PIONEERING

BE PREPARED

MERIT BADGE SERIES

BOY SCOUTS OF AMERICA

WHAT MERIT BADGES CAN DO FOR YOU

Merit badges can give you more skill in things you already like to do. They can also give you a chance to try out new activities so you can find new things that you really like.

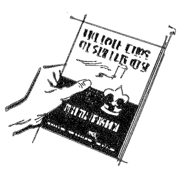
HOW TO EARN A MERIT BADGE

The key word here is EARN—don't just pass a merit badge, earn it! Follow these steps:

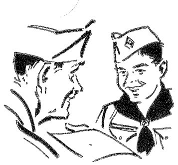
Make an appointment with a merit badge counselor. Your Scoutmaster or Explorer Advisor can tell you how to get in touch with the right one.

Meet with the counselor—several times, if necessary. Keep appointments — BE ON TIME.

While planning and working on each project, use a merit badge pamphlet; get help from your family, teachers, other Scouts, or neighbors.



Meet with the counselor to qualify for your merit badge. If you do not qualify, stick with it until you do. The counselor will then approve your application.



Give the approved application to your Scoutmaster or Advisor. You'll receive the merit badge at a court of honor.

Also see inside back cover.

PIONEERING

By

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REQUIREMENTS

To obtain this merit badge, you must:

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

2. Tie quickly twelve knots and hitches and explain their specific use in pioneering.

3. Make a long, a short, and an eye splice.

4. Lash spars together properly using square, diagonal, and shear lashings.

5. (a) Build, without the use of nails, spikes or wire, a bridge or derrick (capable of supporting two hundred pounds in weight) or other practical pioneering project such as signal tower, monkey bridge, gateway;

   OR

   (b) Build a shack of one kind or another suitable for three occupants;

   OR

   (c) Using lashings only, make a model bridge at least 18 inches long and explain the principles involved in its construction.

NOTE: A Second Class Scout may earn this badge, but he must do First Class Scoutcraft Requirement 3 first.

INTRODUCTION

WHEN you think of a pioneer you think of someone who goes beyond the boundaries of civilization, braving the unbroken wilderness and preparing the way for others. This is just what happened in our own country where pioneering played such an important part in the making of America.

In this pamphlet you are going to learn some of the skills with which the pioneer conquered the unknown. Keep in mind that his task was to prepare the way for the advance of civilization. He himself was an inhabitant of the wilderness, using whatever materials were at hand to supply his needs. Thus, you can learn how to build a bridge without nails, how to build a shack for yourself and two or three of your pals, and how to lay a solid, well-planned trail—the things which pioneers actually had to do when they helped to make America.

Remember that the skills covered in this pamphlet are by no means a complete description of pioneering. The Scout who would make himself a true pioneer will be interested in such merit badges as Camping, Soil and Water Conservation, Wildlife Management, Forestry, Signaling, Hiking, Surveying — in fact, anything which will make him a useful citizen of the wilderness. The Seamanship merit badge will also be helpful.

And when it comes to help in preparing for your Pioneering merit badge, don't forget the list of interesting books in the back of this pamphlet.

The pioneers had few tools but plenty of gumption and ingenuity. Here is a piece of ingenuity worthy of the old

pioneers. I remember one job when it was necessary to use a spirit level and there was none to be found. One ingenious fellow who had lived back in the country where the principal tool was an ax, solved the problem by using a shallow pan of water which he filled about three-quarters full and judged the distance all around between the water and the top of the pan. Such ingenuity makes it possible to do many difficult things with make-shifts.

When preparing to do a pioneering job, first see what should be done, and what material is at hand or can be obtained in order to do the work. When the work is in progress there will be many opportunities for initiative, ingenuity and teamwork, as well as a lot of fun. No job was ever done properly unless there was some responsible person in charge, so before undertaking any work Scouts should select one of their number to be the foreman. Choose a fellow who is level-headed and knows more about pioneering than you do. Know what part of the work you are to do. Then follow directions without asking why. Become a smooth working part of the team and see how quickly the job will go ahead.

A word of advice to the foreman. Remember that a good boss does not have to be "bossy."

Make careful measurements and check them. Be sure to have the proper tools. The pioneers had few tools but they made good use of what they had, and they also took good care of them. Don't abuse a good tool; treat it as a useful friend.

It is better to be patient and work thoroughly than to hurry and have to do the work over. Sometimes an improperly-tied knot or lashing may cause serious trouble. The fellow who says, "That's good enough," is a slovenly workman who does not go far.

Some Tools Most Used in Pioneering

Rope
Block and tackle
Long-handled axe, 2½ lbs. to 3 lbs.
Hand axe
Two-man crosscut saw
One-man crosscut saw } These are awkward in the woods and a buck saw will cut up to 8 inches.
1 inch auger and handle
Cutter mattock
Pick
Sledge, 8 lbs.
Steel wedges, for splitting logs
Long-handled shovel, round blade
General purpose steel chain, 12 feet long with slip and grab hooks
Machete or corn knife
Cant hook
Chalk-line (You can substitute charcoal)

Double-bitted axes are not recommended for Scouts. There is no better axe, when used by an experienced chopper, but it is a dangerous weapon in the hands of a beginner.

After grinding your axe on a wet grindstone it can be kept sharp by using a file. The best file to use is the type known as "all work file" with a coarse edge for fast cutting and a smooth edge for finishing. Some prefer a carborundum or a vitrified file, which is a four-sided, quick-cutting stone.

ROPE

In pioneering you will find rope essential; you would have a difficult time getting along without it. The construction of knots and lashings is of great importance, since a wrong knot, an insecure lashing, or weak rope may lead to disaster. Be sure to use sound material and take no chances.

Rope normally used is made of sisal, manila, or synthetic fibers. Cotton, coir, or other vegetable yarns are also used. Hemp is a strong and durable fiber, but as the supply of true hemp is insufficient to fill the demand, a substitute has been found in the abaca, a species of the banana plant grown in the Philippines, from which comes practically 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. A dark or black color in the rope indicates that the leaves underwent fermentation while being cured. Ropes containing brown or black colored fibers are inferior.

Sisal hemp from Yucatan is also used in the manufacture of rope. It is about two-thirds as strong as manila. Sisal hemp rope, when new and clean, is of a yellowish-white color with sometimes a slight greenish tinge. It lacks the gloss and brilliancy of good manila fiber. The fibers are stiff and harsh and have a tendency to splinter. This accounts for the rough feel when drawn through the hands.

Synthetic ropes such as nylon and dacron are very strong for their size. They are durable because they resist mildew and do not rot. Nylon ropes will stretch under stress and should not be used where this would be a disadvantage.

Withes, Bark, Vines and Roots

Sometimes when you are in need of rope there is none to be had. Don't worry—do as the Indians and pioneers did. In place of rope, use withes, bark, vines or roots.

Withes are flexible, whippy twigs or branches, which can be made pliable by placing your foot on one end and twisting the other, until the fibers of the wood are twisted like a rope. Use tough, green wood such as yellow birch, black birch, hickory, or white oak. Do not attempt to tie a knot in a withe; twist the ends together and tuck them under, and they will stay in place. Withes and grapevines can be used for lashings.

A rope can be made of the inner bark of trees: slippery elm, willow, linden, cedar, chestnut and basswood. For example, split the inner bark of a cedar into narrow strips, making long loose strands of fibers. Take one end of one of these strips, let another Scout take the other end, and then twist throughout the entire length. The result is a heavy cord. Two or three of these cords can be twisted into a rope or braided together, the ends tucked into the braid. For a lighter cord use the thin roots of tamarack, spruce, cedar or mulberry. Each section of the country has its own particular bush or tree best suited to this purpose.

The Lay of Rope

To determine the lay of a rope, pick up one end. You will usually find that the strands run from the bottom left hand 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 running upward to the left.

Measurement of Rope

The approximate strength of rope is best obtained by formula, and to arrive at the approximate loads which various sizes of hemp rope up to six inches in circumference will stand, the following may be used:

$$\text{Breaking load} = \frac{\text{circumference}^2}{3} = \text{tons}$$

$$\text{Proof load} = \frac{\text{circumference}^2}{9} = \text{tons}$$

$$\text{Working load} = \frac{\text{circumference}^2}{6} = \text{tons}$$

$$\text{Safe working load} = \frac{\text{circumference}^2}{18} = \text{tons}$$

Care of Rope

It is important that a thorough inspection of a rope be made from time to time throughout its entire length.

(a) Look for worn spots and broken fibers on the outside.

(b) Inspect the inner fibers by untwisting the rope in several places. If the inner yarns are bright, clear and unspotted, strength has been preserved to a large degree.

(c) Unwind from the rope a piece of yarn eight inches long and break it with your hands. If the yarn breaks with little effort, the rope is unsafe.

(d) 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 and 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 it. Kinking is more liable to occur when a rope is wet.

To avoid kinks in new rope while uncoiling, 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 counter clockwise. 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 the ground.

To preserve a rope which is in use, and to keep it supple and at the same time 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, or with the sun, and left-handed rope counter clockwise.

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

KNOTS AND HITCHES

Familiarize yourself with the following knots and hitches, which you will find very useful:

Overhand Knot

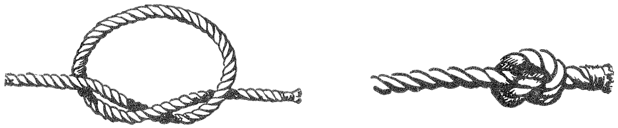
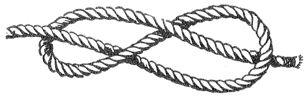
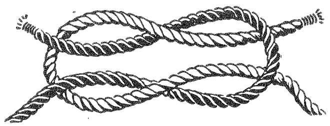


