Chapter 12

Marlinespike Seamanship

Marlinespike seamanship is a general term for the handling, knotting, whipping, splicing, and caring for fiber line and wire rope used aboard ship or in other marine operations. The knowledge and practical application of marlinespike seamanship principles and procedures are important to the crewman. A person who is truly dedicated to his work takes pride in the handling and caring of fiber line and wire rope to make operations safe and satisfactory. This chapter covers all of the phases of marlinespike seamanship required by the watercraft operator.

CARE AND USE OF FIBER LINE

12-1. One characteristic of a good watercraft operator is his ability to work with fiber line. To be able to do this, he must know the characteristics and properties of fiber line, how to handle and care for the line, and tie the basic knots, bends, and hitches.

MATERIALS FOR FIBER LINE

12-2. Fiber line is made of either vegetable or synthetic fibers. Vegetable fibers include manila, sisal, hemp, cotton, and flax. Synthetic fibers include nylon, Dacron, polyethylene, and polypropylene. Nylon is the primary synthetic fiber line used in the Army, so this text covers only nylon and none of the other synthetic fibers. These materials are described below.

Manila

12-3. Manila is a strong fiber that comes from the leaf stems of the abaca plant that is in the banana family. Varying in length from 4 to 15 feet in their natural state, the fibers have the length and quality to give manila rope relatively high elasticity, strength, and resistance to wear and deterioration. Most lines used in the Army are manila.

Sisal

12-4. Sisal is made from sisalana, a species of the agave plant. Although sisal is seldom used in the Army, it is covered here because it is a good substitute for manila. Sisal fibers are 2 to 4 feet long. Sisal withstands exposure to seawater very well.

Hemp

12-5. Hemp is a tall plant that has useful fibers for making rope and cloth. It was used extensively before manila was introduced. Now hemp's principal use is in fittings such as ratline and marline. Because hemp is absorbent, the fittings are invariably tarred to make them more water resistant. Uses of marline include lashings and whippings.

Nylon

12-6. Nylon is made from mineral products is waterproof, absorbs shocks, stretches, and resumes its original length. It also resists abrasion, decay, and fungus growth.

CONSTRUCTION OF FIBER LINE

12-7. Figure 12-1 shows how a fiber line is made by twisting fibers into yarns, yarns into strands, and strands into the finished line. The fibers are twisted from left to right to spin the yarn. The yarn is twisted from right to left to form the strands. The strands are then twisted from left to right to lay or form the line. Three-stranded nylon line is constructed in the same way as fiber line.

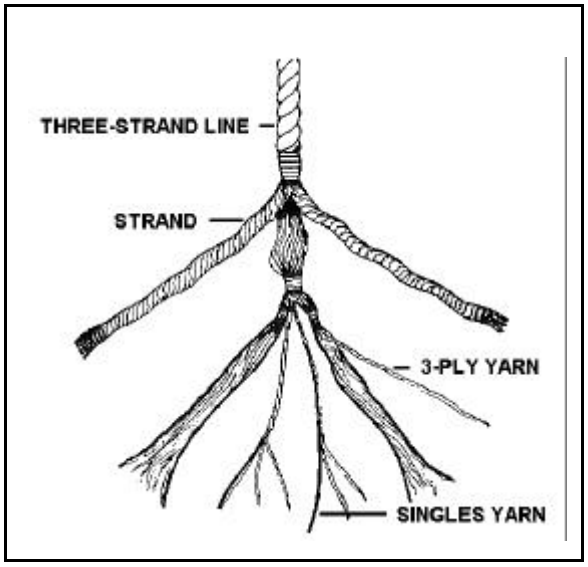

Figure 12-1. Fabrication of Fiber Line

SIZE OF LINE

12-8. Fiber line is measured, in inches, by its circumference. One exception is "small stuff". Small stuff has fiber line that is 1 3/4 inches or less in circumference. It also has three strands. The number of threads it contains determines its size. Small stuff will range in size from 6 to 21 threads. To determine the number of threads, count the number in one strand and then multiply it by three. Small stuff is used for lashing material and heaving lines.

12-9. Fiber line between 1 3/4 and 5 inches in circumference is referred to as line. Line over 5 inches in circumference is referred to as hawser. Hawsers are used for mooring and towing.

STRENGTH OF FIBER LINE

12-10. Manila is the standard line against which all other types of fiber line are measured. Implied in the measurement is that all the other lines have the same circumference as that of the manila line against which each is measured. With manila line having a strength of 100 percent, the strengths of the other lines are shown in Table 12-1.

Table 12-1. Line Strengths

TYPE LINE	STRENGTH
Manila	100 percent
Three-strand nylon	250 percent
2-in-1 braided nylon	300 percent
Sisal	80 percent

12-11. Nylon line is fast replacing natural fiber line for mooring and towing because of its strength and durability. With three-stranded nylon being 250 percent stronger than manila, size for size, it allows the use of smaller and lighter mooring and towing lines.

12-12. Three-stranded nylon line will stretch 30 to 35 percent under an average load or a load that does not exceed the safety factor for that size line. Three-stranded nylon line will stretch 40 percent without being damaged and draw back to its original length. The nylon line will part at 50 percent.

USEFUL FORMULAS

12-13. The manufacturer states the size and BS of its lines. If this information is available, use the manufacturer's figures for determining the strength of line. If this information is not available, then use the rule of thumb to compute the SWL and the BS. These rules of thumb give only approximate results (because of the constants that are used in the below formulas) but the error will be on the side of safety.

TYPE LINE	CONSTANT
Sisal	160
Manila	200
Three-strand nylon	500
2-in-1 braided nylon	600
With "C" meaning circumference in inches, the formula for SWL in pounds is:	
C^2 X constant for line = SWL	
Examples:	
3-inch sisal:	
3 X 3 X 160 = 9 X 160 = 1,440 pounds SWL	
3-inch manila:	
3 X 3 X 200 = 9 X 200 = 1,800 pounds SWL	
3-inch three-strand nylon:	
3 X 3 X 500 = 9 X 500 = 4,500 pounds SWL	
3-inch 2-in-1 braided nylon:	
3 X 3 X 600 = 9 X 600 = 5,400 pounds SWL	
In marine operations, a safety factor of 5 is generally used. If you multiply this times the SWL you will find the BS of the fiber line. This is the amount of weight in pounds required to part the line. If you are given the BS of a line and divide it by the safety factor 5, you will find the SWL.	
Note: The safety factor of 5 is valid when using new line or line that is in good condition. As line ages and wears out through use, the safety factor drops. Old line may have a safety factor of 3.	
Example: Find the BS of 3-inch manila line:	
Solution: C^2 X constant = SWL: 3 X 3 X 200 = 9 X 200 = 1,800 pounds	
BS = SWL X SF = 1,800 X 5 = 9,000 pounds	
Example: Find the SWL for a 6-inch hawser that has a BS of 36,000 pounds:	
Solution:	
SWL = $\frac{BS}{36,000}$ =7,200 pounds	

SF 5

12-14. Table 12-2 shows the SWL and BS of the various sizes of lines used on Army watercraft.

Table 12-2. Line Strength Table (Safety Factor of 5)

SIZE IN INCHES	MANILA		THREE-STRAND NYLON		2-IN-1 BRAIDED NYLON	
	SWL	BS	SWL	BS	SWL	BS
1	200	1,000	500	2,500	600	3,000
1 1/2	450	2,250	1,125	5,625	1,350	6,750
2	800	4,000	2,000	10,000	2,400	12,000
2 1/2	1,250	6,250	3,125	15,625	3,750	18,750
3	1,800	9,000	4,500	22,500	5,400	27,000
3 1/2	2,450	12,250	6,125	30,625	7,350	36,750
4	3,200	16,000	8,000	40,000	9,600	48,000
4 1/2	4,050	20,250	10,125	50,625	12,150	60,750
5	5,000	25,000	12,500	62,500	15,000	75,000
5 1/2	6,050	30,250	15,125	75,625	18,150	90,750
6	7,200	36,000	18,000	90,000	21,600	108,000
6 1/2	8,450	42,250	21,125	105,625	25,350	126,750
7	9,800	49,000	24,500	122,500	29,400	147,000
7 1/2	11,250	56,250	28,125	140,625	33,750	168,750
8	12,800	64,000	32,000	160,000	38,400	192,000
8 1/2	14,450	72,250	36,125	180,625	43,350	216,750

CORDAGE

12-15. In marine usage, cordage is a collective term that includes all cord, twine, line, and string made from twisted vegetable or synthetic fibers. Cord, string, and twine are loosely used to mean small line.

Cotton Twine

12-16. This is like the string found in homes. It is used for temporary whippings and should be run through beeswax before use.

Sail Twine

12-17. This is made of flax or of a better grade of cotton than that used in cotton twine. It is waxed during manufacture. Measured by the number of plies, it comes in three to seven plies. Like a yarn, a ply has a certain number of fibers. Sail twine is used for whippings.

Marline

12-18. This is tarred hemp. It is made of two yarns with fibers making up the yarns. Marline is used for whippings on lines 3 inches and larger.

Flax

12-19. This is braided. It is used for halyards or the lines for flags and pennants. Flax is stronger than cotton and lasts longer.

INSPECTION

12-20. The outside appearance of the line is not always a good indication of its internal condition. Therefore, it is necessary to inspect the inside as well as the outside. Overloading a line may cause it to break with possible damage to material and injury to personnel.

12-21. Inspect line carefully at regular intervals to determine its condition. Untwist the strands slightly to open the line so that you can examine the inside. Mildewed line has a musty odor and inside fibers have a dark, stained appearance. It is ordinarily easy to identify broken strands of yarn. Dirt and sawdust-like material inside the line means that it has been damaged. If the line has a core, it should not break away in small pieces. If it does, the line has been overstrained. If the line appears to be satisfactory in all respects, pull out two fibers and try to break them. Sound fibers should offer considerable resistance to breakage.

12-22. When any unsatisfactory conditions are found, destroy the line or cut it up in short pieces. Make sure that none of these pieces is long enough to permit its use in hoisting. This not only prevents the use of line for hoisting, but saves the short pieces for miscellaneous use such as lashings, whippings, and seizings.

UNCOILING NEW LINE

12-23. New line is coiled, bound, and wrapped in burlap as a protective covering. The burlap covering should not be opened until the line is to be used. To open, strip back the burlap wrapping and look inside the coil for the end of the line. It should be at the bottom of the coil. If it is not, turn the coil over so that the end will be at the bottom. Put your hand down through the center and grab the end of the line. Pull the end of the line up through the center of the coil. As the line comes up through the coil, it will unwind in a counterclockwise direction (Figure 12-2, page 12-6).

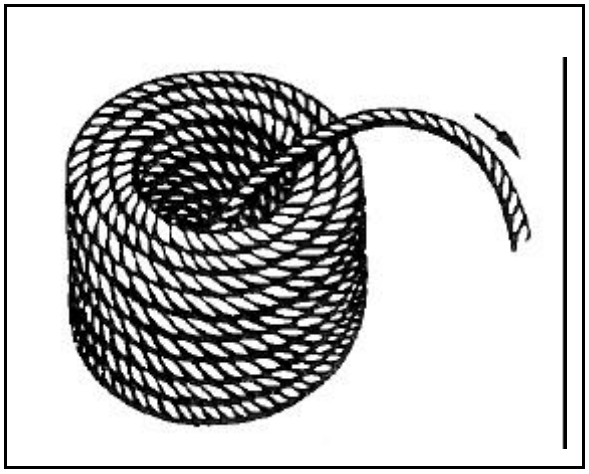

Figure 12-2. Opening View Coil Line

STOWING LINE

12-24. Hawsers and line must never be stowed when wet. After they are thoroughly dry and cleaned, they should be stowed in a dry, unheated, well-ventilated area or locker. Hawsers should be loosely coiled on wood grating or hung on wood pegs. Hawsers should never be stowed in contact with metal surfaces. Line can be coiled, flemished, or faked down.

12-25. Coiling down a line means laying it up in circles, roughly one on top of the other. Always coil down right-laid line right-handed or clockwise (Figure 12-3). When a line is coiled down, the top end is ready to run off. If you try the bottom end, the line will kink. If for some reason the bottom end must go first, it is necessary to turn over the coil to free it for running.

12-26. To flemish down a line, start with the bitter end and lay on the deck successive circles of the line. Always flemish down right-laid line clockwise, and left-laid counterclockwise. Figure 12-4 shows the bitter end is in the middle. Short lengths of a line, such as bitter ends of boat painters and guys, usually are flemished down.

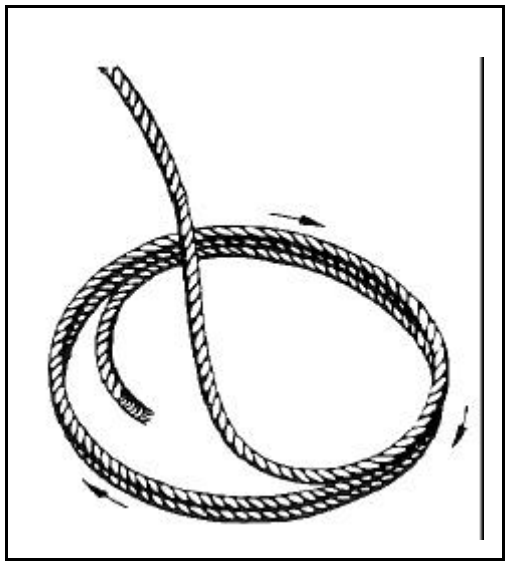

Figure 12-3. Coiling Line

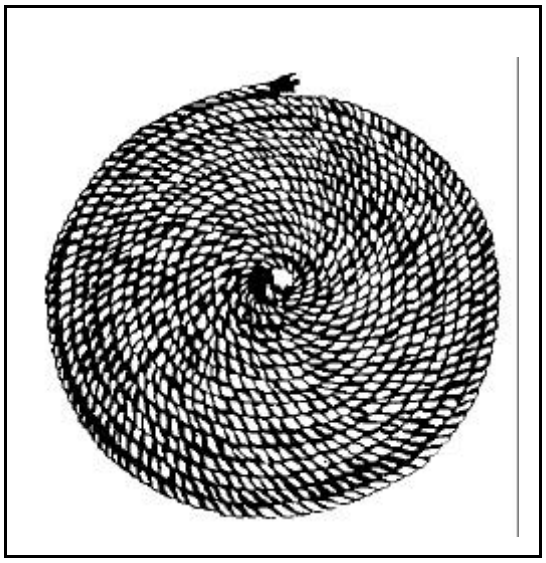

Figure 12-4. Flemishing Down a Line

Note: Nylon comes on reels. To uncoil it, place a reel on stands or jacks. Nylon is handled differently from natural fiber line. Coil three-strand nylon clockwise one week and counterclockwise the next week, because continuously coiling three-strand nylon line down one way tends to take the lay out of the strands. With 2-in-1 braided nylon line, simply put it in figure eights.

12-27. Faking down a line is laying it up the same way as in coiling down, except that it is laid out in long flat bights, one alongside the other, instead of in coils (Figure 12-5). The main advantage of working with line that is faked down is that it runs off easily.

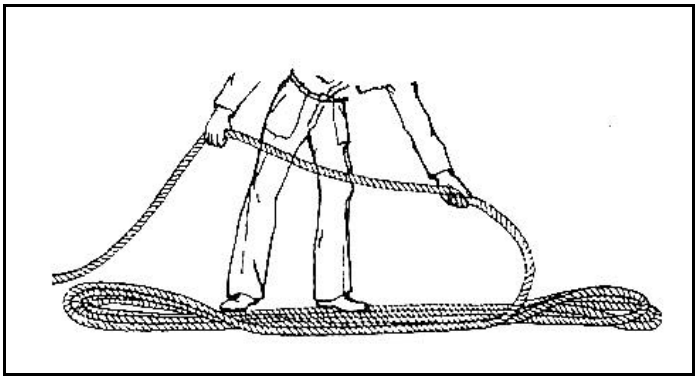

Figure 12-5. Faking Down a Line

WHIPPING A LINE

12-28. Never cut a line or leave the end of a line dangling loose without a whipping to prevent it from unlaying. A line without a whipping will unlay of its own accord. A frayed line is a painful sight to a good seaman. Whenever a line or hawser has to be cut, whippings should be put on first. Put one whipping on each side of the cut. To prevent fraying, a temporary or plain whipping can be put on with any type of cordage, even with rope yarn. Figure 12-6 shows one of several methods that can be used for putting a temporary whipping on a line.

12-29. Do the following to make a temporary whipping (see also Figure 12-6).

- **Step 1.** Lay the end of the whipping along the line and bind it down with three or four round turns.
- **Step 2.** Then lay the other end on the opposite way.
- **Step 3.** Bind it with a bight of the whipping.
- **Step 4.** Then take a couple more turns.
- **Step 5.** Take the bitter end of the whipping and pull it tight.

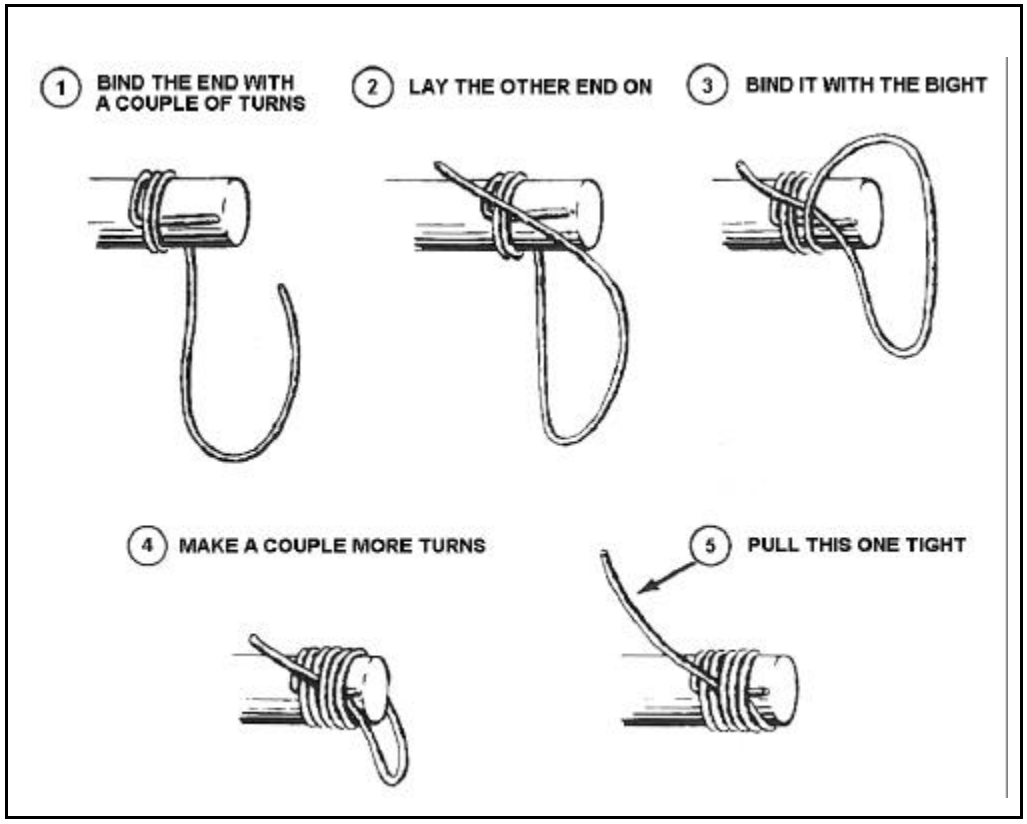

Figure 12-6. Plain or Temporary Whipping

12-30. As its name implies, a permanent whipping is put on to stay. One way to put on a permanent whipping is with a needle (Figure 12-7) and a sewing palm (Figure 12-8). Sewing palms are made for both right- and left-handed people. The width of the permanent whipping should equal the diameter of the line. Two whippings are recommended. The space between the two whippings should be six times the width of the first whipping.

