shore. This requires competency in handling small boats and making landings on exposed coasts. Officers and crew who are experienced small boatmen and good seamen are essential for aids to navigation work, but it must not be assumed that one who is an otherwise competent seaman has the necessary knowledge and experience to make small boat landings under dangerous conditions. This is an art in itself, requiring special knowledge and skill only acquired by practical experience and one which many seafaring men never have occasion to practice. When undertaken by the inexperienced, the danger involved can scarcely be overestimated. The handling of a small motor boat follows the principles of handling a single-screw ship as described in previous sections, with due allowance being made for the difference in size and the fact that most motor boats used in aids to navigation work are steered by means of a tiller in lieu of a wheel. Thus it is necessary to move the tiller in the opposite direction to that of the wheel in order to make the rudder act in the manner described.

B. *Lowering the boat.*—A variety of opinions exists as to the best method of lowering a boat; however, a general procedure is described in the following paragraphs (circumstances, of course, may alter these procedures):

(1) The boat is designated by the officer of the deck's order, "clear away the starboard (port) cargo (life) boat." The crew dons life jackets and take their positions in the boat. If the boat is at the davits, the crew members not otherwise engaged, seize the life lines as a safety precaution. When all members of the crew are in the boat, the gripes are cleared away. Frapping lines, sternfast, and steadying lines (if necessary) are used to keep the boat from swinging. Frapping lines are passed around the falls and kept taut by men on deck. Most ships have a metal ring, served with leather, around the falls to which the frapping line is secured. The steadying lines may be secured in the boat or held by hand. Many ships use no other lines for steadying than the frapping lines and painters. The sternfast should be led well aft. Members of the crew in the waist of the boat breast off the ship's side. When using boat hooks, they must hold the ends above the gunwale to avoid the possibility of staving holes in the boat. Use extreme care in manning a boat hook. The ends can be dangerous to not only the man handling it but to the rest of the crew as well. Members of the boat crew stand by the falls and sea-painter. When all is in order, the one in charge commands, "lower away together," or, if the boat is on the cargo boom and in checks, "hoist away," and "swing out and lower away."

(2) Strain is taken on the frapping lines, and the boat is steadied by men in the waist with boathooks. Any slack in the sea-painter and sternfast is taken in on deck. The sea-painter is secured by a toggle in the boat, with a round turn around the inboard side of the second thwart (if a pulling boat). A man stands by to clear the sea-painter by pulling the toggle when ordered. In boats at the davits, men must tend the falls to keep then clear and to keep the blocks from striking members of the crew after the falls are let go. The boat must be lowered smartly, especially in rough weather. When the boat is at the davits, the falls must invariably be lowered together. While being lowered, the crew not otherwise engaged clear away the oars and hold firmly to the lifelines (or the engineer starts the engine). The boat is not lowered entirely into the water until the coxswain determines that sea conditions are favorable and he gives the order, "let fall." The men on deck tending the falls throw off the turns so that the falls pay out freely.

(3) As soon as the boat is waterborne, the boat officer (coxswain) commands, "let go the after fall," then "let go the forward fall." The *after* fall is always let go first unless the ship has sternway. If being lowered from a cargo boom, the hook is tripped and the sling ring thereby unhooked when the boat is waterborne. A hazardous moment in lowering a boat comes just as it is water-borne, because of the great danger that the boat will be dashed against the ship's side. Expert boat handling is demanded. Sternfast and steadying lines are cast off and the coxswain gives the stern a sheer *in* with the steering oar or rudder to get the bow out. A rudder should never be used on a pulling boat in rough weather. The strain on the sea-painter sheers the boat away from the ship's side.

When clear of the side, the coxswain commands, "cast off the sea-painter." An axe or hatchet should always be ready for use in case of a jam at a critical moment. When the boat is clear, the men man their oars (the engineer engages his clutch), and the boat moves off on her mission. If a motor boat, the crew on deck should rapidly haul the sea-painter aboard to prevent its being fouled in the boat's propeller.

C. *The sea-painter* mentioned above is a long line used to sheer a waterborne boat clear of a ship's side. The line is secured by a toggle over the inboard gunwale, to the second thwart if a pulling boat, or to a corresponding position on a motor boat, in the bow of the boat. It is led outboard of all rigging and well forward where it is tended on the deck of the ship. It creates a pivoting point on the inboard side of the boat just abaft the bow. Its usefulness would be entirely negated if it were made fast at the bow. As both the boat and the ship have headway, the pressure of water on the bow of the boat causes it to sheer away from the side of the ship. The coxswain supplements this action by using the rudder or steering oar.

D. *Hoisting a boat.*—The same principles of good seamanship followed in lowering a boat are applied when hoisting her aboard ship. The most important task of coxswain and crew is to keep their craft away from the ship's side to prevent damage. The boat should never have to wait for preparations on deck. Boat falls should be well overhauled, led along the deck, and well manned or taken around the drum of the winch, which should be turning at the desired speed before the order, "Hoist away" is given. The boom hook (if used) should be lowered, but clear of the heads of the crew. The frapping lines, and steadying lines (the boom hook tripping line), and the sea-painter should be ready for use.

(1) When all is ready on deck and a lee has been made, the boat comes alongside and the sea-painter is passed to her. The sea-painter is given one turn about the inboard end of the forward thwart, and its end held in hand. The ship must have some way on her, and once the sea-painter is passed around the thwart, a strain will be taken thereon. By proper use of the steering oar or rudder, the coxswain can now hold the boat at the desired position off the ship's side. By moving the oar or rudder, the sheer in of the stern may be lessened and the boat brought in slowly to the ship. If the boat should lurch toward the ship, the danger of being crashed against the side may be offset quickly by increasing the sheer in of the stern and sheer out of the bow, with the oar or rudder. The strain on the sea-painter will then pull the boat clear. Do not make the sheer off so radical that the sea-painter must be cast off to avoid swamping.

(2) The boat is hauled under the devits or boom by manning the sea-painter on deck. Next, the frapping lines, and steadying lines (tripping line) are passed. When hoisting with the boom, the tripping line is rove through the sling ring and made fast to the eye of the safety runner. A line should be led from the stern of the boat to a point well aft on the ship to prevent the boat from lurching forward when it leaves the water. This is known as the stern-fast and is essential if the ship is pitching. Men tending the blocks of the falls while hooking on should hug the block firmly against their life jackets, holding it upright until a strain is taken and the boat hoisted clear of the water. Thus the block will not snap and whip about as the boat rises and falls in the seas. Attempting to hold a block steady in the hands often results in mashed fingers and heads.

(3) When all is ready on deck and in the boat, stand by and wait for relatively steady conditions. Then, if at the davits, hook forward, then aft, haul taut, and hoist away as the ship rolls toward the boat, hoisting the boat quickly and steadily. If at the boom, hook the sling ring on the boom-fall hook by a pull on the tripping line from on deck, start the winch as the ship rolls toward the boat, and hoist the boat quickly and steadily. Frapping lines and steadying lines should be tended and the boat hooks used as in lowering, to keep the boat from bumping into the ship's side.

E. *Running a line.*—There are numerous occasions when a boat crew may be called upon to run a ship's line to a mooring buoy, another vessel or dock. When so ordered, the crew will coil most of the line in the stern sheets, and leave enough in the bow to make fast when the landing is reached. Be sure to have enough line to reach, and have plenty of good seizing stuff (small stuff used for binding) for securing. Have an axe handy for cutting if ordered to do so. If moving with the tide, take less line in the boat than otherwise. If against the tide, it will save work to take all the line in the boat, pull up, make fast, and then bring the end back to the ship.

(1) When required to lay out a long heavy line in a strong current it may be necessary to have two boats—one to run away with the end, the other to underrun the line at intervals, floating it and pulling upstream with the bight. This lessens the line's resistance to the current.

(2) When necessary to tow a heavy length of line, do not make it fast to the stern of the boat. Take a turn around the bits forward or around a thwart midships so that the stern may be free to pivot. This may prevent the boat from being set constantly to leeward in heavy seas with no means of bringing the boat's head up to the seas or wind. Be careful to keep the line out of the propeller. Have an axe or hatchet handy in the boat at all times.

F. *Running before a sea with a powerboat.*—One of the more risky situations arises when a powerboat is running before a sea. When the hull is lifted by the stern, there is danger that steerageway and power may be lost. This may occur when the screw and rudder are clear of the water. The boat may then swing around broadside to the seas. The coxswain must call upon all his skill and adroitness in the use of the rudder to keep the stern to the mountains of water that sometimes are encountered when the going gets rough. It is helpful to reduce speed, and to allow large swells to roll by. In extreme cases, a drogue or long hawser may be streamed astern.

G. *Running into a sea with a powerboat.*—Running into a sea is less hazardous, but not without peril in bad weather. Reduced speed will lessen the strain on both engine and hull. To this end, the throttle should be adjusted so that the bow will rise with oncoming waves rather than drive into them. Taking seas on one bow is sound seamanship. Avoid the trough except in an emergency. When moving broadside to the waves, swing the boat momentarily so as to take larger wave crests on the weather bow, then return to course when conditions permit.

H. For an excellent description of landing craft and their handling, such as LCVP's and LCM's used by aids to navigation vessels on loran station logistic trips, see Navpers 16044, The Powerboat Book.

I. *Handling boat under oars in rough water.*—Although the skill required for handling boats under oars in rough water and surf can be acquired only by continuous training and experience under such conditions, a knowledge of the following principles will aid the boat handler in acquiring the required skill:

(1) The forces exerted by waves and breakers are tremendous and must be understood and respected. A poorly or improperly handled boat is almost sure to be swamped, broached, or pitchpoled. *Swamping* results from seas breaking into the boat or results

from broaching. *Broaching* results from permitting a breaker to strike the boat on the bow or quarter and to slew the boat around until the seas are on the beam, with the dangerous probability of being swamped or capsized. *Pitchpoling* results from permitting the boat to ride on the shoreward or front side of the sea. The stern is elevated and the bow depressed into the slower water at the base of the breaker and, as the resistance on the bow increases, the stern is raised higher and higher until the boat is toppled over, end for end and bottom up.

(2) Adequate speed to overcome the force of the breakers must be used when heading into them. Only use that speed which is necessary to keep the boat under control and prevent her from being carried back by the surf. Too much speed will have a tendency to drive the boat into the oncoming sea or cause the bow to fall too heavily after topping a sea and thus place unnecessary strain on the boat.

(3) If at all possible, manage the boat so that the heavier breaking seas are avoided. If it is impossible to so maneuver the boat, meet the breakers squarely so that their force will be equally distributed on each bow.

(4) In running with a surf, maneuver the boat so that the seas will break ahead. Make sure that the boat has sufficient inertia to permit the breakers to pass the boat. Do not try to ride the surf. Trim the boat by the stern and keep the stern in such a position that overtaking breakers will meet the stern squarely with equal force on both sides.

(5) Better and more positive control of the boat is obtained with the steering oar. Therefore, *unship the rudder* and *ship the steering oar* before entering the surf.

(6) Any of several means of *increasing the inertia* of the boat relative to overtaking breakers may be used. A drogue may be towed astern, apex forward, until just before the time a breaker overtakes the boat, at which point the tripping line should be released, creating a drag on the forward motion of the boat. The boat may be backed in, with the oarsmen pulling ahead as each breaker approaches the boat. The boat may go in bow first, with the stroke oarsmen facing forward and pulling against the seas as each breaker approaches. In the case of power boats, an oarsman on each quarter can check the way on the boat by rowing against the surf as each breaker approaches, however, a sea anchor is probably better.

(7) The *use of oil* may be of assistance when running with heavy seas. Oakum or cotton waste saturated with oil, stuffed in a canvas container may be attached to the drogue. The container should be pricked with a sharp instrument in several places to permit the oil to escape.

J. *Launching a boat into a surf:*

(1) A surf makes launching dangerous and it is, therefore, important to await the *opportune moment* for launching the boat into the surf. Usually, a comparatively mild interval will follow a series of heavier seas. During this interval, launch the boat as quickly as possible so that it may pass beyond the first line of breakers before the next series of heavy seas begins.

(2) At the command GO, the oarsmen jump into the boat (if not already in), take their respective thwarts, and all start rowing immediately, without further command. This is a most crucial moment and the entire crew must pull a strong, coordinated stroke to pass through the onrushing seas.

(3) *Speed* is essential when rowing against an angry surf. If the sea is heavy, the crew must exert every effort to keep sufficient way on to enable the boat to pass over the onrushing seas.

(4) After launching into the first line of breakers, endeavor to maneuver the boat so that it will not strike a breaking sea.

K. *Landing through a surf:*

(1) When approaching the outer line of breakers, bear in mind that the *height of the sea as viewed from offshore is deceptive*. The seas will appear much smaller and less dangerous from seaward than they actually are. Watch the succession of seas and begin the run for the beach during a comparatively mild interval. When the run is started, use enough speed to keep the boat under control, but be prepared to check the way of the boat to permit overtaking seas to pass.

(2) *Landing by backing in.*—Before entering the outer line of breakers, turn the head of the boat to seaward and back (making sternway) toward the beach. The crew pulls ahead each time a heavy sea approaches. After the sea passes, the crew again backs in toward the shore. This method permits the full force of the oars to be used against a heavy surf.

(3) *Landing by use of drogue.*—The drogue should be rigged before entering the surf and towed apex forward until it is desired to check the headway of the boat. In order that the lines may be distinguished, the holding line should be marked with a piece of red bunting tucked in the lay at the point where it is normally belayed. Care must be exercised not to foul the lines. The holding line should be belayed on the quarter. When headway is desired, the tripping line is hauled in until the drogue is towed apex forward. When it is desired to check the headway, the tripping line is paid off until the drogue is towed mouth forward.

(4) *Landing by using surf-line and anchor.*—Drop an anchor from the stern of the boat just outside the breakers; keep a strain on the line and pay out the anchor line as the boat moves through the surf. Usually the surge of the sea will carry the boat toward the beach as quickly as desired; if not, headway can be increased by use of oars.

(5) *Landing by using surf-line and power boat.*—The offshore end of the surf-line is made fast to a powerboat instead of to an anchor. The powerboat may be anchored, but usually it is kept underway when there is a strong current parallel to the shore so that the line can be paid out in directions that will permit the pulling boat to pass through the breakers *end on* to the sea. The line should be cut instantly if the pulling boat will not pass through the surf *end on.*

(6) *Landing by using the hauling line*—In addition to employing a surf line (anchor or powerboat) attached to the offshore end of the pulling boat, an additional hauling line can be attached from the inshore end of the boat to the beach. With competent assistance on the beach, the boat is simply hauled back and forth through the surf. This

method is especially desirable when a number of trips must be made through the surf.

(7) *As soon as the boat strikes the beach*, the crew should leap out and pull the boat up well out of the way of the seas.

L. *Simple landing with powerboat.*—When surf is not a major problem and a simple landing with a large motor launch is to be made, and where the current or wind may turn the boat broadside to the beach, anchored surf lines may be effectively used.

(1) As the boat heads in toward the beach, an anchor is dropped from the quarter, well outside the rough water. The boat, under power, then quarters off toward the opposite side and another anchor is let go from the opposite quarter, preferably to windward, in such a position as to give the largest possible span. The boat is then headed for the beach, veering the surf lines as necessary. The bow is rammed firmly into the sand on the beach. The boat is then held bows-on to the beach with her nose in the sand, the surf lines tending at an angle from each quarter and resisting the tendency of the boat to bring up broadside to the beach. Should the boat get broadside-on she might sustain injury to her propeller or rudder and getting clear of the beach would be difficult.

(2) With the boat held bows-on to the beach with the surf line, getting clear involves nothing more than heaving on the surf lines and backing the engine. The surf lines may be used to overcome any tendency of the boat to back into the wind and sea or to back to port. As in all cases where lines are over the side, care must be taken that the lines do not foul the propeller.

(3) In any case where a powerboat is landed on a sandy beach it must be remembered that the sand kicked up by the turbulence of the propeller stream or surf may enter the cooling system through the injection and possibily put the engine out of commission.

M. *In summary*, some important rules to follow in connection with small-boat landings under difficult conditions are as follows:

(1) Use only experienced personnel.

(2) Conditions never appear as dangerous from seaward as they really are.

(3) Always use a steering oar, never a rudder.

(4) Keep the boat under control at all times.

(5) The outermost series of breakers is much the heaviest.

(6) In a strange locality, lie-to outside the breakers to study the particular conditions before attempting a landing.

(7) The No. 1 danger, when running before a sea, is that of broaching-to.

(8) A number of heavy swells are often followed by a short and comparatively mild interval.

(9) Launching a boat through breakers is a more difficult and exhausting operation, though not necessarily a more dangerous one, than making a landing under similar conditions.

(10) An entirely different technique is required on a steep, rocky shore from that required on a gently sloping sand beach.

(*a*) For example, on a rocky shore, the locality selected for landing should be free from nearby breakers and back of some rock or small point if available, but a small area partially enclosed and subject to violent to-and-fro movement of the sea should, of course, be avoided. The best landing place is one having a fairly steep-to face, where covered and uncovered by the swell, and at the same time offering adequate foothold. The swell here has less tendency to break or may not break at all.

(*b*) On a sandy beach, a double-ended surf boat is the best for landings, but for landings on rocky shores, use a light, easily handled square stern-type boat. Approach stern first under oars, having a bow line to an anchor offshore. The line is manned so as to be able to haul the boat away at any time. The stern is brought within jumping or stepping distance of the selected spot immediately following the end of a break, and a landing is made preceding the approach of the next break if there is time to do so. Several attempts may be necessary before a quiet spell of sufficient duration occurs.

27–11 POSITIONING OF BUOYS

27–11–1 General—

A. *Accurate position.*—The accurate positioning of buoys is one of the major responsibilities of the officer engaged in aids to navigation work. A buoy which is off station is a false aid and in some cases it may be worse than no aid at all. The position of a buoy and the method used in ascertainment thereof has been the subject of litigation involving the Coast Guard in the past, and too much emphasis cannot be placed on this matter.

B. *Tolerance of accuracy.*—Every reasonable effort shall be made to place buoys on their correct locations, using all available means commensurate with the circumstances. The tolerance of accuracy is dependent on the immediate purpose of the buoy and the means available for determining its position. Buoys located along the edge of a dredged channel or confined waters must be more accurately placed on charted position than sea buoys marking the entrance to a bay and located many miles offshore.

C. *Strong three point fix not always available.*—The tender officer will not always find three prominent objects conveniently located so as to provide a strong three point fix. Sometimes the angles are too large or too small, or the distances to the objects out of reasonable proportion, etc. Often prominent objects such as radio towers, etc., which would be excellent for observation purposes, are not charted. However, in such cases, if time or circumstances permit, the location of these objects can be found and plotted for future use. See the method described under paragraph 27–11–10 (A). Therefore, tender officers must use their judgment in selecting such available methods as will give them the strongest fix under the circumstances. A buoy placed on station by one method should be checked by other available means whenever practicable. The observer is strictly cautioned against using the following in determining the position of a buoy:

(1) *Buoys or other floating objects.*—Although the positions of the buoys may have been accurately determined, they are subject to displacement due to scope of mooring and the effects of change of current or wind.

(2) *Minor fixed lights*—unless it is definitely known that the position has been accurately determined.

D. *The general methods currently used* for locating the position of a buoy are as follows:

(1) *The most accurate method* is the three-point fix (described under section 27–11–5). There are several variations or special cases where the three-point fix is combined with other methods (described under section 27–11–10).

(2) *Other accurate methods are:*

(*a*) Two natural or artificial ranges.

(*b*) One range and one angle from the range to a third object.

(3) *Other less accurate methods are:*

(*a*) Inclined angle and azimuth of the sun.

(*b*) Soundings and character of the bottom.

(*c*) Soundings on a visible range.

(*d*) Radar bearing and distance (range).

(*e*) Visible range and radar distance.

(*f*) Radio direction-finder cross bearings.

(*g*) Visual cross-bearings.

(*h*) Loran lines of position.

E. *Soundings should always be taken when a buoy is set.*—Often the nature of the bottom has changed through shoaling, and for the safety of navigation the buoy must be moved from its charted position. When there is good reason why the buoy should not be placed on its charted position, it should be so reported to the District Commander by dispatch. There are times when soundings, instead of being used as a check on position, must be used in combination either with the nature of the bottom or with a visible range, bearing, or radar distance as the prime means of determining the position. Naturally the accuracy is not "pin-point" in this case.

F. *Record all visible ranges.*—The following is a good practice: when the buoy has been initially set and its position checked and rechecked by standard methods, record all visible natural and artificial objects which form a range through the buoy's position. These objects may not necessarily be charted but if readily observed, logging the information on a card for each buoy will materially assist the tender in the future in more rapidly ascertaining the buoy's position when time for the buoy's relief. Some older tenders still have "angle books" kept by commanding officers years ago, in which similar local information was listed. There are some locations where this local information is practically the only means available of setting the buoy on station. When logging artificial or natural ranges, give very complete descriptions. Another man's ranges are difficult to identify unless the descriptions are complete. Do not choose ranges in the winter months that will be obscured by foliage in the summer. Refrain from describing objects by color, as changes may be expected. The logging of ranges is particularly important in inland waters where charted objects frequently change or disappear.