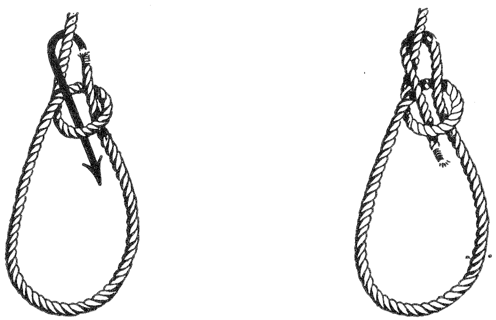
Figure of Eight Knot



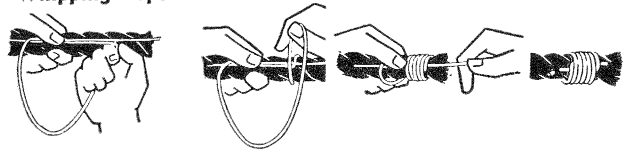
Square Knot



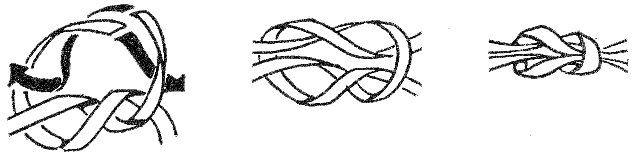
Bowline



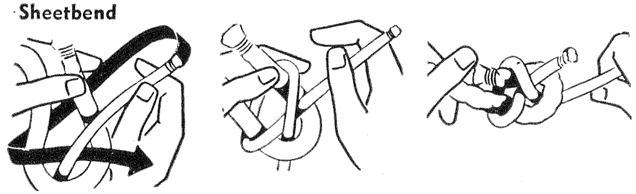
Whipping Rope



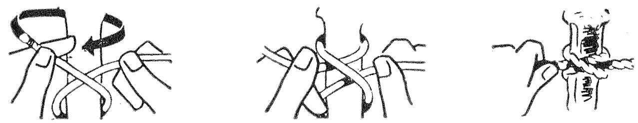
Square Knot



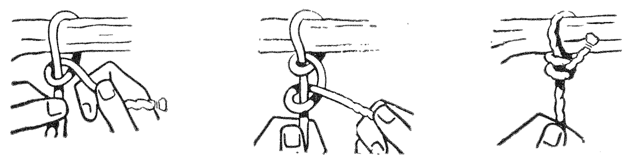
Sheetbend



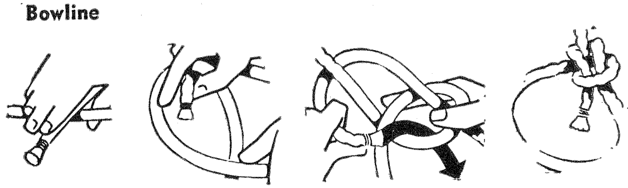
Clove Hitch



Two Half Hitches

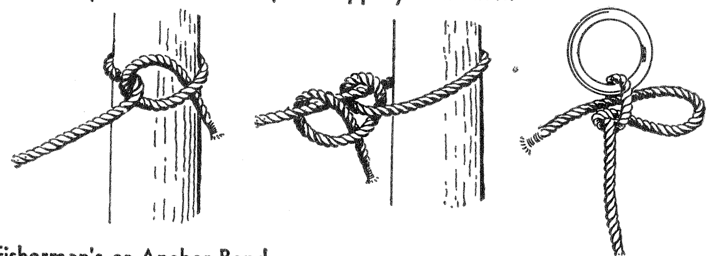


Bowline

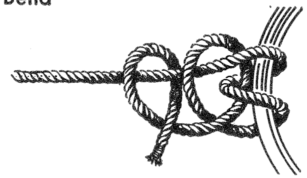


Clove Hitch Over Bar

Half Hitch, Two Half Hitches, and Slippery Half Hitch

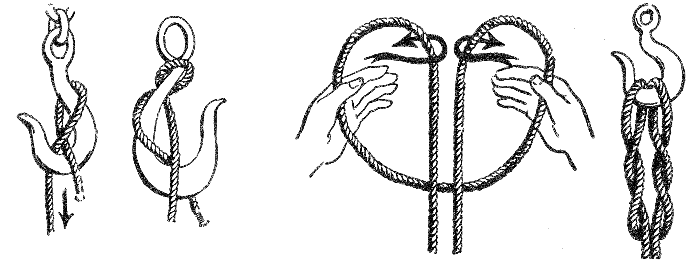


Fisherman's or Anchor Bend

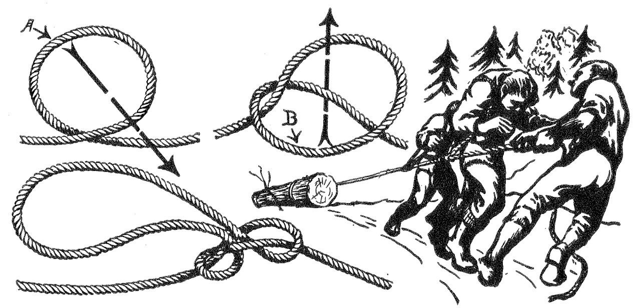


Stopper Hitch

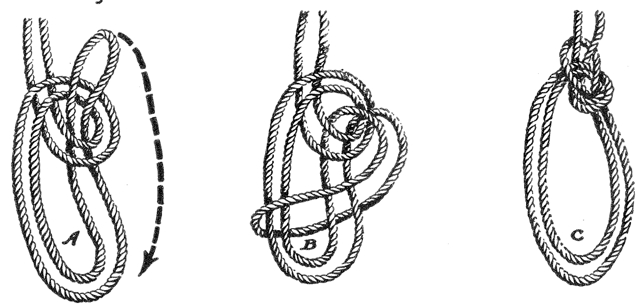
Single and Double Blackwall Hitches; Catspaw



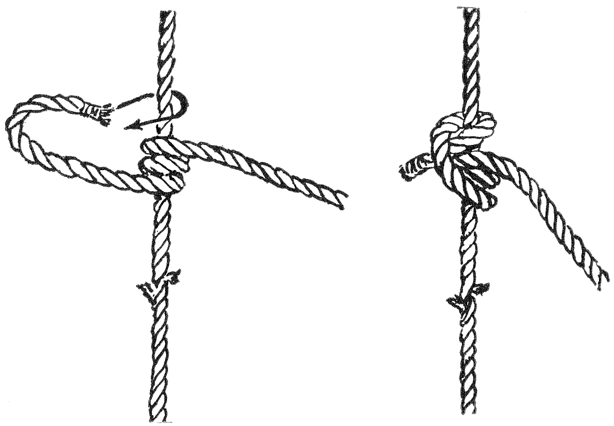
Man-Harness Knot



Bowline on a Bight



Taut Line Hitch



Weakening Effect 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 result of a series of tests which were made at the Massachusetts Institute of Technology to determine the efficiency of manila fiber rope when used in connection with some of the common and well-known knots and hitches:

Full strength of dry rope	100 per cent efficiency
Eye splice over iron thimble	90 per cent efficiency
Short splice in rope	80 per cent efficiency
Timber hitch, round turn, half hitch	65 per cent efficiency
Bowline, slip knot, clove hitch	60 per cent efficiency
Square knot, weaver's knot, Sheet bend	50 per cent efficiency
Flemish eye, Overhand knot	45 per cent efficiency

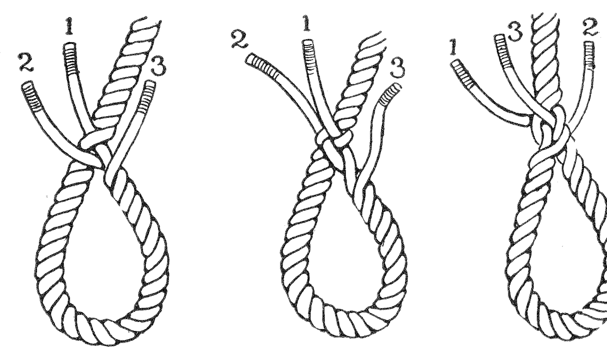
SPLICES

Ropes will break and need mending, or one rope will have to be fastened to another. Such jobs call for a splice.

Eye Splice

Unlay the rope for a sufficient distance from the end, depending upon the size of eye required, and the size of rope. Have enough length unlayed to tuck full once, and two times more with reduced strands. Where the eye is to be fitted with a metal thimble, or used otherwise, the crotch of the opened strands is brought down over the standing part, where the eye is to begin, middle strand up, and with the other two strands lying on each side. Have the eye toward you and the strands and standing part of the rope away from you. Then tuck middle strand under the uppermost strand of the rope, immediately under the crotch of the opened rope. Haul tight, tucking from right to left. Take the left strand and tuck it from right to left under the next strand of the rope, and haul tight. The last strand to be tucked is the one to the right. Give it a bit of extra turn, and tuck under the remaining strand, from right to left.

Make certain the three strands are pulled taut, all equally so, and each under its proper strand in the rope. Also make certain the eye so formed is the required size, and that the eye itself is not distorted in any way.



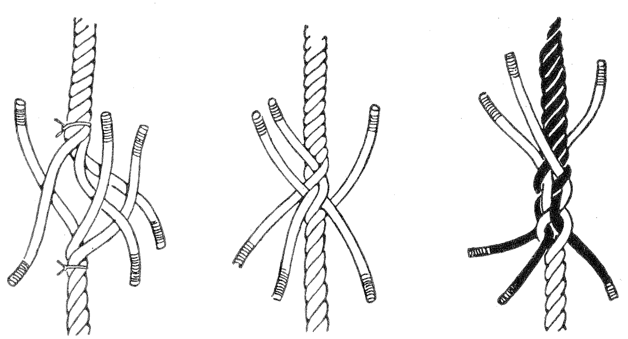
Having made one tuck, it is advisable to take out about a third of the yarns remaining in the strands. These are cut out on the underneath side of the strand. The second tucks are made by going over the first strand and under the next in order of the standing part of the rope. When you tuck, let out some of the turn so the tucking strand will lay flat as it goes over, and then under the next strand. Each strand is so tucked in turn, and you are ready for the third and last tuck.

Again take out a good third of the remaining strands, or perhaps a bit more. After cutting the yarns out from the under side of the tucking strands, again tuck, over and under from right to left. The splice should then taper down nicely, should show no bumps or bulges, and all strands tucked should be under equal tension with the rope itself. After making the last tuck, cut off the ends about a quarter-inch from the rope, first getting the eye on a good stretch. A neat eye splice is easily made, and once made you will never forget how to do the trick.

Short Splice

A short splice is used to join two ropes not required to pass through a block. The result will be a strong splice, but there will be a bulge where the two ends are joined.

Unlay the ropes a convenient distance, and clutch them together so that the strands of one rope go alternately be-



tween the strands of the other. Then tuck the strands of each rope into the other.

The advantages of this splice are the small waste of rope, and the speed with which it can be made. Its disadvantage is the bulge, and the fact that this bulge may make it difficult to run the rope through a block, or fair lead.

Long Splice

This is the splice wherein the Scout must show his skill and judgment. Properly made, it is hard to detect and will run over the sheaves of a block without trouble. It uses up considerable rope, but does not affect the strength of the rope to any great extent.

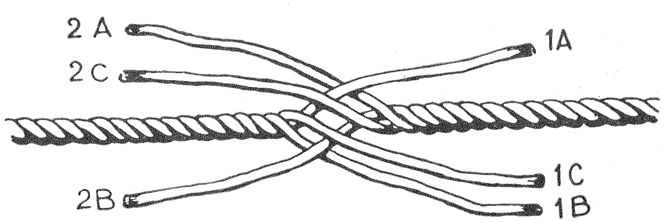
The long splice should be carefully made. The ropes to be joined, (if not a parted rope), should be of the same size and lay as far as possible. To begin the splice, carefully unlay at least six times the circumference of the rope. For a three-inch rope, unlay at least a foot and a half. If the rope is to run over a sheave, more than double this and unlay at least four feet for a three-inch rope, and a proportionate length for others.

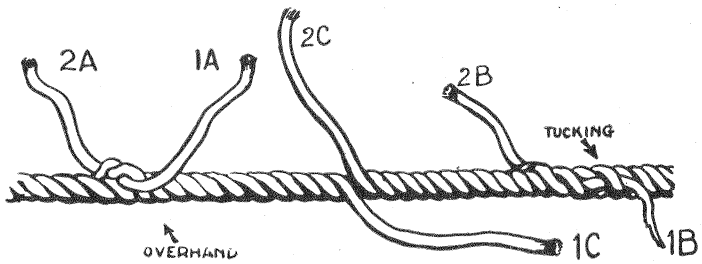
Crotch the strands, hold them in close contact, and carefully lay back a strand from the crotch, laying in the strand from the other part as you unlay the strand along the standing part.

When you get to a point where enough end remains for at least two tucks with the following strand, hitch or jerk the two, from right to left, taking out a bit of turn so they will fit into the score between the two other strands of the rope.

Then go back to the crotch and unlay a strand in the other direction for a similar distance, and hitch the two remaining strands.

You now have the rope with all strands hitched once, and at equal distance apart. If you have been careful to keep the turn in the strands and have unlayed and followed in a seamanlike manner, the rope will look like one continuous





piece. The three tuckings are then pounded down into the lay of the rope, the ends are cut out, about half the yarns from each strand, taking them from underneath, and are tucked again, and perhaps again with a further cutting out. The rope is put on a stretch and the ends are cut off.

One thing to note is that as you come to tuck, the ends of strands that have been laid back are very long and should be cut off at once leaving only enough strand to make the two taper tucks.

Once you have made this splice, the drawings and the description will be plain. It is an easy splice to make if you take your time about it and understand the essential structure of rope. Be careful not to loosen any of the turn in the strands as you unlay, and especially as you fill in with the following strands. Do not unlay more than one strand at a time, and follow immediately with the filling strand.

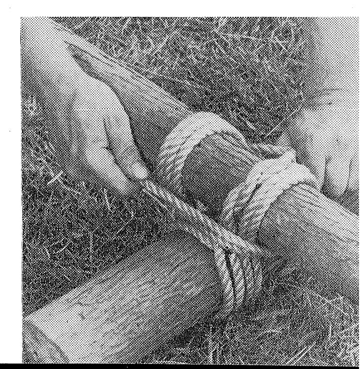
LASHINGS

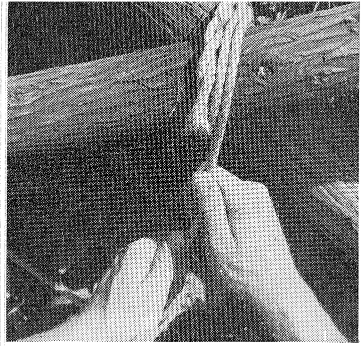
Lashings hold poles together. With them you can make the camp tripods and table, and also bridges and signal towers. For poles crossed at right angles, use a square lashing; for poles crossed at other angles, a diagonal lashing; and for parallel poles, a shear lashing. Take your time and make every lashing firm and neat. The trick is to keep the rope tight as you go along.