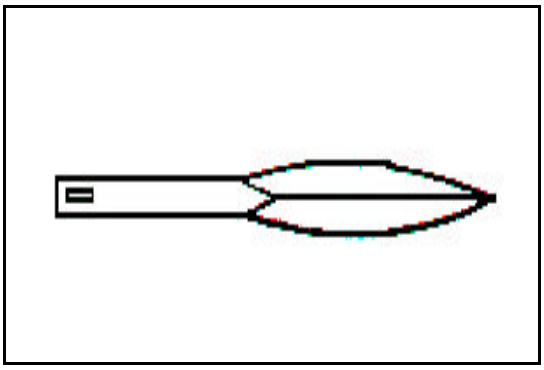

Figure 12-7. Short Spur Needle for Rope Work

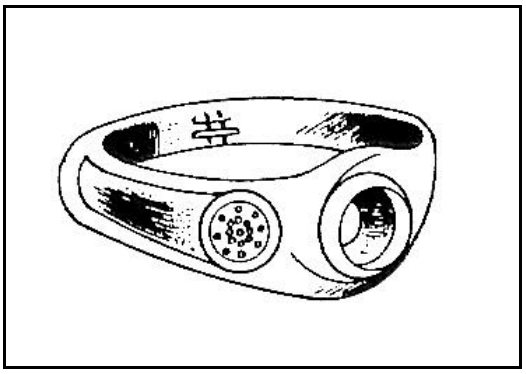

Figure 12-8. Sewing Palm

12-31. Do the following steps to make a permanent whipping (see also Figure 12-9, page 12-10).

Note: The needle is threaded with sail twine, doubled. Figure 12-9 also shows a single strand for clearness.

- **Step 1.** Push the needle through the middle of a strand so that it comes out between two strands on the other side.
- **Step 2.** Wind the turns toward the bitter end. The number of turns or the width of the whipping will depend on the diameter of the line.
- **Step 3.** Push the needle through the middle of a strand so that it comes out between two strands again.
- **Step 4.** Then go up and down between strands so as to put a cross-seizing between each pair of strands.
- **Step 5.** Pull each cross-seizing taut before taking the next one.
- **Step 6.** Have the thread come out through the middle of a strand the last time you push it through so that after you knot and cut the thread, the strand will hold the end of the twine.

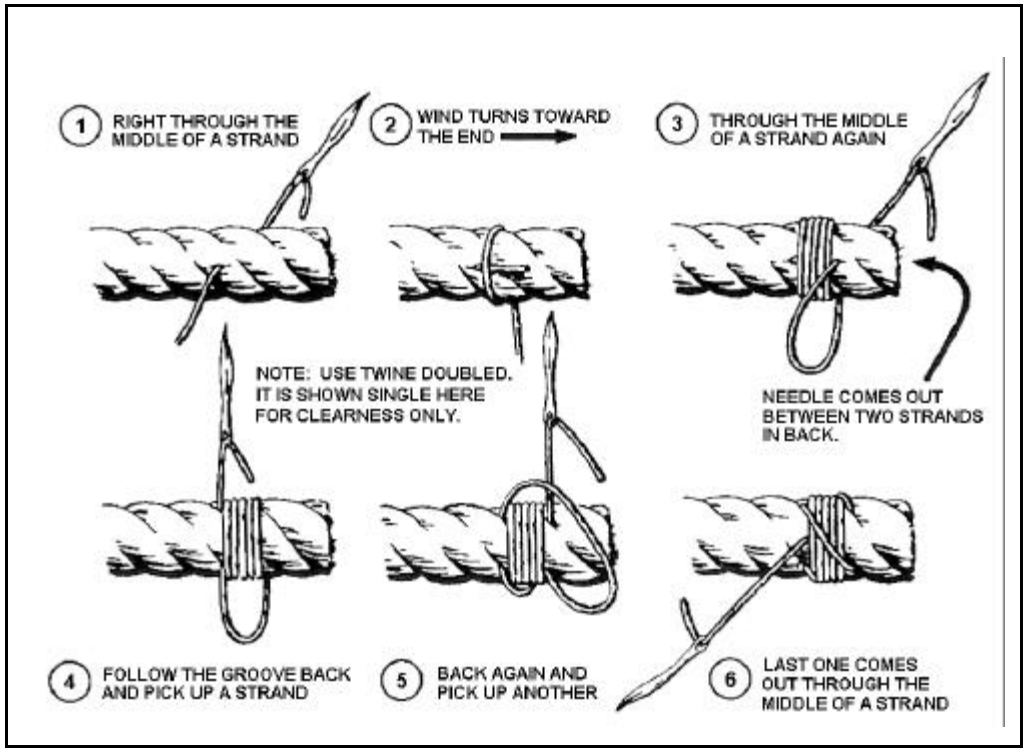

Figure 12-9. Making a Permanent Whipping

KNOTS, BENDS, AND HITCHES

12-32. A good knot must be easy to tie, hold without slipping, and be easy to untie. The choice of the best knot, bend, or hitch to use depends largely on the job it has to do (Figure 12-10). This FM explains why a given one is used and also gives the efficiency or strength of many of the knots, bends, and hitches. Always follow this rule: never tie a knot on which you are not willing to stake your life.

12-33. Each of the three terms--knot, bend, and hitch--has a specific definition. In a knot, a line is usually bent or tied to itself, forming an eye or a knob or securing a cord or line around an object, such as a package. In its noun form, a bend ordinarily is that used to join the ends of two lines together. In its verb form, bend means the act of joining; bent is the past tense of bend. A hitch differs from a knot and a bend in that it ordinarily is tied to a ring, around a spar or stanchion, or around another line. In other words, it is not merely tied back on itself to form an eye or to bend two lines together.

12-34. Tying a knot, bend, or hitch in a line weakens it because the fibers are bent sharply, causing the line to lose varying degrees of its efficiency or strength. A general rule to follow is to use a knot, bend, or hitch for temporary work and use a splice for permanent work because it retains more of the line's strength.

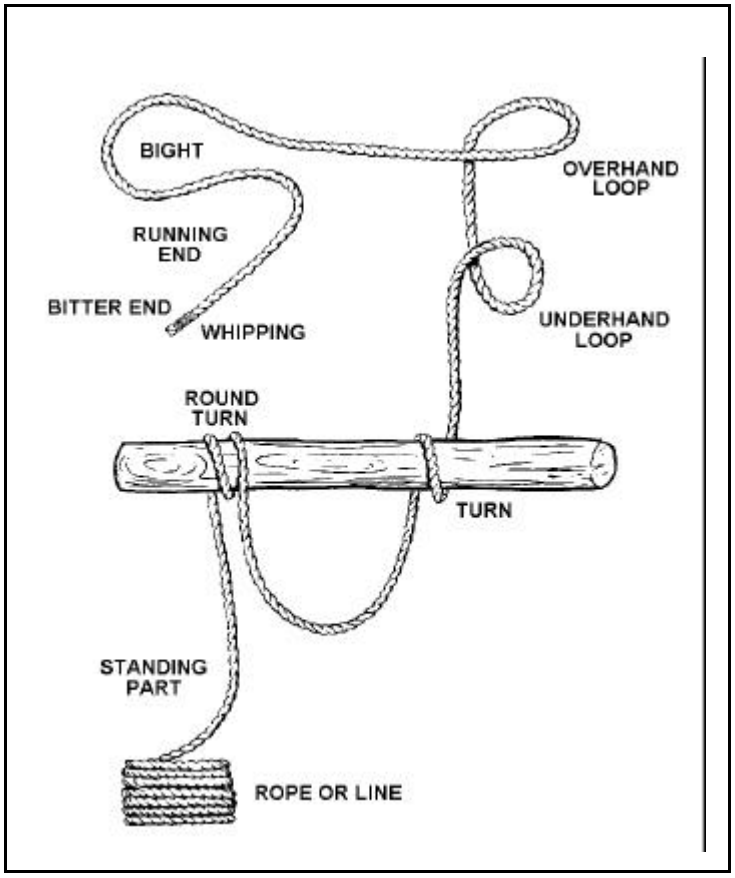

Figure 12-10. Elements of the Knot, Bend, and Hitch

OVERHAND KNOT

12-35. The overhand knot (Figure 12-11, page 12-12) is the basis for all knots. It is the simplest of all and the most commonly used. It may be used to prevent the end of a line from untwisting, to form a knot at the end of a line, or to be part of another knot. When tied to the end of a line, this knot will prevent it from running through a block, hole, or other knot.

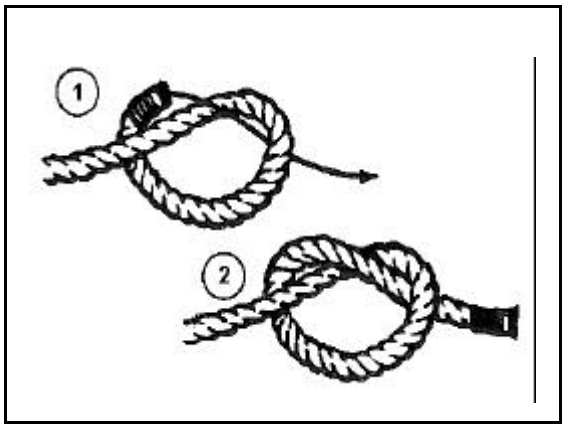

Figure 12-11. Overhand Knot

FIGURE EIGHT KNOT

12-36. The figure eight knot (Figure 12-12) is used to form a larger knot at the end of a line than would be formed by an overhand knot. It is used to prevent the end of the line from running through a block. It is an easy knot to tie.

12-37. To tie this knot, form an overhand loop in the line and pass the running end under the standing part, up the other side, and through the loop. Tighten the knot by pulling on the running end and the standing part.

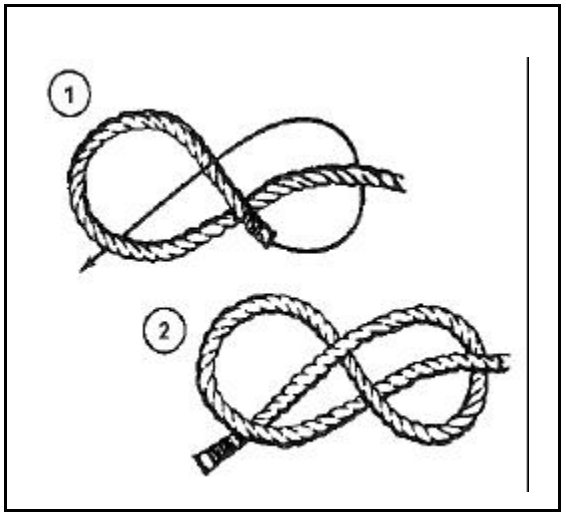

Figure 12-12. Figure Eight Knot

SQUARE KNOT

12-38. Use the square knot (Figure 12-13) to tie two lines of equal size together so that they will not slip. Figure 12-13 shows that for the square knot, the end and standing part of one line come out on the same side of the bight formed by the other line. This knot will not hold if the lines are wet or are of unequal sizes. It tightens under strain but can be untied by grasping the ends of the two bights and pulling the knot apart. Its strength is 45 percent.

12-39. To avoid a "granny" or a "fool's knot" which will slip, follow this procedure. Take the end in your right hand and say "over and under." Pass it over and under the part in your left hand as shown in Figure 12-13. With your right hand, take the end that was in your left hand. This time say to yourself "under and over." Pass it under and over the part in your left hand.

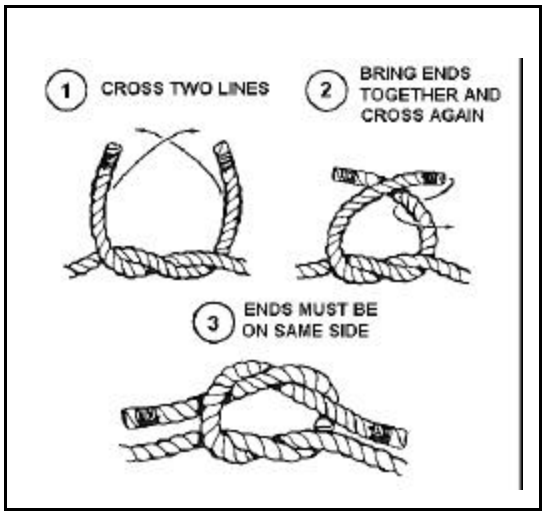

Figure 12-13. Square Knot

SHEET OR BECKET BEND

12-40. Use a single sheet or becket bend to tie two lines of unequal size together and to tie a line to an eye. Always use a double sheet or becket bend to tie the gantline to a boatswain's chair. The single sheet or becket bend will draw tight, but will loosen when the line is slackened. The single sheet or becket bend is stronger than the square knot, with a strength of 55 percent, and is more easily untied than the square knot.

12-41. To tie a single sheet or becket bend (Figure 12-14), take a bight in the larger of the two lines. Using the smaller of the two lines, put its end up through the bight. Then put it around the standing part of the larger line first because it will have the strain on it and then around the end of the larger line. Next put the end of the smaller line under its standing part. The strain on the standing part will hold the end. Notice in the double sheet or becket bend that the end of the smaller line goes under its standing part both times.

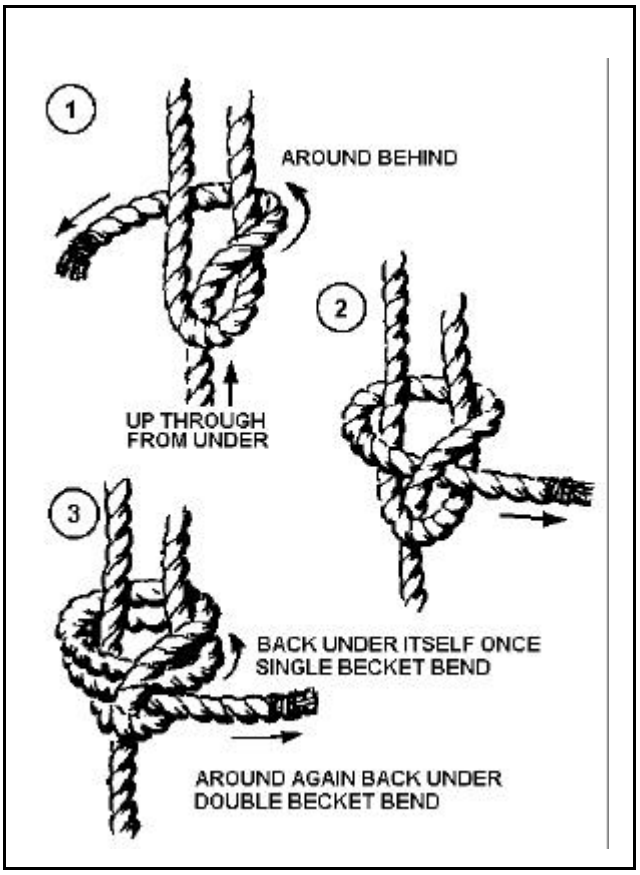

Figure 12-14. Tying the Single and Double Sheet or Becket Bend

BOWLINE

12-42. User the bowline to tie a temporary eye in the end of a line. A bowline neither slips nor jams and unties easily. An example of a temporary use is that of tying a heaving line or messenger to a hawser and throwing it to a pier where line handlers can pull the hawser to the pier, using the heaving line or messenger.

12-43. To tie a bowline (Figure 12-15), hold the standing part with your left hand and the running end with your right. Flip an overhand loop in the standing part, and hold the standing part and loop with the thumb and fingers of your left hand. Using your right hand, pass the running end up through the loop, under the standing part, and down through the loop. Its strength is 60 percent.

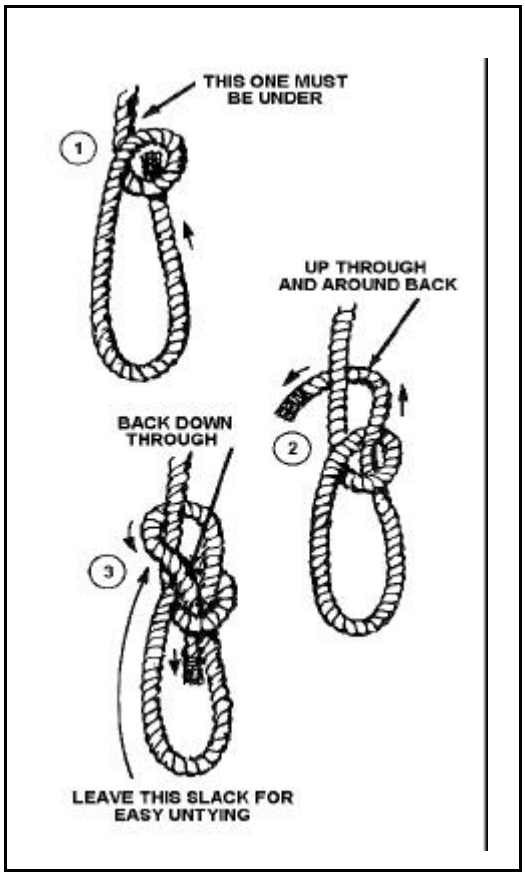

Figure 12-15. Tying a Bowline

BOWLINE ON A BIGHT

12-44. A bowline on a bight gives two loops instead of one, neither of which slips. It can be used for the same purpose as a boatswain's chair. It does not leave both hands free, but its twin, nonslipping loops form a comfortable seat. Use the bowline on a bight when:

- Strength (greater than a single bowline) is necessary.
- A loop is needed at some point in a line other than at the end.

- The end of a line is not accessible.

The bowline is easily untied and can be tied at the end of a line by doubling the line for a short section.

12-45. To tie a bowline on a bight (see Figure 12-16) double the line, form an overhand loop, and put the end of the bight through the loop. Put your hand through the bight, take hold of the bight under the loop, and pull it through the first bight to tighten the knot.

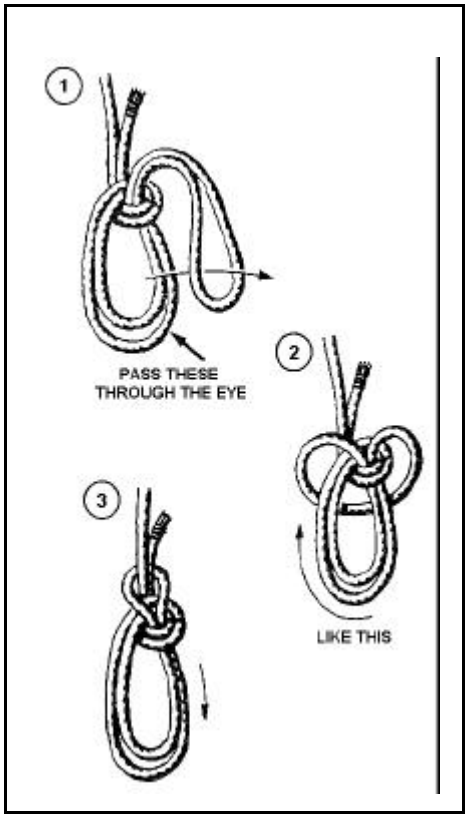

Figure 12-16. Typing a Bowline on a Bight

FRENCH BOWLINE

12-46. Use a French bowline as a sling for lifting an injured person. For this purpose, one loop is used as a seat and the other loop is put around the body under the arms, then the knot is drawn tight at the chest. Even an unconscious person can ride up safely in a properly secured French bowline, because his weight keeps the two loops tight so that he will not fall out. It follows, though, that it is necessary to take care not to allow the loop under his arms to catch on any projections. Also use the French bowline where a person is working alone and needs both hands free. The two loops of the knot can be adjusted to the required size. Figure 12-17 shows the step-by-step procedure for tying the French bowline.

