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MOORING OPERATIONS TECHNIQUES OF THE  
BUOY PROJECT AT THE WOODS HOLE  
OCEANOGRAPHIC INSTITUTION

by

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TECHNICAL REPORT

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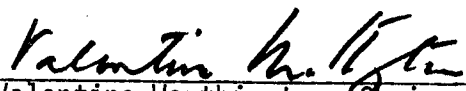
  
Valentine Worthington, Chairman  
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## ABSTRACT

This report covers the techniques of deploying and recovering the moorings used by the Buoy Project at Woods Hole Oceanographic Institution. A brief description of the moorings and associated hardware is included. Deck equipment is discussed. Step by step descriptions are given of the procedures for handling of the mooring gear at sea during setting and recovery. Documentation and quality control are also discussed.

## INTRODUCTION

This report is a detailed description of the techniques developed over the years for deploying and recovering the deep-sea moorings of the Buoy Project at the Woods Hole Oceanographic Institution. These techniques are the result of twelve years of evolution. Although the process of change, of course, will not stop with the preparation of this document, this report is an attempt to summarize our operations techniques at the time of writing. It is hoped that it will be of use to others using deep-sea moorings, of the Woods Hole type or any other design.

Deck operations are described in considerable detail for those who are not familiar with the standard methods of working at sea. In addition, a glossary of terms is provided in Appendix II. For those already familiar with rigging operations at sea, the report should serve as a general outline of the procedures used by the Buoy Project at Woods Hole for mooring operations.

These procedures have been developed to meet the problems of setting and recovery of our own moorings and are tailored to our equipment and our ships. However, the basic approach is adaptable to other mooring configurations and for use on different vessels.

Although the general form of our moorings will be outlined, the reader interested in a more detailed description should consult other publications.<sup>1</sup> Recent design changes are incorporated in the drawings in this report and discussed in the text.

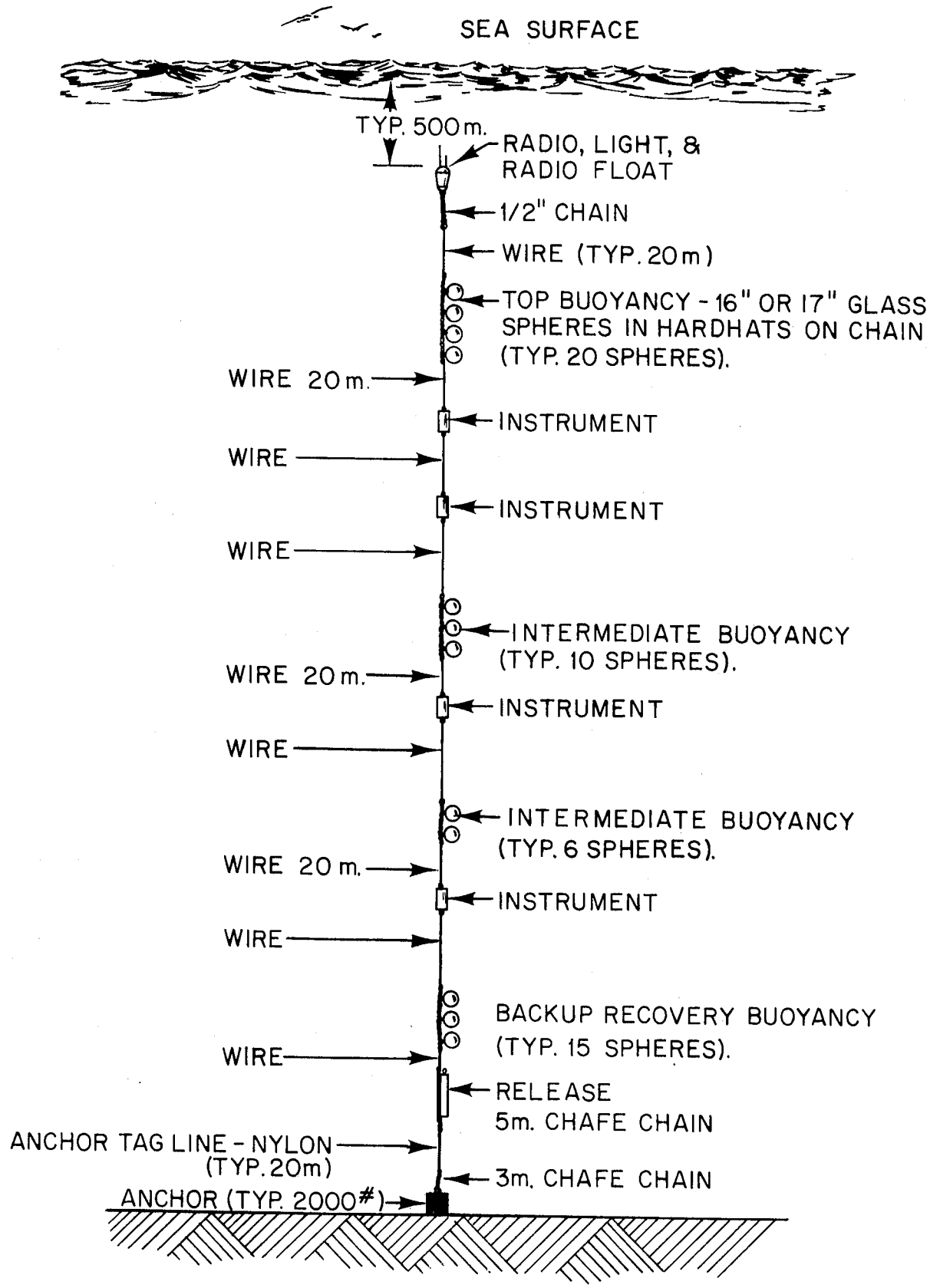


FIG. 1 INTERMEDIATE MOORING

## THE MOORINGS

### Mooring Configurations

Moorings used by the Buoy Project fall into three general configurations. The intermediate mooring, shown in Figure 1, is a subsurface mooring with buoyancy sections at several depths. The lowest buoyancy section provides backup recovery in the event of mooring failure.<sup>2</sup> The depth of the top of the mooring can vary up to within 200 meters of the surface or less.

The deep-sea surface mooring is shown in schematic form in Figure 2. A variety of floats has been used. The weight of the anchor varies with the expected current profile. A single cluster of glass spheres near the bottom makes up the backup recovery section.

Some recent design changes have been made in the intermediate and surface moorings. A twenty-meter wire shot is now placed between a glass-sphere section and any instrument or release directly below it to ease handling at launch and recovery. On the surface moorings, the backup-recovery section is glass spheres in hardhats on chain, instead of in nets on nylon line as before. This eliminates the need to test spheres because the mooring will not be endangered if a sphere implodes on chain.

Bottom moorings, shown in Figure 3, are used to make near-bottom measurements and for transponder placement and are usually 200 meters or less in length. They have no backup recovery section and typically carry only one or two instruments.

### Computer Design

Intermediate and bottom moorings are designed using a computer program. The program is written to be used on the Hewlett-Packard computers available on each of the WHOI vessels. A similar computer is available ashore.

The program, called NOYFB,<sup>3</sup> allows the operator to model any configuration of subsurface mooring in a wide range of environmental conditions. Various output formats are available. For the purposes of initial mooring design, a format is used which lists the depth and tilt of every component of the mooring in a given current profile. The program is very flexible and allows the operator to rapidly test a series of mooring configurations in a variety of current profiles.

Buoyancy sections and other mooring components must be adjusted until the mooring design performs within specifications in the maximum expected current. The essential parameters are instrument depth and tilt. For each experiment, the scientist specifies a maximum variation

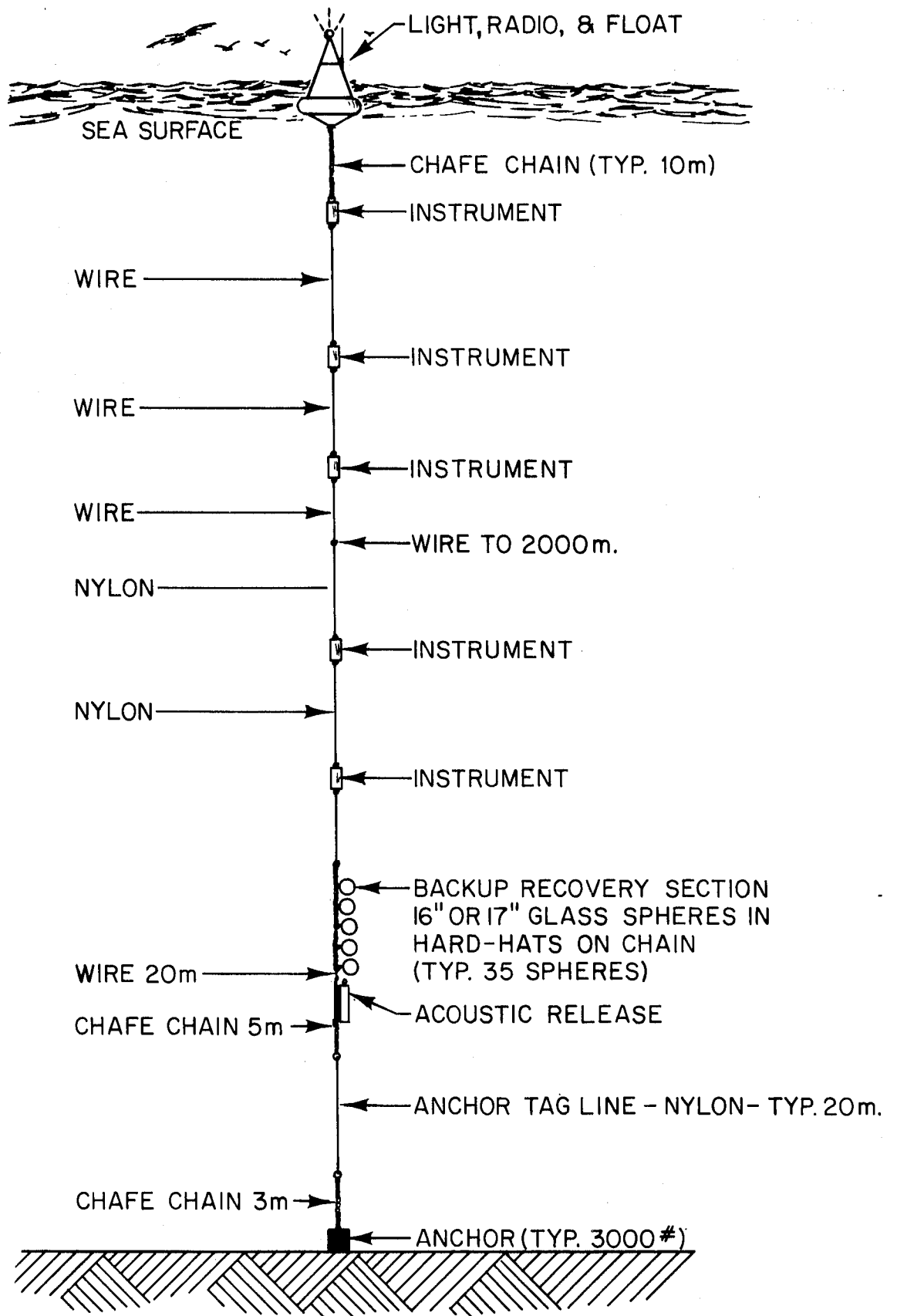
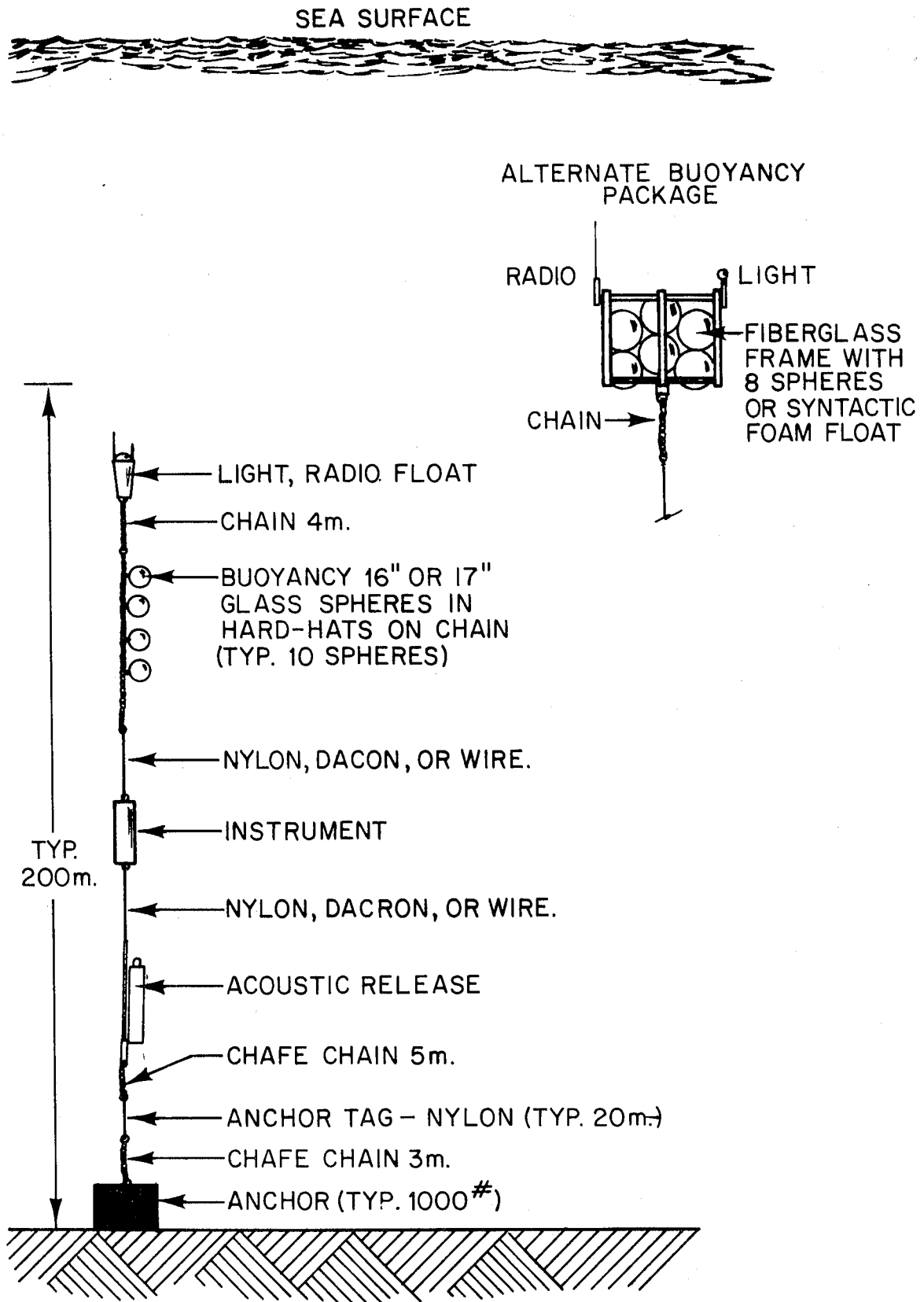


FIG. 2 SURFACE MOORING



**FIG. 3 BOTTOM MOORING**



in the depth of the instruments in profiles varying from no current to maximum. A typical specification is for a maximum of ten meters variation in 5,000 meters depth. Instrument tilt must be kept low enough so that the calibration is not affected, less than ten degrees in the case of Savonius-rotor current meters.

The program is also used at sea to check last-minute changes due to bottom depth variations, etc. to insure that they do not jeopardize the mooring performance.

The program can produce a punched paper tape listing the mooring configuration and other parameters for easy access later. These tapes are used for analysis of mooring performance after recovery.

#### Hardware Interconnections

All interconnections on the moorings, between line terminations, instrument bales, etc., are made with standard hardware (with the exception of special clevis links below the radio float and release, for corrosion isolation). In order to facilitate the launch and recovery operations, attention must be paid to the arrangement of these connections.

All interconnections in a mooring include at least one oval sling link (or master link) large enough so that there is plenty of room left after connecting two shackles. This sling link is used to relieve the tension on the wire, line, or instruments during the deployment and retrieval phases while a third shackle or snap hook is being inserted (stopping off). Figure 4 shows several typical hardware connections on moorings. In each case a sling link provides a convenient place to stop off during launch and recovery operations.

Figure 5 shows how the sling link is used to stop off between two wire shots. Figure 5a shows the arrangement of hardware, under tension as on a mooring. In Figure 5b, a snap hook on a pennant has been clipped into the sling link. In Figure 5c, the tension has been transferred to the stopper, and the upper termination is slack for removal, as in Figure 5d.

Sling links should be used at virtually all connection points, including both above and below the instruments for use in stopping off. If two interconnection points are separated by one-half meter or less the sling link may be omitted, especially if it would add extra unwanted length between components, since the stopper can always be attached a half-meter higher or lower without inconvenience.

#### Quality Control

All components used in our moorings are standardized. A continuous program of testing is carried on to insure that wire and hardware meet specifications as to materials, rated breaking strength, and quality.

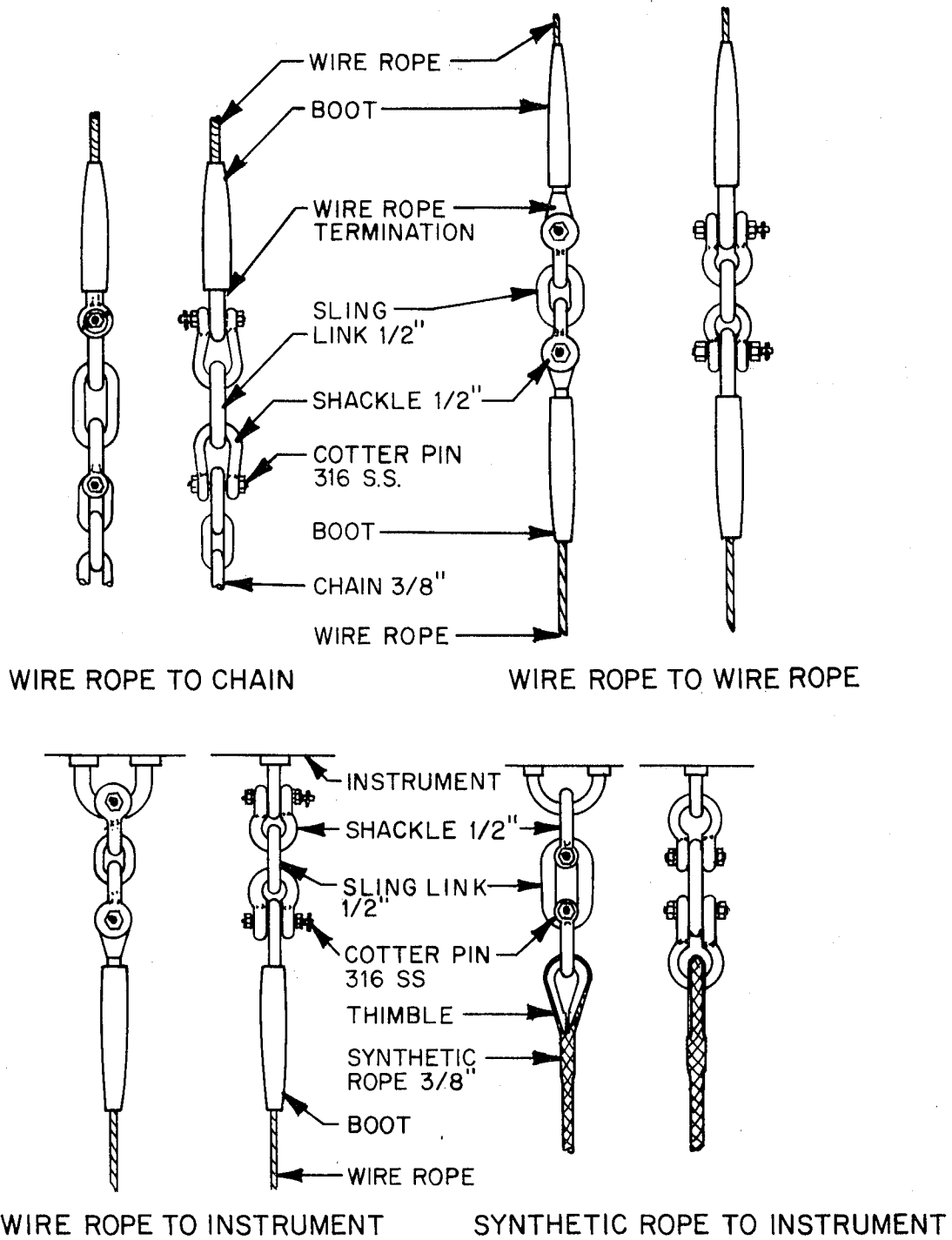
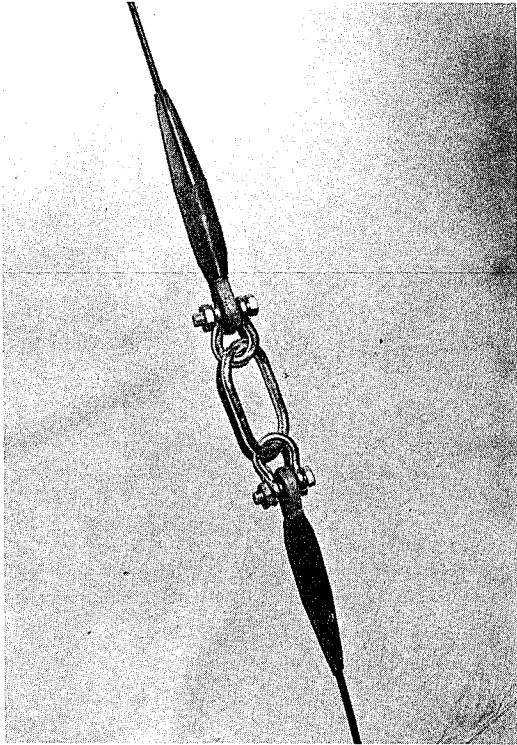
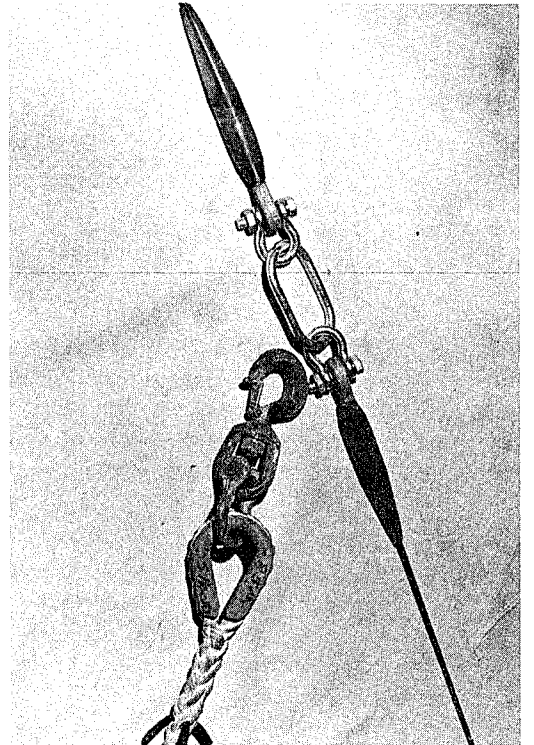


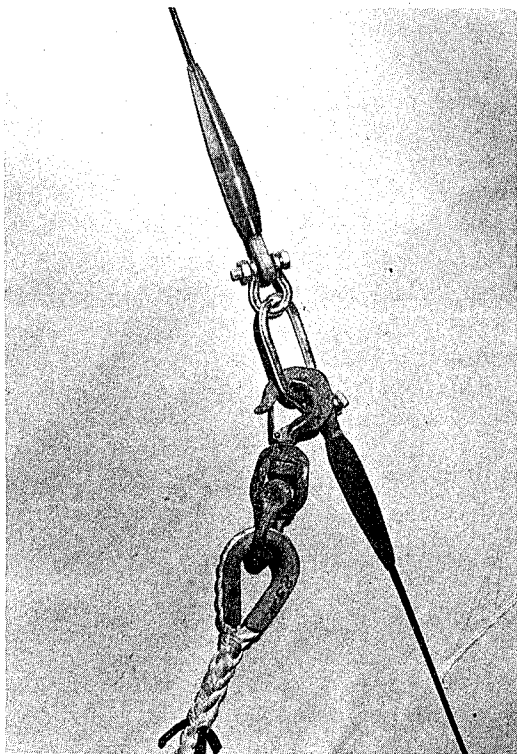
FIG. 4 TYPICAL HARDWARE INTERCONNECTIONS



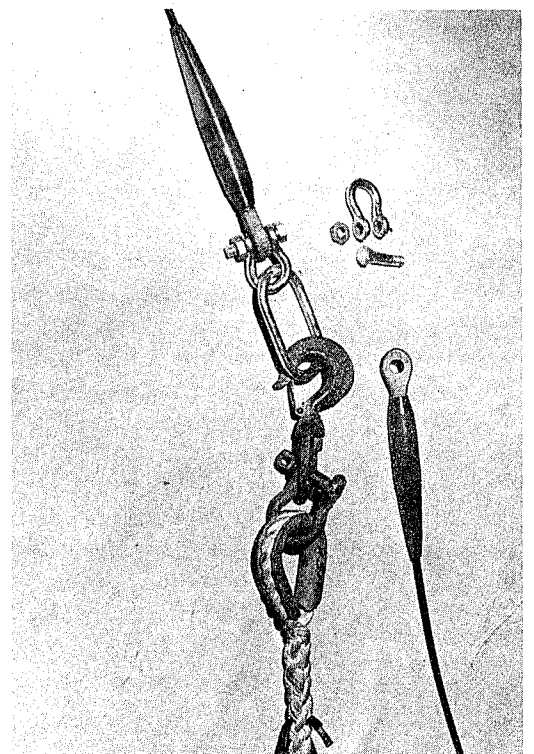
Terminations with Shackles and Sling Link



Stopping-off Hook



Hook Engaged



Tension on Stopper - Wire Shot Unshackled

Figure 5  
Stopping Off

Wire is purchased in bulk and terminated in-house. All terminations are tested to 60% of rated breaking strength on a test rig as shown in Figure 6. Wire is inspected during the measuring and terminating process for defects in the jacket, etc.

Hardware must be inspected after each recovery, including chain, shackles and sling links. Any hardware which has lost most of its galvanizing must be regalvanized or discarded.

Stainless-steel hardware must be inspected before use to make sure that it is the correct alloy. In some batches of stainless-steel cotter pins, in particular, mild steel pins will have been included. They may be sorted magnetically. Suppliers must be impressed with the importance of providing the alloy specified.

Wire samples are routinely cut from the ends of recovered wire. The termination and six to eight feet of wire are saved. A new termination is put on the cut end and the sample tested for breaking strength.

## MOORING DEPLOYMENT

### General Considerations

Most of our deployments are made by the anchor-last method. That is, the top of the mooring is paid out over the stern with the ship moving upwind at a speed of two or three knots. The line and other gear is paid out under moderate tension until the bottom or lower end of the mooring is reached. Finally, the anchor is attached and allowed to free-fall to the bottom.

The anchor-last deployment has the advantage of putting the least strain on the mooring line during most of the deployment. However, in order to place the mooring at a selected location careful selection of the starting point, line tension, and ship's speed relative to the water depth and mooring length are required.

In general it has been found that for a mooring which is of a length of from eighty to 100% of the water depth (such as near-surface intermediate moorings and surface moorings) it is usually best to start a distance of about one and one-half times the water depth downwind from the mooring location. Selection of a starting point is, perhaps, more of an art than a science and involves a knowledge of how the vessel will be influenced by sea and wind during the launch period. Because of this, using the same vessel consistently on successive cruises is an advantage.

