CHAPTER 3

MARLINESPIKE SEAMANSHIP

Marlinespike Seamanship is the art of handling and working all kinds of fiber and wire rope. It includes every variety of knotting, splicing, serving, and fancy work. Although canvas and leather work are not part of marlinespike seamanship, we will briefly discuss them in this chapter.

You will find marlinespike seamanship easy to learn if you master the basic knots before you try the fancy work.

This chapter is important because you will handle and work with all kinds of line and wire rope aboard ship.

For example, you will use line for tying up during mooring and docking and for rigging aloft or over the side during painting details. You will also use wire rope during replenishment of supplies and for highline transfers. These are only a few of the jobs that require you to use line or wire rope; there are many more. Learning the proper care and methods of handling line and wire rope and practicing these techniques are an essential part of your job as a Seaman.

ROPE

LEARNING OBJECTIVE: Explain the construction, use, care, and other characteristics of wire rope and line.

Rope is manufactured from wire, fiber, and combinations of the two. Fiber rope–or line, as it is commonly called–is fashioned from natural or synthetic fibers. Lines made from a variety of natural fibers (cotton, agave, jute, hemp, sisal, and abaca) have seen service in the Navy in the past, and some are still used. For example, tarred hemp is known as marline and ratline. On the other hand, sisal may still be found as a wire-rope core. Manila (made from the fibers of the abaca plant) formerly was authorized for use only where great strength was required. Now, manila is authorized for lashings, frapping lines, and steadying lines. However, synthetic lines have replaced manila in most applications.

Rope, a general term, can be applied to both fiber rope and wire rope. In the Navy, sailors refer to fiber rope as *line*, whereas they refer to wire rope as *rope, wire rope,* or just *wire.* More clearly defined, a *line* is a piece of rope, either fiber or synthetic, that is in use or has been cut for a specific purpose, such as a lifeline, heaving line, or leadline.

This chapter discusses the fundamental uses and care of rope of all kinds. Knots and splicing may be difficult to understand, so do not hesitate to ask for help from a more experienced hand.

CONSTRUCTION OF LINE

Line currently used in the Navy may be three-strand line, braided, or plaited. In three-strand line, fibers are twisted into yarns or threads, the yarns are twisted in the opposite direction into strands, and the strands are twisted in the first direction, making line. Taking the process further, lines are twisted into cable. Line can have various numbers of strands, and the direction the strands are twisted determines the lay of the line. That is, if the strands are twisted to the right, the line is said to be right-laid.

Four-strand line is right-laid strands around a center core. Each strand is aramid fibers laid into parallel yarns left laid helically around the strand core with a braided helical of alternating aramid and polyester yarns.

Braided lines have certain advantages over twisted ropes. They will not kink nor will they flex open to admit dirt or abrasives. The construction of some braids, however, makes it impossible to inspect the inner yarns for damage. The more common braided lines are hollow braided, stuffer braided, solid braided, and double braided lines.

Hollow braided lines usually have an even number of parallel, tapelike groups of small yarns braided into a hollow, tubelike cord. This type of construction in cotton formerly was used for signal halyards–a purpose now served largely by three-strand and double braided nylon. Other uses are parachute shroud lines and shot lines for line-throwing guns.

Stuffer braided lines are manufactured in a similar manner except that the braid is formed around a highly twisted yarn core, which rounds out and hardens the

line. This type of construction in cotton is used for sash cord (heaving lines).

Solid-braided lines are fashioned in various ways. One familiar construction is that used for leadlines, taffrail log lines, and the like. This braid is of large yarns, either single or plied, tightly braided to form a hard, relatively stiff line that will not kink, snag, or swell in water.

Single braided line consists of 12 strands in a twill pattern, where one strand of one direction of rotation about the axis of rope passes over two strands of the opposite direction and then passes under the next two strands of the opposite direction. Single braided line is used for mooring lines and towing hawsers.

Double braided line is, essentially, two hollow braided lines, one inside the other. The core is made of large, single yarns in a slack braid. The cover is also made of large, single yarns but in a tight braid that compresses and holds the core. Double braided line is manufactured only from synthetics, and about 50 percent of the strength is in the core. It is used for mooring lines, towing hawsers, signal halyards, dressing lines, and many other purposes.

Plaited line is made of eight strands–four right-twisted and four left-twisted. The strands are paired and worked like a four-strand braid. Consequently, there are two pairs of right-hand strands and two pairs of left-hand strands formed into a line that is more or less square. Plaited line is used for towing hawsers, ship mooring lines, messengers, and other applications.

USE AND CARE OF LINE

Manila line is not used as it once was. The replacement lines for the personnel highline, the inhaul and outhaul lines, the light freight transfer line, and the replenishment-at-sea messenger are made of spun polyester. Other synthetics have taken over other uses with some exceptions where manila will be retained.

Manila lines of 4 inches or more should be reserved for fueling-at-sea riding lines.

Following are some pointers on the use and care of fiber line for you to remember:

- Coil right-laid line right-handed or clockwise. Flake down braided and plaited line.

- Keep line from touching stays, guys, or other standing rigging.

- When surging line around bitts, take off enough turns so the line does not jerk but surges smoothly.

- If line becomes chafed or damaged, cut and splice. A good splice is safer than a damaged section. However, do not cut a line without your supervisor's permission.

- Do not lubricate the line.

- Whip all line ends.

- Inspect natural fiber line frequently for deterioration. Open the lay and inspect the fibers. White, powdery residue indicates internal wear.

- Dragging a line over sharp or rough objects cuts or breaks the outer fibers. When line is dragged on the ground, other particles are picked up and eventually work into the line, cutting the inner strands.

- Natural fiber line exposed to the atmosphere deteriorates about 30 percent in 2 years from weathering alone. Natural fiber line received from supply that is 3 years old should be returned to supply noting uneconomical to use.

WARNING

If a natural fiber line is more than 5 years old (either used or unused), you must not use it for critical operations or those involving the lives of personnel. You can use these lines only for lashing, fenders, and matting.

- Line loaded in excess of 40 percent of its breaking strength can be permanently damaged. Inspection of the inside yarns reveals whether they are broken. Synthetic line that has been overstressed will have inside yarns fused together.

SMALL STUFF

LEARNING OBJECTIVE: Identify small stuff line.

Line 1 1/2 inches or less in circumference is called small stuff. Its size specification is governed by the number of yarns it contains (called threads in this instance).

Line larger than 1 1/2 inches in circumference is always designated in size by its circumference in inches. In general, any line larger than 5 inches that is used in towing, mooring, and similar operations is

called a hawser. Remember, it is the size around (the circumference) the line that is measured, not the diameter.

SIZE OF SMALL STUFF

To find the size of a piece of small stuff, open a strand, count the number of threads it has, and multiply this result by 3 for three-strand stuff. The largest small stuff is 24-thread, with three strands each containing eight yarns.

USE OF SMALL STUFF

Certain small stuff used for special purposes is designated by name, with no reference to size. Marline is the most common stuff of this type seen aboard ship. Dark brown in color, it is two-strand, left-laid tarred hemp. It is inexpensive, fairly strong, and protected against the weather by its tarring.

Housing line is three-strand, left-laid tarred hemp. It is used for light seizings, serving pennants, riggings, and outside work exposed to weather.

Round line is three-strand, right-laid tarred hemp. It is used for seizings and servings on ships where neatness is required.

Sail twine is small stuff laid up right-handed by machine, like regular line, but it is not much larger than fishing line. It is used for servings when a fancier job than can be done with marline is desired.

Cod line is the light, white line formerly used in hammock clews (lines for suspending a hammock). It now is used for decorative purposes.

Rope yarns for temporary seizings, whippings, and lashings are pulled from large strands of old line that has outlived its usefulness. Pull your yarn from the middle, away from the ends, or it may get fouled. Keep an old strand about a fathom long hanging in the boatswain's locker for this purpose.

Small coils of line may be loaded into a cargo net and hoisted aboard. Large hawsers may be hoisted in a sling placed around the ends of a piece of pipe or a crowbar shoved through the center tunnel of the coil. The large hawsers may also be rolled forward along the deck, hoop fashion, and jiggered into place by the same rig.

STOWING SMALL STUFF

Coils of natural fiber line should always be stowed on shelves or platforms clear of the deck. They should never be allowed to become covered with an accumulation of junk that may prevent the evaporation of moisture. Always remember that line composed of natural fiber is susceptible to mildew and rotting.

Arrange the coils of small stuff along a shelf according to its size. Set each coil up with the inside end at the bottom of the center tunnel so it come open properly. The burlap wrapper should be left on each coil. You will find that the stoppers for securing the coil are inside the wrapper. Cut these stoppers and draw up the inside end so the line is started properly. It is a common custom–and a good idea–to set up a narrow, flat strip of wood horizontally over the shelf containing the small stuff, with a hole bored in the strip over each coil. The starting end of the line is drawn up through the hole, and is prevented from dropping back by an overhand knot. This method ensures that anyone coming down for a piece of small stuff need not grope around inside the tunnel for the end, with the possibility of getting hold of the wrong end when the coil is pretty well depleted.

The most commonly used sizes of small stuff should be put on reels; then you will not have to worry about somebody fouling up a partially used coil.

Once the stoppers of the coil are cut, bights of tightly wound coils of marline have a tendency to work off the ends of a coil and become hopelessly snarled. To prevent snarling, transfer the marline to a reel. Take a short length of pipe or a squeegee handle, and shove it through the center of the coil. Block it up so the coil is free to turn. In this case, take the outside end of the marline, secure it to the reel, and start laying it up. You will need help with this job because the coils must be tended carefully to prevent bights from slipping off the ends of the coil.

Coils of large line should be stowed with their proper side up for opening. Line from 2 to 4 inches or so, which is needed in various lengths on deck, should be opened and a few feet of the end led out.

When a new coil of line is to be opened, give it your personal attention. Five minutes of your time here may save hours later trying to work kinks out of an improperly opened coil.

Whenever possible, wet line should be dried thoroughly before stowing. Sometimes drying is impossible, as with mooring lines that must be sent

below before the ship gets outside in heavy weather. If line must be stowed wet, it should be laid up on gratings in long fakes so that it may dry as quickly as possible. It should never be covered over.

SYNTHETIC FIBER LINES

LEARNING OBJECTIVES: Describe the general usage and care of synthetic line. List safety precautions for handling synthetic line.

Aramid, nylon, polyester, polypropylene, and polyethylene, in the descending order of strength are the synthetic fibers used to make line.

Synthetic fiber line has several advantages over manila. Size for size, it is 1.7 to nearly 6 times as strong and lasts 5 times as long. On a strength for strength basis, a synthetic fiber line of less than half the size of a manila line is required for the same task. For these reasons, synthetic fiber is cheaper in the long run, even if its initial price is more. Because synthetic fiber does not rot or age as does natural fiber line, its strength is more stable throughout its life. It is less bulky, more flexible and, therefore, easier to handle and requires less stowage space. Other advantages, and a few disadvantages, are pointed out later in this discussion.

NAVSEA has also approved a new synthetic fiber, aramid fiber line (Kevlar), for use aboard ship as mooring and tending lines. aramid rope is lighter, easier to handle, and smaller than nylon or polyester of equivalent strength. It also requires less hawser reel storage space. However, since it stretches only 6 percent at minimum breaking strength, tattle-tale cords cannot be used to determine the strain on their line, and the line will respond differently compared to other synthetic lines, which stretch 30 to 65 percent at minimum breaking strength. Also, this aramid line does not fuse and smoke when surged around the bitts. The line surges smoothly around bitts compared to other synthetic mooring lines. Aramid line safety precautions that should be observed will be discussed later.

A coil of synthetic fiber line, unlike natural fiber line, is not opened by pulling the end up through the eye of the coil. It should be unreeled in the same manner as wire rope. (See the section on Wire Rope in this chapter.) Normally, plain-laid nylon line is right-handed and should be coiled on capstans and reels in a clockwise direction. Cable-laid nylon or synthetic line is left-laid and should be coiled on capstans or reels in a counterclockwise direction.

Because of the characteristics of synthetic line, safety precautions more explicit than those for manila line must be observed. A complete list of precautions is located in chapter 613 of the *Naval Ships' Technical Manual* (NSTM), but some of the more important safety precautions to be observed are listed below:

1. Because of the lower coefficient of friction of synthetic fiber line, exercise extreme care when a line is being payed out or eased from securing devices (bitts, cleats). For control in easing out, take two round turns and no more than two figure-eight bends. Any more than this will present danger to personnel and difficulty in handling the line. All lines on capstans and gypsy heads shall be payed out using power and never by surging. Figure 3-1 shows the method of securing a mooring line to the bitts.

2. Since a snap-back action inevitably occurs when a line parts under tension, never allow personnel to stand in the direct line of pull of the line when it is being pulled or when it is under tension. A synthetic line parting under tension will snap back at near the speed of sound, and reaction time to clear the area will not be available. Where possible, position line handlers 90° from the direction of the tension force (fig. 3-2).

3. Synthetic line has higher breaking strengths than equal sizes of manila line. Failures of blocks, pad eyes, shackles, and line couplings can be caused by improper substitutions. For this reason, personnel should determine the identification and capacity of all gear and fittings used with synthetic fiber line to ensure that their strength exceeds the minimum breaking strength of the line.

4. Synthetic line has poor knot-holding characteristics. Some knots that offer good characteristics for securing manila line, such as the square knot, are not adequate for belaying or securing synthetic line. The bowline is one knot known to offer reasonable security when bending together or securing synthetic line.

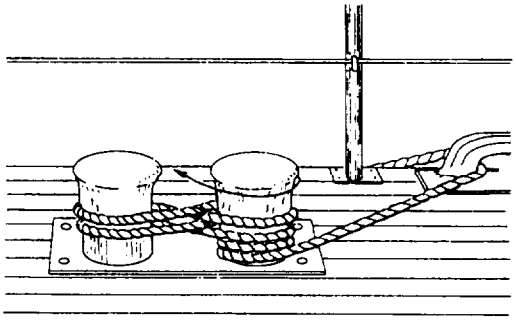

Figure 3-1.–Securing lines to bitts.

