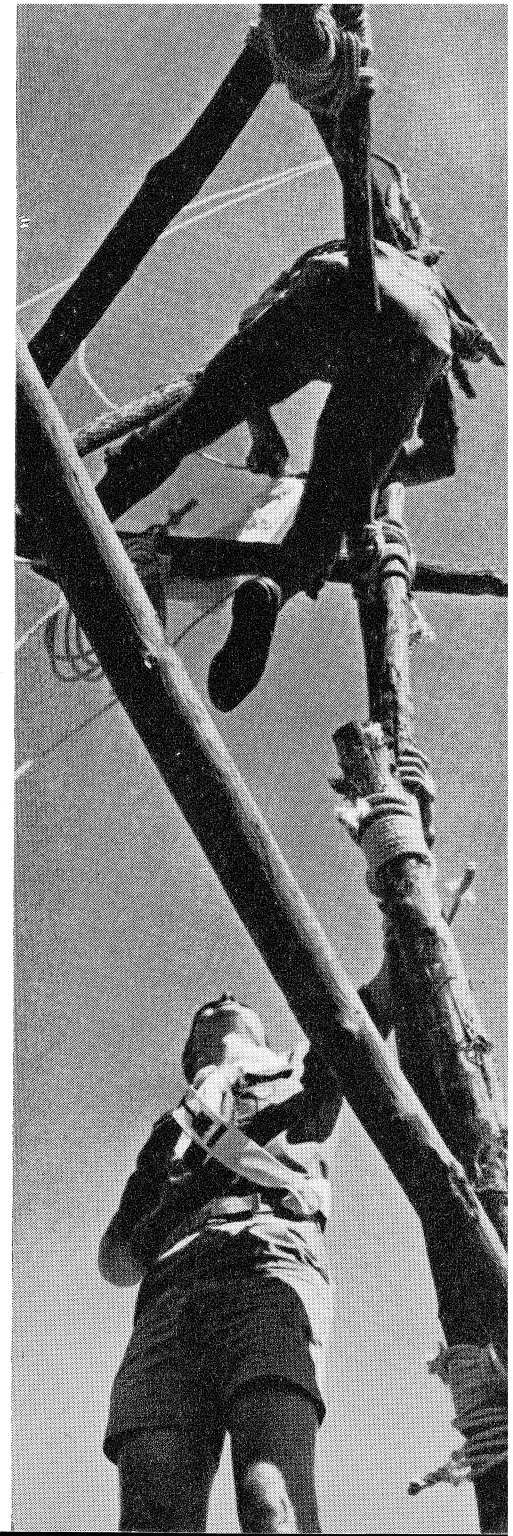
PIONEERING

MERIT BADGE SERIES

BOY SCOUTS OF AMERICA

PIONEERING



Requirements

1. Hand-coil a length of rope. Describe (a) kinds of rope, (b) care of rope, (c) weakening effect of knots.

2. Tie 10 knots and hitches and explain their specific use in pioneering. Include bowline, clove hitch, two half hitches, tautline hitch, square knot, timber hitch, plus any four others.

3. Make a short splice, end splice, and eye splice.

4. Build a ropemaking machine. Using heavy twine or other line make a 6-foot rope ¼ inch or more in diameter. Whip the ends to prevent fraying.

5. Make and demonstrate one device for moving heavy logs, rocks, etc., using rope and natural materials; OR, using rope, build a conveyer cable system for hauling materials over a ravine or up a steep hillside.

6. Following an approved design and using square, diagonal, and shear lashings, build a log bridge, signal tower, monkey bridge, or raft.* (Dismantle after use and inspection unless built for permanent use.)

*Project 6 may be done in a council camp activities area where poles are available for general use in pioneering projects. Trees should never be cut on private or public property without permission.

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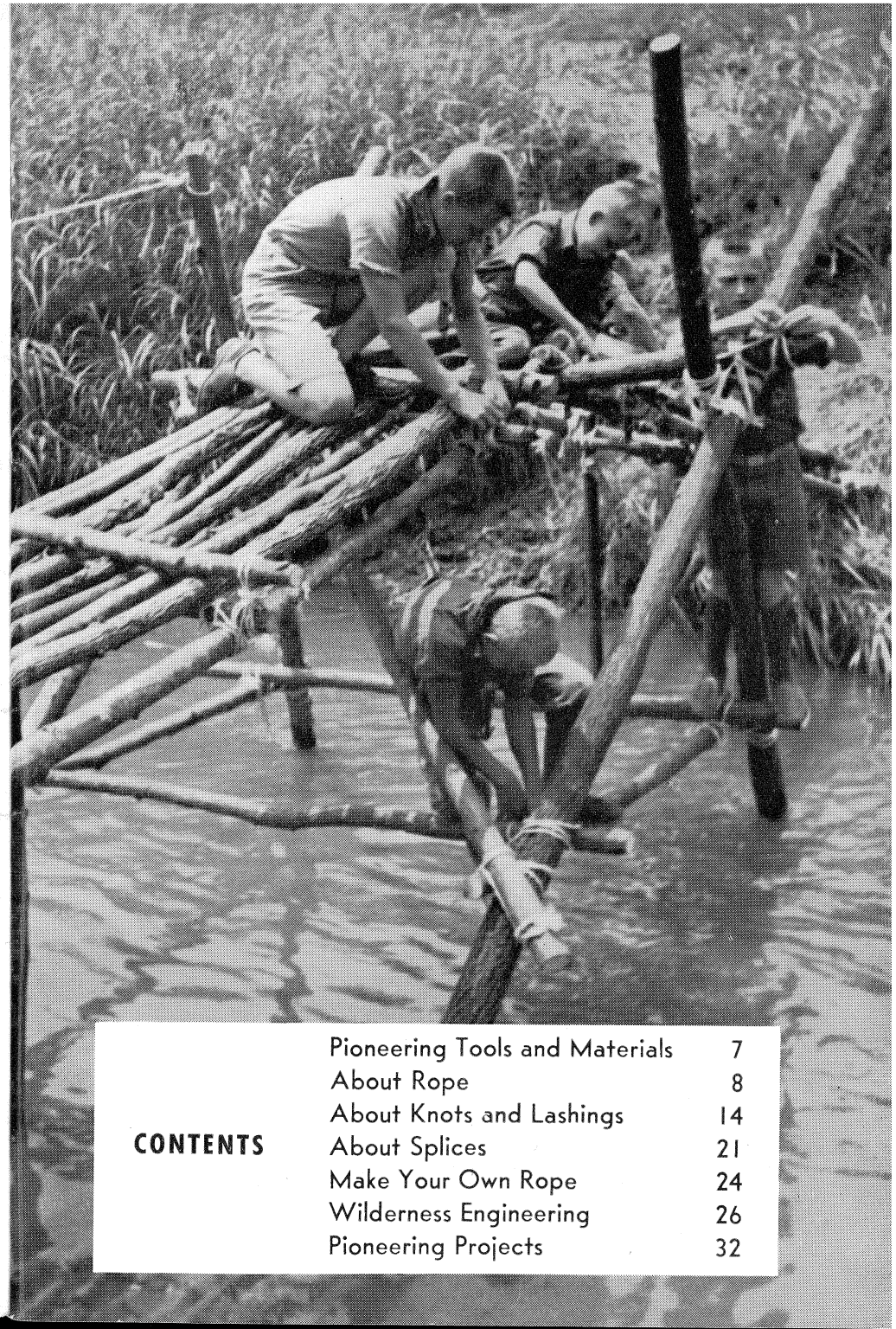


CONTENTS

Introduction

If you want to get really modern about pioneering, you could call it "backwoods engineering" or "wilderness engineering" and you'd have it about right. True, it is typical of the type of construction done by the pioneers who made the trails, cabins, forts and bridges that helped bring civilization to the wilderness of our beautiful America.

Today, we don't have the same kind of need they had in pioneer days. It isn't often necessary to build as our forefathers did. But we have new needs of our own.

American men have always loved the outdoors. We have more hunters and campers than any other nation. Today more than ever, our country needs the ability to be original and resourceful in meeting construction and transportation problems when we're out on the trail without much heavy equipment.

Modern Pioneering

Take a look at the Navy's Seabees or the Army Engineers if you want an idea of modern pioneering. Those men have to go into country where there isn't any facility for the thousands of men who are to follow them, and build what needs to be built regardless of obstacles.

Talk about resourceful! In an unbelievably short time, an engineering detachment or Seabee outfit will move into a jungle or a swampland, and come up with barracks, roads, bridges water reservoir (with safe water), airfields, hangars, mess halls, and about any other kind of facility you can think of. We watched a Seabee work crew build a reservoir that was intended to supply hundreds of people with safe drinking water. They first planned to build a dam near the dining facility, but wisely tested the soil first. It was too porous and allowed water to run right through it. Then they moved up a rocky, torturous ravine with sides so steep it seemed impossible to get any equipment up there. Using ropes, they inched a big cement mixer up the ravine and right up a bank that was practically a cliff.

While the cement crew was doing this, another crew was hauling lumber up the ravine for forms, and then building them. Cement and water and sand and gravel were hauled up a cable to the mixer, and concrete was run down by pulley in a big bucket and poured into the forms. In 1 day, the dam was completed and the equipment was somewhere else, doing another job.

The Importance of Ingenuity

Now Scouts don't have the kind of heavy equipment available to military engineers or civilian engineers—no bulldozers, no cement mixers or backhoes or power shovels. But we know that many a Seabee, many an Army engineer or civil engineer, and many a hunter or camper has thanked his luckiest stars that he earned the Pioneering merit badge as a Scout. Because, more important than the equipment that a man has available is the ingenuity and know-how and "make-do" that you will practice as you take on the requirements for this badge. Good luck with your first big job of "wilderness engineering"! You're going to have fun as you plan and complete your projects.

How To Start

The first step is always to talk it over with your Scoutmaster or Explorer Advisor. He will help you map out a plan of preparation; perhaps there will be others in your troop or post who

are also interested in earning this merit badge, and a working team can be created.

With the guidance of your unit leader or some qualified person assigned by him, you can begin to learn and practice the proper way to make the lashings, splices, and knots required to meet the test of stress and strain of pioneering construction.

Practice Anywhere

Using this merit badge pamphlet as a guide, you can practice at home using dowels or old broom handles. You may also practice at your unit or patrol meeting, if this is agreeable to your unit leader. If there are no staves available, have the rest of the team bring old broom handles to the unit meeting. In fact, you can practice your knots, splices, and lashings almost anywhere in a spare moment.

When your unit leader feels that your group is ready, he may set up a special weekend campout where he or the qualified person assigned by him will direct and advise you in building the real thing. Everything may not go exactly right as you work on your project, but you will learn by doing and, therefore, be prepared when the time comes to do a similar construction for your merit badge counselor. The feeling of accomplishment when you finally pass a requirement is truly worthwhile. It will reward all of your efforts.

Pioneering Tools and Materials

Rope, chalk line, and string or binder twine
File
Carborundum sharpening stone
Hand ax
1-inch chisel
¾ ax (1¾ to 2½) (long-handled)
Knife (Scout pocketknife is more use to the pioneer than the sheath knife.)
Shovel (long-handled, round blade)
Spade and pick
Maul (a heavy wooden hammer) or 10-lb. sledgehammer
1 two-man crosscut saw
1-inch auger and handle
Saw (preferably bow saw)

Before attempting the chosen project, all Scouts should be trained in the use of these tools so that they may complete the job with out injury or wasted effort. Remember, woods tools are as necessary and as valuable today as they were many years ago. They should be taken care of, always cleaned after use, and the handles oiled from time to time to keep them from getting brittle. (Any sweet oil, such as linseed, will do.)

When tools are stored for the winter, the heads of all shovels, spades, picks, and axes should be greased to keep them from rusting, and it is best to wrap them up in a piece of old sacking. Saws should be greased and laid flat on a shelf or hung vertically.