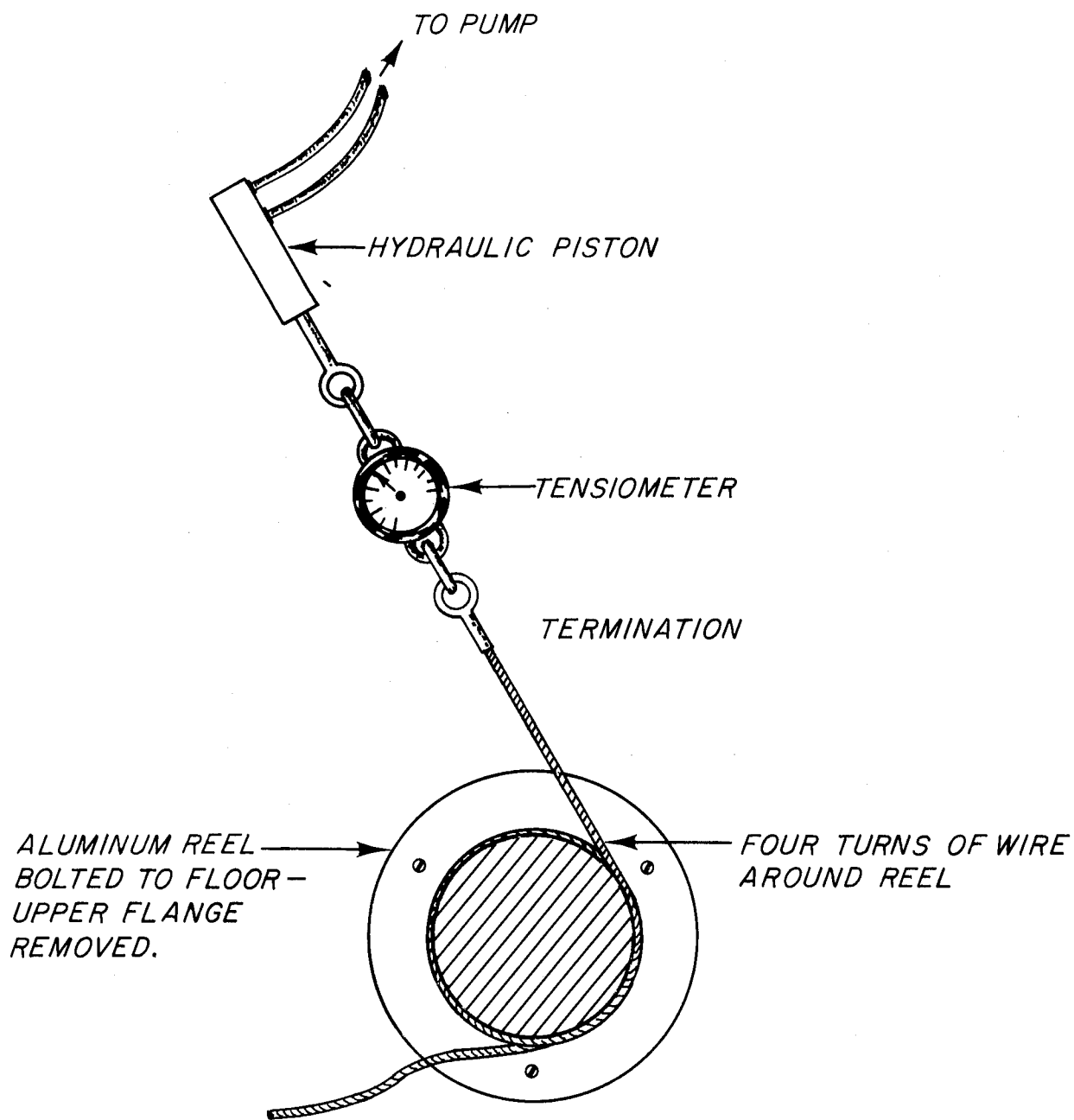


FIG. 6 SETUP FOR TESTING OF WIRE ROPE TERMINATIONS

The distance the ship goes during deployment will also be affected by the mooring configuration. If a mooring contains more components than usual or pieces of equipment which are likely to be difficult to assemble on the mooring, thus delaying the payout process, more distance should be allowed. Conversely, if a mooring has one or more elements on it which will provide high drag, such as an unusually large surface float, the ship must proceed at a lower speed for a given line tension during launch and less distance will be covered. Of course, if the mooring is to extend through only a fraction of the water depth it will be launched more quickly and with shorter distance covered.

Surface currents along the direction of travel will generally provide a constant set which can be easily allowed for. Allowance for all the other factors mentioned depends upon judgment gained only through experience. A savvy ship's bosun or mate can be extremely helpful on an unfamiliar vessel.

If in doubt as to the distance to be run it is better to err on the side of a starting point too far away. If the mooring is not ready to be dropped when the location is reached there is no turning back without the danger of putting kinks in the mooring. Whereas, if the mooring is ready but the site has yet not been reached the mooring string can be simply towed into position.

If it is desired to place the mooring at a particular depth (as opposed to a particular location regardless of depth) it may be desirable to move the ship along the appropriate depth contour line rather than upwind. Steaming upwind, of course, provides the best control over the ship, particularly at the low speeds involved. However, this advantage may be offset by the difficulty of getting the mooring at the desired depth as the ship steams across the contour lines. Similarly, if a strong surface current exists in a direction different from that of the wind, it may be desirable to move into the current rather than upwind.

In many cases some compromise will be made between combinations of wind, current, and depth contours. The direction of the launch run may be influenced also by the necessity of avoiding moorings already existing in the immediate area.

Corrections may be made in the direction of the ship as the launch progresses and environmental conditions change, or previously unknown factors affect the ship's track, such as a set by the current. Course changes of up to ninety degrees may be safely made provided that adequate tension is maintained on the mooring. However, radical changes may cause problems with the lead of the line aft and it is preferable to achieve large changes in small stages every several minutes, if possible, allowing the mooring to come more nearly aft after each change.

The ship's speed will vary during the launch process. As more and more mooring gear is strung out aft, the speed will slowly drop if it is not adjusted. Tension on the line as it pays out is the deciding factor. Tension should be maintained at 200 to 300 pounds to prevent the possibility of kinking or tangling in a slack line. Too high a tension may cause damage to the wire jacket or to synthetic line. Figure 7 shows a calculated curve of tension versus ship's speed during launch for a typical intermediate mooring, along with data from an actual launch.<sup>4</sup>

During periods when the payout of line is halted, such as while the instruments are being inserted, the ship may have to be slowed to avoid the build-up of excessive tension. It is important to anticipate these periods since there is a time delay while the ship is losing way. For a mooring 5,000 meters long, a typical deployment with this technique takes about one and one-half hours.

In general, a smooth and successful launch is the product of careful planning and preparation. Once the launch has started, any major delay may cause the mooring to be badly positioned and could result in a mooring failure. Those ship's crew and officers participating should be thoroughly briefed. All equipment and tools should be laid out beforehand, including equipment to cope with the occasional crisis. A checklist may be desirable.

#### Deck Equipment

Several items of deck equipment have been built or acquired at Woods Hole for the setting and recovery of moorings. All of these pieces of gear are installed aboard ship for a buoy cruise and removed for servicing between cruises. Although when necessary some types of permanent ship's gear such as trawl and hydrographic winches and capstans have been used, it has been found that the extra expense and trouble of using specialized gear is offset by having winches and other equipment well suited to the job and in known good condition, ready when needed. It also eliminates the necessity for having an additional member of the ship's crew available, on those vessels where ship's gear must be operated by ship's personnel. However, for a small mooring group having specialized winches may not be possible or desirable due to the expense.

The launch winch is a simple arrangement of two shafts with heavy-duty brakes, facing aft. It has no power and is used only to pay out the mooring line under tension, from reels mounted on either shaft (Figure 8).

All wire and synthetic-line shots are measured, terminated, and wound on small aluminum reels in the lab ashore. These reels, shown in Figure 9, will fit on the shafts of either the launch or recovery winches

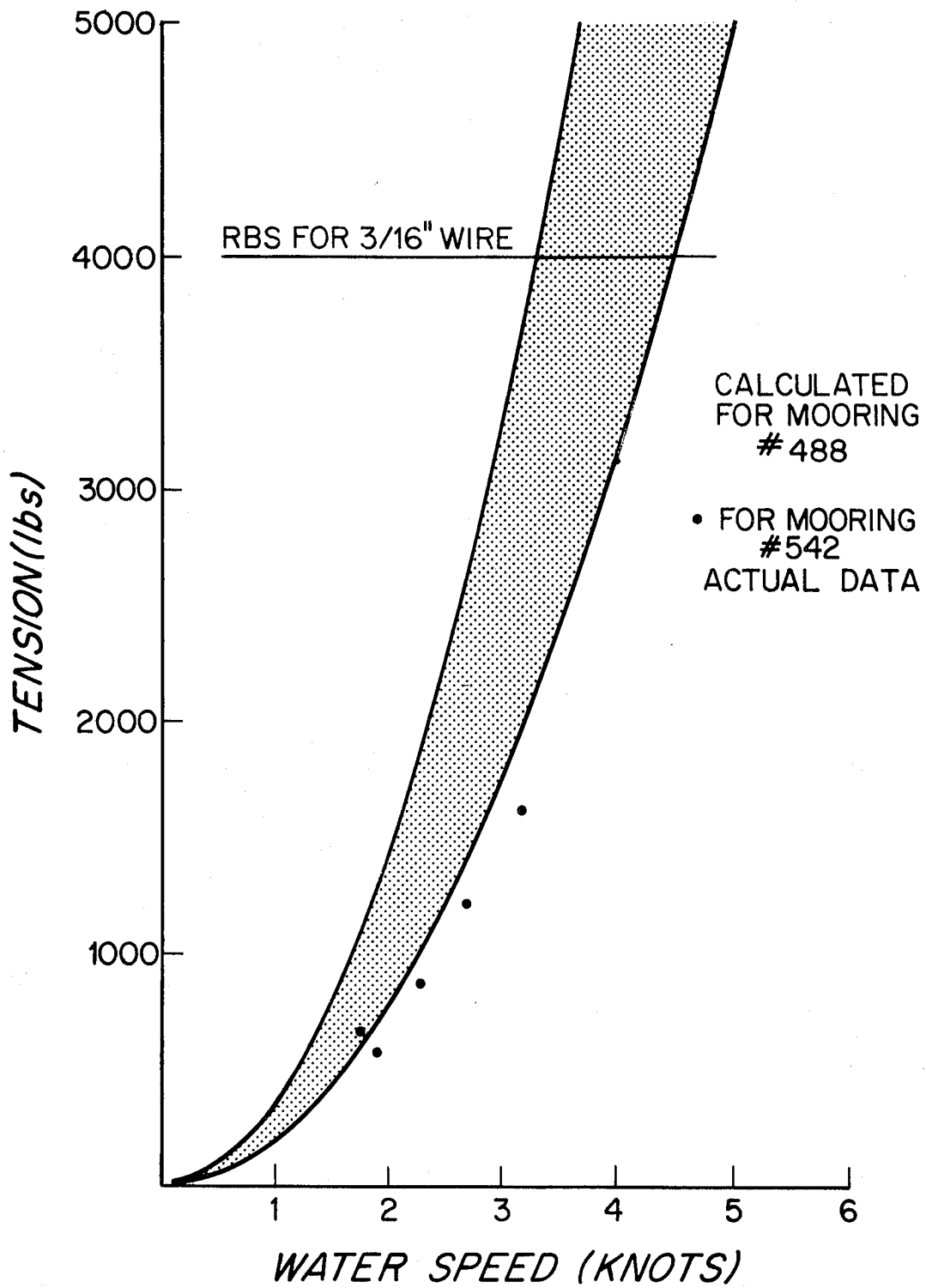
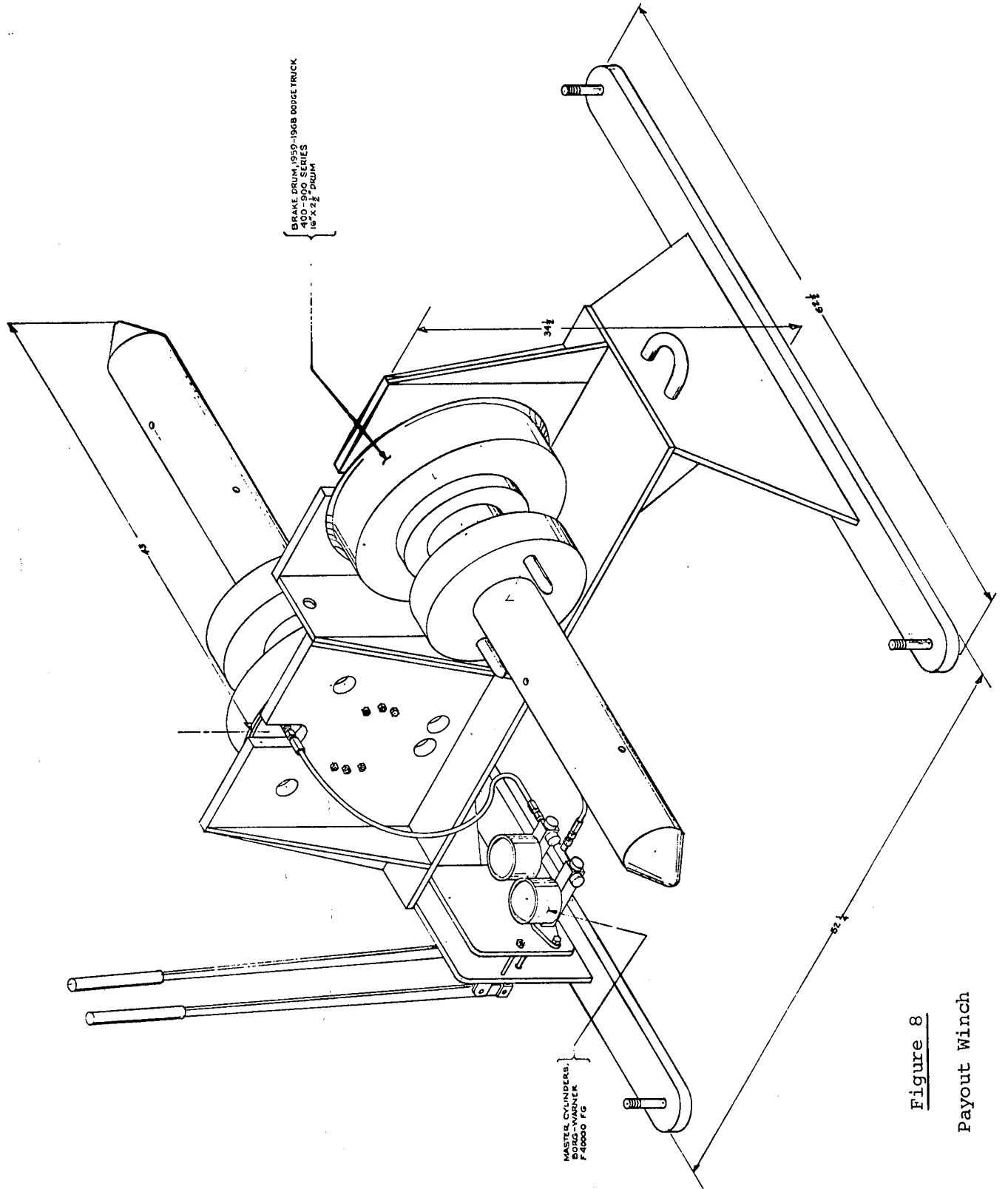


FIG. 7 LINE TENSION VS TOW SPEED

(From Walden, 1975<sup>4</sup>)





**Figure 8**  
Payout Winch

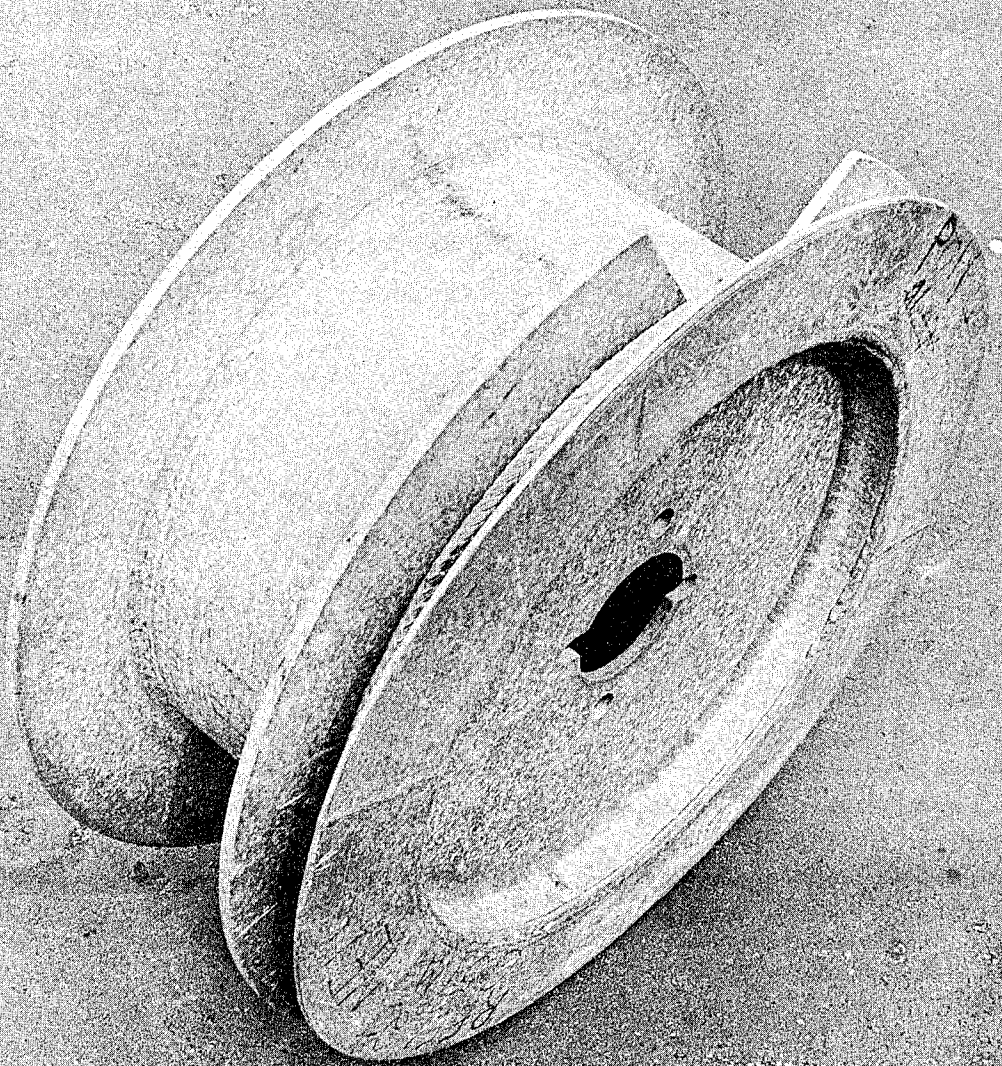


Figure 9

Reel

and have a separate section on one side separated from the main part of the reel by a flange. A wire tagline is passed through a hole in the core in this separate section and a fitting is swaged on inside the core to permanently attach it to the reel. The outer end of the tagline has a swaged eye. To wind a shot on a reel, the end of the shot is shackled to the tagline and the tagline, fittings, and terminations are wound on the core inside of this section before the major part of the shot is passed through a gap in the flange to the main section of the drum and wound on. In this way the bulky terminations are kept separate from the main body of the wire or synthetic line and damage to the line, wound under tension, is avoided. A sling link is always used between the tag line of the mooring shot.

Occasionally a number of short shots must be stored. To save reels several of these may be connected together and wound on one reel. In this case the terminations will be too bulky to all be stored in the extra section. Terminations and fittings may then be wound on the drum proper but must be carefully padded by canvas wrappings or layers of heavy rubber sheeting to prevent damage to the line wound on top of them.

If two adjoining shots are to be launched without any components (instruments or buoyancy package) inserted between them, they may be connected on the reel with the safety anchor shackles used in the final mooring configuration. The cotter pins should be left out, to avoid cutting synthetic line or damaging wire jacketing, and installed later in the launch process after the terminations have come off the reel. A sling link should be included between the shots.

A roller fairlead is used at the stern to prevent damage to line and instruments during launch. It consists of a six-foot long roller six inches in diameter mounted horizontally at the stern. Its shaft fits in bearings on brackets welded to the edge of the deck. At either end, port and starboard, is a three-foot high vertical stanchion to prevent the line from moving to the side off the roller. Both roller and stanchions are covered with a soft material. Figure 10 shows roller and stanchions in place.

Sheets of plywood are laid on the deck between the launch winch and the stern roller and are held down with round-head bolts to minimize projections. This plywood provides a smooth surface for the instruments to slide on. It extends aft to almost touch the surface of the roller and an effort is made in mounting the roller to make the plywood/roller transition as smooth as possible, with the upper surface of the plywood and the top of the roller at the same level.

Several types of tiedowns and cleats are used for stoppers. If adequate permanent cleats are available on the vessel they are used. If they are not available, two or more portable cleats are used. These are standard cleats, welded to a plate which is then bolted to the ship's

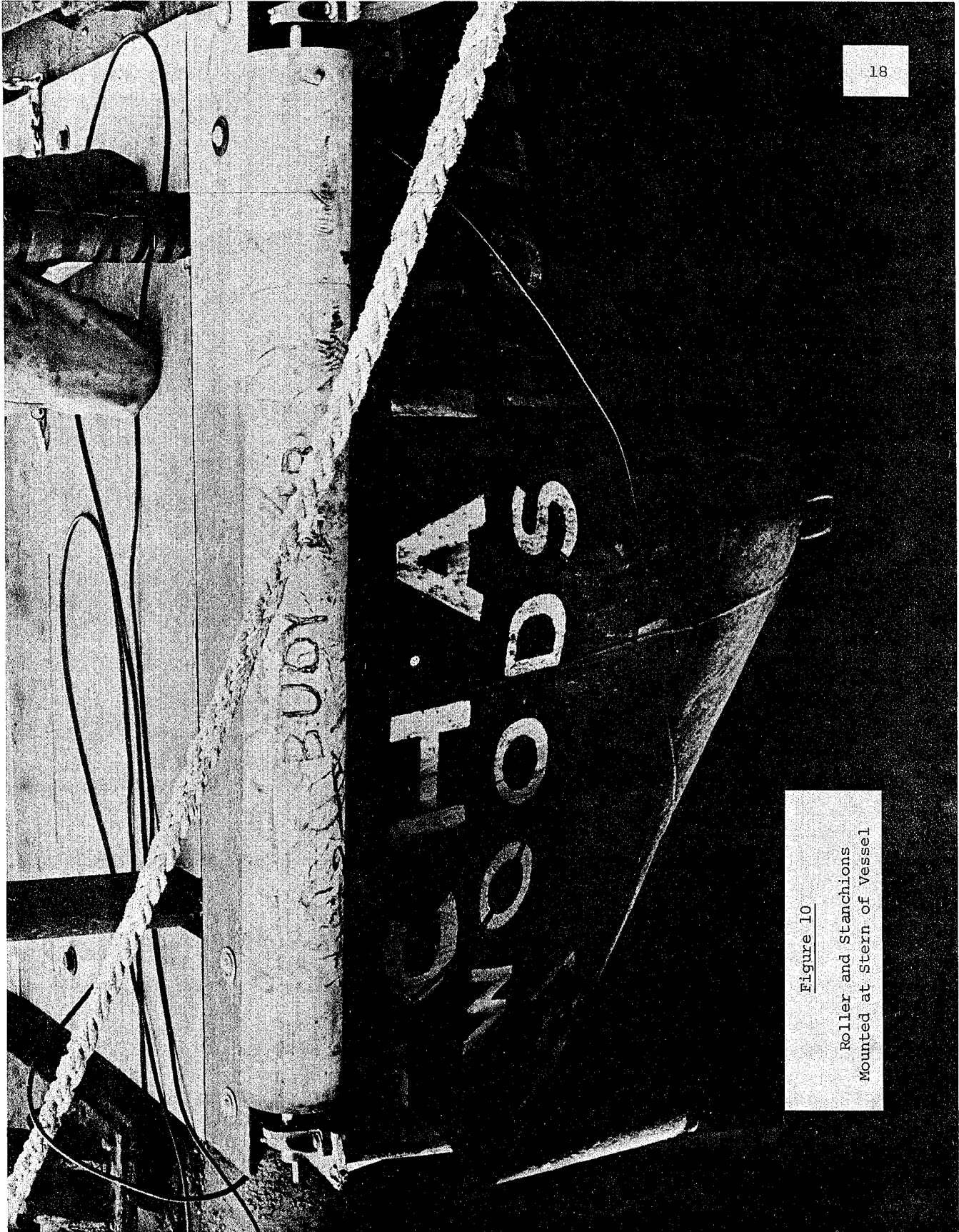


Figure 10  
Roller and Stanchions  
Mounted at Stern of Vessel

deck in a convenient spot, using the deck holddowns available on all of the Institution's vessels. An eye at the after side of the winch base provides an attachment for a snatch block. A dacron line with a safety hook on one end is led from a cleat through the snatch block and aft, to provide a means of stopping off between line shots (Figure 11).

Available at the start of the launch are two dacron (to minimize stretch) stopper lines with chain grabs on the ends, with a cleat assigned to each, for paying out the glass-ball sections of intermediate moorings. The line through the snatch block may be used for one of these, with the snap hook temporarily replaced with a chain grab.

#### Pre-Deployment Procedures

The first step in preparing for mooring deployment is to find a spot close to the desired site with an adequately flat bottom, particularly if the depth is critical. A trade-off may be involved between position, depth and ease of deployment.

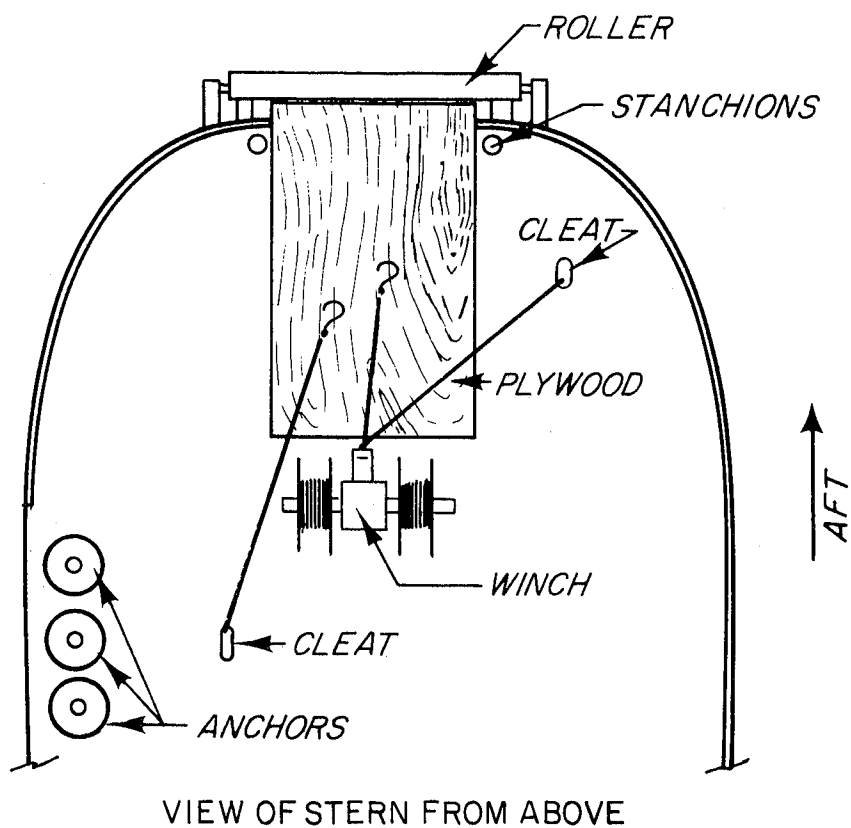
The basic mooring design is done ashore. However, in areas where the depth is not accurately known beforehand, an adjustable shot of synthetic line may be designed into an appropriate place in the mooring (usually below the instruments).

Once a site has been selected and its depth determined, a computer run is made to determine the final length of the adjustable shot. This shot is then cut and terminated with an eye splice on a thimble. If the bottom is very flat and the depth was known beforehand, no adjustment may be necessary. A final working drawing is prepared of the mooring as it is to be launched.