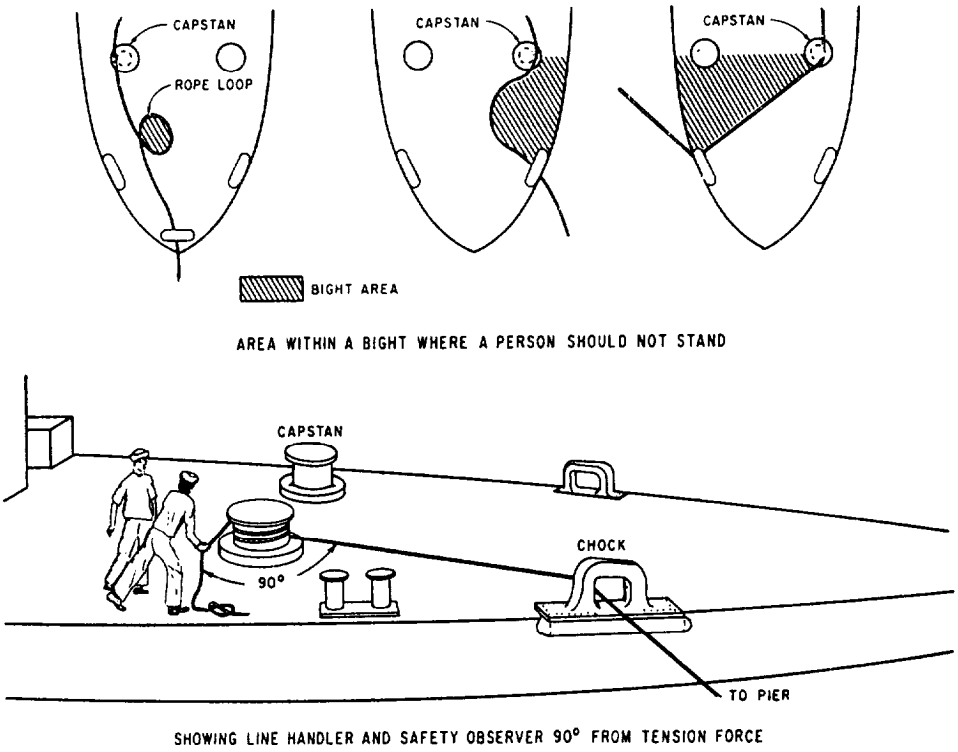

Figure 3-2.–Safe work areas.

5. Do not mix lines of different materials or constructions. This is an unsafe practice because unequal stretch results in unequal loading.

6. Shiphandlers and linehandlers should be made aware the new aramid line is a low-stretch line and that it does not neck down appreciably when put under a strain. The strain should be carefully controlled to avoid excessive tension. This is best accomplished by having linehandlers check the line frequently until they have the feel of it.

7. As with all other lines, it is recommended you use chafing gear where aramid lines pass through chocks. If the cover of any strand of the aramid line is abraded to the extent that the inner fibers are visible but not damaged, the strand or entire line may be served with marline or synthetic cord. If the inner fibers are damaged, you must cut out that section of the line and re-splice it.

The three following safety rules for line-handling must be heeded regardless of the line fiber material:

1. Never stand in the bight of a line or in the direct line of pull when the line is being pulled or under tension. See figure 3-2 for an example of bight areas.

2. Never continue to increase the load on a line after the rigs have been two-blocked or tightened. Many injuries and fatalities have occurred when operators have not observed this rule.

3. Remember: A safety observer is a must in every case where lines are being worked.

Before using new three-strand synthetic fiber line, it should be faked down on deck and allowed to relax for 24 hours. The shorter the line, the less time the relaxing process takes; for example, a length of less than 50 feet will relax in 1 hour.

When wet, synthetic line shrinks slightly but does not swell or stiffen. When the line is tensioned, the water squeezes out; and under working loads, it appears as vapor. Because line under tension develops friction and, thus, heat, the water has a beneficial cooling effect.

Nylon differs from natural fiber line in that it stretches under load, yet recovers to its normal size when tension is removed. With plain-laid and cable-laid nylon, a stretch of one-third of its length is normal under safe working loads. A stretch of 40-percent of its length is the critical point, and it parts at 50-percent stretch. With double braided nylon, the critical point is reached when the line is stretched 27 percent; it parts when the stretch is 30 percent. This elongation at times may be a disadvantage, but it can be reduced by doubling up the lines by passing bight. Nylon line can stand repeated stretching with no serious effect.

Sharp, cracking noises, caused by readjustment of the strands, are heard when applying a load to new cable-laid hawsers. Nylon line that has been under

heavy strain may develop glazed areas where it has worked against bitt and chock surfaces. This condition may be caused by paint or the fusing of the fibers. In either condition, the effect on the line's strength is negligible.

New cable-laid nylon hawsers tend to be stiff and difficult to handle. To alleviate this condition, put the cables under tension for 20 minutes at 30 percent extension; for example, 100 feet when under tension would measure 130 feet.

Nylon line can hold a load even though a considerable number of the yarns become abraded. Where such a condition is excessive but localized, the chafed section may be cut away and the ends spliced together for satisfactory reuse.

When nylon lines become iced over in use, they should be thawed carefully at moderate temperatures and drained before stowing.

If a nylon line becomes slippery from contact with oil or grease, it should be scrubbed down. Spots may be removed by cleaning with light oils such as kerosene or diesel oil.

Do not stow nylon line in strong sunlight. Cover it with paulins. In stowage, keep it away from heat and strong chemicals.

Synthetic lines under stress are far more dangerous than natural fiber lines. Remember synthetic line, unlike natural fiber line, will not give you an audible warning that it is under great strain and is in danger of parting. You must rely on visual cues; the line begins to smoke because of the heat generated by stretching, the line diameter will get smaller and smaller as stretching continues, and finally the tattletale cord will lay taut against the line. A *tattletale cord* is a bight of six-thread manila hanging from two measured points on the working line. When tensioned to its safe working load (SWL), the line will stretch to a certain percentage of its length. When this point is reached, the six thread becomes taut, warning that there is danger of exceeding the line's SWL. Table 3-1 shows the dimensions for tattletale lines.

NATURAL FIBER LINES

LEARNING OBJECTIVES: Describe natural fiber lines. Describe the characteristics of natural fiber lines.

When you have a new coil of natural fiber line to open, remember that if you open it backwards, or from the wrong end, you will have a kink for every turn in the coil. Every kink must be unwound by walking it out the entire length of the line. When you start to walk out a kink from the middle, you turn into the next kink and the next, until the line is one large tangle.

The end of a new coil to be drawn out first is marked with a tag. Occasionally, it is tagged on the wrong end. The only way you can be sure that you are opening a coil properly is to know how to do it. The inside of every new coil is in the form of a round tunnel. At one end of the tunnel is the inside end of the line. This inside end always comes out first, usually from the bottom of the tunnel up through the tunnel. Reach through the tunnel until you find the end, and determine on which end to set the coil so the line will uncoil in a counterclockwise direction. Reach in, draw the end up through the tunnel, and the entire coil will run off without a kink. The important point to bear in mind is that when you pull on the inside end, the line must uncoil in a counterclockwise direction.

STRENGTHS

Until the development of synthetics, manila was the strongest line. It also was the most expensive. It was natural to compare other ropes with manila, and it still is convenient to do so. The following table gives the comparative strengths of the various lines using manila as a base strength of 1. (All synthetics are stronger than manila.)

Rope Type	Strength Rating
Aramid (four-strand)	5.6
Nylon (three-strand)	2.9
Polyester (three strand)	2.4
Polypropylene	1.7

MEASURING

When you are sent to the Bos'n locker for 5 fathoms of line, you need not measure off exactly 360 inches with a tape measure. Your two arms, spread as wide apart as possible, will equal approximately 1 fathom (6 feet). With the end of the line in one hand, spread your arms, grab the line where your other hand reaches, and change hands until you have spread your arms five times.

In measuring a long line, such as a boat fall, it is much easier and faster to measure a long stretch on deck and fake your line back and forth until the desired length is laid out.

Table 3-1.–Dimensions for Tattletale Lines

Type of Synthetic Rope	Length of Tattletale (inches)	Distance Between Marks (inches)
Nylon three-strand	35 1/2	30
Nylon plaited	43 1/2	40
Nylon double-braided	43 1/2	40
Polyester three-strand	63 1/2	60
Polyester plaited	62 1/2	60
Polyester double-braided	62	60

MAKING UP A LINE

LEARNING OBJECTIVE: Identify the proper procedures for making up a line.

Once line is removed from the manufacturer's coil, it may be made up either by winding on a reel or by coiling down, faking down, or flemishing.

Coiling down a line means laying it up in circles, roughly one on top of the other. Always coil right-laid line right-handed, or clockwise. Figure 3-3 shows you how to coil a right-laid line. When a line is coiled, one end is ready to run off. This end went down last and now it is on top.) If you try to walk away with the bottom end, a foul-up results. If, for some reason, the bottom end must go out first, you must upset your entire coil to free it for running.

Faking down a line (fig. 3-4) is laying it out in long, flat bights, one alongside the other, instead of in round coils. The main advantage of working with line that is faked is that it runs off more easily.

Flemishing a line is starting with the bitter end and laying successive circles on the deck of line in the manner of a clock spring with the bitter end in the center

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Figure 3-3.–Coiling down a line.

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Figure 3-4.–Faking down a line.

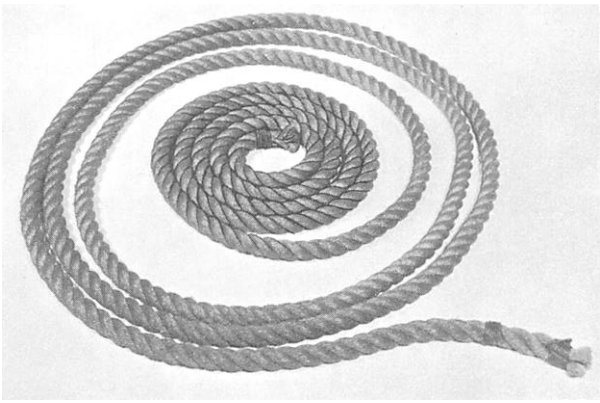

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Figure 3-5.–Partially flemished line.

(fig. 3-5). Right-laid line is laid down clockwise; left-laid line, counterclockwise.

SECURING ENDS

LEARNING OBJECTIVE: Explain the procedures for securing ends of lines. Identify the difference between a temporary whipping and a permanent whipping of a line.

Never leave the end of a line dangling loose without a whipping to prevent it from unlaying. The end of line will begin to unlay of its own accord. To prevent fraying, you should put a temporary plain whipping on with anything, even a rope yarn, as shown in figure 3-6. Lay the end of the whipping along the line and bind it down with a couple of turns. Then lay the other end on the opposite way, bind it with a couple of turns from the bight of the whipping, and pull your end tight.

A permanent whipping is put on with a palm and needle (see the section on Seaman's Tools in this chapter). Thread a needle with sail twine, double it (figure 3-7 shows single twine for clearness only), and shove it through the middle of a strand so it comes out between two strands on the other side. Bind the end down with six or eight turns wound on from inboard toward the end, and again shove the needle through the middle of a strand near the end so it comes out between two strands again. Then go up and down between strands so as to place a cross-seizing between each pair, as in figure 3-7.

Pull each cross-seizing taut before taking the next one, and have the needle come out through the middle of a strand on the last shove through, so the strand will hold the end after you cut the sail. Remember, you must wind the turns of whipping from the line toward the end; otherwise, the needle will come out at the wrong side of the whipping after you make the final cross-seizing. When you cut a line, it is best to put on the whipping before cutting the line. Ends of small stuff can be laid up with a palm and needle whipping.

Several pieces of ropework start from a crown knot, so now is the best time for you to learn to tie a crown. Figure 3-8 diagrams the steps in making one. After you haul down the crown taut by heaving on each of the

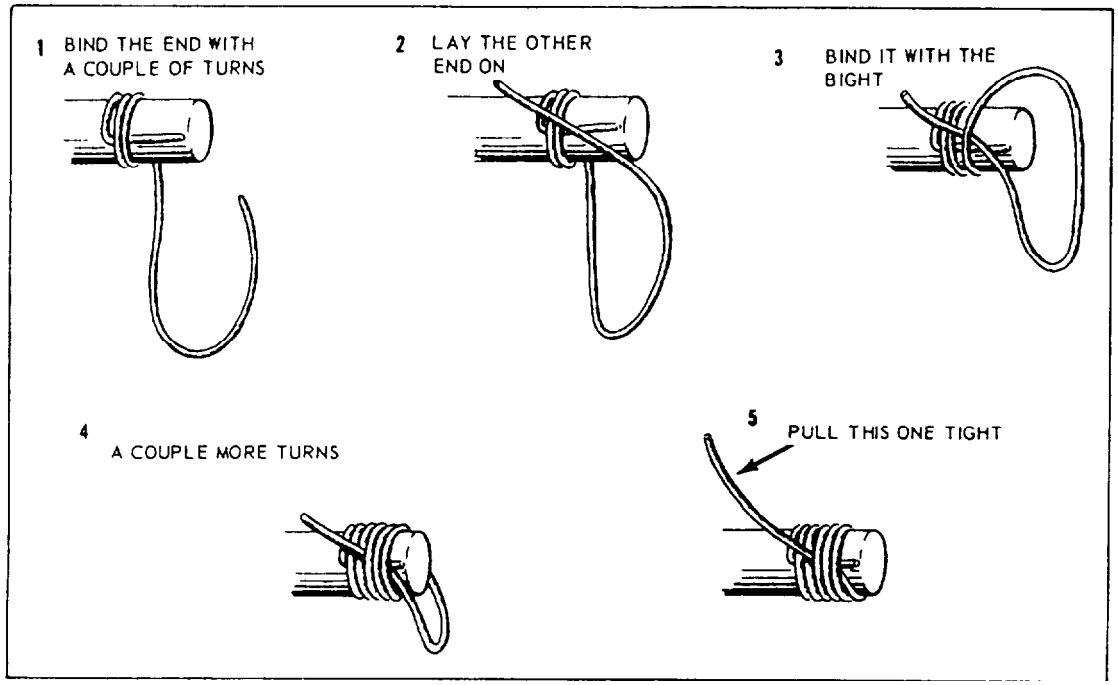

Figure 3-6.–Plain whipping a line.

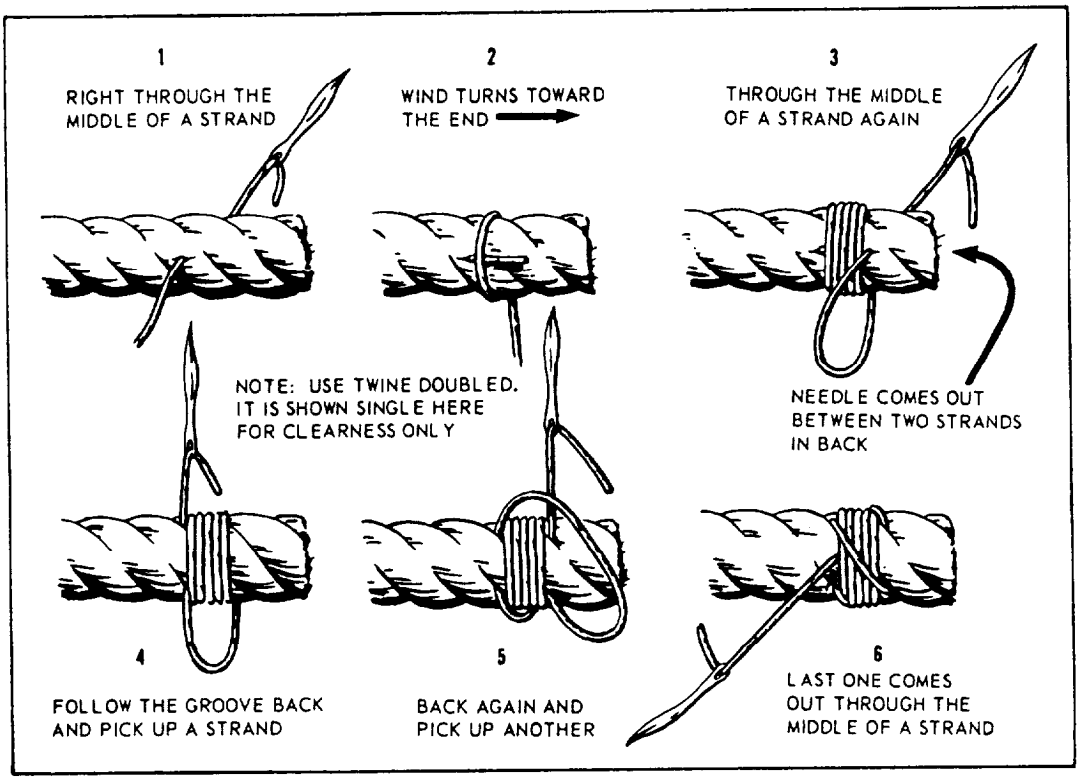

Figure 3-7.–Palm and needle whipping.

three strands, lay up your backsplice by merely tucking each strand back up the line, over and under, as described later for the eye splice. Throw a whipping on any line you see dangling loose, and make up any slack ends of lines not made up properly or hanging adrift. Always take care of the end.