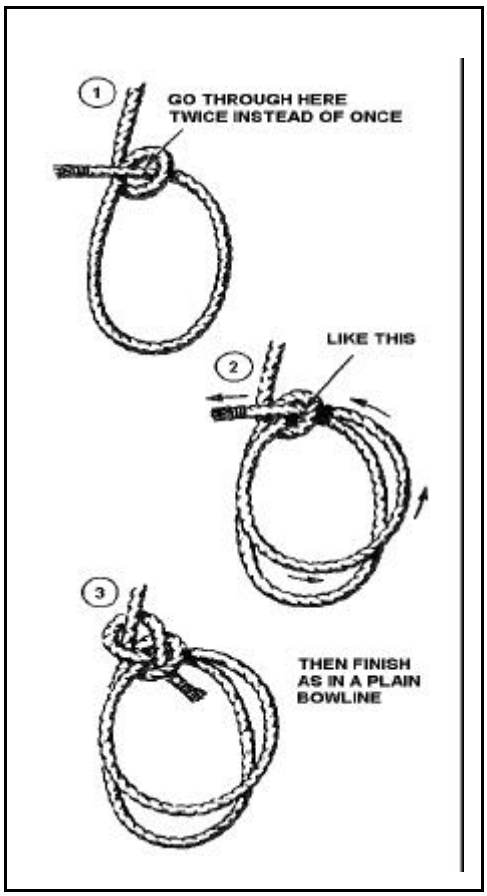

Figure 12-17. Typing a French Bowline

DOUBLE CARRICK BEND

12-47. A double carrick bend with its ends seized (Figure 12-18) is recommended for tying together two hawsers. Even after a heavy strain, it is easy to untie because it never draws up. Its strength is 56 percent. However, a double carrick will draw up if the ends are not seized.

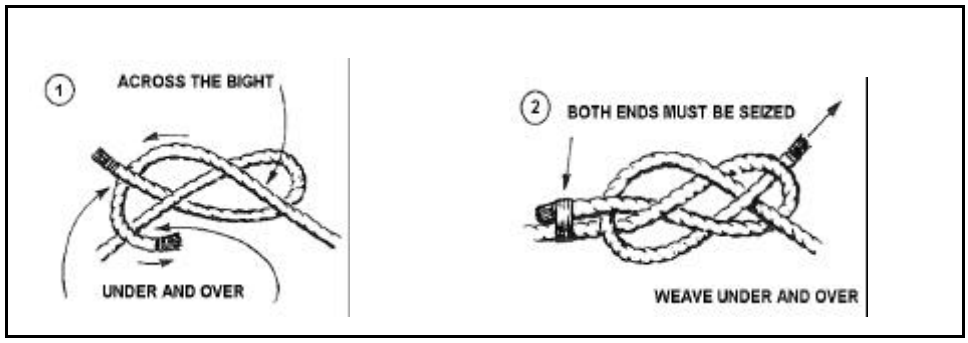

Figure 12-18. Tying the Double Carrick Bend

HALF HITCH

12-48. Use the half hitch to back up other knots, but tie with the short end of the line. Never tie two half hitches by themselves. Instead, take two round turns so that the strain will be on the line, not the hitches, and then tie the hitches (Figure 12-19).

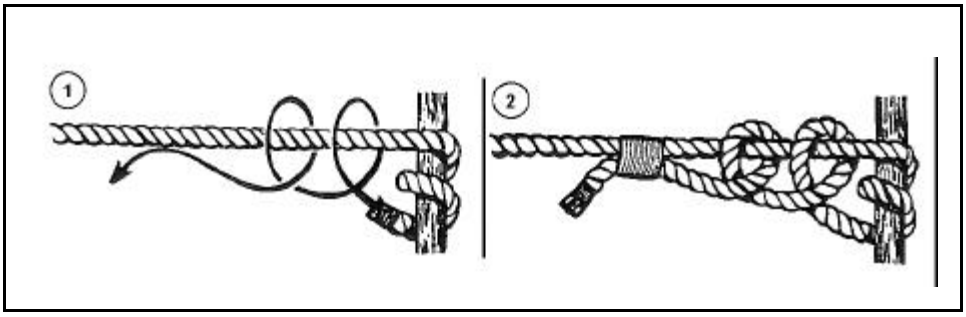

Figure 12-19. Half Hitch

CLOVE HITCH

12-49. The best knot for tying a line to a ring, a spar, or anything that is round is a clove hitch (Figure 12-20). It will not jam or pull out. Its strength is 55 to 60 percent.

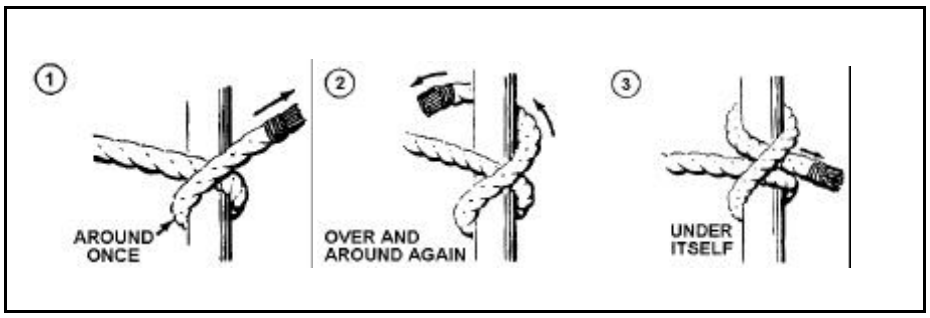

Figure 12-20. Clove Hitch

STOPPER HITCH

12-50. A possible defect of a clove hitch is that it can slide along the round object to which it is tied. To prevent this, use a stopper hitch (Figure 12-21), commonly called a rolling hitch.

12-51. When tying, make a turn around the line with the stopper (first view). Pull tight and take another turn. This one must cross the first turn and then pass between the first turn and the stopper (second view). This completes the stopper hitch itself, but it must be stopped off in one of two ways.

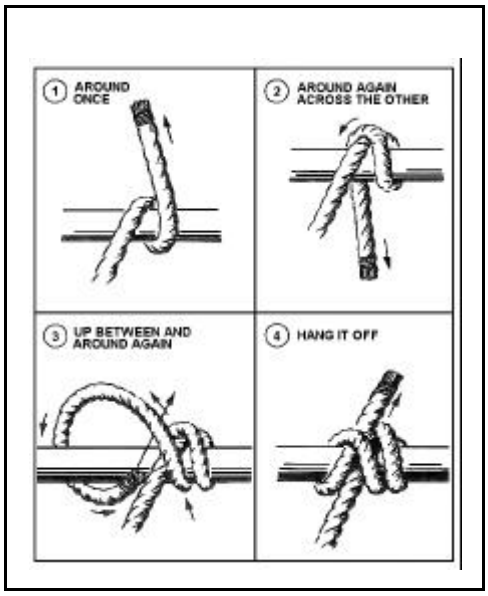

Figure 12-21. Stopper Hitch

12-52. You may make two or more turns with the lay of the line and then seize the stopper to the line with marline. Another method is to tie a half hitch directly above the rolling hitch (third view), and then take a couple of turns against the lay, and seize the stopper to the line.

STAGE HITCH

12-53. Use a stage hitch (Figure 12-22, page 12-20) for working over the side of a vessel. A stage hitch consists of a plank with a wooden horn attached at a right angle to the plank near each end to keep it away from the side.

12-54. Note that two parts of the line go under the plank. Therefore, the line supports the plank, as well as the horns. This gives more protection to persons working on the stage.

MONKEY FIST

12-55. The monkey fist (Figure 12-23, page 12-20) is tied at the end of a heaving line and a weight is put in it so that it can be thrown for a distance with some ease and accuracy. The monkey fist consists of three sets of turns taken at right angles to each other. For clarity, Figure 12-23 shows only three turns in each set; four turns per set are more likely to be used. To tie a monkey fist, start as in view 1, taking a set of turns around your hand. Then slip this set off your hand, hold it as shown in view 2, and pass the running end over your thumb and under and over the first set. Complete this set of turns. Put the last set around the second and through the first as shown in view 3. Note that the first turn of the last set locks the first two sets in place.

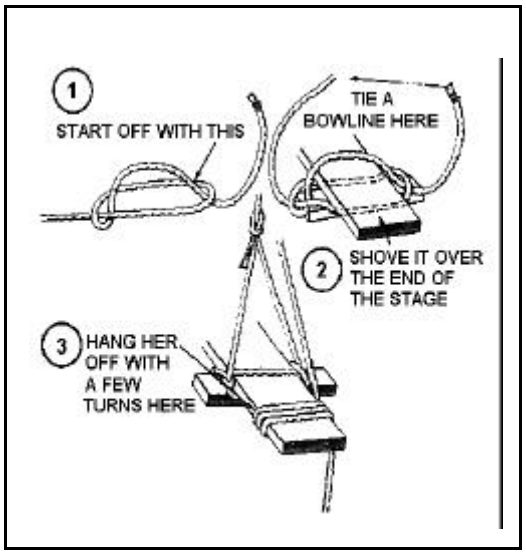

Figure 12-22. Stage Hitch

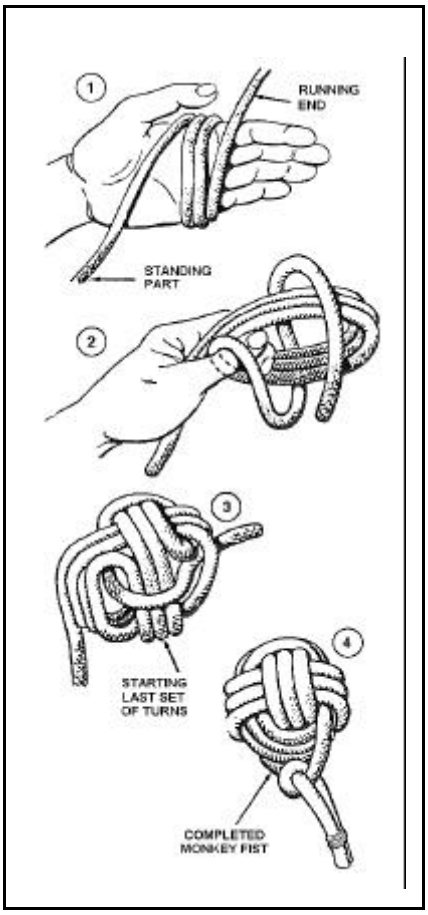

Figure 12-23. Monkey Fist

12-56. After completing the third set of turns, insert a 5- to 10-ounce weight in the monkey fist. Tighten the turns by working the slack back towards the standing part. In a properly tied monkey fist, the ends come out at opposite corners as shown in view 4. To complete the monkey fist, put a half hitch on the standing part with the running end and seize it to the standing part.

SPLICING THREE-STRAND FIBER LINE

12-57. Splicing is a method of permanently joining the ends of two lines or of bending-a line back on itself to form a permanent loop or an eye. If two lines are going to be spliced, strands on an end of each line are unlaid, and the strands are interwoven with those of the standing part of the line. Small stuff can be spliced without need of a fid. A fid is a tapering length of hickory or some other hard wood used in splicing larger lines. A knife is needed to cut off the ends of the strands. This paragraph explains and shows the back, short, and eye splices.

BACK SPLICE WITH A CROWN KNOT

12-58. Where the end of a fiber line is to be spliced to prevent unlaying and a slight enlargement of the end is not objectionable, use a back splice. This splice is usually done on small stuff. To make this splice, do the following:

- **Step 1.** Unlay six turns of the line (Figure 12-24, page 12-22).
- **Step 2.** To start the crown knot, form a bight with the left strand and lay the bitter end of the strand between the right and center strand. Then lay the center strand over the running end of the left strand. Take the right strand under the running end of the left strand, over the running end of the center strand, and back through the bight of the left strand. Then take all the slack out of the strands and gently pull the strands tight (Figure 12-25, page 12-22).
- **Step 3.** Start the left strand; go over one strand, tuck under the next one, and pull the strand tight (Figure 12-26, page 12-22).
- **Step 4.** Turn the line and tuck each strand. Three complete tucks are required for each strand (Figure 12-27, page 12-22).
- **Step 5.** Trim off the ends of the strands. Then lay the splice on the deck, put your foot on it, and roll it back and forth. This will tighten up and smooth out the splice.

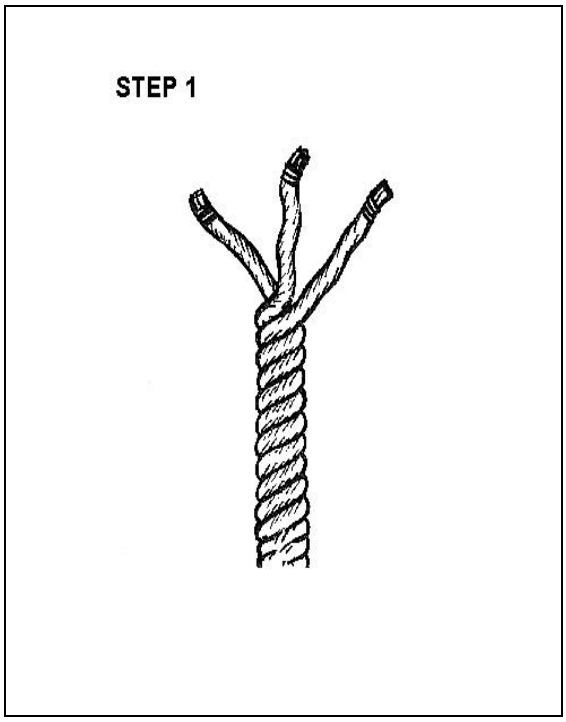

Figure 12-24. Making a Back Splice, Step 1

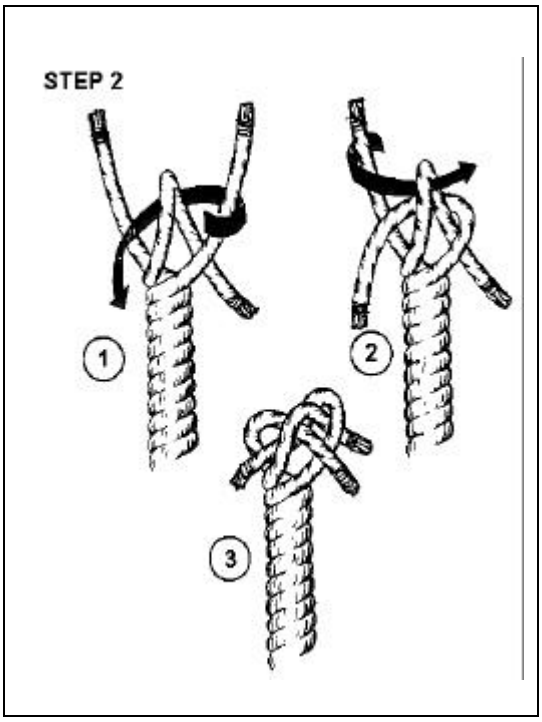

Figure 12-25. Making a Back Splice, Step 2

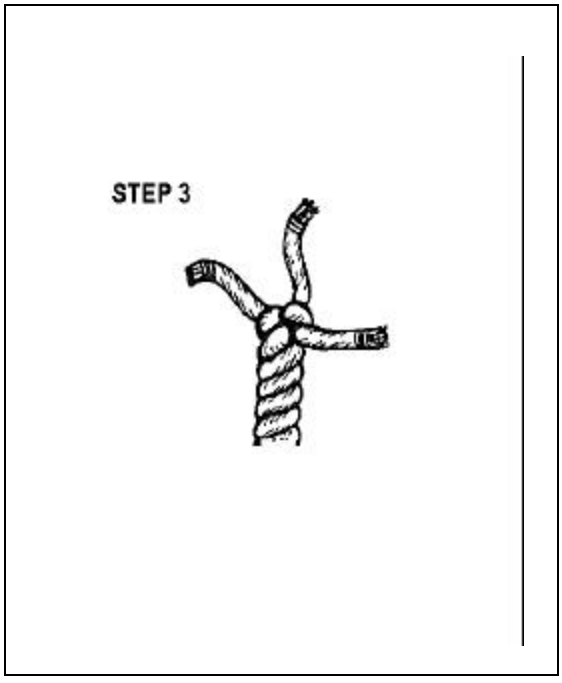

Figure 12-26. Making a Back Splice, Step 3

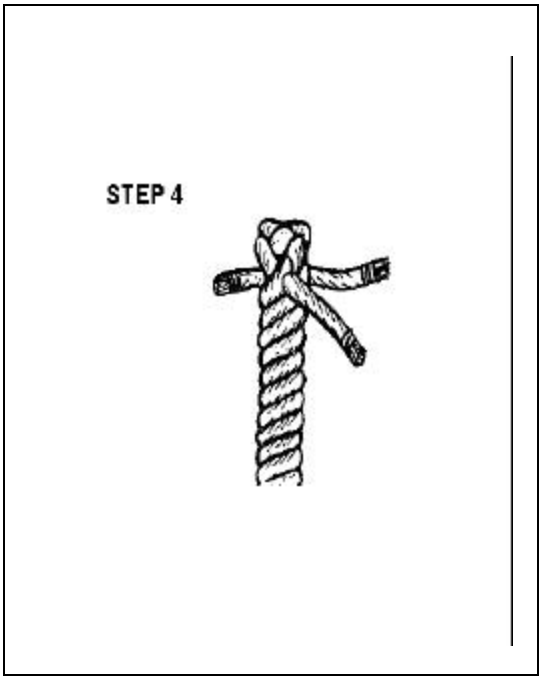

Figure 12-27. Making a Back Splice, Step 4

SHORT SPLICE

12-59. The short splice (Figure 12-28, page 12-24) is as strong as the rope of which it is made. However, the short splice will increase the diameter of the line at the splice and can be used only where this increase in diameter will not affect the operation. Use the short splice to repair damaged lines. The damaged parts of the line are cut out and the short splice rejoins the line. Only lines of the same size can be joined together using the short splice.

12-60. Do the following to make a short splice (see also Figure 12-28):

- **Step 1.** Untwist one end of each line five complete turns. Whip or tape each strand. Bring these strands tightly together so that each strand of one line alternates with a strand of the other line. Put a temporary whipping on the lines where they join to keep them from suddenly coming apart. Do this with small lines until you are skilled enough to hold them together while you tuck.
- **Step 2.** Starting with either line, tuck a round of strands in the other line. Then, using the strands of the other line, tuck a round in the first line. These first two rounds of tucks are expressed: "Tuck in one direction. Reverse and tuck in the other direction." When making a round of tucks, regardless of the direction, face where the lines are butted so to always tuck from right to left. Pull each strand as required to tighten the center of the splice.
- **Step 3.** Tuck two more rounds in each direction. After tucking in one direction and reversing and tucking in the other direction, pull the strands as required to strengthen the center of the splice. When finished with three rounds of tucks in each direction, cut off any excess length on the strands. To have a smoother splice, you may cut off one-third of the circumference of each strand before making the second round of tucks and another one-third cut before the third round.
- **Step 4.** When the splice is completed, cut off the excess strands as before. Lay the splice on the deck and roll it with your foot to smooth out and tighten the splice.

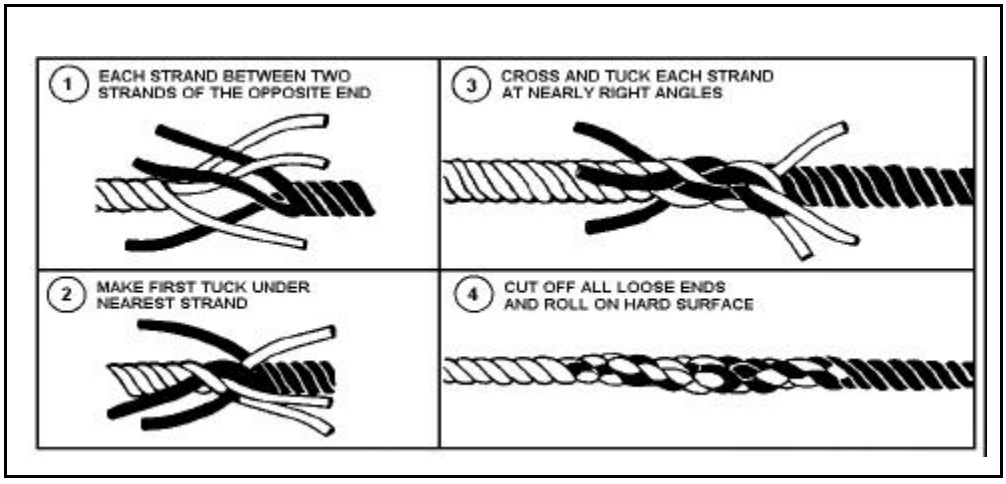

Figure 12-28. Making a Short Splice

EYE SPLICE

12-61. When a loop is to be permanent, put in the line with an eye splice, which has a strength of 90 to 95 percent. Compare this with the strength of a bowline of 60 percent.