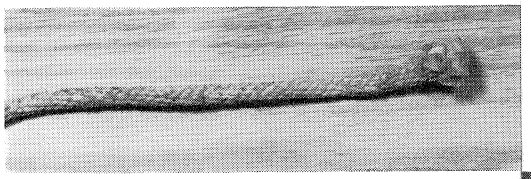
About Rope

1. Hand-coil a length of rope. Describe (a) kinds of rope, (b) care of rope, (c) weakening effect of knots.

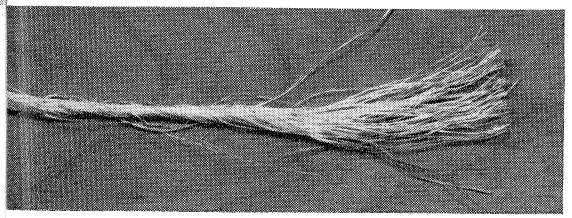
In pioneering you will find rope essential. Choosing good rope and making knots or lashings properly are vital since a wrong knot, an insecure lashing, or a weak rope may lead to disaster. Be sure to use sound material and take no chances.

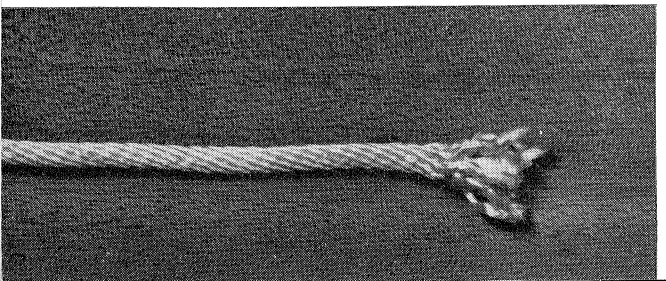
LAID ROPE: Natural and synthetic fibers are often twisted into yarns, the yarns into strands, and then the strands twisted into ropes in such a way that the twists are equalized so the rope is stable but flexible. This is called "laying." This construction, shown at right, permits using the shorter lengths of natural fibers to make uniformly strong rope, but it's fine for synthetics, too. Such rope comes from twine size up to ship's hawser size. Sizes are given in diameters or circumferences according to custom in certain usages.

SASH CORD or clothesline is woven of cotton and glazed with starch or other filler. It is unreliable and clumsy for pioneering.



BINDER TWINE is unsuitable and should be avoided.





WOVEN ROPE: Synthetic fibers are often woven or braided into line or rope in smaller diameters. Instead of whipping, unraveling is prevented by fusing with a flame or a hot iron.

Take every precaution to see that the materials used are sound and that risk is minimized as much as possible.

Rope normally used in pioneering is made of sisal, manila, or synthetic fibers. Cotton, coir (made from the husk of coconuts), or other vegetable yarns are also used. Hemp is a strong and durable fiber but, because the supply of true hemp is insufficient to fill the demand, a substitute has been found in abaca, a kind of banana plant grown in the Philippines. From it comes all the "hemp" that is used commercially.

A good grade of new, clean manila rope is hard but pliant, yellowish in color, with a silvery or pearly luster. When drawn through the hand it has a smooth, almost silky feel.

Sisal from Yucatan is also used in making rope. It is about two-thirds as strong as manila. When new and clean, it is of a yellowish-white color, sometimes with a slight greenish tinge. The fibers are stiff and harsh and have a tendency to splinter.

Synthetic fibers like nylon and Dacron make excellent rope for many purposes, since they are very strong and moistureproof. They are not too good for pioneering work, being too slick to hold in lashings.

The Lay of Rope

The lay of a rope is the direction in which the strands are twisted. It is important to determine what the lay is before rope is used to prevent kinking or breaking when knots, splices, or lashings are made. To determine the lay of a rope, pick up one end. You will usually find that the strands are twisted from the bottom left to the top right. The twisting of the strands together is called the lay, and in this case the rope is known as right-handed. A left-handed rope has the strands twisted upward to the left.

Rope Sizes Strength of Rope

Before you risk your neck, or anyone else's, be sure you know how strong your rope is. There are great variations in the strength of various types of the same size, so be sure you know how much load *your* rope will bear. The table below gives you the breaking point in pounds of your rope *if it is fairly new and in good condition, without kinks, breaks, or knots.*

The *safe working load* of a new rope is only one-quarter of the breaking strength, and with average rope you had better figure only one-sixth with a steady strain. Jerking the rope or dropping the load will *double* the strain. Any knots or splices will also reduce its strength.

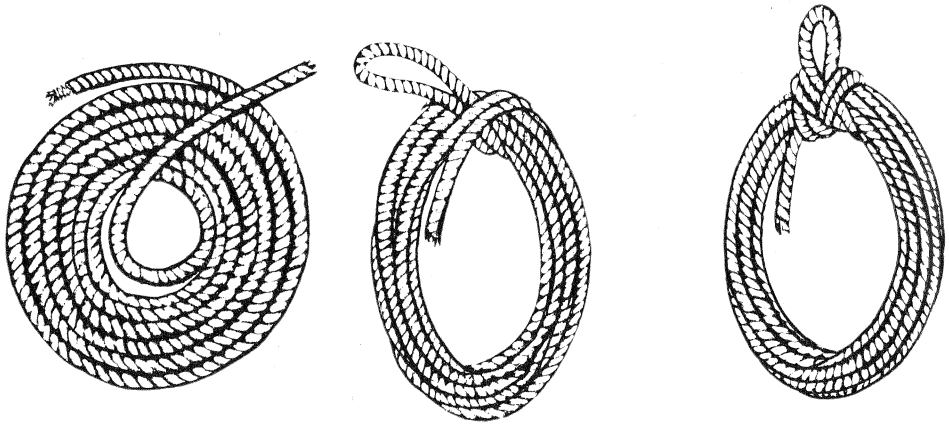
Weakening Effects of Knots

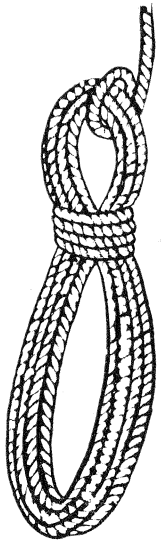
Knots, turns, and hitches weaken a rope by forming a bend which distributes the load on the fibers unequally. The shorter the bend in the standing part of the rope, the weaker the knot. The following table gives the results of a series of tests made by the Massachusetts Institute of Technology. It shows the reduced strength of manila rope with some of the common knots and hitches:

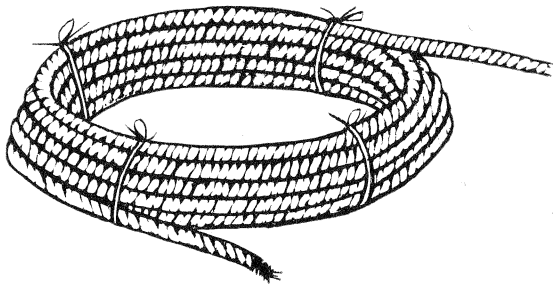
	Percent Efficiency
Full strength of dry rope	100
Eye splice over iron thimble	90
Short splice on rope	80
Timber hitch, round turn, half hitch	65
Bowline, slip knot, clove hitch	60
Square knot, weaver's knot, sheet bend	50
Flemish eye, overhand knot	45

Approximate Breaking Strengths

Diameter (inches)	Sisal	Manila	Polypropylene	Dacron	Nylon
1/4	480	600	1,050	1,600	1,800
3/8	1,080	1,350	2,200	3,300	4,000
1/2	2,120	2,650	3,800	5,500	7,100
3/4	4,320	5,400	8,100	11,000	14,200
1	7,200	9,000	14,000	18,500	24,600







Ropes are measured and described by their circumference in inches. A 3-inch rope, for example, is 3 inches around and just under an inch in diameter. The word "rope" is not usually used to describe anything less than 1 inch in circumference. Smaller sizes are described as line or cord.

Care of Rope

It is important that a thorough inspection of a rope be made from time to time. Here is how to do it:

- Look for worn spots and broken fibers on the outside.
- Inspect the inner fibers by untwisting the rope in several places. If the inner strands are bright, clear, and unspotted, most of its strength has probably been preserved.
- Unwind a strand 8 inches long and break it with your hands. If it breaks with little effort, the rope is unsafe.
- In general, a rope that has lost its feel of stretch or has become limp or in which the fibers have lost their luster and appear dry and brittle should be looked at with suspicion. It should be replaced by a new rope, particularly if it is used on scaffolding.

Since even a moderate load on a rope in which there is a kink may overtax the fibers at the point of the bend, great care should be taken to avoid kinking; kinks are most likely to occur when a rope is wet. To avoid kinks in a new rope while uncoiling it, lay the coil on the floor with the inside end down; then reach down through the center of the coil and pull this end up and unwind the coil counterclockwise. If it uncoils in the wrong direction, turn the coil over and pull the end out on the other side.

If a new rope is so kinky that it cannot be used, the twist can be removed by dragging it backward and forward along a smooth section of ground.

To preserve a rope that is not in use and to keep it supple and clear of kinks, it should be kept coiled down. A rope should always be coiled in the direction of its lay; thus, right-handed rope should be coiled clockwise, and left-handed rope counterclockwise.

All ropes should be kept as dry as possible, because, if coiled or put away when damp, they will mildew very quickly. Mildew causes damage that will become apparent only when the rope suddenly breaks. Wet ropes should always be hung over a ladder or pole and remain hanging until quite dry before being coiled.

NOTE: If possible, avoid using binder twine for pioneering projects because it will not make a safe lashing for heavy weights. Always use quarter-inch rope.

About Knots and Lashings

2. Tie 10 knots and hitches and explain their specific use in pioneering. Include bowline, clove hitch, two half hitches, tautline hitch, square knot, timber hitch, plus any four others.

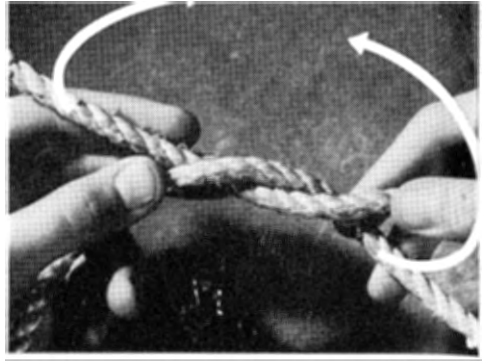
Knots

All knots and hitches are formed by just three methods of laying rope: bights, loops, and overhand knots. When you know these, you can tie any knot easily.

BIGHT: Formed by turning the rope so that the end is parallel to the rest of the rope.

LOOP: Made by crossing the rope end over or under the rest.

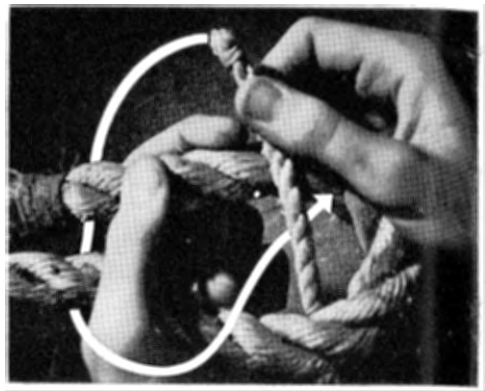
OVERHAND KNOT: Made by passing the end of the rope through a loop.



SQUARE KNOT: Twist left-hand rope over, behind, and under right-hand rope.

Make a bight on right-hand rope. Bring end of left-hand rope over, behind, and under end of right-hand rope.

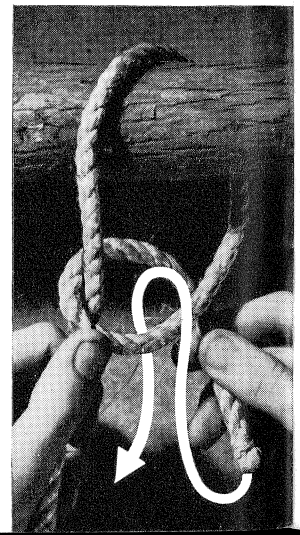
Pull the ends until knot is taut.



SHEET BEND: Make a bight on end of heavier rope and hold in left hand. Bring end of thinner rope through bight from below.

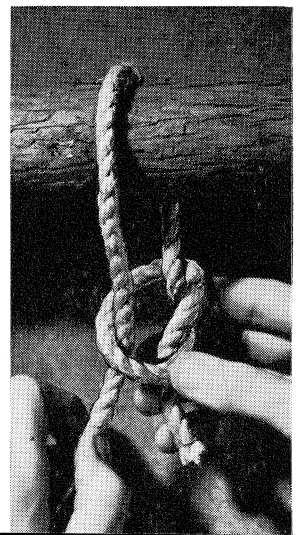
Bring end of thinner rope over, around, and under bight. Then slip it under its own standing part where this enters bight. (Note that both rope ends are on same side.)