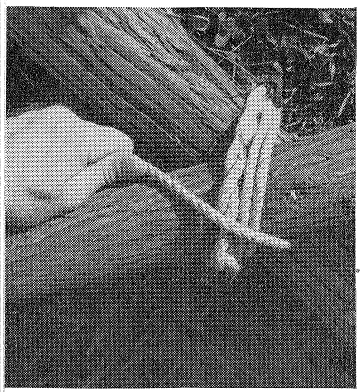
Square Lashing

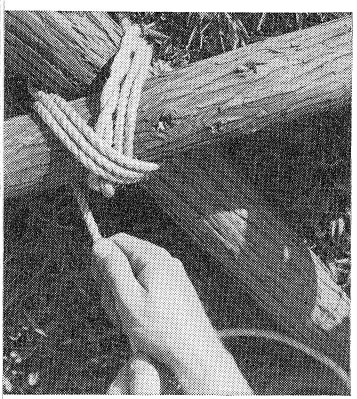
Start with a clove or timber hitch around the upright pole, just below the horizontal pole. Twist the short end of the rope around the long end for neatness. Pass the rope over horizontal pole, then around behind and under upright pole, over horizontal pole and under upright pole. Now you have laid a rope "trail" completely around the poles. Follow this same trail two or three times more, always keeping the rope tight.

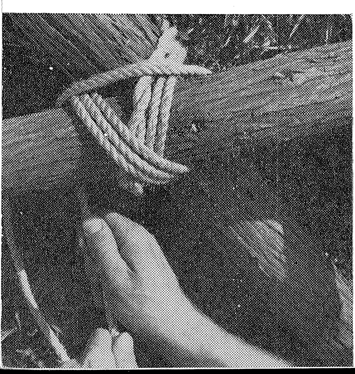
Run the rope inside the previous trail, on the uprights and outside the previous trail on the horizontals. Make three frapping turns,











passing the rope between the spars and around the turns of rope already in place. Pull frappings tight and finish off with a clove or timber hitch.

Diagonal Lashing

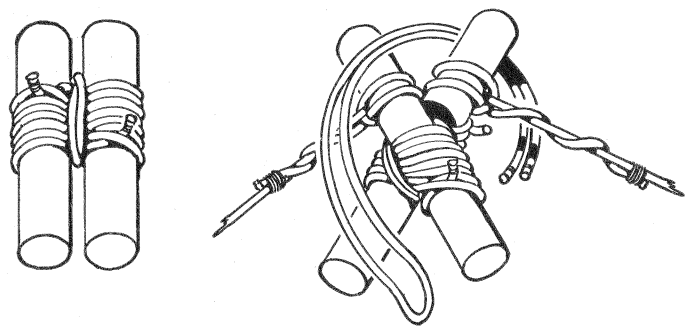
Start with a timber hitch around both poles, and pull tight. Make three or four turns with the rope around the same fork of the poles, and then three or four turns around the other fork. Take two frapping turns, tighten, and finish with a clove hitch around either pole.

Shear Lashing

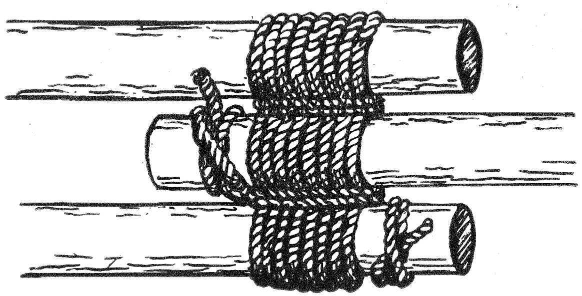
Lay two poles on the ground as shown on opposite page. Begin with a clove hitch around one pole. Take seven or eight loose turns around the two poles. Make two loose frapping turns. Finish with a clove hitch around the other pole. Hoist into place. If necessary, adjust the lashing, making it looser or tighter.

The two spars for the shears are laid alongside each other with their butts on the ground and their ends propped on a piece of timber, so that you can pass the rope around the spars easily. A clove

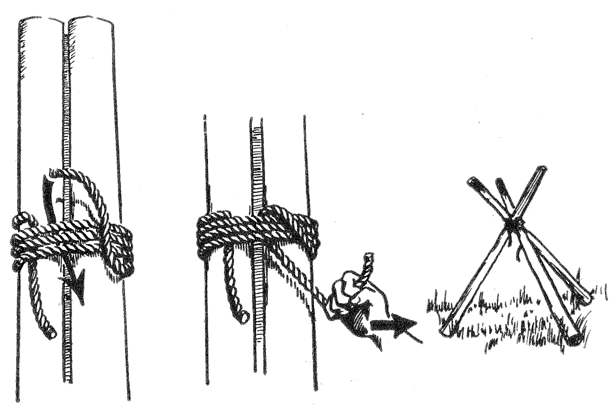
hitch is made round one spar and the lashing taken *loosely* seven or eight times about the two spars above the turns on one of the spars. (Study the drawing below.) The butts of the spars are then opened out and a sling passed over the fork, to which the block is hooked or lashed, and fore and back guys are made fast with clove hitches to the bottom and top spars, respectively, just above the fork.

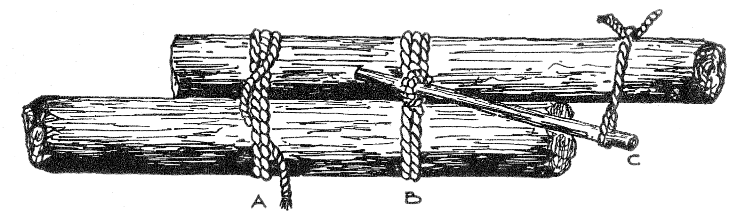


To lash three spars together for a tripod, mark on each spar the distance from the butt to the center of the lashing. Lay two of the spars parallel to each other with an interval a little greater than the diameter. Rest their tips on a piece of timber or small log so that you can pass the rope around them easily and lay the third spar between them with its butt in the opposite direction, so that the marks on each spar will be in line. Make a clove hitch on one of the outer spars below the lashing and take seven or eight *loose* turns around the three. Take a couple of loose frapping turns between each pair of spars in succession and finish off with a clove hitch on the central spar above the lashing, as shown on the next page. Pass a sling over the lashing and the tripod is ready for raising. If this lashing is made too tight, it will not be possible to bring the legs to form an equilateral triangle.



Here is another and quicker way of lashing poles together in order to form a tripod, if it is not to be used for supporting heavy weights. Hold the poles in a vertical position, butts on the ground. Lay the end of the lashing along one of the poles and tightly wrap the other end three or four times around the poles, winding from the top downwards and binding the first end laid against the pole. Now carry the free end upward over the wrappings, and then downward underneath the wrappings as shown in the drawing below. Pull this end down snugly and then jam it sidewise, under the wrappings, tight against one of the poles. Spread the poles at the other end, and the lashing, binding them tightly, will hold them in place.

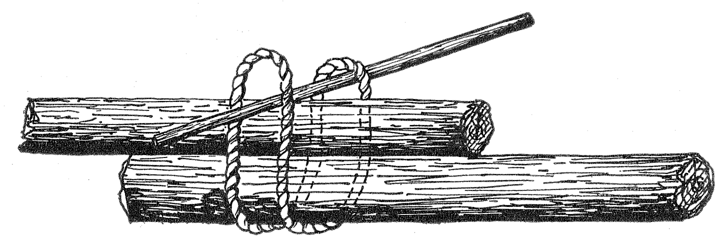




The Garrote Lashing

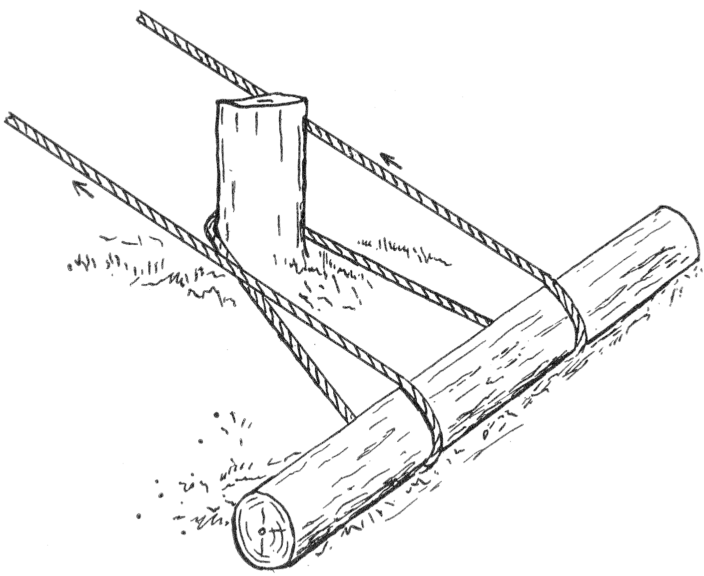
The garrote lashing is used for binding timbers tightly together. This knot is shown in A and B. It is tightened by means of a "rack stick" or "packing stick," which is twisted under the knot and turned and fastened at C.

The packing knot, below, uses a loop prepared by splicing the ends of a short length of rope. After twisting the stick, its end is lashed as above.



Lashing a Block to a Spar

Begin with a clove hitch around the spar above the block, take the lashing two or three times round the spar and the hook of the block and finish off with a clove hitch round the spar below the block.



The Parbuckle

A parbuckle is used in order to move logs or other cylindrical objects on the ground, or to haul them up or lower them down an inclined plane. The rope is bent in two and the loop hitched round a tree, stump, post or other firm anchorage. Both ends of the rope are then passed under the log, round 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, raised or lowered, comparatively easily. If the stress upon the two ends is not equal the direction of a log may be changed slightly, but if a short object—such as a barrel—is being moved, it may slip out of the parbuckle.

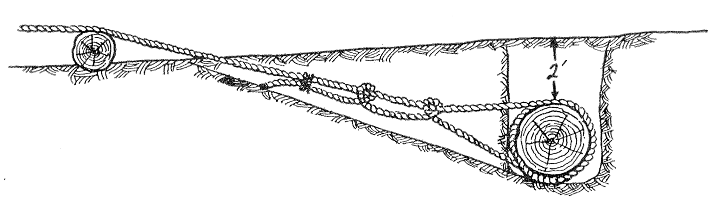
Anchorages

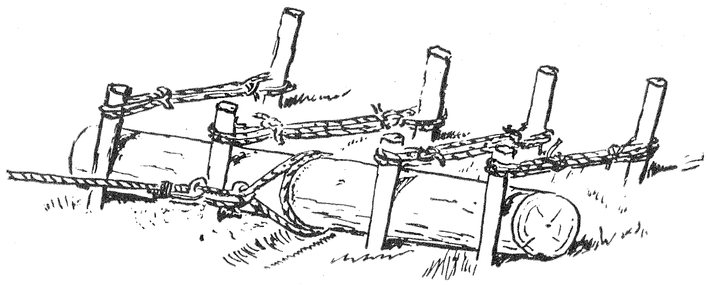
If a natural anchorage, such as a tree, can be had to fasten a rope to when a stress has to be taken, that will save a lot of trouble. Otherwise, it is necessary to set up an anchorage.

The 3-2-1 holdfast is the most popular form of temporary anchorage. The pickets or stakes forming it should be from 4 to 5 feet long and at least 3 inches in diameter; for not only must they hold fast when driven into the ground, but must be strong enough themselves to take a heavy load without breaking. Select the pickets carefully in order to make the anchorage safe.

A picket driven three feet into the ground will safely take a load of 700 pounds. A 2-1 holdfast will take about a ton and a 3-2-1 holdfast 2 tons. The pickets should be driven in as shown in the photo at right angles to the line of the load and should be lashed together at right angles to themselves, the lashing extending from the top of the front picket to the bottom of the next. These lashings must be made secure and the anchorage be made firm before putting stress upon it. As soon as the stress is taken watch the anchorage and see that it does not draw or give way. Be sure to have someone watch the anchorage while under stress.

For greater loads a buried log known as a deadman anchorage is used, but a log and picket holdfast makes a





very good substitute for a deadman and is quickly and easily made. A log and picket anchorage will safely take a load of 1,200 pounds for every pair of pickets. See that the log is placed at right angles to the direction of the load, have the same number of pickets on each side of the hawser that the anchorage is to hold, and see that the log bears evenly on all pickets in front of it. A small trench should be cut under the log in order to pass the hawser under it, for if the log is raised off the ground by the hawser there will be a much greater strain on the pickets.