12-62. Unlay (untwist) the strands four to five turns and splice them into the standing part of the line by tucking the unlaid strands from the ends into the standing part. Whip or tape the ends of the strands. An original round of tucks with two more complete rounds is enough because, if the line parts, it will likely part in the eye rather than in the splice. For this reason, three rounds are as effective as a greater number. Do the following to make an eye splice:

Note: Always whip or tape the ends of the strands before starting; otherwise they will unlay. Seize large lines at the point where unlaying stops to avoid trouble working with them. With up to 21 threads, you can open the strands in the standing part with your fingers. Use the fid for larger lines.

- **Step 1.** Figure 12-29 shows how to make the first two tucks. Separate the strands in the end and hold them up as shown. Place the three unlaid strands against the standing part where they will be tucked, forming an eye the size you need. Always tuck the middle strand facing you first. Put a reverse twist on the standing part so that you can raise the strand under which you will make the first tuck. Pick up the strand that you will tuck, and tuck it under the strand raised. Always tuck from right to left or with the lay of the line.

- **Step 2.** Be sure to keep the next strand on the side of the line that is towards you. Tuck that one next. Put it over the strand under which the first one is tucked, and tuck it under the next one (Figure 12-30).
- **Step 3.** Now turn the incomplete eye over as shown. Check the third strand to be sure that it has not unlaid more. If it has, twist it back to where it should be. Take the last strand and put it across the standing part, turn its end back toward you, put it under the strand over which the first tuck was made, and tuck it in a direction toward you. This results in the third tuck going to where the second came out and coming out where the first went in. After this round of tucks, there is a strand in each lay (Figure 12-31).

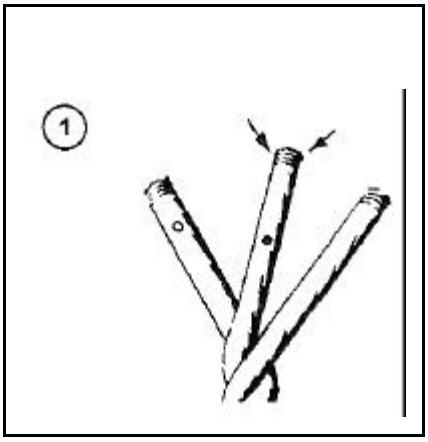

Figure 12-29. Selecting the Middle Strand

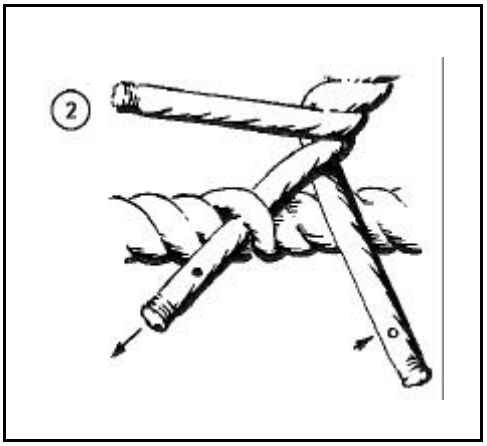

Figure 12-30. First Two Tucks in an Eye Splice

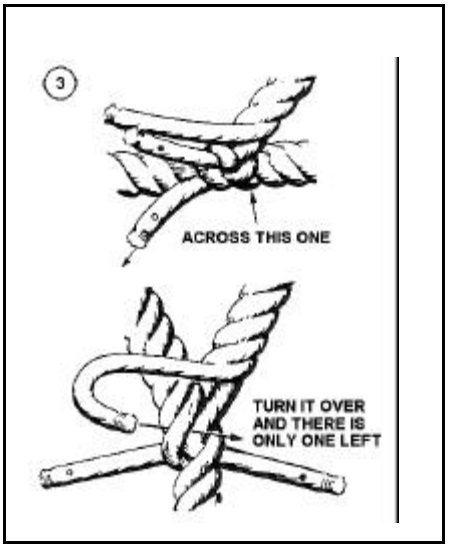

Figure 12-31. Last Tucks of an Eye Splice

12-63. Pull each of the three strands tucked backward at about a 45-degree angle to the eye to tighten the splice.

12-64. The first round of tucks is the key to making perfect eye splices. Starting with any strand, simply tuck each one over and under two more times. None of the last two rounds of tucks requires "over and back." However, always tuck from right to left. As required, pull the tucked strands away from the eye and twist the splice and line to tighten them.

12-65. After finishing the splice, bend the end of each strand back toward the splice and, using a knife, cut it off, up, and away, leaving a one-fourth inch tip.

CARE AND USE OF WIRE ROPE

12-66. Wire rope is made of steel (the core is likely to be fiber). The grades in descending order of strength are: extra improved plow, improved plow, plow, and mild plow steel. Of these four grades, the Army uses improved plow steel extensively and plow steel to a lesser extent. The manufacturer stamps the grade on the reel. Because you cannot tell the grade of wire rope by looking at it, always treat it as plow steel.

MAKEUP OF WIRE ROPE

12-67. The basic unit of wire rope is the individual wire. 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. Strands are laid around a core to form the wire rope (Figure 12-32).

12-68. The core may be a wire, hemp, or polypropylene (a synthetic fiber. Use wire rope, with a wire as its core, where high temperatures would damage hemp and polypropylene. New wire rope is made with polypropylene as the core. The core is a foundation to keep the wire rope round, is a shock absorber when the wire rope contracts under strain, and is a reservoir or place where a portion of the lubricant is stored.

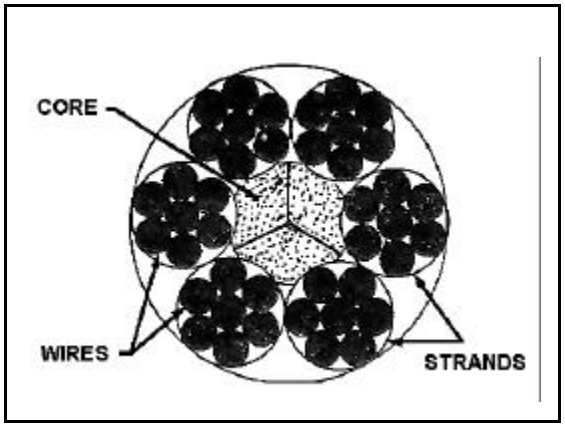

Figure 12-32. Makeup of Wire Rope

CLASSIFICATION

12-69. Wire rope is classified by the following:

- Number of strands
- Number of wires per strand.
- Strand construction.
- Type of lay.

Strands and Wires

12-70. Standard wire rope has six strands. The present commercial classifications are not factually descriptive. Rather, they are groupings of wire ropes of similar weight, flexibility, and strength. Therefore, the 6 x 19 classification has 6 strands of wires per strand. The 6 x 37 classification has six strands and 37 wires in each strand. Figure 12-33 shows cross sections of four classifications. The smaller and more numerous the wires, the more flexible the rope, but the less resistant to external abrasion. Wire rope made up of a smaller number of larger wires is less flexible and more resistant to abrasion. All else being equal, two ropes of the same size have the same strength even though, for example, one is 6 x 19 and the other is 6 x 37.

Strand Construction

12-71. Wires and strands used in most wire rope are preformed. Preforming is a method of presetting the wires in the strands into the permanent corkscrew form they will have in the completed rope. As a result, preformed wire rope does not have the internal stresses found in non-preformed wire rope, does not untwist as readily as non-preformed wire rope, and is more flexible.

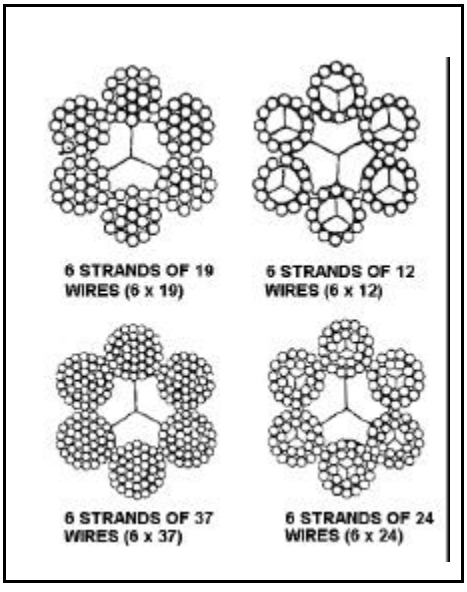

Figure 12-33. Strands and Wires

Types of Lay

12-72. Lay refers to the direction of winding of the wires in the strands and the strands in the rope. Both may be wound in the same direction or they may be wound in opposite directions.

12-73. In regular lay, the strands and wires are wound in opposite directions. Most common is the right, regular lay in which the strands are wound right and wires left. Use this lay in marine operations.

12-74. In Lang lay, the strands and wires are wound in the same direction. Use this type of wire rope on the blades of bulldozers and scrapers.

MEASUREMENT

12-75. Whatever its grade, wire rope is usually measured by its diameter. Figure 12-34 shows the correct and incorrect methods of measuring the diameter of wire rope. To measure wire rope correctly, place it in the caliper so that the outermost points of the strands will be touching the jaws of the caliper. Because of friction and tension, the diameter of used wire rope will be 1/64- to 1/8-inch less than when new.

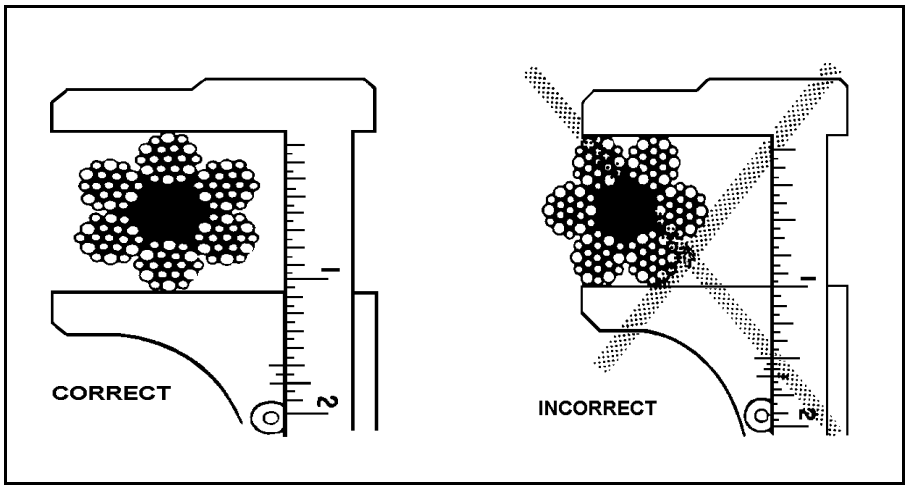

Figure 12-34. Measuring Wire Rope

SAFE WORK LOAD AND BREAKING STRENGTH

12-76. Useful formulas for determining the SWL of several grades of wire rope have constants not to be confused with safety factors. For example, the formula for the SWL in short tons (2,000 pounds) for extra improved plow steel wire rope is diameter squared times 10 or SWL = D^2 X 10.

12-77. To find the SWL of 1-inch, 6 X 19, extra improved plow steel wire rope:

$$SWL = D^2 \text{ X } 10 = 1 \text{ X } 1 \text{ X } 10 = 10 \text{ STON}$$

12-78. A figure relatively constant in marine operations, especially for new wire rope, is the safety factor. The safety factor is 5. Use the SF with the SWL to find the breaking strength or strain.

$$BS = SWL \text{ X } 5$$

$$BS = 10 \text{ X } 5 = 50 \text{ STON}$$

12-79. The formulas for improved plow steel, plow steel, and mild plow steel (6 X 19 wire rope) are as follows:

- **Improved plow steel.**
  $SWL = D^2 \text{ X } 8 = STON$
  $BS = SWL \text{ X } SF = STON$
- **Plow steel.**
  $SWL = D^2 \text{ X } 7 = STON$
  $BS = SWL \text{ X } SF = STON$
- **Mild plow steel.**
  $SWL = D^2 \text{ X } 6 = STON$
  $BS = SWL \text{ X } SF = STON$

INSPECTION

12-80. Inspect wire ropes frequently and replace frayed, kinked, worn, or corroded ropes. How frequently rope should be inspected depends on the amount of its use. A rope used 1 or 2 hours a week requires less frequent inspection than one used 24 hours a day.

12-81. The common causes of wire rope failures are the following:

- Using rope of incorrect size, construction, or grade.
- Allowing rope to drag over obstacles.
- Operating over sheaves and drums of inadequate size.
- Overwinding or crosswinding on drums.
- Operating over sheaves and drums out of alignment.
- Permitting rope to jump sheaves.
- Subjecting rope to moisture or acid fumes.
- Permitting rope to untwist.
- Using kinked rope.

12-82. Carefully inspect weak points and points of greatest stress. Worn or weak spots show up as shiny flat spots on the wires. If the outer wires have been reduced in diameter by one-half, the wire rope is unsafe.

12-83. Broken wires also show where the greatest stress occurs. If individual wires are broken next to one another, unequal load distribution at this point will make the rope unsafe. These broken wires are called "fishhooks." To determine the extent of damage to the wire rope, slide your finger along one strand of wire for one complete turn, which is equal to the length of one wire rope lay. Count the number of "fishhooks." If you count eight or more "fishhooks," replace the wire rope immediately. Any time you find six to eight "fishhooks" with the measured area, you will consider the wire rope unsafe and should have it replaced.

UNREELING

12-84. When removing wire rope from a reel or coil, be sure to rotate the reel or coil (Figure 12-35). If the reel is mounted, unwind the wire rope by holding the end and walking away from the reel. If a wire rope is in a small coil, stand the coil on end and roll it along the deck, barge, wharf, or ground. Be sure to remove any loops that may form, although the reason for rotating the reel or coil is to avoid loops.

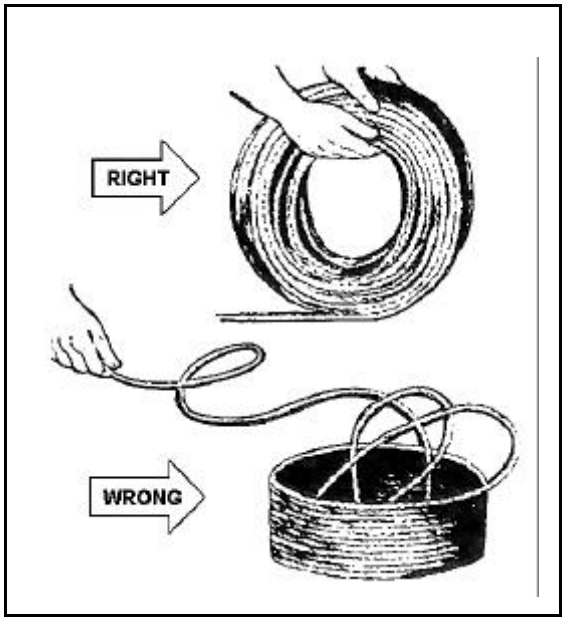

Figure 12-35. Uncoiling Wire Rope

SEIZING

12-85. Seize all wire rope before cutting. If the ends of the rope are not properly secured, the original balance of tension is disturbed and maximum service cannot be obtained because some strands carry a greater load than others. Use annealed wire for the seizings. Figure 12-36 shows the steps on how to seize wire rope. The turns of the annealed wire rope should be put on close and tight so that it will not be necessary to tighten them when the ends are being twisted together. It is well to twist the ends together at one end of the seizing so that the completed twist can be tapped into the groove between two strands where it is less likely to be knocked off.

12-86. There are three formulas for determining the number and length of seizings and the space between them. When a calculation results in a fraction, use the next larger whole number. The following formulas are based on a wire rope with three-fourths inch diameter:

12-87. The number of seizings required equals about three times the diameter of the rope. For example:

3 X 3/4 = 2 1/4 or 3 seizings

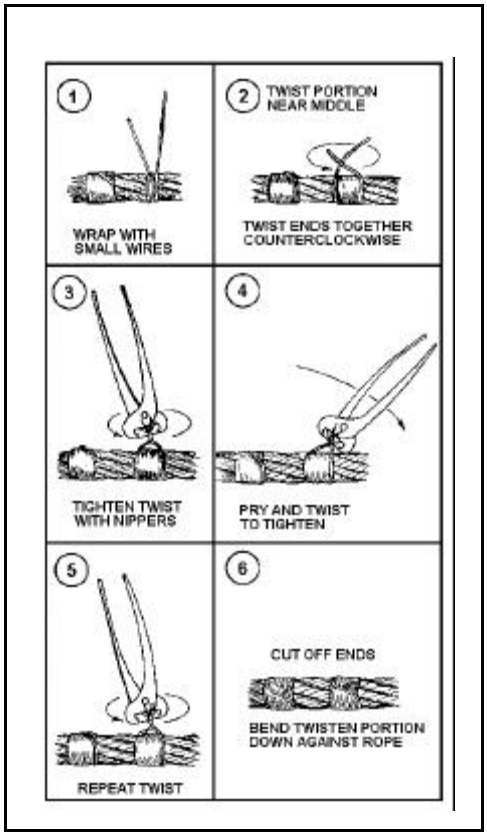

Figure 12-36. Seizing Wire Rope

12-88. Because the rope will be cut, six seizings are required so that there will be three on each rope end after the cut. The length of a seizing should be equal to the diameter of the rope. For example: 1 X 3/4 = 3/4 or 1 inch

12-89. The seizings should be spaced apart at a distance equal to twice the diameter. For example: 2 X 3/4 = 1 1/2 or 2 inches.

CUTTING

12-90. Wire rope may be cut with a wire rope cutter, a cold chisel, a hacksaw, bolt clippers, or an oxyacetylene cutting torch.

12-91. After seizing the wire rope, insert it into the cutter with the blade coming between the two central seizings. Close the locking device. Then, close the valve on the cutter and pump the handle to build up enough pressure to force the blade through the rope.

12-92. Use the bolt clippers on wire rope of fairly small diameter. However, the oxyacetylene torch can be used on wire of any diameter. Cutting with the hacksaw and cold chisel is slower than cutting with the other tools and equipment.

COILING

12-93. It may be necessary to take a length of wire rope from a reel and coil it down before using. Small loops or twists will form if the wire rope is coiled in a direction opposite to the lay. To avoid them, coil right lay wire rope clockwise and left lay counterclockwise. When a loop forms in the wire, put a back turn in as shown in Figure 12-37.

SIZE OF SHEAVES AND DRUMS

12-94. Two things happen when a wire rope is bent over a sheave or drum:

- Each wire is bent to conform to the curvature.
- The wires slide against each other longitudinally because the inside arc of the rope against the sheave or drum is shorter than the outside arc.

The smaller the diameter of the sheave or drum, the greater the bending and sliding. This bending and moving of wires should be kept to a minimum to reduce wear.

12-95. The minimum recommended sheave and drum diameter is 20 times the diameter of the rope. For example, determine the minimum sheave diameter for 6/8-inch rope:

20 X 5/8 = 12 1/2 inch sheave

If a 12 1/2-inch sheave is not on hand, use the next larger size. Never use a smaller size.