Hold the bight with one hand and then tighten the sheet bend by pulling on the other rope's standing part.

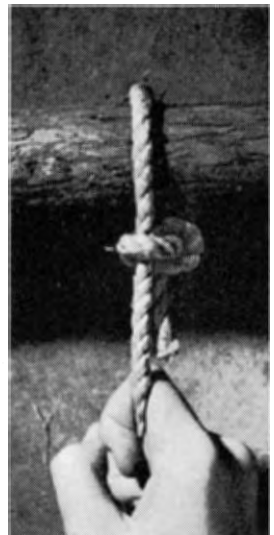


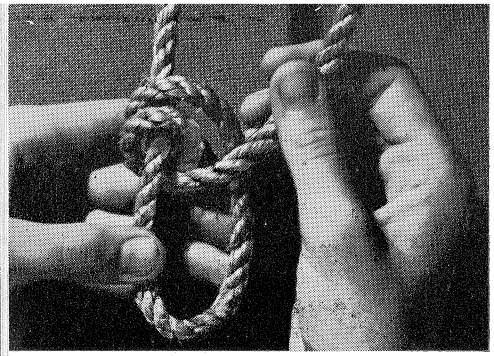
SLIPKNOT: Loop rope over pole.

Tie end of rope around its standing part with overhand knot. (It will be more secure if an overhand knot was first tied in the end of the rope.)



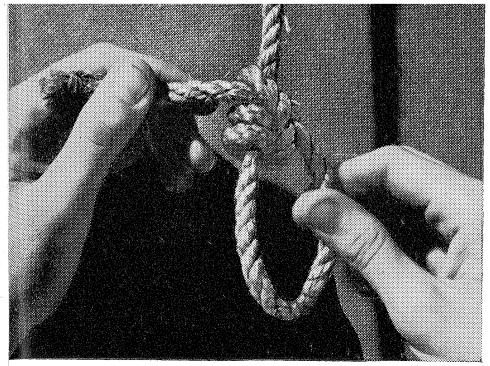
Pull overhand knot taut. Push it against pole and tighten slipknot by pulling the standing part.





TAUT-LINE HITCH: Bring rope around peg, then over and under the standing part and twice through the loop.

Make another turn around the standing part by bringing the end over, under, and through the loop.



Work hitch until it is taut around standing part. It can be pushed up and down the standing part to adjust rope.

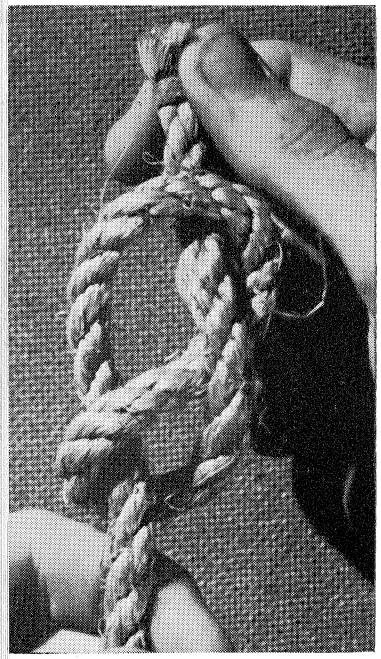
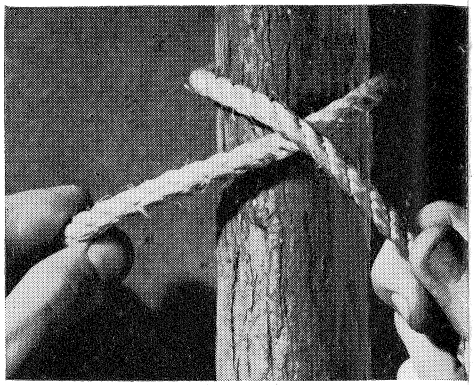
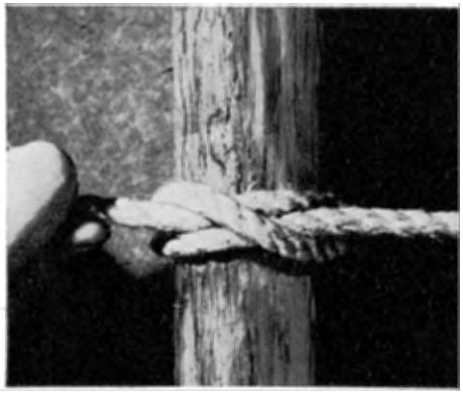


FIGURE EIGHT: Can be used to keep a string or rope from unraveling.



CLOVE HITCH: Bring rope around pole and cross it in the front.

Pass rope end around the pole again below the first turn. Bring the end under the rope.

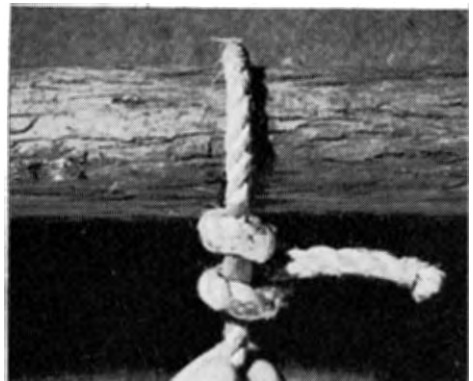


Push loops together and tighten by pulling both ends to complete the knot.

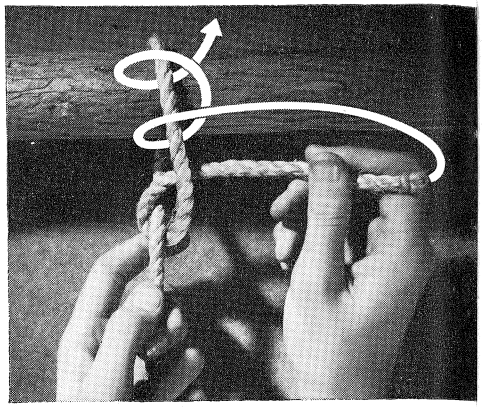
TWO HALF HITCHES: Pass end of rope around pole, then over and under its standing part and through the loop.

Make second half hitch in front of the first by repeating the process.

Push half hitches together and tighten by pulling on the standing part.

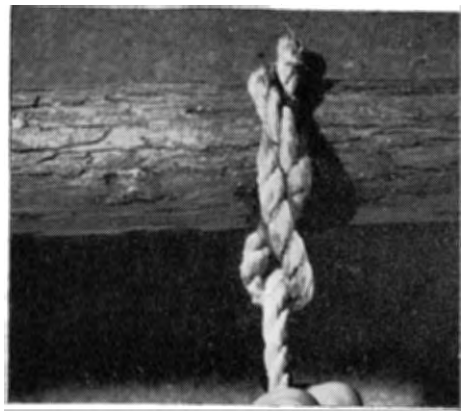


BOWLINE ON A BIGHT: May be tied in the middle or at end of rope. It is better than regular bowline in an emergency.



TIMBER HITCH: Pass end of rope around pole, then under and over its standing part and through loop.

Make bend near the end and twist rope several times around the part next to it.



Push timber hitch firmly against pole and pull on the standing part.

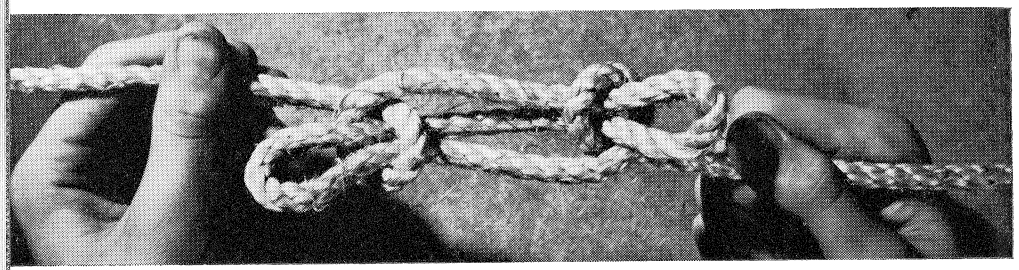
BOWLINE: Place end on standing part, carrying the end around, forming the loop.

Bring end through the loop, around standing part and down through small loop just formed.

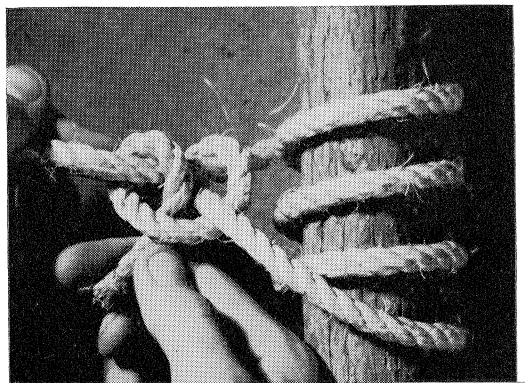
Tighten by holding the bight formed by the end and pulling hard on standing part.

LARIAT LOOP: An overhand knot with the end put through and pulled tight. This running knot makes a lariat.

SHEEPSHANK: Used to shorten a rope without cutting it. It holds only when there is strain on it.



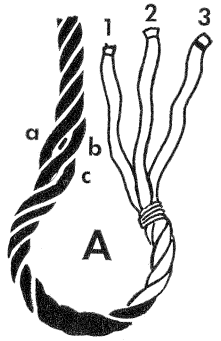
PIPE HITCH: Used to pull a pipe or stake out of the ground. It is tied securely like two half hitches.

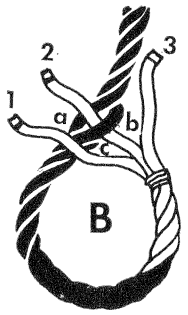


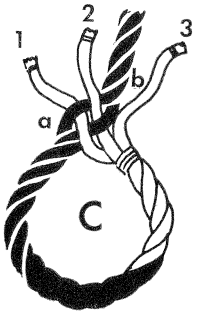
About Splices

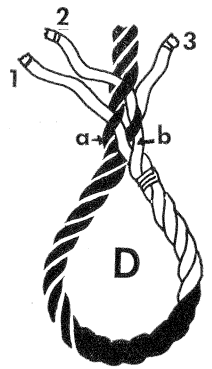
3. Make a short splice, end splice, and eye splice.

NOTE: All rope or line must have whipped ends or back-spliced ends before use.









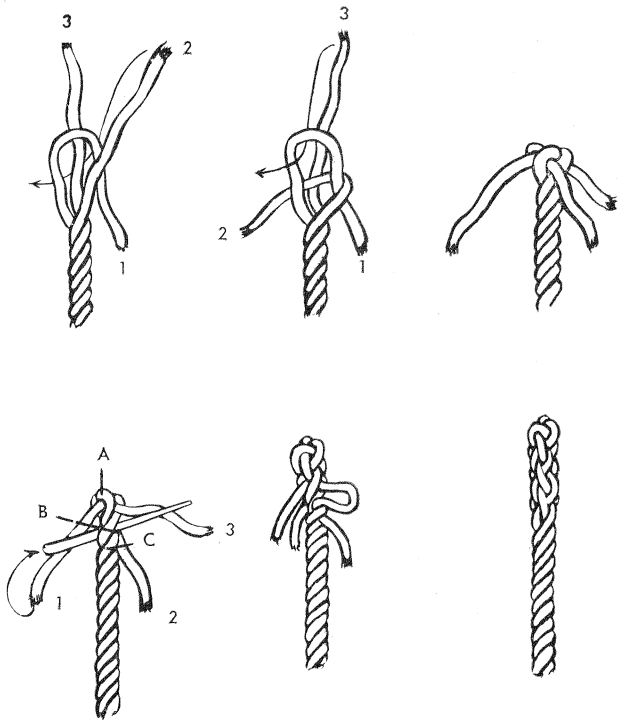
EYE SPLICE:

A. Unlay end.

B. Tuck strand 2 over strand c, under b, and out between a and b.

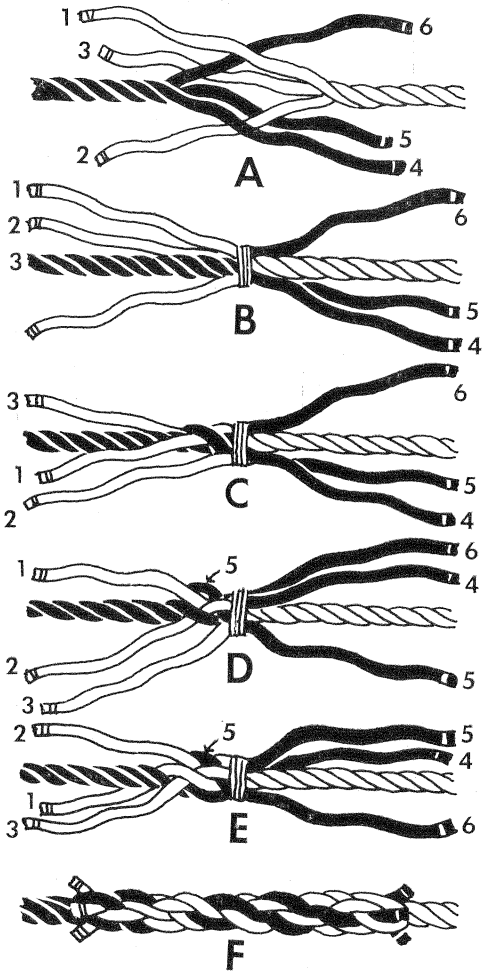
C. Tuck strand 1 once over b and under a.