G. *Buoy may be dragged off station when setting.*—Many buoys, although accurately stationed, are dragged off position by the wind or current acting against the tender, when the buoy is not unhooked smartly. Care must be taken in handling the vessel not to drag the buoy off station. In every case, after the buoy is clear, its position should be verified by check angles (preferably other than the ones used in placing the buoy initially) or by other available means. An excellent proof of angles is to read them around 360° (close the horizon) when possible. If more than one observer is taking the angles, they may not total 360° exactly, being generally 6 or 8 minutes different.

27–11–5 Three-Point Horizontal Angle Fix—

A. *Selecting objects.*—Extreme care must be used in selecting objects for the three-point horizontal-angle fix. The latest and largest scale chart should be used, taking care to select prominent objects such as major lights, church spires, towers, or buildings which are indicated on the chart and are readily distinguished from surrounding objects. If points or tangents of land are used, choose, when practicable, rocky bluffs or clear out rocky points that are less subject to change.

B. The theory of the three-point fix is as follows:

(1) The circumference of a circle can be described through any three given points.

(2) If two points are fixed in position, the angle between them measured at a third point will be the same for all points on that part of the circumference of the circle on the same side of a line joining the two fixed points.

(3) If, in addition to the first angle, a second angle is measured from the same unknown point to two points, one of which always, and both of which occasionally, differ from the first two, the position of the unknown point will also be defined by a second circle. Since the unknown point lies on the circumference of the two circles, its position will be defined by their point of intersection.

C. *"Strong" or "weak" fix.*—The three-point fix may be either "strong" or "weak," depending on the relative position of the objects selected to the location of the observer. Care should be taken to select, whenever possible, objects that give the strongest possible fix in accordance with the rules given under paragraph (D) below. The strength of a position determined by a three-point fix depends directly on the angle of intersection of the two circumferences defined by the two angles and the three known points. Consider now in figure 27–309, a circle may be drawn through points A, B and P (A being the lefthand object, B the right, P the position of observer). Similarly another circle may be drawn through B, C, and P (C being the righthand object). The angle of intersection of these circles determines the strength of the fix; the more nearly this intersection approaches 90° the stronger the fix, the more nearly the circles approach tangency, i. e., the angle at interception approaches 0°, the weaker the fix.

D. *Rules for a strong three-point fix.*—The following general rules will be useful in selecting objects:

(1) The strongest fix is when the observer is inside the triangle formed by three objects. In each case the fix is strongest when the three objects form an equilateral triangle, with the observer at the center, and the objects are close to the observer. (See fig. 27–309.)

(2) The fix is strong when the sum of the two angles is equal to or greater than 180° and neither angle is less than 30°. The nearer the angles equal each other, the stronger the fix. (See fig. 27–310.)

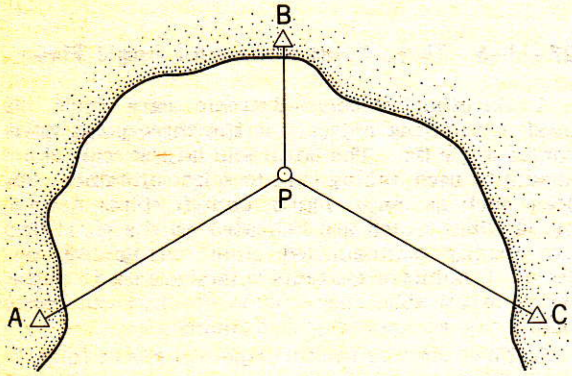

FIGURE 27–309.—Illustrating a strong three-point fix.

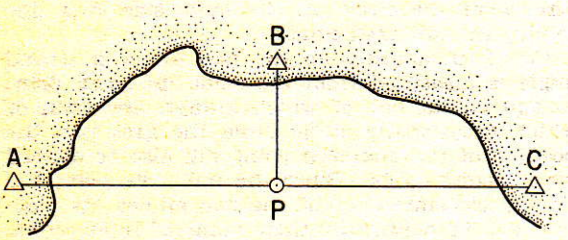

FIGURE 27–310.—A strong three-point fix.

(3) The fix is strong when the three objects are in a straight line and the center object is nearest the observer. (See fig. 27–311.)

(4) The fix is strong when the center object lies between the observer and a line joining the other two, and the center object is nearest the observer. (See fig. 27–312.)

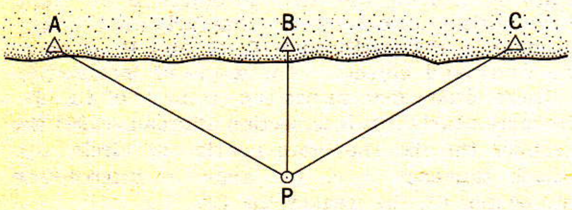

FIGURE 27–311.—A strong three-point fix.

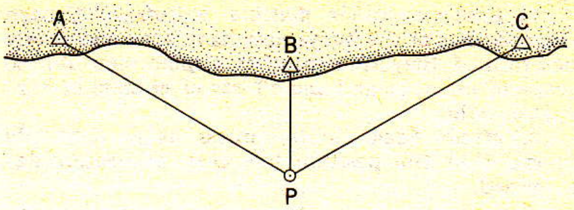

FIGURE 27–312.—A strong three-point fix.

(5) The fix is strong when two objects are a considerable distance apart and in range, and the angle to the third object is not less than 45°. (See fig. 27–313.)

(6) A strong fix will be obtained with one small angle when the vessel is a little off range and the nearer of the two objects in the range is the center object. (See fig. 27–314.) In this case the small angle must be observed very accurately and the position of the two range objects must be very accurately plotted, or large errors in position will result. It should also be noted that such fixes are strong only when the center object is nearest the observer; it will become very weak when the observer moves to a position where the distant object is the center object.

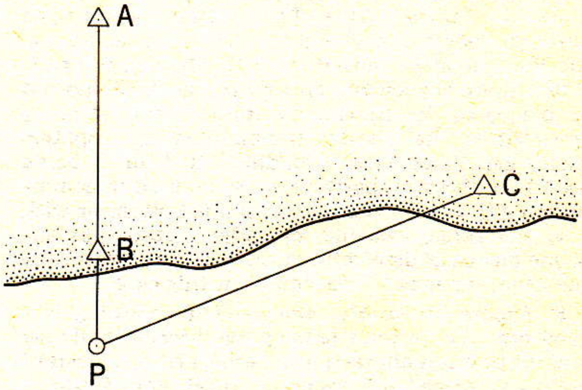

FIGURE 27–313.—A strong three-point fix.

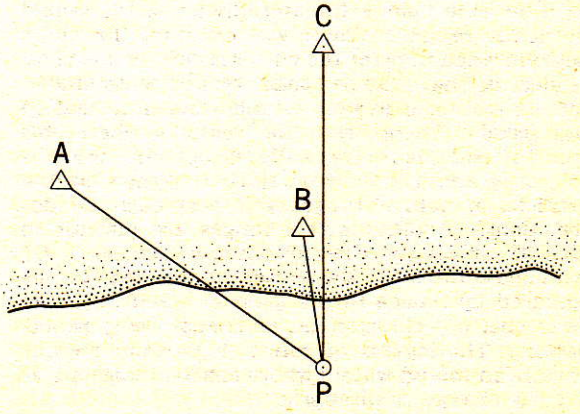

FIGURE 27–314.—A strong three-point fix.

E. *Caution—"revolver" or "swinger" fix.*—Avoid using objects where the two circles coincide, or the angle of intersection is near 0°, because the position becomes indeterminate and results in a "revolver" or "swinger." When an attempt is made to plot such angles with the protractors, the protractor may be moved along the arc of the coincident circles, since any point on them will satisfy the conditions. (See fig. 27–315.) An easy method for checking objects to determine whether or not a "revolver" is being inadvertently used is to erect a perpendicular bisector to the chords between the center and left and the center and right objects respectively. With the intersection of these two perpendicular bisectors as a center, draw a circle through the three objects. Any point on or near this circle is a "revolver" point.

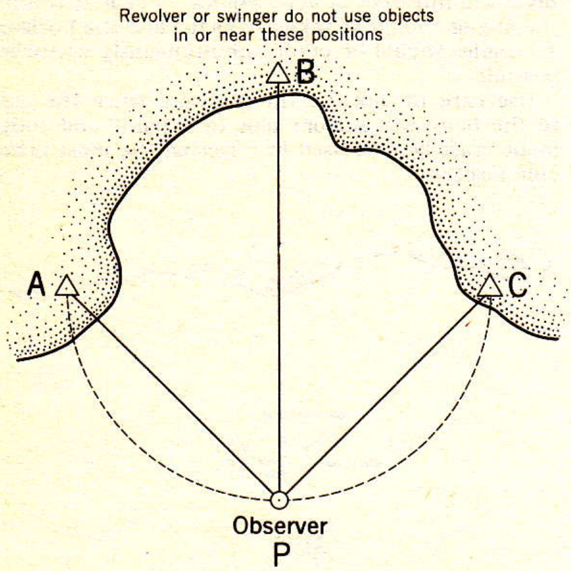

FIGURE 27–315.—Unsuitable arrangement of objects for a three-point fix.

F. *Avoid small angles.*—Generally, small angles should be avoided, as they result in weak fixes. Avoid using indefinite objects or one whose position is uncertain. Do not use buoys as objects, as their positions change with the current and the drift of the mooring.

G. *Plotting.*—Theoretically, a three-point fix cannot be plotted precisely on a Mercator projection, the error varying with the latitudinal and the longitudinal distance between the buoy and the shore objects. A line of sight is a portion of a great circle, and for precise work the angles must be converted to Mercator bearings before plotting. On large scale harbor charts, or for offshore locations where the buoys are within a few miles of the shore, the difference between the actual and plotted positions is negligible. However, considering a buoy 10 miles offshore in Florida and Maine, the difference between actual and Mercator bearings are about 2½ and 5 minutes, respectively. This will explain why an angle taken to a fourth object may not check exactly with the three-point fix.

H. *Locating position by three-point fix.*—Although the method of locating position by two sextant angles between three objects is somewhat trial-and-error in its application when attempting to maneuver the ship or small boat to the point where the angles are "on," there are several steps that may be taken to make the job easier.

(1) One method of locating a buoy position used by many vessels is to "angle in" the buoy being relieved, plotting its actual position on the chart and thereby obtaining an approximate bearing and distance to the correct position of the buoy. This may be estimated to assist in maneuvering to bring the correct angles "on." Depending on location, the angles may be taken from the tender or small boat.

(2) A marker buoy may be dropped, its position found by angling, and the estimated direction and distance to the correct spot obtained. Several markers are usually dropped before the exact spot is found.

(3) When it is not desirable or feasible to approach the buoy (due to rough weather or close proximity of a shoal, etc.) then any of the methods listed below may be used.

(*a*) See the methods involving the special cases of a three-point fix described in section 27–11–10.

(*b*) Using table 11 of Bowditch, "Distance by Angle Between Object and the Horizon Beyond," obtain the distance from the vessel to the buoy by observing accurately the angle between the waterline of the buoy and the horizon beyond, from a known height of eye. The position of the ship being fixed simultaneously, the bearing of the buoy observed, and the distance computed, the position of the buoy may be plotted.

(*c*) Table 11 of Bowditch "Distance by Angle Between Object and the Horizon Beyond," can also be used advantageously when relieving a buoy, using the procedure described under Paragraph (H) (1) above, particularly if the old buoy is well off station where distance would be hard to estimate. Determine the position of the buoy being relieved as in Paragraph (H) (1) above, and from the chart obtain the bearing and distance to the correct position. Compute from table 11 the vertical angle for the distance involved. As the tender steams toward the buoy on the proper bearing, observations of the vertical angle of the waterline of the buoy to the horizon beyond will indicate when the ship is coming "on." Of course, the position should be verified by the usual three-point fix angles.

(4) If a mental picture is held of the arcs of the two circles passing through the buoy and the respective pair of objects, it may be easier to maneuver as the angles approach their correct value.

(5) Here is one method that has been used successfully: Use two observers if possible, and have each measure the actual angle at frequent regular intervals, calling out to the conning officer the difference in minutes between the observed angle and the correct charted angle. For example, "left 20 large, right 12 small." This denotes to the conning officer that he is outside the circle of position passing through the buoy and the center and right hand objects, but is inside the circle passing through the center and left hand objects. Therefore he maneu-

vers accordingly, and is able to watch the effect of his maneuvering on the angular differences as the observers report to him every few minutes of change.

(6) In any method using sextant angles, the angles should be observed from a single observation station. When angles are observed from aboard a tender, the observation station should be as near as practicable to the point from where the sinker is dropped. When necessary, due allowance should be made for the difference in location between these two points.

27–11–10 Special Cases of the Three-Point Fix—

A. *To fix position when not at that position.*—To cut in the position of a buoy or other station from a point away from the position, proceed as follows:

(1) Fix successive positions of the vessel or launch by three-point fixes, from each of which a simultaneous sextant angle is measured from one of the objects to the buoy. The vessel should be stationary at each three-point fix since accurate results cannot be obtained from a vessel underway.

(2) For best results, the angles should be measured simultaneously, and if verification is undertaken, the angles should be interchanged among the observers.

(3) The ship or launch positions should be carefully selected so as to give strong fixes, and so that the cuts to the buoy will give a good intersection at the new station. A minimum of three cuts should be taken, and the more nearly they approach an intersection of 90°, the stronger the fix.

(4) The above method is useful for cutting in prominent objects ashore which are not charted but which would be useful for future observations as a control point.

B. *Three-point fixes on range with shore objects.*—The position of a buoy may be determined by observing three-point fixes at three or more ship stations, each of which is on a range with the buoy and a shore object. The position of the buoy is easily determined by graphic plotting. (See fig. 27–316.) The shore stations should be selected to give the best possible intersections at the buoy. A fix is observed when the ship is exactly on range with the buoy and the shore object at any convenient distance (a quarter to one-half a mile) from the buoy. The fix may be repeated several times if

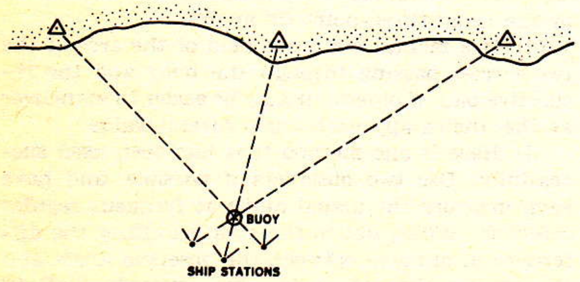

FIGURE 27–316.—Buoy location from ship stations in range with shore stations.

desired, while steaming slowly directly away from or toward the buoy, but keeping the observation station exactly on the range.

In order that the angles will be observed when exactly on the range, the observer who is viewing the buoy direct, not reflected, should give the mark. (This is possible in all cases except when the ship is on range with the right hand object.)

C. *Observations between buoy and shore.*—A buoy may be located by sextant at a *maximum distance* from shore by observing three-point fixes at successive ship stations *between* the shore and the buoy simultaneously with cuts to the buoy. This method requires unusual care to avoid an uncertain position of the buoy. The successive ship stations should be selected with care, so that the position determinations will be strong and the cuts to the buoy will intersect at good angles. For best results, the angles should be taken so as to close the horizon. All angles should be taken simultaneously whenever possible.

Use care in plotting the position, since the cuts to the buoy will seldom plot to a point and judgment must be exercised in selecting the most probable position.

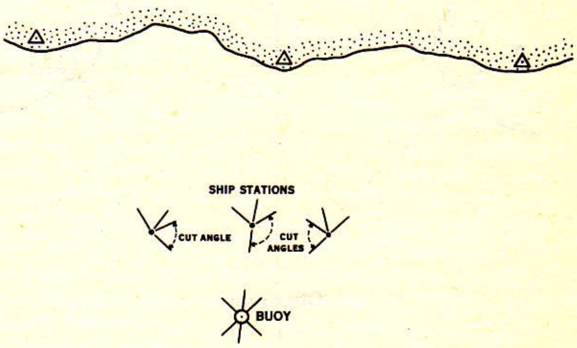

FIGURE 27–317.—Buoy location by cuts from ship stations.

D. *One angle at buoy and one cut from three-point fix.*—A buoy station may be established in hazy weather, with the expectation of determining its position by sextant fix at the buoy when conditions become more favorable. Assume that only two of the three shore stations are visible. Measure the angle between the two objects, and at a point further inshore, selected to give a good intersection with the locus of the angle obtained at the buoy, obtain a three-point fix simultaneously with a cut to the buoy.

To plot graphically, plot the three-point fix first and draw the cut to the buoy. Next, set the angle observed at the buoy on a metal protractor, and orientate the center along the direction of the cut until the arms of the protractor intersect the objects ashore. The center of the protractor is the center of the buoy. (See fig. 27–318.)

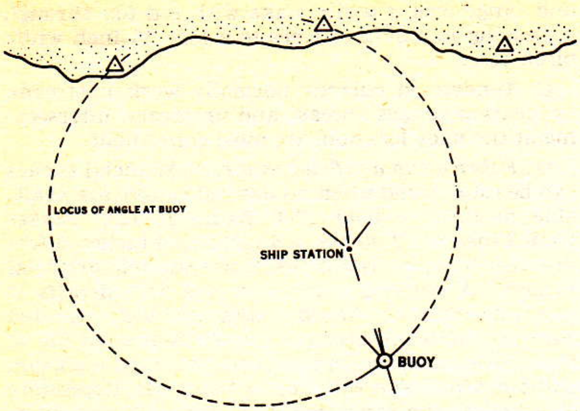

FIGURE 27–318.—Buoy location by one angle at buoy and one cut from a ship station.

E. The above methods are widely used in hydrographic survey and may at times be useful in aids to navigation work. There are many cases where objects are not visible at the buoy yet are visible a little further inshore, or when conditions are not safe for going alongside of a buoy, etc.

27–11–15 Other Methods of Locating Position—

A. *Range and angle.*—The use of one natural or artificial range and the angle between one of the range objects and another object is simple to implement. One runs down the range until the angle is "on."

B. *Range and sounding.*—A single range and a sounding may be utilized in a similar manner. This is, of course, not subject to pin-point accuracy, except perhaps when running across the edge of a dredged channel.

C. *Two ranges.*—Two natural or artificial ranges are excellent for positioning buoys. However, as in all cases, careful soundings should be taken, since the topography of the ranges or the character of the bottom may have changed since the last relieving.

D. *Radio direction finder and radar.*—It has been found that radio direction-finder bearings are seldom sufficiently accurate for positioning a buoy except as a last resort. A radar may give a position to within + or − 2 percent or + or − 50 yards accuracy, depending on which is the greater. However, here again the bearing may not be too accurate. Other methods should be used whenever practicable.

E. *Loran lines of position* when calculated under favorable conditions may give accuracy of from 200 to 500 yards.

F. *Inclined angle and azimuth of the sun.*—In locating offshore buoys where the available fix is weak, or where only two shore objects are available, the method of sun azimuth and one angle will result in a better location than magnetic or gyro bearings. (See fig. 27–319.) The procedure is as follows:

The angle between the two shore objects is measured at the time the buoy anchor is dropped, after which the tender is maneuvered until on range with the buoy and one shore object. An inclined angle from the near tangent of the sun to the shore object at the visible horizon is measured and, simultaneously, an altitude is observed on the sun's lower limb. Corrections for index error and semidiameter must be applied to observed h and i, and from these values the horizontal angle between the tender, shore object, and sun is computed from the formula:

$$\cos a = \frac{\cos i}{\cos h}, \text{ where } a = \text{the horizontal angle;}$$

h=the altitude of the sun's center; and i the inclined angle to the sun's center. The azimuth of the sun, as obtained from azimuth tables is then added to or subtracted from the computed horizontal angle to obtain the true azimuth of the line between

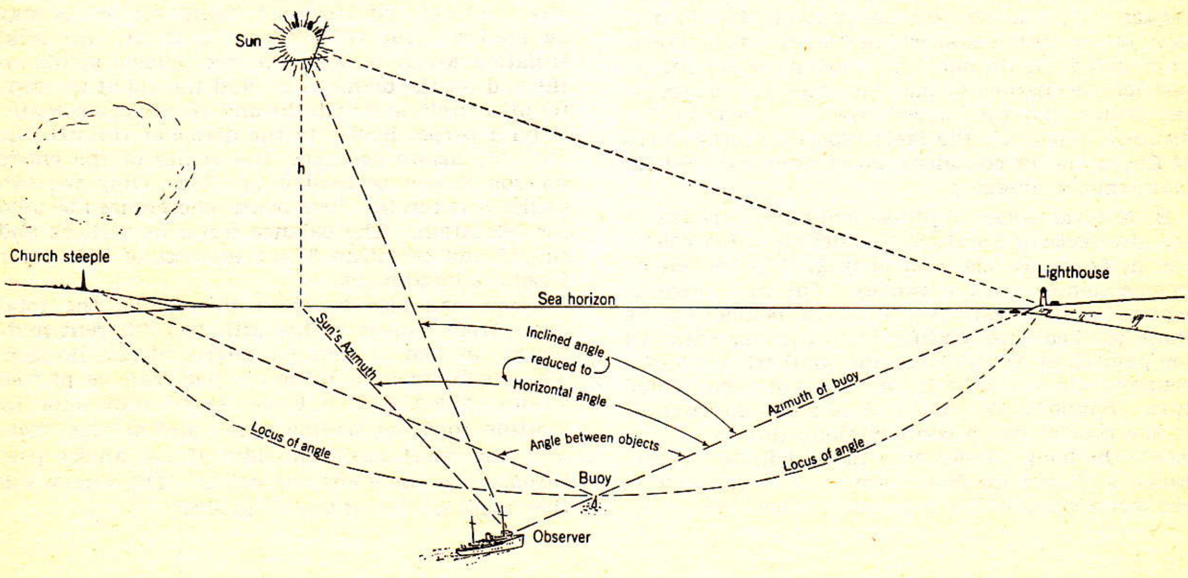

FIGURE 27–319.—Location of offshore buoy by sun azimuth and one angle.

the tender, buoy and shore object. This line is plotted on the chart. The intersection of this line with the locus of the angle measured between the two shore objects is the position of the buoy. A convenient form for computing the observation follows:

1. Watch reads		Obs. *h*	
2. Chronometer—Watch		Index corr	
3. Chronometer time		Semi diam	
4. Chronometer corr		*h*	
5. G. C. T.			
6. Eq. of time			
7. G. A. T.		Obs. *i*	
8. Longitude		Index corr	
9. L. A. T.		Semidiam.	
10. Hour angle		*i*	
11. Azimuth of sun from tables			
Log cos *i*		No correction should be included for parallax or refraction.	
Log cos *h*			
Log cos *a*			
a			
Sun's azimuth (11 above)			
Azimuth buoy to shore object			

The above computation neglects the dip correction which is generally small.