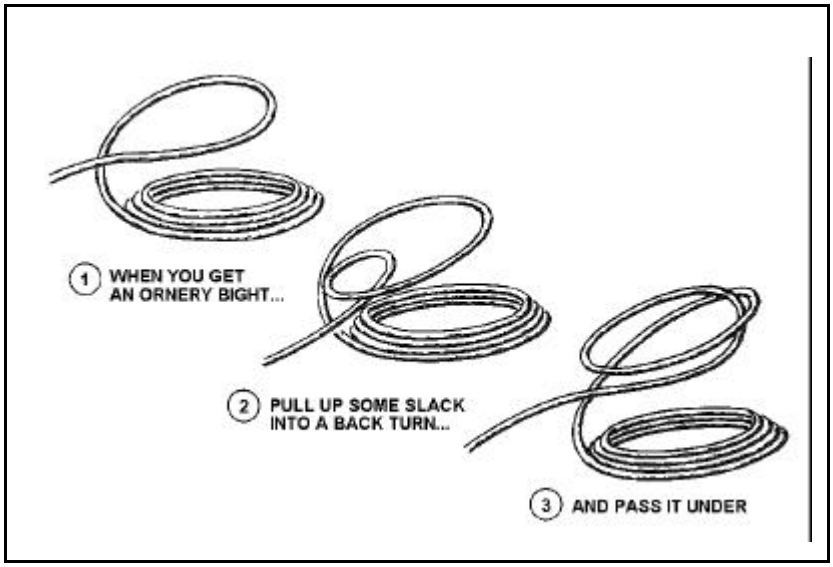

Figure 12-37. Putting a Back Turn in Wire Rope

LUBRICATION

12-96. Wire rope is lubricated when it is manufactured. The lubricant generally does not last throughout the life of the rope, which makes relubrication necessary. Crater "C" compound is recommended, but oil on hand may be used rather than delaying lubrication. Always lubricate as often as necessary. Heat Crater "C" compound before putting it on the wire rope. When lubricating, use a brush if one is on hand. If not, use a sponge or cloth, but look out for "fishhooks" or broken wires.

REVERSING ENDS

12-97. It is sometimes wise to reverse ends or cut back the ends to get more service from wire rope. Reversing ends is more satisfactory than just cutting ends because frequently the wear and fatigue on a rope are more severe at certain points than at others. Reversing distributes other, stronger parts of the rope to the points getting wear and fatigue. To reverse ends, remove the drum end and put it in the attachment. Then fasten the end taken from the attachment to the drum. Cutting back the ends has a similar effect, but there is not as much change involved. In reversing ends, cut off short lengths of both ends to remove the sections that have sustained the greatest local fatigue.

STORAGE

12-98. Wire rope should be coiled on a spool for storage. Attach a tag to the rope or spool to show its grade, size, and length. Store wire rope in a dry place to reduce corrosion. Do not store it with chemicals or where chemicals have been stored because both chemicals and their fumes might attack the metal. Always clean and lubricate wire rope before storing.

PUTTING AN EYE IN WIRE ROPE

12-99. This paragraph discusses how to put both a temporary eye and a permanent eye in wire rope. A temporary eye can be put in wire rope by using wire rope clips or by using a field expedient known as a "hasty eye" or "Molly Hogan" splice. A Liverpool splice is the accepted method for putting a permanent eye in the end of a wire rope. With the proper equipment, and a bit of practice, a Liverpool splice can be put in wire rope in less than 15 minutes.

TOOLS USED FOR SPLICING

12-100. Except for the knife, Figure 12-38 shows the tools needed for splicing. Use the marlinespike for opening the strands in the standing part of the wire rope and for working the strands to be spliced into the standing part. Use the wire cutters for cutting the strands after the splice is complete. Use the hydraulic wire rope cutter to cut the length of wire rope that will be spliced. Use a thimble to keep the wires from moving and the vise from crushing them when a soft eye is made. An eye splice can be made with or without a thimble. Always use a thimble whenever an eye splice is put in unless special circumstances prohibit it. The thimble protects the wire rope from sharp bends and abrasive action. The efficiency of a well-made splice with a heavy-duty thimble varies from 70 to 90 percent. After splicing the soft eye, remove the thimble. When an eye is to have a thimble as a permanent part, the thimble is the size of the eye desired.

TEMPORARY EYE USING WIRE ROPE CLIPS

12-101. A temporary eye may be put in wire by using wire rope clips. Figure 12-39 shows the correct and incorrect ways of using these clips. The U-bolt always goes over the bitter end and the roddle on the standing part. Space the clips apart at a distance equal to six times the diameter of the wire. After a rope is under strain, tighten the clips again. On operating ropes, tighten the clips every few hours and inspect the rope carefully. Inspect at points on the rope where there are clips. 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.

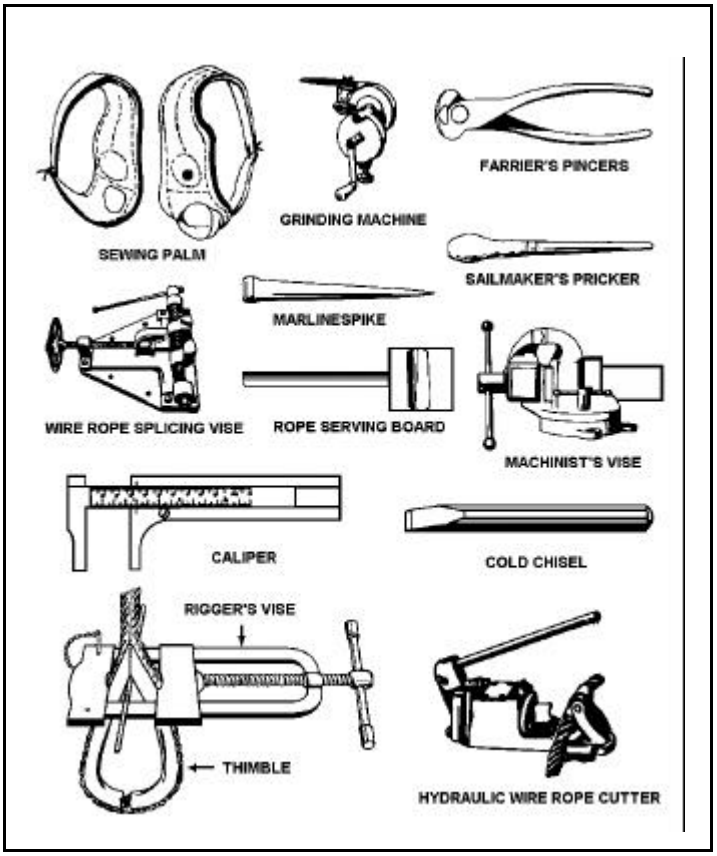

Figure 12-38. Selected Components of Rigger's Cargo Set

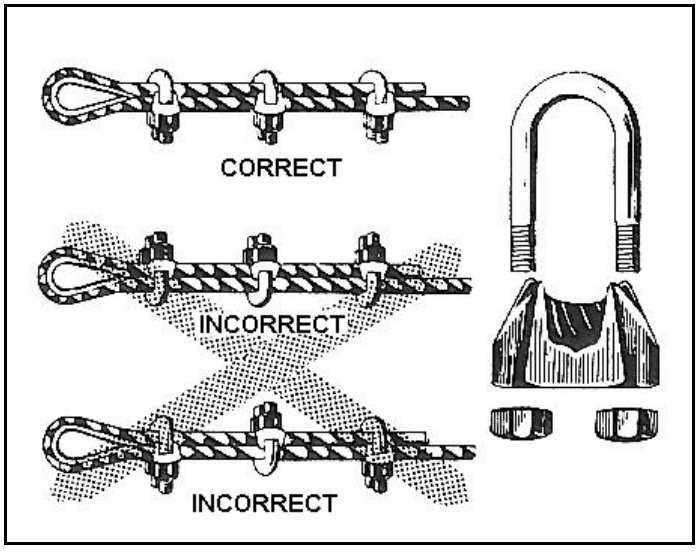

Figure 12-39. Correct and Incorrect Use of Wire Clips

12-102. To obtain maximum strength from the temporary eye, use the correct size and number of wire clips. Size is stamped on the roddle between the two holes. The correct number of clips to use for various sizes of wire ropes is shown in Figure 12-40.

12-103. Or use the following formula:

3 X diameter of rope + 1 =
number of clips (round off)

12-104. Correct spacing between clips is:

6 X diameter of rope =
correct spacing (inches)

SIZE OF ROPE (INCHES)	NUMBER OF CLIPS
1/2	2
5/8	3
3/4	3
7/8	4
1	4
1 1/8	5
1 1/4	5
1 1/2	6

Figure 12-40. Size and Number of Wire Clips

12-105. The improved type of wire rope clip shown in Figure 12-41 has a few advantages over the older type. Both halves are identical and provide a bearing surface for both parts of the rope. Therefore, it cannot be put on wrong and it does not distort the wire. It also allows a full swing with a wrench.

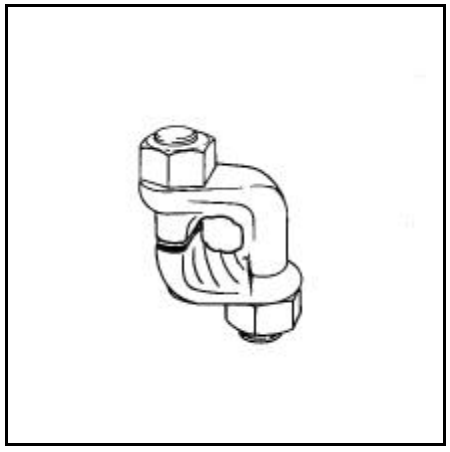

Figure 12-41. Improved Type of Wire Rope Clip

THE HASTY EYE ("MOLLY HOGAN") SPLICE

12-106. Sometimes it becomes necessary to construct a field expedient, called the hasty eye or "Molly Hogan" splice. This splice can be easily and quickly made, but it is limited to about 70 percent of the strength of the wire rope. Never use this splice to lift heavy loads. Use this splice only when working with preformed wire rope. To make this splice, do the following steps.

- **Step 1.** Using a marlinespike, screwdriver, or if necessary, a nail; separate the wire rope into two three-strand sections. These sections should be unlaid four times the diameter of the desired eye. If you want a 1-foot diameter eye, unlay the sections back 4 feet (Figure 12-42).
- **Step 2.** Use the two sections to form a loop of the desired diameter for the eye. Then, lay the strands back around each other to form the eye (Figure 12-43).
- **Step 3.** After the strands have been laid back around each other and the eye has been formed, seize the wire to complete the splice (Figure 12-44).

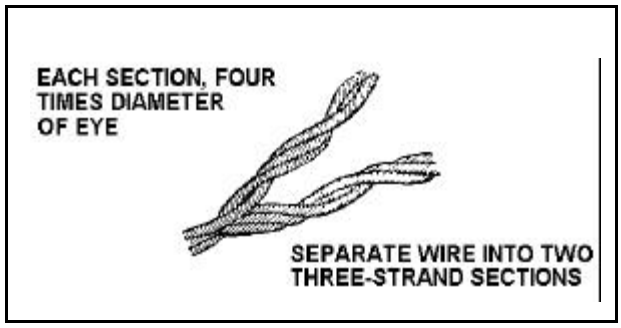

Figure 12-42. Making a Hasty Eye (Molly Hogan) Splice, Step 1

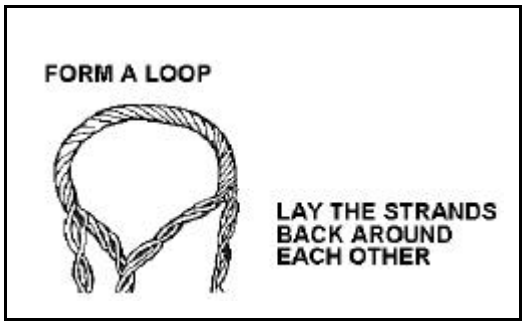

Figure 12-43. Making a Hasty Eye (Molly Hogan) Splice, Step 2

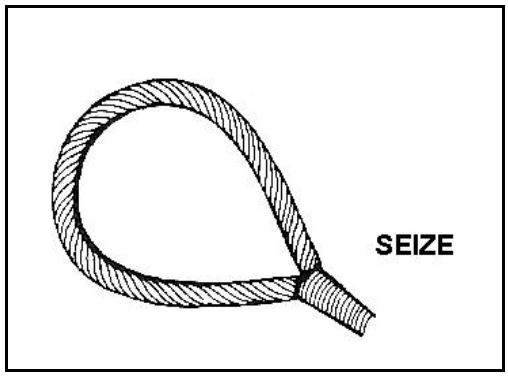

Figure 12-44. Making a Hasty Eye

(Molly Hogan) Splice, Step 3

THE LIVERPOOL SPLICE

12-107. The Liverpool splice is the easiest and most common of the wire splices make. It is the primary splice used when a permanent eye is required.

12-108. To find the distance the strands should be unlaid for an eye splice, multiply the diameter of the wire by 36 inches. (Example: 5/8-inch wire rope--5/8 X 36/1 = 180/8 = 22 1/2 or 23 inches.) Measure off that distance on the wire rope and put a seizing at that point.

12-109. Next, cut the end seizing and carefully unlay the strands. Whip the ends of each strand with either sail twine or friction tape.

12-110. Form the desired size eye and put the eye in the rigger's vise with the unlaid strands to your right as you face the vise. Stretch out the standing part of the wire, clamp and lash it, and you are ready to start.

Note: When splicing wire, always insert the marlinespike against the lay of the wire, and make sure not to shove it through the core. The core must be on the left-hand side of the spike.

Making the First Tuck of Strands One, Two, and Three

12-111. In the Liverpool splice (Figure 12-45) the first strand goes under three strands, the second strand goes in the same place but only under two strands, and number three strand goes in the same opening but only under one strand. All of the strands go in at the same point, but come out at different places.

12-112. Then, run the spike behind the three strands under which the first three are tucked, but above the first three strands as tucked. Holding the marlinespike at a 90-degree angle to the standing part, turn the spike counterclockwise about one fourth of a turn and insert the core through the standing part. This is called "dipping the core." Make sure that the core is inserted under the marlinespike. Pull the core down and run it down into the splice.

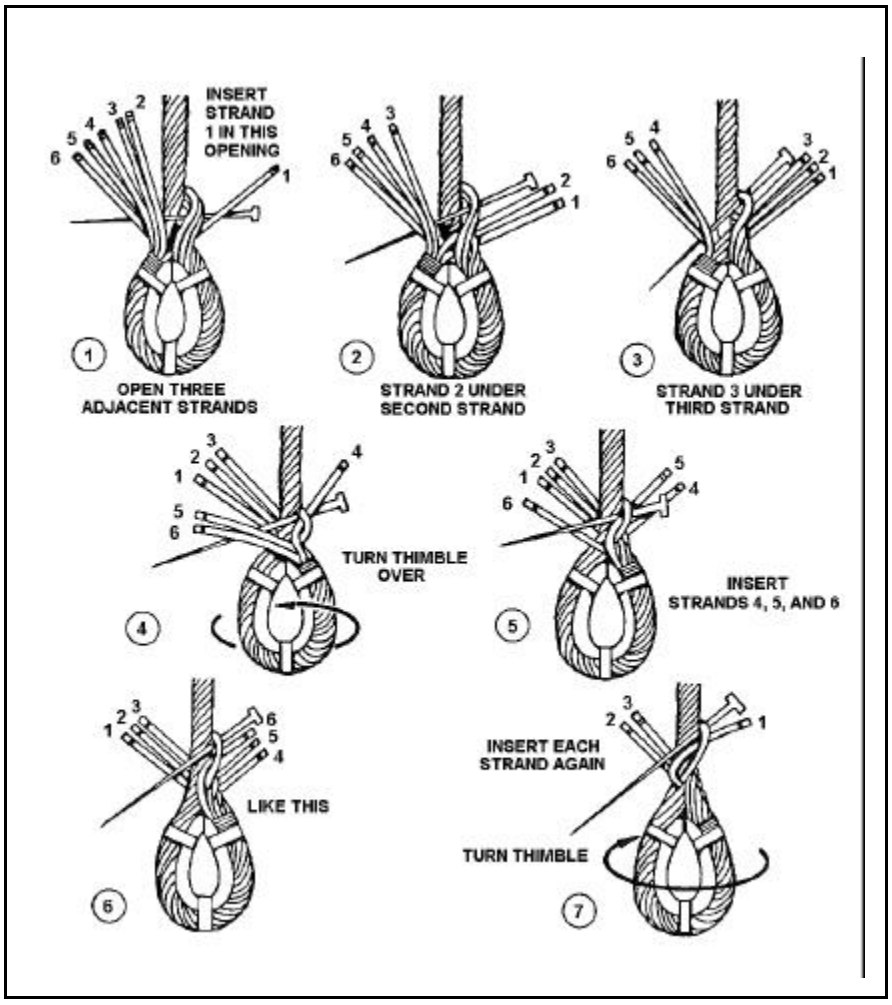

Figure 12-45. Tucking Strands of a Liverpool Splice

Tucking Strands Four, Five, and Six

12-113. Remember that the core was between strands three and four and that the strands are numbered clockwise. To tuck strand four, put the marlinespike under the strand to the left of where one, two, and three were tucked through the standing part. Turn the marlinespike counterclockwise around the standing part and tuck the strand. Pull it tight and run it down with the spike. Tuck strand four around the same strand four times. Lock each tuck in place by holding the strand down and running the spike up.

12-114. Push the marlinespike under the next higher strand on the standing part and tuck strand five around it four times, using the same procedure as with strand four. Then tuck strand six four times. This completes strands four, five, and six.

Running the Core Up

12-115. Burying the core in the center of the splice in the standing part is called "running the core up." Not the entire core is run up and the excess is cut off. This is done before strands one, two, and three are tucked three more times.

12-116. Run the spike under the same three strands under which strand one was passed. With the spike in your left hand and the core in your right hand, move the spike to the left and down, and pull up the core with your right hand to tighten. Then move the spike back to the right. Run up the core into the center of the splice and cut off the excess.

Tucking Strands One, Two, and Three

12-117. To avoid kinking the strands on the last tucks, insert the spike and run it up the wire. Follow the spike up with the strand, shove it under the spike, and pull taut. Keeping a strain on the strand, work the spike and strand back around and down together. Hold the strand there and work the spike back up the wire. Follow up with the strand and take the last tuck. Work the strand back down and hold it there. Before pulling out the spike, run it back up until the strands of the standing wire bind the working strand in place (see also Figure 12-46). Make the second and third tucks with the remaining strands in the same way.

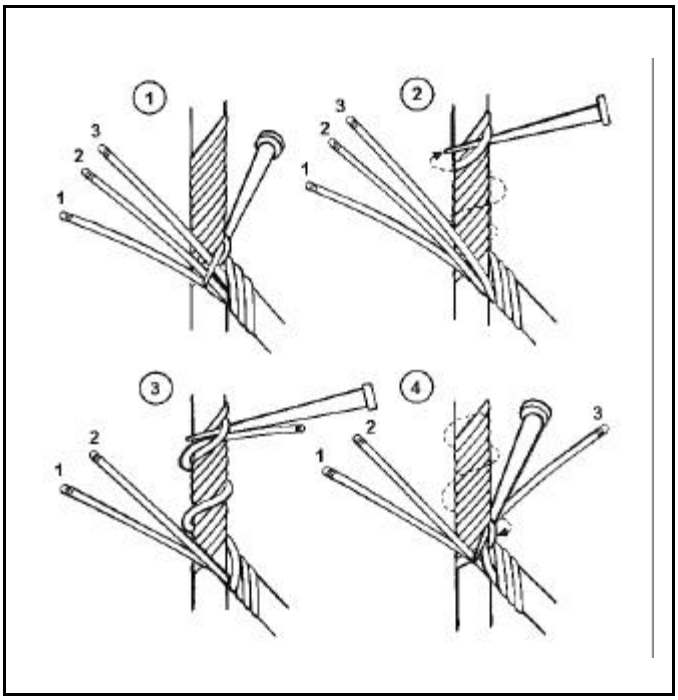

Figure 12-46. How to Avoid a Kink

Completing a Splice

12-118. The recommended order for finishing the splice is to tuck strands three, two, and one. Each is tucked three times in a row, ending up with a total of four tucks each. Remove the wire from the vise, take a hammer and pound the splice into shape, and cut off the ends of the tucking strands close to the splice.

SPLICING 2-IN-1 DOUBLE-BRAIDED NYLON LINE (Samson 2-in-1 Braid-Splicing Principles)

12-119. Double-braided nylon has a braided core inside a braided cover. It is commonly called 2-in-1 braided nylon line. Special tools and procedures are required to splice this type of line.

12-120. The following describes the procedures for making the standard eye splice and the end-for-end splice. The Samson Cordage Works developed both splices and the line that are used. The following information is used with permission and through the courtesy of Samson Ocean Systems, Inc., Boston, Massachusetts.