In all anchorages the angle between the hawser and the ground should not be more than 25 degrees. When a hawser is being brought over shear legs before being anchored this mistake is often made: the holdfast is placed too close to the shear legs; the distance apart should be at *least* twice the height of the shears. This is important.

Shear Legs

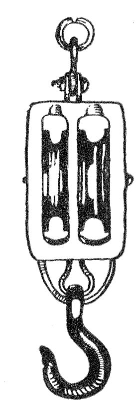
Shears are used for lifting heavy weights, supporting ropeways, and a number of other uses, such as erecting spars, stepping masts, etc. If the shears are to lift weights, then the shear lashing will be placed close to the top of the legs, ending six inches from the top; but for different types of ropeways the position of the lashings will be much lower. Whatever this position is, the legs of the shears should not be spread wider apart than one third of the height of the lashing from the butts. So that the shears will not slip when stress is applied, it is necessary that small holes be dug

in the ground in which the feet are placed. Care and measurement is necessary before the shears are constructed and set up.

Shears require only two guys — fore and back — which should be fastened to the legs above the fork by a clove hitch and a half hitch round the standing part. The back guy should be fixed to the fore spar and the fore guy fixed to back spar. This tends to draw the legs closer and not strain the lashing.

As soon as the shears are erected a light spar should be lashed to the legs close to the ground to prevent them from straining apart.

If the shears are to be used for lifting weights, the upper block of the tackle is suspended from a sling passed over the back. In lifting weights, shears should never lean over more than one third of their height. When used as supports for a ropeway, they should only lean slightly from the vertical, away from the anchorage of the hawser.



Blocks and Tackles

The parts of a block are the shell or frame, the sheave or wheel upon which the rope runs, and the pin upon which the wheel turns in the shell. A strap of iron or rope passes around the shell and forms attachments for a hook at one end and an eye at the other.

Blocks are also made entirely of metal, in which case the strap is replaced by bolts.

Blocks are designated by the length of the shell in inches and by the number of their sheaves. Those with one, two, three or four sheaves are called *single, double, triple* and *quadruple*. The largest rope a wooden block will take has a circumference equal to one third the length of the shell. Ample clearance for the rope in blocks is necessary to prevent friction and wear of the rope.

A snatch block is a single block with the shell open at one side to admit a rope without passing the end through.

A running block is attached to the object to be moved; a standing block is fixed to some permanent support. A simple tackle consists of one or more blocks rove with a single rope or fall. The end of the fall fixed in the tackle is called the standing end; the other is the running end. Each part of the fall between the two blocks, or between either end and the block, is called a return.

To overhaul is to separate the blocks; to round in, to bring them closer together. When the blocks are in contact the fall is said to be "chockablock."

Reeving Tackles

The process of passing a rope through blocks to form them into blocks and tackle is called reeving. Reeving tackles should be done as follows: assuming that the rope to be rove off as a fall is right-handed, place the two blocks to be used on the floor, hooks up, about three or four feet apart. Take the end you intend for the starting part. Enter this into the sheave you intend to lead the hauling part out of and reeve off the tackle from right to left against the sun, or against the direction of the hands of a watch. When your standing part comes to an end, splice or hitch it into the becket of the block to which it is to be made fast.

Luff, or Watch Tackle

This is one of the most useful tackles and consists of a single and double block. Standing part of fall made fast to the becket of single block, rove through the double block, back through the single block and back again through the second sheave of the double block. When the double block is attached to the object to be moved the power gained is four times, neglecting about one fourth for friction. When the object to be moved is attached to the single block the power gained is three times the pull, again neglecting friction.

Remember this rule: Count the number of rope parts leading from the movable block and you have the number of times the power is theoretically increased.

Twofold Tackle

This consists of a purchase rove off with two double blocks. The power gained is either four or five, depending

which is the movable block. When the hauling part of the fall is leading from the movable block, that is, when you are pulling directly from the object to be moved, the power is always greater.

Pulling on a Rope

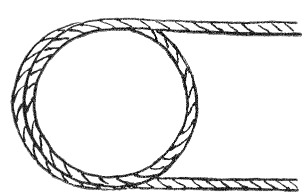
Scouts should be equally spaced on alternate sides of the rope, and should pull with arms straight, using the weight of their bodies. Let the foreman see that everyone on the rope is set and then give the command: "Yo, HEAVE." Throw your weight back, keeping your feet together and square with the rope and face in the direction of the load or the object you are pulling. In "walking away," when it is necessary to keep a constant strain and the weight moving, face away from the load or in the direction you wish to move, stretch your arms back to their full extent, and stamp your feet in unison.

Using the Round Turn

One, two or three round turns around a smooth tree or spar may be used for the purpose of easing a heavy load or lowering a heavy weight with safety. The turns are taken on top of the standing part, and are eased from the same direction as the strain. One turn is generally all that is necessary and only a very heavy load needs more turns.

It is interesting to see how heavy loads of logs are eased down steep places by the lumberjacks. A smooth tree or stump is selected at the top of the incline. A couple of turns of a heavy rope, are taken round it enabling one man to ease down the load.

In raising a weight or taking a load by short pulls, the round turn is very useful. Before commencing to pull, the free end of the rope is taken round some smooth, fixed object. One man holds the end, and takes in the slack. This saves hanging on all the time the rope is under stress.



Round Turn

BRIDGES

The earliest bridge builders, when they wanted to cross a narrow stream, selected a tree that grew on the edge and felled it so that it spanned the gap. When longer spans were necessary, crude cables made from vines were suspended from shore to shore. Some of these bridges are still used in different parts of the world, but they are for acrobatic foot passengers only. This is the original monkey bridge.

Ingenuity and gumption often help in times of emergency. At the siege of Vicksburg in the Civil War, the entire command of the Thirteenth Missouri U. S. Volunteers, with their artillery, were able to cross a deep but sluggish stream on a brush bridge built by backwoods pioneers.

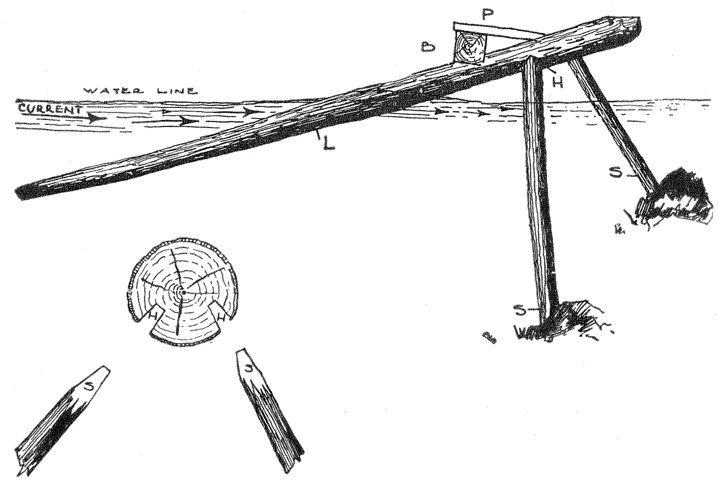
They cut two trees on opposite sides of the stream so that they fell into the water with their branches interlocking. On this foundation of branches, brush was heaped and then covered with earth till a roadway extended its full length. The sluggish stream flowed through the bottom. This principle may be used for smaller structures.

Selecting Site for Bridge

In selecting the site of a bridge, it is necessary to 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. On the height of the bank will depend the height of the roadway of the bridge above water. At the outside of bends the current flows and the water is deeper. It is better to build the bridge where the stream is straight and where there is less depth of water.

Straddle-Bug

Uncle Dan Beard called the following a straddle-bug. It can be used in swiftly flowing water too deep to ford afoot and too boisterous for horses and wagons. It is a simple structure that can be made with an ax and auger. The bug stick consists of a pole, L, with two diagonal holes, H H, bored near the larger end. The drawing shows the larger or butt end sawed off so as to display holes H.



Into the H holes the leg sticks, S S, are driven. These leg sticks are made from stout saplings, each with one end whittled down to fit the holes in the butt end of the pole. When they are securely driven into the auger holes, the bug is finished.

To make the bridge it is only necessary to fasten the leveling blocks B. By using two poles or logs, a thick one for the lower one and more slender poles for the top, a level bridge may be made without the use of planks. The number of bugs necessary depends upon the width of the stream and the length of the connecting planks for the walk.

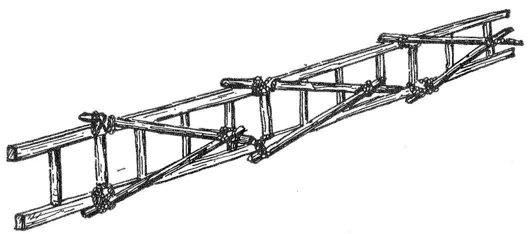
In bridging ditches, thick logs may be split and the halves laid alongside each other, split side up. If the logs cannot be split straight, then score the top side with the ax and hew it smooth.

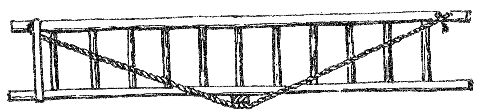
Ladder Bridge

A temporary bridge may be made with a ladder. The ladder is not laid flat, as it would surely sag and probably break, but it is used as a kind of girder to support the bridge. Narrow slots are cut in the banks, into which the ends of the ladder are placed. Brackets are lashed along the ladder at intervals, forming a trestle on which planking may be laid.

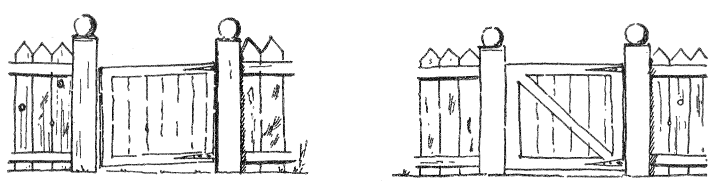
If two ladders can be obtained, a more solid and wider bridge can be erected. The ladders are laid on edge in slots in the bank. Road bearers are then lashed across between the two at frequent intervals, and planks laid on these.

A ladder may be greatly strengthened by trussing with a rope as shown.





This is an engineering principle involved in the construction of most bridges: that under stress a triangle will hold its shape up to the breaking point, whereas a rectangle will give way and squeeze sidewise, unless braced by a diagonal, which makes it into two triangles. For instance, the garden gate would sag if it had no diagonal brace to keep it rigid.



Light Pole Bridge

A bridge of light poles, built with a number of shear legs, is a common form in various parts of the world.

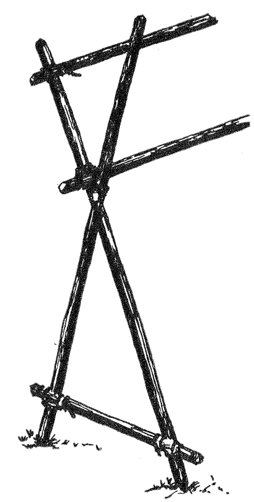
Light poles ten or twelve feet in length and about two inches thick can be used. Two poles are lashed together about three feet from the top with a shear lashing, another pole is lashed to the butt ends by a square lashing. The distance between the butt ends when the legs are spread out and lashed apart should not be greater than one third of the height of the legs. Another pole is then placed in the fork of the shears and at right angles to them, to form the footway, and is tied to one of the legs with a square lashing. The handrail is lashed to the top of one of the legs.

These five poles form a bay, and the bridge is built out from the bank one bay after another. The handrail of the first bay should be fastened to a post on the edge of the stream, and the end of the footway fastened to the bank by a couple of stakes.

When the first bay is secured and the legs are settled, the second bay is put in position from the far end, using the ends of the handrail and footway to work it in place. Lash the ends of this bay to the first bay, lashing the footway on the opposite shear leg, and proceed with the third bay. If the feet of the shears are weighted they will sing easier and a line tied to the ledger can be used to pull the bottom or butt ends in position.

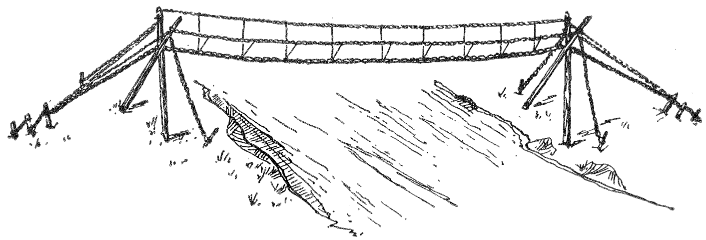
This bridge can only be built over shallow water and where the bottom is not too soft. It is convenient to use short lengths of light pole for the ledgers, four or five being sufficient; if the bottom is soft a long ledger will keep the trestle from sinking in too far.