D. Tuck strands twice, as strand 2.



END SPLICE:

This is also referred to as the "back splice." This is a permanent fastening on the end of a rope to prevent unraveling. Begin by making a crown knot. To make the crown knot, unlay the end of the rope far enough so that the knot or splice may be completed, then bring strand 1 down between strands 2 and 3, forming a loop. Pass strand 2 across the loop thus formed, so that it will lie between the loop and strand 3. Strand 3 is now passed through the first loop. Then splice back the loose ends. Strand 1 is passed over the nearest strand (a) on the main rope and under the second (b), diagonally, almost at right angles to the twist of the strand. Strands 2 and 3, in turn, are spliced back, 2 over (b) and under (c), and 3 over (c) and under (a). Each strand is tucked under but one strand of the main rope at a time. To make a smooth, tapering splice, cut out a portion of the fibers after each tuck and when finished pound the splice lightly with a short stick or hammer and roll it on the floor under the foot. It also helps to singe all loose strands with a small flame (match) so the splice appears tight and neat. This, of course, should only be done outdoors. In splicing ropes, a smooth, pointed, hardwood stick or marlinspike is very convenient for raising the strands.



SHORT SPLICE:

A. Unlay each rope a few turns. Alternate the strands.

B. Tie strands down to prevent more unlaying.

C. Tuck strand 1 over an opposing strand and under the next strand.

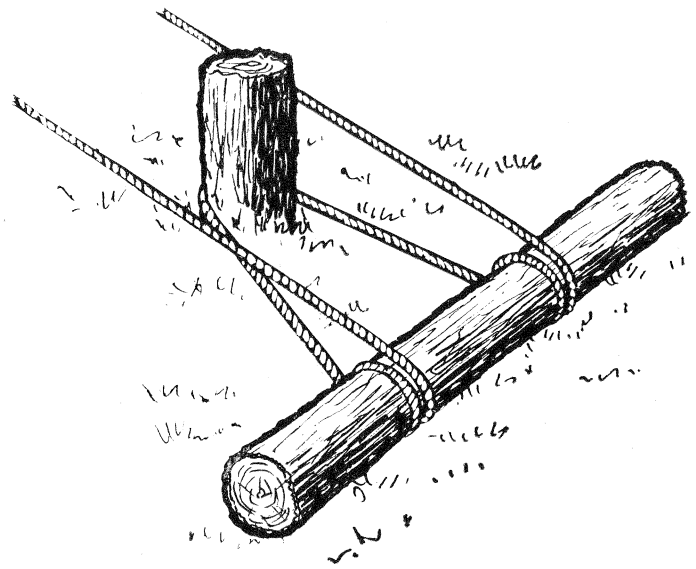
D. Tuck of strand 2 goes over strand 5, under the second, and out between the second and third.

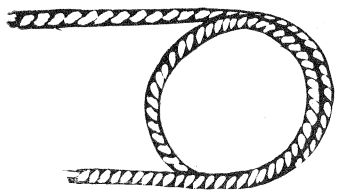
E. Repeat operation with strands 1 and 3 from same rope end.

F. Remove tie and repeat operation on other rope end. Make two more tucks for each strand, roll tucks, clip ends.

Wilderness Engineering

5. Make and demonstrate one device for moving heavy logs, rocks, etc., using rope and natural materials; OR, using rope, build a conveyer cable system for hauling materials over a ravine or up a steep hillside.





The Parbuckle

A parbuckle is used to move logs or other cylindrical objects on the ground or to haul them up or lower them down an inclined plane. The center of the rope is looped or hitched around a tree stump, post, or other firm anchorage. Both ends of the rope are then passed under the log, around behind, and over it, and are brought back in the direction of the anchorage. If the ends of the rope are hauled taut, or slackened together, the log may be moved, rolled, or lowered easily. If the pull on the two ends is not equal, the direction of a log will be changed, but if a short object such as a barrel is being moved, the pull must be kept even or the barrel may slip out of the parbuckle.

Using the Round Turn

One, two, or three round turns around a smooth tree or spar may be used to ease a heavy load or lower a heavy weight to safety. The turns are eased from the same direction as the strain.

It is interesting to see how heavy loads of logs are eased down steep places by lumberjacks. A smooth stump or tree is selected at the top of the incline. A couple of turns of a heavy rope are taken around it, enabling one man to ease the load down without difficulty.

In raising a weight or taking a load by short pulls, the round turn is very useful. One man holds the end and takes in the slack. The other men then do not have to hang on all the time the rope is under stress.

Lumberjack Pulley

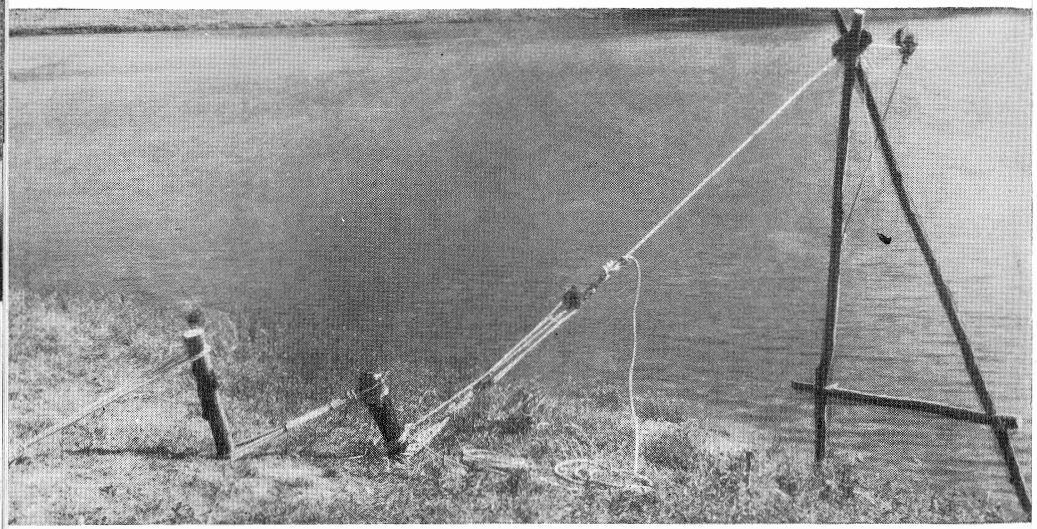
By using this simple technique, a small boy can move a very heavy weight. Take a long piece of rope—about 100 to 150 feet for a good-sized log. With the end of the rope, tie a timber hitch a couple of feet from the end of the log. Then take the rope and tie a half hitch near the end of the log. See illustration. Now take the rope and pull it counterclockwise around a tree or other stationary object a short distance away. Make a 6-inch overhand loop in the original line about 3 or 4 feet from the log. Pull the end of the line through the loop and take the rope around the tree counterclockwise. Make an overhand loop in the section which you have just brought around the tree (rope which you wish to pull) and put end of rope through it. See illustration. Bring end of rope counterclockwise around tree and follow same procedure, making one more overhand loop and bringing rope around the tree again. Pull end of line to move object.

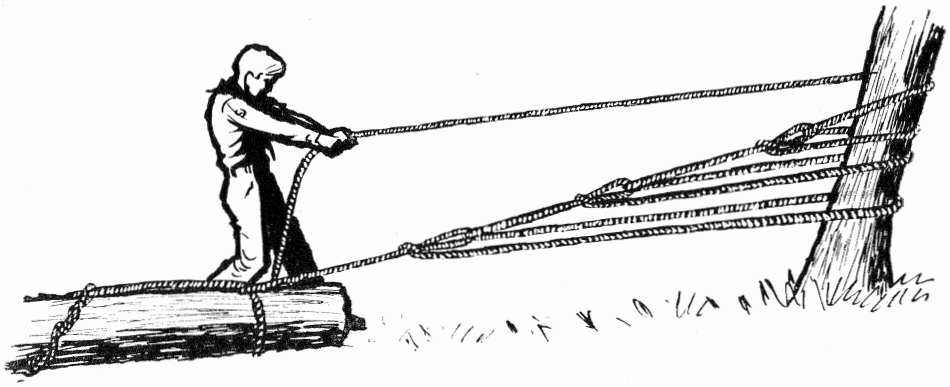
NOTE: The three loops act as pulleys and are very effective.

Equipment

Large log
100- to 150-foot rope (size of rope is determined by weight to be moved)

A CONVEYER CABLE: This is used to transport heavy materials across a stream or up and down a steep incline. It can be rigged between trees, or a support can be built as shown here.





The Spanish Windlass

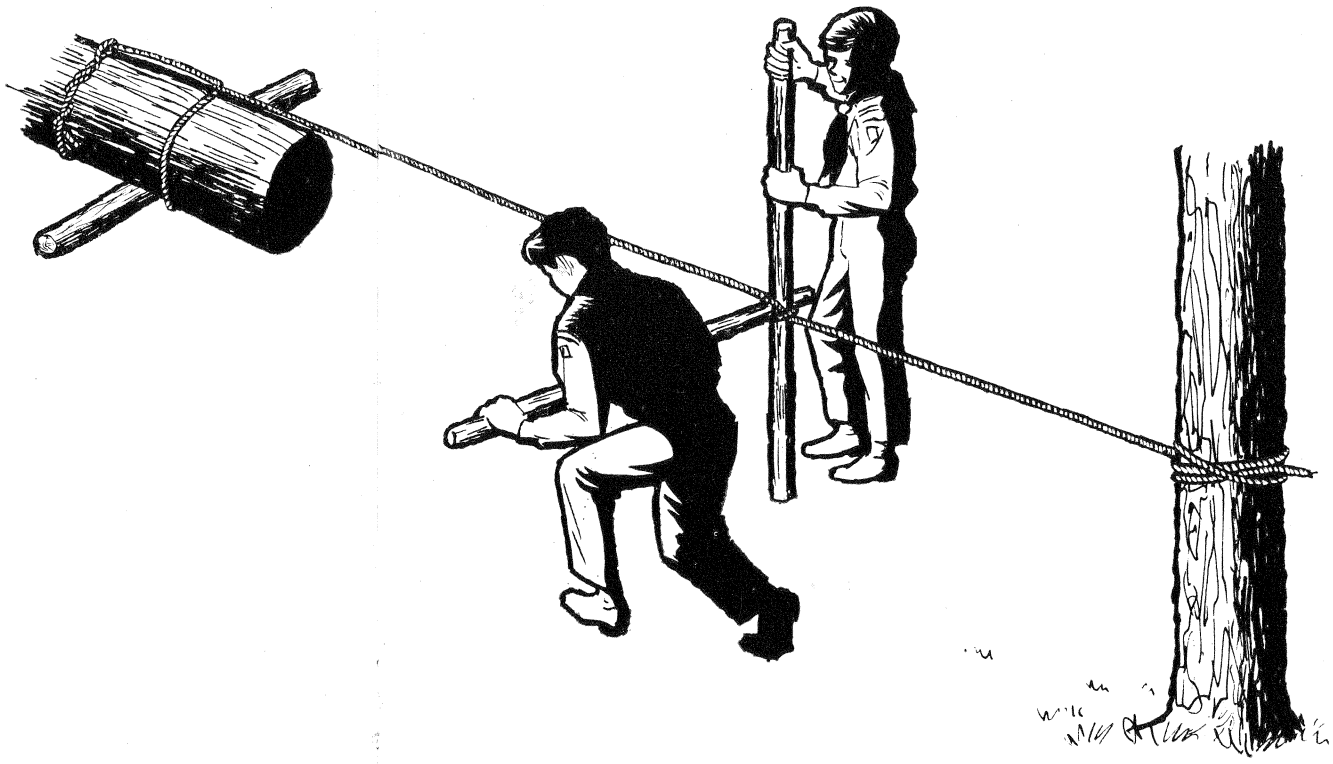
Use ½- to ¾-inch rope to make the windlass. Tie one end to a tree 25 to 35 feet away from the object you want to move. Tie the other end to the object, leaving some slack. At the rope and about 100 feet from the object, hold a 3- to 4-inch butt pole upright. The pole should be 6 to 7 feet long. Take a longer (10-foot) but more slender pole, place it next to the upright about knee-high, and make a simple loop over this pole as shown in illustration. Walk the slender stick clockwise around upright. Step over rope each time around.