A schematic diagram of the mooring should be available on deck at launch. Frequent reference to it will insure that all component items are inserted into the mooring in proper order. In addition, while a section is being paid out the diagram can be used to anticipate and lay out for deployment the next components. If enough personnel are available, it is important to assign to one person the tasks of keeping the moored station log sheet and calling out each succeeding component to be launched (see page 59 for details on Moored Station Log Sheet).

All gear to go on the mooring should be at hand before the deployment is started. Similarly, all deck gear necessary to the operation should be readied.

Once preparations are complete the ship proceeds to the starting position for the launch run.



**FIG. 11 DECK ARRANGEMENT FOR DEPLOYMENT**

### General Payout Procedure

The following procedures are used for the deployment of both surface and intermediate moorings. Specifics for each type are discussed separately.

Line is paid out from alternate sides of the launch winch. As the end of a shot is reached the winch is slowed and the terminations and tagline are allowed to pay slowly off the drum. As the termination to the tagline comes just off the drum, the snap hook of the main stopper is snapped into the sling link between the wire shot and the tagline (Figure 12a). The inboard end of the stopper is made fast to a cleat and the tagline is paid out until the tension is on the stopper (Figure 12b). The tagline is then unshackled from the sling link. The tagline is wound back on the reel and the empty reel removed from the winch shaft (Figure 12c), and the next full reel put on.

When an instrument is to be inserted, its upper end is then shackled to the sling link. (Remember - the top of the mooring is paid out first.) The lower end is shackled to the upper end of the wire shot on the next full reel (Figure 13a). The slack line is hauled onto the second reel and the brake locked. The stopper line is slacked until the tension is on the reel and the stopper hook is removed (Figure 13b). One person is assigned to handle each stopper line.

The instrument is paid out slowly over the stern roller and into the water. Instruments should be tended carefully as they go over the roller to make sure they do not hang up and cause the line from the instrument to the winch to go slack. Impacts of instruments against the deck or stanchion must be avoided.

If two shots have been shackled together on a reel and no instrument is to be inserted the line does not need to be stopped off. The terminations can be stopped just aft of the winch while the cotter pins are inserted. Payout is then resumed.

When an instrument is to be inserted between two shots on the same reel the top shot is stopped off as above and the instrument connected. However, payout resumes with the next shot on the same reel instead of going to the other reel.

Figure 14 shows the steps in anchor launch. When the lower end of the mooring is ready to go overboard the anchor release is attached to the lower end of the last shot (or the lower end of the backup recovery section, to be described later, see Figure 14a). The anchors are placed at the starboard rail before the ship leaves port. On all Institution vessels a section of the bulwarks is removable at this point. On other vessels the anchor may be picked up by the crane

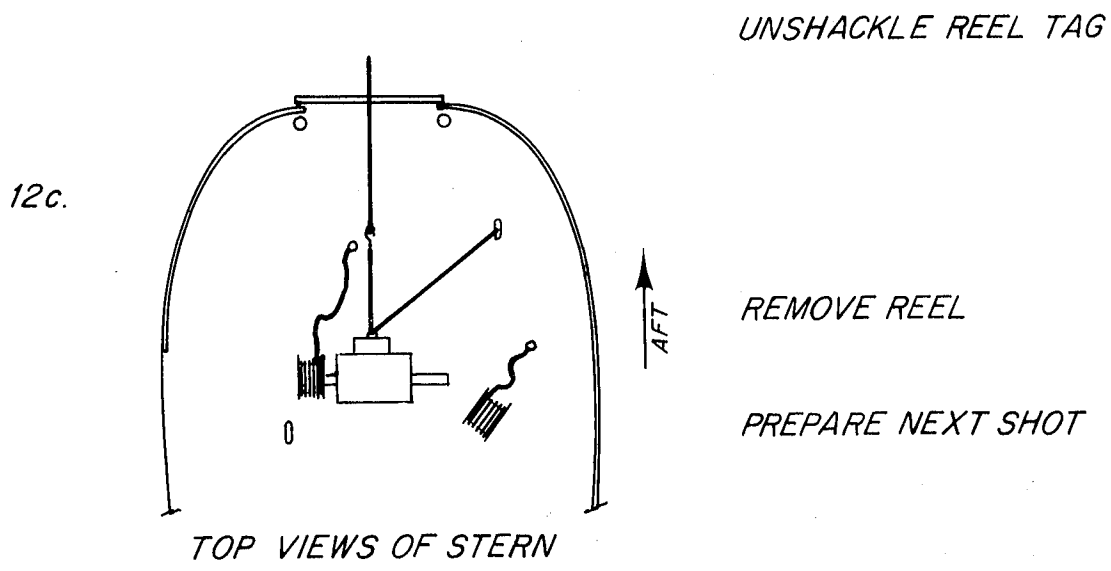
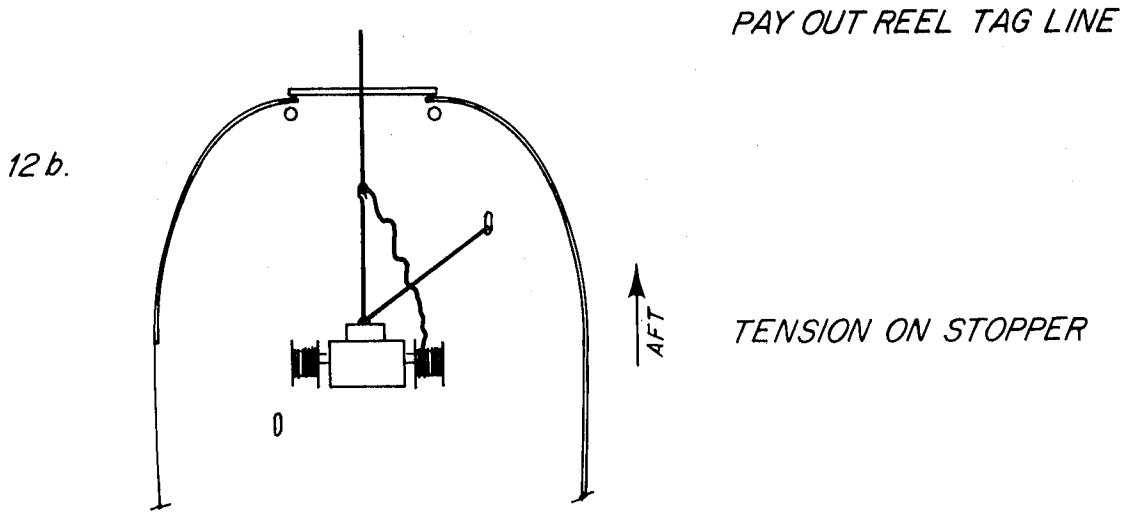
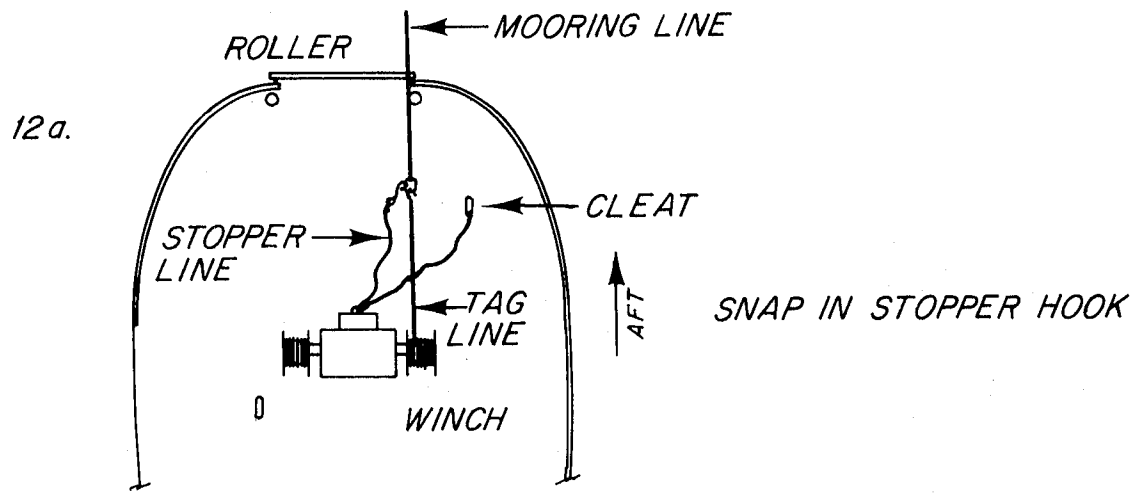
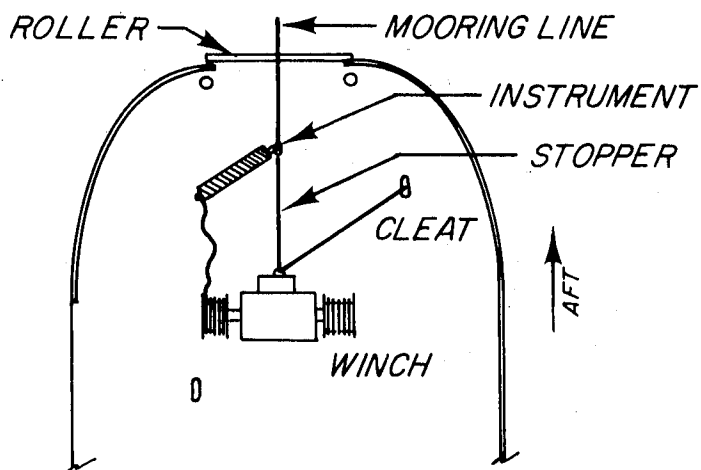


FIG. 12 STOPPING OFF WIRE SHOT - REEL CHANGE



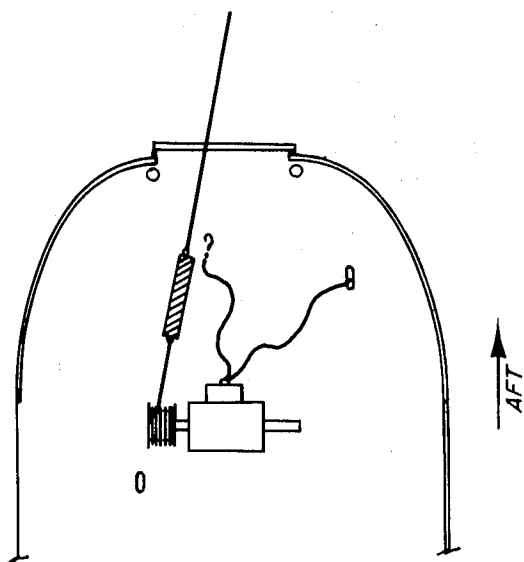
13a



SHACKLE IN INSTRUMENT

SET BRAKE ON REEL  
SLACK STOPPER

13b



TOP VIEWS OF STERN

TENSION ON REEL  
REMOVE STOPPER

FIG. 13 INSERTION OF INSTRUMENTS

TOP VIEWS OF STERN

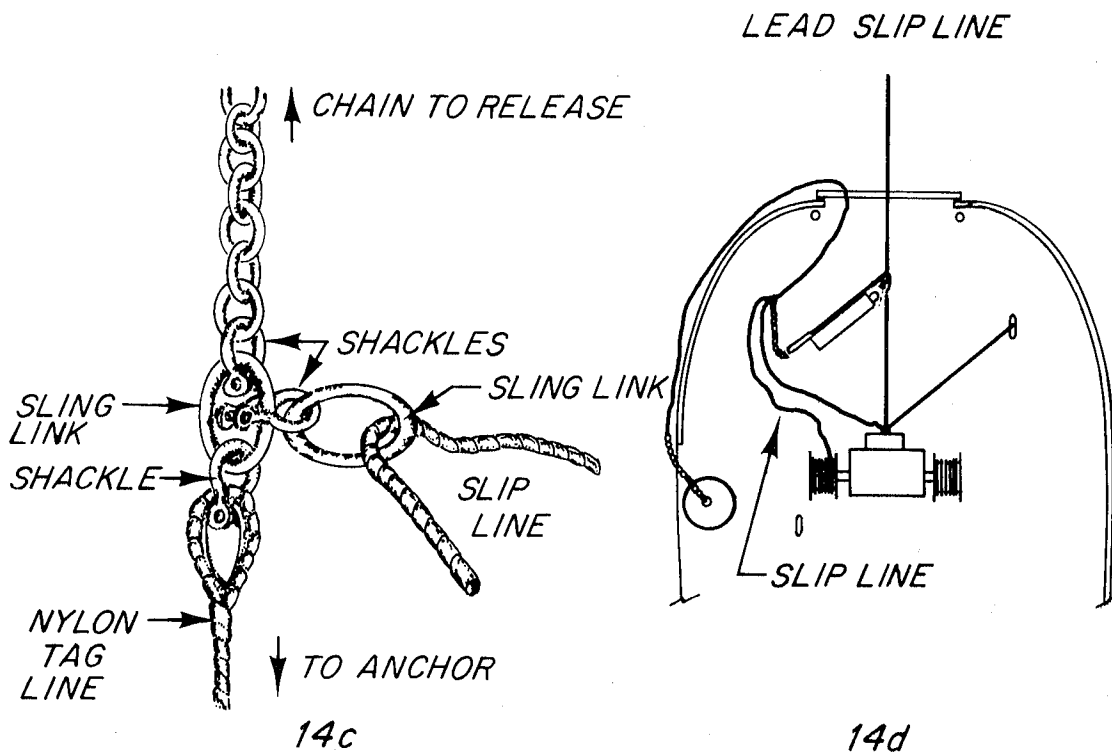
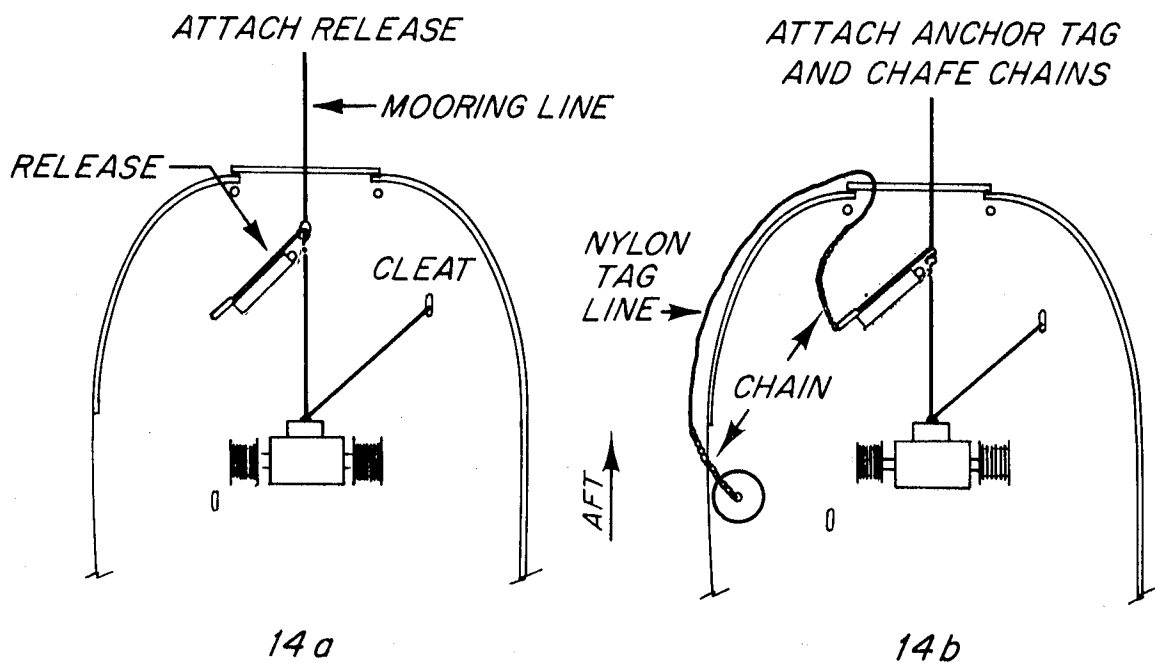


FIG. 14 LAUNCH OF RELEASE AND ANCHOR

TOP VIEWS OF STERN

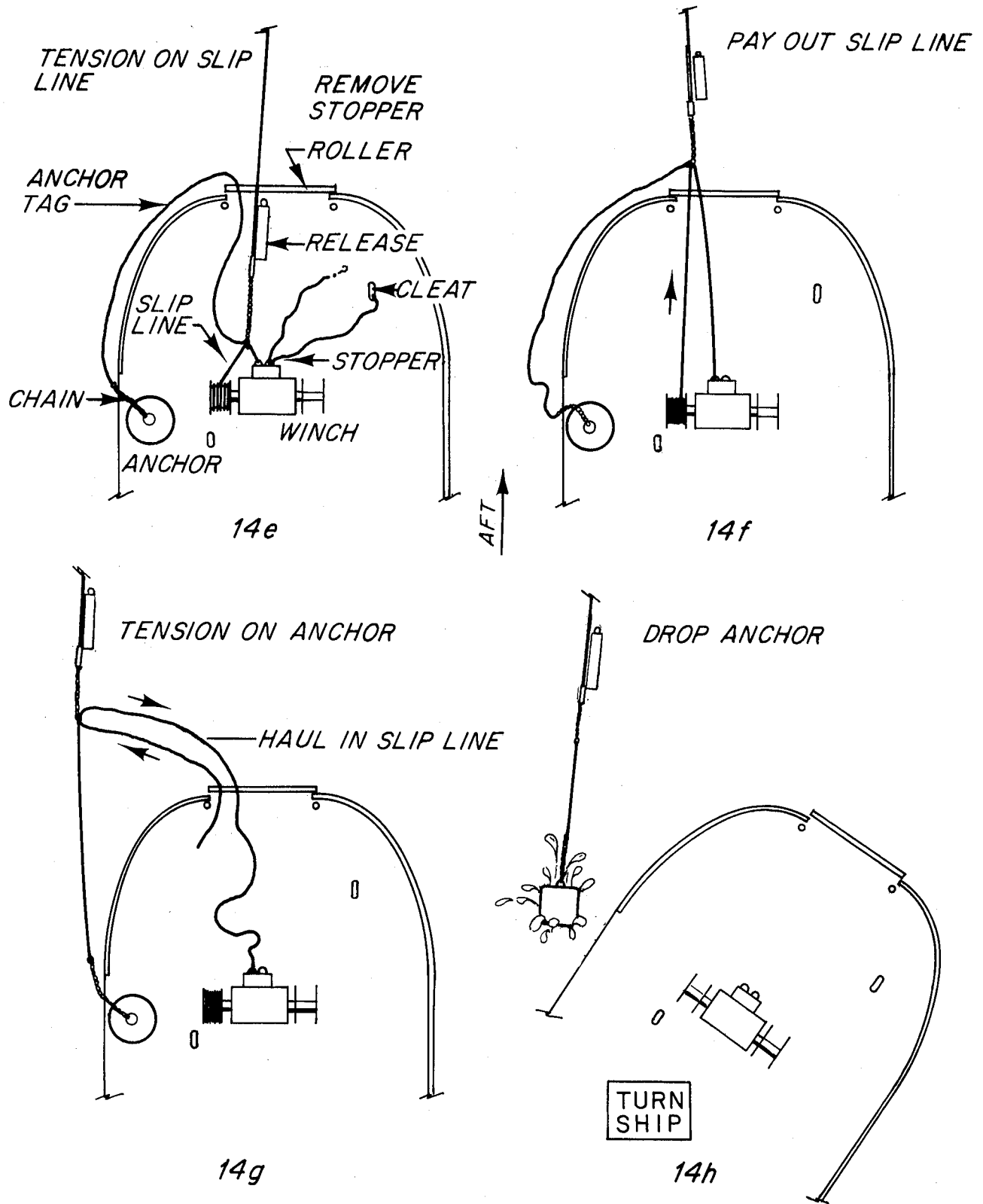


FIG. 14 cont. LAUNCH OF RELEASE AND ANCHOR

before the launch begins and slung over the rail on a heavy nylon strap, to be cut away at the proper moment.

The anchor chafe chain, nylon tag line and release chafe chain are all shackled together. The lower end is shackled to the anchor bridle and the string is led around the quarter outside the bulwarks and brought in through the stern roller. The upper end of the chafe chain is shackled to the release ring (Figure 14b).

An extra sling link is attached to the sling link separating the chafe chain and tag line, as shown in detail in Figure 14c. A slip line is now run from the eye at the base of the winch, through the extra sling link, and back to the winch where it is wound on an empty reel with end free on the inside (Figure 14d). The slip line is then hauled up tight and the brake set on the winch. The stopper line is slacked off until the full tension is on the slip line (Figure 14e). (On smaller vessels there may not be space between the winch and roller to stretch out the chain and release. In this case, it is better to use a chafe chain in two pieces connected with two shackles and a sling link. The extra sling ring can then be attached at this stage, a suitable distance below the release. The procedure is then the same. It is unwise to attach this ring directly at the bottom of the release as there is some danger of the end fouling in the release mechanism when it is slipped.)

The slip line is now paid slowly off the reel. The release is eased over the roller while one person tends the anchor tag line to insure that it does not foul (Figure 14f). The slip line is paid out until the mooring tension is on the anchor, which has been restrained with a lashing if necessary. Finally, the end of the slip line is allowed to come off the reel and the line is hauled back clear of the mooring from the fixed end (Figure 14g). If the slip line should foul on a cotter pin or some other part of the mooring, under no circumstances should it be cut free of the ship. If the remnants of the line foul on the release during anchor free-fall, they could prevent anchor separation at recovery time. If fouling occurs and the slip line cannot be pulled free, the anchor tag line should be put on a winch or capstan and hauled back, the snarl cleared, and the procedure repeated.

Once the slip line is clear and the anchor tag line taut, the ship is put into a sharp starboard turn and the speed increased to half ahead to build up tension momentarily. When the mooring is taut and well clear of the ship the anchor lashings are cut and the anchor dropped over the side (Figure 14h).

#### Intermediate Mooring Deployment

Preparation for deployment of an intermediate mooring consists of assembling the uppermost buoyancy section on deck, including the radio float. Two stopper lines with chain grabs are prepared.

Launch of the buoyancy section is shown in Figure 15. The launch begins with the ship in position and moving in the desired direction at about three knots. One chain grab is fastened into the chain of the buoyancy section about twenty feet from the top. The radio float is passed over the stern roller and the stopper slacked carefully to allow the glass spheres to pay out (Figure 15a). Until sufficient spheres are in the water to provide some drag the spheres will have to be pushed over the stern.

The stopper is paid out until the grab reaches the roller. The second grab is attached near the winch (Figure 15b), and made fast on its cleat. The first grab is slacked, transferring tension to the second (Figure 15c). The first grab may now be removed while the second is carefully paid out (Figure 15d). When the second grab is at the roller the process is repeated until the lower end of the section is reached (Figure 15e, 15f, and 15g). The lower end may then be attached to the upper end of the wire shot while being held on the stopper (Figure 15h).

The brake is set on the winch and the last stopper is slacked, transferring tension onto the winch (Figure 15i). Payout then continues as described above (Figure 15j).

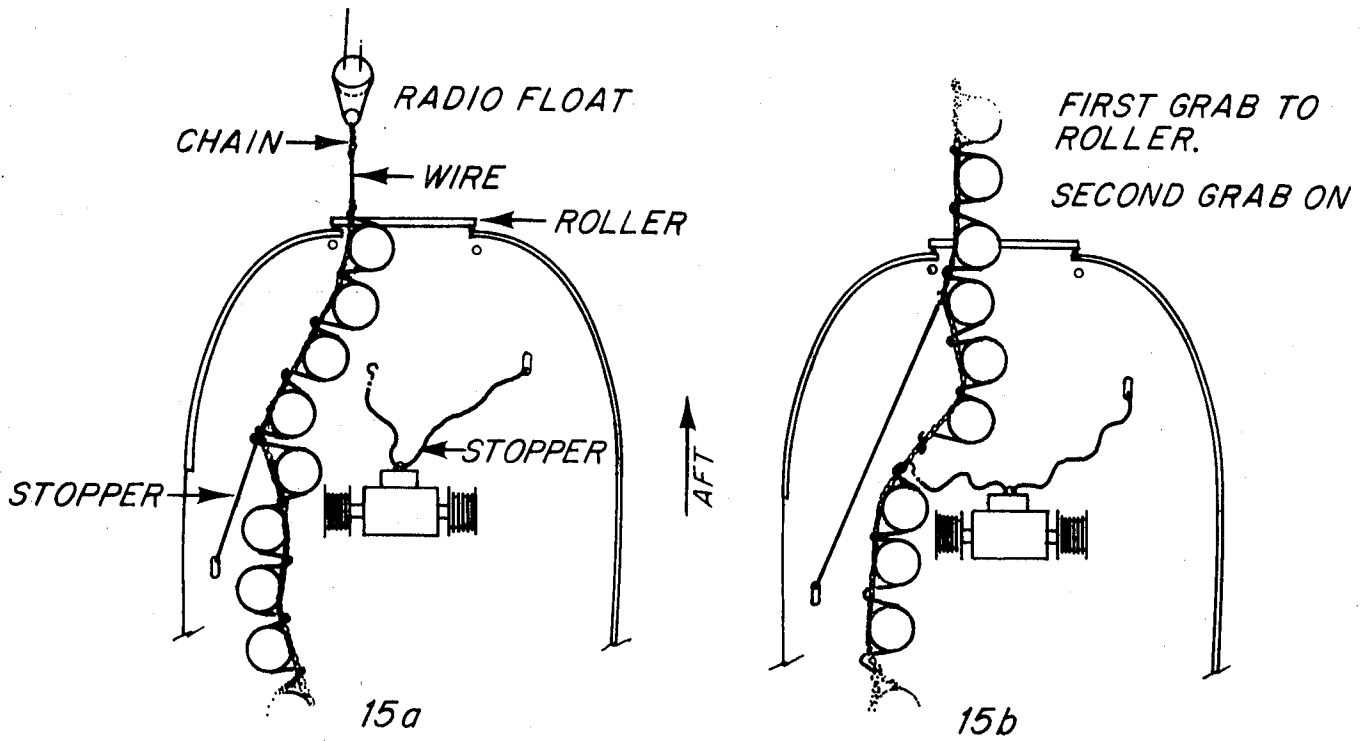
The procedure is the same for each buoyancy section, including the backup recovery, as it comes up during the payout. Instruments are inserted and the release and anchor deployed as described in the previous section.

#### Surface Mooring Deployment

In preparation for the launch of a surface mooring, the float is placed on the starboard side of the fantail and fully rigged. The chafe chain is attached. The crane hook is attached to the buoy with a quick-release mechanism. The upper end of the first wire shot is led around the outside of the rail forward and shackled to the chain, or to the lower end of the instrument if one is to be inserted just below the float (Figure 16a).

If there is to be an instrument at the lower end of the chain, it is useful to use a slip line at each end of it to ease it over the side, as shown in Figures 16a and 16b.