The space between bays should be about six feet. See to it that all lashings are made tight.



Monkey Bridge

This type of bridge takes but a short time to make, and when it is finished you are in for some new ways of crossing a stream, for these bridges have a sway and buck that is all their own. Don't try too great a span at first: twenty-five feet should be long enough.

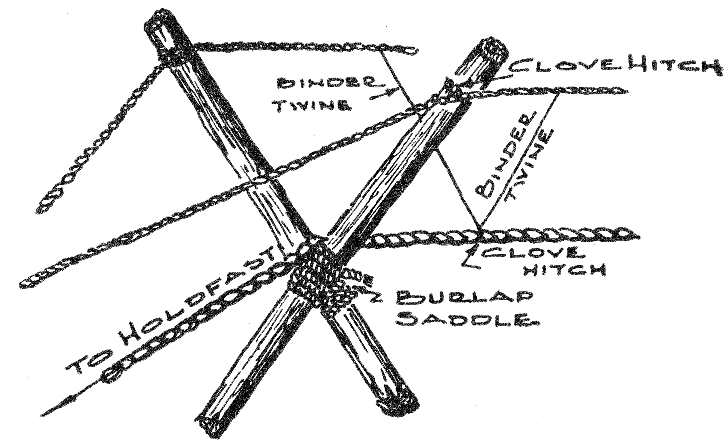


You will need one rope an inch in diameter for the foot rope, two lighter ropes of the same length for hand ropes, a ball of strong binder twine, four spars about eight feet long and six inches in diameter, six good lashings, twelve pickets for holdfasts—if no natural anchorage can be found—and some burlap or empty feed sacks for saddles.

Lash the spars about four feet from their tips, spread the butts about four feet and lash a pole across them a short distance from the butt ends. Dig holes a few inches deep for the legs. The anchorage should be at least eight feet behind the shears.

Lay out the foot rope and the two hand ropes on the ground, the hand ropes on each side of the foot rope, parallel to it and three to four feet away. Beginning at the middle, the ropes are joined by the binder twine with clove hitches. These connecting lines are tied three feet apart, and gradually widen to four feet apart.

When everything is ready, the three ropes which have been wound together are pulled over the gap by a line passed from the far side. The ropes are then untwisted and the foot rope laid across the bagging, protecting the lashing of



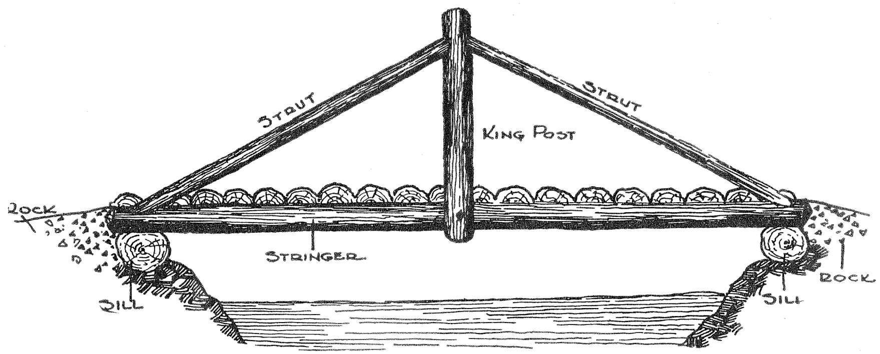
the shears. The shears have been guyed to prevent their tipping. Fasten the outer ropes to the spars four feet above the cross, using a clove hitch. The three ropes are then made fast to the anchorages.

The foot rope is made fast by a round turn and two half hitches round the bottom of the first pickets. The hand ropes can be fastened in the same manner, or their ends passed round the pickets and tied together. The foot rope can be tightened by using blocks and tackle. Care should be taken to tighten the hand ropes in the same direction, or the connecting binder twine will go out of line and upset the balance of the bridge.

Every part of the bridge should be thoroughly inspected and tested before allowing passengers to use it, special attention being given to the anchorages, lashings and knots. If a natural anchorage such as a tree or stump can be used, it will save time and effort.

King Post Bridge

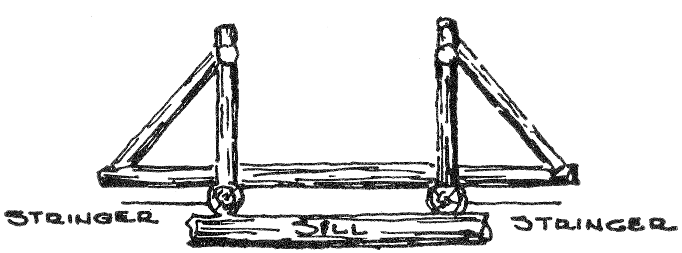
To build a king post bridge, first select two logs for the sills on which the two horizontal logs, or stringers, are to rest. These should be of the most rot-resistant wood avail-

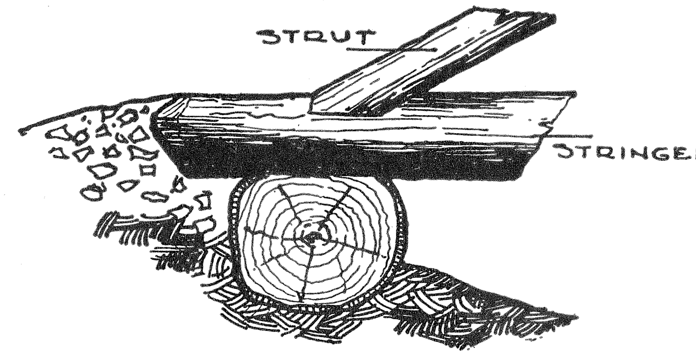


able, such as cedar, chestnut, locust, cypress, fir, yellow pine, redwood or some oaks. Place the sills on firm ground, and fill in around them with rocks, not earth, as rocks permit drainage and reduce the rate of decay. Always peel the bark from all logs or poles.

Select two logs of approximately the same diameter and long enough to span the gap, and allow enough to rest on the sills to give them a solid base. These logs are the stringers, each of which is supported by a king post suspended from two diagonal struts. The foot of the king post is fastened to the stringer by an iron bolt, or by a strong wooden peg driven through an auger hole.

Be careful to make the notches in the king post and stringers fit the ends of the struts neatly. Use a small spike



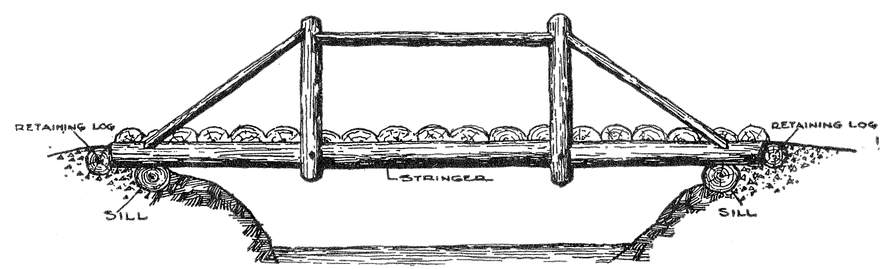


to hold them in place, for the strain is not sidewise, but is a push against the point where the ends of the struts rest.

For the floor use small logs selected for their straight, even sides. These can be spiked to the stringers. If round material is used for flooring, hew a tread along the center line about two feet wide. Do not put dirt over the floor, as it will cause rot.

Queen Post Bridge

This bridge shows the same principle as the king post bridge, and is good for a span up to fifteen feet.

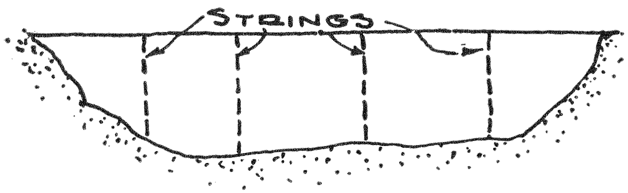


Trestle Bridge

Before beginning to build a trestle it is necessary to become familiar with the names of the various parts. The drawing on the next page shows a typical trestle with its parts named. Note their proportions.

The slope of the legs should be one in six. This can be obtained by marking the points where the legs are to cross the transom, and adding to this distance apart one-third of the height of the leg from the transom to the ledger.

After you have selected the site for the bridge, decide how far apart the trestles are to be placed. If the water is of unequal depth, soundings must be taken, and the trestles will have to be of different heights. To make soundings stretch a line from bank to bank. At points where the trestles will come, tie pieces of string to the line and take soundings to the bed of the stream. This will give the height of the transom above the bed.



All bridges should have a camber, a slope from each bank upward to the center. The usual slope is one in thirty, that is, a one inch rise for every two feet six inches of length. This may be increased to allow for probable settlement of the footings.

Make out a table like this, showing the lengths of the legs of the trestles:

Height of transom.

Allowance for sinking in mud (A ledger on each side of the leg helps to prevent settling.)

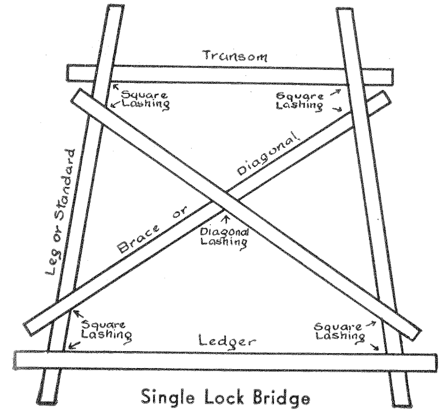
Allowance for vertical height (Slope of one in six).

Allowance for camber of roadway (rise of one in thirty).

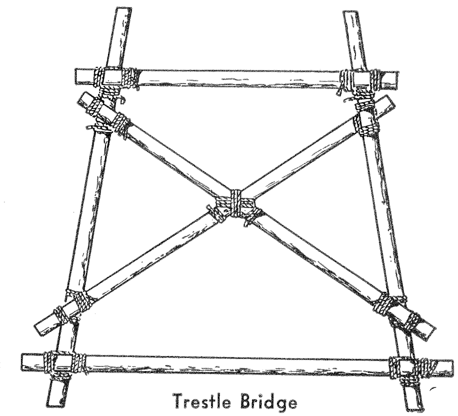
Height of transom on leg.

Height above transom at which handrail will be lashed.

Total-length of leg.



Single Lock Bridge



Trestle Bridge

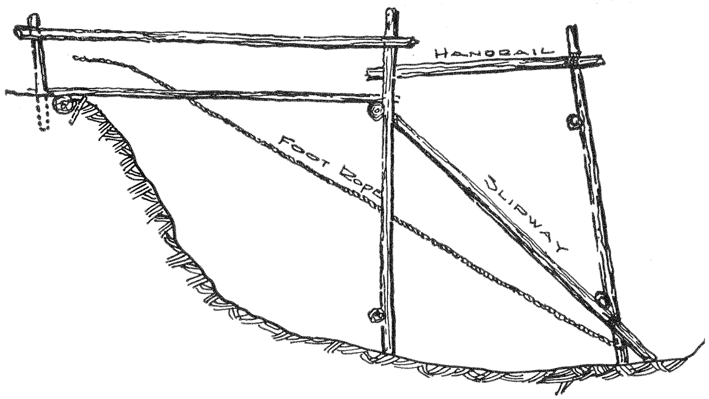
Now that you have the measurements of the trestles, lay the spars out on the ground, and mark the points where the lashings will come. The marking may be done with chalk, a charred stick or an axe. But care is necessary to produce a squared-up trestle.

Where the bed of the stream is muddy, the ledgers should be lashed on as low as possible. Where the ground is very soft two ledgers lashed one above the other on different sides of the legs will help to prevent sinking.

The frame is lashed as shown, with the transom and ledger on the same side of the legs. Now square the trestle, bring the tips of the diagonals into position and lash them to the legs. The two diagonal braces are then drawn together where they cross, with a diagonal lashing. Now test the trestle to see that all lashings are firm and well tied, and that there is no motion of any of the spars.

Launching the Trestles

The first trestle is placed in position, and kept vertical by guy ropes until the two outer road bearers have been lashed to the transom and anchored to the bank. If the hand rails are first lashed to the tips of the legs, the setting up of the trestle will be made easier.



In order to launch the next trestle two spars, one on each side of the bridge, are used as a slipway. This slipway should rest on the bed of the stream a short distance beyond the point where the trestle will stand. Foot ropes are attached to the butts of the legs, and handrails to the tips. The trestle is carried to the slipway and launched down by easing on the foot ropes. When the legs are on the bed of the stream, the foot ropes are made fast and the handrails pushed out until the trestle is upright. The handrails are then lashed to the preceding trestle, road-bearers put in place and lashed, and the roadway built.