27–11–20 Buoy Location on Inland Waterways—

A. *Establishment and maintenance of artificial buoy location ranges*, or logging of natural location ranges will more than justify the additional initial work and subsequent maintenance involved. Location ranges aid in proper replacement of buoys on station, indicate the location at which a buoy sunk on station may be recovered, and will make shoaling formation or other changes in the channel edge apparent. Buoys should never be set on station solely by use of the location ranges without sounding the channel line or project depth contour adjacent to, above, and below the buoy, to insure that it marks navigable water of project depth. Shallow water on the channel side of the station marked by location ranges will of course indicate shoaling, bar formation, or an obstruction which had not been previously noted. If the shoaling is extensive, tending to restrict the channel or make it necessary to reroute the sailing line, the buoy should be moved out, the distance noted and the facts reported to the Corps of Engineers for consideration of probable need for maintenance dredging.

B. *Natural ranges* of permanent nature are best if the intersections are sharp and definite. For example, in figure 27–320, nun buoy 27/2 is located by intersection of natural ranges. The first range is normal to the stream over a natural boulder on the shore marked with a white vertical stripe with red top painted at water's edge and southerly edge of a concrete silo at southerly end of a red gable roofed barn. Sounding in toward shore from the channel to the project depth contour along this range will locate the buoy. However, a more definite location which will show up shoal formations is available at the intersection of the first range above with a second range over a white stake with red top through a clearing in clump of trees to a lone 15-inch white birch tree.

C. Tenders in current normally work upstream, so location ranges abreast and upstream, intersecting at the buoy location, are most convenient.

D. *Fabricating artificial ranges.*—Artificial ranges can be established when no natural ranges are available, as for nun buoy 27/6, figure 27–320. Stakes from 2 inches x 2 inches to 4 inches x 4 inches, 5 feet to 6 feet long, or iron pipes, make suitable artificial ranges. A painted strip on a tree will identify it as a range marker. Wooden stakes should be treated with carbolineum, creosote or Wolman salts for at least 2 feet of the sharpened end, the middle portion painted white, and with red or black top, depending on whether the range marks a nun or a can buoy. As a rule, red top stakes will be located on the nun side of the channel, and black top stakes will be located on the can side of the channel. However, where one bank or the other is not suitable, both ranges may be located on one bank and identified by their colors. A combination of artificial and natural ranges will often prove advantageous.

E. *Range and one angle.*—A sextant used with one set of artificial or natural ranges will locate a buoy very carefully, as for can buoy 27/5, figure 27–320. The buoy will be on the natural range through the sheer vertical face of rock bluff, and the boulder abreast of nun buoy 27/2. With the sextant at the buoy location, read the horizontal angle from the range line described to the center of the semicircular cave entrance in the right bank rock face as 97°–25 minutes. Relocation is accomplished by moving along the natural range with sextant set at 97°–25 minutes until the cave entrance satisfies the sextant angle.

F. *Three-point fix.*—Sextant locations using horizontal angles only will locate a buoy quite accurately from three points. If to be located on or from a chart, the three points should be chosen on the chart. If merely to relocate without use of chart, any three suitably located recognizable points may be used without reference to a chart. An ideal situation would be with the two outside points on the ends of the diameter of, and the aid at the center of, a circle, and with the mid-point approximately on a perpendicular to the diameter through the aid. To insure accuracy, the angles of the entire horizon should be read if possible. Only the two angles between the three points chosen need be used for relocation. The balance serves as a check and should add to within 6 to 8 minutes of 360° for a 1 minute instrument.

Check can also be made by reading the total angle from outside points with two different mid-points, in lieu of reading angles of the horizon. The angles read, if to be charted, can be plotted without the use of a three legged protractor by plotting them on tracing paper and moving them over the chart until the sides of the angles pass through the three charted points. The vertex will then mark the site of the aid located.

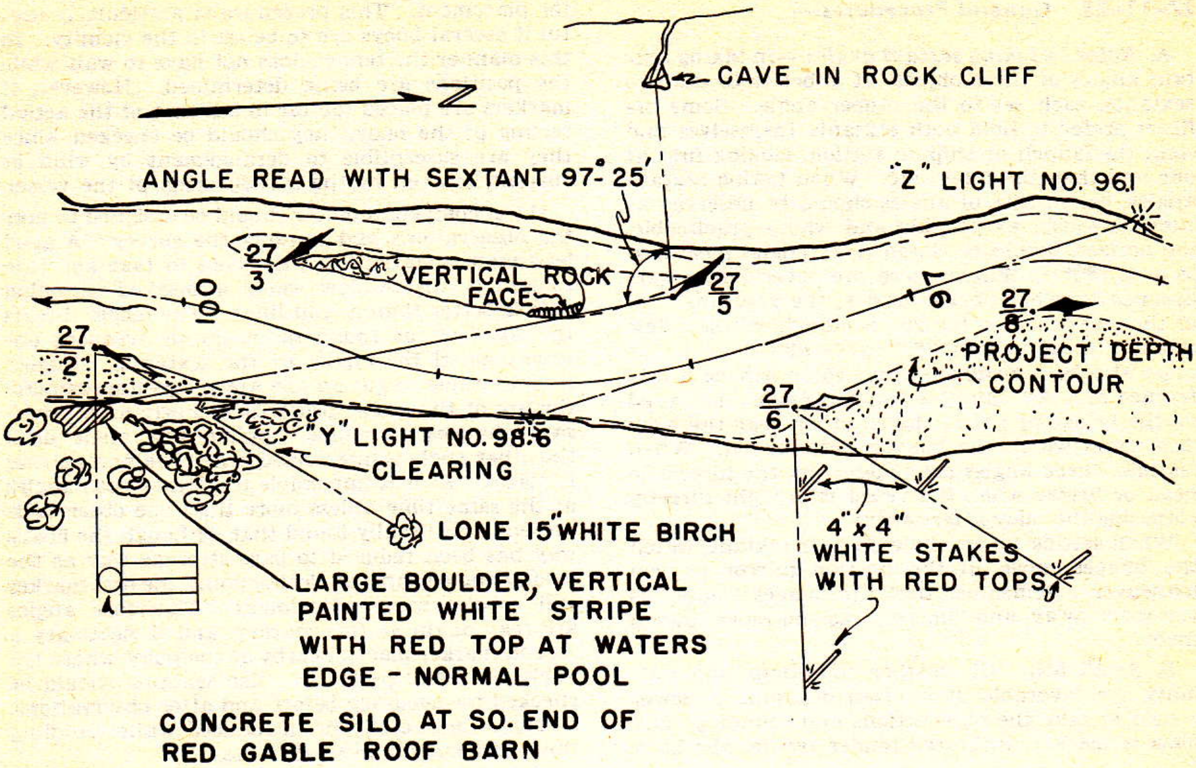

FIGURE 27–320.—Typical examples of buoy location in the Mississippi River area.

G. *Records.*—Notes of sketches should be kept for each buoy location to avoid confusion, assure proper location of the buoy, and to permit replacements of artificial ranges. It is well to place the artificial ranges, whenever possible, to at least the project depth plus two feet above the normal water level, so that the buoy can be checked or replaced as long as there is need for it on station.

H. *Caution.*—Never set a buoy on shore location ranges without sounding the channel above and below the buoy to make certain that the edge of the channel has not shoaled in since location ranges were last adjusted. The ranges will be of assistance in recovery of buoys sunk on station.

I. *Intracoastal Waterway.*—Buoys along the Intracoastal Waterway are generally placed along the bottom edge of the channel, which is found by careful soundings. Objects for taking sextant and bearings are seldom available. Most channels on this waterway are dredged and the edges are straight and definite. Positioning of buoys which are abreast of minor lights is done by sounding into the bottom edge of the channel and placing the buoy directly abreast of the light. The distance usually varies from about 75 to 125 feet. If measurement is required, it may sometimes be done be using the tender as a yardstick. Buoys between lights are also placed on the bottom edge of the channel, which puts them all in a straight line along the same reach. Distance apart is often done by estimate or "by sight." With experience, one becomes quite precise in this manner of estimating. Of course, if objects are available, angles are taken in the standard manner.

The spacing of buoys can easily be checked by computing time, speed and distance problems. The exact distance between two minor lights being determined from the chart, unless unusual changes of current are present, reasonable accuracy may be obtained over short reaches. Buoys in the Intracoastal Waterway are generally spaced equidistantly between minor lights.

J. *Use of tag-line.*—Many unlighted buoys which mark channel banks are set by means of a tag-line. The ship's work boat runs down the channel range, using a sextant angle between the range and one object to determine midchannel position between two opposite channel buoys. A marker is set at this midchannel position and the tag-line sinker dropped here. The boat now runs slowly directly athwart the channel until the tag-line measures one-half the channel width where another marker is dropped. The procedure is repeated and the other buoy marker located. The tag-line is retrieved and the positions checked with soundings. When all the markers are set, they are aligned to make a fair line along the edge of the channel. (If necessary to move the markers, they should never be moved outside the channel bank, but just enough to complete the alignment.) The ship checks each marker again before setting the buoy, using angles, bearings, soundings, etc.

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27–11–25 General Procedures—

A. *Notes on taking sextant angles.*—In taking sextant angles of three objects, it is better to use two sextants, each set to the proper angle. Some officers prefer to hold both sextants themselves and conn the launch or ship on station, looking first at one and then the other, etc. When taking sextant angles, each series of angles should be observed as simultaneously as possible and where practicable, the horizon should be closed (i. e., angles measured to total 360°). Where there are several observers grouped together on the bridge, the resulting sum of the angles, if the horizon is closed, will be a few minutes greater than 360°, generally 6 or 8. It must also be remembered that there will be a difference of a few minutes between angles measured on the bridge and those taken on or near the buoy deck from which the buoy is actually set. When feasible, check angles are taken from the forecastle head or bridge when the vessel is brought directly alongside the buoy after setting.

When setting up an angle on your sextant, watch the images move in the horizon mirror as you maneuver. Remember that the images "close" as you move away, and "uncross" as you move toward them.

B. *Small boat.*—If weather conditions and visibility are favorable, it is often desirable to lower a boat to take the observations and soundings and place a marker, while the tender readies the buoy for placement. This procedure is particularly useful if several buoys are to be set in the vicinity. In this manner the tender does not have to wait while the positions are being determined. However, if markers are placed too far in advance of the actual setting of the buoy, they should be checked, since they are susceptible to derangement by wind or current, or even by the maneuvering of the vessel.

(1) A competent officer should be assigned to take the observations and conduct the survey. A good leadsman is stationed in the boat to take accurate soundings (in shallow water a marked sounding pole is better than a lead line). The officer directs the coxswain as found necessary by frequent observations of the angles by the sextants. Usually, it is desirable to get on one angle and approximate the arc of the circle, proceeding slowly with necessary changes of course, holding this angle until the other angle is intersected, when the first marker is placed. As it is impossible to observe both angles at the same time unless more than one observer is present, it is usually found that, although the boat's way has been reduced to bare steerage way as the second angle nears the closing point, the first marker will require some adjustment. Therefore angles are read again at this marker, and if necessary a second marker placed nearby at the point where the angles intersect perfectly. The sextants should be checked for accuracy before and after observations, as errors may easily be introduced while handling these instruments in small boats.

FIGURE 27–321.—Ranges used to locate York Island Shoals Lighted Bell Buoy 1A, Lake Superior.

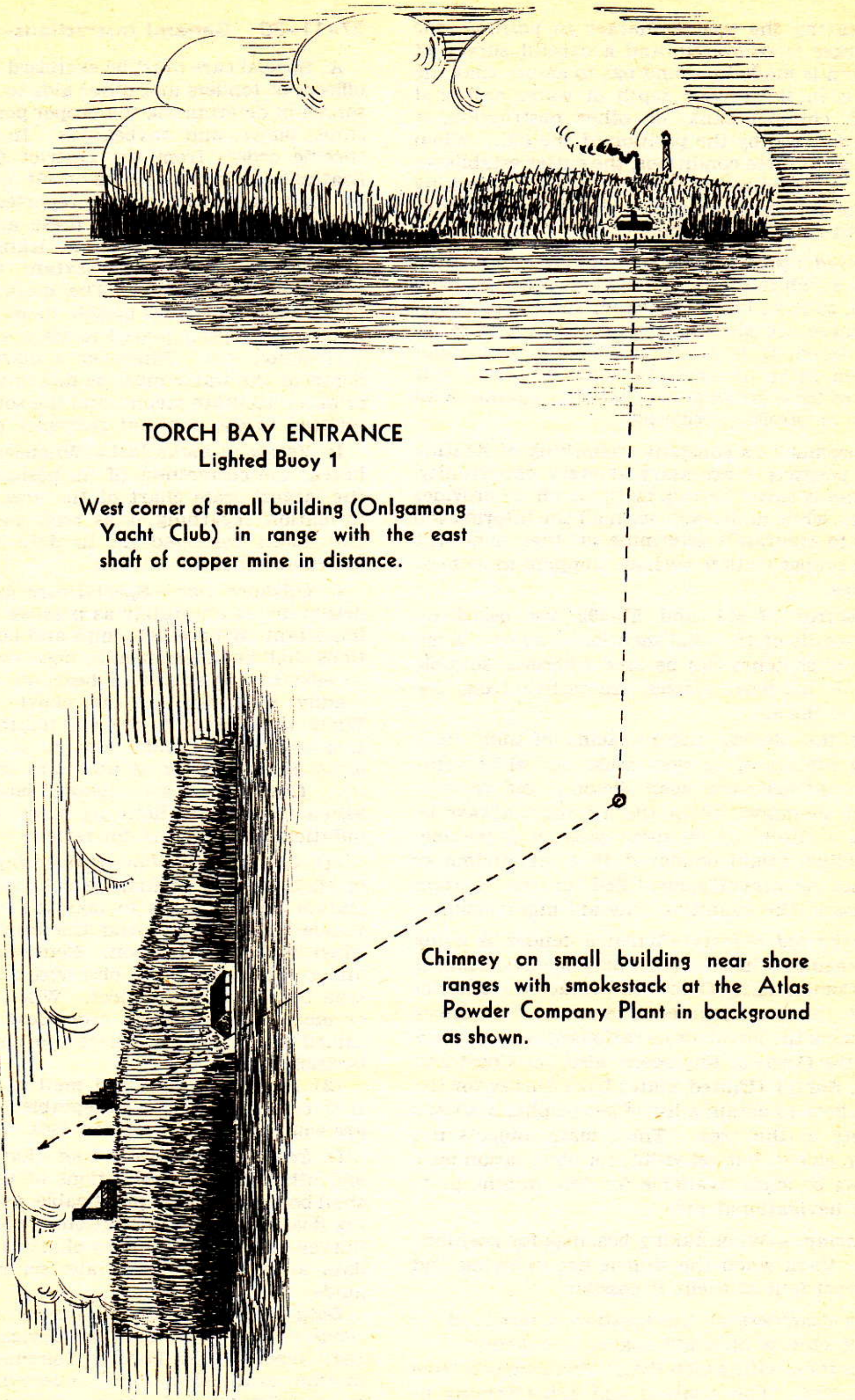

FIGURE 27–322.—Ranges used to locate Torch Bay Entrance Lighted Buoy 1, Lake Superior.

(2) Leaving the second marker in position, the first marker is recovered, and a careful survey of the bottom is made by soundings to assure that the marker is in the proper depth of water and that the reef, channel bank, or other obstruction, is properly marked by the position of the aid. When satisfied as to these conditions, the cutter establishes the aid, proceeding cautiously, while rechecking soundings and angles to insure that the marker has not moved in the meantime.

C. *Record visible ranges.*—Landmarks can often be found which fall in line of sight, as observed from the buoy, to form cross ranges for future reference. Where these are absent, or where only one range can be found, it is often possible to erect small targets on shore to serve the same purpose. The location of these landmarks or targets, together with sketches, is carefully recorded.

(1) Inasmuch as constant rechecking of floating aids for position is necessary at every opportunity, much time is saved by this method, which provides the cutter, while under way, with all the information required to accurately determine whether or not the aid is on proper station, without stopping to recheck the angles.

(2) Figures 27–321 and 27–322 are based on tender records of the kind mentioned above. Such ranges and sketches can be used wherever suitable natural or artificial ranges are visible from the location of the aid.

(3) In the placing and replacing of aids, commanding officers of tenders must not place complete dependence upon such sketches and records. Sufficient soundings about the aid must always be taken as a check, for in some cases, it is possible that buildings might be moved, that the landmarks might not be properly identified, or that bottom conditions in the vicinity of the aid might change.

D. *Uncharted objects.*—When a tender is going to work regularly in an area, it may be advantageous for the Commanding Officer to contact the District Engineer, Corps of Engineers, to obtain field drawings showing the locations of various survey markers used by the Corps of Engineers; also, the Coast and Geodetic Survey (United States Lake Survey, for the Great Lakes) to obtain a list of geographic positions of objects in the area. Thus, many objects not shown on charts, but yet visible for observation purposes, can be made available for determining positions of navigational aids.

E. *Bearings.*—When taking bearings for positioning, take them when the ship is not swinging and plot at least four of them, if possible.

F. The exactness of the position determined by means of objects observed ashore is dependent on the correctness with which the observed objects have been charted. The symbols and abbreviations in figures 27–324 and 27–325 are shown on Coast and Geodetic charts and can nearly always be referred to as objects the positions of which have been accurately determined.

27–11–30 General Instructions—

A. Special care must be exercised by commanding officers of tenders and other aids to navigation personnel in determining the proper positions for lightships, buoys, and daybeacons. In the absence of specific orders from the District Commander, all floating aids found missing or out of position should be replaced and promptly reported. Every effort must be made to replace these aids as near the correct positions as possible, using the available landmarks, the lead, the sextant, the charts, and other available means. The usefulness of an aid to navigation depends mainly upon the certainty of finding it properly placed to mark a channel, shoal, obstruction, etc. Whenever a buoy is placed, the depth of the water must be determined by the lead or other accurate means, and the sounding obtained reduced to the plane of reference of the charts.

B. *Verify in Light List.*—Whenever a buoy is relieved, the correctness of its position as shown on the largest scale chart of the area, and other information regarding it as published in the Light List (both corrected up to date from Notice to Mariners) shall be verified.

C. *Offshore aids.*—Special care must be taken to determine as accurately as possible the positions of important offshore lightships and buoys. The positions shall be determined by observations at the aid, by sextant angles and/or bearings on fixed objects readily identified on the chart, when possible. When such methods are not feasible, obtain position by utilizing radio aids to navigation, radar, loran, soundings, or, if necessary, by dead reckoning. Check by an astronomical position if feasible. When such observations are made, submit all computations for the work for review.

(1) *Checking position of lightship.*—One method of checking the position of a lightship while on a station near shore is to take the angle between a visible object ashore and the bearing of the sun when in the true horizon. Compute the amplitude and combine with the observed angle to give the true bearing of the object. When done with two or more objects ashore, cross-bearings will be obtained which may be plotted to check the vessel's position.

(2) Any other standard method of determining true cross-bearings is acceptable. New lightships are equipped with gyrocompasses.

D. *Service publications and charts.*—Light Lists and other official publications of the Coast Guard shall be used so far as practicable, as a guide in placing floating aids to navigation. Coast and Geodetic Survey charts, Lake Survey charts and other survey data so far as they exist, also serve as a basis and guide.