With the ship in the start location and moving slowly on the desired course, the slack is taken out of the line leading to the surface float, which is then lifted out over the side (Figure 16b) and the quick-release hook tripped to place it in the water (Figure 16c). The line must now be kept taut by hauling in on the reel as the float moves



TOP VIEWS OF STERN

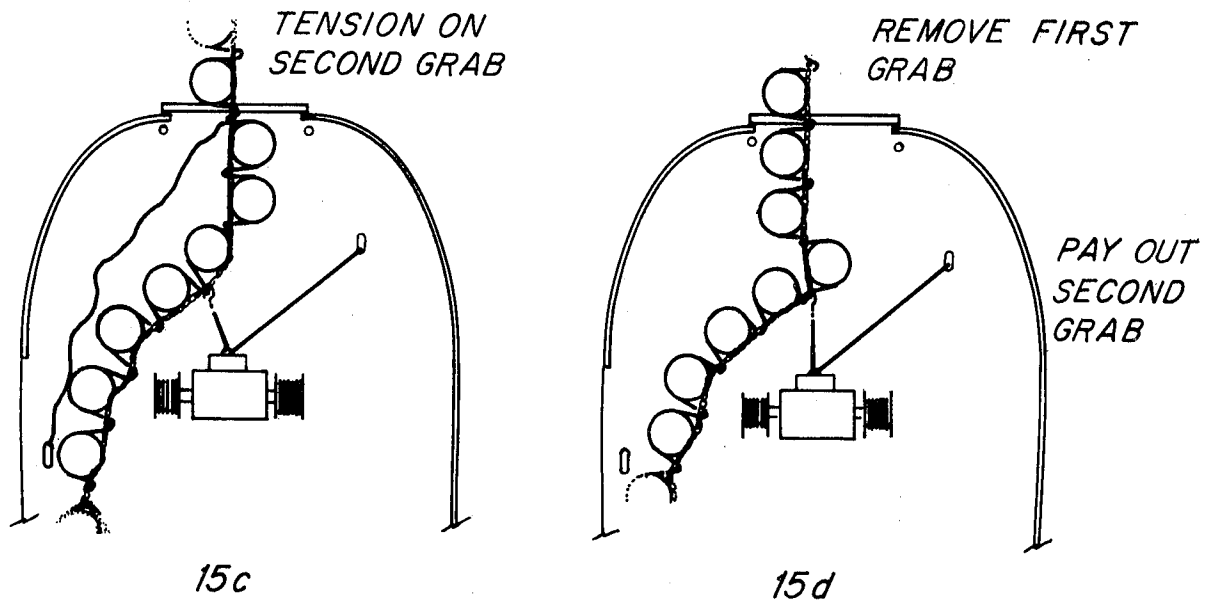
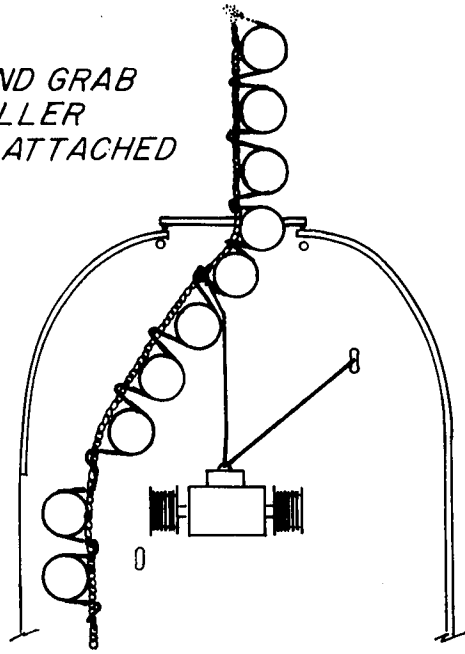


FIG. 15 INTERMEDIATE MOORING DEPLOYMENT TOP BOUYANCY SECTION

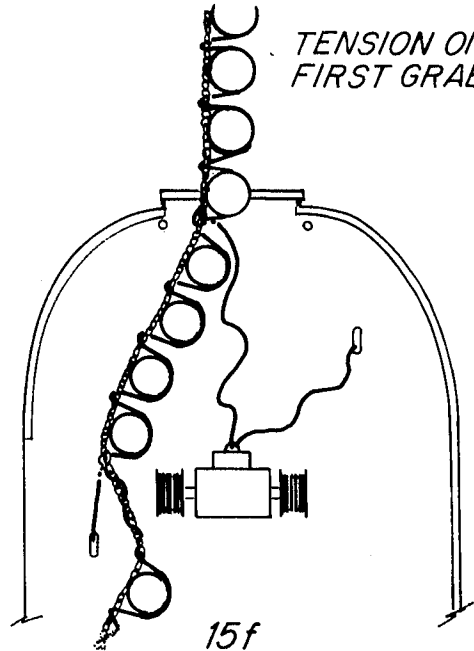
TOP VIEW OF STERN

SECOND GRAB  
AT ROLLER  
FIRST ATTACHED



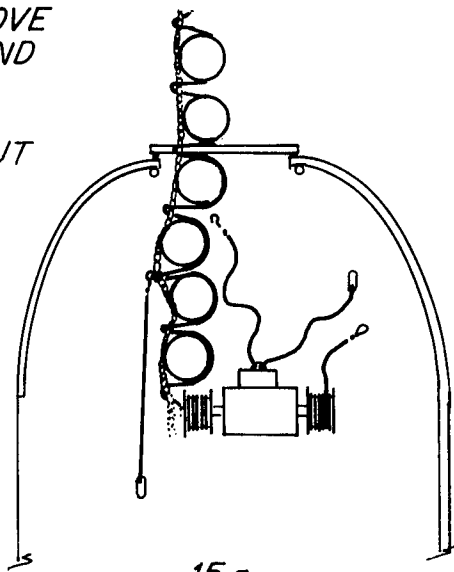
15e

TENSION ON  
FIRST GRAB



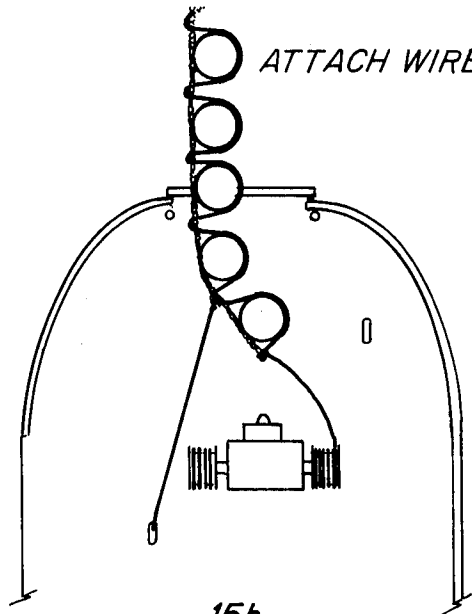
15f

REMOVE  
SECOND  
GRAB  
PAYOUT



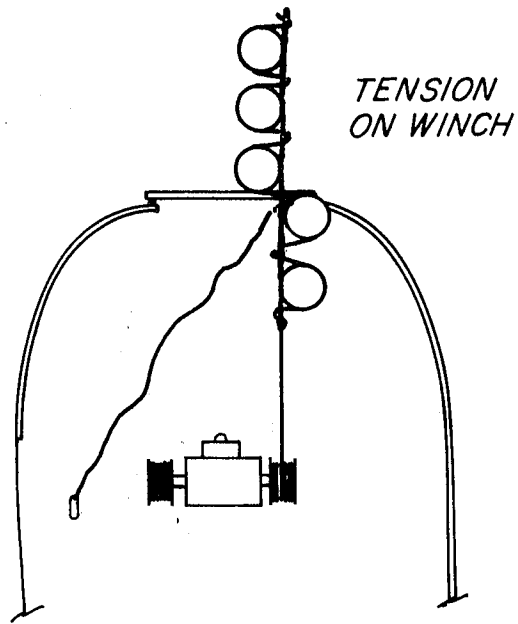
15g

ATTACH WIRE



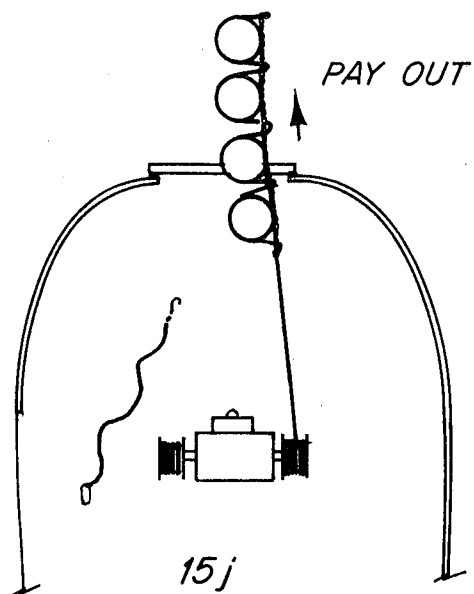
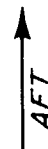
15h

FIG. 15 cont. INTERMEDIATE MOORING DEPLOYMENT  
TOP BOUYANCY SECTION



15i

TOP VIEW OF STERN



15j

FIG. 15 cont. INTERMEDIATE MOORING DEPLOYMENT  
TOP BOUYANCY SECTION



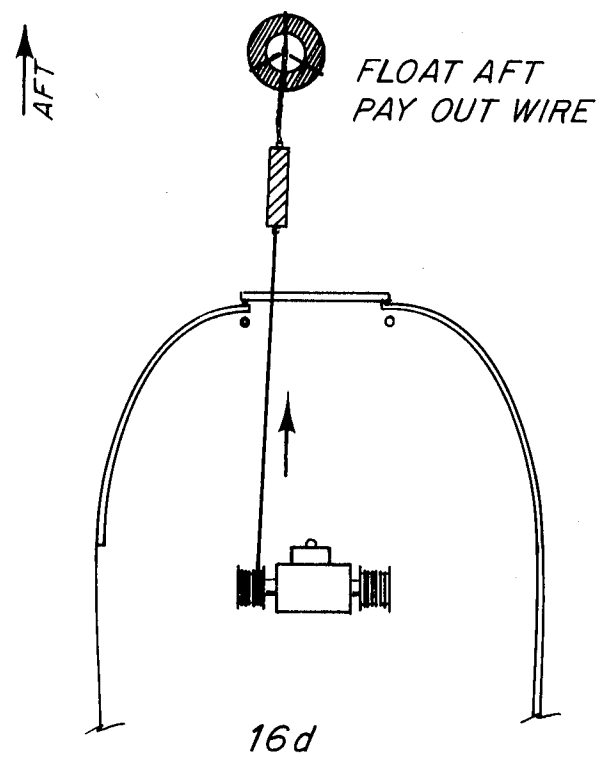
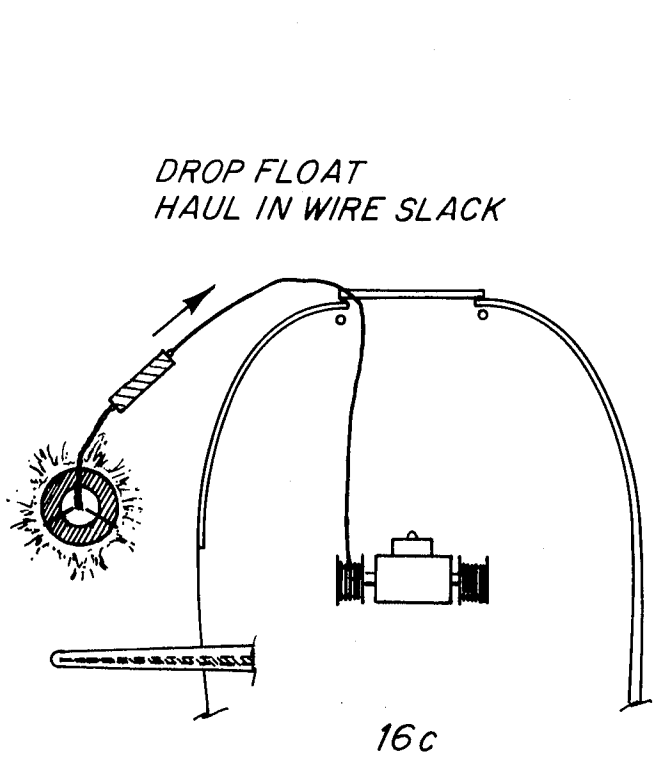
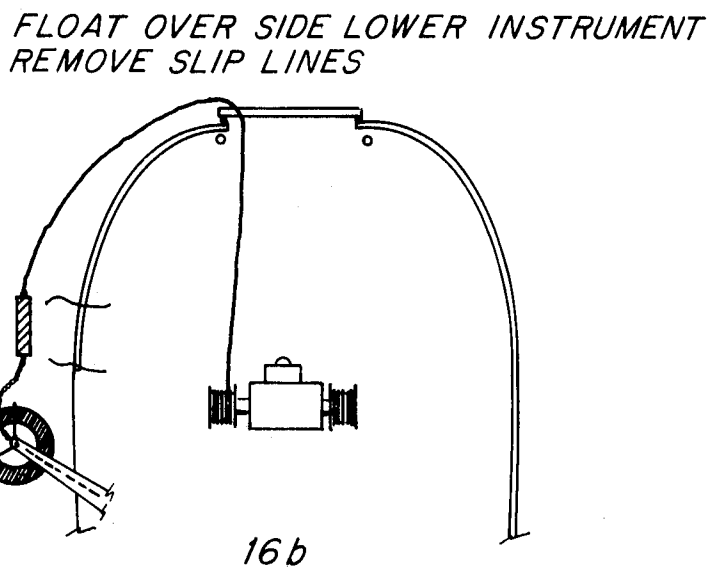
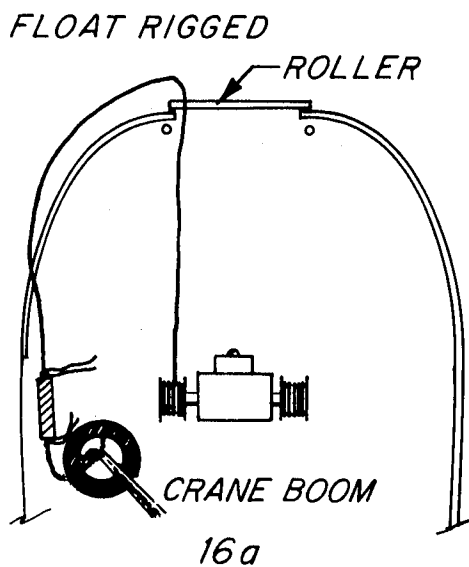


FIG. 16 SURFACE FLOAT LAUNCH

aft alongside the vessel (Figure 16d). Once the float is well aft, payout of the line can start.

The launch may now proceed routinely, as described in the general deployment section. As each reel is emptied, payout continues on the other reel while the empty is removed and a new full reel placed on the shaft. This process continues until the backup recovery section is reached.

The launch of the backup recovery section, consisting of glass spheres in hardhats mounted on chain, is the same as that described for the buoyancy sections of an intermediate mooring, discussed in the previous section. The release and anchor are deployed as described in the general deployment procedures section.

#### Bottom Mooring Deployment

Bottom moorings, usually relatively short and uncomplicated, are generally paid out by hand without using the winch. The entire mooring is preassembled on the stern, as in Figure 17a. The anchor may be either at the stern or at the starboard side, or, if the ship has no opening at the rail, may be slung over the side on a nylon strap.

All instruments and the release are laid at the roller, upper end aft. Short shots of line may be faked down carefully just inboard of the instruments. Longer shots may be put in barrels. If plaited or braided synthetic line is dropped loosely into a barrel or other open-topped container and allowed to remain undisturbed until launch, it will pay out smoothly with no snarls. (Tensions are so low in a bottom-mooring launch that the line may be stopped for a few seconds by hand to clear minor kinks.)

With the ship in position and moving slowly upwind the glass spheres, if used, are simply pushed over the stern. If a syntactic foam float or glass-sphere "package" is used, it may be lifted over the starboard side with the crane, released and allowed to move aft. In either case tension is taken below the first instrument by a person (wearing heavy work gloves) who then controls the payout, keeping minimal tension on the line (Figure 17b). As each instrument or the release comes up, someone else takes the tension of the line below it and the upper line is dropped over the roller (Figures 17c, 17d, and 17e). Eventually tension is passed to the anchor and the anchor is pushed over the stern (Figure 17f).

#### Anchor-First Launches

Occasionally it may be necessary to launch a mooring anchor-first. This may be to achieve a precise geographical position, place a mooring

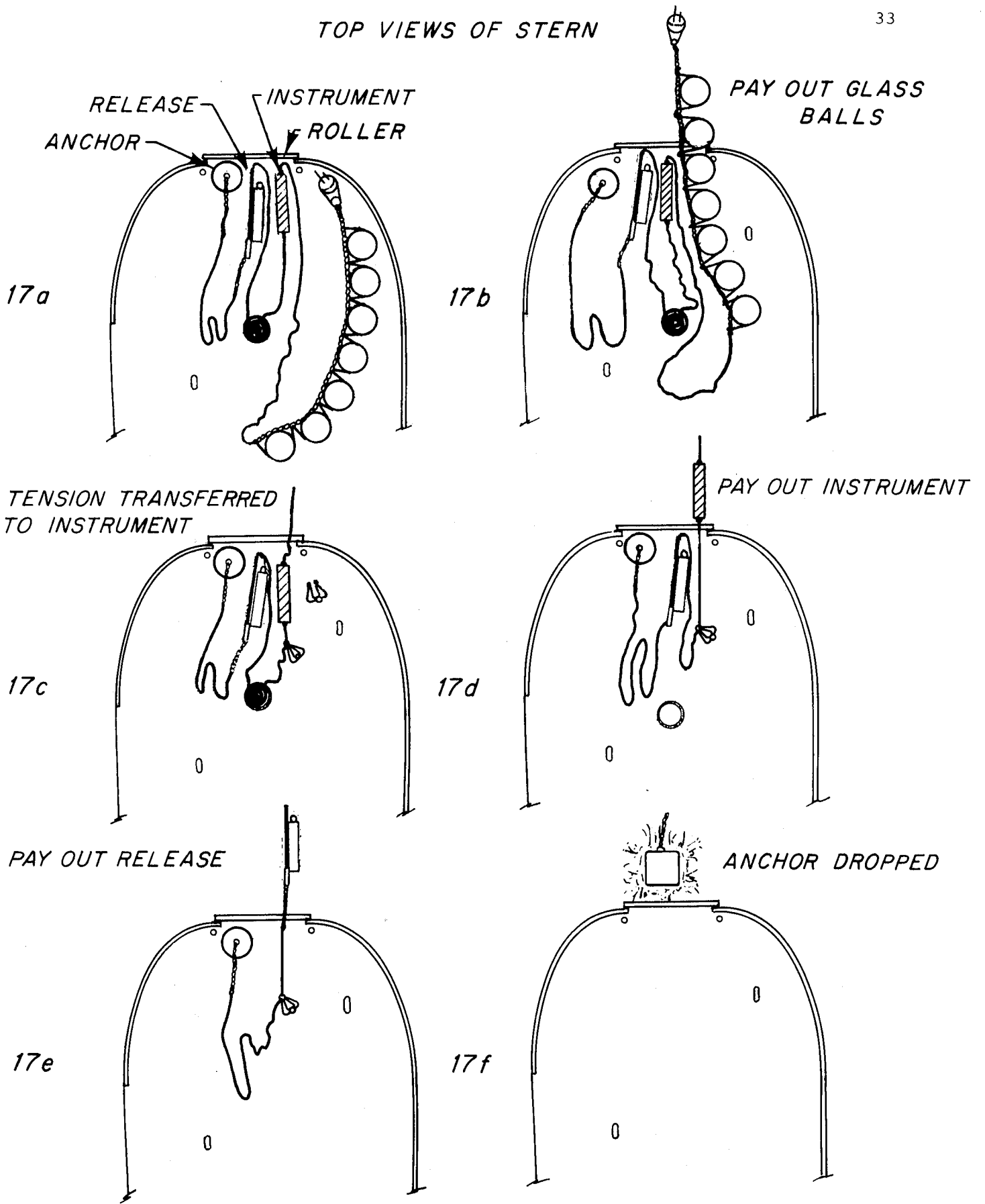


FIG. 17 LAUNCH OF BOTTOM MOORING

very precisely relative to one already in place, or to protect a fragile piece of equipment which might be damaged by the high relative water speeds of the anchor-last deployment method.

In an anchor-first deployment the mooring is paid out off the recovery winch over the starboard side (Figure 18). The line goes over a block on the A-frame or crane boom. A stopper with a snap hook hangs next to the block. (See section on recovery for a description of this equipment.)

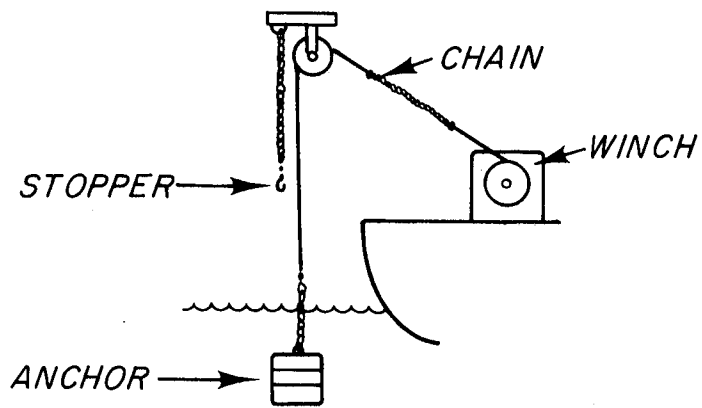
The anchor, chafe chain, anchor tag line, and release chafe chain are all shackled together. The upper end of the assembly is shackled to the tag line on a reel on the winch and wound on the reel. The winch is used to pick up the anchor and lower it into the water. During this part of the operation, very high dynamic loading on the mooring line can result from drag on the anchor as the ship heaves or rolls. This is particularly true if the anchor presents a high drag profile in the vertical. If an anchor with a large horizontal surface area is used it is desirable to launch it tipped on its side. The Stimson anchor, for instance, acts like a horizontal flat plate. For an anchor-first launch, one of the three anchor bridle chains may be cut so that it will lie vertically. (This, however, will reduce its effective holding power on the bottom. An alternative is to tilt the anchor up on edge and restrain it there with a corrossible lashing of magnesium wire which will allow it to assume its normal position after several hours in the water.)

Once the anchor is over, the tag line is paid out until the upper end of the release chafe chain is at the rail outboard of the block. The snap hook on the stopper is put into the sling ring (Figure 18b) and the winch tag line slacked to put the tension on the stopper (Figure 18c). The lower end of the release is shackled to the upper end of the chain tag (Figure 18d). The lower end of the short wire shot between release and backup recovery section is shackled to the release and the shot wound on the reel (Figure 18e). The winch takes the tension and the stopper is removed (Figure 18f). This shot can then be paid out until the upper end is reached and it is stopped off (Figures 18g and 18h).

Next the backup-recovery section must be deployed. The lower end of the glass-sphere section is attached to the top of the wire shot (Figure 18i). A tag line (or the next mooring shot) with a chain grab is secured to the chain a few feet up and the spheres hoisted up until the tension is taken off the fixed stopper (Figures 18j and 18k). The winch is lowered until the chain grab is at deck level. A chain grab, attached to the fixed stopper hook, is then used to take the tension, as in Figure 18l, and the movable stopper, running to the winch, is moved further up the chain and the process repeated (Figures 18m and 18n). Finally, the lower end of the next wire shot is shackled to the

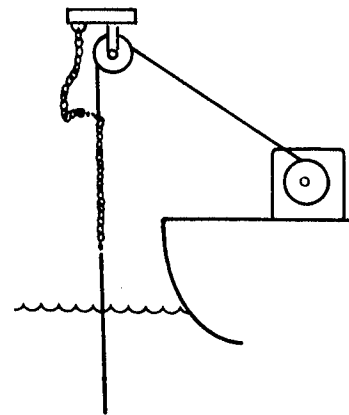
VIEWS OF STARBOARD SIDE  
FROM FORWARD

ANCHOR IN WATER



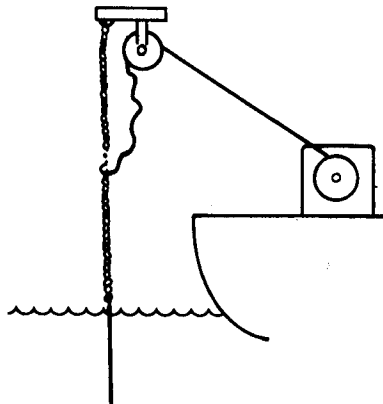
18a

STOPPER ON TERMINATION



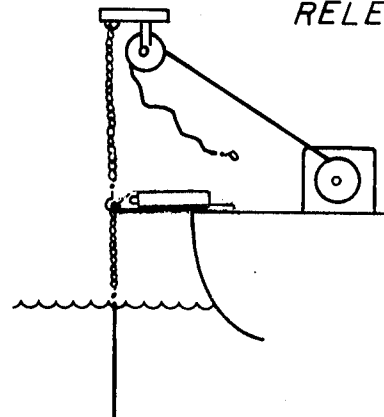
18b

TENSION ON STOPPER



18c

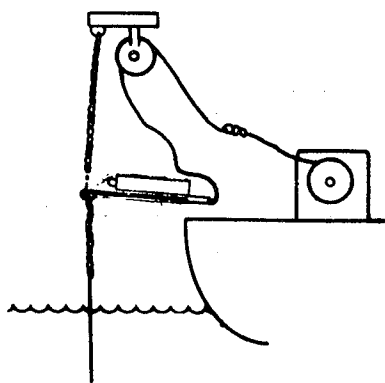
REMOVE TAG LINE ATTACH  
RELEASE



18d

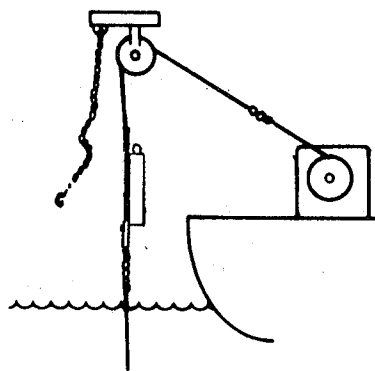
FIG. 18 ANCHOR-FIRST LAUNCH

ATTACH WIRE SHOT



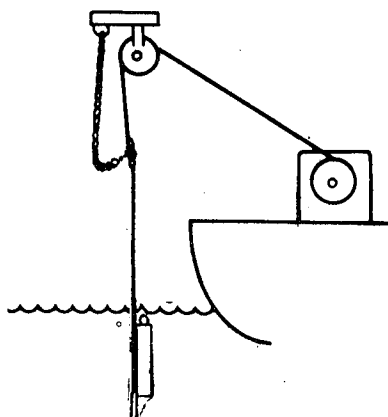
18e

TENSION ON WINCH  
STOPPER OFF



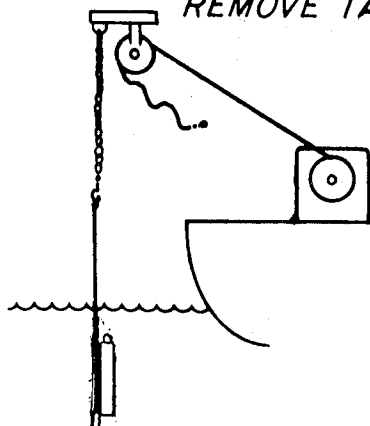
18f

PAY OUT TO END OF SHOT  
ATTACH STOPPER



18g

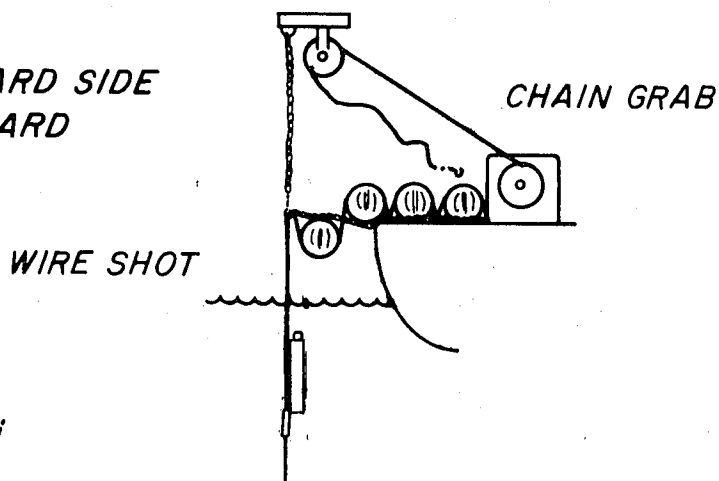
TENSION ON STOPPER  
REMOVE TAG LINE



18h

ATTACH GLASS BALLS

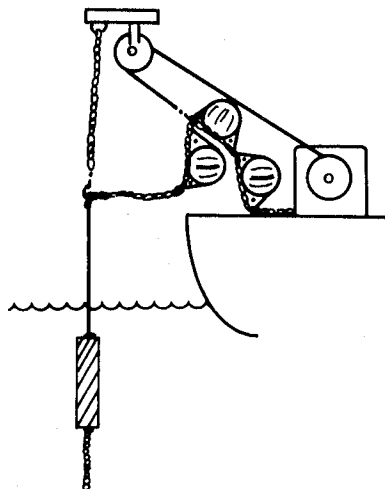
VIEWS OF STARBOARD SIDE  
FROM FORWARD



18i

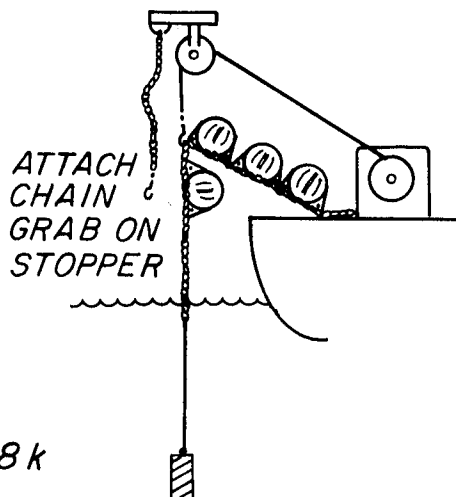
FIG. 18 cont. ANCHOR-FIRST DEPLOYMENT

HOIST UP BALLS  
WITH CHAIN GRAB  
ON WINCH



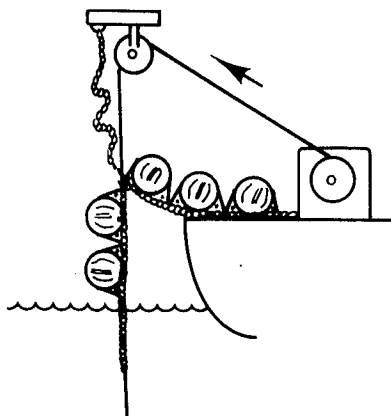
18j

TENSION ON WINCH



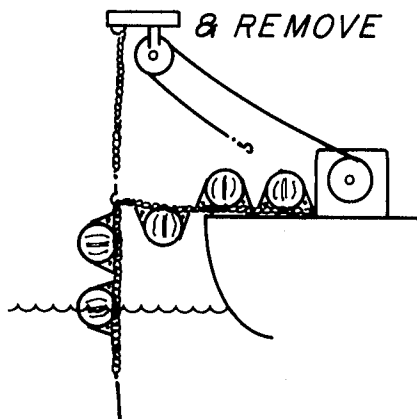
18k

VIEWS OF STARBOARD SIDE  
FROM FORWARD



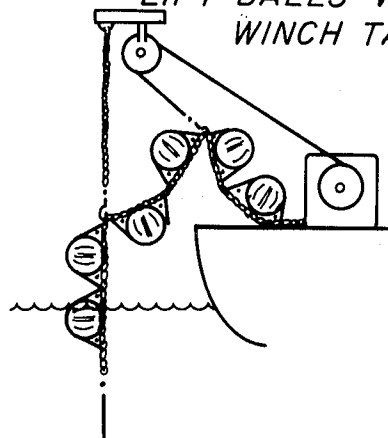
18l

TENSION ON STOPPER  
- SLACK WINCH TAG  
& REMOVE



18m

SECOND 'BITE' -  
LIFT BALLS WITH  
WINCH TAG



18n

REPEAT PROCESS UNTILL ALL SPHERES ARE OVER  
THE SIDE.