FAIRLEADS, KINKS, AND TWISTS

LEARNING OBJECTIVE: Determine the proper method for rigging fairlead blocks.

If a line does not lead fairly to a winch or capstan, it becomes badly distorted when it is heaved in.

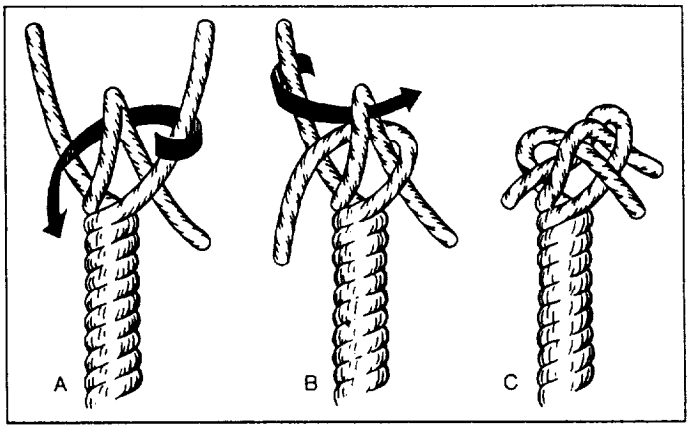

Figure 3-8.–Steps in making a crown.

Frequently, it is necessary to put on inside turns (fig. 3-9) when a fairlead does not line up properly with a winch drum. You must put on turns by pulling back slack and winding your turns on backwards (as shown), from inboard to outboard on the winch drum because you cannot get hold of the end.

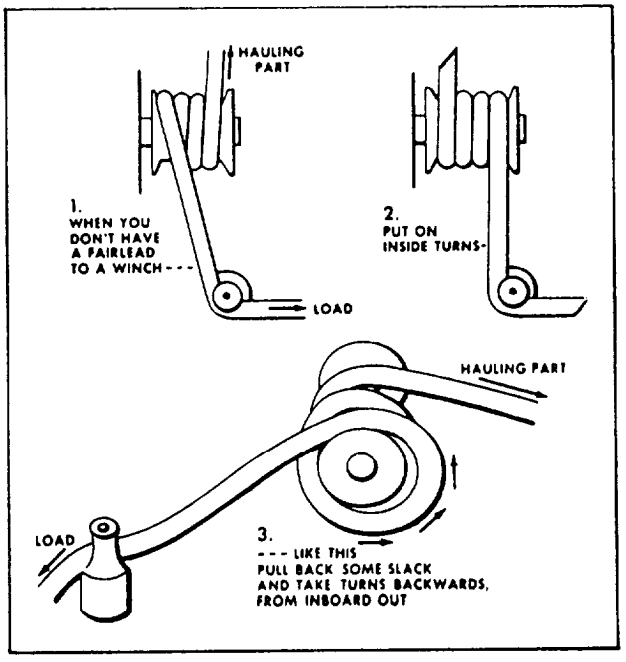

Figure 3-9.–Putting on inside turns to get a fairlead.

Whenever possible, a right-laid line should be put on a winch drum or capstan right-handed, or in clockwise turns. Heaving on a right-laid line with left-handed turns eventually creates kinks in the line.

A line with a kink in it, or a tackle that is twisted from having a dip in it, should never be heaved hard while that condition exists. A strong strain on a kinked or twisted line puts a permanent distortion in the line.

Figure 3-10 shows what frequently happens when a line with a kink in it is heaved hard. Now the original kink has been forced into each strand. It is impossible to work out the kink; hence, the line is ruined.

Deterioration of natural fiber line through age or exposure is indicated by the gradual change in its color from a yellowish white to a gray.

Deterioration from use or abuse is shown by the bristling of the ends of broken yarns. An overstrained line also shows a decrease in diameter. An individual should never be sent aloft or over the side on such a line.

If the identification marker tape indicates the natural fiber rope is 5 years old, it should not be used for critical operations or those involving the lives of personnel.

SEAMAN'S TOOLS

LEARNING OBJECTIVE: Recognize and describe the most common tools used by Seamen.

There are many tools used by a deck Seaman. We only discuss a few of them in this chapter. To find out more about the tools used in painting, you should refer to *Boatswain's Mate, Volume 1*, NAVEDTRA 10101. We discuss the Seaman's knife, marlinespikes, and fids first. We address the sail needles and the sail palms in the canvas section of this chapter.

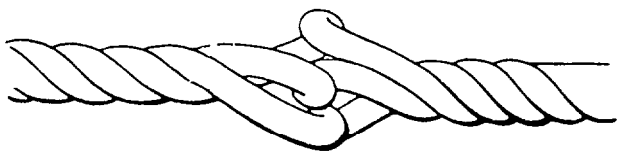

Figure 3-10.–Result of a strong strain on a line with a kink in it.

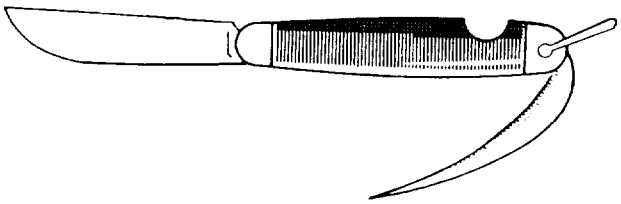

Figure 3-11.–Best type of knife for a Seaman.

Figure 3-11 shows the best type of knife for working with line. This knife is available almost anywhere ashore. Its blade has a straight cutting edge rather than a curved one. The small spike on the knife is convenient for opening shackles, and it is indispensable for drawing up close knots like monkey fists, manrope knots, and Turk's heads.

The wooden fid is a long, tapered tool used for opening strands in line for splicing. Never use it for anything else, and never hammer the butt end of a fid to drive it through. It splits or splinters very easily. To open heavy line, set the butt of the fid on deck and hammer the line onto the point. Never call a fid a marlinespike.

The marlinespike, a tapered steel tool, serves the same purpose with wire that the fid does with line. A good spike should never be used as a crowbar or a pin to open shackles, and care must be taken to avoid bending or blunting its point. Unlike the fid, you can hammer the butt of a marlinespike.

KNOTS

LEARNING OBJECTIVES: Define the types of knots used in a line. Identify the knots used to form a loop or an eye. Explain bending to a hook, ring, or spar.

Learning the proper methods of handling and applying knots and splices, and practicing them, are an essential part of your job as a Seaman apprentice.

Among Seamen the term *knot* must give way to its more specific meanings: *bend* and *hitch.* In addition, Seamen must know which knot, bend, or hitch will serve best in a particular circumstance.

First and foremost, a good knot must hold fast without slipping. Next, if it is a knot in general use and not an ornament, it should be easy to tie. The best knot is one that possesses all these advantages and is easy to untie as well.

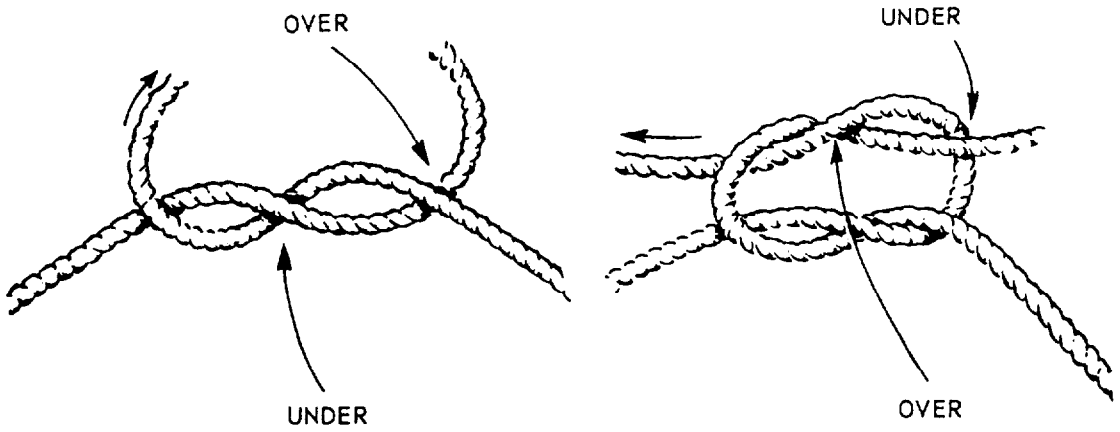

Figure 3-12.–Square knot.

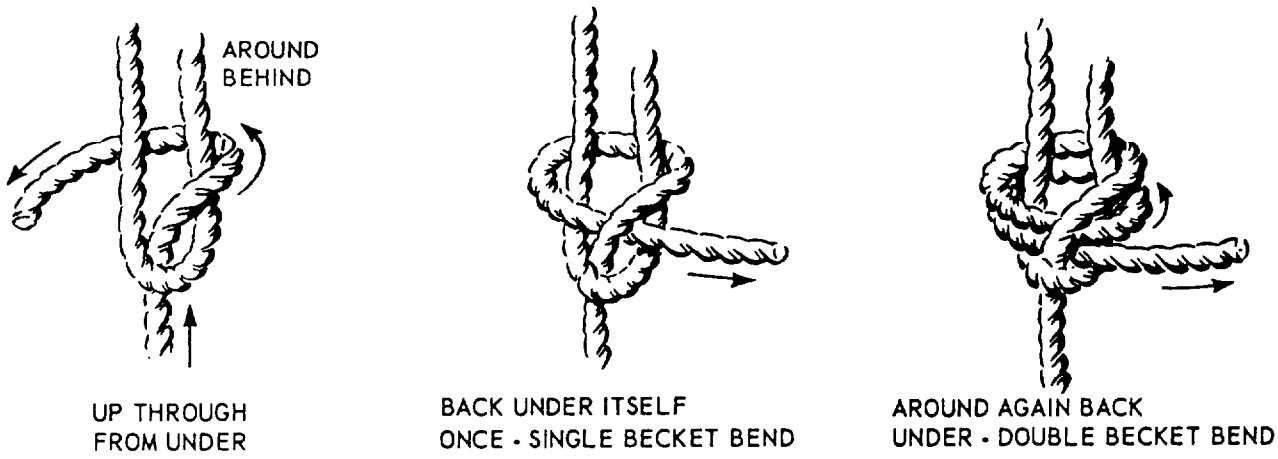

Figure 3-13.–Tying single and double becket bends.

The bowline is a good knot with many uses. It is used whenever a loop is needed, such as in making a temporary eye in a mooring line.

You must know which knot or splice will serve best in different circumstances such as tying up to a mooring or dock, rigging aloft or over the side during painting, and highline transfer during replenishment.

In the small group of knots described in this section, you will find every knot you will need around the decks, together with an idea of the uses to which each may be put. You should make every effort to learn them.

According to a Seaman's use of the term knot, the line usually is bent to itself. The knot forms an eye or knob or secures a cord or line around an object, such as a package.

A bend ordinarily is used to join two lines together. The square knot, also called the reef knot, is the best known knot for bending two lines together. However, it can jam on a strain and become very difficult to untie.

For a square knot, both parts of the line must be under the same bight. If one part is up and the other part is down, you have a granny knot, which is of no use to any seaman. Figure 3-12 shows how to get a square knot every time.

Here is the proper procedure for tying a square knot: Take the end in your right hand, say to yourself, “over-under,” and pass it over and under the part in your left hand, as shown. With your right hand take the end that was in your left, say to yourself this time, “under-over,” and pass it under and over the part in your left hand.

A becket bend, is especially good for bending together two lines of different sizes. Figure 3-13 details

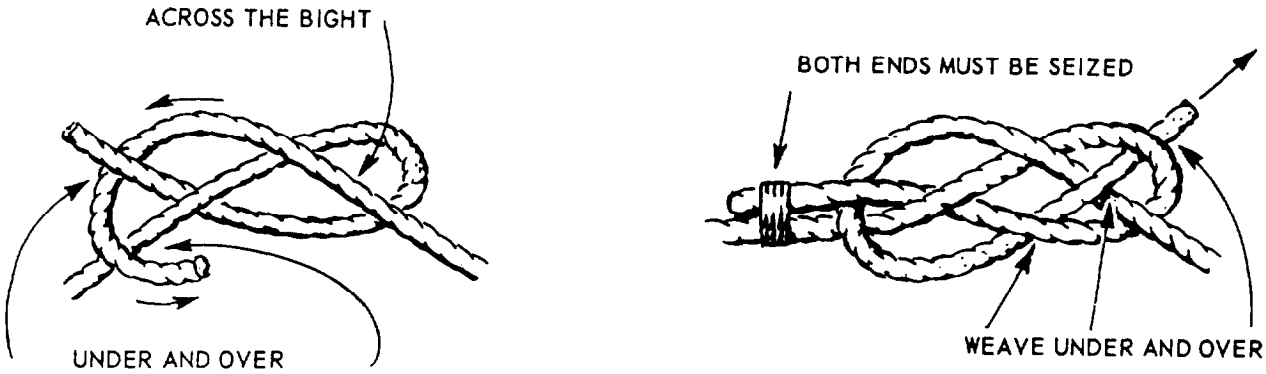

Figure 3-14.–Tying a carrick bend.

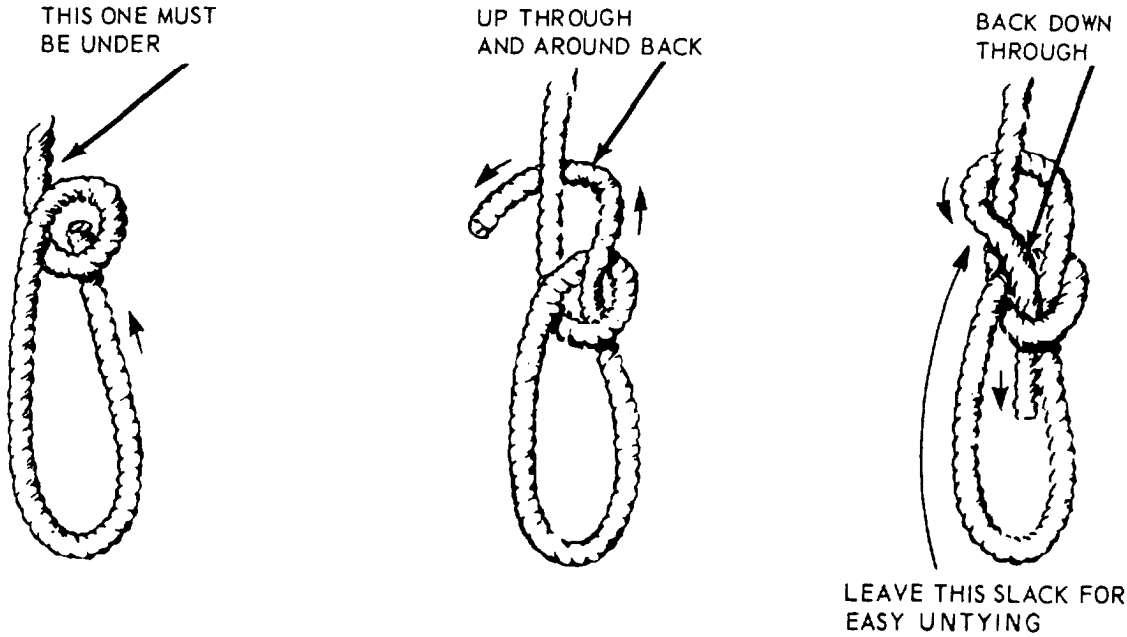

Figure 3-15.–Tying a bowline.