Building the Bridge

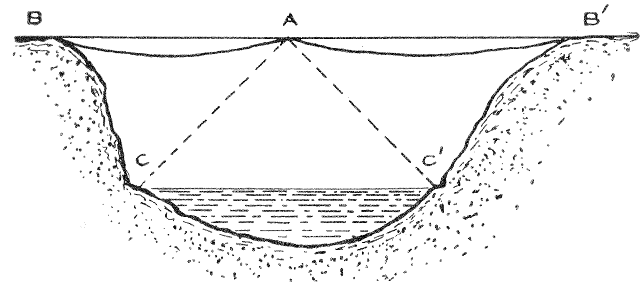
The bridge is built up bay by bay, and the roadway laid as the work advances. The roadway consists of decking carried on road-bearers or stringers, which rest on the transoms of each trestle and on sills on the bank. The number and size of the road-bearers depend on the length of the span. The decking should be fastened to the outer road-bearers, and should not project more than a few inches beyond them.

If the bridge is a long one, diagonal braces should be lashed occasionally between the pairs of trestles so as to stiffen the bridge.

Place a sill under the ends of the road-bearers on each bank, holding it in place by stakes if necessary.

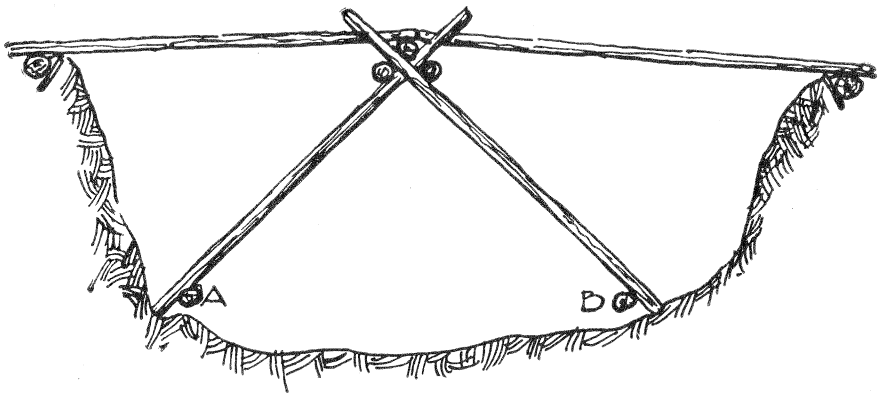
Single Lock Bridge

The single lock bridge is suitable for spans of thirty feet or less. In constructing the bridge the first step is to measure the gap to be bridged, and to select the position of the footings on either bank. To do this, take two small lines a little longer than the width of the gap, double each and tie the bights together. Stretch them tightly across the gap so that the tied part comes in the middle as at A in the illustration. Take one end of each and stretch it to the footing on the same side, as indicated by the dotted lines. Mark each line at the footing C or C^1, and at the position chosen for the abutment sill, B or B^1. This gives the lengths between the transoms and adding two or more feet gives the length of the road-bearers required. The distances A C and A C^1 are the lengths of the legs from butt to top of transom, and adding three feet gives the total length of spars required.



The two frames lock together at the center of the span. The footings at A and B (see diagram) must be firm and horizontal. In firm soil a trench will be sufficient. In yielding soil a plank or sill must be laid in the trench. The frames are made with an additional length to give a camber or slope from each bank upward to the center. This should be a rise of one foot in thirty feet, or a one inch rise for every two feet six inches of length. This may be increased to allow for the probable settlement of the footings.

Now that you have the height of the trestle, lay the spars out on the ground, and mark the spots where the lashings will come. It is better to construct a frame on each bank. The legs are laid on the ground in line with the direction of



the bridge, and the points where the lashings will come are marked on them. Mark the other spars also. This method is very important in making a properly squared trestle, and should always be observed.

For a single lock bridge one trestle must be narrower than the other, so that it will lock in between the legs of the wider one. Be careful of the measurements of the diameter of the legs of the trestle before laying out your work.

The frame is lashed by a square lashing, with the transom on one side of the legs and the ledger on the opposite side. The tips and one butt of the two diagonal braces are placed on the side of the legs opposite to the ledger, the other butt being on the same side. The butts of the diagonal braces are lashed to the legs with square lashings. The two diagonals are lashed together where they cross with a diagonal lashing. Test for firmness.

Lower the trestles, easing the butts into the footings by means of foot ropes, and gradually lowering the tops toward the center of the gap by guy ropes. When they reach the center they will lock. The fork transom is laid across the two frames, and the road-bearers laid on it and lashed in position. (The fork transom carries a lot of weight so be sure to have a sufficiently strong spar). The floor or roadway is then laid across these, and held in place by placing a pole over the outside road-bearers and lashing it to them.

Double Lock Bridge

This type of bridge is used for crossing a wider gap, and can be used for a span of forty-five feet. The two trestles do not lock together but are held apart, the middle bay being formed by two distance pieces, one on each side of the bridge. In this way the gap is divided into three equal bays.

The trestles are built and launched in the same manner as for a single lock bridge, except that they do not lock together, and should thus be the same width. The guy ropes are made fast and the distance pieces run across and lashed to the transoms of the trestles; the road transoms are placed and lashed to the distance pieces, and both frames are now lowered until they jam. Study the photograph below.

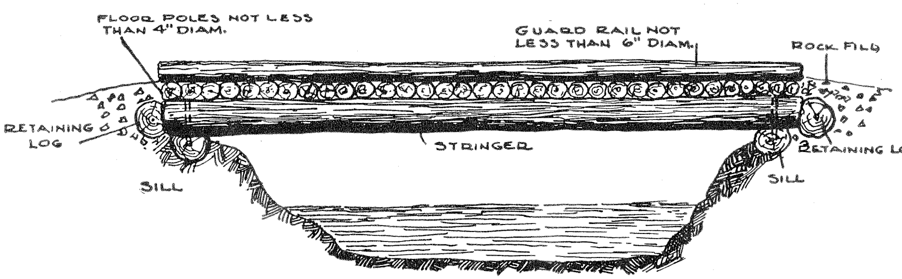
An important point in lock bridges is that the trestle must never lay over at a greater slope than two over one.

GEORGE BERGSTROM PHOTO

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, in order to permit drainage and reduce the rate of decay.



On the sills place the stringers, which should be spiked to the sills or held by hard-wood pins, or tree nails, driven in holes bored in the timber. 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 six inches in diameter, and spike or pin it down to the stringer.

If round material is used for flooring, hew a tread along the center about two feet wide. Round material split through the center and laid as shown in the detail, also makes a satisfactory floor. If horses or cattle use the bridge, the floor laid across the stringers gives better footing. *Do not put a dirt covering over the floor.*

In heavy snow country, and where timber is small, use more stringers than are generally required. All fills around logs should be of rock and not dirt.

A PERMANENT BRIDGE

Lashed bridges are not permanent, but they are very useful and give you a lot of practice in lashing and teamwork.

There may be some Scouts, however, who live on the farm and who would like to build a permanent bridge over a stream or gully on the place. Make it of heavy material, and wide enough for a wagon. This will be ten feet wide from the center of one outside stringer to the center of the other outside stringer, with two other stringers between them each three feet four inches apart, center to center. (See table, page 46, Minimum Dimensions of Stringers).

Remove bark from all timbers and poles.

If you make the deck or roadway of planks, be sure they are at least three inches thick. Leave a space of one-half inch between planks for drainage. Nail deck with four spikes per plank. If you use logs for the deck, hew two parallel wagon tracks, one foot wide and four feet eight inches from center to center. Spike these logs to the stringers and place a guard rail not less than six inches in diameter on the deck over the outside stringers. Spike it down to the stringers or, better still, driftbolt it or use wooden pins or tree nails. Make these tree nails of strong dry hardwood. Drive them all the way in the auger holes and make sure they are a tight fit. If the pins are dry, dampness will cause them to swell and hold tight. If you ever see an old barn where the timbers have been hewn with a broadaxe and pinned together, you will know how well a good wooden pin can hold.

Driftbolt or pin all the timbers where they cross. Be sure to have the bridge high enough to be clear of floating logs, stumps, etc. which come with high water.

At the pioneer camp at Camp Siwanoy, Wingdale, New York, we built a stringer bridge, part of which was fastened with fence wire, as we did not have enough spikes. This bridge was used for eleven years on a pack animal trail, and was finally carried out by a freshet. Had the approaches and abutments been two feet higher, the bridge would have been saved.

Build the abutments of rock on a solid foundation, giving them a batter, or slope, of at least two inches to each foot in height. This can best be done at a time of low water. One-fourth of the faces and backs of the abutments should be composed of headers. A header is the short stone in the face of the wall; it goes back into the wall at least two and one-half times the width of the face. To illustrate this, look at a brick wall and you will see most of the bricks laid sideways, but others endways. The bricks laid endways to the face are the headers that tie the wall together.

If the snow is exceptionally heavy in your part of the country and portions of the deck cannot be removed in the fall, a truss bridge may be necessary to avoid a permanent sag caused in this type of bridge by the weight of snow.

The following table is furnished by the United States Department of Agriculture:

Minimum Dimensions for Stringers

Span in feet	3-stringer bridge, 6 feet wide			4-stringer bridge, 6-7 feet wide		
	Sawed lumber		Round timber, diameter	Sawed lumber		Round timber, diameter
	Width	Depth		Width	Depth	
8	3	8	7	3	8	7
10	3	10	8	3	10	8
12	3	12	9	3	12	9
14	4	12	10	4	12	10
16	6	12	11	6	12	12
18	8	12	13	6	12	13
20	10	12	14	8	12	14

The round-timber diameters are to be measured at the small end after deducting one-half of the diameter of the sapwood.

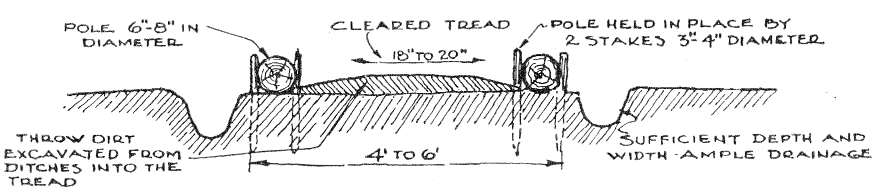
TRAILS

Some Scout camps are on reservations large enough to have a system of trails laid out. These are a great help in fire control, as well as an easy means of getting around on foot or horseback.

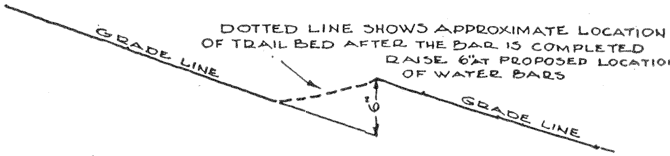
Do not start work on any trail until, after careful examination and consideration, you have chosen the route. Indicate by stakes or other markers the line you want to take. A piece of white cloth or any other easily located material fastened above or near the stake is a practical means of identification.

The trail should be wide enough for the passage of loaded pack animals. Remove obstacles within reach of the extended arms of a man standing in the center of the trail. Clearance overhead to a height of ten feet is sufficient. Only brush and small trees should be cut, and these as close to the ground as possible, leaving no roots looping up to catch your foot. Pile the brush where it can be burned without danger of starting a forest fire. It is necessary to consult your regional fire warden or forest ranger before burning brush, for there are certain times of the year when this is very dangerous.

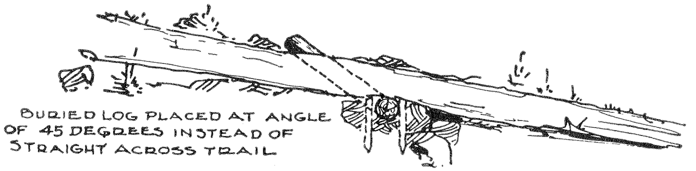
The width of the cleared path, or tread, is shown below. On grades where rain water and melting snow may cause damage by washing out the trail, set a log across it at an angle of 45 degrees. This is called a water bar. Fasten the log in place with stakes placed on the sides at each end. When finished, the trail bed should be six inches higher at the top of the water bar. Start four to six feet from the log, and gradually grade up to the top.