FIG. 18 cont. ANCHOR-FIRST DEPLOYMENT.  
HANDLING OF GLASS-SPHERE  
SECTIONS.

upper end of the chain and paid out. A similar procedure is used for intermediate buoyancy sections.

When instruments must be inserted the line is paid out and the fixed stopper hook used to support the mooring by the sling ring (Figure 19a). The lower end of the instrument is attached to the wire and the upper end to the next shot (Figure 19b). The tension is then taken on the new shot (Figure 19c) and payout resumes (Figure 19d). A similar procedure is used at the end of a reel. The mooring is supported on the fixed stopper while the reels are changed and the lower end of the first shot on the new reel is led through the block and shackled to the previous shot. Much of this work requires care since it is done beyond the rail of the ship.

Payout continues in this manner until the top of the mooring is reached. If it is a surface mooring the float should be rigged and ready on deck close by the A-frame. The chafe chains, instrument if any, and tag line should be attached. When the upper end of the top shot is reached the float is lifted on the quick-release hook on the crane and the tag line, or lower end of the instrument, is shackled to the end (Figure 20a). The winch tag line is then paid out until the tension is on the crane (Figure 20b). The winch tag line is then removed (Figure 20c) and the float may be swung out and released (Figure 20d).

For surface-mooring anchor-first deployments the anchor will be on the bottom during the last part of the payout. Thus very high tensions can develop if the ship is tending to drift.

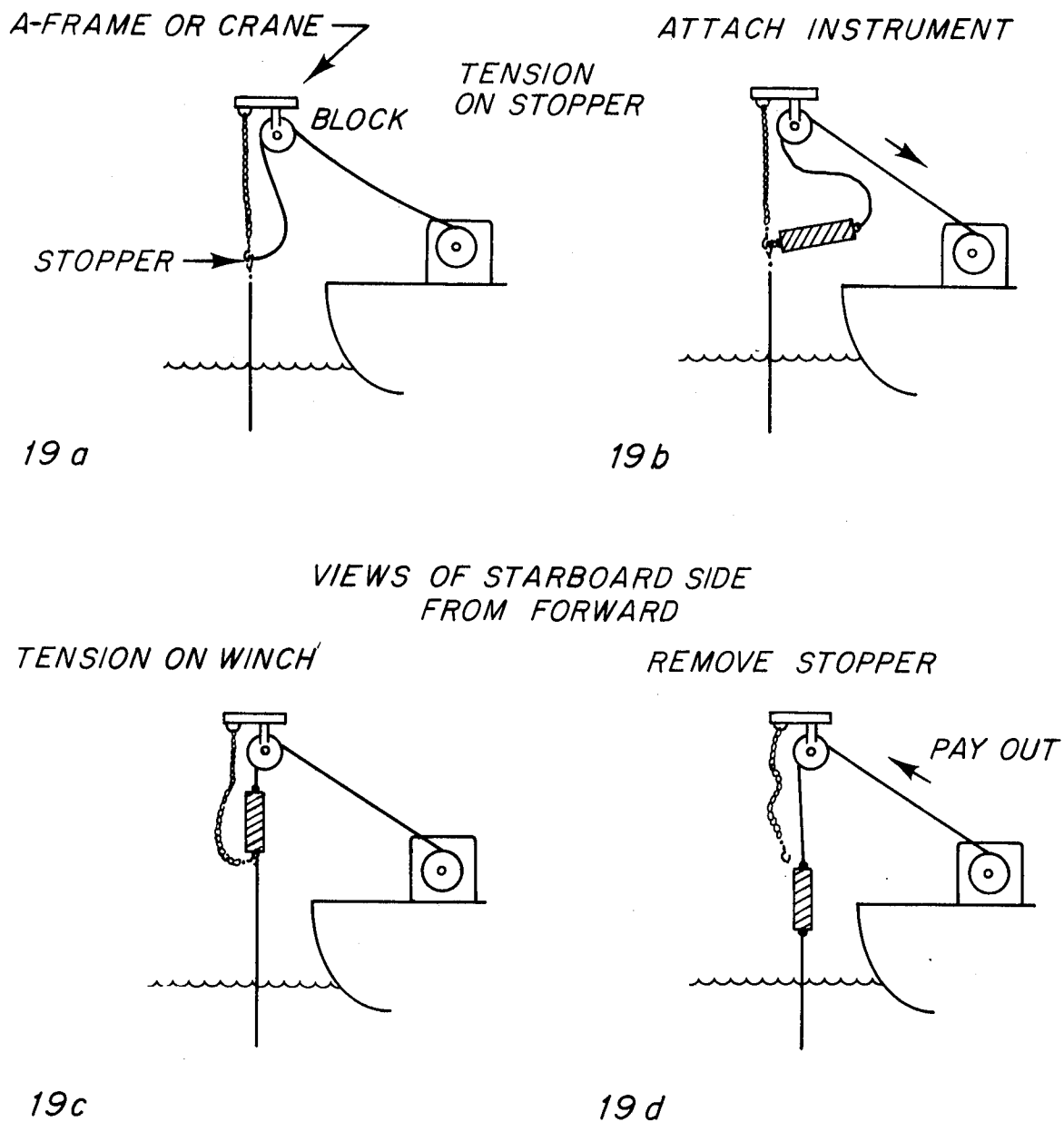
If the mooring is an intermediate mooring the top buoyancy section may be paid out until the radio float is reached. The string may be grabbed with a quick-release hook through a sling ring just below the radio float and released.

There is no point in setting bottom moorings anchor first, normally. The entire anchor-last method takes about two minutes so the ship doesn't move appreciably. In either case most of the position error will occur while the mooring is falling to the bottom.

It should be noted that deployment by the anchor-first method is much slower than anchor-last. If the ship cannot maintain position during this period, the method may be no more accurate in positioning than the anchor-last technique.

In general, moorings with no compliance, i.e., all-wire moorings with no synthetic line, should not be launched anchor first. Compliance in the lower part of the mooring is necessary to reduce dynamic loading on the anchor during the early part of the launch and, in the case of a surface mooring, to compensate for ship drift between the time the anchor bottoms and the float is released.





**FIG. 19 ANCHOR-FIRST LAUNCH  
INSTRUMENT DEPLOYMENT**

VIEW OF STERN FROM STARBOARD SIDE

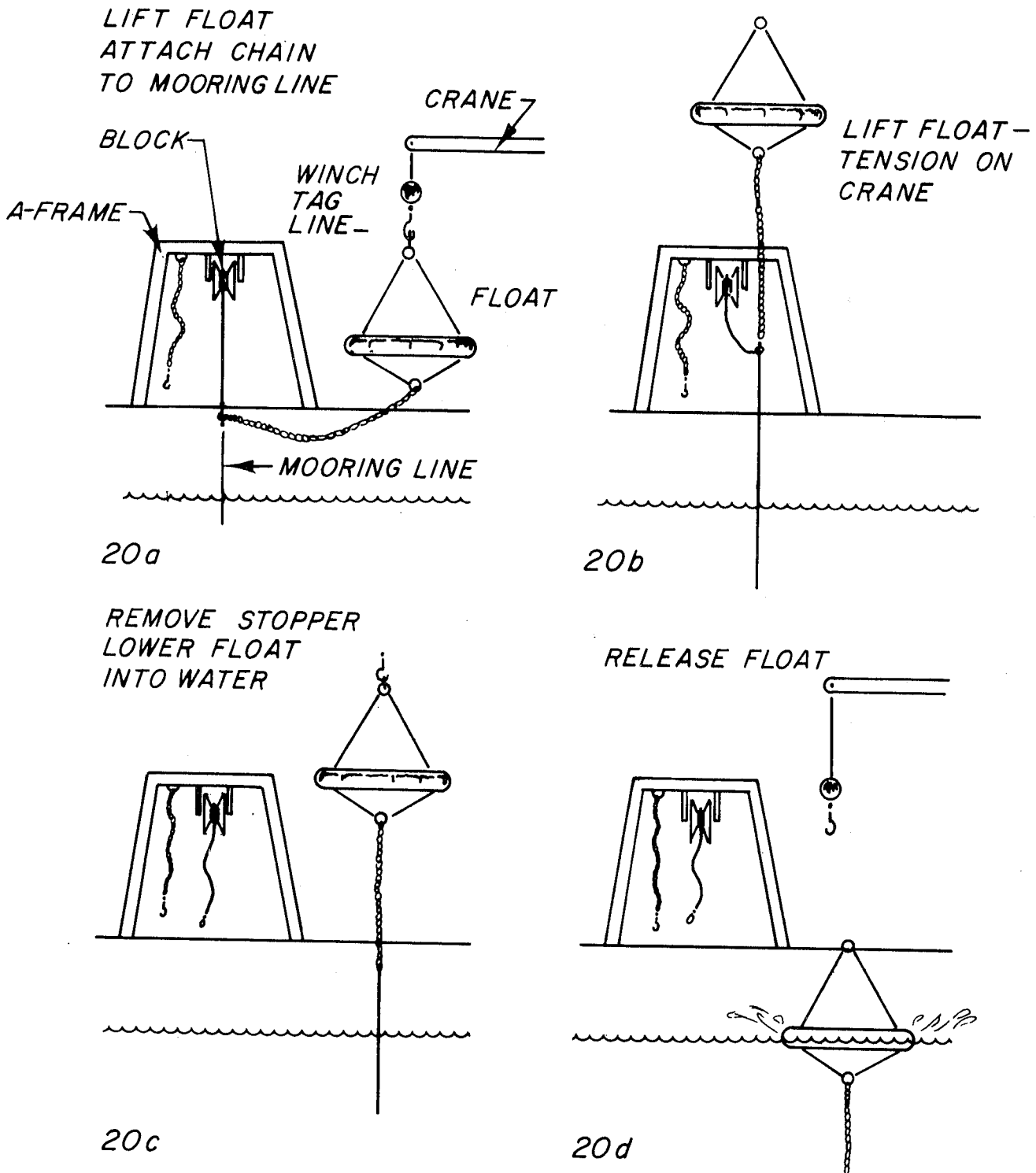


FIG. 20 ANCHOR-FIRST LAUNCH, SURFACE-FLOAT DEPLOYMENT

### Post-Deployment Procedures

Immediately after anchor drop the ship is hove to. Normally the acoustic release is tracked to the bottom and the time of bottoming noted. (The transponder range is plotted versus time on a graph. Anchor bottoming appears as a change in the slope of the line. Normally, since the ship is drifting, the range continues to increase after bottoming. The event may not be easily detectable without a graph.) A series of checks are then run on the release and recorded on a separate form. These checks are discussed in LaRochelle's report on release operations.<sup>5</sup>

It is important to monitor the descent of the release. If a failure of the mooring occurs during the free-fall, it can be detected by this method. If the descent rate suddenly increases, the mooring has parted above the release. If the release suddenly starts to rise, the anchor tag line has parted. (This occurred on two moorings in the MODE experiment.<sup>6</sup>)

In the aftermath of a mooring deployment with personnel engaged in cleaning up or preparing for the next operation, it is easy to forget that the mooring could still fail, allowing all or part of the mooring string to come back to the surface where it might not be seen visually, particularly at night, unless someone was looking for it. Monitoring the release descent will help to guard against this. In addition, a radio receiver should be left on for several hours after anchor launch to insure that the top of the mooring has not separated and resurfaced.

Surface moorings have been known to settle out to within a hundred meters of the anchor-drop position and in any case will overshoot slightly before settling out. It is usually desirable to move a few hundred yards cross-wind after dropping the anchor of a surface mooring to avoid having the float come too close to the ship.

In recording the position of a bottom or an intermediate mooring the position of anchor drop is usually used. It has been found, both by computer modeling and by experiment,<sup>7</sup> that the anchor will settle out at a distance of between 10% and 15% of the water depth from the anchor-drop position back towards the direction from which the ship was coming during the payout process. In 6,000 meters of water this error is usually within the error of navigation.

If more accurate navigation is available, and a more precise mooring position is desired, it may be possible to maneuver the ship directly over the acoustic release by means of the transponder in order to get a fix. This is usually a time-consuming process, however.

The water depth at anchor drop is normally used as the mooring depth. Here significant errors may result, particularly if the bottom

is very rough. Again, if a more accurate depth is desired, some time may be spent maneuvering over the mooring release for a measurement.

For surface moorings, of course, it is possible to move alongside the float for a fix and depth measurement. Because of the watch circle of even a very taut mooring, however, the position may still be in error by up to a kilometer or more in deep water. At the same time, a visual check can be made for damage to the float and whether the light is operating.

If an intermediate or bottom mooring has been launched, the mooring design is run through the computer in the exact configuration in which it was launched, including all last-minute component substitutions and adjustments. The depth of each instrument with zero current profile is computed and recorded on the station log and a paper tape is prepared with the component listing for the mooring.

#### MOORING RECOVERY

##### General Considerations

Recoveries, which are primarily rigging exercises, are generally more straightforward than deployments. The first problem, however, may be to find the mooring. If a surface-mooring float is not found at the expected location a check should be made for the release in case the mooring has parted. If there is acoustic contact the bottom part of the parted mooring can be recovered by firing the release and allowing the backup recovery flotation to bring it to the surface.<sup>2</sup> If the release is not in the expected location the recorded position may be in error.

A comparison should be made between the recorded depth at launch and the depth at the recovery site, and the original navigation logs during the launch checked for mistakes. If everything checks, a visual search may be made around the area in case the mooring dragged some distance. Radar and radio monitoring (if the float carried a beacon) may, of course, also help locate it.

In the case of bottom or intermediate moorings, only the acoustic release is available to ascertain the mooring location. If an area search has to be made, the hull-mounted acoustic transducer is invaluable, particularly if it is directional. If no contact is made with the release, as a last resort a firing command may be sent at the best known mooring location and a visual/radio search made for a surfaced mooring on the assumption that the pinger/transponder part of the release is dead.

In our operations we commonly get useful transponder ranges of up to eight kilometers. This will, of course, vary depending on the ship, sea state, and condition of the release.

### Deck Equipment

A gasoline-powered winch (Figure 21) with a single shaft, which uses the same reels as the launch winch, is used for recovery. The winch is situated facing the starboard A-frame. It has an eye with a stopper chain and hook at its base. A large block (Figure 22) is hung from the A-frame on the starboard side or from the crane boom. An important feature of this block is the wide sheave which allows sufficient clearance between the cheeks to pass chain and complete terminations (two shackles and a sling ring). (If the block must be hung from the crane boom, the recovery process becomes a bit more complicated during periods when the crane must be used to lift floats, etc.) A stopper, consisting of a length of chain with a snap hook on the end, hangs next to the block. The hook hangs to about a foot above deck level. The arrangement of the fixed deck equipment is shown in Figure 23.

A snap hook mounted on a pole is used to hook onto floats from a distance over the side of the ship. This is a snap closure hook with a piece of barstock welded on (Figure 24a). The pole is of titanium tubing to reduce weight, and has a socket to hold the hook (Figure 24b). A pennant attached to the hook has a loop at the inboard end for the crane hook. The hook is snapped into a pickup ring on the float (Figure 24c) and the pole removed (Figure 24d). The tag line is then lifted with the crane.

A generous supply of stopper lines and chain-grab hooks is on hand before recovery starts.

Deck gear for the acoustic release is described elsewhere.<sup>5,8</sup>

### Release of Anchor

Firing of the acoustic anchor release on a surface or intermediate mooring is usually done with the ship at a distance of about a third of the water depth or more to avoid the possibility of becoming fouled in the glass sphere buoyancy sections as they surface.

Before actuating the release a series of checks are run on the release.<sup>5</sup> If the release is extremely balky or if it is difficult to maintain contact with it due to poor acoustic conditions or difficulty in keeping the ship in the vicinity of the mooring, such as in very high currents, it may be desirable to omit the release checks and fire the release as soon as good contact is established.

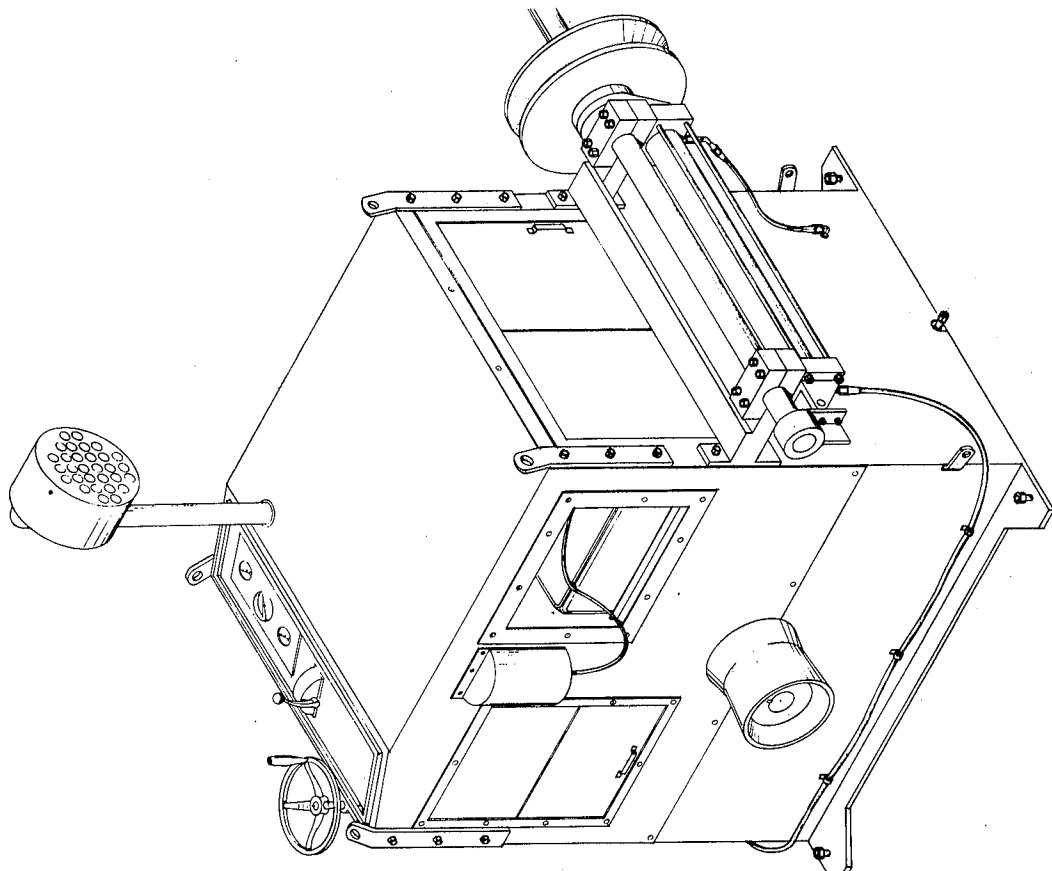
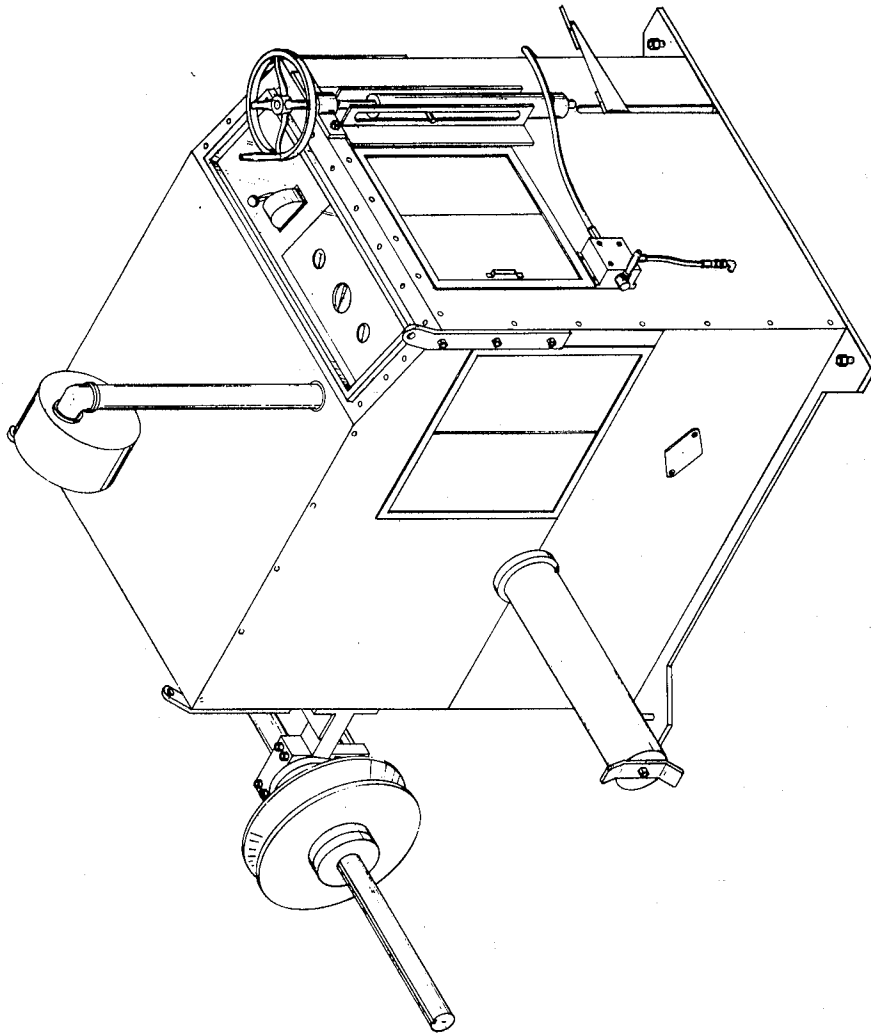


Figure 21  
Hauling Winch

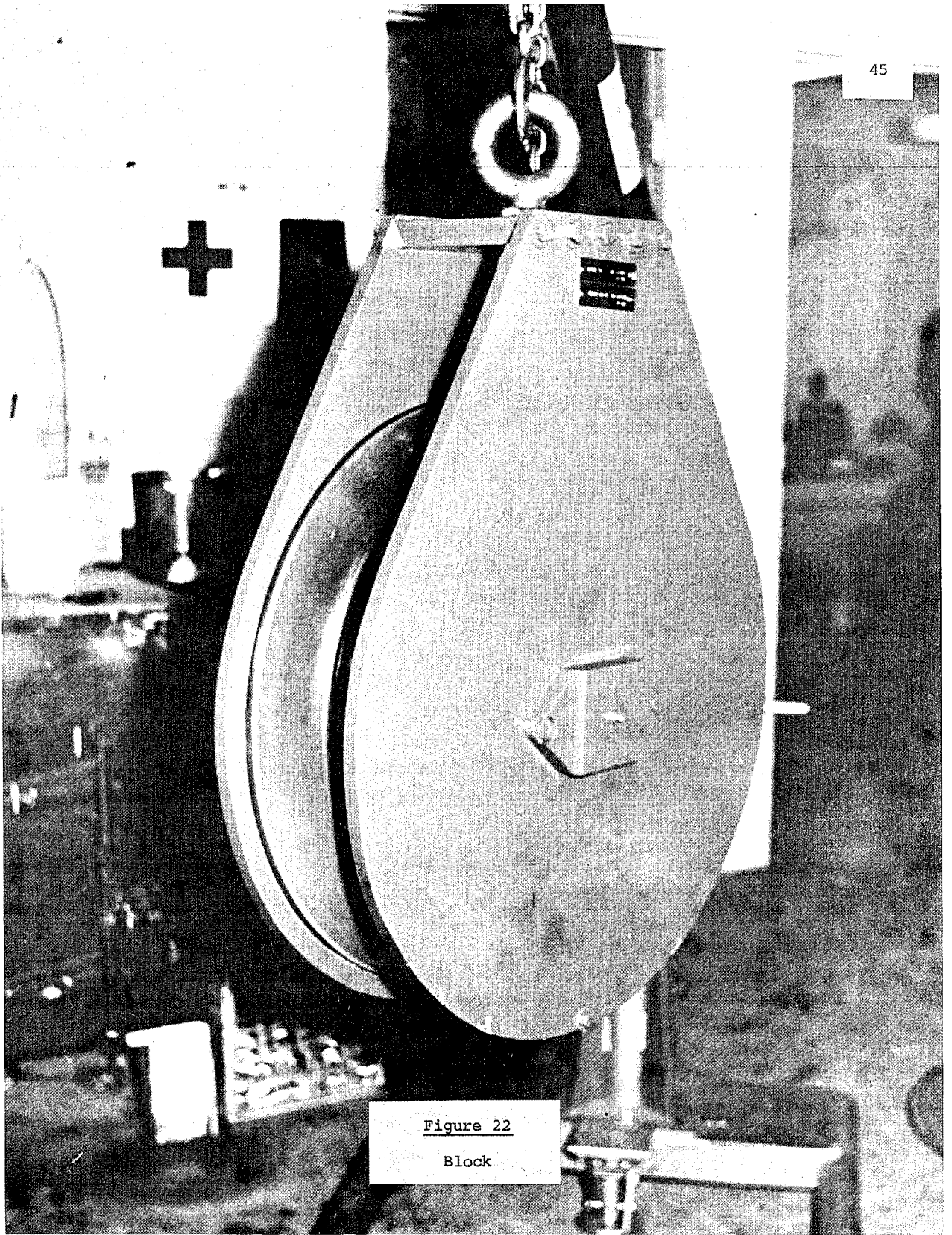
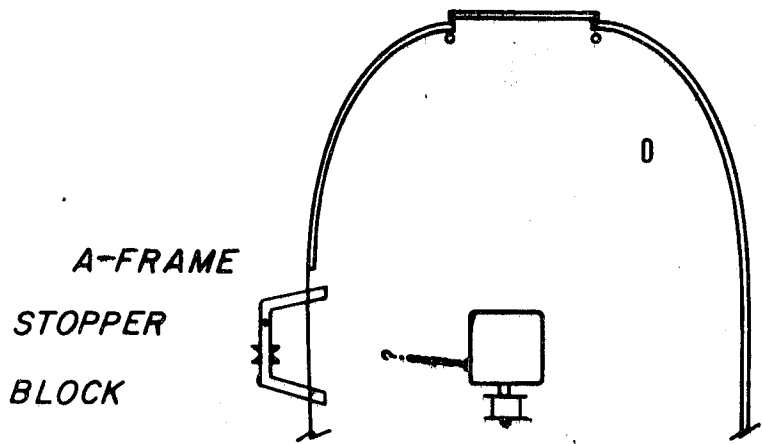


Figure 22

Block

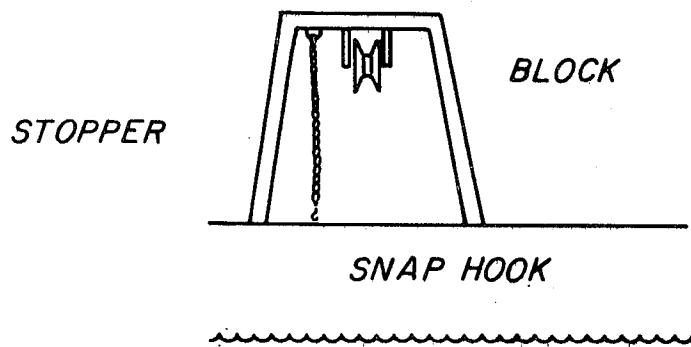
TOP VIEW OF STERN



23a

BLOCK AND STOPPER  
MAY BE HUNG FROM  
CRANE BOOM IF A-  
FRAME NOT AVAILABLE.