Data affecting charts.—Commanding officers of tenders and other aids to navigation personnel, shall report to the District Commander any information obtained by them affecting the accuracy or completeness of charts, sailing directions, or other nautical publications, including notes as to prominent landmarks, dangers, or important improvements not shown, or erroneous information on the charts. When desirable, sections of charts

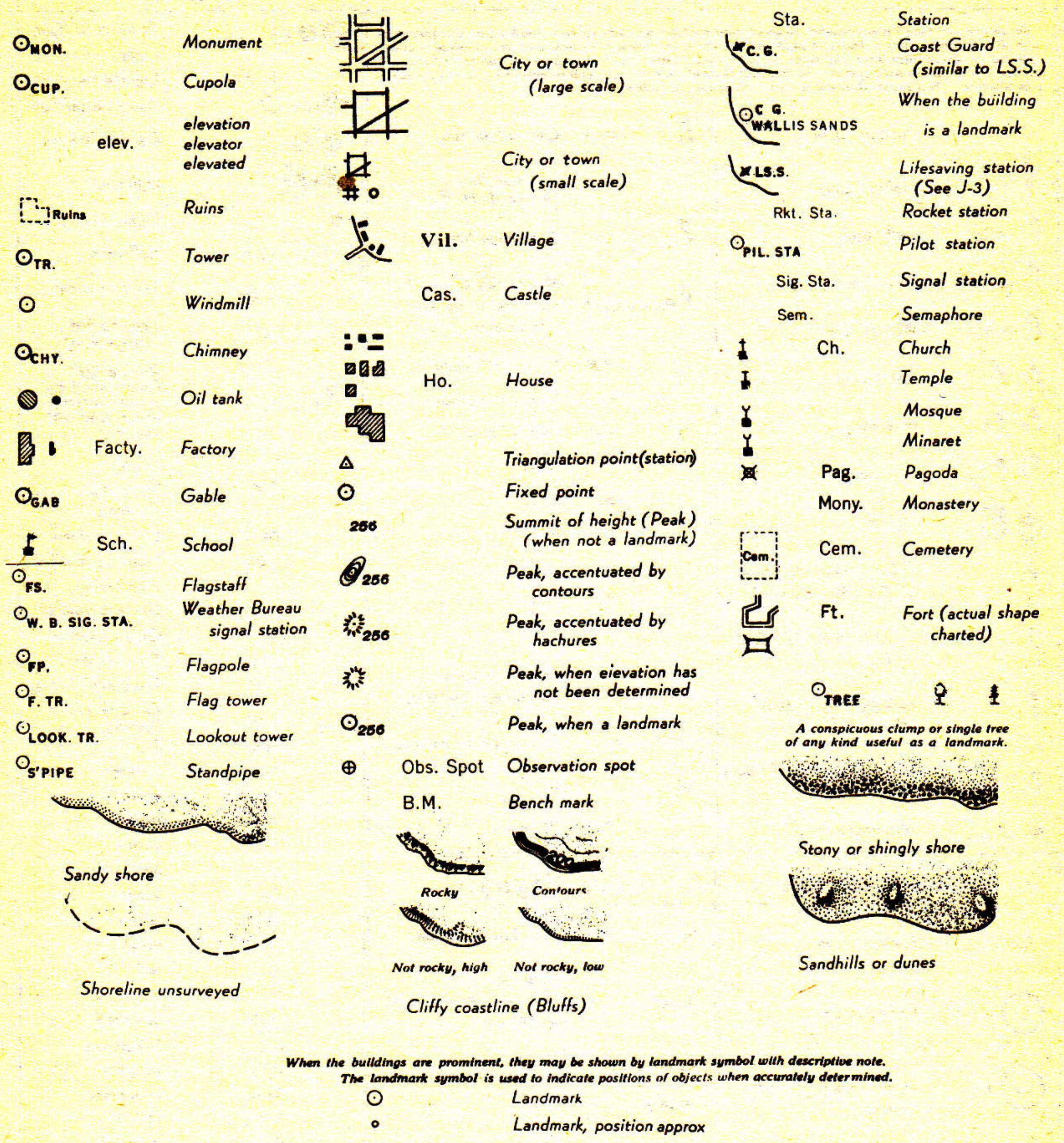

FIGURE 27–323.—List of chart symbols and abbreviations.

Buoys and Daybeacons

On entering a channel from seaward, buoys on starboard side are red with even numbers, on port side black with odd numbers. Lights on buoys on starboard side of channel are red or white, on port side white or green. Mid-channel buoys have black and white vertical stripes. Obstruction buoys have red and black horizontal bands. The dot of the buoy symbol, and the small circle of the light vessel and mooring buoy symbols indicate their positions. This system does not always apply to foreign waters.

•	Position of buoy
	Lighted buoy
BELL	Bell buoy
GONG	Gong buoy
WHISTLE	Whistle buoy
C C	Can buoy
N N	Nun buoy
S S S	Spar buoy
	Lightship
	Fairway buoy (B. & W. V. S.) (Mid-channel)
	Junction buoy (R. & B. H. B.)
	Isolated danger buoy (R. & B. H. B.)
	Wreck or obstruction buoy (R. & B. H. B.)
	Mooring buoy
Y Quar.	Quarantine buoy
	Fish trap buoy (W. & B. H. B.)
	Anchorage buoy
Priv. maintd.	Maintained by private interests; to be used with caution
H.B.	Horizontal bands
H.S.	Horizontal stripes
V.S.	Vertical stripes
W.	white
B.	black
R.	red
Y.	yellow
G.	green
Br.	brown
△ ▲▲	Fixed daybeacons (unlighted daymarks)
MARKER	Private aid to navigation
⊙	Landmark
REF.	Reflector

Lights

	Position of light
Lt.	Light
Lt. Ho.	Lighthouse
Aero	Aeronautical light
	Lighted beacon
	Lightship
	Lighted buoy
REF.	Reflector
	Limit of sector
------	Leading line (Range line)
Priv. maintd.	Private light (maintained by private interests; to be used with caution)
F.	Fixed
Occ.	Occulting
FL.	Flashing
Qk. FL.	Quick flashing
I. Qk.	Interrupted quick
Alt.	Alternating
Gp. Occ.	Group occulting
Gp. FL.	Group flashing
S-L	Short-long
F. FL.	Fixed and flashing
F. Gp. FL.	Fixed & group flashing
Rev.	Revolving
min.	minutes
sec.	seconds
ev.	every
vis.	visible
m.	nautical mile
Gp.	group
SEC.	sector
G.	green
R.	red
W.	white
OBSC.	obscured
(U)	unwatched
Irreg.	irregular
Temp.	temporary
Vert.	vertical
Hor.	horizontal
D.	destroyed
V.B.	vertical beam
Exper.	experimental
R.	range
AERO	aeronautical

Radio Stations

⊙ R.S.	Radio station
⊙ R.Bn.	Radiobeacon
⊙ R.C.	Radio Direction Finder Station
⊙ R.Tr.	Radio tower
⊙ R.Tr. (WEAF)	Commercial broadcast

Fog Signals

Fog Sig.	Fog Signal Station
HORN	Diaphragm horn (Electric, steam, or air) Reed horn
DIAPHONE	Diaphone
SIREN	Siren
BELL	Bell
WHISTLE	Whistle
GONG	Gong
D.F.S.	Distance Finding Station

FIGURE 27–324.—Symbols and abbreviations used by the United States Coast and Geodetic Survey for indicating aids to navigation on nautical charts. (For complete list of symbols and abbreviations used by the United States Coast and Geodetic Survey, see their chart No. 1.)

should be used in forwarding this information. The District Commanders will forward such reports to the Commandant for transmittal to the office issuing the chart or other publication.

E. *Plotting of aids.*—Persons required to plot exact position of aids will use the largest scale chart available. Sextant angles actually observed will be used, and from the position thus determined there should be taken three bearings, intersecting at not less than 30° when practicable, on fixed objects which may be readily identified on charts; the distance in yards or miles (nautical on the sea and Gulf coasts; statute on the northern lakes and rivers) should be given to the most convenient one of these objects.

(1) *Bearings taken from charts* should not be stated closer than it is practicable to read them from the graduations engraved on the charts, i. e., not closer than one-half degree. In taking off bearings from compasses on charts, the full diameter of the compass should be used, rather than the radius. All bearings should be stated in degrees true, beginning at 0° at north and reading clockwise to 360°.

(2) *Bearings and angles shall be observed* from the position of the aid at the time the aid is being established, or changed in position, on three or more fixed objects readily identified on the charts, when practicable. If only two objects are visible, give angle between them, and the true bearing to one of the objects.

(3) *Correct compass bearings.*—Where compass bearings are taken they must be corrected for compass errors, and converted to true bearings.

F. *Sounding contours.*—When necessary to check, the charted hydrography, bottom contours should be developed by adequate soundings in the vicinity, giving date and time of day soundings are made. Refer depths to the plane of reference of the chart used.

G. *Report all reliable data.*—Report all the reliable data readily available. While two sextant angles to well-defined fixed objects on the chart will ordinarily fix the position of the aid, additional angles are desirable as a check. The position shall be plotted on the largest scale chart available, before leaving the locality of the aid. If the position appears to be doubtful, the angles or bearings shall be verified by observing them again.

H. *Identity of observers.*—Where more than one person has assisted in the work, the names of all should be entered on the report of location of the aid. All observations should be checked by the person certifying to the correctness thereof.

I. *Liaison with other agencies.*—It sometimes is not possible to carry out these instructions without consulting with charting agencies and securing their assistance in the way of location of reference marks, monuments, signals, ranges, etc., and even actual surveys in the field. This cooperation of charting agencies may be furnished in a number of ways such as:

(1) By placing on the chart certain existing landmarks suitably located for taking bearings or angles when establishing and changing locations of buoys and other aids. These marks may or may not be especially valuable to the mariner.

(2) By erecting or leaving in place survey targets for the same purpose indicated in paragraph (1) above.

(3) By leaving in place certain shore dredging targets useful for lining up buoys to mark a dredged channel.

(4) By actually performing the field surveys and furnishing the correct position of aids on fixed structures.

(5) By furnishing coordinates of visible survey control points, not always desirable for charting, but useful in determining positions of aids.

J. *Form CG 2555, "Report on Position of Aids to Navigation,"* must be submitted to the District Commander by the Commanding Officer of the tender and by others, whenever action is taken affecting the position of an aid to navigation. This information forms the basis for Notice to Mariners and correction of charts.

K. *Observation of aids.*—A careful inspection by tenders in passing will be made of the appearance, position, functioning, and characteristic of all aids to navigation. Any unauthorized deviation therein or indication of neglect shall be promptly reported to the District Commander, and in the case of unattended aids, the defect shall be corrected by the tender if this can be accomplished without interference with more urgent work.

27–11–35 Position of Buoys Marking Sunken Wrecks—

A. *Important function.*—The proper marking of sunken wrecks is an important function, due to the existing danger to navigation and the future possibility of litigation involving the Coast Guard. Chapter 5 of this manual deals with the marking of wrecks in detail.

B. *Where placed.*—Buoys to mark wrecks should be placed as close to the wreck as practicable, and on the seaward or channelward side of the wreck.

C. *Caution.*—Commanding Officers of tenders must exercise extreme care in approaching or searching for a wreck. Since Coast Guard vessels are not normally equipped for wire drag investigations, unless the wreck is easily located or already marked, the Corps of Engineers should be requested to assist in its location. When searching for a wreck, use small boats whenever practicable for taking soundings, rather than expose the tender to danger. Take a complete set of soundings so as to reveal the contour of the wreck and submit a sketch when necessary. Be alert for portions of the wreck which may have broken away and constitute a menace in another location which might require additional marking.

D. *Measure distance.*—In the absence of specific instructions of the District Commander, the marking of a wreck shall be in accordance with Chapter 5 of this manual, and the exact location of the marking shall be carefully fixed. In addition, whenever possible, a measurement of the distance of the buoy from the wreck should be determined by whatever means available. Some vessels have made up a reel of measuring line consisting of small wire, or heavy cod line or braided line. A measuring line will be found useful in other aids to navigation work as well as for the purpose outlined above. Another method of measuring distances from a buoy to a wreck is to take the sextant angle from a small boat located over the wreck between the mast head of the tender when alongside the buoy and the waterline. Solve the problem, or use tables to find distance.

27–11–40 Training Observers in Taking Angles—

A. Maneuvering a tender into a given location quickly and efficiently by means of two sextent angles only, requires considerable practice. This practice can best be obtained on shore, with one observer taking angles and recording them accurately, and another observer taking the sextants and recorded angles and finding the spot which can be identified by placing a coin or other object just under the soil. This practice offers a challenge to the accuracy of both observers, as the recorded angles must be fully described and accurately taken and recorded, in order that the second observer may find the spot. It offers the second observer good practice, since the leeway found in boat handling is eliminated and he can retrace steps taken in the wrong direction and make a study of errors. There is a knack to be acquired, both in taking and writing up angles, and in understanding the vagaries in maneuvering a vessel to the correct spot.

27–11–45 Establishing Buoy in Unmarked Location—

A. Following is a suggested method for establishing a buoy in an unmarked location: assume that a tender has orders to establish a buoy on a submerged, detached shoal, 3 or 4 miles from shore. The buoy is to be established on the 30-foot contour at the most southerly point of the shoal.

(1) Obtain protractor angles from the chart of the approximate position of the buoy.

(2) Anchor the tender about one-half mile from the location.

(3) Take the work boat with 8 or 10 marker buoys and place 1 buoy on the angles taken from the chart. It is unlikely that the final position of the buoy will be here.

(4) Run 300 or 400 feet up either side of the shoal in deep water, and cutting in towards the shoal, take soundings and place a marker on the 30-foot contour. Then sound continuously following the 30-foot contour, setting markers every couple of hundred feet or so until the south end of the shoal

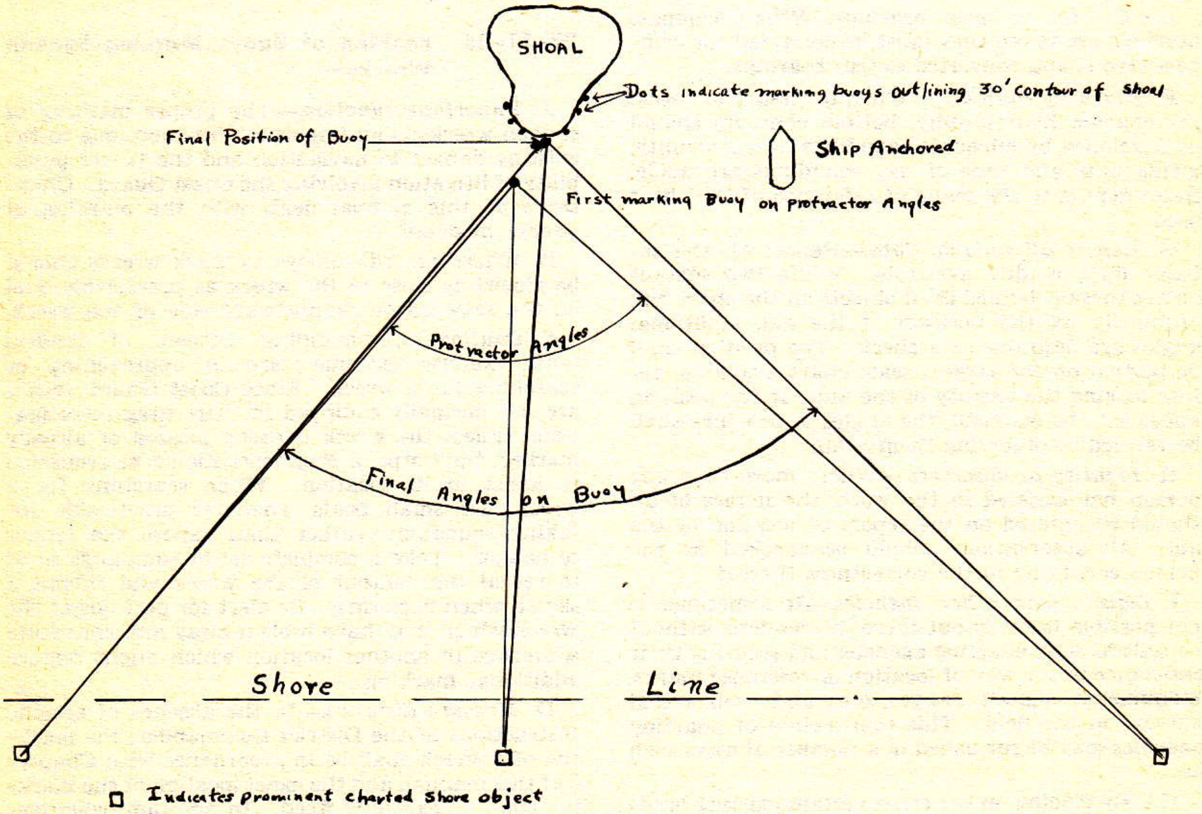

FIGURE 27–325.—Establishing a buoy in an unmarked location.

has been rounded and marker buoys continued for 300 or 400 feet up the opposite side of the shoal from the starting point. The marker buoys will then be in a semi-circular pattern providing visible evidence on the surface of the 30-foot contour around the south end of the shoal.

(5) Proceed to the extreme south end of the shoal, sound out the immediate area and establish the exact location of the buoy.

(6) Set the buoy with the tender.

(7) Obtain angles and ranges of the exact spot. Destroy the original angles taken from the chart as they have no further use, and if retained might at some future time be confused with the correct angles.

27–12 ICE SEAMANSHIP

27–12–1 General—

A. Inasmuch as a number of 180-foot-class tenders are or may be engaged in icebreaking activities from time to time, a discussion of fundamental principles and procedures will be included in the following sections. A more complete study of ice formation, classification, physical and chemical properties, movement and drift, notes on types and fitting out of vessels for extensive ice operations, and other pertinent data, has been prepared by the Navy Hydrographic Office and is available to units upon request.

27–12–5 Classification and Description of Ice—

A. *Fast ice* forms in sheltered bays, gulfs, and fiords, as well as among floating lumps of old ice. Developing along the shore and spreading into the sea, it joins the new ice formed around islands, grounded floebergs, and floating masses of old ice. Though then subjected to repeated fracturing, with the fall in temperature of the air, it spreads farther and farther into the sea, increasing in thickness and offering more and more resistance to breaking up. Finally, in the first months of winter, it reaches its maximum offshore extension, beyond which the region of the pack is found. The development of the width of the fast ice belt depends upon the configuration of the shore, since the more rugged the coast line and the greater the number of islands in its vicinity, the greater is the width of the fast ice; it also depends upon the relief of the bottom, since the shoaler the sea, the less prevalent are strong currents and wave motion. Stranded hummocks in shoal water also assist fast ice development.

B. *Pack ice* is composed of sea ice frozen in the open sea, of detached fragments of fast ice formed along the coast line, and to a lesser extent, of disintegrated particles of land ice. These elements are not uniformly influenced by winds and currents; as a result there is a differential movement with a decisive effect upon the composition and stability of the pack. This conglomeration drifts under the influence of wind and tide, current, and the component due to the earth's rotation. Pack ice is classified according to compactness of arrangement into consolidated pack, close pack, open pack, and drift ice. The ice masses themselves, according to size, may be ice fields, floes, blocks, or pancakes; according to surface, may be level, or hummocked; according to thickness, may be light (up to 2 feet in thickness) or heavy (more than 10 feet in thickness).

C. *Influence of the wind.*—Under the influence of variable winds, the ice, in all seasons of the year, is torn apart in some localities, forming lanes of open water, and elsewhere is crowded together. Where lanes are formed, the ice always breaks along a jagged line, and when the ice fields move apart, they may also be displaced laterally. When they close due to change in wind direction, the two sides of the lane do not fit; corners meet corners, and openings of different shapes remain between the corners.

D. *Pressure.*—Often consolidated pack, the heaviest form of pack ice, will drift from shore or will separate, forming leads or passages through the ice area. Massive detachments of ice resulting from hummocking are called floebergs. These should not be confused with icebergs, or growlers, which are of glacial origin. Pressure ridges are formed by a very large external loose floe riding upon a fixed floe or upon the shore, or by elevation of the ice above the normal level under the pressure of the wind or the current. They are higher near the shore and lower at the sea end.

E. *Cracks.*—Sea ice when newly formed is highly plastic and readily conforms to stresses. It acquires brittleness with age, and reaches a state of strain where it may require but a slight impulse to break it. This impulse is usually provided by the wind. This tendency to crack is always present in an ice field, whether composed of young ice or hummocky floes. All cracks are due to the relief of strain produced by stresses set up by sudden differences of temperature, by unequal loading, or by pressure. Although cracks are due to the relief of stress within the pack, they also allow movement of the pack. Blocks and floes are the product of cracks and, under the influence of the wind, they constantly shift their relative position, thereby producing leads which make the pack navigable. Such openings, however, permit the production of pressure and formation of hummocks, which make the passage through the pack dangerous to vessels.

F. *Bending, tenting, and rafting.*—Pressure set up in the pack produces bending, tenting, and rafting. The first stage, bending, occurs in thin and very plastic ice. In heavier floes, which are less resilient, the ice bends up until a crack is formed perpendicular to the direction of pressure, resulting in a tentlike structure. Other radiating cracks usually occur and, if the movement is continued, the blocks so formed pile up into a pressure ridge. Rafting is the overriding of one floe on another and is the most common effect of pressure.

27–12–10 Movement and Drift of Ice—

A. *Effect of wind and current.*—Sea ice, other than fast ice in sheltered bays or along the coast, is continually in motion as a result of the effects of wind, tide, and current. Although this motion may be the same for a time over a considerable area, there is a number of factors tending to produce differential motion of adjacent masses. Cakes, for example, vary in area and thickness, so that the effect of wind and current differs on different masses of ice. Wind and current are also subject to continual local variations, wind from the usual meteorological causes, and currents from tidal effects.

B. *Screwing effect.*—The swinging or turning of ice floes is due to the tendency of each cake to trim itself to the wind when the pack is sufficiently open to permit this freedom of movement. In close pack this tendency may be produced by pressure from another floe; but since floes continually hinder each other, and the wind may not be constant in direction, even greater forces may result. Thus wind, produces rotation as well as translation. This screwing or shearing effect results in excessive pressure at the jutting corners of floes, and forms a hummock of loose ice blocks. Ice undergoing such movement is called "screwing pack," and is extremely dangerous to vessels.