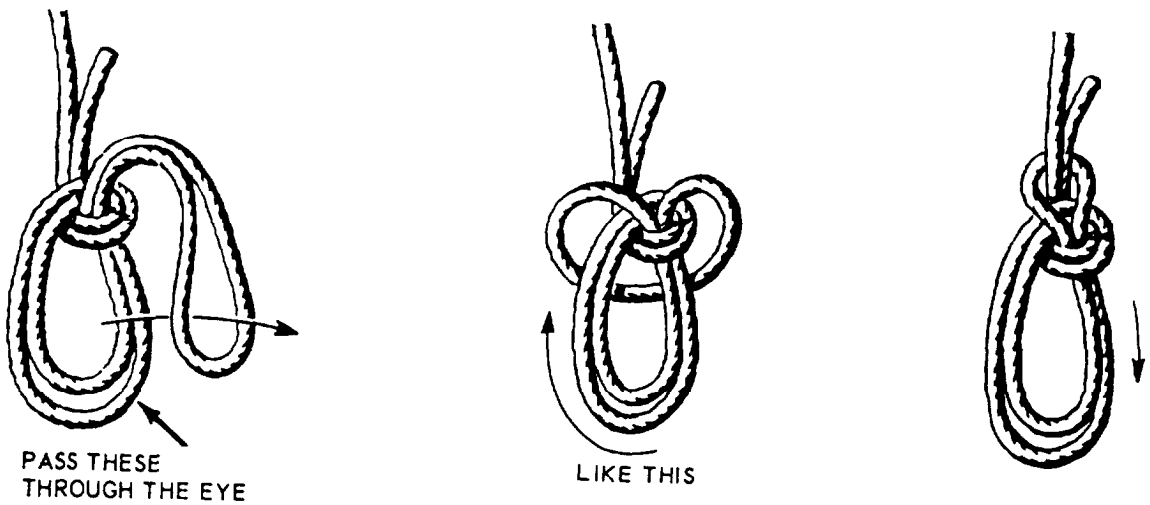

Figure 3-16.–Bowline on a bight.

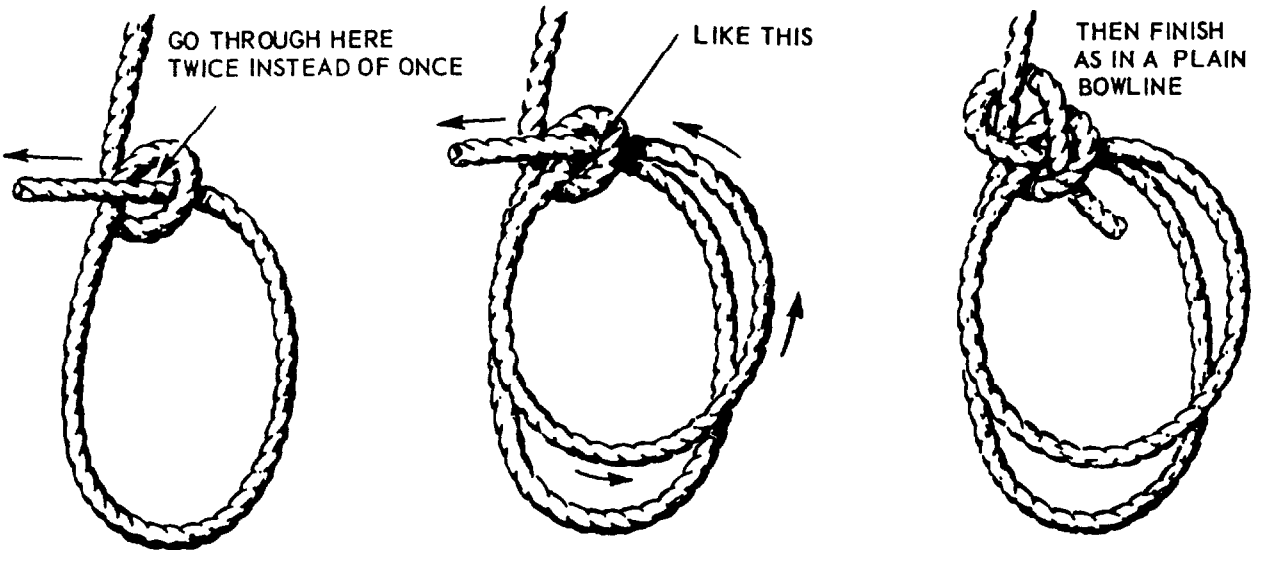

Figure 3-17.–Tying a French bowline.

the steps in tying a single and a double becket bend. A double becket bend is always used to bend the gantline (riding up and down line) onto a boatswain's chair.

The carrick bend (fig. 3-14) is an easy knot formed by two overhand loops crossing each other. It provides a very secure means of fastening two hawsers together, and has the advantage that when drawn taut, it assumes a form that can be passed around a barrel or winch. The ends should be seized down on their standing parts for security.

Another method of quickly bending two lines together is the bowline bend. It is formed of two bowlines one crossing the loop of the other.

KNOTS TO FORM A LOOP OR EYE

The bowline (fig. 3-15) is the standby for putting a loop in the end of a line. It neither slips nor jams, yet unties easily. A bowline is the best knot to use for bending a heaving line or messenger to the eye of a hawser because it is quick to tie and easy to get off.

A bowline on a bight gives two loops instead of one, neither of which slips. It is used to hoist a person, chair-seat fashion, out of a lifeboat or hold. Figure 3-16 shows you how to tie a bowline on a bight. As you can see, you start with your line doubled.

A French bowline has the same purpose as a bowline on a bight. It gives you two loops that can be adjusted to fit. Adjust one of the loops under both hips, the other under the armpits, and draw the loops tight with the knot at the chest. You can transport an unconscious crew member safely in a properly secured bowline if you take care not to allow the part under the arms to catch on any projections. A step-by-step example of how to make a French bowline is given in figure 3-17.

A running bowline is just regular bowline made around the standing part of its line to form a running noose. Just tie a small bowline around the line's standing part, keeping it slack enough to run freely.

BENDING TO A HOOK, RING, OR SPAR

You can use a hitch to secure a line to a hook, ring or spar. We will describe various hitches in this section.

A hitch differs from a knot in that it ordinarily is tied to a ring, around a spar or stanchion, or around another line. It is not tied back on itself to form an eye or to bend two lines together.

The rolling hitch is one of the most useful and important hitches on deck.

Use it for passing a stopper on a mooring line when shifting the line from a winch or capstan to a cleat or bitts. It may also be used to secure a taut line back on itself. If tied properly, it holds as long as there is a strain on the hitch.

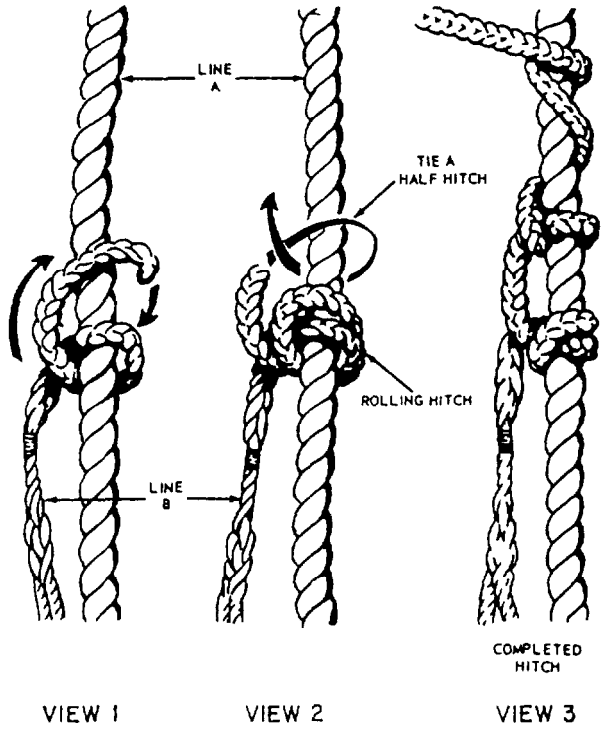

Figure 3-18.–Rolling hitch.

When tying the rolling hitch, take a turn around the line with the stopper as in view 1 of figure 3-18. Pull taut, then take another turn. This turn must cross over the first (view 1) and pass between the first turn and the stopper (view 2). The rolling hitch itself is now complete, but it must be stopped off in one of several ways.

You may take two or more turns with the lay of the line and then marry the stopper to the line by hand or seize the stopper to the line with marline. Another method is to tie a half hitch directly above the rolling hitch (view 3), then take a couple of turns against the lay, and marry or seize the stopper to the line.

A clove hitch is the best all-round knot for bending to a ring, spar, or anything else that is round or nearly round. This is such a fine knot that the old-time seamen used to call a man who was worth his salt "all in a clove hitch." Figure 3-19 shows you how to throw one.

A clove hitch will not jam and seldom pulls out. A slack clove hitch, as on a boat painter, however, might work itself out. For that reason, it is a good idea to put a half hitch in the end as in figure 3-20. A half hitch, by the way, never becomes a whole hitch. Put another one on, and all you have is two half hitches, as shown.

The slight disadvantage a clove hitch might have is that it can slide along a slippery spar when the strain is along the spar. The knot that cannot slide this way is the stopper hitch (fig. 3-21). This knot is especially useful for bending a boat painter to a larger line whose end is unavailable. It jams tight on a hard strain, however.

SPLICES

LEARNING OBJECTIVES: Define line splices. Identify the types of splices.

Splices are used to make permanent eyes and permanent repairs in lines. There are three general types of splices: eye, short, and long. When splicing fiber line, you should take three or four tucks with each strand.

Figure 3-19.–Throwing a clove hitch.

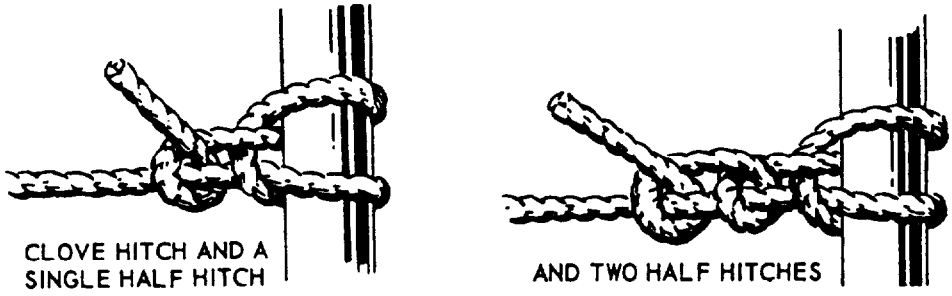

Figure 3-20.–Clove hitch and two half hitches.

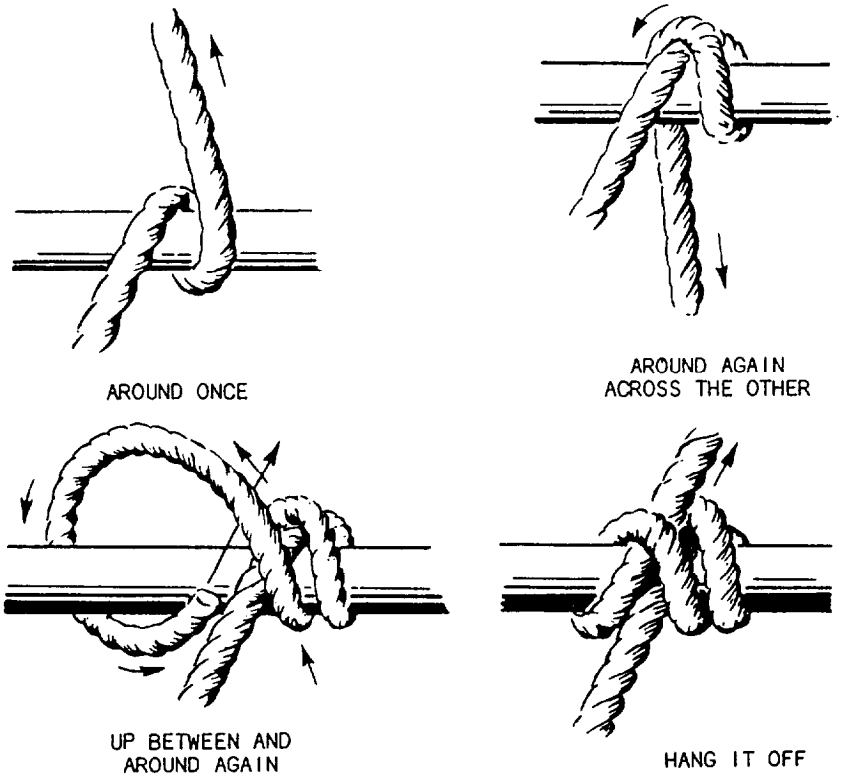

Figure 3-21.–Stopper hitch.

EYE SPLICE

To make an eye splice with manila or synthetic lines, you must untwist the strands in the end of your line anywhere from 4 inches to 2 feet, depending on the size of the line, and splice them into the standing part of the line by tucking the unlaid strands from the end into the standing part.

Learn to estimate the length of line you need to unlay for your complete splice so you will not finish short nor waste a lot of line by cutting it off. An original round of tucks, plus three more complete rounds, are enough for an ordinary eye splice. Four tucks are mandatory in nylon because of its low friction and stretch characteristics.

With large lines you must whip the ends of the strands before you start, otherwise they will unravel and become troublesome. Large lines also must be seized at the point where the unlaying stops or you will have trouble working them. With any line up to about 2 inches, you can open the strands in the standing part with your fingers. The fid must be used for larger lines.