Equipment

1 6- to 7-foot pole with 3- to 4-inch butt

1 10-foot pole with 3- to 4-inch butt

1 ¾-inch rope, 60 feet long



Pioneering Projects

6. Following an approved design and using square, diagonal, and shear lashings, build a log bridge, signal tower, monkey bridge, or raft.* (Dismantle after use and inspection unless built for permanent use.)

***Project 6 may be done in a council camp activities area where poles are available for general use in pioneering projects. Trees should never be cut on private or public property without permission.**

DIAGONAL LASHING: Begin this lashing with a timber hitch around the two timbers at the point of crossing, springing, or binding them together.

Make three turns around both timbers. Place turns beside each other, not on top of or around each other.

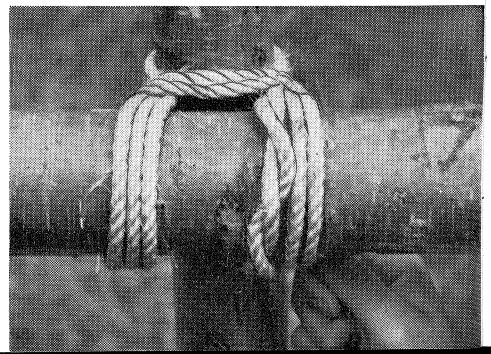
Make three more turns crosswise to previous turns. Pull each turn hard to make it tight.

Make two frapping turns between timbers around diagonal lashings. Pull rope as taut as you can to secure lashing.

Finish with a clove hitch around either timber.

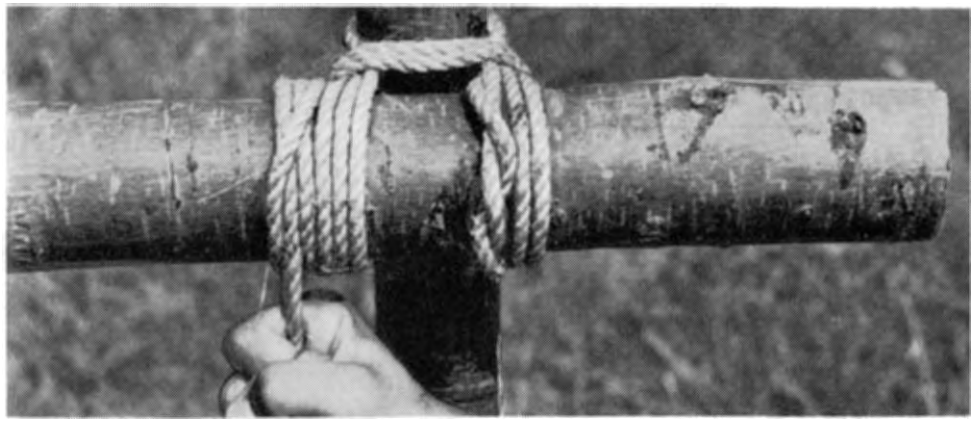
SQUARE LASHING: Start with a clove hitch around upright, just under the spot where crosspiece is to be.

After three or four tight wrapping turns, make two or three "frapping" turns between timbers. Pull them tightly.

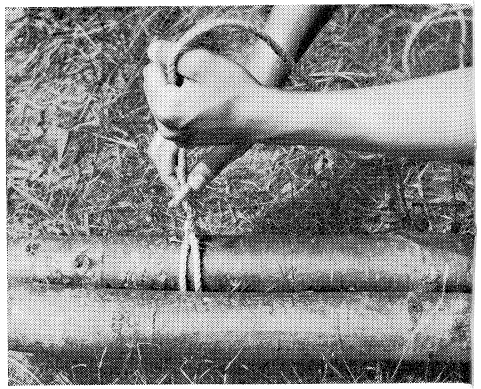


Twist end of rope into the standing part. Then "wrap" rope around crosspiece and upright, binding them together.

In wrapping, the rope goes on outside of previous turn around crosspiece, on the inside of previous turn around upright.



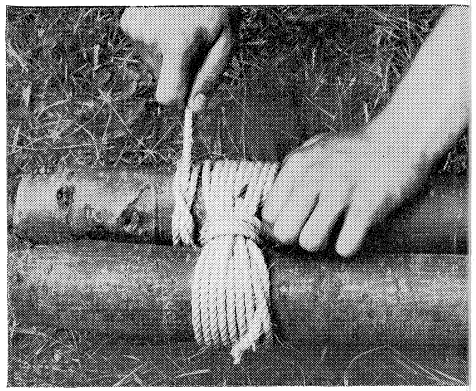
Finish with clove hitch around end of crosspiece.



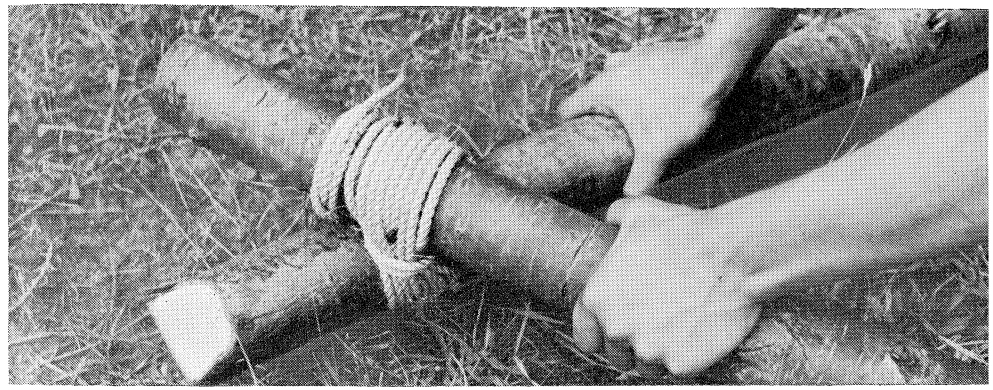
SHEAR LASHING: Put the two timbers together and tie clove hitch near the top of one.

Bind timbers together by seven or eight turns. Make turns loose, one beside the other.

Make two complete frapping turns around lashing turns between the timbers.



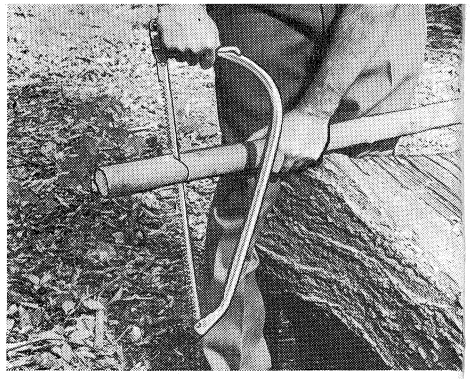
Fasten securely with clove hitch around second timber.



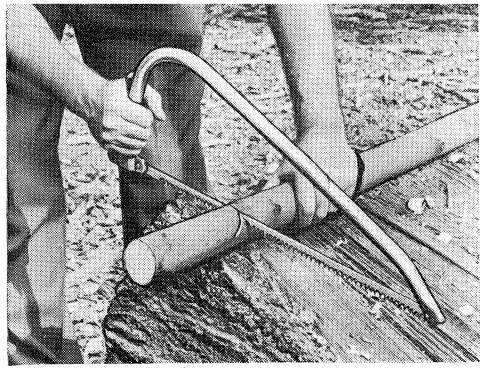
Open out the timbers. NOTE: Two shear lashings without frappings are used to lash two timbers into one long one.

Dovetailing

With the handy bow saw and a pocketknife, you can make excellent joints for log structures without lashings. This is done as illustrated, by making a triangular notch in the "receiving" log and a tapered end on the other log or pole. This is called "dovetailing" and if done correctly, it provides a tight, rigid joint that is neat and strong.

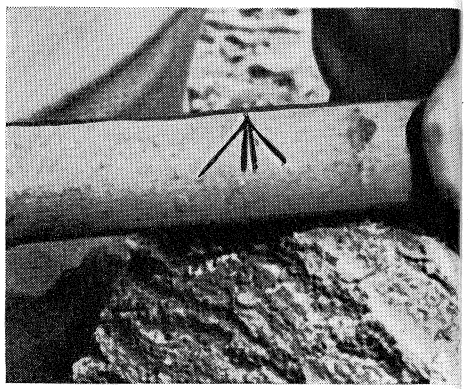


DOVETAIL NOTCH: Make cut that slants to your right, not quite halfway through and in from the end. Avoid knots.

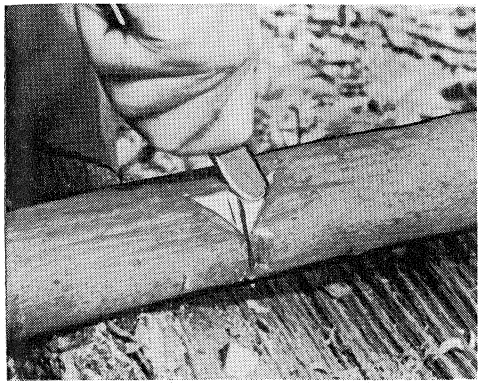


Make an equal cut to the left. Note that cuts are almost at right angles. The angle can be sharper on thick pieces.

Cut straight down to the depth of side cuts and make a second vertical cut to one side of the first cut.



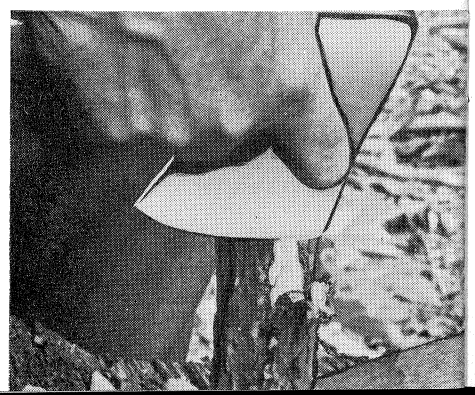
The side cuts outline the dovetail, and the center cuts break up the fibers so your knife can pry them out.



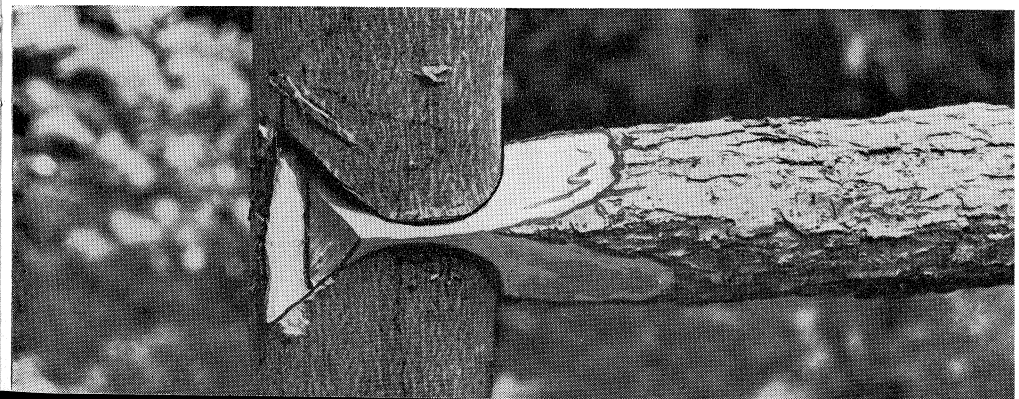
Pry out wood in the notch, first on one side and then the other. It chips out easily.