C. *Accordion movement.*—In its motion the ice opens and shuts like an accordion; there is always a certain number of lanes present, otherwise the ice could not move. Swell also tends to break up the ice, as well as the vertical movement of the tide in narrow or shallow waters. As a result of all these agencies, the ice is alternately being broken up and subjected to pressure.

D. *Hummocking.*—As moving floes are driven together or pressed against fast ice, bending, tenting, or rafting occurs, according to the degree of pressure and the composition of the ice. Definite ridges may thus be formed, the lines of which are at right angles to the direction of impact; or confused pressure areas of hummocky ice may be formed. The longer the pressure lasts, the greater the chaos produced. The release of pressure gives rise to lines of weakness in ice fields in the form of cracks or lanes. These are often parallel to pressure ridges, but owing to internal stresses an ice field does not necessarily crack in its thinnest part. Thus, cracks are frequently found passing through ridges and hummocks of considerable height.

E. *Regrouping.*—Any wind will tend to regroup ice that is more or less scattered over a considerable area. As the wind rises, the separate floes form lines in a direction at right angles to the wind direction. These chains break up when the wind changes, and after a time realign themselves at right angles to the new wind direction. When the wind blows from the shore, a channel of open water usually forms between the coast and the ice or increases in width if already existing. On the other hand, a wind blowing on to a coast or on to fast ice tends to reduce the width of the channel previously existing. If the wind is strong enough, hummocks will be produced along a line approximately perpendicular to the wind direction.

F. *Effect of temperature.*—The air temperature as influenced by the wind also has an effect on the grouping of ice. If the wind which has regrouped ice is a cold one, the lowered temperature may cause further freezing, so that the masses may become joined by new formation.

In this case, the ice would not be so readily broken up and regrouped by a change of wind. On the other hand, if the weather is mild, cakes brought together by a change of wind will not drift together.

G. *Direction of drift.*—Pack ice drifts with the wind and tide, usually to the left of the true wind in the Southern Hemisphere, and to the right in the Northern Hemisphere. The speed of drift may not depend entirely upon the strength of wind, since it is influenced by the pressure or absence of open water in the direction of drift, even though the open water is somewhat distant. Neglecting the resistance of the ice, Elkman's theory of wind drift calls for ice to drift 45° from the wind direction. Observations show that the actual drift is about 30° from the wind direction on the average, or very nearly parallel to the isobars on a weather map.

27–12–15 Shipboard Precautions—

A. *Removing snow.*—Sweep decks clear of snow before it has an opportunity to form a crust or become trampled and hardened. This is particularly essential on the bridge and on the gangways. Extreme care should be exercised when using scrapers to remove ice close to electric cables and equipment because of the possibility of breaking them loose from switch boxes and other connections. Salt water hosing is a rapid means of melting snow and clearing decks but should be used only in nonfreezing weather after making sure that overboard deck drains are not frozen.

B. *Cover running rigging.*—All running rigging that can reasonably be covered should be provided with canvas covers. Lowering a boat with ice on the falls and cleats is a very dangerous operation. Canvas covers are considered a necessity for all deck winches and appliances. They are also essential for open boats if the bilges are to be kept dry.

C. *Fire-fighting apparatus.*—Secure firemain cutout valves on firemain risers to weather decks and drain plugs at lowest point between riser and plug. Drain fire hose on weather deck and dry in heated compartment before restowing in racks. Keep proportioners in heated compartments adjacent to a hatch or door where access to weather decks will permit rapid connection to be made to the fire plugs. Drain them after use, and dismantle, dry, oil, and reassemble the chamber change-over valves. In using fire hoses at freezing temperatures, satisfactory results can be obtained if good pressure is maintained; however, when the pressure is reduced or the hose is secured, the nozzle and plug may become frozen, and the nozzle must be replaced.

D. *Main engines.*—When operating in pack ice, keep the ship's main engines manned and ready for immediate use at all times.

27–12–20 Anchoring—

A. It may be advantageous to lie at anchor when in brash, but as little of the cable as possible should be paid out. The capstan should be kept ready for weighing in case of the approach of large masses of pack ice. When anchoring in rotten ice in shoal water, get into the ice as far as possible to avoid the swell; but if the water is deep and ice is present, anchoring should be avoided. It may be preferable to lie to and keep power available to move the ship as necessitated by the shifting floes. It is not recommended to anchor to the bottom while in pack ice, as in most cases it is useless and will probably result in the loss of the anchor and cable. The more successful and easier method is lying to with the bow wedged in the ice. This, however, would apply only to the icebreaker class of vessels because others would not be able to force themselves into the ice sufficiently.

B. *Riding to ice anchor.*—If deciding to ride to an ice anchor, choose a strong floe which can shelter the vessel from the surrounding ice. To insure as nearly as possible obtaining shelter of a natural dock, it would be well in making fast to a floe to take a position where a bight is formed by two strong projections. Such places may often be found. They offer at least moderate security in the event of other ice setting toward the ship, the projecting angles of the floes receiving the first shock.

Lay the anchor from the side of the floe where a patch of open water is formed, or where the surrounding ice is least packed. When riding to an anchor, the movement of the ice must be continually observed. If there is a risk of the ice surrounding the ship, weigh anchor and move into a more open region off another floe. Therefore keep the engines ready for immediate action. If a small berg or larger bit drifts down on the ship, it can frequently be avoided and permitted to drift clear by judicious use of the engines while at anchor.

C. *Choose shallow depth.*—In selecting an anchorage in a bay or harbor which is open to drifting ice, the shallowest depths should be chosen, provided other conditions are suitable.

D. *Fast ice.*—In bays or fiords where fast ice exists, the tidal currents may cause this ice to drift in and out of the harbor, rendering the anchorage unsafe. Fast ice in a harbor usually moves along a tidal crack and, under the force of onshore winds, may acquire violent motion. Vessels should quit moorings at the edge of fast ice whenever onshore winds blow.

27–12–25 Handling an Unescorted Vessel in Ice—

A. *Entry into ice.*—When a vessel encounters ice lying on her course, a careful decision must be made whether to attempt to penetrate the ice, or to steam around it. If the boundaries of the ice are in sight, do not enter, but skirt it to windward. In the case of larger ice areas, unless they fill straits through which the vessel must pass or completely block access to her port of destination, the vessel will generally find it more economical of fuel and time to take the longer way around the ice zone. When conditions make it necessary to enter the ice, the point of entry should be selected with great care.

(1) Consider the penetrability of the ice along the proposed course inside the edge of the ice field, with regard both to the thickness and the degree of consolidation.

(2) Never enter ice where pressure exists, as evidenced by tenting or rafting.

(3) If possible, enter the ice upwind. The windward edge of an ice field is more compact than the leeward edge. Moreover, the individual pieces of ice in violent motion from wave action will be damped out on the leeward edge. If it is necessary to enter downwind, use great care to avoid damage to the hull of the vessel through collision with the ice cakes.

(4) If the ice is thick and drifting rapidly, wait for a change in direction of the ice movement, which may be accompanied by an improvement in ice conditions. Take into account the time of ebb and flood; ice generally becomes more compact on the flood but begins to break up on the ebb.

(5) The ice edge is usually not straight, but often has projecting tongues between bights. Enter at such a bight, for here the surge will be least.

(6) Enter at the slowest possible speed, to reduce the force of the initial impact on the stem. Once the bow is in the ice and is cutting or pushing the ice aside, increase power to avoid losing headway and adjust revolutions thereafter in accordance with the state of the ice.

(7) Always enter the ice on a course perpendicular to its edge. Failure to observe this precaution may result in a glancing blow which will very likely damage the bow plating on the side toward the ice, and may swing the stern into the ice with resulting damage to rudder and propeller.

B. *Working through ice.*—Some guiding principles of working in pack are:

(a) Keep moving.
(b) Work with the ice, not against it.
(c) Do not rush the work.
(d) Respect the ice; do not fear it.
(e) Stay in open water or leads.
(f) Watch the propeller.
(g) Never hit a large piece of ice if you can go around it: if you must hit it, hit it head on.

The type, thickness, and area of ice which can be attempted depend on the type, size, strength, and shaft horsepower of the vessel employed. Ice covering up to five- or six-tenths of the sea surface is passable by all powered vessels, for a way can always be found around individual blocks or masses of ice. Independent navigation by vessels in ice covering more than six-tenths is more difficult; the commanding officer's experience in ice navigation, and the existence of leads or areas of open water are the things that count. Bearing in mind the contour of the coast, the position of islands, and the direction of the wind and permanent currents, one may form an idea of the direction in which the ice may be getting thicker or breaking up. The state of the ice should be viewed from as great a height as possible.

C. *Determining direction.*—Constant attention is necessary, so that the most favorable direction in which to proceed can be determined by noting the presence and distribution of leads or polynyas near the line of course. Pressure ridges should also be looked for so that they can be avoided and all movements of the ice noted. Arctic and Antarctic whalers consider that ice which has a greenish-blue color is the hardest and should be avoided where possible.

D. *Maneuverability.*—When working in ice, the maneuverability of a ship is reduced. At the slow speeds often required, a vessel will answer her helm badly and be slow in turning. A short ship turns more readily and is thus easier to maneuver in ice. When the use of full power is limited, a kick at full speed after the helm is put over may be found of assistance. If the ship is down by the head, steering will be especially difficult. On the other hand, although some protection may be offered the propeller and rudder by trimming the vessel down by the stern, if overdone this impairs the maneuvering properties of the ship. The bow, because of its large sail area, will fall off in a moderate breeze. The result is that the stern will be brought up against the ice. Stopping the main engines to protect the propeller results in losing headway and accelerating the falling off. If way is lost entirely, the ship will gather sternway in a moderate breeze, and drift into the ice, thereby endangering the rudder and propeller. On impact with ice, the ship will move in the direction of least resistance without regard to the position of the rudder. With experience, a helmsman may be able to take advantage of this fact.

E. *Ship going astern.*—Go astern in ice only with extreme care; put the rudder amidships, and keep a sharp lookout for ice under the quarter. Again, a twin-screw vessel is at a particular disadvantage when backing in ice, owing to the great likelihood of pieces of ice being sucked in toward the ship and jamming between the propellers and the side. One system for working astern when breaking ice which has been found expeditious is to:

(1) Allow the screw to wash the ice astern for a few minutes before backing.

(2) Back full until just before contact with debris, then

(3) Stop and allow momentum to carry the vessel well into the debris.

(4) When all ice has surfaced, give a kick ahead and stop.

(5) Back full again, repeating the process until the ice canal is of sufficient length to ram it full speed on the next lunge.

F. *Direction of cracks.*—The line of a crack or lead in an ice field is usually normal to the direction of the movement of the field. A new crack will thus form according to the direction of the wind or current, and either widen out into a lane or form a new hummock. A field of ice does not necessarily crack in its thinnest part; frequently cracks are found passing through hummocks, leaving thin, half-melted ice holding it together. However, in many cases this half-melted ice is completely destroyed when the wind changes.

G. *Vessel forcing into ice.*—When a crack in a floe is but partly made, it sometimes is possible for a ship, by ramming her way into it, to complete the crack and widen it into a lane. A vessel may also force her way through an ice field of young ice, or through a bridge connecting two floes, if the bridge is not too thick and heavy. Great care should be taken in such operations, for old and heavy pieces of ice can withstand the impact of the most powerful vessel; even fairly stout ships can then suffer damage, but vessels that have been specially constructed for use in ice are usually so strong that their engines cannot force them against the ice with sufficient force to injure them by a head-on impact. Ships so constructed can charge the ice again and again, backing away for each charge.

A vessel may attempt to force a way through ice, but only in the absence of pressure from the ice due to the influence of winds or currents. Always avoid pressure ridges of any type. Such ridges are formed on a line roughly perpendicular to the direction of movement of the ice. Cracks may be formed in ice fields along the line of pressure, likewise perpendicular to the movement of the ice. Such a crack is usually covered with thin ridged ice from 1 to 3 feet thick. On the least change of wind the heavy masses may come together again, entirely crushing and grinding the thin ice between. A vessel should, therefore, in no circumstances proceed along through a pressure ridge. Other cracks often occur, cutting right through pressure ridges, which may be as much as 30 feet thick; these cracks are similarly covered with thin ice. Such a crack should not be entered, unless it is obvious that it will take the vessel quickly out of the whole area affected by the pressure.

H. *Motion of ice.*—Ice in the sea, other than fast ice, is in continual movement under the influence of wind or current, causing the various pieces or masses to gather together and move along, retaining the openings between. Heavy onshore winds and swell break up the ice, and if offshore winds follow, the ice will open out, making the waters navigable. Once broken up in mild weather, the pack ice will not recement if brought together again, and consequently will open more readily to light winds. Proceed through the lanes thus formed, even if they do not lead in exactly the same direction as the vessel's course; by proceeding through weak patches in the ice from one lane to another, a ship can thus make good her course. To avoid ultimately taking the vessel far from its objective, it should be impressed upon conning officers that the compass must be closely watched while navigating leads and care taken to adhere within reasonable limits to the base course. An offshore wind usually forms a channel between the coast and the pack ice which is frequently used by navigators, who must, however, be on guard against an onshore wind setting the ice back onto the coast. In such a case, shelter should be sought in a bay, behind an island, or even behind a floe. The alternative is to proceed out to meet the ice so as to work a way through it to clear water beyond, before the floes pile up on each other against the land. However, this can only be done where one is reasonably sure of finding open water well away from the coast; it must never be done on coasts like the north shore of Alaska, unless direct information of open water offshore has been received. Northward of western Canada, Alaska, and Siberia, the amount of ice to be met increases with the distance from shore.

I. *Caution.*—If entering a narrow strait or bay into which the winds blow directly, keep an alert watch on drifting ice, since the greatest danger from ice exists in an enclosed space. If operating in an area to windward of a prominent point in the coast line, exercise caution; a sudden increase in the wind may bring the pack down upon the vessel which, if set toward a lee shore, may become quickly beset and subjected to pressure. Care should be taken when operating in the vicinity of ice tongues which project seaward from the coast line without reference to the trend of the coast line. An ice jam along an otherwise clear coast may indicate the existence to leeward of such a tongue. Stranded bergs, shoals, islands, and seaward extensions of land may produce ice jams, and vessels finding themselves to windward of such features must be prepared to quit the vicinity upon the appearance of pack ice.

J. *Two methods of progress.*—In slewing through pack ice there are two effective ways in which progress can be made through areas in which there are only cracks and narrow lanes between floes. In the first method, the vessel charges the openings between the floes and, upon impact, puts the rudder hard over. When the forward motion of the ship ceases, the rudder is reversed and the engines placed on half-speed ahead. The effect is to widen the opening and let the ship gain easier entrance. This operation is repeated until the floes yield, forming a lead wide enough to allow the vessel to proceed ahead. In close pack, the second method is employed when the first is not fully effective. In this operation, the vessel is used as a lever to force a path between the floes. Upon gaining entrance of the stem of the ship by ramming, the bow is brought up against that floe which is to be forced to leeward or in such direction that space is made available for the vessel's movement. The engines are then placed on full speed, and with full rudder the vessel is pivoted with the bow hard against the floe. The ship then acts as a fulcrum and effectively overcomes the inertia of the floe in contact which slowly picks up motion in the direction impelled. Sallying is often helpful in working a small vessel through narrow leads. Vessels should always be kept clear of corners and projecting points of ice masses as such points become the foci of pressure. In working the pack by slewing, skillful use must be made of the rudder to prevent the stern from swinging into the ice.

K. *Speed.*—Successful ice navigation is basically a matter of speed through the ice. Pack ice, unless very open, must be entered at the lowest possible speed, which should be increased only after observing the state of the ice and the extent to which it is possible to pass through it. The possible speed through ice is determined primarily by two factors, the amount of surface covered, and the possible force of impact with the ice without damage to the ship. When possible, maintain way on the ship at 2 to 5 knots so as to have some control of the rudder. Coasting into the ice with engines stopped results in the loss of effective rudder control. Ships must be prepared to back down emergency full at all times. When ice does cover more than six-tenths of the sea surface, the speed of a vessel passing through it without an icebreaker will depend on the distribution of leads and polynyas. If the distribution is suitable for navigation, the speed may even be increased to full from time to time. On the other hand, it must be reduced occasionally to examine the state of the ice and adapt the course accordingly. Ice covering seven- to eight-tenths of the surface must be traversed throughout at slow speed, so that any impacts with the ice will not damage the hull. Once inside pack ice covering eight-tenths or more of the surface, revolutions may be increased even to full with the object, not of increasing speed, but of forcing a passage through the ice by using the power of the engines.

L. *Operating in darkness.*—When darkness descends, or the visibility becomes poor, a vessel working her way through leads or weak areas in close pack should heave to or ride to an ice anchor. Otherwise she may unwittingly enter thick ice from which it will be difficult to withdraw when the visibility improves. On the other hand, when navigating at night or in poor visibility through more broken ice, it is recommended not to stop, but to proceed with caution at a very slow speed. Under such circumstances, keep searchlights manned for immediate use. The main criticism against using these lights is that they are located behind the observer (generally) and the glare partially blinds him. As an alternative, two portable lamps similar to "sealed beam" automobile headlights can be rigged so that they can be installed on the forward bridge bulwark and operated as necessary by bridge lookouts. A portable damage control lamp has also been successfully tested.

27–12–30 Hazards in Ice—

A. *Pressure.*—The most serious danger is that caused by the pressure of the ice on a vessel, which may result in the crushing of the hull or the nipping off of a ship's bottom. This risk is greatest when navigating in pack ice covering seven-tenths or more of the surrounding sea. Apart from this hazard, a vessel beset by ice and therefore drifting with it, may be forced into waters which are dangerous to navigation.

B. *Ice masses.*—Another danger is the meeting of masses of thick broken ice, especially those that bear signs of erosion by the sea on their upper surfaces. Such ice masses often have underwater spurs. The submerged portions of such pieces are extraordinarily strong and are hardly affected by melting. These can be very dangerous on impact with the hull or screws of a fast-moving vessel. Dirty ice, broken away from coastal regions, may sometimes be encountered at sea. This ice may also be very strong. Furthermore, it must be remembered that the strength of ice increases markedly with the approach of frost and the fall of air temperature.

C. *When making turns.*—When working through the ice, a ship makes use of every weak spot en route and is, therefore, frequently required to make sharp turns. If in trying to save time, these turns are made at all possible speed, the stern may be thrown against ice edges. Sometimes the blows are very heavy and a broken blade or shaft results. Sometimes breakage results from metal fatigue caused by the propeller hitting the ice frequently over a long period of time. In such cases, the loss of the blade or the entire propeller may occur almost imperceptibly. When navigating in deeply submerged old ice, the conning officer should therefore endeavor to make slow turns and prevent the stern from striking sharply against the ice. When maneuvering astern, a lookout should always be kept on the fantail with direct communication to the bridge and a warning system worked out. Most damage to propellers and rudders happens when ships are working at night in heavy ice.

D. *Ramming.*—When forcing a passage through the ice by ramming, it is necessary to pay strict attention to the loss of headway at the moment of running into the ice. If it is evident that as a result of the run taken the obstacle will not be overcome and the ship will stop, it is then necessary, to avoid being embedded, to go full astern even before she stops. At the moment when way is lost the engines should already be going full speed astern. It is not advisable to continue forcing a passage if the channel so made does not considerably exceed the beam of the vessel, so that she can move freely out astern. Moving forward in such a channel may cause the vessel to become beset or even eventually crushed. A vessel may sometimes be beset and yet be saved from pressure. When the besetting ice has underwater spurs, due to the melting back of the uppermost 2 or 3 feet of ice, these may act as a cradle for the ship.

27–12–35 Release of a Vessel—

A. *Sliding up on the ice.*—In endeavoring to avoid getting fast in ice it sometimes happens that taking a run at the ice may result not in breaking of the ice, but in the vessel's bow sliding up on the ice edge, so that she becomes fast. This tendency to slide up on the ice depends on the lines of the forward part of the ship and on her loading and trim. One or more of the following methods may be used for releasing the vessel.

(1) Go full speed astern. This may extricate the vessel, but it is not always successful. If it fails, stop the engines, put the helm over and go full speed ahead. By putting the helm over alternately from side to side and going full speed ahead, it is often possible to induce the stern to move a little to one side, so that the bow will move slightly; then by going full speed astern the vessel may slip off the ice.

(2) Try to split the ice by striking it at the point of pressure with crowbars. This is one of the simplest methods.

(3) List the vessel by transferring water in the ballast tanks.

(4) Alternately flood and empty the fore and after peaks. First flood the fore peak, and then empty the fore peak and flood the after peak.

(5) If the foregoing methods fail, try an ice anchor or warp attached to the ice astern. Pass the anchor cable through the mooring chock on the forecastle and lead it to the windlass. Take a strain while the engines are going full speed astern. An alternative of this method is to take an ice anchor or warp attached to the ice asetern. Pass the masthead.

(6) Lay out ice anchors on each beam and heave first one and then on the other, keeping the engines going full astern.