SPECIAL TERMS

12-121. Refer to the following terms when making the standard eye splice and the end-for-end splice.

- **Tubular fid.** The hollow steel tool used for cover and core insertions (see Figure 12-47, page 12-42).
- **Metal wire fid.** For line over 1 inch diameter (see Figure 12-48, page 12-43).
- **One fid length.** The full length of one tubular fid; two full lengths of a wire fid.
- **Short section of fid.** Distance away from open end to the scribe marks on body of fid. Approximately 35 percent of the full fid length.
- **Pusher.** Ice-pick-like tool used to extract core from cover and to aid in sliding fid through rope elements (see Figure 12-49, page 12-43).
- **Eye.** The closed loop formed at the end of rope as a result of splicing.
- **Crossover.** The point of intersection of cover and core created during splicing.
- **Milking.** The intermittent squeezing-pulling-sliding movement of the hand used to bring cover over core in forming splice.
- **Smooth Out.** To "milk" the slack out of a particular section during the splicing process.

- **Point X.** The extraction point; place on cover from where the core is initially extracted.
- **Point R.** The reference point; the mark made after measuring one fid length from taped end of cover.
- **Point T.** The point from which the taper count is measured.
- **Point Z.** The point on the cover from which the core tail will emerge; located one-half fid below point X.
- **Strand.** The strand of a braid is a group of one or more plied yarn ends, which make up one stich or pic. The usual number of cover strands in a Samson braid is 16, 20, 24, or 32. (Note: Since most Samson braid covers have two ends per strand, they are referred to in the splicing book as strand pairs.)
- **End.** An end is a plied yarn component of a braid strand. In a cover strand one to four ends are found. In a core strand two to six ends can be found.

Note: On many Samson 2-in-1 braids, it is possible to distinguish between the cover and core as follows: The cover has a light blue tracer strand while the core has no visible tracer strand.

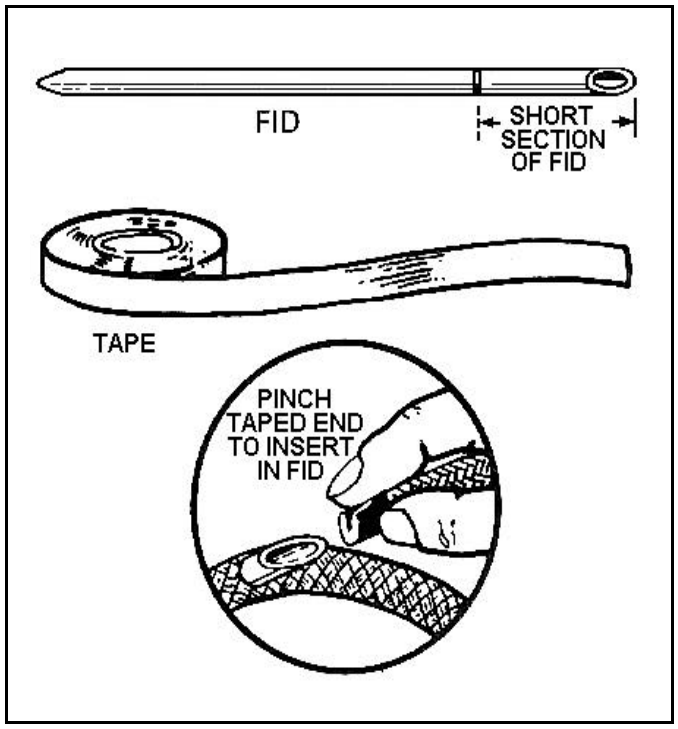

Figure 12-47. Tublar Fid

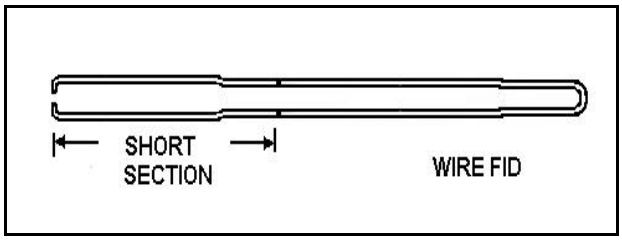

Figure 12-48. Metal Wire Fid

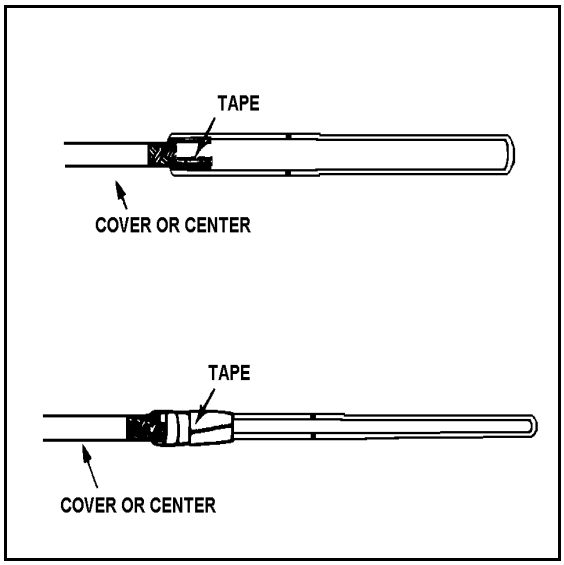

Figure 12-49. Pusher

SPECIAL TOOLS AND TECHNIQUES

12-122. The following are the special tools and techniques needed when making the standard eye splice.

For Splice With Thimble

12-123. STEP 1 in the procedure for the standard eye splice, paragraph 12-133, tells how to determine eye size.

12-124. Minimum eye and eye sling length with 2-in-1 braid is five fid lengths from extraction Mark X to extraction Mark X, regardless of rope diameter. The size of eye does not affect the minimum length (see Figure 12-50, page 12-44).

12-125. Exact overall lengths with eye splices are determined by allowing for extra rope to be used in making the splices. For each splice, the length of extra rope is equal to one and one-half fid lengths plus one-half the circumference of the eye.

12-126. When burying exposed core as in STEP 8, bury to crossover and insert thimble into eye before milking cover all the way. When using a thimble with ears, as in STEP 5, insert core through the rings (ears) and slide thimble beyond Mark 3 before inserting cover into core. Proceed to make the splice according to instructions.

Note: Before final burying, slide thimble around to cover side of eye.

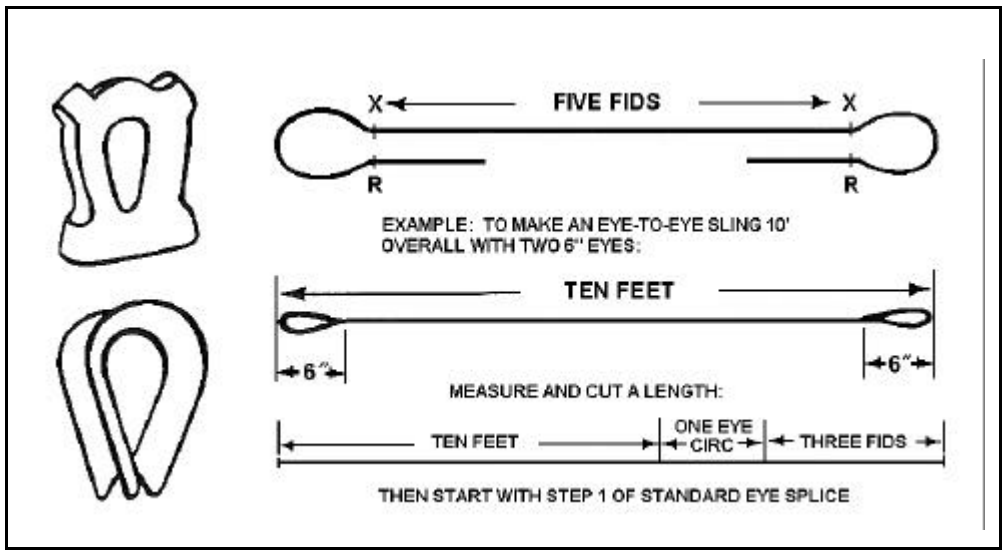

Figure 12-50. Minimum Lengths for Standard Eye Splice

12-127. To secure finished eye tightly around thimble, either whip throat or dip the eye in hot water for several minutes. Hot water will shrink eye tightly around thimble.

12-128. Minimum endless loop (grommet) with 2-in-1 braid is 10 fid lengths between extraction Mark X to extraction Mark X, regardless of rope diameter. Proceed to make the end-for-end splice as shown in Figure 12-51.

For Line Less Than 1-Inch Diameter (3-Inch Circumference)

12-129. Each size line requires a different size of tubular fid. Use the fid, along with the pusher, to insert the cover into the core and vice versa. Also use the fid as a measuring device. The scribe marks indicate the short section of the fid.

For Line Larger Than 1-Inch Diameter (3-Inch Circumference)

12-130. Use only a metal wire fid for splicing larger lines (a pusher is not needed). As with the tubular fid, there are different sizes of wire fids for each size of line. Cover and center measurements are made with the wire fid in the same manner as the tubular fids.

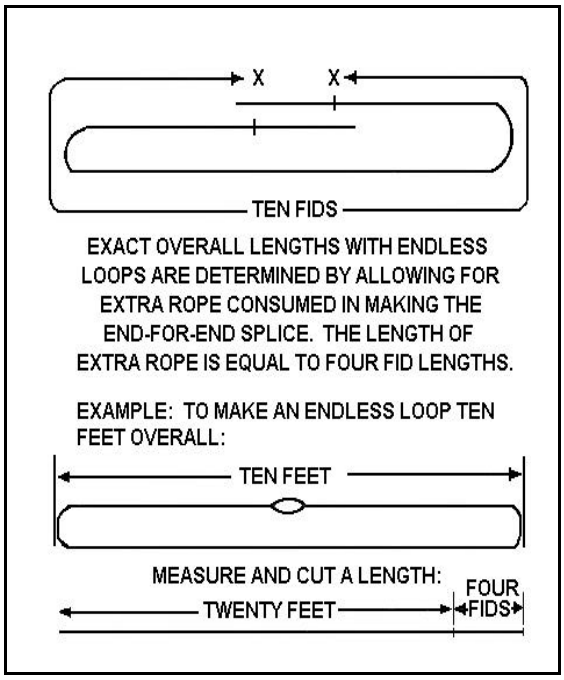

Figure 12-51. Minimum Lengths for End-for-End Splice

12-131. Tightly tape end of braided cover or center after extraction (STEP 2 of splicing procedure). Press prongs of fid into cover or center just behind tape.

12-132. Tape wire fid to braid by wrapping tape in a tight, smooth, spiral, starting on the braid and wrapping in the direction of the round tip of the fid. Keep tape smooth to ease the fid through braid. The round end of the fid can then be inserted and pushed through without a pusher.

STANDARD EYE SPLICE

12-133. This Samson eye splice is for new line only. It retains about 90 percent of the average new line strength.

- **STEP 1 -- Marking the measurements.** Tape end to be spliced with one thin layer of tape. Then measure one tubular fid length (two wire fid lengths because wire fid is one-half size) from end of line and mark. This is point R (see Figure 12-52, page 12-46). From R, form a loop the size of the eye desired and mark. This is point X (where you extract core from inside the cover). If using a thimble, form the loop around the thimble. Tie a tight slip knot about five fid lengths from point X. THIS MUST BE DONE. If you require the line with the finished splice(s) to be a certain overall length, see paragraph 12-125.

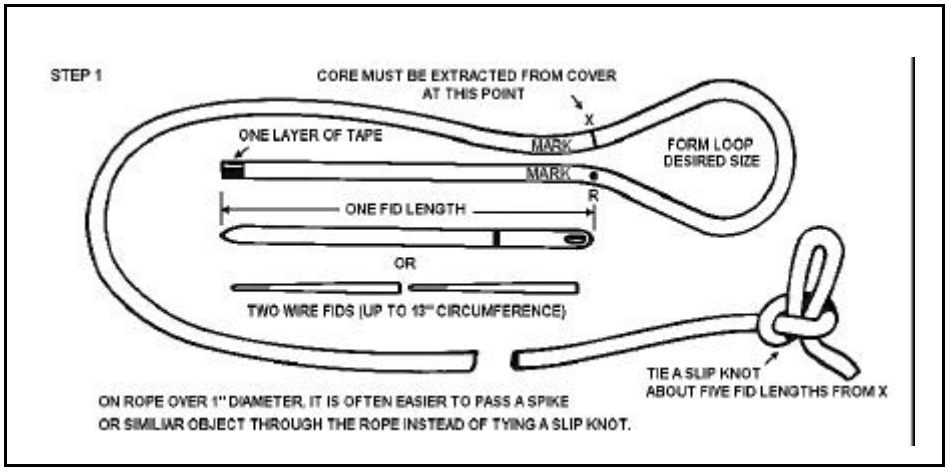

Figure 12-52. Marking the Measurements (Step 1)

- **STEP 2 -- Extract the core.** Bend the line sharply at point X. With the pusher or any sharp tool such as an ice pick, an awl, or a marlinespike, spread the cover strands to expose the core. Pry and then pull the core completely out of the cover from point X to the taped end of the line. Put one layer only of tape on end of the core (see Figure 12-53).

Note: DO NOT pull cover strands away from line when spreading as this will distort rope unnecessarily.

Holding the exposed core, slide cover as far back towards the tightly tied slip knot as you can. Then, firmly smooth the cover back from the slip knot towards taped end. Smooth again until all cover slack is removed. Then, mark the core where it comes out of the cover; this is Mark 1.

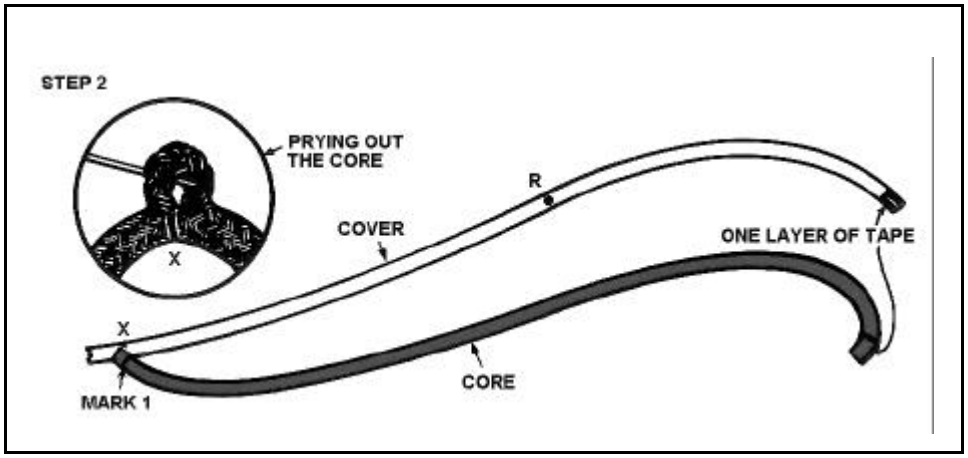

Figure 12-53. Extracting the Core (Step 2)

- **STEP 3 -- Marking the core.** Again, slide cover toward slip knot to expose more core. From Mark 1 following the core towards point X, measure a distance equal to the short section of tubular fid (two short sections with wire fid) and make two heavy marks. This is Mark 2. From Mark 2, measure in the same direction one fid length plus another short section of the fid (with wire fid, double measurements). Make three heavy marks for Mark 3 (see Figure 12-54).

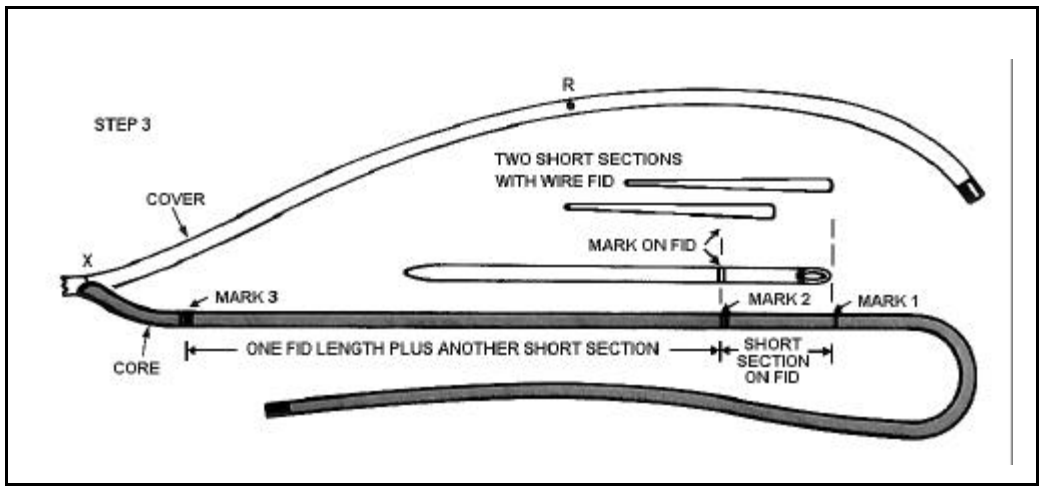

Figure 12-54. Marking the Core (Step 3)

- **STEP 4 -- Marking the cover for tapering.** Note nature of cover braid. It is made up of strands -- either one or two (pair). By inspection, you can see half the strands revolve to the right around rope and half revolve to the left. Beginning at point R and working toward the taped end of the cover, count eight consecutive strands (single or pairs) which revolve to the right (or left). MARK THE EIGHTH STRAND. This is point T (see Figure 12-55, page 12-48, insert). Mark point T completely around cover. Starting at point T and working toward the taped cover end, count and mark every fifth right and left strand (single or paired) until you have progressed down to end of taped cover.

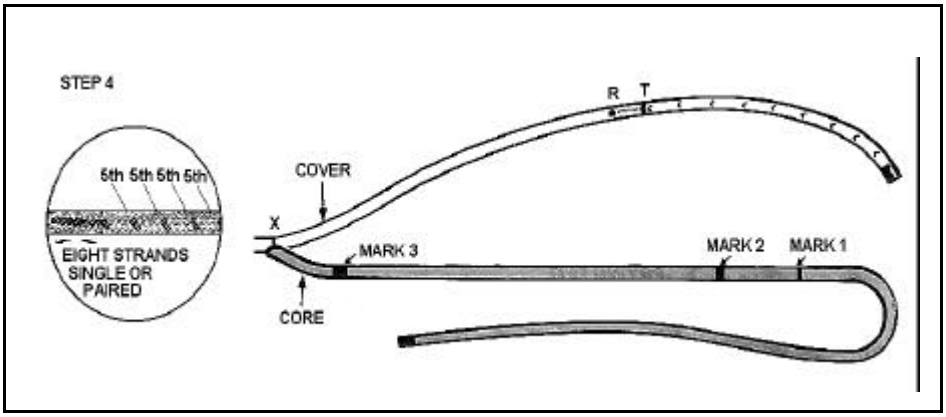

Figure 12-55. Marking the Cover for Tapering

- **STEP 5 -- Putting the cover inside the core.** Insert fid into core at Mark 2. Slide it through and out at Mark 3. Add extra tape to cover end; then jam it tightly into the hollow end of fid (see Figure 12-56 insert). Hold core lightly at Mark 3, place pusher point into taped end, and push fid and cover through from Mark 2 and out at Mark 3. Press prongs of wire fid into cover. Then tape over them. After the fid is on, milk braid over fid while pulling fid through from Mark 2 to Mark 3. Take the fid off the cover. Continue pulling cover tail through the core until point R on the cover emerges from Mark 3. Then remove tape from end of cover.