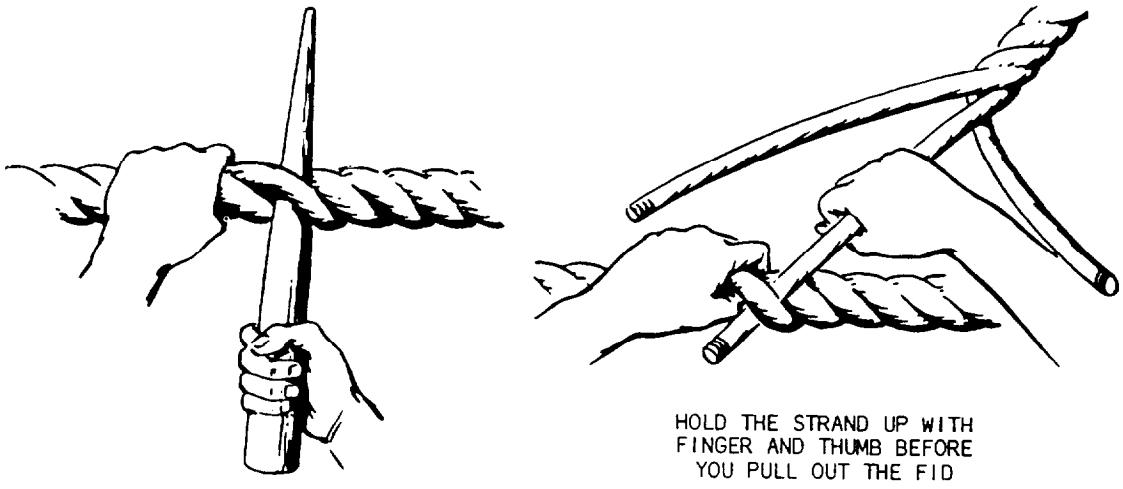

Figure 3-22.–Working the fid.

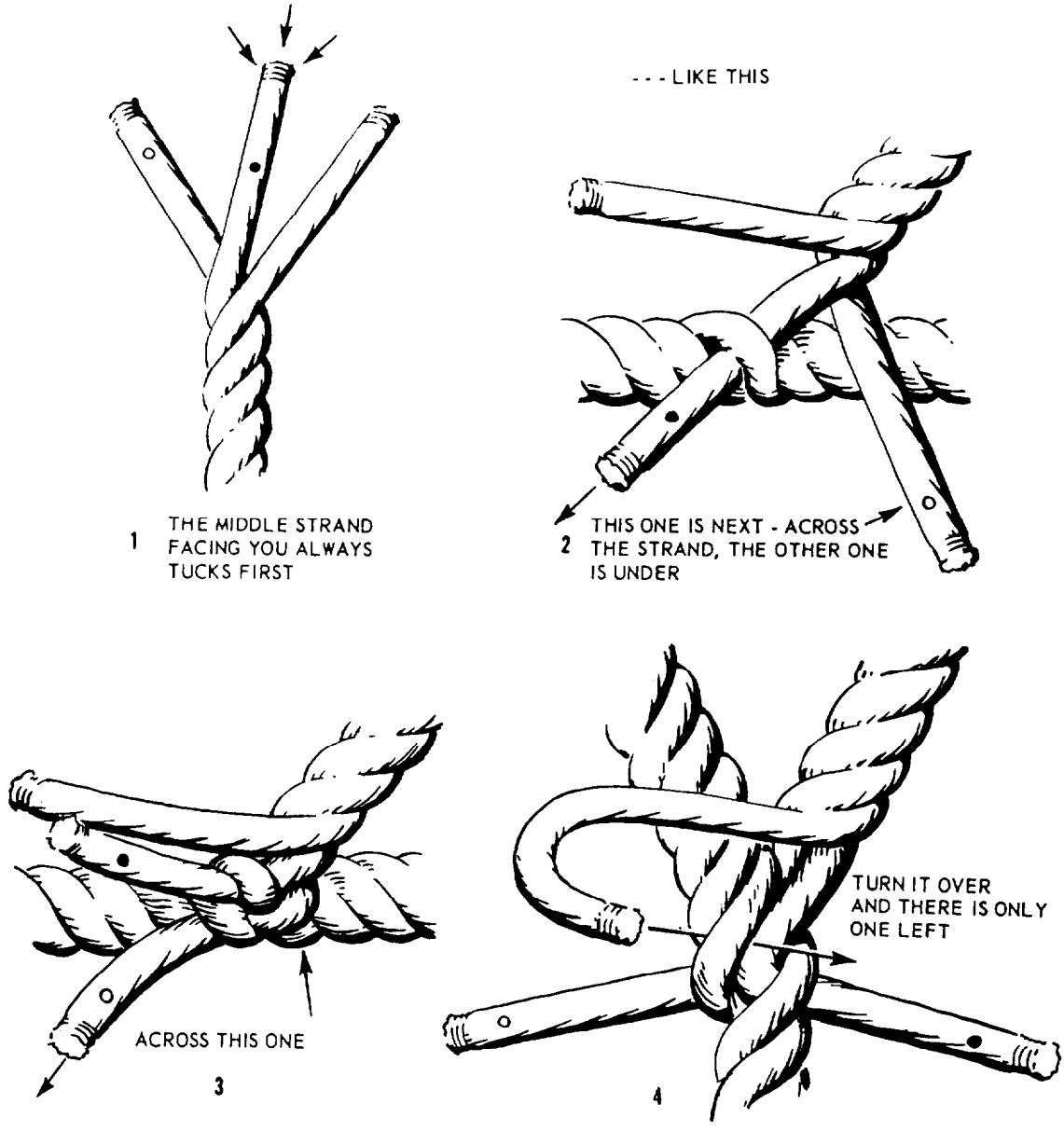

Figure 3-23.–Making an eye splice.

Figure 3-22 shows the knack of working the fid in making an eye splice. Lay out your line along the deck with the end to your right. Bend the line back until the eye is the desired size, and shove the fid through the standing part at the correct spot to raise the top strand. With your right hand shove the fid through, away from you, holding the line with your left hand. Grab the raised strand with your left finger and thumb, and hold it up while you pull out the fid. Lay the fid down, pick up the proper strand in the end, and tuck it through the raised strand from outboard toward you.

Your first round of tucks must be taken in proper order to avoid getting fouled up. Separate the strands in the end and hold them up as indicated in view 1 in figure 3-23. The middle strand (facing you) always tucks first. Be sure to keep the right-hand strand, shown in view 2, on the side of the line that is toward you. Tuck that one next, over the strand you just tucked the other one under, and under the strand just below it, shown in view 3.

Now turn the whole thing over. In view 4, you can see that you now have only one strand from the end left untucked, and only one strand in the standing part that does not already have a strand under it. Do not forget to tuck the last strand from outboard toward you.

The first round of tucks is the key to making perfect eye splices; the rest is easy. Simply tuck each strand from the end over the strand of the standing part that it is now above, and under the next strand below that one, until you tuck each strand twice more besides the original tuck Three tucks to each strand in all is enough for natural fiber rope. Four or five tucks are needed for synthetic fiber, especially the more slippery nylon.

SHORT SPLICE

Lines are short spliced together when a slight enlargement of the diameter of the line is of no importance. Slings are made of pieces of line, with their own ends short spliced together.

The only trick to short splicing is in seizing the ends together (fig. 3-24) so each strand in one end lies along a corresponding strand in the other end. After unlaying the strands, you simply butt the two ends against each other until you see that they are interlaced correctly.

With large lines you now must put on a temporary seizing where they join to keep them from suddenly coming apart. It is better to do that with small lines, too, until you get the hang of holding them together while you tuck.

Once your seizing is on, tuck over and under the same way you finish off an eye splice. Three tucks on each side of the seizing are sufficient.

SAILMAKER'S SPLICE FOR FOUR-STRAND ROPE

An eye splice consists of three main component, the eye, individual strands, and the standing part of the rope. The eyes in mooring lines are normally 6 to 10 feet

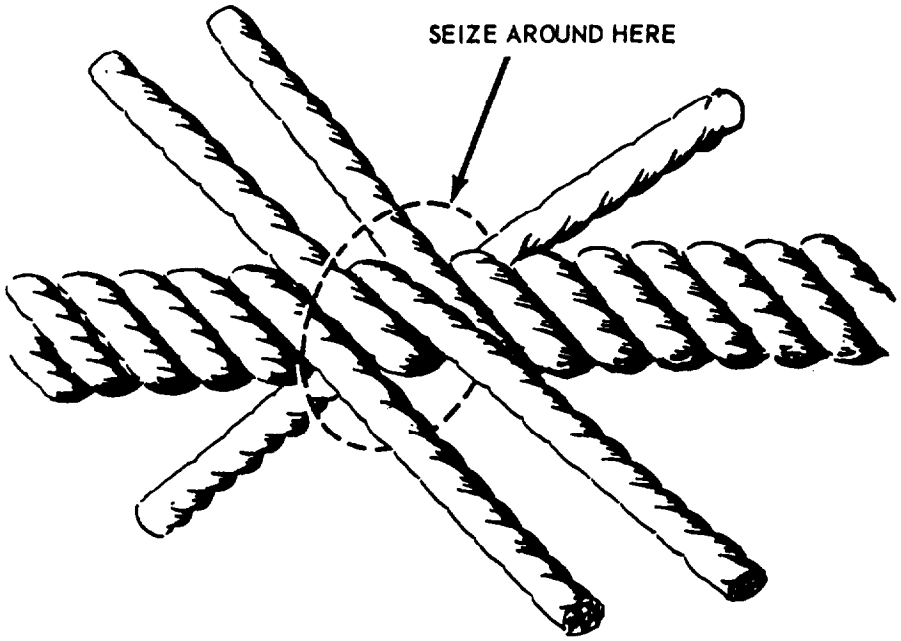

Figure 3-24.–Seizing lines for splicing.

in length, depending on the size fitting used. The rule of thumb for preferred length of the eye is 5 times the diameter of the fitting. This prevent uneven loading of the eye. The following is the procedure for splicing four-strand rope:

1. Measure a distance of seven times the rope circumference from the end of the rope and mark using a temporary whipping. Determine the eye size and form a loop which places the first whipping on the standing part at the end of the eye and mark with a second temporary whipping.

2. Unlay the strands of the rope to the first whipping and cut out the center core. Looking in the direction of the standing part, tuck the first strand under the top strand of the standing part from left to right with the lay at the base of the second whipping.

3. Tuck the second strand under the next strand of the standing part with the lay. Tuck the third strand under the next strand of the standing part with the lay.

4. Turn the rope over and tuck the fourth strand under the last strand of the standing part of the lay.

5. This constitutes one full tuck. Ensure all working strands are pulled tight and free of twists.

6. Continue tucking all four strands in succession over and under the strands of the standing part for a total of six tucks.

7. Using a light strain, set the splice.

8. Marry the working strands using an inside whipping under the strands of the standing part at the last full tuck.

9. Cut the remaining working strands off flush with the rope.

NOTE

The last two tucks may be tapered, if desired, by cutting approximately half of the fibers for each taper. Chafing gear on the eye is required for abrasion.

WIRE ROPE

LEARNING OBJECTIVE: Describe the construction, use, and care of wire rope.

Although wire rope may have only a few applications in some Navy ships, in others, wire rope is very important. It behooves all seamen to learn all they can about wire rope.

CONSTRUCTION OF WIRE ROPE

The basic unit of wire-rope construction is the individual wire made of steel or other metal in various sizes. These wires are laid together to form strands. The number of wires in a strand varies according to the purpose for which the rope is intended. A number of strands are laid together to form the wire rope itself. Wire rope is designated by the number of strands per rope and the number of wires per strand. Thus, a 6 X 19 rope has 6 strands with 19 wires per strand, but has the same outside diameter as a 6 X 37 wire rope, which has 6 strands with 37 wires of much smaller size per strand. Wire rope made up of a large number of small wires is flexible, but the small wires break so easily that the wire rope is not resistant to external abrasion. Wire rope made up of a smaller number of larger wires is more resistant to external abrasion, but is less flexible.

The strands of the wire rope are laid up around a central core, which may be fiber, a single strand of wire, or an independent wire rope. A fiber core contributes flexibility, cushions the strands as the wire rope contracts under strain, and holds a portion of lubricant for continuous lubrication. A wire core is stronger than a fiber core and can be used where conditions such as high temperatures would damage the fiber. Some end views of the arrangements of strands in wire ropes are shown in figure 3-25.

Wire rope may be fabricated by either of two methods. If the strands of wires are shaped to conform to the curvature of the finished rope before their laying up, the wire rope is termed *preformed.* If the strands are not shaped before fabrication, the wire rope is termed *non-preformed.* When cut, preformed wire rope tends not to untwist and is more flexible than other wire rope.

Wire rope is made of annealed steel, traction steel, or improved plow steel. The basic metal may be plain or galvanized. Galvanizing protects the rope from the elements, but makes it stiffer and reduces its strength by as much as 10 percent. Galvanized rope most commonly is used for standing rigging, but also is used for some running rigging (such as wheel ropes) where it is not subject to much wear. Ordinarily, this rope is not used for hoisting jobs because the constant bending and flexing as the rope runs over the sheaves and around drums causes the protective coating to crack and peel off.

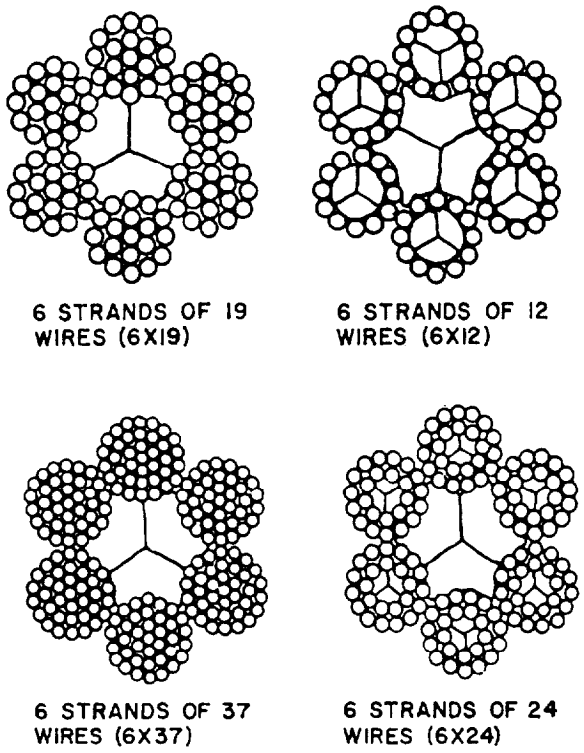

Figure 3-25.–Arrangement of strands in wire rope.

As shown in figure 3-26, wire rope is laid up in various ways:

RIGHT REGULAR LAY: Wires in the strands are twisted to the left; strands in the rope are twisted to the right.

LEFT REGULAR LAY: Wires in the strands are twisted to the right; strands are twisted to the left.

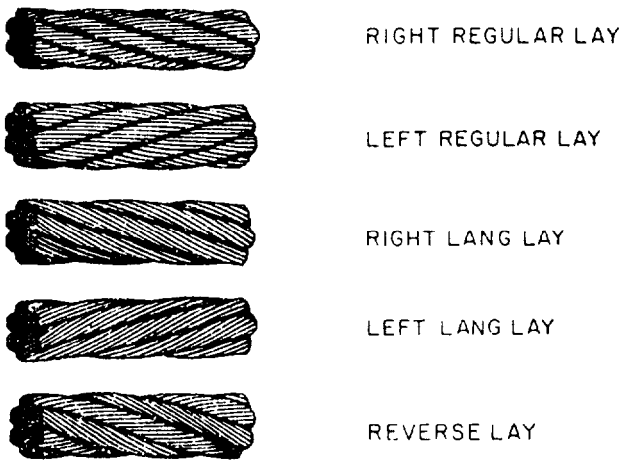

Figure 3-26.–Lays of wire rope.