(7) If all these means fail, try blasting. The usual position for placing explosive charges is about 35 or 40 feet from the ship, abeam of the bridge. If the ship is only held forward, good places are directly ahead and at each side of the bow, the idea being to break off a portion of the floe without enough buoyancy to support the ship. A blasting charge of 8 ounces of guncotton in a hole 6 inches deep will blow a hole either through the ice or deep enough to use an 18½-pound charge effectively, and this is the amount generally necessary. At the time of the detonation, the engines should be working full astern. It may also be helpful to hold a strain on ice anchors laid out astern.

(8) When all else fails, a ship can be sawed out of the ice provided the ambient air temperature is not below the freezing point of the sea water.

27–12–40 Vessel Beset—

A. *If a vessel is in danger of getting fast,* especially if signs of pressure are evident, the commanding officer will be faced with the necessity of attempting to break through ice. The same problem arises if a floe which cannot be circumnavigated is encountered, provided no pressure is observed in the floe. Except in these circumstances, icebreaking should not be attempted by an ordinary vessel. It will be possible to break only ice masses which have already been so weakened by thawing that the impact does not damage the hull. Head blows against the ice must be avoided. The impact should be taken on the stem perpendicular to the edge of the ice. A blow struck at any other angle will not break through. Instead, the vessel will graze with her bow along the edge of the ice and the forward plating may suffer as a result of the blow. In addition, the stern of the vessel is thrown violently to one side and, on coming into contact with the ice, the rudder and propeller may be damaged. A blow against the ice can only be achieved by taking something of a run. The length of the run should be calculated in accordance with the hardness of the ice and the strength of the hull of the vessel. With a run, it is possible to open up a floe along the lines of narrow cracks and openings. It is necessary, however, to watch the ice very carefully to avoid hitting any projection that may buckle the plates.

B. *When a vessel is beset by ice, aground, or jammed between two ice blocks,* the above measures should be tried in an effort to extricate her. If they fail, clear away the ice at the sides of the vessel, although it is not always the ice at the sides that is the cause of stoppage. It is often the tongue under water which cannot very well be reached. In such cases it may be desirable to work on the opposite side of the ice masses, where possibly sufficient ice can be cut away to ease the pressure and permit the vessel to pass. Blasting by gunpowder or dynamite has been used to free ships that have been caught in the ice, or to open a passage when an intervening floe has blocked the way to open water. Passages opened by cutting or by blasting can sometimes be kept open long enough for the ship to pass through by placing some of the loose blocks of ice as wedges between the two floes, ahead and astern of the vessel. Men working on the ice at such times, or those crossing it on foot to look for a lead, should hold a boat hook or small ice pole in their hands horizontally, to guard against falling through a partly hidden crack. A strong plank drawn after one of the party can be very useful for crossing places too wide to leap across.

27–12–45 Operating in Ice—

A. *Find open leads.*—The most expedient way to traverse ice is to find the open leads and polynyas even if it entails actually going much greater distances than intended. Too frequently, ships that do not follow the above rule will find themselves back-tracking and looking for these open leads after having wasted many hours trying to bull their way through a short cut. Brash, slush, pancake, and new ice may tend to slow the ship but do not prevent her from maintaining a course. All these types are navigable by ordinary ships and are mentioned because they are quite frequently encountered. No particular skill or operating procedure is required except a good degree of common sense if these pieces of brash ice become heavy enough to throw the ice breaker off her course.

B. *In open pack ice,* where numerous big open leads are to be found, the progress of the ship will be determined by the conning officer's skill in spotting the best leads far enough ahead to keep his ship on the course nearest to the base course desired. Practically any speed desired may be used, provided caution is used in maneuvering around and between heavy floes in order not to strike the bow into these floes so as to cause the ship to be thrown off her course, possibly to such an extent that she will hit and rebound from floes on the other side. An experienced helmsman can maneuver the ship through this type of ice if the officer of the deck will merely point out to him which direction or lead to take and then let the helmsman use his own initiative. The passage of an icebreaker through this type of ice can be compared to an automobile driving through heavy traffic. The chauffeur can do better if back-seat drivers are kept to a minimum.

C. *In close pack or field ice,* the icebreaker literally runs into the real job of icebreaking. It is very serious business and must be approached with the highest degree of skill possible. First, the ship should be ballasted properly, down as much as the ballast and trim tanks will permit, not only to protect the propeller, but also to keep the engine injections low enough to avoid their being clogged with broken ice.

D. *Trim of vessel.*—The bow should ride lower than the stern in order to present a sharp cutting edge for entering ice. Because the center of gravity is moved forward under these ballasting conditions, more weight is concentrated forward to wedge the ship through the ice. As the bow comes up onto the ice, the ship's more buoyant stern is forced down; however, this extra buoyancy causes the stern to be pushed up again until it regains equilibrium with the bow. In effect, as the bow is lifted by the ice, there is a constant lifting under the stern tending to force the bow back down again. The weight of the bow, of course, is what breaks the ice. Another advantage of keeping the bow low is that the ice is broken and forced out along the sides of the ship where it will slide clear of the screws and rudder. It has been observed that where extremely heavy floes were run upon by a high bow and low stern, if there was not ample room for a floe to slide to one side due to the heavy pack, then the floe would slide under the hull and come up aft in the way of the propellers. However, the bow should not be trimmed down to the extent where the screws are raised appreciably, further endangering them.

E. *The momentum of the ship,* combined with the proper ballasting and use of the engine, is the greatest factor in breaking heavy ice. The full power revolutions for stalled conditions should be determined and the ship should make her approach to the ice at a predetermined number of turns. As the ship is slowed by the ice, more throttle should be applied to keep the shafts at the stalled condition full-load revolutions. This procedure gives the maximum power with the least possible strain on the power plant. There are times when the ship's progress is stopped completely and she must back down to take a new start and ram the ice. During this backing, caution must be used to see that the ship does not ram heavy ice that has drifted in astern, endangering the screws and rudder. Use only enough power to gain sternway.

F. *Snow-cover.*—An icebreaker's progress can be slowed appreciably by relatively low snow-covered hummocks with a snow cover of 24 inches or deeper in drifts. If the temperature is not too low, the snow forms a cushion absorbing a large part of the breaking force so that only a small percentage is effective in actually breaking ice. Frequently, the fuel consumption for one-half mile in this type of ice can be equal to that in 340 miles of open water.

G. *Rudder when going astern.*—It is also imperative that the rudder always be in the amidships position when backing down. If it is necessary to force back heavy ice that has drifted in astern, the ship should be eased up to the ice as slowly as possible until contact is made, then power applied and backing continued. This method will allow more of the ice to move along the side of the hull at the waterline rather than force it directly under the hull into the screws. One to three ship lengths is usually enough starting room for the next lunge at the ice.

H. *Heeling the vessel.*—In instances where backing down for new starts is necessary, the ship sometimes becomes wedged into the pack so tightly that she is unable to back out even with full power. This is a situation where the heeling system can help keep the ship on its way. It is believed that the heeling system should not be used continuously while underway except in heavy pack that is rotten enough to give a mushroom effect. That is, the ice is unmoved except in the direct path of the ship and the ship acts as a wedge which is driven in but does not break its way through. If the ship is heeling under these ice conditions, every roll she makes has the effect of extra, small wedges assisting in relieving her for another strike at the ice. Another situation in which heeling would be necessary is where large bergs or land on either side will not permit the heavy floes to move out of the ship's way, causing the ship to become wedged in. The necessity and importance of the heeling system cannot be overemphasized. It should be used only when it is necessary to keep the ship moving or to break her out in the event she is beset.

The 180-foot tenders have no heeling system; however, a similar effect may be accomplished by swinging weights from side to side on the boom.

I. *Watch results carefully.*—During the heeling of the icebreaker, when beset and attempting to free her, keep a careful lookout for the results, so as not to miss the moment when the icebreaker falls through the ice. At this moment, all engines must be backed, since during the listing of the ice breaker the engines are stopped. The desired effect cannot be secured if they are left running. If they are not stopped, they create a peculiar equilibrium between the holding force of the ice and the pulling force of the propellers, whereas a sudden jerk is needed to get the icebreaker off. This is accomplished by starting all engines simultaneously and operating them at full speed at the exact moment the icebreaker falls through the ice. If the heeling method does not achieve the desired results, it can be supplemented by changing the draft forward and aft. For this purpose the fore peak tanks are filled and the after peak tanks are emptied; this process is then reversed, causing the stern to submerge and the bow to emerge. While heeling and operating the trimming tanks, the space in which the icebreaker is stuck is somewhat increased, enabling the ship to back up and run ahead.

J. *Use of ice anchor.*—It sometimes happens that an icebreaker wedges in so solidly that both these methods are insufficient. Additional help can then be given by working the engines in different directions. The ship may then swing a little and sometimes loosen herself out of the wedge. If all these methods used either separately or together do not produce results, ice anchors are used. The ice anchor is led out on the ice and placed about halfway between the bow and the stern of the ship. The fluke of the ice anchor is put into a hole or crack in the ice and the line from it led through a bow chock to the drum of the windlass. When everything is ready, all engines are worked full astern. The icebreaker must at the same time be heeled to one side. The windlass takes a strain on the line secured to the ice anchor and with this additional pulling force the icebreaker moves astern. This maneuver usually brings good results and the ship is released.

K. *Course erratic.*—In continuous sheet ice, even when the icebreaker is able to maintain speed through it, as she can in ice only a few feet thick, the course is likely to be erratic. As the ship hits the sheet ice, cracks radiate from the point of impact, forming paths of least resistance. The ship is likely to start down one of these cracks, making it extremely difficult to get the heading on the proper direction again. Often even with full rudder the icebreaker may go contrary to the desired course for a considerable period of time.

L. *Methods of conning.*—There appear to be two main methods in conning an icebreaker through the ice pack, both of which are dependent upon the degree of initiative allowed the helmsman. In the first method, much latitude is given the helmsman. Usually the officer of the deck points out some identifying mark in the pack which lies within a few degrees of the desired course. Also, he tells him the amount he may vary each side of the base course. Except for an occasional bit of advice, the O. O. D. then generally allows the helmsman to follow his own bent. In the second method, the onus is placed upon the O. O. D. He orders all changes of course and makes all decisions in following leads. In doing this, he must make up his mind sufficiently well in advance to communicate an early decision to the helmsman so that the order may be understood and acted upon. Both methods have their advantages and disadvantages, and the employment of either is dependent upon existing conditions, the temperament and experience of the O. O. D., and the helmsman, etc.

27–12–50 Convoying in Ice—

A. An ice convoy consists of one or more ordinary ships, whether or not strengthened for ice navigation, accompanied by one or more icebreakers. It is desirable that a convoy while in ice be under the direction of the commanding officer of the leading icebreaker. There are three possible types of ice convoy;

(1) Single ship convoy.

(2) Simple convoy: one icebreaker escorting a group of ships.

(3) Composite convoy: two or more icebreakers escorting several ships.

B. *A simple convoy* consists of several vessels and one leading icebreaker. The captain of the leading icebreaker decides on the number of vessels he can take through. His decision depends on the type of ships which are to follow the icebreaker and the condition of the ice en route. If the ships to be convoyed are reinforced for ice navigation and have sufficiently powerful engines, an icebreaker can take an average of four of them through an ice coverage of 70 to 80 percent. If the condition is favorable, only 50 to 60 percent ice, the number of ships can be increased. If there is close pack with over 80 percent coverage, the number of ships must be limited to two or one. In conducting a large number of ships in such heavy ice, it will be necessary for the icebreaker to keep falling back in order to break the ships out thus losing more time than if piloting two vessels.

C. *The arrangement of the convoy* should be carefully worked out. The varying ice conditions in the areas along the route, and the variety of ships forming the convoy must be taken into consideration. The first factor to be considered is the power of the ships. The weakest, as a rule, are placed immediately behind the icebreakers, so that they can avoid striking ice obstacles and be able to move in a comparatively clear channel. The most powerful and beamiest ships are so placed in the convoy that less powerful vessels can proceed in their wake. Consideration must also be given to whether a ship is loaded or in ballast. Finally, it is essential that one of the most powerful ships in the convoy be placed in the last position in line.

D. *A composite convoy* consists of two or three simple convoys. The number of ships to each icebreaker and their place in column is determined in the same way as for a simple convoy. The difficulty of controlling from a position in front is an important drawback to this type of convoy, which frequently stretches out over a distance of 1½ to 2 miles. The first icebreaker is designated the leader; the others are placed according to orders of the leader's captain, either in column or in line of bearing for breaking out.

E. *The operating procedure* is for the most powerful icebreaker to lead the convoy, breaking a channel in the ice without stopping to break out other ships. Following the leader at a distance decided upon by the leader's captain, are two or three ships, the weakest and beamiest in the entire convoy. The second icebreaker proceeds astern to the first group followed by two or three ships, and so on. The assignment of the second icebreaker is to break out the ships ahead of her so that the leader will not have to return to them and thus detain the convoy. The second icebreaker, on receiving a signal "Stuck" from any of the preceding ships, increases speed, leaves the column and breaks out the ship. When the latter is freed and moving, the icebreaker resumes her previous position in the column. The same action is taken by the second icebreaker upon hearing the same signal from one of the ships astern, provided there are no more icebreakers in the convoy. If there is a third icebreaker, she breaks out the ships following the second icebreaker. Ships must be broken out while proceeding, in order not to delay the progress of the entire convoy. When several icebreakers are present in line of bearing for breaking out, they follow behind the leader at a set distance to leeward in such a way as to thin out the ice in the channel made by the leader, and remain always in readiness for breaking out or towing any ship that gets stuck or lags behind.

F. *Brief masters of ships.*—Prior to entering the ice, the captains of all ships must be carefully briefed as to the order in which they are to follow the icebreaker. They must understand the importance of maintaining the distance between the ships and the icebreakers and between the other ships, as ordered by the leader while moving in ice. Accurate station keeping is essential for the safe and speedy progress of the convoy.

G. *Distance between ships.*—If the condition of the ice is not too bad, say less than 70 percent coverage, the ships can follow the icebreaker without much difficulty. The beaminess of the latter makes it especially easy for the ships closest to her, but as the channel closes in farther astern, the ships at the end of the convoy encounter greater difficulties than those in the van. It is, therefore, unwise to have the convoy strung out in too long a line. At the same time, the distance between ships should be great enough for way to be checked and collision averted if a "Stop" signal is given by the icebreaker. As a rule, way can be checked in clear water by going astern over a distance of 3 to 3½ ship lengths, provided a full back bell is given. This distance should therefore be the minimum between ships when navigating ice with less than 70 percent coverage. At the same time, it should be fully appreciated that if this distance is increased, the speed of advance of the whole convoy is reduced. The channel made by the icebreaker quickly fills with broken pieces of ice. The pressure exerted by this ice on a ship in a narrow channel naturally increases when the distance between ships is increased, and even powerful ships find their speed greatly reduced. This is another argument for maintaining the minimum prescribed distance apart. A sharp lookout must be kept for signals from the leading icebreaker, and these must be executed promptly and correctly. The ships ahead and astern, as well as the condition of the ice, must be carefully watched.

H. *Distance when in thick ice.*—When navigating in thicker ice, the distances suggested above must be decreased. In order to avoid damage from the ice floating in the channel, the engines must work slowly and the ship must carry little headway. If the ice is completely unbroken and under considerable pressure, the distance must be reduced to a few yards. Under these conditions the channel will be quickly covered with ice, leaving only a small lead astern of the icebreaker, narrower than

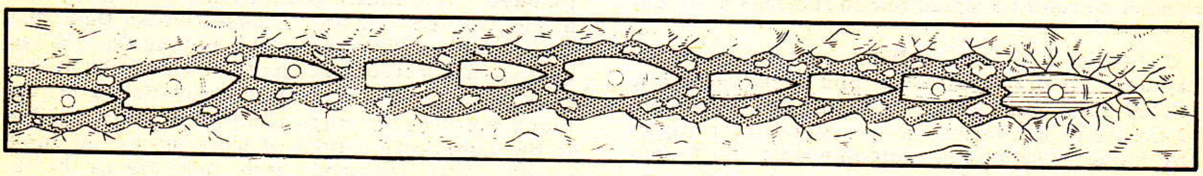

FIGURE 27–326.—A composite convoy in column following an icebreaker.

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the beam of the vessel. If a ship should follow at a distance of two to three ship lengths from the icebreaker, the influence of the icebreaker would hardly be noticed. The vessel vessel would therefore either stop or be stuck in the ice.

I. *Piloting at reduced distances.*—Piloting a ship in convoy at reduced distances requires a certain amount of experience on the part of both the icebreaker's company and the personnel of the other vessels. It often happens that in heavy ice, there are obstacles which the icebreaker cannot overcome

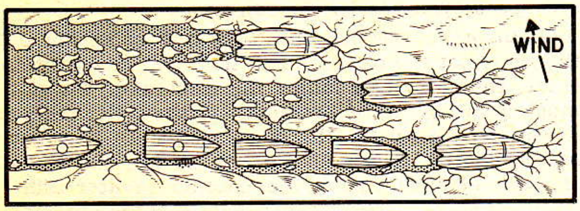

FIGURE 27–327.—Line of bearing for breaking out.

on the run. She may suddenly stop and give the signal "Full Astern" to the following ships. In order to avoid collision, the ships must go astern immediately. When moving in such close formation, the thickness of the ice ahead must be carefully observed by the icebreaker so that probable fluctuations in speed can be anticipated, and the necessary warning passed to the ships astern in plenty of time. The danger resulting from a sudden stop on the part of the icebreaker is obvious. The importance of maintaining the correct distance applicable to the ice conditions is therefore clear. This distance should never be more than 3 to 3½ ship lengths, and is usually a matter of only a few yards. To assist the conning officer in keeping the ship in position, it is advisable to establish a "stadimeter watch" who can furnish readings as frequently as may be required. The spacing must be changed with the varying condition of the ice, and great stress must be laid on accurate station keeping. When navigating in ice, disregard of these rules can result in very serious consequences.

By virtue both of his experience and of his position in the convoy, which enable him to assess as well as sample the ice conditions ahead, the captain of the leading icebreaker must estimate the correct distances apart to be maintained by the ships. He must signal any changes required due to altered ice conditions, etc. It is absolutely necessary that the officers of the piloted ships should be thoroughly acquainted with all the signals used for convoying in ice. It should never be necessary for the icebreaker to repeat a signal due to slowness of execution.

J. *Course and speed.*—Before entering the ice, captains of the icebreakers and masters of the piloted ships must clearly visualize the conditions of the ice in the various sectors along the prospective route. The longest route in open water is generally shorter than the more direct one in ice, and the selected track should pass through areas of thin ice or open water, regardless of the length of the voyage, provided the depths along the route are adequate. Consideration must also be given to the assistance that may be forthcoming from the prevailing wind and current. In some areas, even in heavy ice, such help is pronounced. Course changes must be gradual, if practicable, since most cases of ships getting stuck occur when sharp turns are made by the icebreaker. The speed of the convoy must be decided upon by the captain of the leading ice breaker. Speed through the pack varies from 4 to 7 knots. The higher speed is desirable due to the better maneuverability of large ships, but the ice conditions will govern.

K. *"Full astern" without warning.*—If a single-screw vessel must back down suddenly "full-astern" without warning while passing through an ice-covered channel, the stern will kick to port and the bow to starboard. Such action will probably cause damage to the propeller, rudder, and the starboard side of the ship. To avoid collision with the ship ahead, it is preferable to ram the ice to one side of the channel, bow foremost, rather than to risk damage to the rudder and propeller by backing down on heavy ice.

L. *Following the icebreaker.*—In following the icebreaker, a convoy must keep dead astern of her. If the icebreaker alters course, all ships must turn in succession to the new course. By looking for independent channels, the ships break up the convoy and may get stuck. Thus, the icebreaker is compelled to return and break out each ship separately, thereby delaying the whole convoy. Since passage through floes and ice fields is more difficult, the icebreaker increases her speed, and by striking the ice, crushes or breaks it ahead of her. The ships astern must then watch their distances carefully and try to enter the channel made by the icebreaker before it closes again. If the icebreaker should encounter a solid ice obstacle where a glancing blow is struck by the stem, she will be thrown backwards and sideways in the direction of least resistance. The ships following close astern will be unable to make a quick enough turn and may receive damage through striking the heavy ice. This is particularly true of single-screw ships. This sudden change of direction or zigzagging must be expected when proceeding through ice of varying structures and strength. Under such circumstances, the icebreaker should not make too rapid a return to the original course and should avoid aggravating the zigzag.

M. *Hummocky ice.*—When it is necessary to pass through ranges of hummocky ice which cannot be outflanked, the hummocks must be crushed in a direction at right angles to their crests. If, however, the hummocks have cracks at an angle to the general line of the crests, the cracks should be followed. It is much easier to maintain the course in close pack consisting of small blocks than in a floe or ice field. When many hummocks are encountered, the icebreaker must first attempt to outflank them. The outward characteristics of the hummocky ice indicate to what extent it is navigable. If the hummocks consist of loose blocks not fused together into one solid piece, they are easily destroyed; but if they are composed of larger masses of ice many feet thick, they are impassable even to an icebreaker.