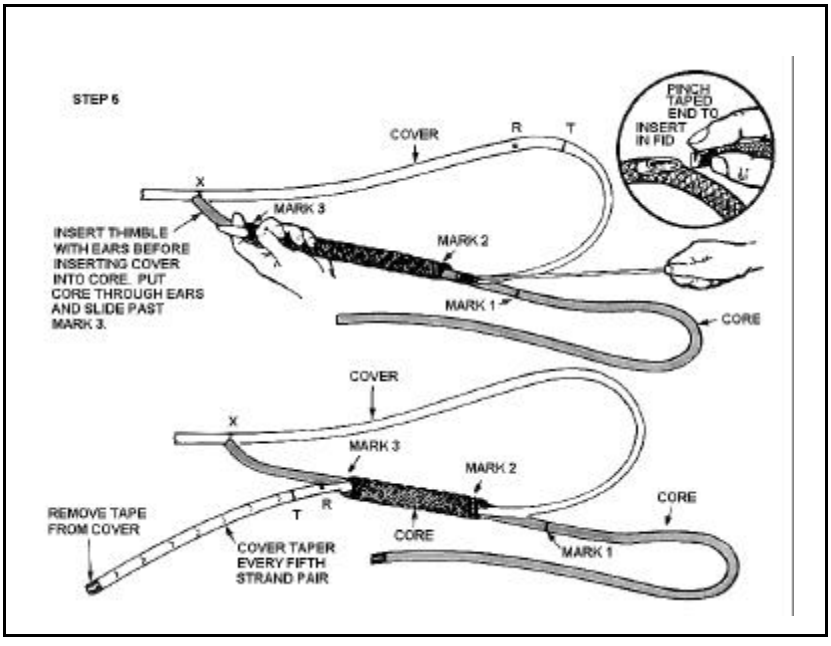

Figure 12-56. Putting the Cover Inside the Core

- **STEP 6 -- Performing the taper.** Make sure tape is removed from cover end. Starting with the last marked pair of cover strands toward the end, cut and pull them completely out (see Figure 12-57 insert). Cut and remove next marked strands and continue with each right and left marked strands until you reach point T. DO NOT cut beyond this point (see Figure 12-57 insert). The result should be a gradual taper ending in a point. Very carefully pull cover back through core until point T emerges from Mark 2 of core.

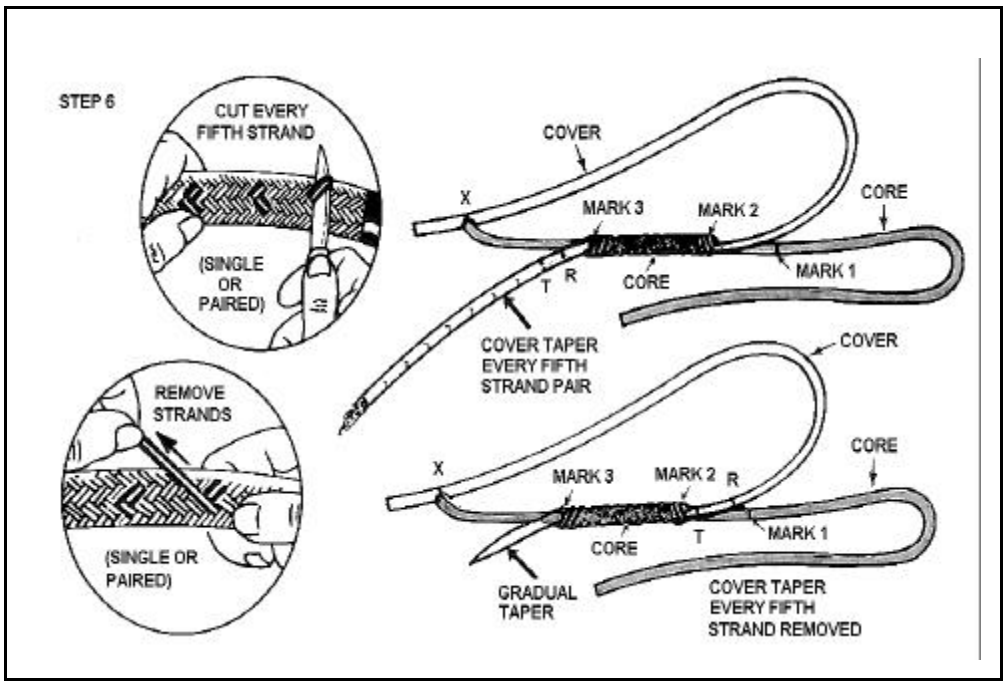

Figure 12-57. Performing the Taper

- **STEP 7 -- Reinserting the core into the cover.** From point X on cover, measure approximately one-half fid length toward slip knot on line and mark this as point Z (see Figure 12-58, page 12-50). You are now ready to put core back into cover from point T to point Z. Insert fid at point T. Jam the taped core end tightly into end of fid. With pusher push fid and core through cover "tunnel," past point X, to and through cover at point Z. When using wire fid, attach fid to taped core. After fid is on, milk braid over fid while pulling through from point T to point Z. When pushing fid past point X to point Z, make sure fid does not catch any internal core strands.

Note: Depending on eye size, fid may not be long enough to reach from point T to point Z in one pass. If not, bring fid out through cover, pull core through and reinsert fid into exact hole it came out. Do this as many times as needed to reach point Z.

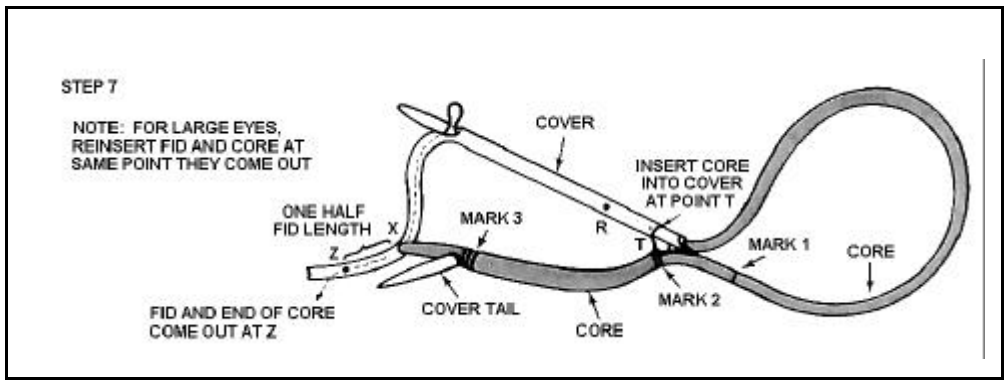

Figure 12-58. Reinserting the Core Into the Cover

- **STEP 8 -- Marking the reduced volume tail core.** Alternately pull on core tail at point Z, then pull on tapered cover at Mark 3. Tighten the crossover until it is about equal to the diameter of the line (see Figure 12-59). Smooth out cover of eye completely, from crossover at point T toward point X, to get all slack out of eye area. MARK CORE TAIL THROUGH COVER AT POINT X. Pull core tail out until mark on core just made is exposed at point Z. Reduce core volume at this point by cutting and removing one strand at each group, progressing around the circumference of the rope (see Figure 12-59 insert). Measure one-third fid length from start of reduction cuts toward end and mark. Cut off remaining tail at this point. Make cut on a 45^{o} angle to prevent a blunt end (see insert). With one hand, hold crossover--Mark T. Smooth cover section of eye out firmly and completely from crossover toward X; tapered core tail should disappear into cover at point Z. Smooth out core section from crossover towards Mark 3 and cover taper will disappear into core.

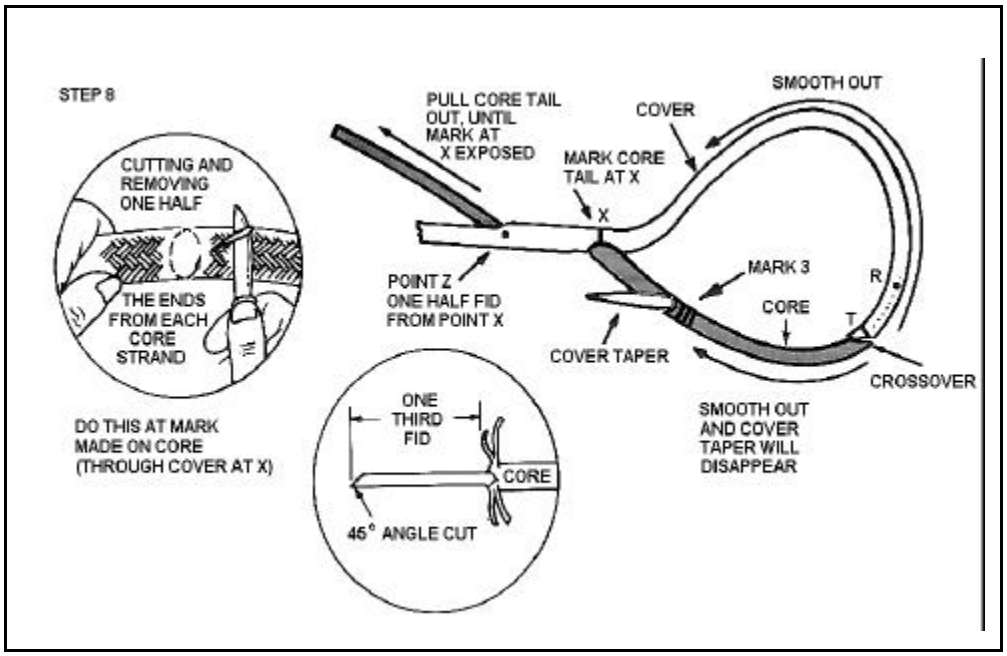

Figure 12-59. Marking the Reduced Volume Tail Core

- **STEP 9 -- Burying the exposed core.** Hold rope at slip knot and with other hand milk cover toward splice, gently at first, then more firmly (see Figure 12-60, page 12-52). Cover will slide over Mark 3, Mark 2, the crossover, and point T and point R. (It may be necessary to occasionally smooth out eye during milking to prevent tapered tail from catching in throat of splice.) If bunching occurs at crossover preventing full burying, smooth cover from point T to point X. Grasp crossover at point T with one hand and then firmly smooth cover slack (female side of eye) with other hand towards throat point X. Repeat as necessary until bunching disappears. Continue milking until all cover slack between knot and throat of eye has been removed.

TIP: Do the following before burying the cover over the crossover:

-- Anchor loop of slip knot by tying it to stationary object before starting to bury. You can then use both hands and weight of body to more easily bury cover over core and crossover (last two views in illustration).

-- Hold the crossover tightly and milk all the excess cover from point R to point X.

Flex and loosen the line at the crossover point during the final burying process. Hammering cover at point X will help loosen strands. With larger ropes it is helpful to securely anchor slip knot, attach a small line to the braided core at the crossover and mechanically apply tension with either a block and tackle, capstan, come-a-long, or power winch. Tension will reduce diameter of core and crossover for easier burying (last view in illustration).

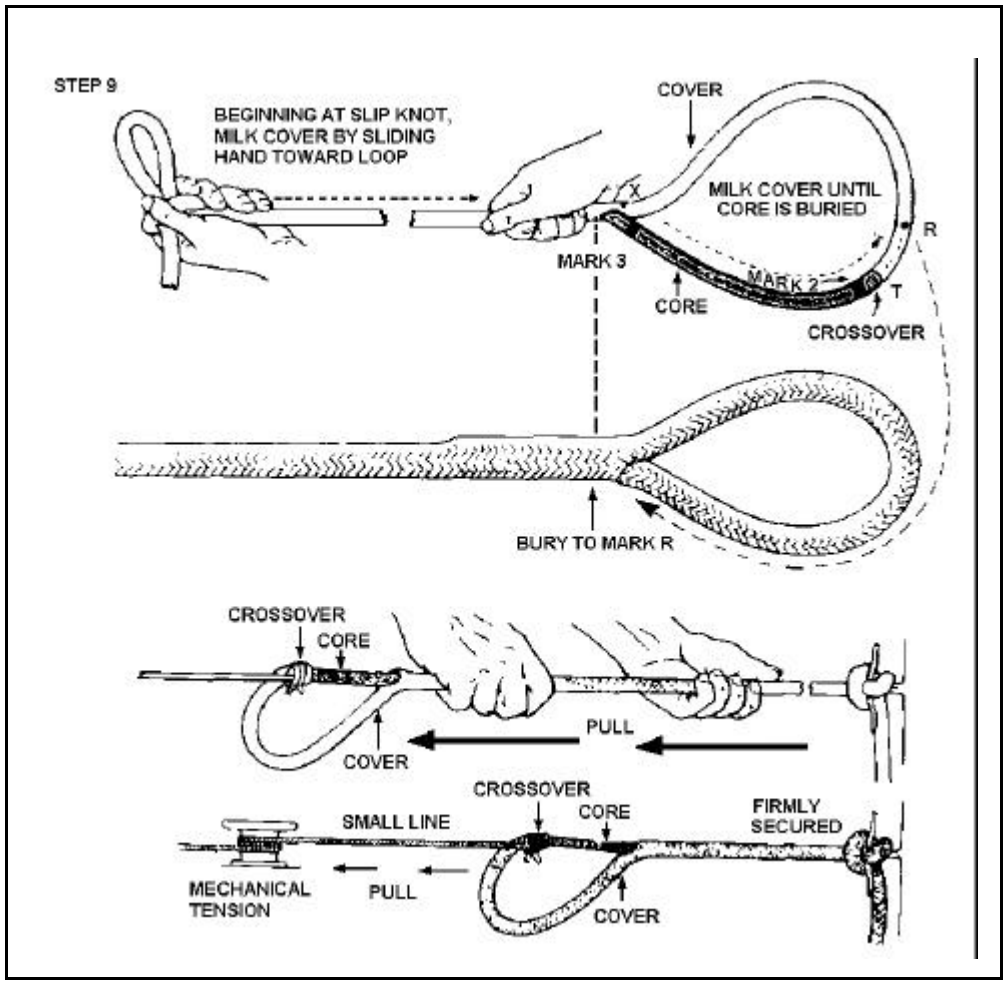

Figure 12-60. Burying the Exposed Core

- **STEP 10 -- Finish the eye splice with lockstitch.** Lockstitch splices to prevent noload opening due to mishandling. Use about one fid length of nylon or polyester whipping twine, about the same size as the strands in the line you are lockstitching. You may also use the same strands cut from the line you are lockstitching (see Figure 12-61).

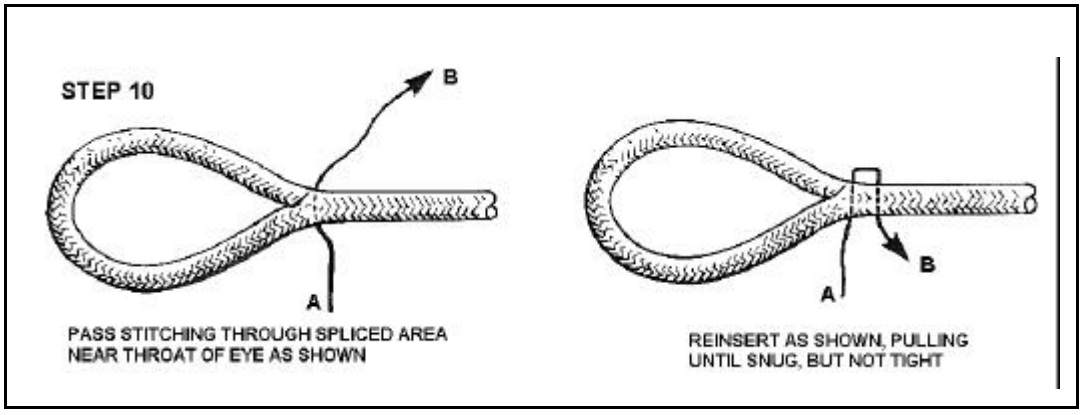

Figure 12-61. Finishing the Eye Splice With Lockstitch

- **STEP 11 -- Continue lockstitching.** Continue to reinsert as shown in Figure 12-62 until you have at least three complete stitches.

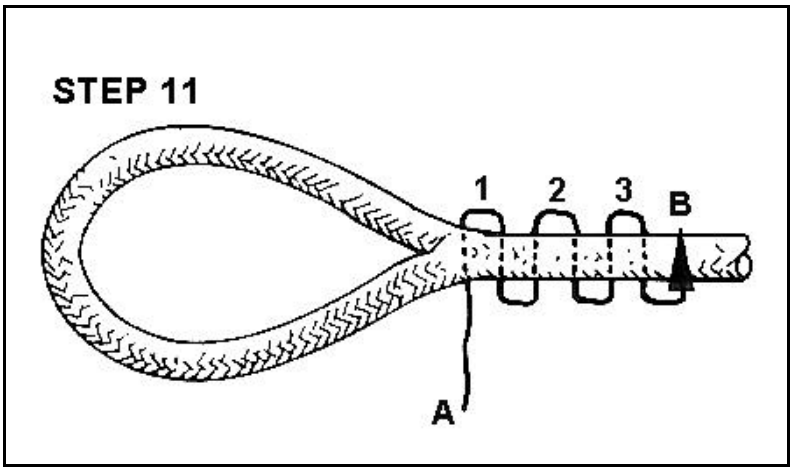

Figure 12-62. Continuing Lockstitching

- **STEP 12 -- Complete lockstitching.** Rotate spliced part of line 90 degrees and reinsert end A into splice area in the same fashion as before. Make sure you do not pull stitching too tight. Complete last stitch so that end A comes out through the same opening in the braid as end B. Tie them together with a square knot and reinsert back ends into braid between cover and core as shown in Figure 12-63.

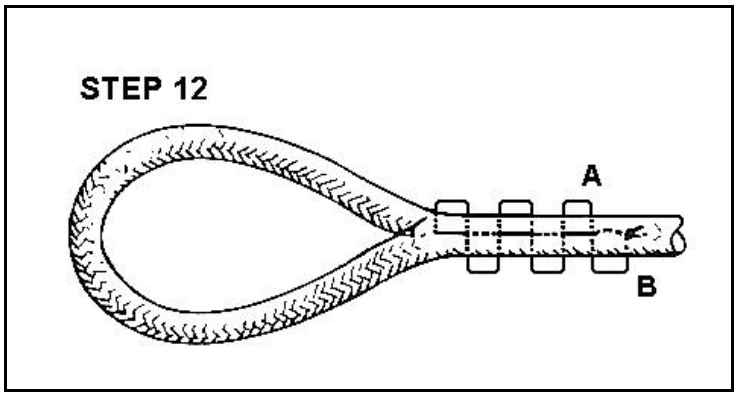

Figure 12-63. Completing Lockstitching

The splice will now be stitched on two planes perpendicular to each other. Configuration of cross section after completion is shown in Figure 12-64.

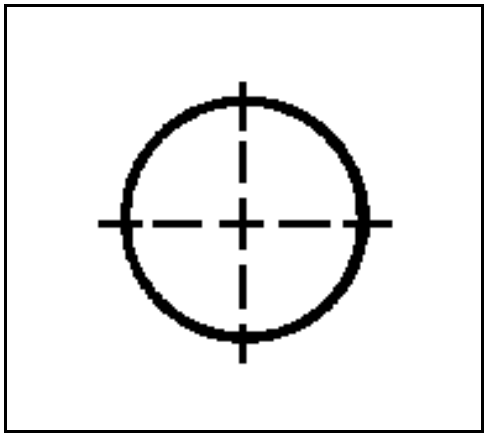

Figure 12-64. Cross Section Configuration

END-FOR-END SPLICE

12-134. The Samson standard end-for-end splice can be done on new and used line (see Figure 12-65). This is an all-purpose splice technique designed for people who splice used line as frequently as new line. It retains up to 85 percent of average new line strength and up to 85 percent of the remaining used line strength.

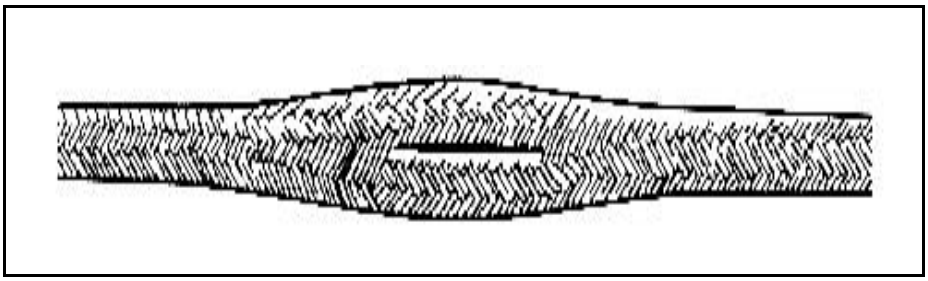

Figure 12-65. Standard End-for-End Splice

- **STEP 1 -- Marking the measurements.** Tape the end of each line with one thin layer of tape. Lay two lines to be spliced side by side and measure one tubular fid length (two wire fid lengths) from end of each line and make a mark. This is point R (see Figure 12-66). From point R measure one short fid section length and mark again. This is point X where you should extract core from inside the cover. Be sure both lines are identically marked. Tie a tight slip knot about five fid lengths from point X. If you require the line with the finished splice to be a certain overall length, refer to Special Tools and Techniques, paragraph 12-122, page 12-43.