RIGHT LANG LAY: Both wires in the strands and strands in the rope are twisted to the right.

LEFT LANG LAY: Both wires in the strands and strands in the rope are twisted to the left.

USES OF WIRE ROPE

Chapter 613 of the *Naval Ships' Technical Manual* specifies the uses that may be made of wire rope of various constructions. A few of the more common constructions and some of their uses follow:

6 X 7: Only the galvanized type is specified. It is not suitable for general hoisting, but is applicable for permanent standing rigging.

6 X 19: Size for size, this type of construction is the strongest of all the wire ropes. When made of galvanized wire, 6 X 19 is used principally for heavy hoisting and is particularly useful on derricks and dredges. Standing rigging, guys, boat slings, and topping lifts for booms are often made of galvanized 6 X 19 wire rope. Phosphor bronze 6 X 19 rope is used for lifelines, wheel ropes, radio antennas, antenna downleads, and so forth, where either noncorrosive or nonmagnetic properties are desirable.

6 X 37: When made of ungalvanized steel wire, this construction is flexible, making it suitable for cranes and similar machinery. It may be used for heavy hoisting. For instance, hoisting ropes larger than 1 3/4 inches in diameter usually are of this type. When made of galvanized steel wire, this wire rope may be used for steering gear, boat crane falls, towing hawsers, bridles, torpedo slings, and heavy running rigging.

CARE OF WIRE ROPE

Long lengths of wire rope are usually on reels when received from your supply activity. Never try to unreel wire rope from a stationary reel. Mount the reel on a pipe or rod supported by two uprights. This method allows the reel to turn as the wire rope is pulled. Unreeling presents no problem, but spooling the wire rope back onto the reel may give you some trouble unless you remember that it tends to roll in the opposite direction from the lay. For example, a right-laid wire rope tends to roll to the left. Consequently, start a right-laid wire rope at the left and work toward the right when spooling over the top of the reel. When spooling under the reel, start at the right and work toward the left. Naturally, handle left-laid wire rope just the opposite.

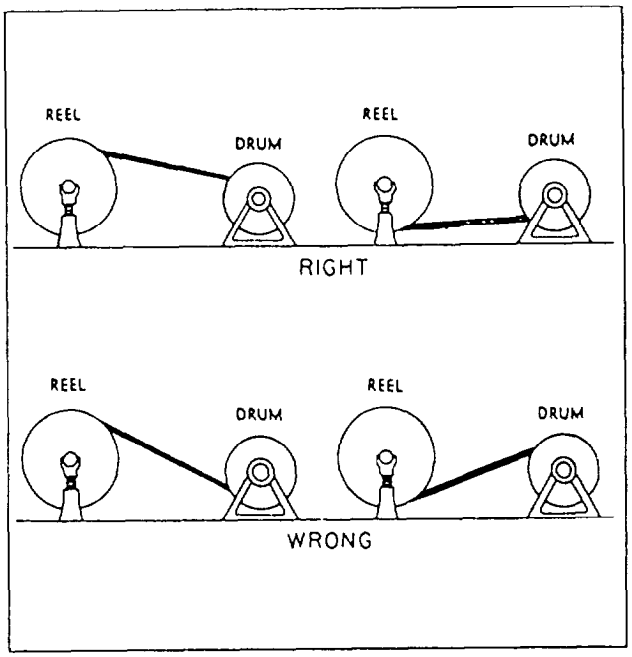

Figure 3-27.–Spooling wire rope from reel to drum.

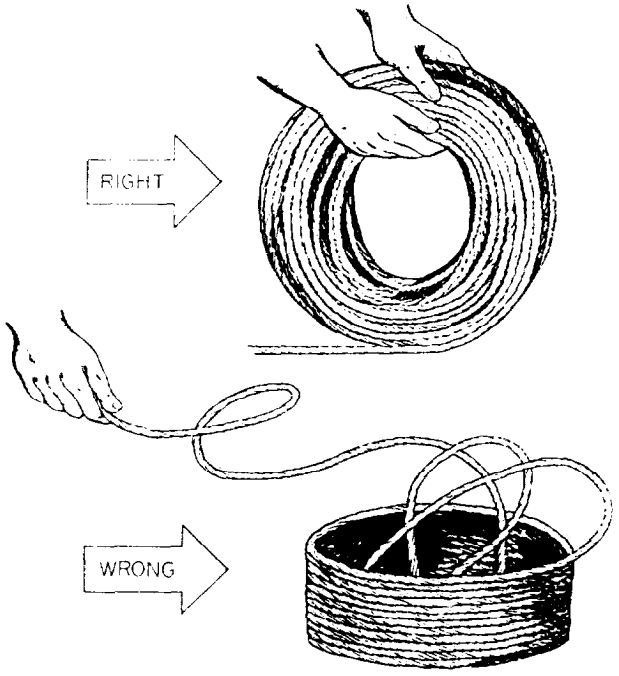

Figure 3-28.–Right and wrong way to uncoil wire rope.

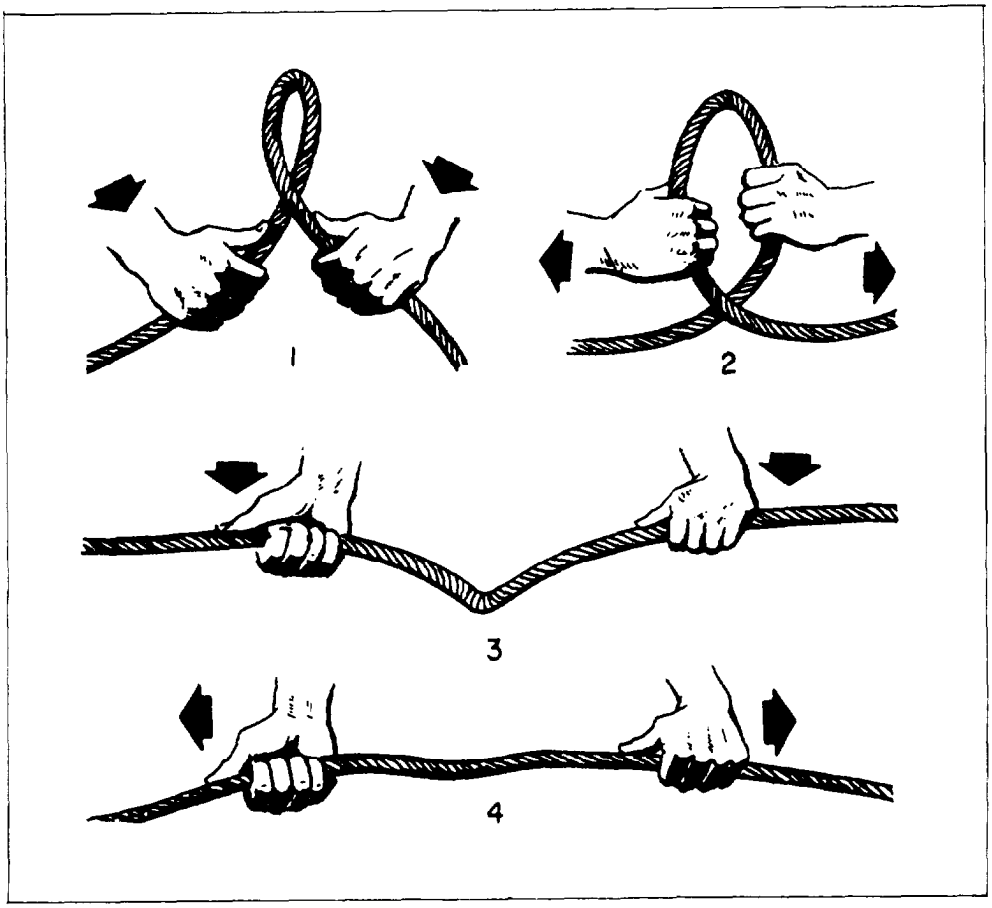

Figure 3-29.–Correct way to take out a kink in wire rope.

If wire rope is being run off one reel to a winch drum or another reel, run it from top to top or from bottom to bottom, as shown in figure 3-27.

Make up short lengths of wire rope in coils and stop off tightly for stowage. When uncoiling wire rope, stand the coil on edge and roll along the deck, uncoiling as you go, as in figure 3-28.

Whenever possible, drums, sheaves, and blocks used with wire rope should be placed so as to avoid reverse or S-shaped bends. Reverse bends cause an unnecessary amount of shifting of the individual wire strands, increasing wear and fatigue. Where a reverse bend is needed, the blocks and drums effecting the reversal should be of larger diameter than ordinarily used and should be spaced as far apart as possible.

If a wire rope becomes kinked, never try to pull it out by putting a strain on either part. As soon as a kink is noticed, uncross the ends by pushing them apart. See step 2 in figure 3-29. Performing these steps reverses the process that started the kink. Now turn the bent portion over and place it on your knee or some firm object and push downward until the kink straightens out somewhat. Then lay it on a flat surface and pound it smooth with a wooden mallet.

If a heavy strain is put on a wire rope with a kink in it, the rope no longer can be trusted. Cut out the kinked part and splice the ends together.

Frequently, abrasion or reverse or sharp bends cause individual wires to break and bend back. These broken wires are known as fishhooks.

Wire rope should be inspected frequently, checking for fishhooks, kinks, and worn and corroded spots. Worn spots show up as shiny flattened surfaces. To determine the wear, you must know (1) the original diameter of the wire rope, (2) the present diameter of the wire rope at the worn place, and (3) the diameter of a single wire in one of the strands of the wire rope. The original diameter of the rope is shown in the ship's allowance list or in the first lieutenant's records. The actual diameter of the rope is found by measuring it with a micrometer or vernier caliper, as shown in figure 3-30.

One or more of the following conditions is sufficient reason for questioning the rope's safety and considering replacement:

1. The normal rope diameter is reduced by more than the amount shown in table 3-2 for the applicable size rope. See figure 3-30 for the correct method of measuring diameter.

2. Six broken wires in one rope lay length, or three broken wires in one strand lay length. See figure 3-30 for definition of a lay length.

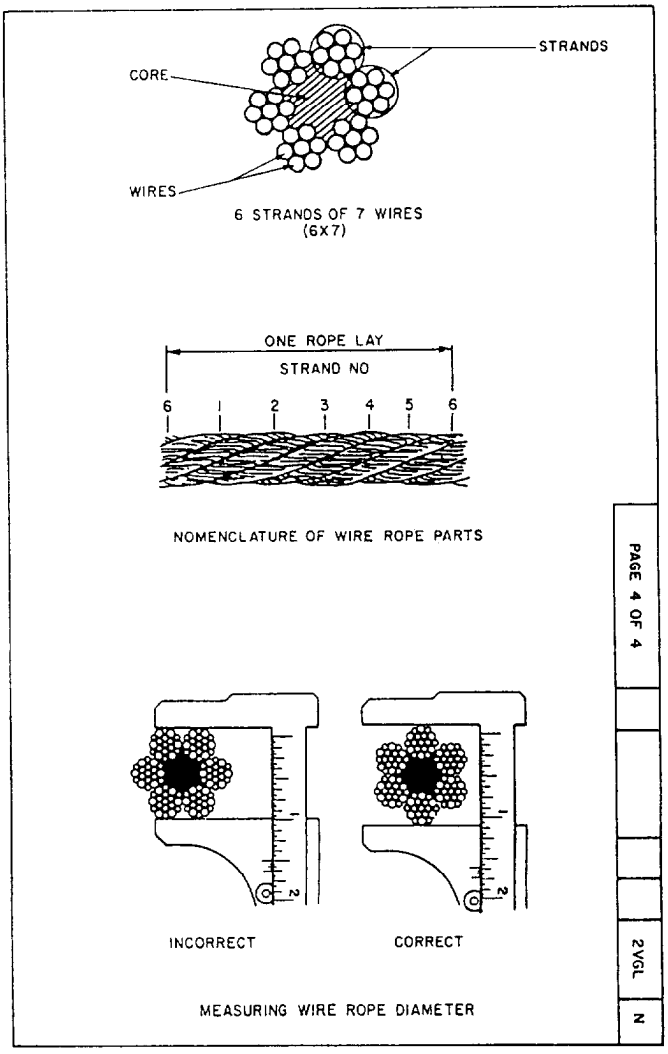

Figure 3-30.–Measuring wire-rope diameter.

Table 3-2.–Wire-Rope Allowable Diameter Reduction

Rope Diameter (inches)	Maximum Allowable Nominal Diameter Reduction (inches)
5/16 and smaller	1/64
3/8 to 1/2	1/32
9/16 to 3/4	3/64
7/8 to 1 1/8	1/16
1 1/4 to 1 1/2	3/32
19/16 to 2	1/8
2 1/8 to 2 1/2	5/32

3. One broken wire within one rope lay length of any end fitting.

4. Wear of one-third the original diameter of outside individual wires.

5. Evidence of pitting due to corrosion.

6. Evidence of heat damage from any cause.

7. Kinking, crushing, or any other damage resulting in distortion of the rope structure.

8. Evidence of internal corrosion, broken wires on the underside of strands, excessive nicks, or core failure.

Rusting and corrosion of the wires and deterioration of the fiber core sharply decrease the strength of a rope. It is impossible to estimate accurately the loss in strength from these effects.

STORAGE

Most of the following information comes from chapter 613 of the *Naval Ships' Technical Manual* (NSTM). The NSTM contains instructions for the maintenance, storage, and repair of equipment under the cognizance of the Naval Sea Systems Command. In it you can find valuable information not available elsewhere on the use, care, and upkeep of much of your equipment. Aboard most ships, the chief engineering officer has a set of these books.

Wire rope should not be stored in places where acid is or has been kept. Stress the importance of keeping acid or acid fumes away from wire rope to all hands at all times. The slightest trace of acid coming in contact with wire rope will damage it at that particular spot. Many times wire rope that has given away at one point has been found to be acid damaged.

Before storage, wire rope should always be cleaned and lubricated. If the lubricant film is applied properly and the wire is stored in a dry place, corrosion will be virtually eliminated.

LUBRICATION

It is important to lubricate wire rope because wire is really a mechanical device with many moving parts. Each time a rope bends or straightens, the wires in the strands and the strands in the rope must slide upon each other, so a film of lubricant is needed on each moving part. Another important reason for lubrication is to prevent corrosion of the wires and deterioration of the hemp core.

Clean used wire ropes before you lubricate them. You can clean them using wire brushes, compressed air, super-heated steam, JP-5, or turbine oil MIL-L-17331 (2190). Cleaning removes the foreign material and old lubricant from the valleys between the strands and from the spaces between the outer wires.

WARNING

When cleaning wire rope with JP-5, you must wear safety goggles, gloves, and protective equipment. Work in a well-ventilated area, preferably open air, to reduce the chance of vapor inhalation.

CAUTION

You should never soak wire rope in JP-5, because soaking may remove the lubricants from the inner wire rope and core. You may, however, soak wire rope in turbine oil if soaking is desired.

Lubricant may be applied with a brush, taking care to work it in well. Another method is to pass the wire rope through a box containing the lubricant.

The *Naval Ships' Technical Manual,* chapter 613, calls for lubricating wire rope with a chain lubricant, military specification MIL-G-18458 (ships). This lubricant should be used when possible. When military specification MIL-G-18458 is unavailable, a medium graphite grease or even motor oil may be substituted. Alternative lubricants must come from the PMS list of alternates. Ordinarily lubricants are applied hot so they can penetrate the strands and the core more easily.