SIDE VIEW FROM STARBOARD



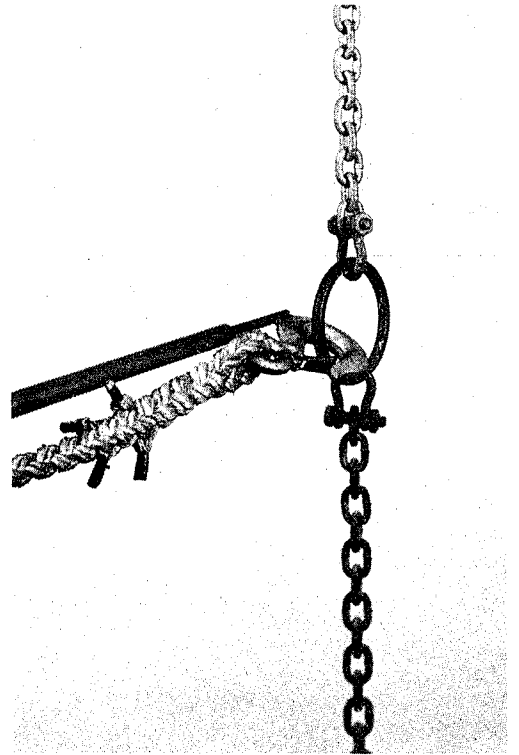
23b

FIG. 23 DECK ARRANGEMENT FOR RECOVERY.

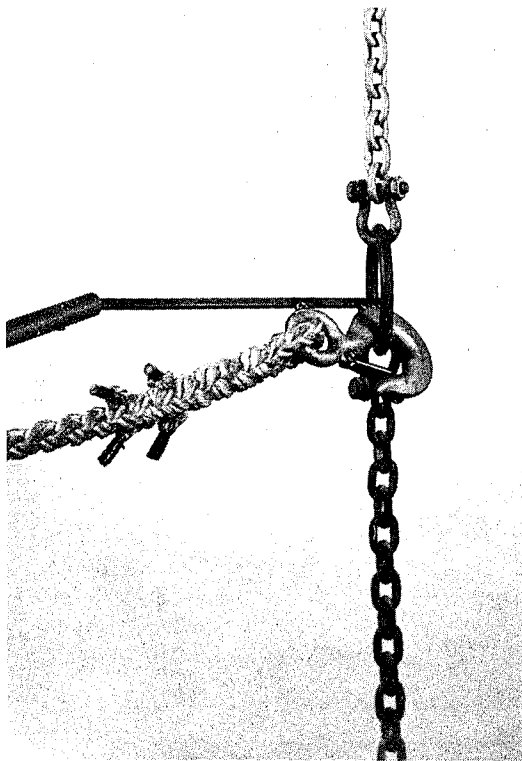




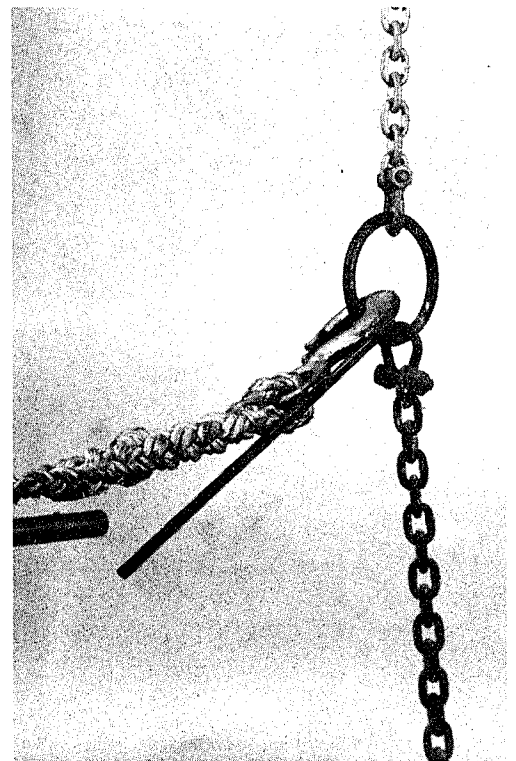
Hook



Hook on Pole



Hook onto Buoy



Pole Removed

Figure 24  
Operation of Pickup Pole

### General Recovery Procedure

Hauling of the mooring string is done over the starboard side. The stopper hanging alongside the recovery block is used to hold the string while instruments are removed or reels changed on the winch.

As an instrument or cluster of glass spheres comes up to the block (Figure 25a) the stopper hook is snapped into the sling ring below the component (Figure 25b). The winch is then slacked off until the tension is on the stopper (Figure 25c). The instrument or sphere cluster is then unshackled from both the upper and lower shots and removed (Figure 25d). If the reel is to be changed on the winch the tag line from the new reel is led through the block and shackled into the shot hanging on the stopper. If the shot is to be wound on top of line already on the reel, the upper shot is simply shackled into the lower shot, in effect becoming a tag line (Figure 25e). The tension is then taken on the winch and the stopper removed (Figures 25f and 25g). Hauling then resumes.

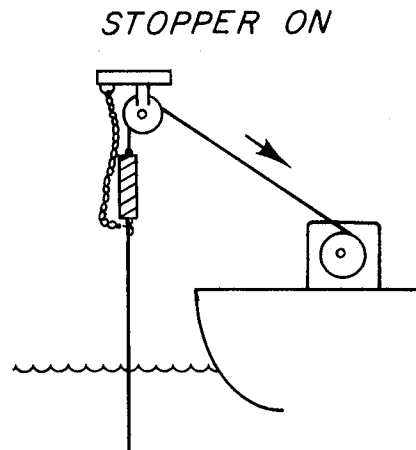
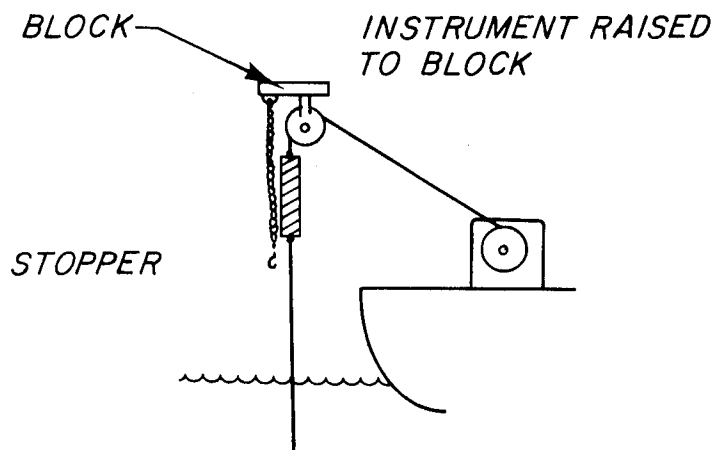
If a termination between two wire shots comes aboard with no instruments in between, the termination may be hauled through the trawl block and stopped off at the stopper on the base of the winch, as shown in Figure 26. The connection is a little easier to work on there. If the termination is to be simply wound on the same reel, there is no need to stop off and disconnect. The cotter pins may be removed and the hauling resumed.

Since wire rope is not reused, no particular care need be taken in winding terminations on the reel. Once the termination section of the reel is full, additional terminations are simply laid on top of the wire turns and the wire wound on top.

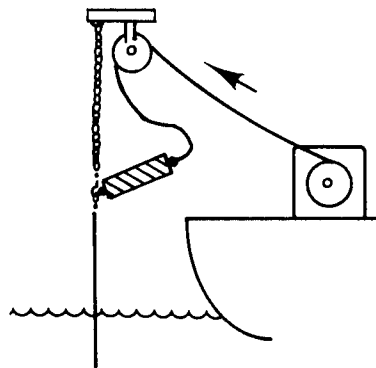
In the case of synthetics, terminations are kept from damaging the line on the reel by wrapping them with canvas as they go on the reel. The next few turns of line are then laid carefully on top until the termination is sufficiently padded that no damage can occur.

Tensions will usually be relatively low, making hauling easy. However, if the wind is causing the ship to drift at a high rate, or if a large component on the mooring is creating very high drag during hauling, very high tensions can result. Care must be taken when winding synthetic line under tension. A great deal of energy can be stored on a reel of stretched line. In some cases this has resulted in the welds of the flanges breaking. Even if the static tension on the mooring string is low the running tension may get quite high if the mooring is hauled too fast, due to the drag. Once a reel flange is broken, pressure on the retainer on the end of the winch shaft makes it difficult and very messy to remove the reel from the shaft.

IEWS OF STARBOARD SIDE FROM FORWARD



TENSION ON STOPPER



REMOVE INSTRUMENT

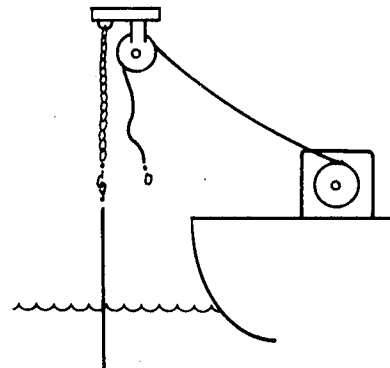


FIG. 25 RECOVERY-REMOVAL OF INSTRUMENTS

VIEWS OF STARBOARD SIDE FROM FORWARD

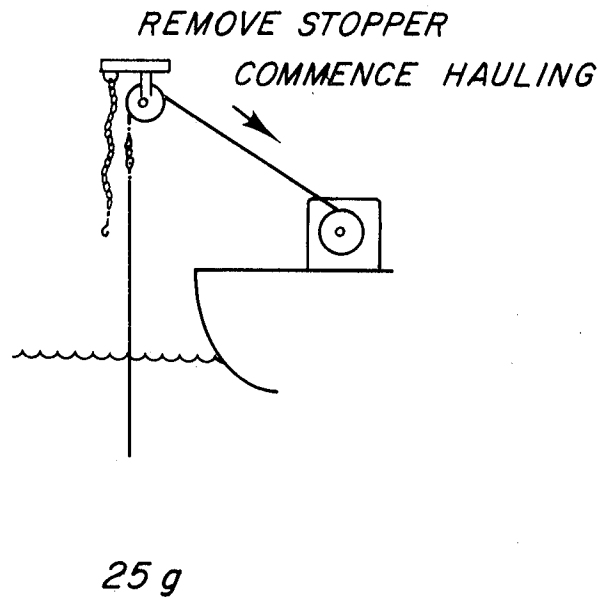
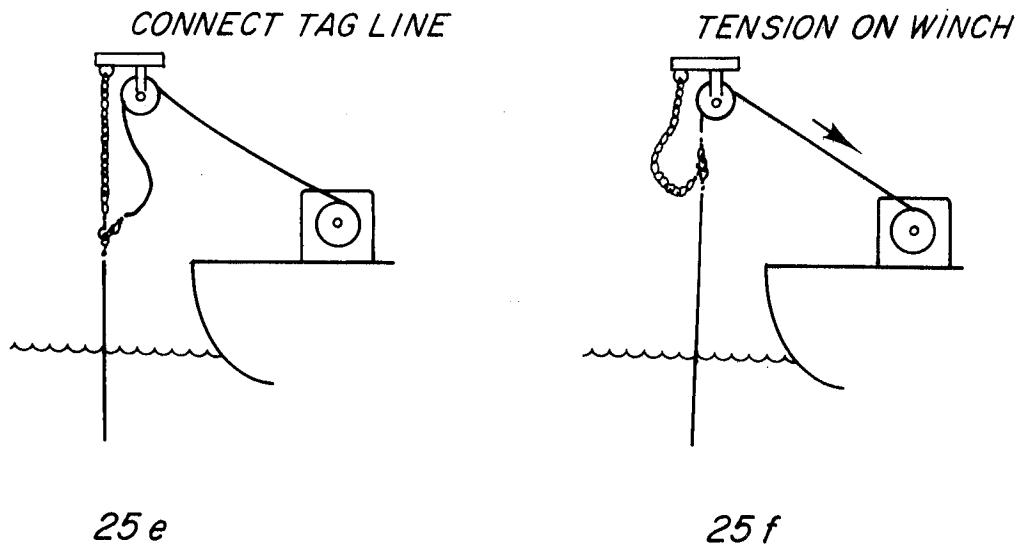


FIG. 25 cont. RECOVERY—REMOVAL OF INSTRUMENTS

VIEWS OF STARBOARD SIDE FROM FORWARD

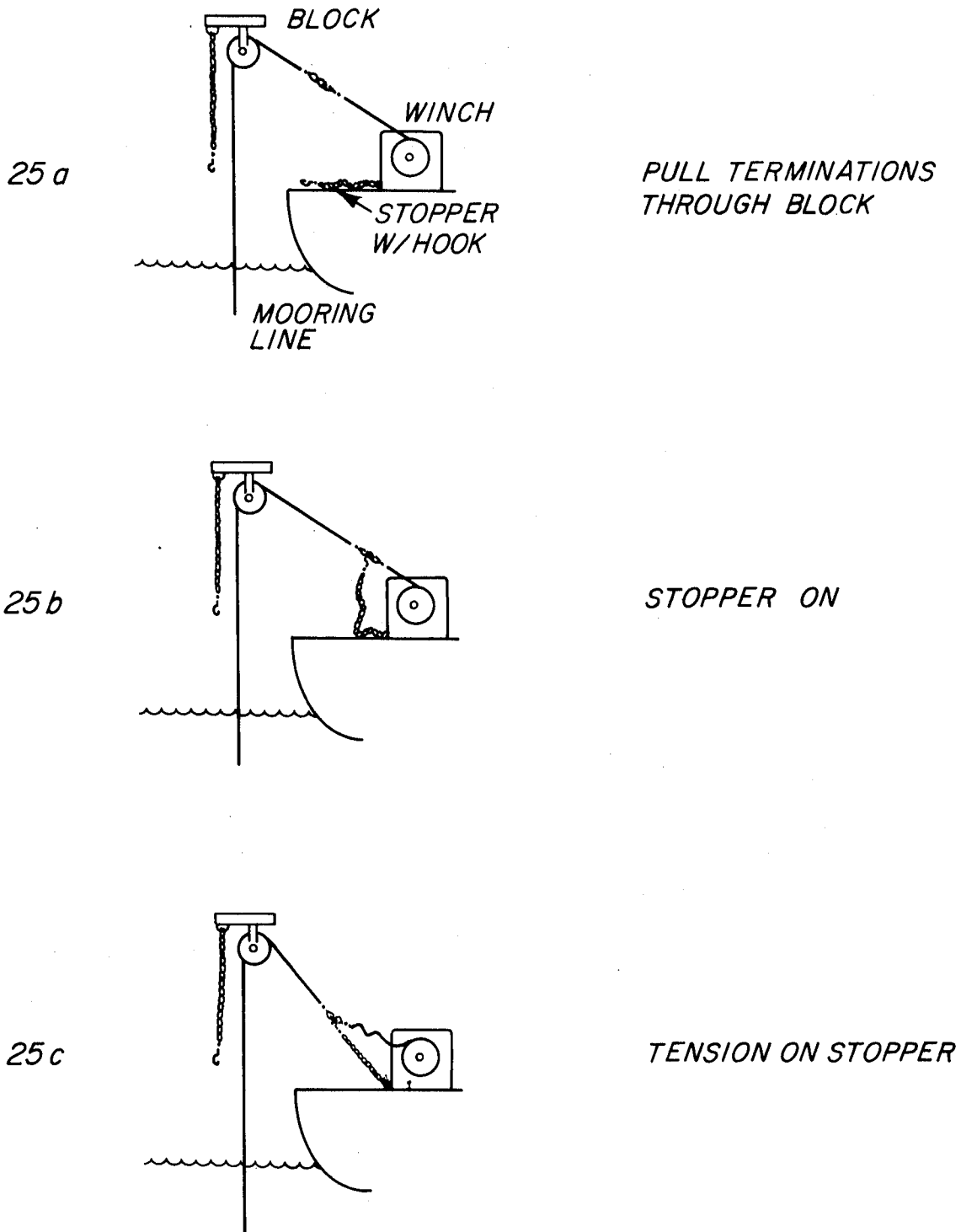


FIG. 26 RECOVERY - USE OF STOPPER AT WINCH

### Intermediate Mooring Recovery

In recovering an intermediate mooring it is important to make sure of the relative location of all glass-sphere clusters before hooking onto the top of the mooring. It is sometimes difficult to know which cluster is which from a distance, but usually the relative size of the clusters will give a clue. Different colored hard-hats in each cluster also help.

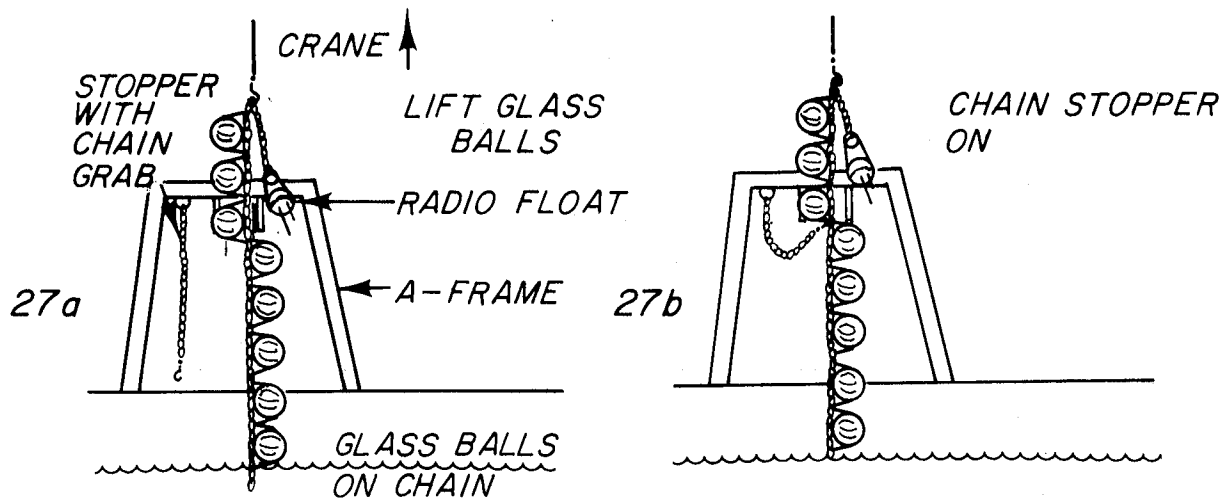
It is necessary to hook onto the downwind cluster to start recovery. However, this cluster must be one of the ends. If this is not the case it may be necessary to put a line on one end and tow the mooring around until it lies right. It does not matter which end. Normally, the top cluster will be downwind since it reached the surface first.

Once the ship is alongside the proper cluster, the pickup hook is put on the chain below the radio float and the spheres lifted with the crane. This cluster will usually be lying in an untangled string. The string should be lifted as high as possible (Figure 27a) and a chain grab used to stop off as far down as possible (Figures 27b and 27c). A second chain grab on the crane hook is used to lift the spheres (Figures 27d through 27i). The process is repeated until the upper end of the first shot of line is reached as in Figure 27j. The spheres and instrument are then removed and the line is hauled on the winch (Figure 27k).

Hauling proceeds until the next sphere cluster is reached. Instruments are removed as described earlier. The intermediate flotation and the backup recovery section are often tangled. Usually they can be brought aboard in a bunch, lifted by the winch. The stopper should be attached below the cluster and the spheres untangled and removed. The procedure is the same as for removing an instrument.

Occasionally tangling among the spheres will involve a few meters of the wire below it. In this case there is no convenient place to stop off and a stopper knot must be tied around the wire with a piece of line and made fast at the other end to a cleat to remove the tension and allow untangling of the spheres. When the end of the wire is freed from the tangle the tag line from the winch reel may be shackled into it and hauling continued as before.

The backup recovery section will usually be tangled in a cluster. This cluster may usually be lifted aboard with the winch and untangled on deck. The release can then be hauled aboard by hand. In the event of a large tangle involving the glass spheres, it may be difficult to find a convenient spot to stop off and get the tension off so the mess can be untangled. Nylon lines may be used, tied with stopper knots at



VIEW OF STERN FROM STARBOARD SIDE

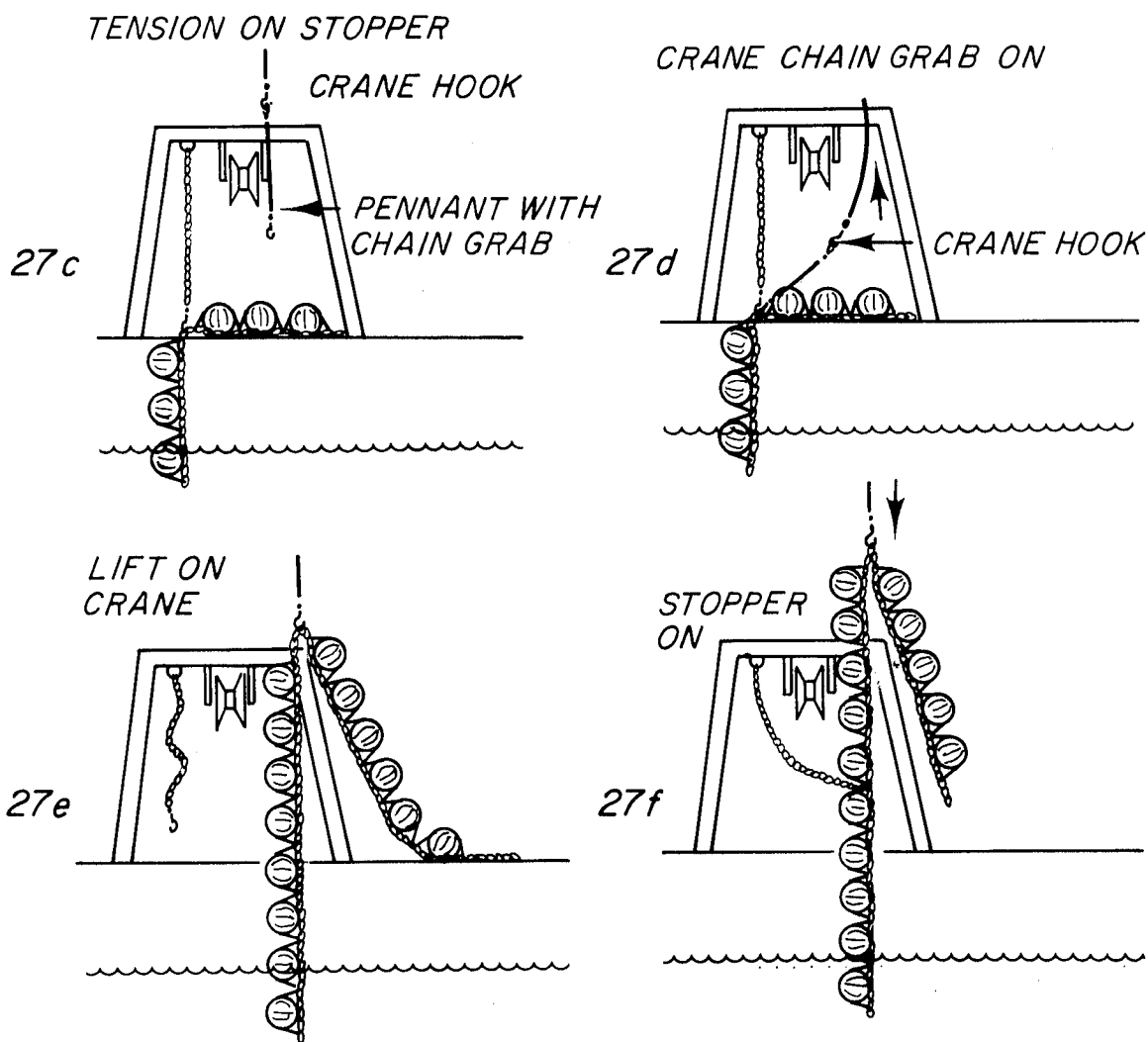
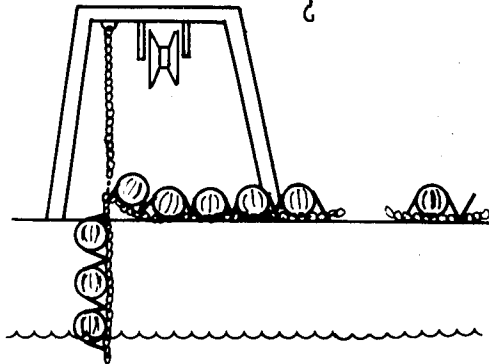


FIG. 27 RECOVERY OF INTERMEDIATE MOORING GLASS BALL BUOYANCY SECTION

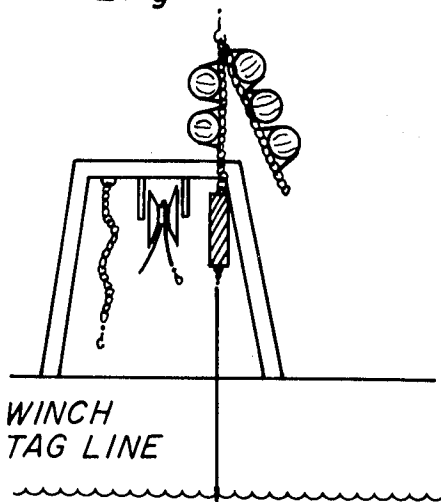
## VIEW OF STERN FROM STARBOARD SIDE

TENSION ON STOPPER  
REMOVE BALLS

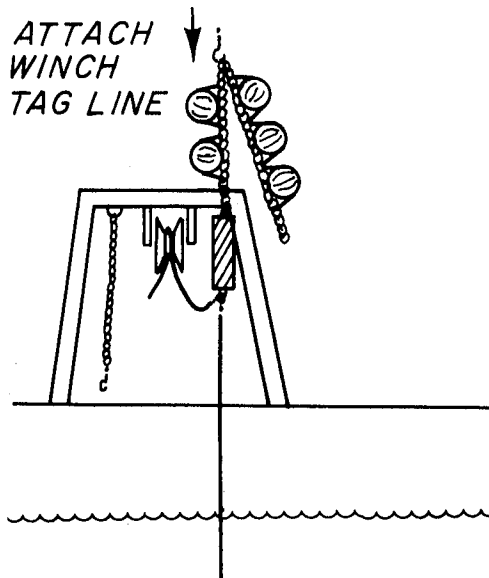


27g

REPEAT THIS PROCESS  
ALTERNATING CHAIN GRABS,  
AND REMOVING FIVE-BALL  
SECTIONS, UNTIL INSTRUMENT  
BELOW BUOYANCY SECTION IS  
REACHED.