N. *Hard ice.*—Experienced icebreaker captains and ice pilots consider that greenish or greenish-blue ice is the hardest to crush. Such ice should be outflanked. This type of ice is sometimes covered with pools of clear water formed during the thaw of snow on the surface of the ice. There are also oval holes caused by the water trickling down the ice after the snow has thawed. If there is a considerable number of these holes on a field of greenish-blue ice, the field will be weakened and the ice can be forced. It will not be necessary to break the entire field, but only the portions separating the holes. The condition as well as the color of the ice must be considered, and an occasional test at slow speed by the icebreaker is well worth while. If sections of dirty-looking ice occur in areas of light-colored ice, the former should provide the easier route, since the darker object absorbs more sun and melts sooner. Even heavy blocks of dark ice are found to be spongy inside and much less compact than the surrounding ice. On impact by the ice breaker's bow, such ice will crack in spite of its thickness.

O. *The most passable ice* is considered to be brash, even though it is completely devoid of leads. Although this ice usually closes up as a result of action of tides and winds, it consists of separate cakes and therefore does not present a serious obstacle for the passage of the icebreaker or the conducted ships. When the pressure is great, however, even though an icebreaker can get through, the ships astern are usually hindered as the channel behind the icebreaker closes up immediately. It must be remembered that in brash, even during pressure, ships are in less danger than if they were being pressed by larger and heavier forms of ice.

P. *Deviation from course.*—For ice navigation, the axiom that "the straight line is the shortest distance between two points" is not necessarily true. Ships must often be taken along tracks unrelated to their general course. Sometimes, cracks and narrow leads at right angles to the course of the convoy are encountered. If the ice belts between the leads are very heavy and wide, it is better to follow the crack and seek easier ones than to attempt to break the heavy ice and proceed directly into the next lead. While the convoy is often led on a directly opposite course, going from lead to lead, it should proceed in the required general direction.

Q. *Close pack ice.*—In zones of close pack ice, there are places where an icebreaker cannot penetrate. The great amount of friction created by the ice against the ice breaker's sides may hinder her advance, causing her to stop. The power of the engines in these cases is insufficient and the ship gradually loses way. Such ice can be broken only by backing and ramming.

R. *Ramming procedure.*—From the thickness and compactness of the ice, the captain of the icebreaker determines the distance from which he must start the icebreaker in order to attain sufficient momentum required for the initial blow. The momentum must be added to the power of the engines, since they alone cannot overcome the obstacle. Usually an icebreaker backs up a distance of from 1 to 3 ship lengths, then goes full speed ahead until her stem is pushed into the ice. It must be remembered that the ice must be struck only by the stem and not by the turn of the bow; in the latter case, the ship's hull might be damaged. If the obstruction is strong and extends over a great distance, the blow must be repeated for many hours in succession. If the ice has not been broken after one blow, the icebreaker upon losing momentum, stops. As soon as the icebreaker slackens speed, the engines should be reversed immediately to full speed astern. If this moment is lost and the icebreaker stops in the ice while the engines are going full speed ahead, the ship will invariably wedge in and time may be lost in releasing her. When the engines are going astern, the rudder must be amidships.

Once clear, the icebreaker backs the required distance and repeats the blow. It may be necessary to make either a simple channel, equal to the width of the beam of the icebreaker, or a double or triple one, depending on the strength and character of the ice. After making a channel, the icebreaker returns to the ships, and if the channel remains open, the icebreaker will be able to lead two or three ships at a time. If there is much ice in the channel, and several ships cannot pass unescorted, the ships are taken through the ice one by one.

S. *If the condition of the ice gets worse en route,* and a convoy of three of four ships becomes too large, the assistance afforded by the icebreaker will be lost on the rearmost ships, which will have to be broken out continually. If, in such circumstances, a radical and rapid change in the condition of the weather or ice is expected, it is better to wait for an improvement and then proceed with the whole convoy. If, however, such a change is not anticipated, the ships must be conducted ahead one by one, eventually resulting in the speedier advance of all the ships. In this case, precautions must be taken to prevent the ships left behind from being damaged by the ice. A more or less homogenerous mass of slush pressing against the ship creates a kind of cushion, with equal pressure along the ship's entire length. If the ship is near a heavy floe or an ice field, the pressure developed may result in serious damage or perhaps loss of the ship. Heavy ice under pressure creates a strain at certain points or over certain sections of the hull. Forced by the closing ice, large blocks of ice in the channel may be crushed against the hull, denting or even penetrating the ship's side. Under these circumstances, the icebreaker must make a few trips around the ships so as to break the large pieces. Then it can take the ships on one by one without fear that those left behind will be damaged or crushed.

T. *Ice with no leads or cracks.*—The most difficult work for an icebreaker is to conduct ships in motionless young ice with no leads or cracks. Broken ice remains in the channel with the exception of a small amount which goes under its edge. If the channel is to be of considerable length, this brash not only hinders the convoyed ships but also makes the progress of the icebreakers more difficult. If small hummocks are encountered, the icebreaker often becomes wedged in. To avoid wedging and to facilitate the movement of the ships, it is necessary to break a channel considerably wider than the beam of the icebreaker. Under such circumstances, the width of the channel must be sufficient for an icebreaker to turn, 100 to 150 yards. To achieve this, a double or triple channel is broken. The double channel is made by the "herringbone" method.

U. *"Herringbone" method.*—To break a channel by this method, the icebreaker first strikes the ice at a small angle to port, then backs up and strikes again at an angle to starboard of the course, and so on, alternating the direction of the blows. Breaking the ice in this way leaves the greater part of the icebreaker free, since only the stem hits the ice. The hull from amidships to the stern is in clear water, thus preventing it from being wedged in. If a double channel is too narrow, a triple one is made. The same method, though a bit more complicated, is used.

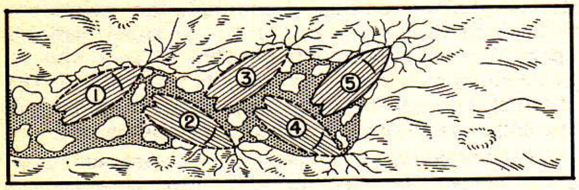

FIGURE 27–328.—Herringbone method of breaking ice.

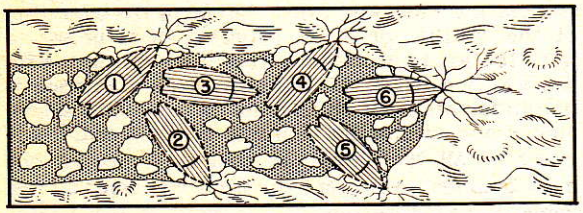

FIGURE 27–329.—Modified herringbone method of breaking a wide lane.

One blow is made to port, but at a greater angle than for a double channel. The second blow to starboard is also at a greater angle. The third blow is directed against the tongue of ice which protrudes in the middle. In this way the triple channel is broken. The time taken to break a channel in young ice about 4 feet thick is considerable, and it has required 40 working hours, on occasion, to break a 7-mile channel in such ice.

V. *Caution.*—While navigating in heavy ice, there is danger of damaging not only the escorted vessels but the icebreakers as well, though they are well equipped for fighting ice. In the forward part of the ship the most vulnerable place is the curved plating of the bow. This may be damaged by striking the ice if the blow is not taken on the stem. The draft of the vessel is also of great importance, since the plating at the water line is usually strongest. Vessels should therefore be so loaded and trimmed that only this strongest plating will be in contact with the ice. In the after part it is the propeller that is exposed to danger. In fact, while in ice it is the most vulnerable part of the ship. It is often assumed that blades are damaged only when a vessel is going astern. This, however, is not always true. The blades can be damaged or lost while going ahead, as well. Sometimes large blocks of ice pass under the ship's hull and turn on edge. Such ice is very dangerous and may damage the propeller. If the captain or watch officer observes a heavy block of ice on edge close aboard one side of the ship, he should immediately take precautionary measures.

27–12–55 Towing in Ice—

A. When piloting vessels in close pack of medium thickness, it is sometimes necessary to take them in tow on account of ice pressure, engine trouble, or propeller or rudder damage. All icebreakers are provided with necessary towing equipment. Towing arrangements must be in full readiness before the convoy sails. Although a bridle should be used for towing in pack ice, the towing hawser should be shackled to the anchor chain for towing in the open sea. The ship's personnel must know how to take aboard a heavy towline as quickly as possible and to secure it so that it can be slipped with minimum delay, when so signaled by the icebreaker. On no account must the tow straps be made fast to the bitts. The latter will invariably break, as they are not strong enough to take the great strain necessary when towing a vessel through ice.

B. *In drift or open pack ice,* a ship is towed by the icebreaker using a long towline. In this case, the entire towline is paid out with the exception or a few turns. Such towing is used when a ship has been damaged and cannot proceed under her own power.

C. *In close pack ice.*—When navigating in close pack, with moderate pressure, a short tow is used if the piloted ship cannot make headway unassisted. In this case, the towline is eased off to 35 to 50 feet and the vessel will advance in the icebreaker's wake, where propeller wash prevents the ice from closing up immediately. If the icebreaker slows down, the towed ship, which is being held back by compact ice, has enough time to go astern, provided the signals for reducing speed for going astern are given by the icebreaker in sufficient time. If the icebreaker stops unexpectedly when using the short tow, collision and damage are almost inevitable. Therefore, the captain of the towed vessel must be fully aware of, and prepared for, such an eventuality.

D. *If collision between the icebreaker and the tow is unavoidable,* the former should go full ahead on her engines so that her wash will throw the towed vessel's bow to one side and make the blow a glancing one instead of a direct bow to stern collision. This action is recommended in all cases (even when not towing) when the ship astern creeps up on the icebreaker.

E. *If heavy ice pressure.*—When the ice pressure is great, the channel closes up immediately astern of the icebreaker. In such circumstances, it is necessary to tow the ship close under the icebreaker's stern. To do this, the stem of the towed vessel is secured as close as possible to the indentation at the icebreaker's stern (tenders do not have this) by means of the towline. The winch, backed by additional stoppers, is secured so that the tow cannot ease off. The icebreaker and the tow move as one unit. Advance is possible in the heaviest ice, as long as the icebreaker can use her engines. The control of the icebreaker is, however, more difficult as the towed vessel tends to act as an uncontrollable rudder. When the icebreaker stops, it is almost impossible to go astern, as the towed vessel's rudder will be endangered.

27–12–60 Breaking Out Ships—

A. *Signal immediately.*—If a ship fails to make headway in the ice, she must signal without delay, "I am stuck in the ice." Upon receiving the signal, and if conditions permit, the icebreaker signals the other ships to proceed on the course without her. Then she returns to, and breaks out, the icebound ship.

B. *Breaking out by going astern.*—Ships are broken out of the ice in various ways, the method depending on the condition of the ice. If the ship is stuck in comparatively thin ice, the icebreaker, to save time, goes astern without turning, keeping her bow on the original course, and passes the ship close to one side. After coming alongside, the icebreaker backs as far as the stern and then goes ahead, simultaneously signaling the ship to follow. If this maneuver is performed at a distance of from 5 to 10 yards from the ship's side, the vessel as a rule can follow the channel, as the ice astern of the icebreaker is considerably thinned out. The direction of the wind must be carefully noted, and for breaking out, the lee side is chosen. If the icebreaker approaches to windward, the ship is blown towards the unbroken ice, and even after being broken out will be unable to move. When the icebreaker comes up on the lee side, a certain weakening is observed even in heavy ice, and the ship is pushed by the wind in that direction. The friction of the ice on the sides becomes less, and by using her engines, the ship can follow the icebreaker. During calm or light winds, and with head winds or winds from aft, the ship must be broken out from the side on which there are fewer ice obstacles.

Caution.—The above applies when the icebreaker breaks out a ship with her stern. In heavy ice conditions this method is not practical since when going astern the ice is piled up under the counter and fouls the propellers. This condition may cause the engines, which are turning at full speed, to stop suddenly. The same happens when a propeller gets caught against a chunk of ice, which in turn presses on other chunks of ice. Since the propeller is unable to overcome this obstacle, a broken blade or loss of the entire propeller may result. Going astern in heavy ice may also disable the icebreaker's rudder. Therefore, the above method of breaking out ships should be employed only when there is no danger of damage to the propeller and rudder, or when there is no other solution.

C. *Breaking out by approaching from windward.*—Another method of breaking out a stuck vessel is to approach on the windward side, with the target angle of approach varying according to the heaviness of the ice. Generally this will be about 155° or 205° (135° or 255° if the ice is heavy). The icebreaker's stern should be swung so that it is as close as possible to the stem of the other vessel and directly ahead thereof when the movement is completed. Between the icebreaker's stern and the beset vessel's stem there will inevitably be a floe fragment, which may be cracked by backing down on it. As soon as the backing is commenced, the beset vessel should be instructed to go ahead with all possible speed consistent with safety. This will keep her bow into the propeller wash as the icebreaker's engines are turned ahead after the floe is cracked. It is advisable for the escorting icebreaker to have a pudding over the sheer of her stem since she may frequently be called upon to push the bow of the escort around. In this event, it may be necessary to break the ice on the quarter toward which her stern will swing to minimize the possibility of damage to rudder and propellers.

D. *Bow turns.*—Ships can also be broken out by the icebreaker's making complete bow turns. This takes a great deal of time as the icebreaker first turns toward the ship and then makes another turn astern of the ship. On making the turn toward the ship, the icebreaker approaches her on the lee side and passes along close aboard. Astern of the ship the icebreaker turns again to the original course. Moving ahead the second time along the ship's side, thinning out the ice, she at the same time signals the ship to follow. The heavier the ice, the more time is required by this method, but in exceptionally heavy ice this is the only suitable way of freeing vessels. Objection is sometimes made to the bow turn method because it piles ice about the rudder and screw of the beset vessel.

E. *When icebreaker cannot reach stuck vessel.*—Sometimes a vessel gets stuck in a floe of such heavy ice that the icebreaker cannot reach her. In such cases, before releasing the ship, the icebreaker is compelled to force the entire floe on one side or the other. By thus thinning the ice and by forcing it, the icebreaker eventually breaks out the ship and enables her to proceed. Often when such a floe is freed, there is a great separate grinding movement called screwing. Screwing pack should be avoided at all costs, because a ship caught in it may receive damage to her hull before the icebreaker can break her out.

F. *Miscellaneous notes.*—It is sometimes necessary to break the ice around the same ship several times before she is freed. This situation usually occurs during ice pressure, or when the ship's engines are very low-powered. The above are the principal methods of breaking out single ships. However, it should be remembered that the other ships, left without assistance, are usually blocked by the ice and unable to proceed on their own. When the ships are in column, the icebreaker can sometimes pass the entire convoy on the lee side along its course at the greatest possible speed, breaking it out entirely. The ships can then proceed along the channel broken by the icebreaker. Usually, if one vessel in the convoy gets stuck, they all get stuck. Also, it is not always possible for the vessels in a convoy to maneuver into parallel track. Therefore, it is necessary for the icebreaker to maneuver ahead of of each ship, back down on the vessel's bow, then run toward the stern of the next vessel, swerving out in time to parallel her, and then repeat the process. This procedure requires rapid handling of the icebreaker because each vessel, as soon as the ice is cleared ahead of her, must start moving. By the time the icebreaker reaches her station ahead of the column, the entire convey is in motion.

While the icebreaker is breaking out a ship, the ice often cracks toward the ship's sides. If the icebreaker passes her at a great speed, the icebreaker's bow will turn along the crack toward the ship. This danger should be carefully guarded against, otherwise collision with resulting damage is probable. In general, when passing close to a ship, the icebreaker must make an estimate of the character of the ice between it and the ship. If there is weak ice close to the ship, the icebreaker may be thrown against the ship. Likewise, when breaking out a ship, the strength of her hull must also be taken into consideration, since the icebreaker presses the ice against the ship's sides with great force while passing close aboard her. The speed of the icebreaker must therefore be regulated with great care.

27–12–65 Convoy Signals—

A. Some system of signals must be agreed upon in ice convoy work. The following one-letter whistle signals are suggested:

Signal	Made by leading icebreaker	Made by conducted vessel
G (— — .)	Am going ahead, follow me.	Am going ahead, follow the icebreaker.
N (— .)	Reduce your speed	Am reducing my speed.
S (. . .)	Go full speed astern	Am going full speed astern.
M (— —)	Do not follow me, stop where you are.	Am stopping where I am.
5 (. . . . .)	Stuck in the ice, attention.	Stuck in the ice, attention.
K (— . —)	Prepare to take tow line	Am prepared to take towline.
	If the vessel is already in tow.	
	Cast off the tow line	The tow line is cast off.
C (— . — .)	Go ahead, follow the channel.	I am going ahead, following the channel.
J (. — — —)	Shorten the interval	I am shortening the interval.
O (— — —)	Proceed on your voyage	I am proceeding to my destination.
R (. — .)	Pay attention to the radio, or listen to the radio.	I am paying attention to the radio, or, I am listening to the radio.
X (— . . —)	Attention; look out for the signal.	Attention; I am looking out for the signal.
P (. — — .)	Anchor	I am anchoring.
Ø (— — — — —)	Work stopped until morning or until more favorable circumstances.	
	If made while work is stopped signifies.	
	Get ready	I am getting ready.

B. The signals (siren or steam whistle) used when vessels are scattered in the ice are the same as in Rules for Preventing Collisions at Sea.

One short blast ..... "Am going to starboard."
Two short blasts .... "Am going to port."
Three short blasts ... "The engines are going astern."

Between ships using air-driven sirens rather than steam whistles, the effectiveness of these signals is largely lost since there is no visual portion of the signal. In this case, they can be simultaneously supplemented by hoisting the corresponding International Code flag, or the cone, ball, and distant drum signals of the old International Code. A voice radio reserved for such traffic might prove more satisfactory, while ships close aboard can use loud speakers to advantage.

27–12–70 Miscellaneous Notes—

A. The following notes were contributed by an officer aboard a 180-foot tender breaking ice in the Hudson River.

(1) "Maneuvering prior to being stuck in the ice:

(*a*) "Shift the rudder 5° to port and starboard as rapidly as possible while maintaining a straight course with increasing speed of the vessel. This causes the ship to roll slightly from side to side, and more distance through the ice is gained than when using the rudder only to maintain a steady course.

(*b*) "If there is sufficient space, describe spiral circles with the ship, chopping off the ice in 20- to 40-foot blocks (depending on the thickness of the ice). This opens a wide channel. Use as much speed as possible to crack the ice throughout the blocks.

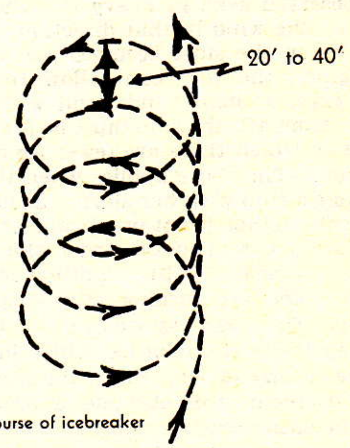

FIGURE 27–330.—Spiral method of breaking ice.

(*c*) "If the ice is of a thickness which slows the vessel down, but does not stop her, maintain as much speed as possible. The wake will break the ice on either side of the track, thus widening the path through the ice.

(*d*) "In the Hudson River, there is normally no difficulty in ice breaking throughout the river from New York to Albany, except at Esopus Meadows, a few miles south of Kingston. Here the ice builds up (windrows) to a depth of as much as 6 to 8 feet, and is 5 miles in length. Normal traffic during winter months consisted of two converted LST's. Their breadth is about 10 feet wider than that of a 180-foot tender so that it was necessary to make two and sometimes three trips through Esopus Meadows to break a path wide enough for them.

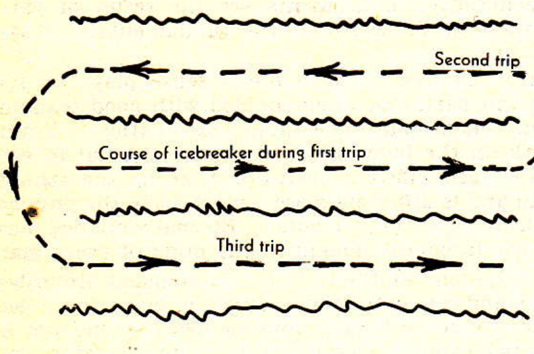

FIGURE 27–331.—Breaking successive parallel lanes of ice.

(2) "Procedures followed when vessel is stuck in the ice:

(*a*) "Just prior to the point of being stuck in the ice, back down full so that the vessel slides up on the ice (slightly) and almost simultaneously with the stopping of the forward movement, begins to move astern.

(*b*) "Moving the boom from side to side sometimes breaks the bow loose from the ice. Have the engine backing at the same time.

(*c*) "Shift the rudder from side to side while maneuvering the engine ahead and astern.

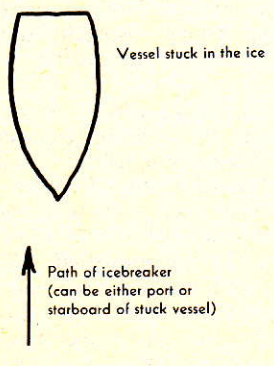

FIGURE 27–332.—Breaking out a vessel stuck in the ice.

(*d*) "A layer of snow 10 to 12 inches thick on top of the ice has a tendency to adhere to the ship, causing it to become stuck. Washing the snow away from the hull with hot discharge water has some effect in clearing the vessel. If a high pressure, high temperature stream of water is available, it is normally only necessary to clear one side of the ship. The engine can do the rest.

(3) "Procedures of breaking out another vessel from the ice:

(*a*) See figure 27–332.