TRAIL ON FLAT SOFT WET GROUND



PROFILE OF GRADE LINE AT WATER BARS



SECTION OF TRAIL SHOWING WATER-BREAK LOG

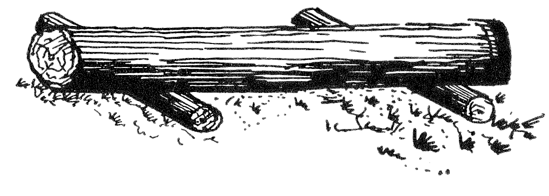
On soft, wet ground it is advisable to dig a ditch on each side of the trail. The ditch must be of sufficient depth and width to give ample drainage.

Lay poles six to eight inches in diameter along the sides of the trail, fastening them with stakes. Outside of these poles dig the ditches and throw the dirt into the tread, between the poles.

Avoid boggy land if possible. If this cannot be done, lay corduroy across such places. Use sills six or eight inches in diameter and six feet long, on which stringers six inches in diameter or more are laid, three feet apart, being careful to make lap joints when joining the stringers. Do not have the joints of both stringers come on the same sill. Alternate the joints. Use sills at least two inches thicker where the joints are. Across the stringers lay a floor of poles four feet long, or else use split logs with the flat surfaces laid on the sills. A binding pole five to eight inches in diameter is laid across the floor above the stringers, and fastened to them with tree nails, or wired to the sills. Where practicable place the entire structure below surface and cover the floor with dirt.

It is well to remember that visitors to your camps who use your trails may not be as tough and wiry as you are, and an occasional resting place will be appreciated by them. A large log rolled alongside the trail and set up on a couple of short pieces of log, notched out to keep it firm, makes a good seat. On a grade, place a thicker piece on the downhill end. Another good seat is made from half of a split log, set up on stones. Don't use a narrow log, and make it as nearly horizontal as you can.

Place one of these half way up any steep slope and be sure to have one at the top. If there is an open space along the trail that commands a good view, don't forget to have one there too.

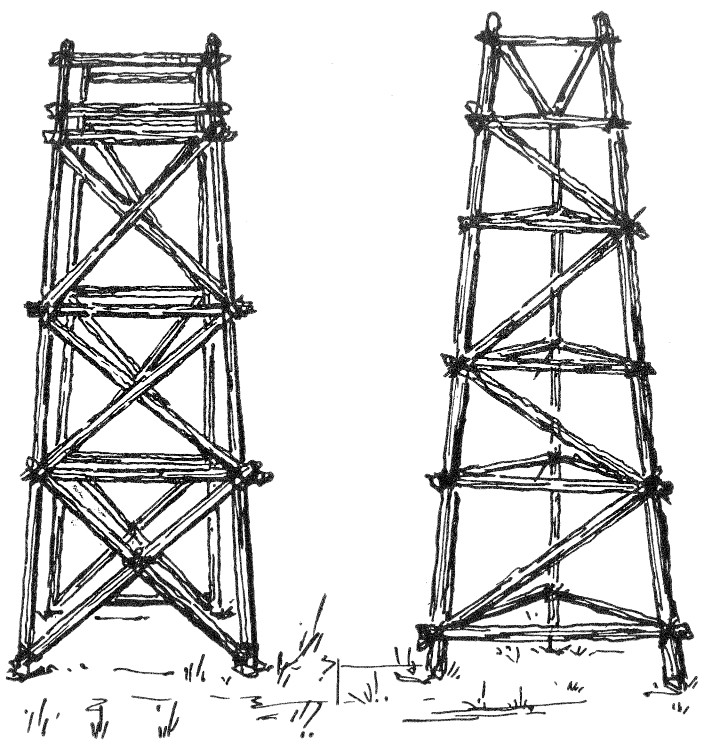


TOWER BUILDING

Tower building is a somewhat hazardous project and should be undertaken only under the most competent leadership.

Towers depend on the bracing to hold the posts together, but in a strong wind the entire structure may overturn if it is not of the proper proportions. So be sure to make towers wide enough at the base. Spread the posts so that the width at the ground is at least one-third the height—one-half is better. As an added precaution, if the tower is to be more than a very temporary structure, the posts should be sunk in the ground four or five feet. On temporary towers, the joints or connections may be lashed, but on more permanent ones they should be bolted.

Always use sound, straight logs. Posts and horizontals should be at least four inches at the small end, and diagonals at least three inches at the small end. Use several guy lines of good rope during erection so there will be no danger of collapse before the job is done. Twenty-five feet is recommended as a maximum height under any circumstances.

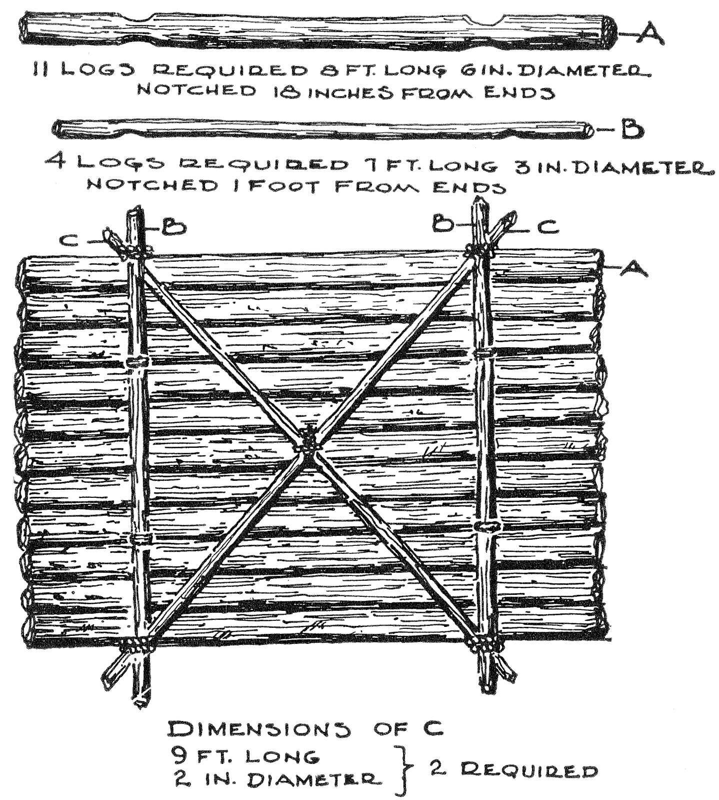


RAFTS

A raft is a makeshift at best. It tilts and sinks when anybody gets aboard it, but it is better than nothing and sometimes it is a necessity.

If you can find dry timber which the freshets have brought down or the ice has deposited on shore, you will find it excellent for your use. The larger and drier the logs, the better the raft will float. Four or five logs, six feet long and five or more inches through, will support one person.

The following sketch will give you an idea how a raft should be built. Lash the logs together with rope or vines.



SHACKS

Shacks are to be built of the natural material found in your own locality. One type adaptable to most situations is the well-known Adirondack lean-to. These shacks may be shingled with birch or spruce bark, or simply covered with brush. Their construction makes them especially useful in case a sudden cold snap catches you on an overnight hike, since the sloping, tightly thatched roof makes an excellent reflector for the fire.

The horizontal cross-pole of the frame should be lashed at least four feet above the ground to two conveniently spaced trees, or rested on forked poles driven into the ground about eight feet apart. Five poles are rested against this cross-bar, and several horizontal ones layed parallel to the ridge pole and lashed to the sloping end poles. This is your framework, over which to place the thatch of leafy boughs.

This is the simplest form of Adirondack lean-to, but for a more permanent shelter a similar structure of logs is a favorite. The logs are notched together so that the walls are built entirely without nails, the front ends firmly supported by short crosspieces. The roof beams are notched into the wall logs, and the roofing done with split shakes, shingles, or tar-paper.

MODELS

The days when you cannot work outdoors are the time for model making. This is your chance, before building a bridge or other structure, to learn how it is done. Building to scale is very important in producing an accurate and handsome model, which will show the proportions of the actual structure. Model bridges are most interesting, and demonstrate the use of lashings, knots and hitches.

A scale of one inch to the foot is generally the most satisfactory to use. It will mean, for example, that the model of a twenty-four foot bridge will be two feet long. This scale will enable you to handle fairly large objects conveniently, and still make your model large enough to show a lot of detail.

For your base use plywood, which will make the model strong enough to handle and will not warp. Make up your mind that you are not going to hurry, make careful measurements and *work to scale*. Remember the rule about lashings, "Never hurry a lashing." Use fish line or a hard, strong cord. Wax the ends of cord to keep it from unraveling. When all the lashings have been finished, give them a coat of shellac to keep them from loosening. Build your model step by step, just as you would a full-sized structure. This is indoor pioneering that will prepare you to tackle the real job with certainty and confidence.

In order to make the river banks, blocks of soft wood the same width as the base should be roughly shaped to look like a river bank, and then fastened to the base by screws from the under side. Make these blocks high enough to give the required height of the trestle when put in place. To make the banks realistic, mix some paper with flour paste, or the kind of paste that is used for wallpaper. Crumple it up in your hand till it becomes pulpy, then attach it to the banks, using a tack here and there. In about two days, when this is dry, give it a coat of shellac, and while the shellac is still wet sprinkle it with sand and very fine gravel. Water can be represented by a piece of glass painted blue on the under side.

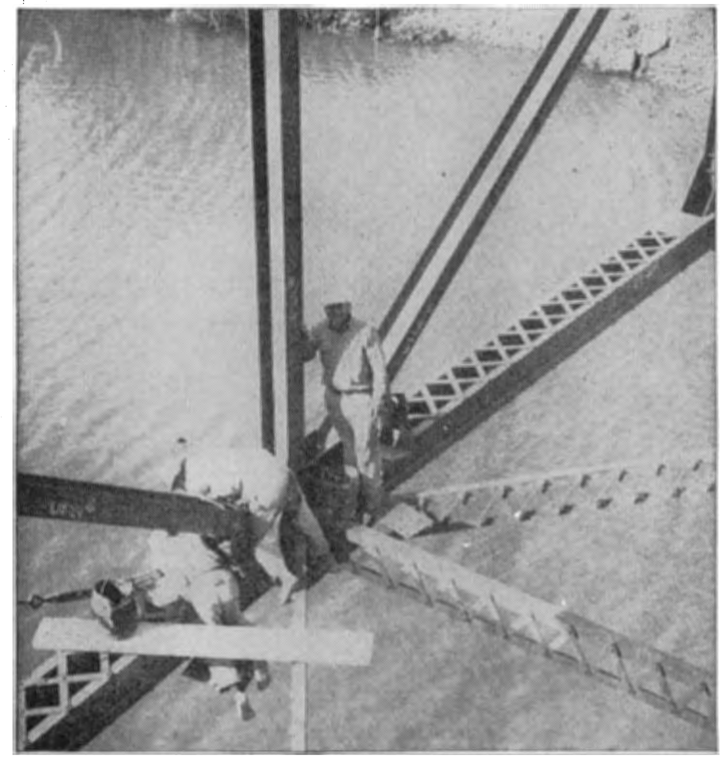
POSTSCRIPT

During the twenty-five years I have been serving as a merit badge counselor, I have found that Scouts may be classified as follows: The fellow who is too lazy or indifferent to work for the badge, the one who has a glib tongue and finds it a simple matter to cram his head full of a lot of facts which last long enough to get by an easy examiner, and the serious fellow who is interested in his work and does a little more than the requirements call for. He is the one you see wearing the Eagle badge.

This is a good time to remind you that the merit badge counselor is a busy man who is willing to give up his time to you, often passing up other pressing duties so that you may receive the benefit of his experience. It is only fair to him that you prepare yourself thoroughly, so that you are able successfully to pass the examination. When you have an appointment for an examination, be punctual. Every minute you keep someone waiting after the appointed time, you are taking from him something that can never be replaced.

Some of the Scouts who were with me in a pioneer camp have been so interested in the work that they have taken up engineering and forestry as professions.

In this pamphlet on Pioneering I have tried to pass on to you some of the ideas I found among the books and pamphlets mentioned in the bibliography, as well as the lessons I have learned in the construction and lumber camps and in actual practice.



U.S. BUREAU OF PUBLIC ROADS

TWENTIETH-CENTURY PIONEERS

Compiled by Science Research Associates, Chicago, for the Boy Scouts of America

The pioneer has always been the scout in the forefront of man's fight for progress. The days of the coonskin cap and the flint-lock gun are long over, yet twentieth-century America still needs her men of skill and daring to penetrate the new frontiers of civilization. Among these modern pioneers are the foresters, inventors, and engineers. These pages discuss some of today's pioneering occupations.