WIRE-ROPE FAILURE

The following are some common causes of wire-rope failure:

- Using incorrect size, construction, or grade
- Dragging over obstacles
- Lubricating improperly
- Operating over sheaves and drums of inadequate size
- Overriding or crosswinding on drums
- Operating over misaligned sheaves and drums

- Operating over sheaves and drums with improperly fitted groves or broken flanges
- Jumping off sheaves
- Subjecting to moisture or acid fumes
- Attaching fittings improperly
- Permitting to untwist
- Subjecting to excessive heat
- Promoting internal wear by allowing grit to penetrate between the strands
- Subjecting to severe or continuing overloads
- Kinking

SEIZING WIRE ROPE

Seizing is the process of securing one rope to another, two or more parts of the same rope to itself, or fittings of any kind to a rope by binding with small stuff or with annealed iron wire.

In the manufacture of wire rope, great care is taken to lay each wire in the strand and each strand in the rope under uniform tension. If the ends of the rope are not secured properly, the original balance of tension will be disturbed and maximum service will not be obtained because some strands will carry a greater portion of the load than others. Before cutting steel wire rope, you must apply proper seizing on both sides of the place where the cut is to be made. For preformed wire rope, one seizing on each side is normally enough. For wire ropes that are not preformed, a minimum of two seizings is required, placed six rope diameters apart. Always apply seizing in the opposite direction from the lay of the rope. This prevents loosening when the wire-rope shrinks as a result of loading. Remember that the length of the seizings must never be less than the diameter of the wire rope being seized.

To make a temporary wire-rope seizing, wind on the seizing wire uniformly, using strong tension on the wire. After taking the required number of turns as shown in step 1 in figure 3-31, twist the ends of the wires counterclockwise as shown in step 2. Grasp the ends with end-cutting nippers and twist up slack as shown in step 3. Do not try to tighten the seizing by twisting. Draw up on the seizing as shown in step 4. Twist up slack Repeat steps 4 and 5 if needed. Cut the ends and pound them down on the rope as shown in step 6. If the seizing is to be permanent, or the rope is 1 5/8 inches or more in diameter, use a serving bar or iron to increase tension on the seizing wire when putting on the turns.

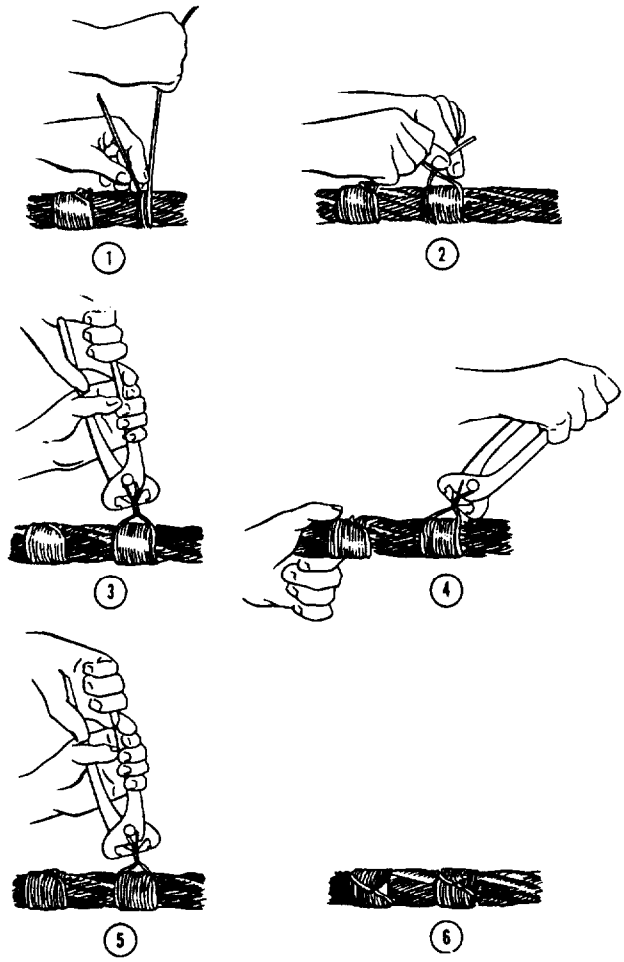

Figure 3-31.–Putting seizing on wire rope.

You must use the proper size and grade of wire for seizing. Table 3-3 lists the proper sizes of seizing wire for use with a range of wire-rope diameters.

Table 3-3.–Seizing for Wire Rope

Rope Diameter (inches)	Annealed Iron Seizing Wire Diameter (inches)
1/2 and smaller	0.035
9/16 to 7/8	.063
1 to 1 1/2	0.92
1 5/8 to 2 1/8	.120
2 1/4 and larger	.135

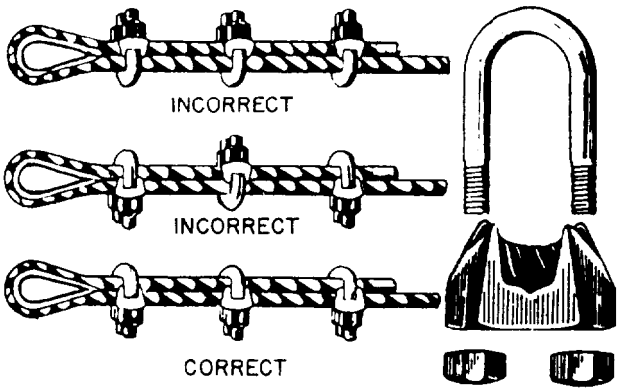

Figure 3-32.–Correct and incorrect use of wire-rope clips.

WIRE-ROPE CLIPS

A temporary eye splice may be put in wire by using wire-rope clips. The correct and incorrect ways of using these clips are shown in figure 3-32. The U-bolt always goes over the bitter end and the roddle goes on the standing part. Space the clips at a distance apart equal to six times the diameter of the wire. After the rope is under strain, tighten the clips again as a safety measure. The clips must be rechecked periodically thereafter and retightened as needed. Pay particular attention to the wire at the clip farthest from the eye because vibration and whipping are dampened here and fatigue breaks are likely to occur.

To obtain maximum strength in the temporary eye splice, you must use the correct size and number of wire clips. The size is stamped on the roddle between the two holes. The minimum number of clips to use for various sizes of wire rope is shown in table 3-4.

The improved type of wire rope clip is shown in figure 3-33. Both halves are identical and provide a bearing surface for both parts of the rope. Thus, it cannot be put on wrong and it does not distort the wire. It also allows a full swing with a wrench.

Personnel handling wire rope must always wear gloves. Even new wire occasionally has a fishhook that, if allowed to slide through the unprotected hand, can inflict a painful hand injury.

Table 3-4.–Number of Clips Regularly Used as a Minimum

Rope Diameter (inches)	All 6x7 Ropes; All Ropes With Independent Wire Rope Centers	All 6x19 and 6x37 Rope	Proper Torque to be Applied to Nuts of Clips [ft/lb(dry)]
3/8	4	3	45
1/2	4	3	65
5/8	4	3	95
3/4	5	4	130
7/8	5	4	225
1	6	5	225
1 1/8	6	5	225
1 1/4	7	6	360
1 3/8	7	6	360
1 1/2	8	7	360
1 3/4	8	7	590

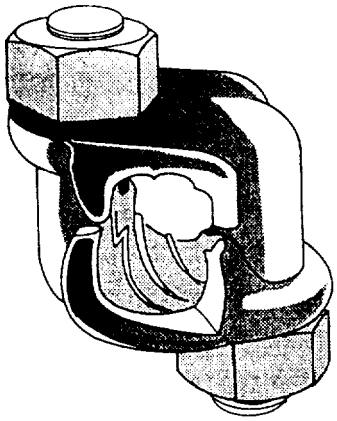

Figure 3-33.–Improved type of wire rope clip.

CANVAS

LEARNING OBJECTIVES: Define canvas. Identify and explain the use and care of canvas material.

Though canvas is not as prevalent today in a Seaman's routine as it once was, it is still important.

Canvas, often called duck, is a general name for a class of strong, heavy plain cloth woven of cotton or linen. *Numbered duck* is the canvas encountered most often, but occasionally you see the term *ounce duck* or *army duck.* Numbered duck runs from No. 1, the heaviest, to No. 12, the lightest; however, 7, 9, and 11 are no longer issued.

Each number means a certain weight in ounces per square yard of cloth. For example, No. 1 is 28.71 ounces per square yard, No. 6 is 20.74 ounces per square yard, and No. 12 is 11.16 ounces per square yard. Canvas in weights besides those designated specifically under the numbered system is called ounce duck. Army ducks are ounce ducks similar to numbered duck, but have finer yarns, higher cloth counts, and usually lighter weights.

Canvas usually is made up in bolts and issued by the linear yard in widths from 22 to 72 inches.

Even with the best of care, canvas is relatively short-lived, and for this reason, the Navy is turning to synthetic fabrics. Synthetic fabrics are lighter and easier to stow and resist rot and mildew. They are also more durable and less expensive in the long run.

One type of synthetic fabric used extensively for tarps and awnings and for boat, winch, and reel covers is a nylon cloth with a vinyl film on both sides. (The smooth or face side is the side to expose to the weather.) Two different companies furnish this type of cloth under their own trade names (Herculite #80 and Hypalon). These white or grey materials weigh approximately 19.6 ounces per square yard and come in 50-inch widths. They are fire, water, weather, and mildew resistant.

Another type of cloth, a black neoprene-coated material, is less suited for topside uses but has many below-deck applications, such as for blackout and welding curtains. This material weighs approximately 2.3 ounces per square yard and comes in a 39-inch width. Generally, the same care given to synthetic lines should be given to the synthetic cloths. When synthetic cloths are dirty, you should wash these fabrics with saddle soap or any other mild soap and water; scrub them with a soft bristle brush, using a circular motion; and rinse them with clear water. In some instances, two cleanings may be necessary.

Much of the canvas issued in the Navy is treated to make it resistant to fire, water, weather, and mildew. Some canvas is waterproof and oil and gasoline resistant. Current specifications for building ships require that all topside canvas be treated according to the intended use. Canvas to be used below decks is usually white and untreated. Preservatives are available for shipboard use on untreated canvas or for re-treating canvas.

New and unused canvas, spare covers, and so forth, should be stowed in a clean, dry storeroom. Never store canvas where acid is (or has been) stowed; acid fumes are detrimental to canvas. Every effort should be made to provide a space free from rats, mice, and insects. Wet, painted, or oil-soaked canvas should not be stowed below decks. Occasionally it is necessary to scrub canvas that has become particularly dirty or stained by grease or oil. Use a mild soap solution, rinse thoroughly, and hang the canvas up to dry.

MEASURING CANVAS

Great care should be taken when measuring and cutting canvas. **MEASURE TWICE AND CUT ONCE.** When measuring canvas for items that will be stretched taut (awnings, for example), **DEDUCT** 1/2 inch for each linear foot in both width and length. If the canvas is to be loose (as for hatch hoods and gun covers), **ADD** 1/2 inch for each linear foot in both width and length. Use the old article for a pattern whenever possible. When it is not available, make a sketch of the item, showing all the necessary dimensions, and work from that.

SEWING CANVAS BY HAND

When you are required to fabricate articles, you will need the appropriate tools. Some of the tools used for fabricating are listed below.

- Sail needles: Needles are numbered according to size; the higher the number, the smaller the needle. The heavier the canvas, the larger your needle should be. After use, needles should be dried carefully and oiled or stowed in a container of powdered chalk to prevent them from rusting.

- Palms: Two types of palms are issued in the Navy: the sailmaker's palm and the roping palm. At first glance you probably see no difference, but if you check the metal slug you can see that the roping palm is designed for larger size needles. This is the palm to use when jobs require the largest needles-sewing on bolt ropes, for example.

- Sailmaker's or bench hook: This hook has a swivel eye. It is used to hold the ends of two pieces of canvas being sewn together, as shown in figure 3-34.

- Beeswax: This substance can hardly be called a tool, but it is a necessary item. It reduces the wear on the sail twine while sewing and retards deterioration.

- Sail twine: Many different types of twine are used for sewing, mostly cotton; but lacing twine (already waxed) is best for sewing by hand.

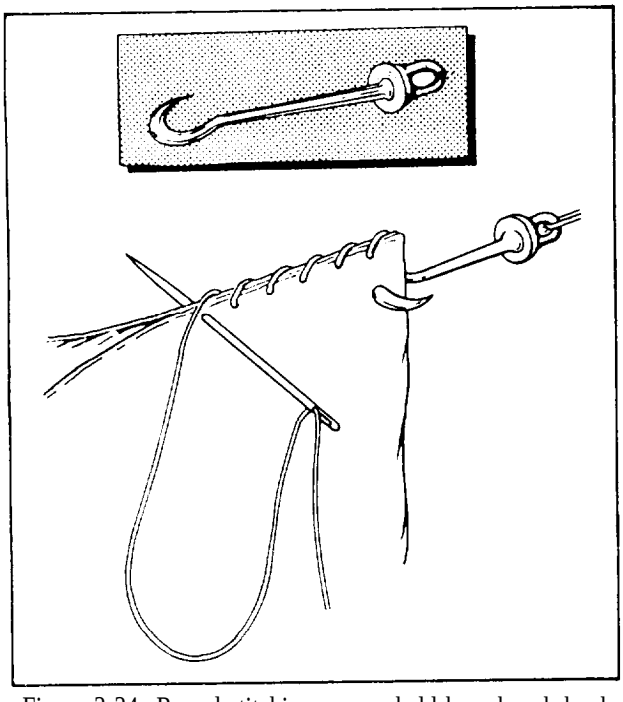

Figure 3-34.–Round stitching canvas held by a bench hook.

Stitches and Their Uses

Here are some of the common stitches that you will find useful in your work.

- Round stitch: The round stitch is the one used most commonly for joining two pieces of canvas. Turn back the edges, hold the pieces together, and send the needle through both pieces at right angles at the seam, as shown in figure 3-34.

- Flat stitch: A flat stitch is used when a strong seam is required, as on a paulin or a sail. Pencil a guideline 1 1/2 or 2 inches from the edge of each strip of canvas, depending on how wide you want the seam. Crease each piece on a line slightly less than halfway to the guideline. Make the folds away from the guidelines and interlock the folds away from the guidelines and interlock the folds (fig. 3-35). Interlocking the edges forms a watertight seam and keeps a ragged edge from showing. Insert the needle at the guideline, and stitch diagonally so that stitches appear at right angles to the seam on top but run at an angle on the reverse side. After completing one edge, turn the canvas over and sew the other edge of the seam. Flat stitching also is used for patching.

- Baseball stitch: The baseball stitch is used to mend tears in light and medium canvas. Figure 3-36 shows how it is done.

- Herringbone stitch: The herringbone stitch is used to mend tears in heavy or painted canvas. Figure 3-37 shows the steps in making this stitch.