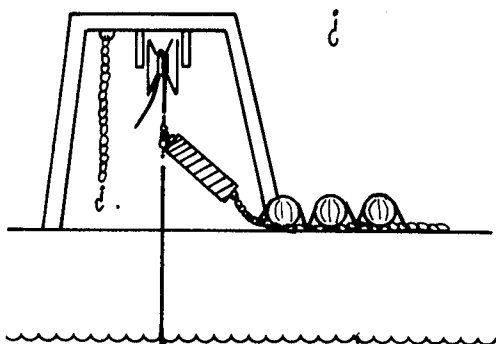


27h



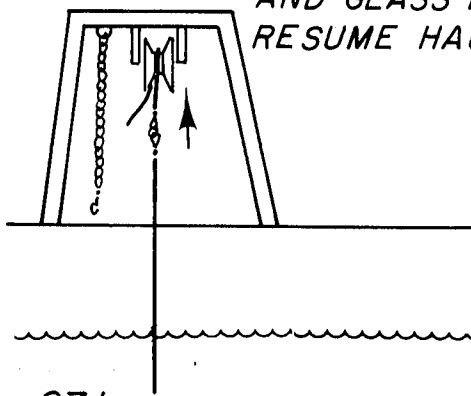
27i

TENSION ON WINCH TAG



27j

REMOVE INSTRUMENT  
AND GLASS BALLS -  
RESUME HAULING



27k

FIG. 27 cont. RECOVERY OF INTERMEDIATE MOORING  
GLASS BALL BUOYANCY AND INTER-  
MEDIATE BUOYANCY.



appropriate places on the mooring line and made fast to a cleat. (Stopper knots are described in The Ashley Book of Knots.<sup>9</sup> The rolling hitch, number 1734, works best.)

#### Surface Mooring Recovery

Recovery of a surface mooring starts with anchor release. Sufficient time is allowed for the backup recovery section to reach the surface. If the recovery is in the daytime this should be confirmed visually. At night enough time should be allowed (assume a rise rate of sixty meters per minute). Before picking up the float it is desirable to locate the glass spheres, with a searchlight if necessary, to see if they are lying upwind of the float.

Since the normal approach and pickup of the surface float will be made from downwind, and the ship will drift to leeward during the hauling, it is important that the float be downwind of the glass spheres. If it is not, it may be possible to put a line on the float and haul it downwind before starting recovery. Otherwise, the mooring line may end up leading underneath the hull. It is possible, but usually less convenient, to recover a surface mooring by picking up the bottom end first.

Once the ship is alongside the float a tagline is hooked into one of the pick-up rings, using the pick-up hook on its pole, as described above. The float is then lifted up (Figure 28a) until a stopper line with a chain grab can be fastened to the chain below the float and made fast (Figure 28b). The float is then removed (Figure 28c) and a tag line from the winch reel attached (Figure 28d and 28e).

Hauling then begins with instruments being removed as they come aboard, as described above, until the backup-recovery section is reached. As with the intermediate mooring, the backup-recovery section can usually be hauled aboard in a cluster and the release hauled aboard by hand.

#### Bottom Mooring Recovery

It is important, because of the difficulty of visually spotting the small float of a bottom mooring on the surface, to track the release and be fairly close when it surfaces. However, care must be taken that the mooring is not run over. Bottom moorings come up at a rate of about eighty meters per minute.

Tracking is fairly easy if a hull-mounted directional transducer is available. However, if the ship must be stopped and a transducer lowered over the side each time a transponder range is to be taken, the procedure can be awkward and time-consuming, particularly in areas of high surface currents.

VIEW OF STERN FROM STARBOARD SIDE

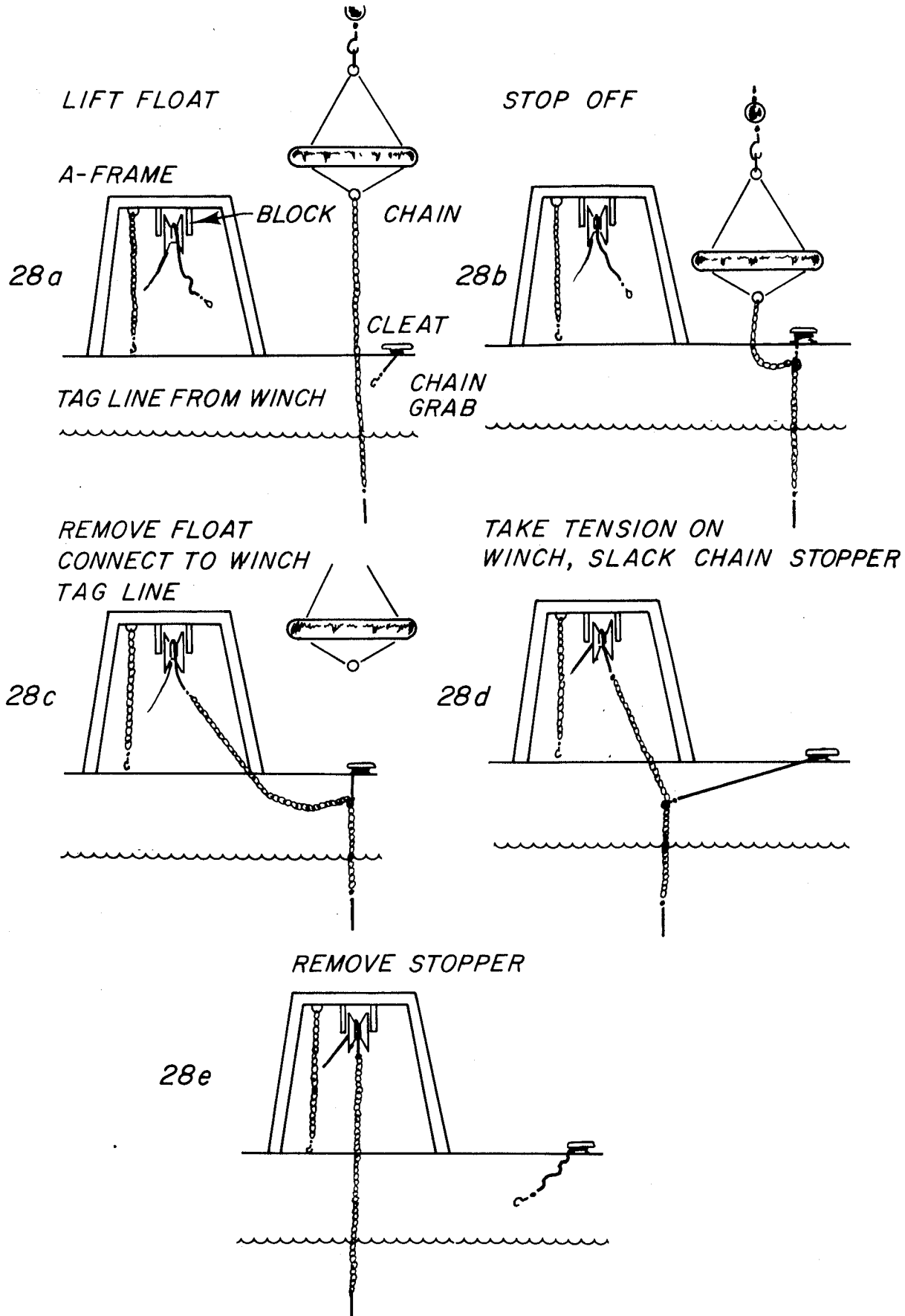


FIG. 28 RECOVERY - REMOVAL OF SURFACE FLOAT

Once the float is on the surface and spotted, the ship goes alongside, the pickup hook is used to grab the radio float or chain, and the entire flotation string is lifted on the crane. Hauling procedure is the same as for an intermediate mooring, but somewhat easier since there are no intermediate buoyancy sections to complicate matters.

If one of the integral floats (glass spheres in a frame or syntactic foam) is used, the procedure is similar to that for recovering a surface mooring. Again the lighter weight and lack of a backup recovery section make the operation straightforward.

#### Backup Recovery

If the mooring has failed and some gear is still on the bottom the remaining gear can be recovered on the backup system. This will generally involve hauling the mooring upside down. Procedures are essentially the same for a normal recovery but will be more difficult because of the inevitable tangling as the mooring falls to the bottom. Figure 29 shows a typical situation during a backup recovery. The release must be carefully tracked to the surface and a visual inspection made to find out how many glass-sphere clusters are still on the mooring.

Two or three patent wire stoppers may be useful to take the tension off large tangles of wire during hauling. Generally it will not be possible to completely untangle the wire and it will have to be cut in several places. Great care should be taken to insure that no wire is cut under tension and lost over the side.

#### Post-Recovery Procedures

All instruments and releases are washed down with fresh water on deck after recovery. Any damage or corrosion is noted and recorded, and sometimes a tag with a description of the circumstances is attached directly to the item. (See section on quality control.) Flooded instruments are opened on deck and the electronics washed in fresh water. Any salvageable components and data tapes are removed.

Wire may be spooled off and stored in coils or on wooden reels while steaming to the next station, particularly if the aluminum reels are needed for the next operation.

All items or components of engineering interest are tagged with the station number and location and attitude (which end was up) on the mooring.

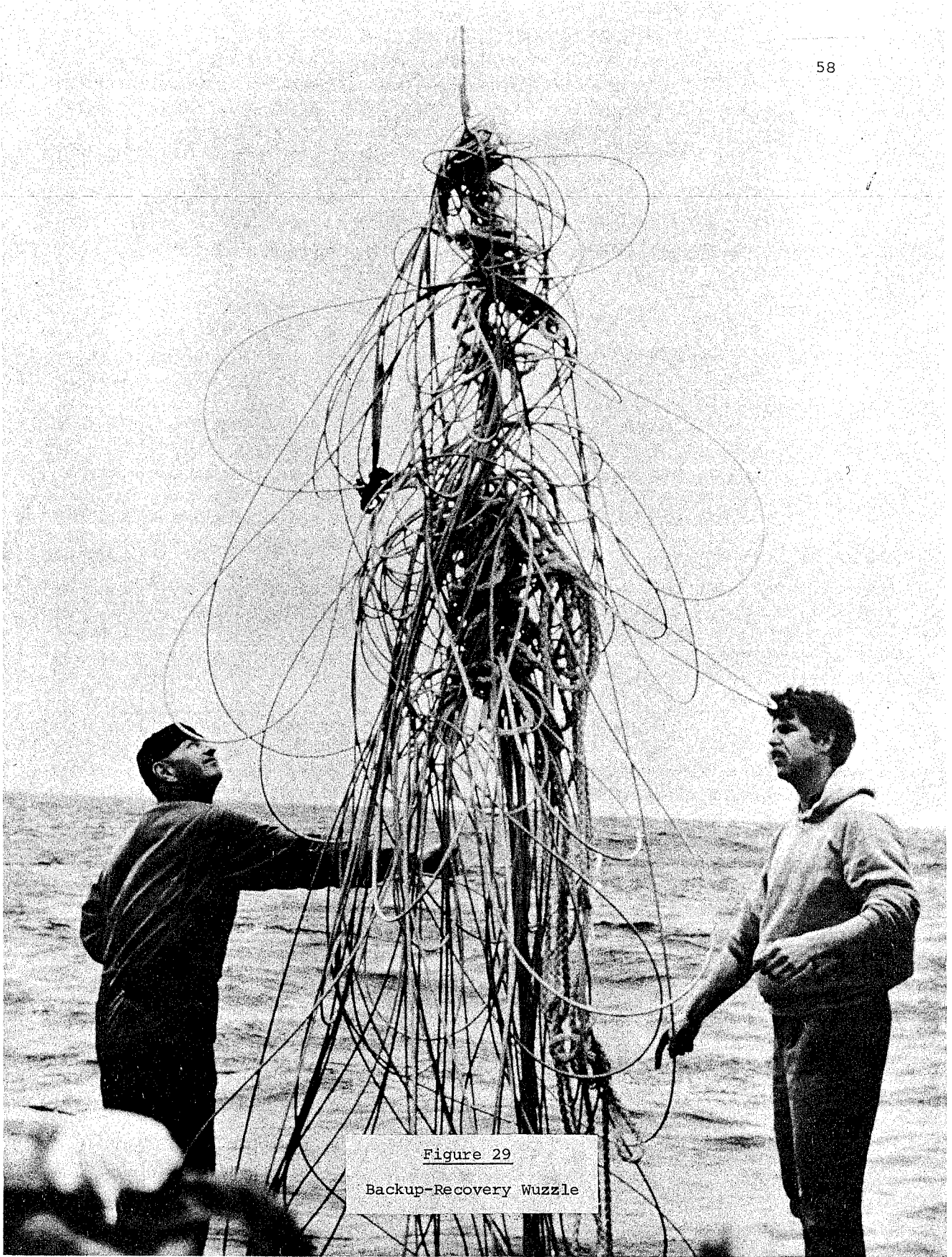


Figure 29  
Backup-Recovery Wuzzle

## DOCUMENTATION AND RECORDS

Moored Station Log

A Moored Station Log Sheet is filled out for each mooring set. These forms are reproduced in Appendix I, pp. 71 and 72, and are several pages folded accordian-fashion. The first page contains all the information on position, general description, cruise, etc. Subsequent pages are identical and provide room for item-by-item listing of all mooring components, with their serial numbers, lengths, times of launch and recovery, and comments. As many of these pages as necessary are used and the remaining unused pages cut off and discarded when the mooring has been recovered.

To insure uniformity and avoid ambiguity in the entries on the Log, guidelines have been developed which are included in a handbook. The section of the handbook on the Station Logs is included in Appendix I.

Greenwich time is always used in mooring records. A small precision twenty-four hour clock has been mounted on a workboard which holds the Station Log sheet during use on deck. This clock is checked against the bridge chronometer or radio time signals before each launch or recovery.

One person is always delegated to keep the mooring records. This person takes no other role in the mooring operations, to avoid being distracted. The role of the records keeper is twofold: to record all data on the mooring, and to insure that the mooring is set as designed. The Chief Scientist or other person in charge of the mooring work supplies a final working drawing of the mooring to the timekeeper just before launch, incorporating all last-minute changes. If any instruments must be placed at specific locations, for instance in the case of limited depth or temperature range, the serial numbers are shown. The records keeper is responsible for letting the deck crew know what components are next on the mooring during launch and for checking serial numbers. Components are always recorded as they are inserted into the mooring, not beforehand, to avoid mistakes.

During a recovery the records keeper works from the Moored Station Log, recording times and warning the deck crew in what order components are coming up.

Engineering/Biological Form

A form for recording engineering and biological data is attached at the end of the Moored Station Log (page 74). It is filled out at the

same time, at launch and recovery. It includes all information on physical damage to the mooring, inoperative or flooded instruments, corrosion, and biological growth or fouling. This sheet usually contains information which is also on the Station Log. However, this page is detached from the rest of the form after recovery and sent to the Engineering Group for their records.

#### Depth Records

The section of the echo-sounder record showing the actual depth at the time of anchor launch is removed from the rest of the record and, with appropriate notations, kept in a notebook for future reference. When possible a similar record is kept from the time of recovery, particularly if the mooring has dragged significantly. These records have proved useful in resolving ambiguities or inconsistencies in assigned instrument depths.

#### Computer Records

All computer records pertaining to moorings are stored for later use in case of questions regarding the design or last-minute changes at sea. In addition, a paper tape is made and filed with the component listing of the mooring as actually set, for use in later analysis of mooring performance after instrument records are processed.

#### Scheduling

Our mooring schedule is generally made up from one year to eighteen months in advance. Two factors must be taken into account. First, we do not usually refurbish instruments at sea and, second, there is a minimum number of personnel required to be aboard for even the simplest of mooring operations.

Releases are rarely refurbished at sea. The only exception is when a series of short-term (a few days) moorings are being set, such as transponder moorings for acoustic navigation. In this case we may turn releases around. Current meters are never refurbished at sea. Since some minimum time between cruises is necessary for working on instruments, we are more limited in the number of deployments per year than would be possible if we turned gear around at sea. However, the check-out procedure is too extensive and critical for this.

Glass spheres and some mooring hardware are, however, turned around which cuts down on the capital investment in the spheres and on the space necessary for storage on the ship. The stainless-steel hardware used to mount the spheres is replaced before resetting.

We require that a minimum of two of our people be aboard for any mooring operation. One must have a good working knowledge of the release gear, in case of problems. The other is usually concerned primarily with the deck rigging. Although on many ships there are competent personnel available from the crew or another scientific party, we have found that it pays to have aboard people who are familiar with the specialized mooring operations.

For larger cruises, involving more instrumentation, it is desirable to have along a third technician, usually a current-meter expert. And for full-scale cruises with fifteen or more mooring launches and retrievals, a full crew of six to eight is necessary.

Using our own skilled personnel, fewer at-sea operations per year are possible than if we relied more on nonspecialized ship's personnel but it pays off in a higher recovery rate and a smoother operation.

#### ACKNOWLEDGEMENTS

The equipment and techniques described in this report are the product of several years of development. Many people in the Buoy Project have contributed to the work, including members of the Operations Group, Engineering Group, Data Processing Group, and the Scientific Group. In the area of mooring preparation and handling procedures, much credit is due particularly to James E. Gifford and R. David Simoneau; in the area of documentation to Susan A. Tarbell and Elizabeth D. Guillard, and to Mrs. Guillard for the editing and preparation of this manuscript.

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APPENDIX I

## A GUIDE TO THE COMPLETION OF MOORED STATION LOGS

Introduction

This booklet is intended to serve as a guide for anyone acting as Chief Scientist on a Buoy Project cruise or in charge of mooring operations on other cruises. Included are several sections on record keeping and paperwork. Samples of the various forms are provided.

We handle the forms and paperwork so much that we sometimes take them for granted. It's easy to forget that some of these pieces of paper carry our primary data and are vitally important.

Heinmiller, Guillard, Tarbell

Notes on Record Keeping

- It doesn't matter how conscientious you are in taking notes and filling out forms if your writing is illegible. Please be sure that others will be able to read what you have written.
- Write in ink. Correct errors by crossing out, without obliterating, the error and writing the correction next to it.
- Please save all notes, graphs, etc. for inclusion in the permanent file kept for each cruise. These materials are sometimes useful later.
- Moored station logs must be Xeroxed and sent to Data Processing soon after the ship docks so that they can be used in the preliminary current-meter data processing.
- It is bad practice to complete the logs or make notes days after the work was done - it leads to error. None of us has that good a memory. Keep your paperwork up to date.
- Avoid time-zone hassles. Keep your records in UTC ("Z" Time). UTC replaces Greenwich (GMT) Time. A section on time zones is included but these problems can be avoided by always working in "Z" time or UTC. In any event, station logsheets must always be filled out using UTC.

### Moored Station Log

The Moored Station Log originates in the Operations Group of the Buoy Project but the information contained is of importance to all groups. The log form has changed many times since the first in 1965 as our experience and need-to-know have changed. The present log form is refined to the point that if you enter all the information the columns demand you have done only half a job. The alternative is to have a column for all necessary information. But this would run into several extra sheets of paper and be hard to handle so this guide to completing the Moored Station Log has been written. Please remember that each item of information called for by the log is important to someone. For instance, the reason why we specify the time the instrument is *in* the water, not just over the side, may seem obscure to the casual observer but knowing the exact time when the instrument hit the water is sometimes of great importance in establishing a credible time base.

Please write all station logs in *ink*. Mistakes should not be obliterated. Draw a single line through the mistake and write the correct entry next to it, or on the next line if a whole line needs correction. This is standard lab practice because it is sometimes useful later to know what the original entry was for sorting out confusions.

The most neglected sections of the log are the notes sections. These never have enough information. As a key for the observer, he or she should keep in mind that every time someone says, "Hey, look at that" or "What happened?" the subject of comment should be noted with appropriate times and/or location. Even non-mooring-related information can be helpful by providing a memory jog years later.

The second most inadequately filled out portion of the log is the section relating to retrieval. Two things seem to occur: either it is a "normal" recovery and everybody relaxes and stops noting times and events, or it is an abnormal recovery and the events are so exciting or demanding of attention that only the barest details get jotted down. Both types of recoveries should, of course, be fully documented.

*Never fill in the item column before launch.* The diagram of the mooring is a guide only. If anything is changed at launch time or

if the Chief Scientist loses track of which shot of nylon is currently going over, a comparison of the Moored Station Log and the mooring diagram will show what is happening. A good way to avoid being rushed and thereby confused when a grouping of items goes over the side is to keep track of the pre-launch information on the mooring diagram, *e.g.* tapes off C.M. 259.

The Observer/Recorder should always verify by eye everything that is noted on the Moored Station Log. This includes all numbers on instruments, lengths of line, relative positions, size of chain, etc. Everyone is most careful but if there is a slip-up an alert Observer/Recorder can catch it before the item goes over the side.

The original handwritten Moored Station Log is kept by the Data Processing Group. A copy is kept by the Operations Group and copies of it may be had on request. Any changes or additions must be okayed by the Chief Scientist of that cruise and changed on the handwritten original, with date and initials.

A Guided Tour through the Moored Station Log Sheets

Page One

1. No.: The Moored Station number, assigned by the Chief Scientist
2. Date Set: The date (year, month day)
3. Time Set: The hour and minute the mooring is set, according to the official Buoy Project twenty-four hour clock.  
This is the time of the first item over the rail
4. Location: The latitude (N, S) and longitude (E, W) where the mooring settled. The location is noted in degrees, minutes, and tenths of minutes
5. Observer/Recorder: The name of the person who filled out the logsheets as the mooring was set or recovered
6. Watch Checked: The watch used should match the time of the official Buoy Project clock so that the times noted can be checked against the data
7. Station Set By: The name of the Chief Scientist
8. Ship & Cruise No.: The name of the ship and its cruise number
9. Date Recovered, Time Recovered, etc.: The same as for Date Set, Time Set, etc.
10. Depth: Rec. Reading, fm./m.: The water depth at the location set, in fathoms or meters, to be taken from echo-sounding readings, not chart
11. Depth Corr.: The correction, from the Matthews tables, to be applied to the recorded depth
12. Corr. M.: The corrected depth in meters is the depth from No. 10 (for fathoms multiply by 1.83) plus the correction from the Matthews tables
13. Float Depth: The depth of the major flotation device as computed by computer program NOYFB
14. Mag. Var.: The magnetic variation at the mooring site as recorded by the Bridge

15. Purpose of Mooring/Array: Indicate experiment(s) to be performed by the mooring(s) and for whom. If one of an array, record any numbers identifying it within that array, *e.g.* POLYMODE Array II, Set 2, Mooring #12. If it replaces an earlier mooring or array for continuing records, include earlier station number(s)
16. Location: This should be a geographic reference, *e.g.* the Continental Shelf, N-S Array E of Bermuda, Site D, beneath Gulf Stream
17. Intended Duration: Length of time it is planned that the mooring be left at sea
18. Actual Days at Sea: Actual days at sea
19. Main Float: Color(s), Markings, etc.: A full description of all markings, sizes, colors and patterns of colors. If the float has a radar ball, its colors and markings, as well as all other identifying facts - anything that would help to identify it if it's washed ashore four or five years later minus most of its paint
20. No. Glass-Sphere Clusters, Total No. of Spheres, Hat Color(s): The number of glass balls in each cluster, the number of clusters, the total number of spheres, and the hat sizes and colors
21. Wire, Rope: The type and size of wire and line used
22. Radio Mfg. & No.: Type and serial number
23. Freq.: Kilocycles or megacycles
24. Char.: (If other than a two-tone signal, signal should be timed with a stop watch)
25. Tension Telemetry: Type of keyer
26. Code: Morse code designation
27. Period: (Timed with a stop watch and note made of the time in seconds of the period or cycle
28. Light Mfg. & No.: Manufacturer and serial number
29. Strobe/Incand.: Circle appropriate type

30. White Light: Cross out if there isn't one
31. Flashing every \_\_\_\_\_ seconds. (Must be timed with a stop watch and note made of interval or cycle)
32. Release:
  - a) AMF #: Serial number
  - b) Receiver #: Number of the receiver to be used
  - c) Release Command: Number of release command
  - d) Time of firing: Time the release actually fired, in UTC
  - e) Remarks: Any additional pertinent information
33. Anchors:
  - a) Stimson \_\_\_\_\_ lbs.: Dry weight in pounds
  - b) Other(s) \_\_\_\_\_ lbs.: Dry weight in pounds with a description of anchor(s)
34. Item Number: The items should be numbered sequentially. The numbers assigned to the items are used in referring to that item under mooring notes, *e.g.* "Item 13" rather than "3rd shot of wire"
35. Length in Meters: The length of each item from the bridle to the anchor chain. Nominal lengths which we use as standards are:

|                   |            |
|-------------------|------------|
| Bridle            | - 2 meters |
| Current Meter     | - 2 meters |
| Beacon            | - 1 meter  |
| Depth Recorder    | - 1 meter  |
| Pressure Recorder | - 1 meter  |
36. Item: Each item should be listed on a separate line in the order it occurs on the mooring. This includes lights, wind recorders, telemetering devices, swivels, special sampling devices, etc. If a section planned as a single shot is made up of two or more shots shackled together, each should be listed as a separate item.
37. Ident. No.: The identification number of the item, *e.g.* W-137, V-012, 0-6, etc.
38. Time Over: The hour (0 to 24) and minute, in UTC time, the item goes into the water. List both start and end times

of wire and line. When present, identification marks stamped on wire terminations should be noted in the "Ident. No." column. Use the space under "Notes".

39. Notes: Observations about individual items. If the comment is long use the space under "Mooring Notes". Anything that appears unusual should be noted. A few specific things required are the times of:
- Radio - on
  - Light - on
  - Wind Recorder - tapes off the sensors
  - Current Meters - tapes off the external sensors, radio first heard, light first seen
  - All other Instruments - the times they were activated
  - All Shots of Line and Wire - the start and stop times of going over the rail
40. Time Back: See 38
41. Notes: The reverse of 39; that is, the times the sensors were taped or turned off
42. True Depth in Meters: Computed by program NOYFB and entered for each recording instrument by the Chief Scientist
43. Data Number: Assigned by the Observer/Recorder for *every* instrument that collects data. This includes biopacks, pyranometers, telemetering instruments, etc.
44. Notes on Moorings, Sightings, Weather Difficulties, etc.: Notes on all occurrences during launch and retrieval. Enter here (until revision of this form) the time the radio stopped signaling, time the release bottomed out, the number of any CTD stations. Enter the dates of subsequent sightings by planes, ships, etc. Dare to try to write too much. For extra space, use back of sheet.



No. \_\_\_\_\_

MOORED-STATION LOG

Set

Recovered

Date \_\_\_\_\_

Date \_\_\_\_\_

Time \_\_\_\_\_ Zone \_\_\_\_\_

Time \_\_\_\_\_ Zone \_\_\_\_\_

Lat. \_\_\_\_\_ Long. \_\_\_\_\_

Lat. \_\_\_\_\_ Long. \_\_\_\_\_

Observer/Recorder \_\_\_\_\_

Observer/Recorder \_\_\_\_\_

Watch Checked: Before \_\_\_\_\_ After \_\_\_\_\_

Watch Checked: Before \_\_\_\_\_ After \_\_\_\_\_

Set By \_\_\_\_\_

Retrieved By \_\_\_\_\_

Ship & Cruise No. \_\_\_\_\_

Ship & Cruise No. \_\_\_\_\_

Depth: Rec. Reading \_\_\_\_\_ fm./m.; Depth Corr. \_\_\_\_\_ Corr. m. \_\_\_\_\_

Float Depth \_\_\_\_\_ Mag. Var. \_\_\_\_\_

Purpose of Mooring/Array \_\_\_\_\_

\_\_\_\_\_ Other Designations \_\_\_\_\_

Location \_\_\_\_\_ Intended Duration \_\_\_\_\_ Actual Days at Sea \_\_\_\_\_

Main Float \_\_\_\_\_ Color(s) \_\_\_\_\_ Markings \_\_\_\_\_

No. of Glass-Sphere Clusters \_\_\_\_\_ Total No. of Spheres \_\_\_\_\_ Hat Color(s) \_\_\_\_\_

Wire \_\_\_\_\_

Rope \_\_\_\_\_

Radio Mfg. & No. \_\_\_\_\_ Tension Telemetry: \_\_\_\_\_ Light Mfg. & No. \_\_\_\_\_

Freq. \_\_\_\_\_ Type \_\_\_\_\_ Strobe/Incand. \_\_\_\_\_ White light

Char. \_\_\_\_\_ Code \_\_\_\_\_ Period \_\_\_\_\_ flashing every \_\_\_\_\_ seconds

AMF Release # \_\_\_\_\_ Time of Firing \_\_\_\_\_

Receiver # \_\_\_\_\_ Remarks \_\_\_\_\_

Rel. Command \_\_\_\_\_

Anchors: Stimson \_\_\_\_\_ lbs. Other(s): \_\_\_\_\_ lbs. \_\_\_\_\_ lbs.