The cleaned-out notch is ready for a fitting—round stick or dovetail.

With the piece to be fitted held over the notch, shape the base and sides. Make the end a little smaller than the notch.



Drive dovetail into notch until it jams. If you want a very rigid joint, shape the dovetail more until it fits tightly.



Fun Building Bridges

In selecting the site for a bridge, you must consider the nature of the banks, the bed of the stream, and the speed of the current. The bed of the stream should be hard rather than muddy so that the legs of the trestle do not sink in too far. The height of the bank will determine the height of the bridge's roadway above water. At the outside of river bends the current flows faster and the water is deeper. It is better to build a bridge where the stream is straight and where there is less depth.

Lashing Line Length
(Approximate lengths only)

Square Lashing – (¼-inch line)

4 5-inch timbers	20 feet
3 4-inch timbers	16 feet
2 3-inch timbers	12 feet

Diagonal Lashing (¼-inch line)

4 5-inch timbers	18 feet
3 4-inch timbers	15 feet
2 3-inch timbers	12 feet

Shear Lashing (¼-inch line)

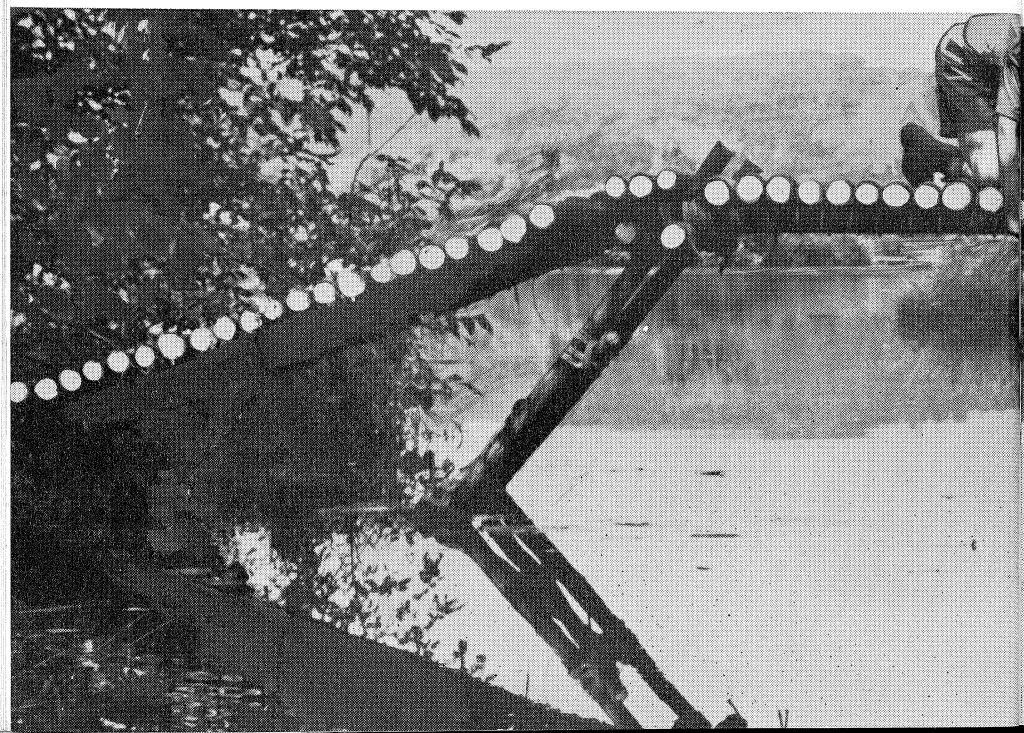
4 5-inch timbers	16 feet
3 4-inch timbers	14 feet
2 3-inch timbers	12 feet

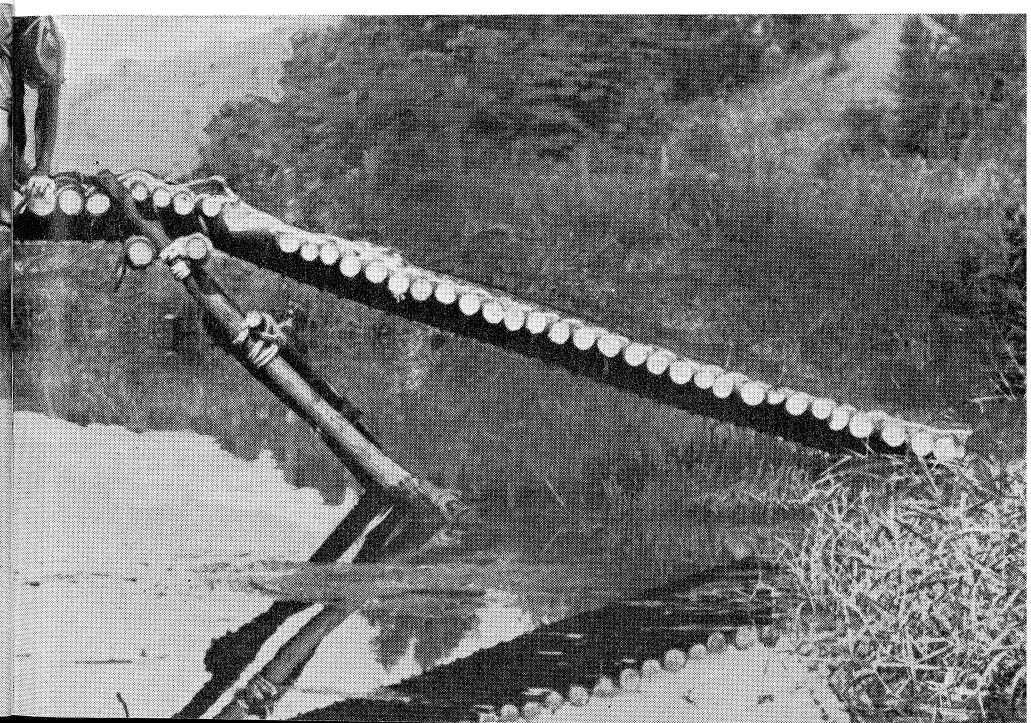
Double-Lock Bridge

The single-lock bridge can span a stream up to 30 feet wide. For a wider span, use a double-lock bridge.

The double-lock bridge uses trestles like the single-lock, but they are not locked together. Instead, the trestles are locked into a horizontal trestle that carries the center section of the road.

Because the trestles in the stream do not lock together in the double-lock bridge, they should be of the same width.



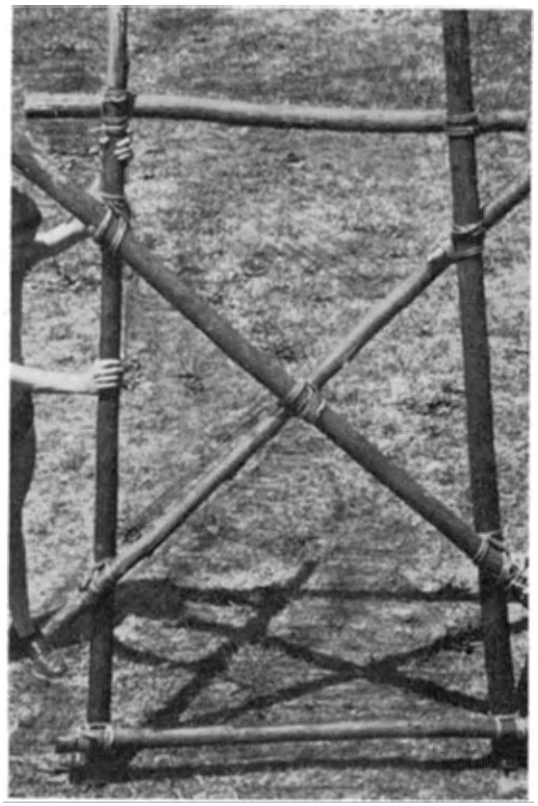


Single-Lock Bridge

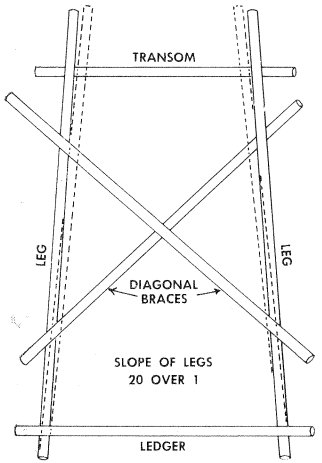
The single-lock bridge is the simplest of the pioneer bridges to build.

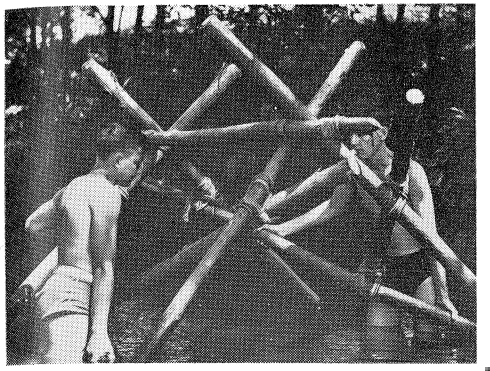
The two trestles are built so that the top of one fits into the top of the other as shown by dotted line in the diagram.

Note that the slope of the legs is "20 over 1." That means that for each 20 feet the trestle is high from ledger to transom, each leg should slope inward 1 foot. If the trestle is 10 feet high, the slope is 6 inches.



SINGLE-LOCK BRIDGE: Notice that the transom and ledgers as illustrated go on opposite sides of the uprights. Note also that one diagonal brace has both ends on the same side of the uprights; the other has one end under one upright and one end over the other upright.

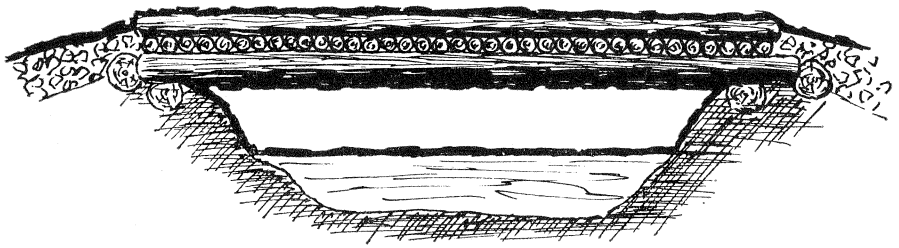




When the trestles are ready, float them into the water and raise them into position. They should face each other squarely and stand securely on the banks. Bring tops together with transoms on the outside. Lock the narrow-topped trestle into the wider one. If the bridge will carry heavy traffic, lay a crosspiece into V's, formed by the uprights, and lash it firmly in place.

Run two timbers (road bearers) from each bank to the transoms and lash near uprights. Lash crosspieces to timbers about 2 feet apart, or lay a complete flooring of crosspieces securing them with floor lashings.

Roadway may be old boards or saplings. Lash securely to the crosspieces. If the bridge is to stand a long time, creosote the timbers and tar the lashings before you put the trestles in the water. Double-lock bridge can span a stream up to 45 feet wide.

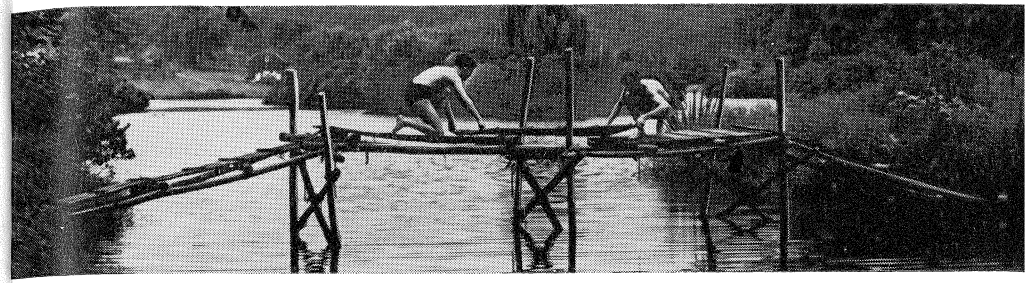


Stringer Bridge

Stringer bridges are used for short spans and are easily and quickly built.

First prepare a shallow trench in which to place the sills. These sills should be of the most rot-resistant wood you can obtain. *Always peel the bark.* Place them in solid earth and fill around with rock. Using rock will permit drainage and reduce the rate of decay.