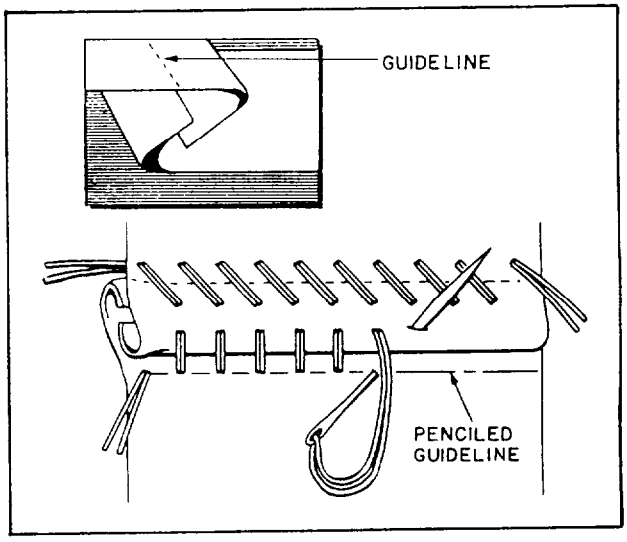

Figure 3-35.–Flat stitch.

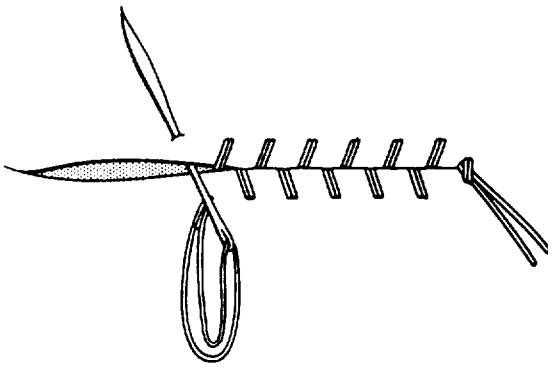

Figure 3-36–Baseball stitch.

Sewing Bolt Ropes to Canvas by Hand

Bolt ropes are the ropes around the edges of awnings and sails. Their purpose is to take the strain of the stops, clews, reef points, and the like. To sew on a bolt rope, hem the canvas and lay the rope along the edge. Use a round stitch, the size of which is determined by the size of the rope. Sew the rope strand by strand to the canvas as shown in figure 3-38. Carefully observe these points when sewing on bolt ropes.

1. Keep the rope taut and the canvas slack.

2. Do not bunch the canvas, but hold your needle at such an angle that it goes through the canvas a fraction of an inch ahead of where it comes out from under the strand.

3. Sew each strand to the canvas, making sure the needle goes under, not through, the strands.

4. Do not let your stitches start to creep up around the rope, but keep them coming out of the rope in a straight line along the underside. If you let them creep, the canvas begins to curl around the rope.

5. **SEW THE BOLT ROPE TIGHT.**

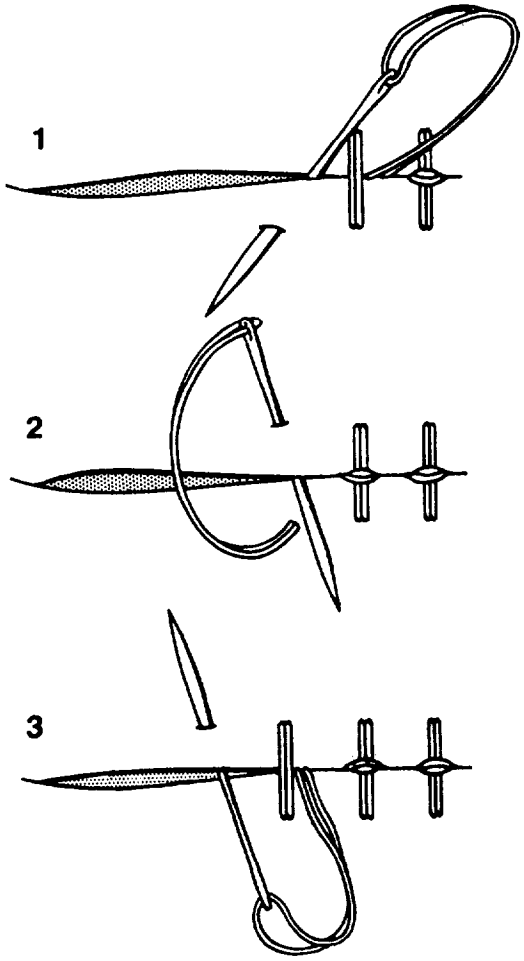

Figure 3-37.–Herringbone stitch.

AWNINGS

Awnings are canvas or synthetic coverings spread over the decks of a vessel to protect the crew from sun and weather. The center of an awning is held up by a strong fore-and-aft wire rope jackstay supported by intermediate stanchions. There may be a wooden strongback in place of the jackstay and others leading from it to the rail. The edges of the awning are hauled out and secured to ridge ropes along the rail. The ridge ropes in turn are supported by specially braced stanchions that usually can be taken down when the awnings are not in use. Edges of some awnings are secured to the ridge rope by lacings reeved around the ridge rope and through grommets in the awning or through awning hooks sewn to the bolt ropes. Other awnings are equipped with stops and earrings (short lengths of line) spliced into the grommets. Earrings are larger and longer lines than the stops. They are spliced to the corner grommets and to the grommets that line up with the ridge-rope stanchions.

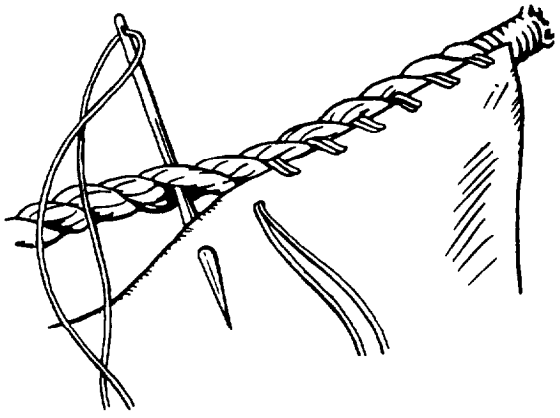

Figure 3-38.–Sewing a bolt rope to canvas.

When you are spreading an awning, haul it over the jackstay and spread it out fore and aft. If the awning is large and heavy, it may be necessary to rig a block and tackle to haul it taut. Next, man and reeve the earrings around the ridge rope. Pull them taut and secure them temporarily to the ridge ropes. Reeve, set taut, and secure the stops temporarily to the ridge ropes. It will be necessary to go back and tighten all stops and earrings to take the sag from the awning. Earrings and stops are secured by wrapping their bitter ends around the parts reeved through the grommets and around the ridge rope, tucking the ends between the parts.

During rains, awnings must be housed to allow them to shed water better. This is done by casting off two or more stops between earrings and securing them lower down to the lifeline. When awnings are secured by long lacings reeved through a number of grommets, it is almost impossible to house them. It may be to your advantage to replace the lacings with earrings and stops.

In particularly windy weather, awnings sometimes are furled. To furl an awning, you cast off the stops and earrings and haul one edge across the jackstay to the other side. Then roll the awning up and secure it to the jackstay with marline hitches.

GROMMETS

Many repair facilities today such as shore intermediate maintenance activities (SIMAs) routinely manufacture canvas items such as awnings and gun covers. However, you may still have to insert grommets. For this reason you should have a basic knowledge of grommets.

Handsewing Grommets

Metal grommets have almost replaced the handsewn type, but if you should ever be caught without the proper size of metal grommets, you should know how to make them by hand. Handsewn grommets are almost as strong as the metal type when they are properly made and sewn to the canvas.

The first step is to fashion a two- or three-strand grommet of marline. Stretch this over a fid to make it round and firm. Double your sail twine, twist the two parts together, and wax it adequately. Then punch a hole slightly smaller than the grommet in the canvas. Sew the grommet into the hole using a round stitch. Pass the needle through the canvas, well back from the edge. After completing the stitches, shape the grommet again with a fid.

Using Metal Grommets

Several different types of metal grommets are in use, but the two that are most familiar are pictured in figure 3-39. The one in view A is called the eyelet-and-ring type; it comes in sizes 6 to 15, inclusive, with inner diameters from 3/4 inch to 2 inches. View B shows the spur type. It is in sizes 0 to 6, inclusive, with inner diameters from 1/4 to 3/4 inch.

The cutting punches shown range in diameter from 1 inch down to 7/16 inch in the double bow type (view C), and from 3/8 to 1/8 inch in the single bow type (view D). When you are using these to punch holes in canvas, lay the canvas on a piece of heavy sheet lead, and they will cut a neat, clean hole.

The grommet-inserting punches and dies are available in sets in the same sizes as the grommets; that is, from 0 to 15. Use the same size set as the size of grommet. In figure 3-39, view E shows the punch and view F shows the die.

The proper way to insert the spur type of grommet is to push the eyelet part of the grommet through the hole in the canvas. Place the eyelet on the die and the spur over the eyelet. The punch fits inside the eyelet and, when struck with a hammer, curls the edge of the

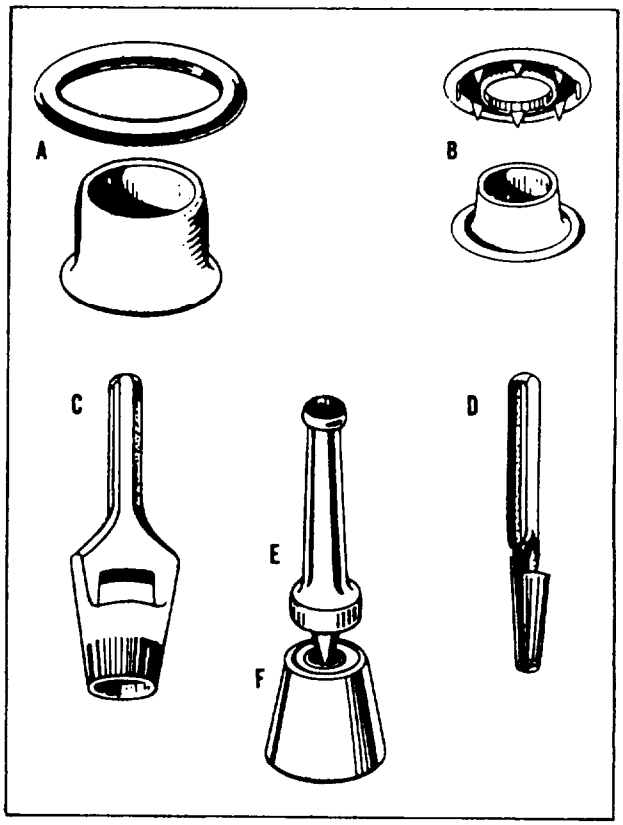

Figure 3-39.–Grommets, cutting punches, and inserting punch die.

eyelet down over the spur. Do not pound too hard on the punch because that causes the grommet to cut through the canvas and later it may pull out.

The eyelet and ring type of grommet is especially for awnings and sails. Properly used, this is the best of all types. The ring part is sewn to the canvas the same as the handmade grommet. Then the eyelet is placed in the ring and set with the punch and die.

LEATHER

LEARNING OBJECTIVES: Define leather: Explain the use and care of leather.

Hides and skins, being of animal origin, vary in area, thickness, and weight. Subsequent tanning and finishing processes further alter these features. The following information concerning the areas, thickness, and weights is, therefore, only approximate.

The types of leather include rigging, harness, shoe, chamois, kid, lacing, belting, and various artificial leathers. Of these, the three you are most likely to need are rigging, belting, and artificial leathers.

Rigging leather is designated by weight as light, medium, or heavy, ranging from 6 ounces per square foot to 10 ounces per square foot. It is issued by the pound.

Belting is either round or flat and is issued in any desired length by the linear foot. Round belting comes in two widths, 1/4 inch and 3/8 inch. Width is used instead of diameter because, despite the name, it is oval rather than round. Flat belting may be either single- or double-ply. Single-ply belting is in 1- to 6-inch widths; double-ply, 2- to 12-inch widths.

The most common types of artificial leathers are used for upholstery and are issued by the square foot.

CARE OF LEATHER

Leather exposed to the elements should be kept well oiled or waxed. Any oil that does not contain harsh chemicals is suitable, but the best is neat's-foot oil. Leather in such places as on lifelines may be kept well-preserved by the application of paste wax. Saddle soap, an excellent preservative and cleaner, can be used on holsters, and on shoes, jackets, and other leather wearing apparel. If leather becomes badly soiled and stained, wash it with a mild soap and water solution, rinse well, and dry in a spot away from intense heat. After it is dry, apply saddle soap or neat's-foot oil to replace the natural oils of the leather.

Leather is especially subject to mildew and rotting. It is also highly susceptible to accidental cutting, gouging, and abrading. Excessive heat causes it to shrink considerably, with consequent rending and cracking. Acids, corrosives, or their fumes have a disastrous effect upon leather.

The foregoing conditions should be borne in mind when stowing leather. Rolls must have top stowage to prevent crushing. Stowage must be well clear of any liquids or greases that might stain. To prevent sticking, paper should be placed between hides stowed one on top of the other. Original moistureproof wrappers should be left on as long as possible to prevent mildew. Stowage should always be in a dry, well-ventilated compartment.

SEWING LEATHER

On leather, the line along which the stitches are to run on each edge should be grooved so as to countersink the stitches below the surface. When joining two pieces of leather by sewing by hand, first draw a line parallel and close to the edge first, then make your groove with a grooving tool (a dull knife will do). Use a block of wood for a straightedge. Next, punch holes along the grooves for the stitches.

The shoemaker's or cobbler's stitch is shown in figure 3-40. A variation of this stitch is to cut the leather carefully so that the edges abut. Angle the grooves toward the edges of the leather and sew through the

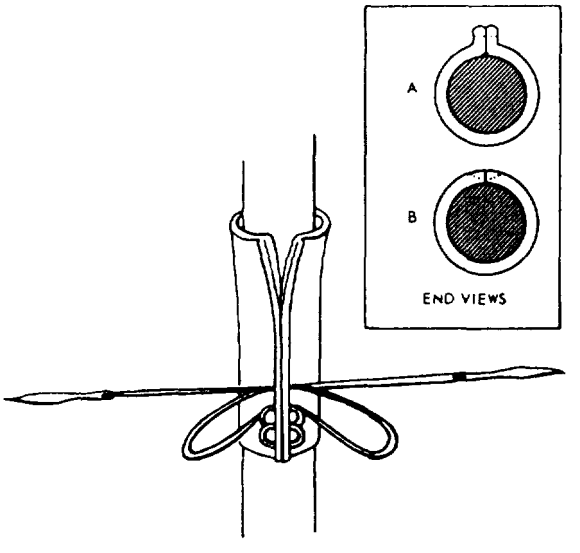

Figure 3-40.–Shoemaker's stitch.

edges. Inset A of figure 3-40 shows the end view of the regular shoemaker's stitch. Inset B shows the variation.

Leather, of course, handles and sews much easier if it is soaked in water for a few minutes.

SUMMARY

In this chapter, we discussed the purpose and use of various knots, bends, and hitches, and the correct method of applying seizing to wire rope and whipping on a line. We also discussed the uses of the eye and short splices.

During your naval career, you will be called upon to act quickly in an emergency or during routine duties to have proficiency in the act of tying knots, bends, and hitches.

Your ship's leading Boatswain's Mate, who is well qualified from years of experience, will help you in mastering any of these procedures. Do not hesitate to seek assistance if you need it.