(*b*) "If the vessel is stuck in the ice on one side only and a few feet of clear water is available on the other side, maneuver as shown in the following illustrations:

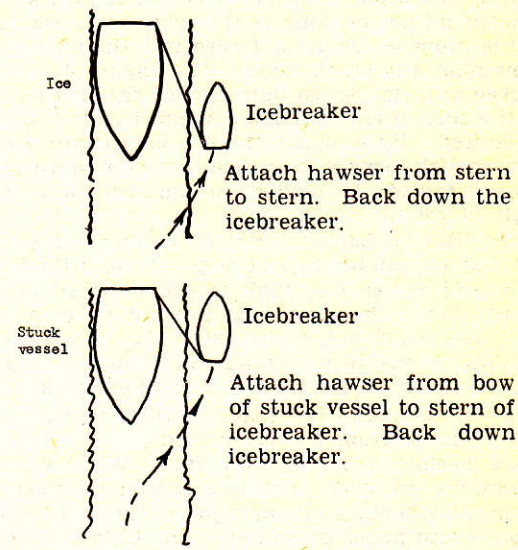

FIGURE 27–333.—Pulling on vessel stuck in the ice.

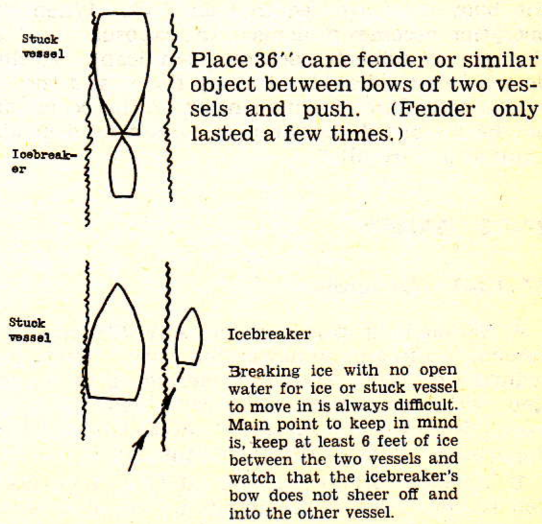

FIGURE 27–334.—Various methods of freeing vessel stuck in the ice.

(4) "In areas where ferry boats cross the channel, exert due caution to prevent breaking ice to too great a degree in the area, as the broken ice will flow into the ferry lane, clogging it up, and should freezing weather be encountered, freeze into windrows. The ferries then find it difficult to keep their lanes open.

(5) "If the intake suctions become clogged, the fore peak tank may be used for cooling the main engines. Suction is taken via fire hose and returned through the fire main to the nearest outlet to the fore peak."

B. The following was contributed by an officer engaged in icebreaking on the Great Lakes.

(1) "It has been found that the propeller should be kept turning over slowly while the vessel has sternway. The natural tendency when backing and desiring to stop the way or go ahead is to stop the engine and/or put it ahead. In ice of any thickness, this should not be done as the relatively weak face of the propeller blades is forced into the ice by the remaining way on the ship. The engine should be backed at a slow speed until the ice checks the way of the ship, then the engine stopped or put ahead as desired. By so doing, the propeller continues to turn enough to cut into any ice encountered with the edge of the blades, tending to diminish the probability of bending them.

(2) "Having ballast forward, available to pump out if stuck, can be of great help. At least the peak tank and center fuel tank should be filled at all times. When the wing tanks forward are empty of fuel, they could well be ballasted also. During recent operations the peak tank was pumped out many times to assist in freeing the ship when stuck.

(3) "It is considered that the value of swinging sinkers hung from the boom from side to side to cause heeling is highly overrated. Whenever ice conditions are such that this procedure must be resorted to, further attempts to get through the ice require continuous operation of the boom, and this has invariably resulted in a situation where the vessel was stuck so firmly that additional help, or pumping of ballast was required. When sinkers are handled in this manner, the most capable men in the buoy crew are required on deck. When this operation becomes prolonged, the exposure to which the men are subjected becomes significant. Heeling does help considerably at many times, and the accepted procedure of using sinkers on the boom cannot be discarded; however, it cannot be depended upon as a 'cure-all'."

27–13 SAFETY

27–13–1 General—

A. Throughout this chapter, SAFETY has been emphasized in aids to navigation work. Safety procedures and hints have been mentioned in connection with descriptions of various aspects of the work. However, the subject of safety is of sufficient importance to merit further discussion.

B. Accident prevention and safety is the concern and responsibility of all hands on board a tender or at any other aids to navigation unit; not just the commanding or executive officers', or the boatswain-mate's, but of *every* man aboard, even the most recent recruit. It is said that handling buoys is hazardous work. This can certainly be so when safe procedures and good seamanship are ignored. There need be no more element of risk than in many other recognized occupations, provided men and equipment engaged in the work have the highest standards of care.

(1) Certain dangers and hazards are inherent or incidental to every trade, industry, and profession. A paperhanger breaks his neck falling from a stepladder, a carpenter cuts off a finger with a hatchet, a machinist skins his knuckles when a wrench slips and dies of blood poisoning because he neglects the wound. It is difficult, if not impossible, to separate the inherent hazards from the incidental ones. The paperhanger might fall off a stepladder while trimming a tree in his backyard with like results. Thus the majority of accidents are the result of carelessness or disregard of the fundamentals of safe conduct.

(2) Ordinary good common sense plays an important part, and when coupled with good seamanship, makes an unbeatable combination. Teamwork on the buoy deck is no less essential to successful and efficient operation than on the athletic field and is infinitely more important to the physical well-being of the personnel. Eternal vigilance must be the foremost thought in the mind of every man.

C. In general, the rules for seamanship prescribed by standard texts apply, with one exception. The rules concerning safe working loads should not be trusted wholly, because unexpected strains frequently occur during the handling of aids to navigation. During operations on board a tender, time is frequently an important factor because of tidal conditions, wind, and scope of operational commitments. Therefore, personnel should be trained constantly and thoroughly to perform specific duties with a minimum of delay consistent with safety. Although rotation of personnel is essential in a military organization, desired efficiency can only be attained by an experienced tender crew.

The servicing of aids to navigation is a duty requiring a maximum of interest, difficult labor, and constant cooperation between men. The work in hand must be completed with dispatch, without confusion. Personnel should be instructed in the use of facilities and nomenclature well in advance of operations. Practical preliminary training is essential. Supervisors and seamen alike must familiarize themselves with standard orders used while working buoys. Specific duties are apportioned to individuals according to demonstrated ability.

D. *Supervision.*—An officer or senior petty officer (depending on the size of the tender) must be present and supervising all operations. The officer in charge of the deck should confer frequently with his men so that each man will know what is expected of him, what equipment is to be used, and how the work is to be accomplished. Bewilderment regarding the next move creates confusion, and that in turn brings casualties. The officer in charge of the buoy deck while the tender is working must be able to visualize events before they occur. Personnel must be continuously reminded to protect themselves and the equipment so that the directing officer can concentrate on the evolutions in progress. His station is usually on the forward deck or on the forecastle head where he can oversee the entire buoy deck, receive instructions from the bridge, and assist in directing maneuvers alongside a floating aid.

(1) To perform an operation safely and efficiently, there must be only one man giving orders. Commanding officers should not attempt to run the buoy deck from the bridge. A tender which is a babel of confusion and conflicting orders is ripe for an accident. If an officer sees that something is wrong or is liable to be, he should stop the operation, point out the mistake or relieve the man in charge, before the operation is continued. The command "Silence on deck" is suitable for this purpose. One commanding officer used a mouth whistle to achieve the same result. When such a command is given, it is notice to all hands that something is wrong, and that they should be instantly alert to the danger. Personnel should not necessarily stop and freeze in their tracks, since there are certain operations that might be more dangerous to stop than to continue.

(2) The person in charge on deck should not (unless in an emergency) take part in the physical work on deck. He should not lend a hand to pass a stopper or chain sling, etc. unless absolutely necessary, because it is often just when his attention is diverted to that particular phase of the job that a potential accident is materializing behind his back.

E. *"Haste makes waste"*.—Buoys should be worked only if wind and sea conditions are favorable, as no buoy can be worked with safety to personnel or equipment, or placed with positive accuracy, when a heavy swell is running, when a strong wind is blowing, or when visibility is poor. "Chances" can and have been taken by tender commanding officers in an effort to overcome a bad weather handicap with a heavy annual workload. Never was "haste makes waste" more appropriate, as when picking up a 9 x 38 lighted buoy in a heavy swell, working on the windward or up-current side of a rock or shoal, or placing a buoy on station in poor visibility. The slightest mischance may result in fatal injuries to personnel, serious damage to or loss of ship and equipment, and in setting buoys in poor visibility, possible stranding or loss of vessels.

F. *System.*—Each type of buoy is handled in basically the same manner, although each tender will use variations dependent upon the hoisting gear and deck fittings. Methods of individuals vary but once a certain system is established on board, it should not be deviated from unless definite improvement is possible. When the work becomes systemized, each man will learn to do the right thing instinctively. The officer in charge should assign men to each individual function prior to operations, when possible. New men should be assigned to the least important tasks, the entire force being advanced in responsibility as experience is gained. For instance, a new man could be detailed to "touching up" buoys or painting numbers, but would not be assigned to the sinker stopper or to passing a chain sling.

27–13–5 Safety Rules, Notes and Procedures—

A. *A few sample regulations* suitable for the buoy deck are as follows:

(1) No smoking on the buoy deck.
(2) Don't converse—listen for orders.
(3) Watch what is going on at all times.
(4) Stay out from under all suspended weights, whether heavy or light; make this a habit.
(5) Stay out of bights of wire, line, or chain. Don't walk over or through them; walk around them.
(6) Don't permit blocks or hooks to swing. Take a turn with the tripping line.
(7) Stand well clear of all gear that has a strain on it except when it is necessary to actually work with it, and at all times be alert to the potential danger.
(8) Acetylene gas is explosive. Electric batteries also may generate explosive gas. Use only non-sparking tools in opening buoy pockets; make this a habit.
(9) Don't wear loose clothing. Wear safety shoes if possible.
(10) Don't squeeze into close quarters.
(11) Don't take chances. Buoys and equipment can be replaced; an arm, leg or life cannot.
(12) Don't toss or leave tools, shackles, lines, turnbuckles, sling chains, etc., lying around on deck in the working area. Carry them to a stowage space where they will not be tripped over, and where you will know where they are if needed quickly in an emergency.

B. *General safety rules.*—Other regulations may be drawn from the safety notes listed below:

(1) Buoys should be securely wedged or chocked when unloaded on the dock by tenders, and should be spaced to permit working access whenever possible. It is much easier for the tender to accomplish this than for the depot crew. When painting, sanding, or repairing buoys, on deck and ashore, chock them securely even though they are to be moved around frequently.

(2) Do not permit welding or burning in or *near* the vicinity of buoys whose pockets or bodies are being opened.

(3) Observe all acetylene safety precautions (Ch. 20) when handling acetylene cylinders afloat or ashore. Gas-free buoy bodies before undertaking any structural repairs.

(4) Remember that a buoy vent does not insure positive ventilation due to lack of air circulation and will *not* remove acetylene gas from a buoy pocket. It only bleeds off accumulated pressure.

(5) Although acetylene gas gives off a distinguishable odor, do not depend on your nose to positively indicate the presence or absence of acetylene. Handle every buoy on the assumption that gas is present and exercise precaution accordingly.

(6) Never underestimate the hazard of a small buoy as compared to a large one. A 600- or 900-pound weight can crush for all practical purposes as effectively as a 10,000-pound one. Chock all buoys securely, even while working on them or connecting up their moorings, if there is any possibility of their moving.

(7) Train boom operators carefully and thoroughly. Do not allow unskilled personnel to operate the boom. Not all men assigned to a tender are suited for the strenuous physical requirements of buoy work and not all are temperamentally suited. Men should be studied and worked into various buoy crew positions commensurate with their capability. A boom operator must be a man with cool nerves, mature temperament, foresight, and a complete familiarity with buoy work.

(8) The officer in charge should confer with his men before starting an unfamiliar job so that each man will know what is expected of him, how the work is to be accomplished, and what equipment will be used. Include the boom operator in these discussions.

(9) Never permit the boom operator to leave the controls while a load is suspended in midair. Do not permit visitors or miscellaneous conversation with the boom operator. Operating a boom is a job requiring full time and attention.

(10) Use only standard hand signals for controlling the boom. (See Fig. 27–97) Keep a Standard Signals sign posted near the boom operator and near the supervisor. Insure that all hands are familiar with them.

(11) Indoctrinate new buoy deck personnel thoroughly. Have a regular training program. Do not allow a new man to work in a difficult or dangerous operation. Hold periodical safety meetings.

(12) A man just reporting aboard who has had prior tender experience may be just as dangerous to himself and others as a new recruit, due to the difference in methods now employed on board the various tenders. Therefore, *all* men reporting on board should be suitably indoctrinated to the extent necessary.

(13) Whenever possible, try to give instructions before the operation begins, to avoid the need for too many directions and orders during the actual work.

(14) Do not put a man on a buoy unless absolutely necessary. Only qualified swimmers who have had ample experience in buoy work should be allowed to board a buoy. Do not use a clumsy man. Men boarding a buoy should wear lifejackets. When a man is aboard a buoy, keep him under observation at all times, and adequately supervise his movements so that he will not board the buoy or return to the ship until the ship is ready in all respects.

(15) Have the minimum number of personnel on the buoy deck to satisfactorily accomplish the work at hand.

(16) Have no horseplay or casual conversation on the buoy deck. Have all equipment necessary for the operation on hand, broken out, and ready for use.

(17) Each man should not only take care not to put himself in a dangerous position, but should be alert to warn anyone else in apparent or potential danger.

(18) No person should be allowed to loiter in the vicinity of buoy operations unless employed in a specific duty requiring his presence.

(19) One vessel has posted safety signs on the buoy deck as a reminder to stay out from under a load on the boom.

(20) Moving buoys around on deck in a seaway requires strict observance of all safety precautions. Great care should be taken in proper placement of men about the deck. When moving a buoy across the deck, allowance must be made for the change in list of the ship, which occurs at the moment the boom crosses the midpoint. Keep the load low so that if a tendency to wildness is observed, the buoy can be lowered to the deck quickly and wedged to prevent it from taking charge.

(21) Do not allow a load to get swinging in midair. Keep all heavy loads low and close to the deck at all times. If it begins to swing, touch it gently to the deck, taking care not to lower so far that the hoisting tackle could accidentally unhook.

(22) Check the alignment of the rigging before taking a lift. If the tackle is not set so as to be directly over the weight, the object will surge upon lifting, and endanger men and equipment.

(23) When hoisting a tackle two-blocks or nearly so, both boom operator and the person in charge of the buoy deck must exercise caution not to jam the tackle. A case is on record of a whip being run up carelessly two-blocks, thereby causing the fitting on the end of the wire to part. The hook dropped on a man, causing a fatal injury. Even if the gear did not part, a kinked wire would probably result. The boom operator must stop the tackle in time even though the person in charge fails to give the stop order.

(24) Always have sufficient steadying lines on heavy weights.

(25) Hoist very easy when a sinker appears sanded-in. If badly sanded, unhook, and if not equipped with the mechanical chain stopper, shackle the mooring into the deck. Let the ship, rather than the hoisting tackle, pull the sinker free. Watch out for a roll of the ship causing excessive strain when heaving on a sinker.

(26) In a seaway, or when the vessel is rolling or is subject to a sudden roll, do not hoist anything higher than absolutely necessary, and then be sure to have ample preventer lines rigged. Keep these lines taut at all times.

(27) Do not test hoisting gear by jerking heavy loads, or by other nonapproved methods.

(28) When loading buoys, check for bent or broken hoisting bails or lifting lugs.

(29) Bear in mind that a stiff new line or one that is wet will come off the hook of a tackle if the object being lowered on the sling should hang up on a projection.

(30) In addition to the prescribed periodic inspections, all running gear should be constantly watched to detect any signs of fault.

(31) Use sand on a slippery deck. Mud from sinkers, etc., can create very slippery conditions. Keep the deck as free as possible of oil, grease, and mud.

(32) Avoid excessive side pulls on booms. Do not permit the wind to set the ship off while hoisting a buoy or mooring. This causes a live load to be placed on the gear, which may quickly exceed the permissive load limits.

(33) Be sure that all weights are blocked and lashed securely before sailing.

(34) Clear the deck of unnecessary gear before working buoys.

(35) Booms not having the double topping lift should be anchored by one purchase as a power vang when hoisting any but the lightest loads.

(36) Look well before giving an order.

(37) Except when necessary to move the ship immediately to a safer position, check to see that the sinker is in sight, free and clear, before getting under way with a relieved buoy.

(38) Have nothing adrift. Lash items as they are loaded aboard. Have steadying lines on all weights moved.

(39) Use lines of the proper strength. Do not attempt to use a line when dubious of its ability to take the load or serve the purpose, i. e., steadying line, etc.

(40) Use goggles when sanding, chipping, welding, or burning.

(41) Men tending boom guys (vangs) should always stand behind the coil of line so that there is no possibility of the line entangling their feet should something carry away, causing the line to run out. They must always be alert to pick up the slack or pay out the line, keeping it under control around the cleat as the boom is topped up or down or trimmed athwartships. The man on the vangs should seldom require a direct order. He must understand the working of the boom well enough so as to know what to do from the order given to the boom operator.

(42) Stand clear at all times of chain that is ranged out on deck for running.

(43) Know the capacity of your ship's hoisting gear, and don't overload it.

(44) Know what is going on behind you when the boom is operating.

(45) Keep hands away from sheaves and running wires.

(46) Never wear light loose gloves when handling lines on a capstan. They are easily caught between the turns.

(47) If you have to strain to lift a weight, don't do it; get some help.

(48) Any injury, no matter how slight, should be reported for treatment.

(49) Be careful when unravelling kinks in twisted and knotted mooring chains. They may suddenly let go with a rush.

(50) Wear laced shoes on the buoy deck. Unlaced shoes can trip you into a dangerous position. Don't wear sneakers or slippers when working buoys. A safety-toed shoe may save you a painful injury someday.

(51) Do not walk between a suspended load, and the ship's bulwarks or another buoy.

(52) Do not permit personnel to ride on the purchase hooks.

(53) Stay outside the bights of lines running through snatch blocks.

(54) Keep your face clear of an acetylene lantern while lighting the pilot. *Ventilate the lantern thoroughly before lighting.*

(55) Be prudent. Do not attempt to work buoys when conditions are so adverse as to involve unwarranted risks.

(56) When servicing aids ashore on inland waters, be alert for snakes, and wear high-topped shoes.

(57) Do not oil or repair hoisting machinery while in operation.

(58) Keep battery charging compartments well ventilated.

(59) Have a life ring and heaving line ready on deck at all times. When the liberty party goes ashore over the buoy deck, provide a suitable well-lighted gangway equipped with handrails.

(60) The keyword in working buoys is "patience." Be patient with a dog-tired crew after a hard day's work, and be patient with cantankerous shiphandling predicaments.

27–13–10 Safety Program—

A. Many ships have established good safety programs. For information, the salient features of one ship's program is outlined in part as follows:

(1) "*Indoctrination of personnel:* New men are not assigned to duty on the buoy deck until they have been aboard a month or so. It is felt that if a man has a chance to observe for a while, he will be considerably more impressed than if just lectured to and sent in 'cold.' The least intelligent cannot help but notice the potential dangers in taking aboard a 9-foot buoy. In addition, he talks with the experienced men and finds that their attitude on safety is not one of hazarding life and limb for the sake of a piece of gear. The new man is personally instructed in safe procedures by the senior petty officers and the officers. He is told that, above all, he must look out for himself. Not only is he told the do's and don't's, but also the reasons why. This process of warning and instruction is a continuing procedure that applies to the seemingly experienced as well as to the recruit. Often the most conscientious and hardest working men are the ones you need to watch the most. They so often disregard safety in their enthusiasm to get the job accomplished.

(2) "*Operating technique:* The ship complies strictly with all directives concerning safe techniques. Buoys are handled slowly and carefully. The work is not hurried just so as to make an early liberty. Buoy work is scheduled in the morning whenever possible, when the men are fresh and alert. On occasion, work was discontinued because the crew became fatigued and was getting careless.

(3) "*Inspection of equipment:* The buoy handling gear is inspected regularly in accordance with current directives, and is not permitted to become a slipshod routine function.

(4) "*Safety equipment:* Safety shoes, gloves, and lifejackets are worn conscientiously. Nonsparking tools are used with all acetylene apparatus."

The above serves to illustrate in part the cognizance of safety which a vessel may take. There is a great deal to be done in this field and results can only be achieved by concerted effort on the part of every individual.

B. Commanding Officers should never lose an opportunity to bring SAFETY to the attention of all hands. The creation and furthering of safety consciousness should be an ever-continuing program. Safety and efficiency are synonymous. A given accident seldom recurs at the same unit in the same fashion, since the personnel have been made aware of the particular conditions or causes involved. But if the safety program of the service as a whole is to benefit by experience, the facts and circumstances surrounding the accident should be made available as information to other units. The best means to this end at present is an accident report which should be submitted in as complete detail as possible. Then preventive measures can be established for the entire service. Remember that the SAFE way is the RIGHT way, and the only RIGHT way is the SAFE way.

27–14 GLOSSARY OF AIDS TO NAVIGATION TERMS

27–14–1 General—

A. See Chapter 28 of this manual for definitions of terms used in connection with aids to navigation design, operation, and maintenance. Colloquial expressions used in working buoys have been included.

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