Foresters

The nation's **foresters** and **conservationists** are very important modern pioneers. Foresters supervise our national forests, keep an alert watch for forest fires, and work to preserve our timber for future use. In addition, many specialists concern themselves with the conservation of our other natural resources—wildlife, soil, minerals, water, etc.—so that America's natural wealth may increase and be stored until the time when it is needed.

Information about occupations in these fields will be found in the *Forestry* and *Soil and Water Conservation* merit badge pamphlets.

Engineers

Another twentieth-century pioneer is the engineer. The bridges spanning rushing rivers, the roads winding endlessly onward, the vehicles in which we travel on these roads, and many more of the devices by which we build our civilization—all are the work of the engineer.

Three main groups in the engineering profession are civil, mechanical, and electrical engineers. Let us examine each of these fields briefly.

Civil Engineers

Civil engineering is the science of building stationary structures. Civil engineers include men who specialize and are known as highway engineers, or building construction engineers, etc.

A **building construction engineer** determines from architects' plans the kinds and sizes of materials to be used in a building, and directs how these materials shall be put together.

The **highway engineer** designs new roads and improves on the design of existing roads. This branch of civil engineering offers many opportunities for the future. Not only must present-day roads constantly be repaired, but new roads must be built. Earlier roads in this country were not made to carry the tons of freight which are now hauled by trucks. As a result, many roads must be wid-

ened, strengthened, or completely rebuilt. Also, roads must be made safe for speedy travel by eliminating many curves and slopes.

The **flood-control engineer** constructs dams and dikes in rivers and streams, so that rising water will do the least possible damage to adjoining property during flood seasons.

A **railway maintenance engineer** plans and supervises the work of keeping railroad tracks, track beds, and bridges in good repair. Today, few new railroads are being built. The engineer's principal task, therefore, is to help the company operate cheaply by planning new routes and shortening the mileage of tracks.

Municipal engineers design and sometimes supervise the construction of streets, water and sewage systems, bridges and buildings belonging to cities and towns.

Surveyors establish lines for building foundations, highways, bridges, railroads, municipal water and sewage systems, and other construction projects, by measuring sites and marking them. Surveying is one of the duties of practically all civil engineers, although some specialize in it.

Agricultural engineering is another branch that is developing specialists, many of whom are civil engineers. Some agricultural engineers specialize in the design and construction of farm buildings, or in the equipment that goes into such buildings. Some study problems of soil erosion, which destroys the value and productivity of the land.

The building and care of docks and harbors, and the protection of shore lines of rivers, lakes, and oceans also call for the services of engineers. In fact, many engineers make these problems their life work.

Mechanical Engineers

While the civil engineer works on stationary structures, **mechanical engineers** are busy creating and improving devices which move. Whenever a wheel turns, whether it is on an automobile, an airplane, in an industrial factory, in a machine shop, or on the battlefield, the hand of the mechanical engineer is behind the scenes.

As in civil engineering, mechanical engineering is divided among many specialists. Right now, of course, the first one to consider is the **aëronautical engineer.** He is the man who designs and helps build the new fast types of planes.

During recent years, a field that has offered increasing opportunities to engineers is the designing and building of power plant equipment. Engineers in this special field are pioneers in developing new turbines, boilers, and pumps which will produce energy more economically and efficiently.

The **railroad mechanical engineer** works out faster locomotives and better cars to help the railroads meet the growing competition of truck and bus lines. The revolution in railway equipment is still young, but has already resulted in streamlined, diesel-driven engines which amaze us as they shriek past at 80 miles or more an hour.

Th **air-conditioning engineer** designs and supervises the construction of equipment which keeps office buildings, homes, railway cars and factories at an even, comfortable temperature the year-round, regardless of weather conditions.

Along with the increase in air-conditioning in modern buildings, there have arisen opportunities for the **refrigeration engineer,** the skilled specialist who helped straighten the backs of millions of housewives by eliminating the over-flowing ice-pan. Thanks to him, a silent gas or electric refrigerator now keeps food fresh and edible and nobody has to remember to "put up the ice card."

He is also responsible for the development of home freezing, cold storage locker plants, improved methods in ice-cream factories, and the machines used in other types of industrial refrigeration.

Each of these specialized branches of mechanical engineering is further divided up into more branches within each field. Therefore, not only must a boy pick out the particular field that he wants to enter, but also he must decide upon a branch of that field.

Probably the best example of this specialization is the **automotive engineer.**

In general, automotive engineers design and supervise the construction of the motors, bodies, chassis, and parts used in assembling an automobile. Quite often, also, they may design the plant and the equipment used in making these various auto parts.

This work is divided among the following specialists:

The **research engineer** is the real pioneer of all engineering workers. In this case, he works on improvements for the automobile by suggesting the use of new and better materials. He devotes time to eliminating body vibration and perfecting a better and more economical engine.

The **development engineers** experiment with the research engineer's discoveries and determine their practical value by building a car or a part and trying it out, and making suggestions for changes.

The **design engineers** combine their artistic ability and their technical knowledge to make the newly-developed improvement as beautiful as possible, or to fit the improved part into the rest of the car assembly.

The **production engineer** sees that the new part or car is manufactured as cheaply and efficiently as possible.

Electrical Engineers

The third main pioneering field of today is electrical engineering. These engineers help to provide us with light and power; they design and make the electric equipment we use in home and factory; they enable us to telephone, listen to the radio, watch television and ride in electric-powered vehicles.

As in the other engineering fields, many persons in this occupation are specialized. Here, too, we have research, development, and design engineers exploring the wonders and different uses in their field.

The television, radio, mining, and automobile manufacturing businesses are some of the industries that use quite a few electrical engineers.

The field of electrical engineering is a fascinating one, out-doing the wonders of Aladdin and his magic lamp. If you are interested in electrical engineering, it would be helpful for you to study the *Electricity* merit badge pamphlet.

TRAINING

To become an engineer you should begin in high school to meet the requirements of engineering colleges by taking courses in mathematics and physics.

In college, a student spends the first two years of his engineering course studying general scientific subjects. This gives him the necessary training, and also affords him an opportunity to decide upon the exact branch of engineering he will follow. Often a boy may believe that he is destined to be a mechanical engineer, but after two or three years of general study he comes to the conclusion that he prefers to be a mining, civil or electrical engineer.

When selecting an engineering school, it is a good idea to find out whether the university or college has any connections with industry. Many industries are looking for new blood, and they make it a practice to cooperate with the schools in picking their technical workers. Thus, a student who shows merit in college often makes helpful contacts which aid him in getting a position when he graduates.

A graduate civil engineer often finds his first job as a "helper" on an engineering project. He may work as a **rodman** with a highway engineer, or as an **inspector** on a building job under the direction of a construction engineer. If he has held such jobs during school vacations, he may find employment more easily after graduation. Beginning mechanical and electrical engineers also start in lower jobs and work their way up. Good experience is very important in getting a promotion.

Federal, state and city government employ engineers,

and civil service examinations are held frequently. The U. S. Civil Service Commission, Washington, D. C., will supply information about federal engineering jobs, and state civil service commissions at capital cities will do the same about jobs in the state service.

Salaries

Beginning salaries in government service may be slightly higher than in private industry. But there are limitations to what an engineer can earn while working for the government. Employment is reasonably certain after the job is obtained, which is an advantage over the ups and downs of employment found in many industries.

While some starting salaries may not seem like a great deal of money after an investment of four or five years in specialized college training, it should be remembered that earnings of mechanical engineers increase up to around the age of 55. After this age, earnings may decline slightly, but remember that there are any number of occupations in which an individual's earning power declines or stops altogether at a much earlier age.

As the popular saying goes, "The wheel of fortune spins 'round and 'round and where she stops, nobody knows." The same applies to the wheel of progress. No one can accurately forecast future events, but one thing is certain. The foresters, inventors, engineers, and other modern pioneers have reserved seats in civilization's hall of fame. As in yesteryears, these pioneers will be the scouting force of the future sent out to explore the ground in advance, and to find out if it is safe for the rest of us to follow.

BOOKS ON PIONEERING

Visit the librarian in your school or public library for helpful books and pamphlets.

Knots and How to Tie Them, Boy Scouts of America

Sea Explorer Manual, Boy Scouts of America

Ropework, James M. Drew

Forest Trail Handbook, United States Department of Agriculture Forest Service

Engineer Field Manual, Corps of Engineers, United States Army

Field and Forest Handy Book, Daniel Carter Beard

The Story of Rope, Plymouth Cordage Co., Plymouth, Mass.

Fiber Rope, Safe Practices Pamphlet No. 6, National Safety Council, Inc., Chicago

Ax Manual, Peter McLaren

Woodcraft, Bernard S. Mason

Junior Book of Woodcraft, Bernard S. Mason

Careers in Forestry, U. S. Dept. of Agriculture, Miscellaneous Publication No. 249, Supt. of Documents, Washington 25, D. C. (15c)

Employment Outlook for Engineers, U. S. Bureau of Labor Statistics Bulletin No. 968, Supt. of Documents, Washington 25, D. C. (60c)

MERIT BADGE SERIES

This is one of a series of pamphlets known as the merit badge library. The pamphlets cover all kinds of hobbies, activities, and vocations, are prepared by experts, and are frequently revised and brought up to date.

These pamphlets do not attempt to give complete information on every requirement, so you will need to use your own initiative in digging out further information to meet some of the requirements. The pamphlet, however, does tell you how you can secure added information from books on the subject, or from your counselors and other experts.

On the inside front and back covers of this pamphlet you will find out how to go about earning any merit badge that interests you. The first step is always to talk it over with your Scoutmaster or Explorer Advisor.

In meeting the requirements, do more than merely follow the requirements technically. Show that you have a real knowledge of the subject. As you know, this knowledge should be practical rather than just "book-learning." A Scout is ready at any examination to answer questions on previous tests given him, and to show that he is putting the Scout Oath and Law into daily practice.

To increase the value of these pamphlets to you, there is vocational information in connection with many of the subjects. If you have any suggestions on the treatment of any of the merit badge subjects, write to Boy Scouting Service, National Council, Boy Scouts of America, New Brunswick, N. J.

MERIT BADGE LIBRARY

Though intended as an aid to Scouts and Explorers in meeting merit badge requirements, these pamphlets are of general interest and are made available by many schools and public libraries. They are prepared by experts and are revised or corrected frequently. The latest copyright date of each is shown below (corrected to January 1, 1963).

35 Cents

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3381	Archery	1941
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3303	Astronomy	1944
3324	Athletics	1943
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3293	Aviation	1954
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	World Brotherhood (see Citizenship)	
3356	Zoology	1941

Merit badge pamphlets are also available in library bound editions. • For complete information write the National Supply Service Division.

BOY SCOUTS OF AMERICA

National Council, New Brunswick, N. J.

231 South Green Street
CHICAGO 7, ILL.

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SAN FRANCISCO 7, CALIF.

New York Retail Store—42 East 33rd Street
Chicago Retail Store—9 West Washington Street

MEET YOUR COUNSELOR . . .

A merit badge counselor is your guide—your adviser. His subject is his hobby or vocation. Because of his keen interest in this subject, he's ready to help you. He will:

Meet with you several times

Help you meet the requirements

Introduce you to a whole new world of interesting and wonderful things

Show you special equipment, collections, or materials

Take or send you on field trips, if necessary

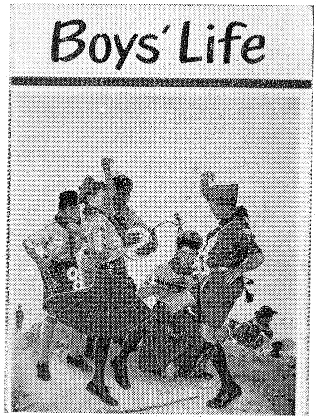
Sign your merit badge application when you've met the requirements

Be Prepared for

Good Scouting

and

Good Reading



To help you get ahead in Scouting, and to enjoy good stories, look to the pages of Boys' Life.

Month after month, you can count on Boy's Life for exciting articles on your merit badge interests:

on camping and cooking;

on hiking and exploration;

on swimming and boating;

on hobbies and Scoutcraft;

and dozens of other activities. You'll get more out of Scouting by reading Boys' Life. What's more, if you belong to the Boy Scouts of America, you can get it at half price through your unit, only $1.50 for twelve issues.