Miscellaneous \_\_\_\_\_



## Notes (Biological/Engineering)

This log sheet is an important source of feedback. Any unusual events and all damage and defects observed should be entered on this sheet and identified by item number. Each item noted should be tagged in a manner which clearly identifies it with the log-sheet notation. When practicable the tagged item should be removed and set aside for delivery to the Engineering Section.

Examples of items which should be logged and tagged are:

|                          |                                        |
|--------------------------|----------------------------------------|
| Handling damage          | Corroded items                         |
| Fishbites                | Bent or broken items                   |
| Kinks and knots          | Unusual types or degrees<br>of fouling |
| Damaged sensors          | Condition of sacrificial anodes        |
| Inoperative lights, etc. | Spalled, broken or missing balls       |

In order to gain an overall view of the performance of the glass spheres used for flotation we require details, when known, of all cases of damage or breakage. Please include in your notes whether the event occurred at the time of setting or retrieval, during the time the mooring was at sea, when the sphere was at the surface in a cluster, alongside the vessel, on the crane or on the deck. Make note of the kind of damage and, if it occurred during handling, whether the handling was routine or careless. Each sphere has a yellow tag inside it with a serial number. It is important that you record this number.

At the bottom of the form is a list of code letters and their explanations. These are intended to both simplify the observer's job and to provide reminders of some of the kinds of observations which should be noted. These should not be expected to cover every contingency which might arise. Don't hesitate to mention anything that might be of interest.



### Depth Records

A short section of the echo-sounding record from the time of anchor drop should be removed and saved. The Operations Group keeps a file of these for later reference in case of question about the depth of a mooring.

With surface moorings the most accurate depth reading is achieved by going alongside the float after it settles. For subsurface moorings use the depth at the time of anchor drop.

Keep the record at the time of mooring recoveries also. It provides redundancy in case no record is available from the launch.

A strip of the record half an hour long is adequate. It should cover the entire width of the GDR paper. Please be certain that the piece you save has on it the information necessary to analyze the trace, *i.e.* range, phase, cycle information, etc. Please be sure the information includes the mooring number, date and time.

\* \* \* \*

### ROSCOP Form

We are required by our government contracts and grants to fill out and file with the National Oceanographic Data Center a "Report of Observations/Samples Collected by Oceanographic Programs" (ROSCOP) for each cruise. Please note that it must be completed and sent to the Data Library (Bill Dunkle) at the DESC Building within thirty days after the cruise.

The form is not as intimidating as it looks. It is easy to fill out once you understand it. For Buoy Group cruises not that much information is required. Following are instructions for the use of the form provided by Bill Dunkle.

*Note:* POLYMODE is a "Declared National Program" (DNP). See ROSCOP instructions.

\*GUIDE  
FOR  
CHIEF SCIENTISTS & OBSERVERS

Explanation of the ROSCOP Form (Report of Observations/Samples collected by Oceanographic Programs)

30 Days after the end of any Cruise or Major Leg this Form has to be Forwarded to The Data Library which will record Information and Forward on to N.O.D.C.

PURPOSE

This is a guide to help reduce the confusion involved in filling out the ROSCOP form for data reporting.

If this form were filled in at sea and turned in when you return, it would eliminate once and for all the continual bother of trying to contact each and every person who collected data during each cruise.

All funding contracts now require that this form be completed within 30 days of the completion of a cruise or major leg.

A dummy copy has been filled out showing as simply as possible what is needed and required. A more complete description of each section and item listed can be found in the rear of this guide. Blank copies of the ROSCOP form have been inserted for use at sea and a full pad can be obtained from the Port Office, Data Library, or George Heimerdinger at Clark.

If you have any question concerning any items on this form, please call William Dunkle or George Heimerdinger.

The completed form should be sent to the Data Library at DESC for retention as a permanent record for future reference. The Data Library will forward a copy to N.O.D.C.

\*[No more than this page is included for the purposes of this paper.]

### Time Zones

Time zones range from -12 hours to +12 hours with zero being at Greenwich, England. Each zone is represented by a letter. The hour designation for a zone is a correction which, when applied to a local-zone time, will give Greenwich Mean Time. Relatively recently an international commission adjusted GMT by stopping it for one second in order to compensate for the very gradual slowing of the rotation of the earth. This time replaces GMT and its designation is UTC which appears to be a compromise between the English "Universal Coordinated Time" and the French "Temps Universel Coordonné". They haven't moved Greenwich, England and the other time zones still relate to it in the manner described above - the designation has simply changed from "GMT" to "UTC".

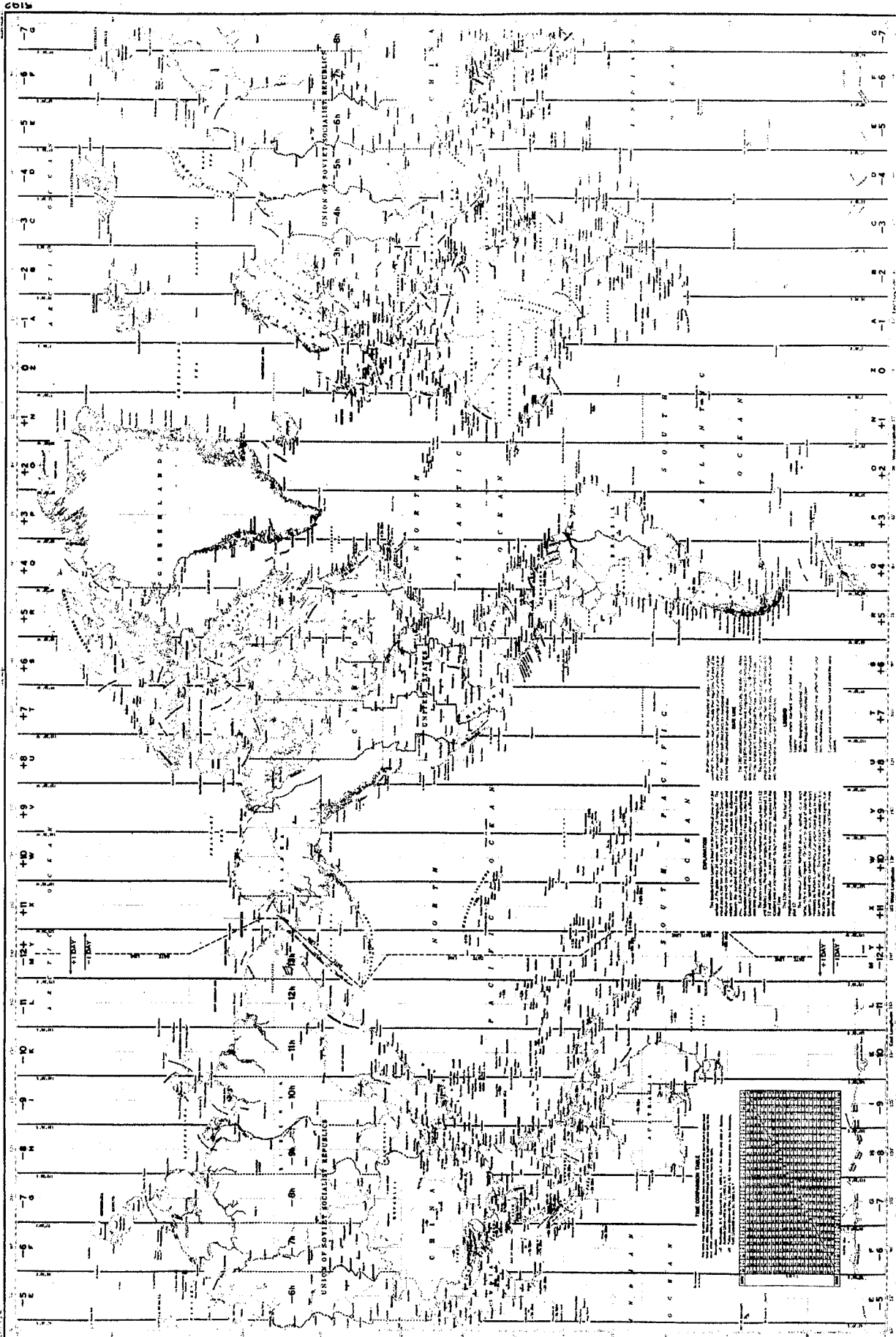
In open waters zones change every fifteen degrees of longitude except near the International Dateline. However, certain island groups in the Pacific use a time which is different from the zone they are in. With these exceptions, time zones are shown on the accompanying map. A more detailed map is on p. 489 of Bowditch (available in most ships' chartrooms).

In some cases it is not so important what zone you use in keeping records as long as the zone used is recorded. *For Moored Station Logs, however, you must use UTC.* When in doubt, consult the ship's navigator. If there is any confusion the safest thing to do is to set your watch to Z (UTC, available by radio signal or from the ship's chronometer, corrected) and stick to it.

If you are using ship's clock time (not chronometer) check each day, particularly when steaming long distances, to see what zone the ship is then in. Again, for anything UTC would be the safest and is mandatory for Moored Station Logs. It should be noted also that ships occasionally set their clocks to the time of a zone different from that which they are in. Examples are "tropical working hours" or when a vessel expects to make an excursion into a nearby zone for a short time and doesn't want to take the trouble to change clocks.

Daylight Savings, or Summer, Time shifts the zone by one hour towards the east. A few commonly-used zones are shown on page 24.

STANDARD TIME CHART OF THE WORLD



HO. 5192  
 5192



Time Zones

| <u>Name</u>      | <u>Letter<br/>Designation</u> | <u>Plus or minus,<br/>in hours, from<br/>Greenwich or UTC</u> |
|------------------|-------------------------------|---------------------------------------------------------------|
| Eastern Standard | R                             | +5                                                            |
| Eastern Daylight | Q                             | +4                                                            |
| Bermuda          | Q                             | +4                                                            |
| Tokyo            | I                             | -9                                                            |
| Honolulu         | W                             | +10                                                           |
| Greenwich        | Z                             | 0                                                             |

## Operational Procedures for AMF Release Gear

The operational procedures outlined here are to be followed and records kept in an effort to improve ability to avoid release problems and to reconstruct the circumstances when problems do occur. Check sheets should be used to insure a permanent, complete record, but these sheets do not replace notebook entries.

### 1. During Transport at Sea

- 1.1 Store units in air-conditioned instrumentation laboratory, if at all possible, to protect batteries.
- 1.2 Do not store units on the open deck or down in the hold where excessively high temperatures may prevail. If this must be done, remove the batteries from the units and place them in an air-conditioned area in sealed plastic bags.
- 1.3 Transport and store units in a manner to minimize excessive shock and vibration.

### 2. Preparation for Lowering Test

- 2.1 Remove the arming plug.
- 2.2 Remove the electronics package and connect all batteries if necessary.
- 2.3 Replace the electronics package. (Do not forget to elevate the release end of the pressure housing.)
- 2.4 Run an air-acoustic test on the timed pinger and transponder modes.
- 2.5 Purge with freon.
- 2.6 Replace arming plug.

### 3. Lowering Test

- 3.1 Check the transponder and the timed-pinger response at the following depths: 100 meters, 500 meters, 1,000 meters and 2,000 meters. If the over-the-side transducer is being used, it should be placed at a depth of 15 to 20 feet.
- 3.2 At the maximum depth, check and record the minimum coder OUTPUT LEVEL setting required for both the transponder interrogations and the timed-pinger command. Also, check to see if unit will respond at all higher coder OUTPUT LEVEL settings. Record any setting at which a response cannot be obtained. (One "hole" in the settings is permissible.) At least three commands of fifteen-seconds duration each should be attempted before a non-response is recorded.
- 3.3 Also during the maximum-depth test, determine and record the minimum setting of the Model 200 Receiver SENSITIVITY control required to hear either the pinger or the transponder. Also record the highest setting the sensitivity control can be set to without being saturated by background noise.
- 3.4 Units which require exceptionally high power to interrogate or have a weak reply should not be deployed without being repaired. A power level of 2 or 3 should be adequate at 2,000 meters. Minimum receiver sensitivity should be about 5 or better.
- 3.5 Remove arming plug and replace with protective cap plug.

### 4. Pre-Launch

- 4.1 Perform air-acoustic test using the test plug to test the squib-firing circuit.
- 4.2 Purge with freon.

4.3 Install arming plug.

4.4 Check external features.

4.4.1 release linkage properly engaged

4.4.2 proper stainless-steel ring and thimble

4.4.3 anodes properly installed

4.5 Record all serial numbers, receiver number, command codes and type of unit on mooring sheet.

5. Launch

5.1 Pull the safety pin.

5.2 Check to see that the mooring line and the release linkage are not fouled.

6. Post-Launch

6.1 Interrogate the transponder once every five minutes until the anchor bottoms out. Record the range associated with each interrogation.

6.2 After the mooring settles out, bring the ship over or alongside the mooring and check both the transponder and timed-pinger modes. Determine and record the minimum required settings of the coder OUTPUT LEVEL and the receiver SENSITIVITY controls. Record also the depth-recorder reading and the transponder range.

6.3 Measure and record the timed-pinger rate.

7. Recovery

7.1 Check the mooring sheet for the proper codes.

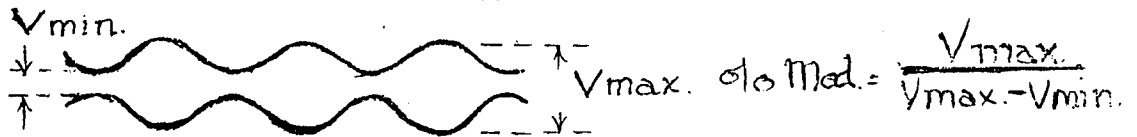
7.2 Interrogate the transponder and command the timed pinger. Measure and record the timed-pinger rate.

- 7.3 For bottom moorings or back-up recovery systems use the transponder to guide the ship close to the mooring.
  - 7.4 Determine and record the minimum required settings of the coder OUTPUT LEVEL and the Model 200 Receiver SENSITIVITY controls. If okay, send the release command at the same minimum output power level as determined for the timed-pinger response.
  - 7.5 Send the timed-pinger command to determine if the pinger has changed rate confirming release.
  - 7.6 Interrogate the transponder as the unit rises and maneuver the ship towards the release as it comes up. Do Not Try to Get Too Close and Take a Chance on Running the Gear Down. Except under very special circumstances, there seems to be no need to be closer than 500 yards when it surfaces.
8. What to Do When the Following Problems Occur
- 8.1 No response at all
    - 8.1.1 Check the mooring coordinates on the mooring sheet and your present position. Also check loran log of cruise on which mooring was set.
    - 8.1.2 Check the codes on the mooring sheet.
    - 8.1.3 Send the timed -pinger command continuously for forty-five seconds while varying the coded OUTPUT-LEVEL control (power output) very slowly in increments of one-half from zero to full power. Do this several times. Also, vary the power over the full range while interrogating the transponder.
    - 8.1.4 Lower the over-the-side transducer to its full depth and vary the output power over its full range while interrogating the transponder and commanding the

timed pinger. Raise the transducer at twenty-five foot intervals and repeat this procedure.

8.1.5 Check the maximum setting of the Model 200 Receiver SENSITIVITY control before the receiver is saturated with noise. If the setting is abnormally low, indicating a high noise level, it may be that you just aren't able to hear the replies above the noise. If this noise is ship noise, lower the transducer all the way to its full depth and have all possible noise-making equipment aboard the ship shut down.

8.1.6 While transmitting the timed-pinger command at full power, monitor the signal at the RECEIVER BNC connector on the front panel of the power amplifier with an oscilloscope. The signal should be a minimum of 250 volts and with at least 85% modulation.



8.1.7 (Deleted because it no longer applies)

8.1.8 Try various ship locations.

8.1.9 Check, double check and persist!

8.2 Transponder response, but no timed-pinger response

8.2.1 (Deleted because it no longer applies)

8.2.2 Make sure that you are actually getting a transponder response and not a bottom echo. To determine this:

8.2.2.1 Send a different transponder code and see if you get a reply. If you do, then you are getting an echo.

8.2.2.2 Send two transponder pulses in less than one second. If you get two replies, they both cannot be transponder replies due to the lockout time in the transponder.

8.2.2.3 If you are using the Model 301 Receiver, it will not respond to transponder-interrogation echos. It has a 400-cycle bandwidth centered about 10 KHz. All interrogation frequencies are outside this bandwidth.

8.2.3 If the timed-pinger mode is determined to be not working, then you will not be able to confirm that release has occurred by this method. You will have to use the transponder to determine if the unit is actually rising after you send the release command.

8.3 If timed pinger works but does not change rate after release command is sent.

8.3.1 In the event that the rate-change circuit in the timed-pinger circuit is not working, interrogate the transponder to see if the unit is coming up.

8.3.2 If not, send the release command again, varying the output power slowly as previously described in section 8.1.

- 8.3.3 Vary the shipboard-transducer depth and power levels.
- 8.3.4 Monitor the command at the RECEIVER BNC connector on the front panel of the power amplifier as described in section 8.1.6 to make sure the transmitted signal is proper.
- 8.3.5 Persist on the assumption that the release-command channel is marginal in this unit and that the right combination of conditions will "do the trick".
- 8.3.6 (Deleted because it no longer applies)

9. Post-Recovery

- 9.1 If unit has worked properly in all phases, interrogate the transponder and command the timed pinger in air. Record that this was done and wash unit down with fresh water.
- 9.2 If unit has not worked properly, perform a complete air-acoustic including the squib firing circuit using the test plug and then purge with freon; record the results and wash unit with fresh water.

10. Notes

- 10.1 All commands are to be recorded. Record anything unusual about the release operations or the release itself.
- 10.2 Use the check sheets.



DEPLOYMENT CHECK-LIST FOR ACOUSTIC RELEASES

Release No. \_\_\_\_\_ Receiver No. \_\_\_\_\_ Release Command \_\_\_\_\_

| <u>Item</u>                                                                                         | <u>Check Here<br/>When Performed</u> |
|-----------------------------------------------------------------------------------------------------|--------------------------------------|
| 1. Check the voltage of the squib battery                                                           | _____                                |
| 2. Connect the squib battery                                                                        | _____                                |
| 3. Connect the squib leads in the release to TB3-1 and TB3-2                                        | _____                                |
| 4. Insure that the pinger switch on top of the squib housing is properly actuated and is not fouled | _____                                |
| 5. Check the voltage of the receiver batteries                                                      | _____                                |
| 6. Connect the receiver batteries                                                                   | _____                                |
| 7. Check the SRL output voltage                                                                     | _____                                |
| 8. Connect the transducer to J1 on the pinger module                                                | _____                                |
| 9. Check the voltage of the pinger battery, BT1                                                     | _____                                |
| 10. Connect the pinger battery, BT1                                                                 | _____                                |
| 11. Check the voltage of the pinger timer battery                                                   | _____                                |
| 12. Connect the pinger timer battery                                                                | _____                                |
| 13. Inspect the end plate O-rings and housing O-ring surfaces                                       | _____                                |
| 14. Assemble the electronic package into the pressure housing                                       | _____                                |
| 15. Perform an air-acoustic check on the unit                                                       | _____                                |
| 16. Install the arming plug                                                                         | _____                                |
| 17. Purge the unit with freon                                                                       | _____                                |
| 18. Check the unit for leaks                                                                        | _____                                |
| 19. Insure that the release arm properly engages the load hook                                      | _____                                |
| 20. Insure that the pressure pad on the end of the piston is in place                               | _____                                |

Remarks: \_\_\_\_\_

Mooring No. \_\_\_\_\_ Date Launched \_\_\_\_\_ Date Recovered \_\_\_\_\_

OPERATIONAL TEST

Release Number \_\_\_\_\_ Receiver Number \_\_\_\_\_ Release Command \_\_\_\_\_  
 Xpndr. Freq. \_\_\_\_\_ Disable Command \_\_\_\_\_ Date \_\_\_\_\_

1a. Wire Test

| <u>Depth</u> | <u>Xpndr. Check</u> | <u>Reply Pinger</u> |
|--------------|---------------------|---------------------|
| 200 meters   | _____               | _____               |
| 1,000 meters | _____               | _____               |
| 2,000 meters | _____               | _____               |
| 3,000 meters | _____               | _____               |

b. Received Sensitivity \_\_\_\_\_ c. Pinger Rate \_\_\_\_\_  
 d. Xpndr. saturation check: levels 1 through 10 \_\_\_\_\_ Holes \_\_\_\_\_  
 e. Air acoustic check: nominal \_\_\_\_\_ volts Fired \_\_\_\_\_ volts

2. Moored Station Checks:

Station Number \_\_\_\_\_ Date \_\_\_\_\_ Depth \_\_\_\_\_  
 Range \_\_\_\_\_ Xpndr. pwr. level \_\_\_\_\_ Reply pinger pwr. level \_\_\_\_\_

3. Pre-recovery Check:

Date \_\_\_\_\_ Depth \_\_\_\_\_ Range \_\_\_\_\_  
 Xpndr. pwr. level \_\_\_\_\_ Reply pinger pwr. level \_\_\_\_\_

a. Received sensitivity \_\_\_\_\_  
 b. Saturation check: levels 1 through 10 \_\_\_\_\_ Holes \_\_\_\_\_  
 c. Reply pinger rate \_\_\_\_\_ Released rate \_\_\_\_\_

Remarks: \_\_\_\_\_  
 \_\_\_\_\_

*Office Memorandum* • WOODS HOLE OCEANOGRAPHIC INSTITUTION

TO : All Participants in Future Buoy Lab Cruises      DATE: June 25, 1971

FROM : R. H. Heinmiller, Jr.

SUBJECT: Sport Fishing during Buoy Cruises

One accident and enough near-accidents have occurred over the years to make it necessary, finally, to prohibit all sport fishing at or near moored stations, whether the station is being set or retrieved, or simply if other work is being done in the vicinity of the moored station. With the possibility of fouling a mooring line as great as it is, and the consequences as undesirable, it doesn't seem unreasonable to require that all recreational fishing be suspended at these times. Anyone who doubts the seriousness of such an occurrence is welcome to have a look at photographs of a fouling accident.

Your cooperation in observing this restriction will be greatly appreciated.

RH

*Office Memorandum* • WOODS HOLE OCEANOGRAPHIC INSTITUTION

**TO** : Everyone

**DATE:** April 5, 1976

**FROM** : Bill Schmitz

**SUBJECT:** XBTs in Proximity of Moored Stations

On several occasions XBT wire has been found tangled in moorings. So far no instruments have been damaged or fouled but before this happens it seems sensible to set a minimum distance between the proposed site of an XBT and an established mooring. We have recently been observing a five-kilometer minimum distance between XBT and mooring sites and request that this practice be continued on all future cruises.

15.

APPENDIX II

## GLOSSARY

- A-FRAME - A frame, in the shape of an "A" or an inverted "U", designed to support a block at a distance above the rail, at the stern or at either side of the fantail. Sometimes fixed in position, sometimes moveable hydraulically
- BLOCK - A large pulley or sheave
- BULWARKS - Fence-like guard along the edge of the deck
- CAPSTAN - A revolving cylindrical device used for hauling in lines under high tension
- CHAFE CHAIN - A piece of chain inserted into a mooring line at a point at which some tangling or chafing might be expected
- CHAIN GRAB - a hook designed specifically for attaching to the middle of a piece of chain
- CLEAT - Double-horned piece of wood or metal around which lines are made fast
- CLEVIS - A fitting with a slot into which a ring or shackle can be inserted and made fast by putting a bolt through it
- COMPLIANCE - Stretch in some or all of a mooring line which allows the mooring to give under high stress
- COTTER PIN - A thin steel pin, split along its length, which can be inserted through a hole and the ends spread to secure it
- FAIRLEAD - A chock or hole, block or sheave, through which a line is run so as to provide a smooth run or change of direction without danger of jamming
- FAKED DOWN - (Line) laid out carefully on deck so as to run out freely from one end
- FANTAIL - After part of the main deck
- FOULING - (1) Biological growth which increases drag or hampers mechanical operations  
(2) Jamming or tangling, in a line
- GLASS SPHERE - A hollow glass ball used for deep buoyancy

- HARDHAT - Plastic clam shell-like containers used to contain a glass sphere for attachment on a mooring line
- HYDROGRAPHIC WINCH - Medium-sized winch with several thousand meters of wire of less than a quarter-inch in diameter. Usually used for taking hydrographic stations
- KINK - Sharp turn or twist in a synthetic line or wire rope
- MASTER LINK - An oval or pear-shaped ring made of steel bar stock
- PATENT WIRE STOPPER - One of several commercial devices used for gripping a wire rope at a point away from the ends without damaging it
- PINGER - An acoustic device that emits pulses at a fixed frequency at fixed time intervals. Usually built into the acoustic anchor release
- QUICK-RELEASE HOOK - A hook designed to drop its load when desired, usually by pulling on a line attached to a trigger
- RELEASE - In this report, an acoustic device to release the anchor of a mooring when it receives a coded acoustic command
- SAFETY ANCHOR SHACKLE - A shackle closed with a bolt through the body, with a nut on the end, usually secured by a cotter pin
- SET - Drift of a ship due to wind or current
- SHACKLE - A U-shaped fitting with a pin across the ends, for connecting two components together. The pin may be threaded in or be secured with a nut and cotter pin
- SHOT - In this report, a single piece of mooring line, terminated at both ends
- SLING LINK - Same as "master link"
- SLIP LINE - A piece of line used to lower or secure a piece of gear. The line is doubled. One end is secured. The gear is released by dropping the free end of the line and retrieved by pulling it back through a ring in the piece of gear
- SNAP HOOK - A hook with a spring-loaded latch to prevent the hook from coming unsecured until desired

- SNATCH BLOCK - A block with a slot in one side of the shell, so that a line may be put into the block without threading the end through
- STANCHION - A vertical support, sometimes moveable
- STOPPER - A device for attaching to a line or load to take the tension. In this report, usually a chain or line with a hook at the end
- STOPPER KNOT - A knot designed to attach the end of one line to the middle of another line, for relieving the tension on the latter
- STOPPER LINE - Any line used as a stopper, either with a hook on the end, or attached with a stopper knot
- STOPPING OFF - The act of using a stopper to relieve the tension on a line
- SWAGING - A process for attaching a fitting to the end of a wire rope by inserting the wire in a hole in the fitting and squeezing or crimping the fitting hydraulically
- SYNTHETIC LINE - Any line made of synthetic fiber, usually nylon, Dacron, or polypropylene
- RAGLINE - A wire rope attached to a winch drum for attaching a shot to be wound on the drum. Also a temporary short line attached to a crane hook, with its own hook on the end, for ease in attachment to a load, or to extend the reach of the crane
- TERMINATION - Fitting attached to the end of a piece of wire rope for convenience in connecting to other mooring components
- TIEDOWN - A fitting permanently set in the deck of a ship to allow convenient fastening in place of equipment
- TRANSPONDER - In this report, an acoustic device, usually built into the anchor release, which emits a pulse when it receives a pulse. Used for range-finding
- TRAWL BLOCK - A large block, designed for heavy loads, and with a large opening
- TRAWL WINCH - A large winch with several thousand meters of wire (typically one-half inch in diameter), usually used for lowering heavy loads

- WIRE JACKET - Plastic covering extruded over wire rope for corrosion and chafe protection
- WUZZLE - Tangle



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