On the sills place the two horizontal logs, or stringers, which should be notched to the sills or held by hardwood pins. At the end of the stringers place a split log with the flat side against the ends of the stringers. This is called the retaining log and keeps the rock fill in place. Across the stringers, which have been flattened on top, place the



floor poles. On top of the floor poles over the outside stringers, place a guard rail at least 6 inches in diameter, and pin it down to the stringer.

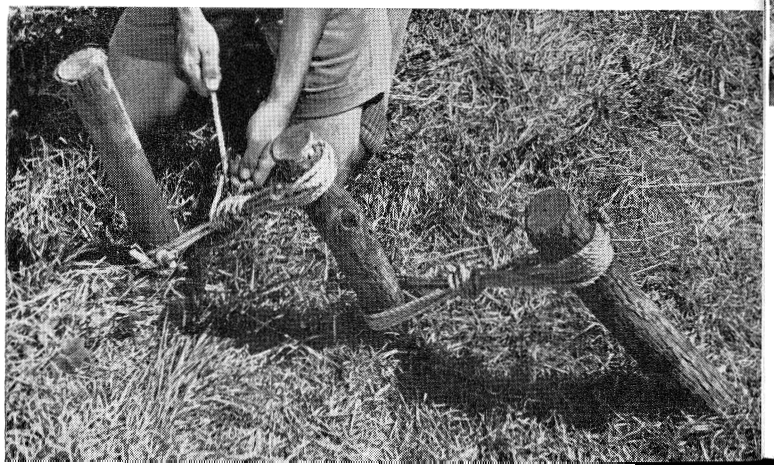
If round material is used for flooring, hew a tread along the center about 2 feet wide. Round material split through the center and laid as shown in the detail also makes a satisfactory floor. *Do not put a dirt covering over the floor.*

Monkey Bridge

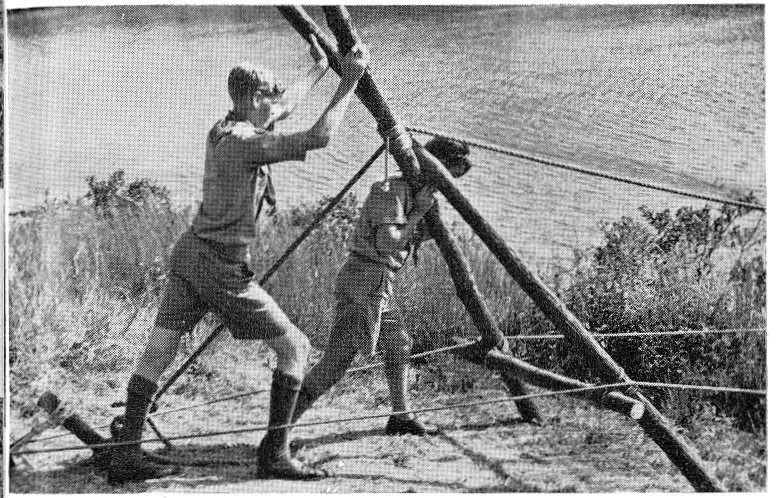
The construction of a monkey bridge is a pioneering feat that will thrill your gang. The monkey bridge can span a much greater distance than the usual pioneering bridge – up to 100 feet. Don't try too great a span at first: 25 feet should be long enough to start with.

MONKEY BRIDGE: Use two 12-foot logs about 4 inches thick at the butt for shear legs. Place side by side and lash together 5 feet from top with shear lashing. Spread the legs and lash 4-foot crosspiece to the legs 2 feet from butts. Use square lashings.

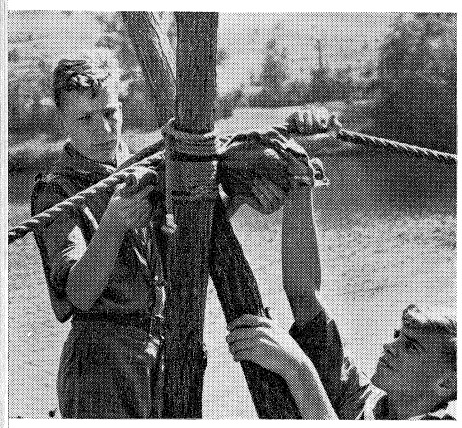
Hammer 3-foot stakes into ground in line with the bridge and pointing at 60-degree angles away from it. Tie them together in pairs. They act as holdfasts.



Use three manila ropes, all 30 feet longer than stream is wide. Foot rope is 1 inch; two hand ropes are ½ inch. Place all three ropes on ground 4 feet apart, with foot rope in the middle. Attach 9-foot "stringers" (1¼-inch rope) to foot rope and hand ropes with clove hitches. Stringers should be 3 feet apart.



Put rope assembly across stream and secure it temporarily to holdfasts. Raise shear legs with butt ends in shallow holes to prevent shifting. Hold shear legs upright with two guy lines from top of legs.



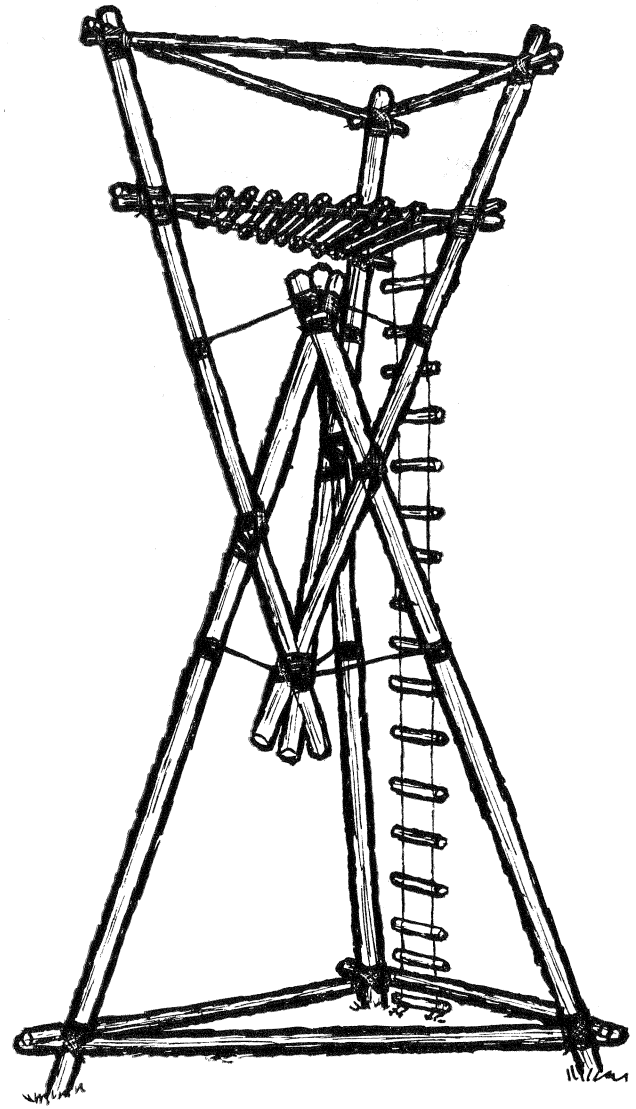
Make the pads of two pieces of burlap. Place in the two shear crotches. Lay all three ropes into the crotches. Lead ends of the foot rope in two turns around the first stakes on each side of river. Then tie them with two half hitches, pulling rope tight.

Have two Scouts stand in the two shear leg crotches, one on each side of the stream. Attach one hand rope to a shear leg with clove hitch, then pull taut and fasten it to shear leg on the other side. Tie the other hand rope the same way.

Tie ends of hand ropes to the first stakes on each side of river with two turns and two half hitches. Go over all the ropes, tightening them as much as possible. Your bridge is done, ready for crossing.

Baden-Powell brought this idea from India. Here he had seen the natives in the Himalaya Mountains make "bridges out of three ropes . . . connected together so that one rope forms the footpath and the others make the handrail on each side." He drew a picture of such a bridge and described it in detail in his *Scouting for Boys*.

It wouldn't be much fun to cross this kind of swaying bridge over a deep mountain chasm, but it's fun in camp where the worst you could get out of a slip would be a ducking.



Fun Building Towers

"Have you ever felt the thrill of sending a message from the top of a signal or pyramid tower you've built yourself? No? Brother, you have a grand experience in store! Pioneering is HE-MAN Scouting, one of the grandest activities in our whole outdoor program. Working with axes and timbers and lashing ropes – you can't beat it." (William Hillcourt)

Now it goes without saying that not a stick of timber is touched unless you have the owner's permission to cut it.

Pyramid Tower

The drawing shows quite clearly that the structure is composed of two similar three-sided pyramids that are lashed together and held in place by short guy ropes. The two pyramids are built separately with the longest sides on the ground and then joined together as shown. Pull them erect, using long guy ropes. This calls for good teamwork. There are several points that must be kept in mind. First, a figure of eight lashing must be used where the three spars meet on each pyramid. Second, sink the butts of the base pyramid into the ground for 3 to 4 inches to give it a secure footing. Third, make certain the rope ladder is in place before erecting the structure. Fourth, do not forget to include handrails.

Gear Required:

Spars: 3 16-foot
3 14-foot
3 12-foot
3 6-foot light
12 staves graduated (2 to 6 feet)

Lashings:
5 20-foot
15 15-foot
1 26-foot section light line for platform and ladder

Also: Rope ladder.

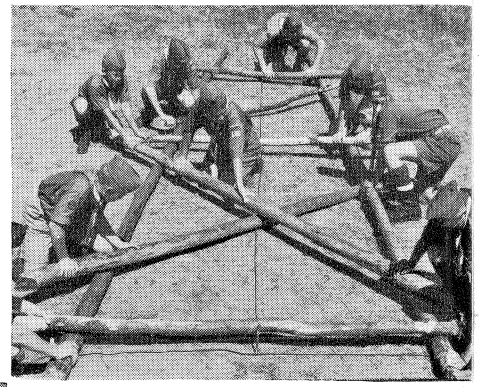
The advantage of this type of structure is that, if you have enough staves, it can be made quite quickly. Two patrols ought to be able to erect it in less than an hour. The project lends itself to indoor pioneering displays at a parents' night.

Signal Tower

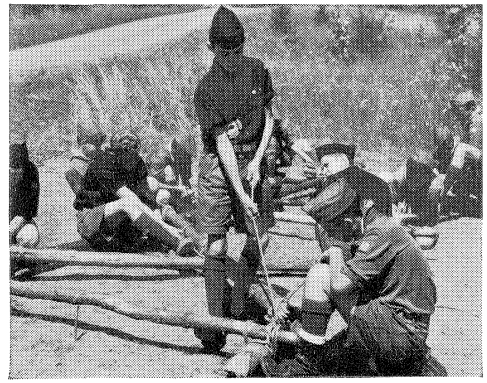
For the 12-foot tower you will need the following:

- 4 12 foot uprights (4 inches thick at the butt end)
- 8 10 foot 6 inch lower diagonals (4 inches)
- 4 6 foot 6 inches middle crosspieces (3 inches)
- 4 8 foot upper diagonals (3 inches)
- 4 5 foot upper crosspieces (3 inches)
- 12 5 foot platform flooring pieces (3 inches)
- 54 15 foot lengths of ¼-inch or 5/16-inch rope, whipped on both ends

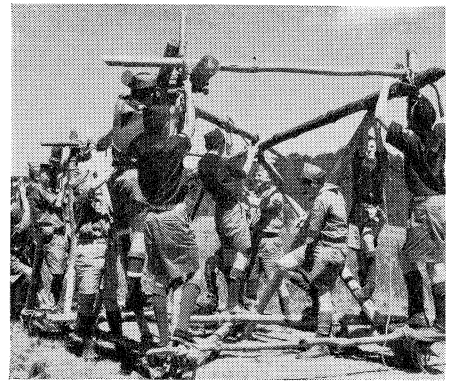
SIGNAL TOWER: Arrange timbers according to length for ease of handling. Peg down a string for a centerline. Lay out one side of tower, following the diagram.