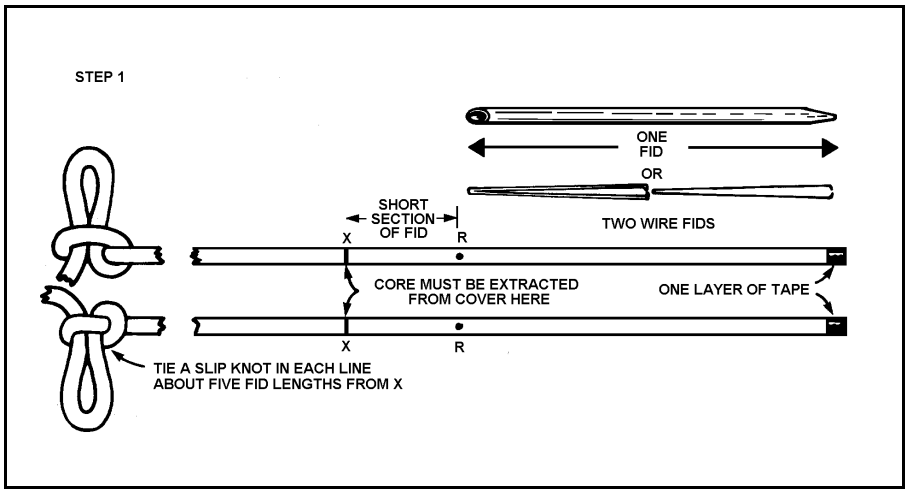

Figure 12-66. Marking the Measurements

- **STEP 2 -- Extracting the cores.** Bend line sharply at point X. With the pusher or any sharp tool such as an ice pick, an awl, or a marlinespike, spread cover strands to expose core. First pry, then pull core completely out of cover from point X to the end of the line. Put only one layer of tape on end of core (see Figure 12-67). To be sure of correct positioning of Mark 1, do the following: Holding the exposed core, slide cover as far back towards the tightly tied slip knot as you can. Then, firmly smooth cover back from the slip knot towards taped end. Smooth again until all cover slack is removed. Then, mark core where it comes out of cover. This is Mark 1. Do this to both lines.

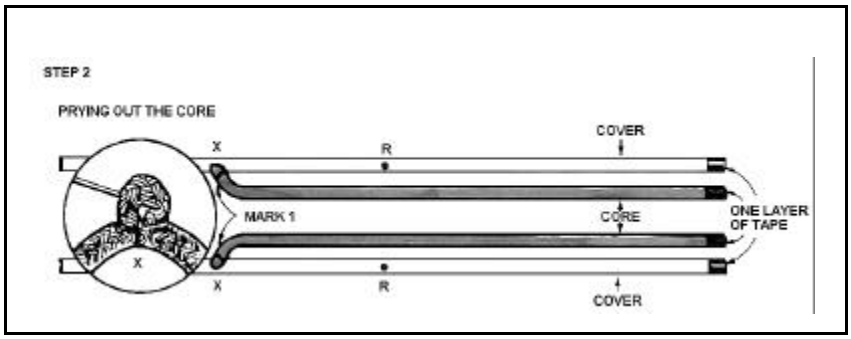

Figure 12-67. Extracting the Cores

- **STEP 3 -- Marking the cores.** Hold one core at Mark 1 and slide cover back to expose more core (see Figure 12-68). From Mark 1 and following the core towards point X, measure a distance equal to the short section of fid and make two heavy marks. This is Mark 2. Measure one fid length plus another short section from Mark 2 in the same direction and make three heavy marks. This is Mark 3. Mark second core by laying it alongside the first and using it as an exact guide.

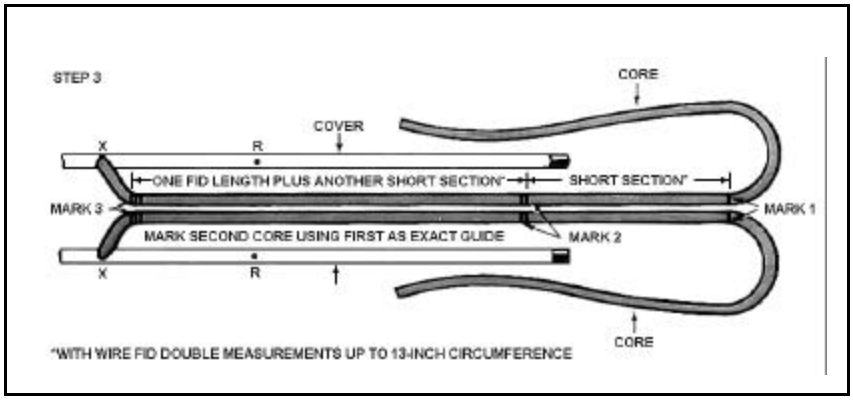

Figure 12-68. Marking the Cores

- **STEP 4 -- Marking the cover for tapering.** Note nature of the cover braid (see Figure 12-69). It is made up of strands. On inspection you can see that half the strands revolve to the right around the line and half revolve to the left. Beginning at point R and working toward the taped end of cover, count eight consecutive pairs of cover strands, which revolve to the right (or left). Mark the eighth pair. This is point T (see insert). Make Mark T go completely around cover. Starting at point T and working toward taped cover end, count and mark every second right pair of strands for a total of six. Again, starting at point T, count and mark every second left pair of strands for a total of six (see insert). Mark both lines identically.

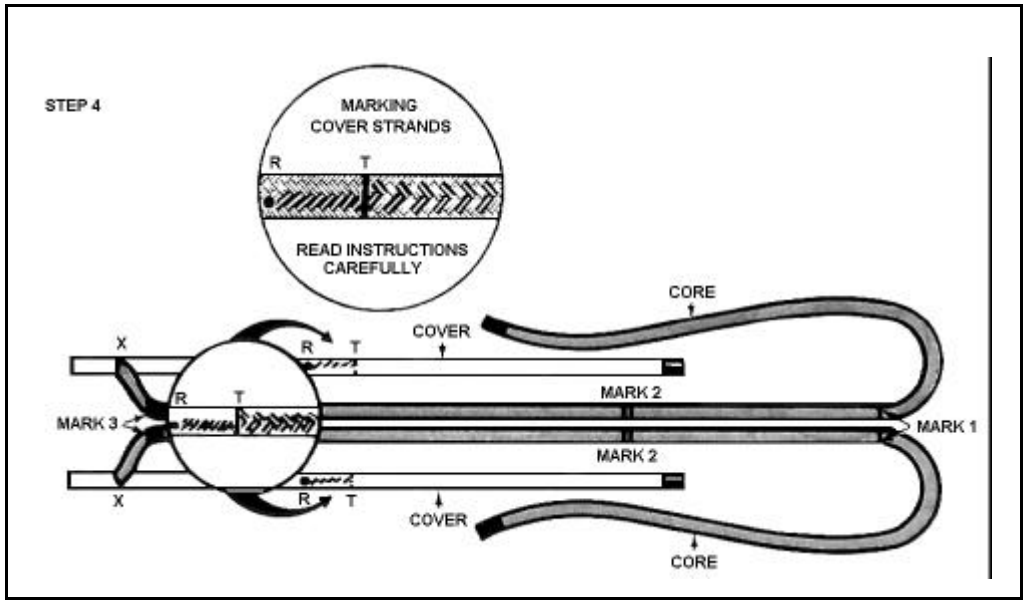

Figure 12-69. Marking the Cover for Tapering

- **STEP 5 -- Performing the taper.** Remove tape from cover end. Starting with last marked pair of cover strands toward the end, cut and pull them completely out (see Figure 12-70 insert, page 12-58). Cut and remove next marked strands and continue with each right and left marked strands until you reach point T. Do not cut beyond this point (see Figure 12-70 insert, page 12-58). Retape tapered end. Cut and remove marked strands on the other marked cover, again stopping at point T. Retape tapered end.

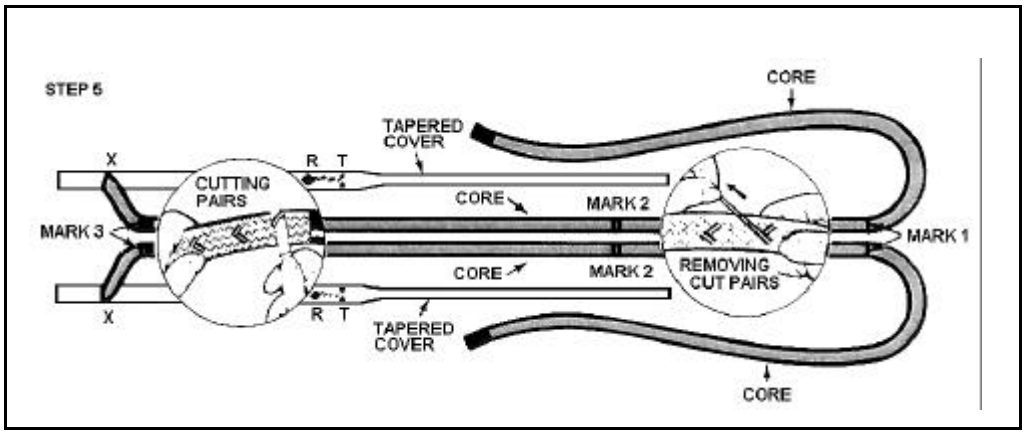

Figure 12-70. Performing the Taper

- **STEP 6 -- Repositioning the lines.** Reposition lines for splicing as shown in Figure 12-71. Note how cover of one line has been paired off with core of the opposite line. Avoid twisting.

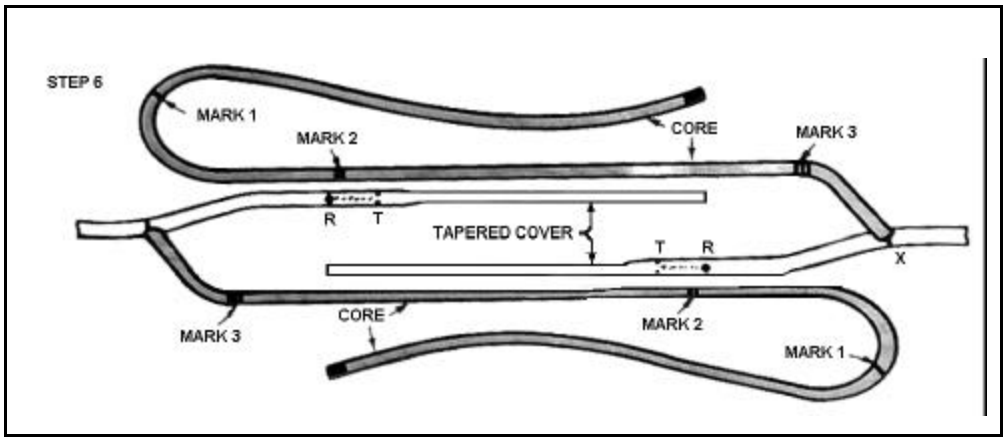

Figure 12-71. Repositioning the Lines

- **STEP 7 -- Putting the cover inside core.** Insert fid into one core at Mark 2 and bring it out at Mark 3. Add extra tape to tapered cover end and jam it tightly into hollow end of fid (see Figure 12-72 insert). Hold core lightly at Mark 3, place pusher point into tapered end, pushing fid with cover in it from Mark 2 out at Mark 3. When using wire fid, attach fid to cover. Then pull fid through from Mark 2 to Mark 3. Pull cover tail through core until Mark T on cover meets Mark 2 on core. Insert other cover into core in same manner.

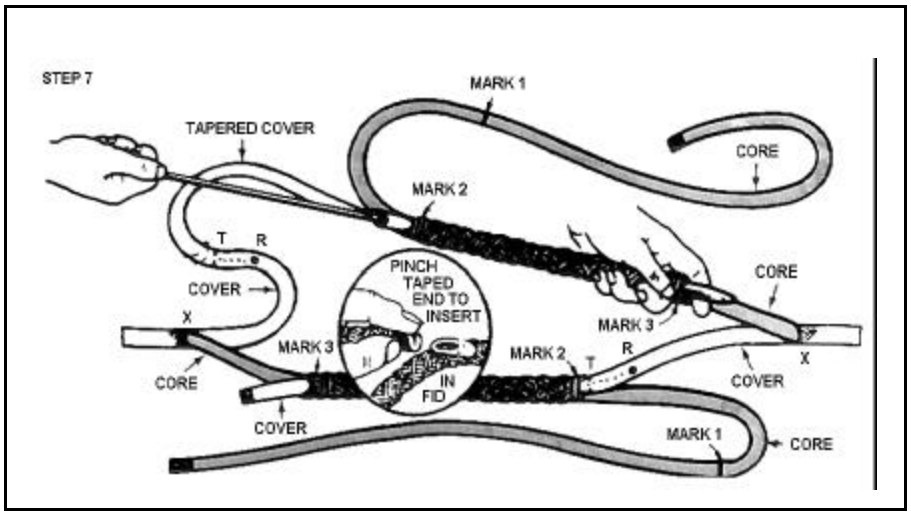

Figure 12-72. Putting the Cover Inside Core

- **STEP 8 -- Reinserting the core into cover.** Now put core back into cover from point T to point X (see Figure 12-73, page 12-60). Insert fid at point T, jam taped core tightly into end of fid. With pusher push fid and core through cover, bringing out at Point X. When using wire fid, attach fid to taped core. Then pull fid and braid through from point T to point X. Do this to both cores. Remove tape from end of cover. Bring crossover up tight by pulling on core tail and on tapered covered tail. Hold crossover tightly, smoothing out all excess braid away from crossover in each direction. Trim end of tapered cover on an angle to eliminate blunt end. Tapered cover tail will disappear at Mark 3. Cut core tail off at an angle close to point X.

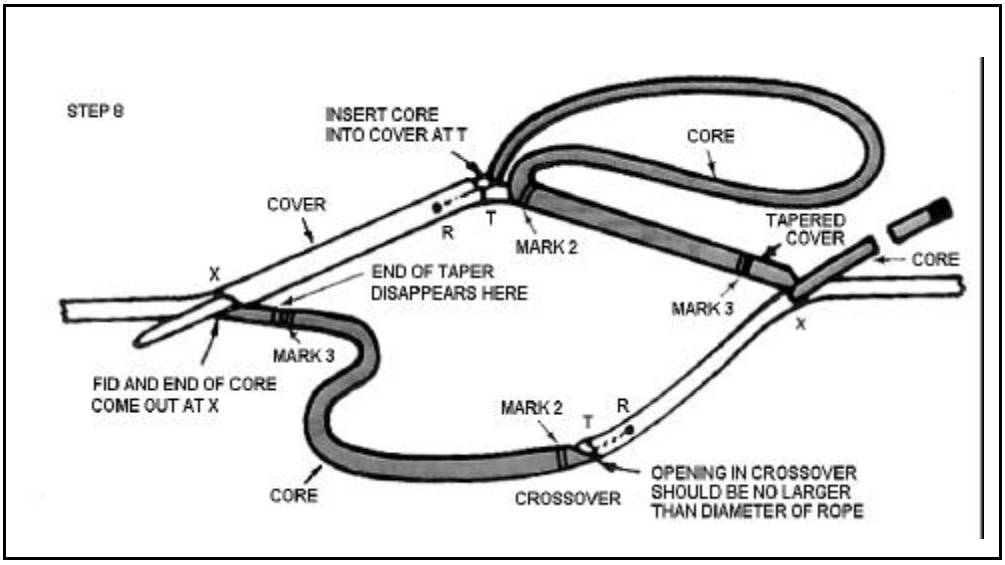

Figure 12-73. Reinserting the Core Into Cover

- **STEP 9 -- Burying the exposed core.** Hold line at slip knot and with other hand milk cover toward the splice, gently at first and then more firmly (see Figure 12-74). The cover will slide over Mark 3, Mark 2, the crossover, and point R. Repeat with the other side of the splice. Continue burying until all cover slack between the knot and the splice has been removed.

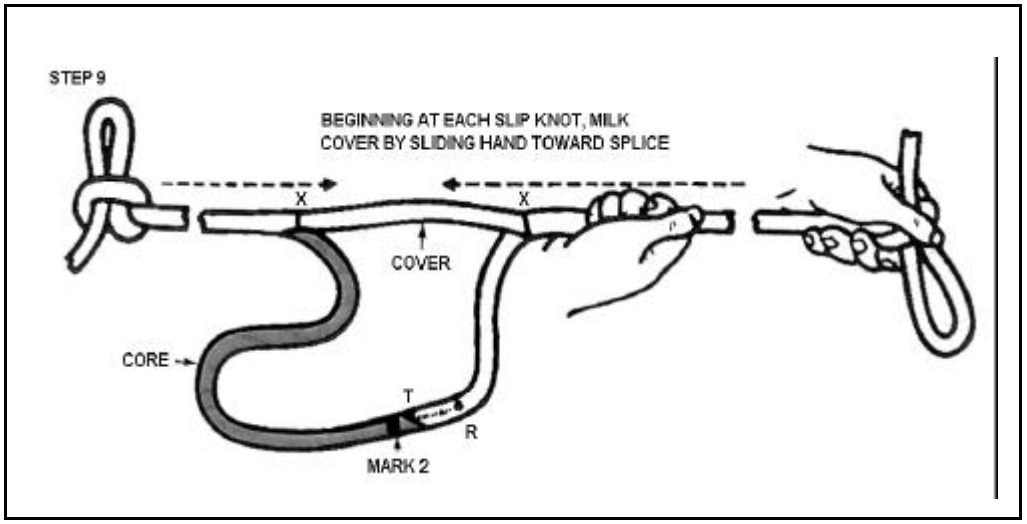

Figure 12-74. Burying the Exposed Core

- **STEP 10 -- Finishing the splice.** The splice is done when all cover slack has been removed and there is an opening in the splice about equal in length to the diameter of line (see Figure 12-75). If one side of the splice at the opening is noticeably longer than the other side, something is wrong. Check steps 1 through 9 and remake if necessary. Now untie the slip knots.

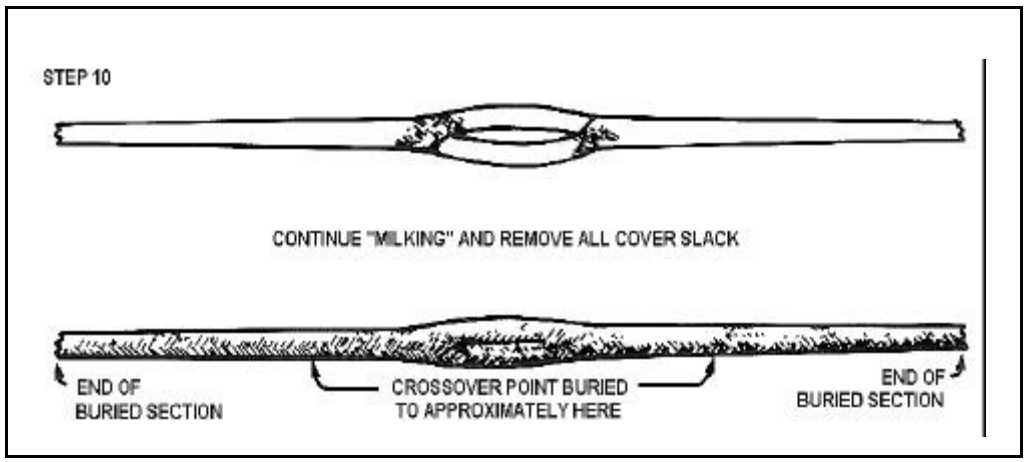

Figure 12-75. Finishing the Splice