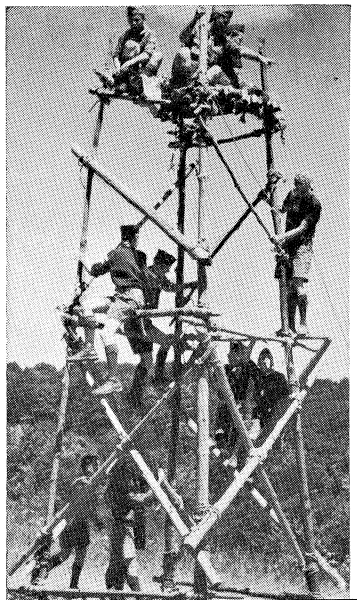


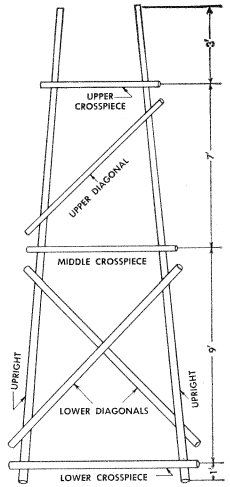
Use square lashings, except where the two lower diagonals meet: there, use diagonal lashings. To make it easy, block up timbers so ropes can slip under them.
Make two sides.



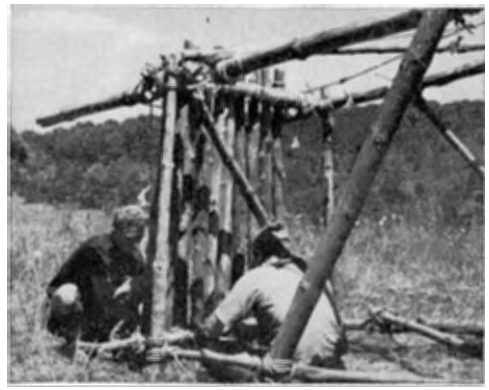
Prop them up facing each other, 7 feet apart at lower crosspiece, 4 feet at upper. Lash together temporarily with diagonal brace. Connect them by crosspieces and diagonals, following diagram used for original sides.



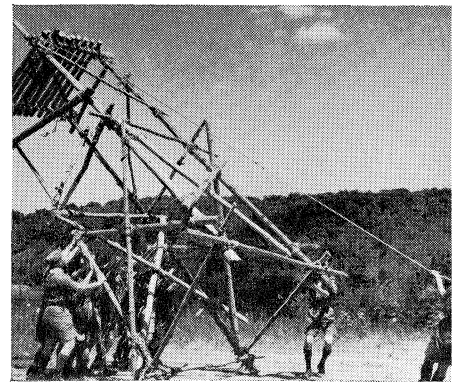




While the tower is still on its side, lash flooring pieces into two opposite upper crosspieces to form a platform. Use square lashings or floor lashings.
Now you're ready to raise it.



Make a large loop in a rope and throw it over the tips of two of the uprights. Throw a loop over the other two. Lift tip of tower a few feet. Now raise it by one gang pulling on one rope, another gang holding back on the other.



Fun Building Rafts

"Where any kind of still or smooth water is available or slowly moving streams, the building of rafts is great fun. The beauty of raft building is that all sorts of material, old and new, can be used; it affords scope for the exercise of a considerable amount of resource and ingenuity. When experiments are being made, care has to be exercised—unless the water is really shallow – that only experienced swimmers try out the makeshift rafts that result. The joy of launching some kind of a contrivance that one has helped to build and finding that it actually floats and even supports a Scout for a time at any rate, has to be felt to be believed." (*Pioneering* by Gilcraft)

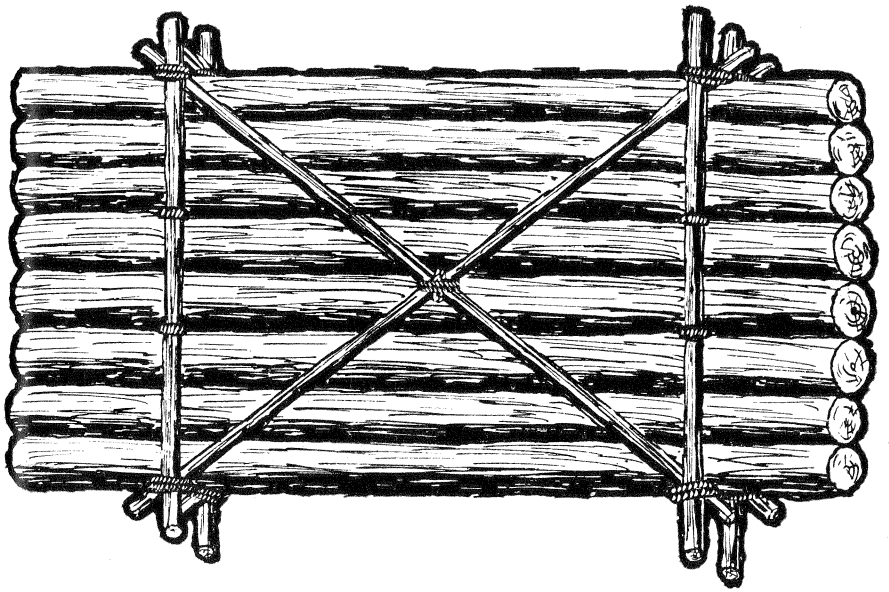
Primitive Rafts

I bet you've thrilled as most of us have to the stories of pioneers and explorers traveling the rivers of the world on primitive rafts. While you read, did you not promise yourself that someday you would follow their example and make a raft?

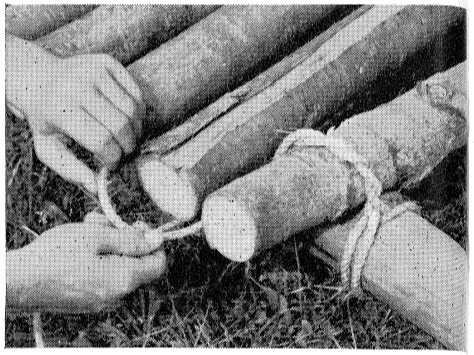
Well, here's your chance. Take your pick among one of these simple designs and combine water fun with pioneering.

To most people a raft consists of a number of large logs lashed together into a floating platform with ropes or pliable vines. But there are other rafts as well, much easier to construct – such as the two shown on these pages.

Remember that rafts can be treacherous. They have a way of turning turtle and spilling their passengers. So if you intend to use a raft for crossing a river or a pond, you'd better be certain that you are a good swimmer before you take off in a raft.



FLOOR LASHING: In floor lashing, start with clove hitch around stringer on which the flooring spars are to be laid.



Make a pigtail of the running and standing ends of the rope and pull it snugly over the first spar of the flooring.

Pull a bight under the stringer and up between the first two spars and slip the bight over the end of the first spar.

Now pull rope under the stringer and up over the second spar — on the outside of the stringer — then repeat third step.

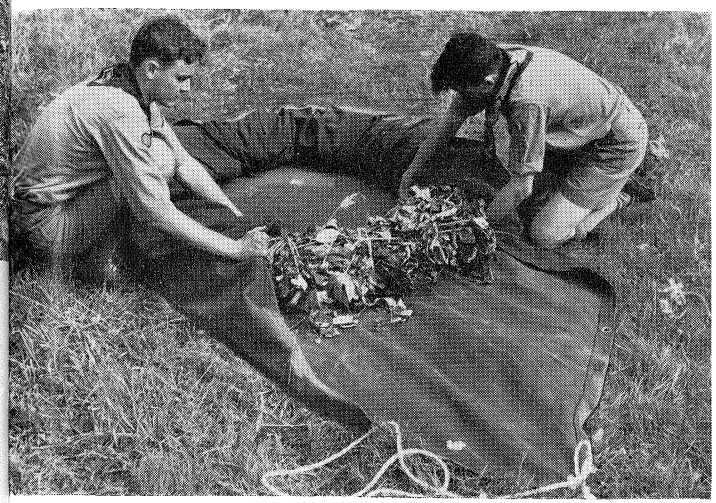
Continue this way until all spars have been laid firmly in place. Finish the lashing with a clove hitch around the stringer.

If the flooring for a bridge or a platform is to consist of a few crosspieces only, you can use square lashings for fastening them to the stringers. But if you intend to lay a floor, you'll be better off using *floor lashings.*

Coracle

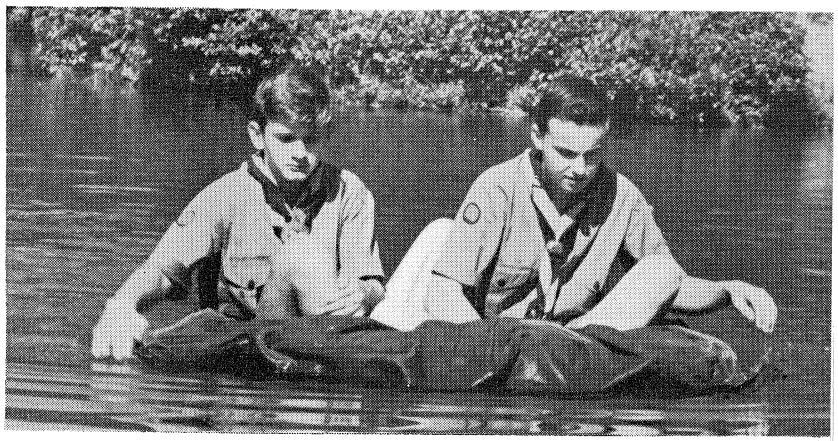
When the ancient Britons wanted to cross a stream, they used a CORACLE. They made the wreath-shaped frame for it on the spot from brushwood, then covered it with a hide. You can make your own coracle from twigs and branches, tying them up with heavy twine, and using a waterproof tarpaulin instead of an animal hide.

Start a coracle by placing twenty 2-foot stakes in two concentric circles, the inner circle 5 feet in diameter.



Fill space between circles with twigs and flexible branches. Then tie brush into a crude wreath with binder twine.

Run rope crisscross into a spiderlike web and place sticks on it for sitting. Then tie a waterproof tarp around the wreath.



Books About Pioneering

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Boy Scout Literature

Camping and *Forestry* merit badge pamphlets

Knots and How To Tie Them

Fieldbook

Sea Exploring Manual

Other Books

All About Camping, W. K. Merrill, 1963
Covers camping on foot, horseback, water, and by auto. The chapter on survival in water, desert, sub-zero weather, and on the coast could save your life. Addresses of outfitters and 4½ pages of other books on camping, cookery, hiking, and the outdoors.

Camping and Woodcraft, Horace Kephart, 1948
Although an old book, these two volumes in one are best on knots, hitches, and lashings. Also covers tanning leather, bee hunting, edible plants, living off the country, cooking, dressing wild game.

Careers in Engineering, Theodore Wachs, Jr., 1964
General picture of engineering, requirements, background, social need.

Handbook of Knots and Splices and Other Work With Hempen and Wire Ropes, Charles E. Gibson, 1963
Clear illustrations, simplified explanations of plain and fancy ropework, including decorative mats and plaits, on three- and four-stranded ropes.

High Timber: Story of American Forestry, Charles I. Coombs, 1960
Conservation, the nature of trees, a history of and future in forestry, woods life, and forest recreation—a good picture of forestry in action. Conservation and good forestry practice go hand-in-hand with use of our wild resources.

Job With Forest Service, Guide to Non-Professional Employment
U. S. Department of Agriculture, 1965. Miscellaneous publication, No. 843, Superintendent of Documents, Washington, D.C. 20403 (10 cents)

Junior Book of Camping and Woodcraft, The, Bernard S. Mason, 1943
The technique of camp and woodland life including axmanship, construction of shelters, benches, tables, eating utensils from wood, using simple tools. Clear illustrations.

New Way of the Wilderness, The, Calvin Rutstrum, 1958
Camping, traveling, and surviving in wilderness areas. Checklists of equipment and supplies to take. Valuable for frigid wilderness survival.

Opportunity in Forest Service Management Careers
U. S. Department of Agriculture, 1965, No. 535, U. S. Department of Agriculture, Washington, D. C. 20250 (free)

Science and Engineering Careers in Government, Descriptions of Beginning Jobs for Young People
Civil Service Commission, 1965, No. 295, Superintendent of Documents, Washington, D.C. 20402 (25 cents)

Wilderness Cabin, Calvin Rutstrum, 1961
How to plan and build the cabin.

Woodsmanship, Bernard S. Mason, 1954
Axmanship, sawing, chopping, camping equipment.

Special Books on Pioneering

Fun With Ropes and Spars, John Thurman

Pioneering, Gilcraft

Pioneering Projects, John Thurman

Rope and Its Uses, A. A. Burger, Iowa State College

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Fun With Ropes and Spars,
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