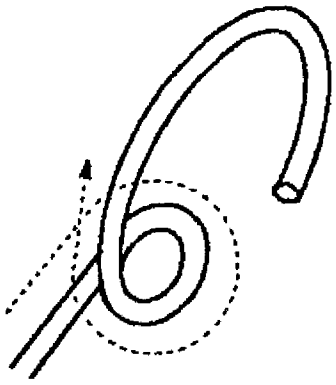
Section 4 Rescue Techniques

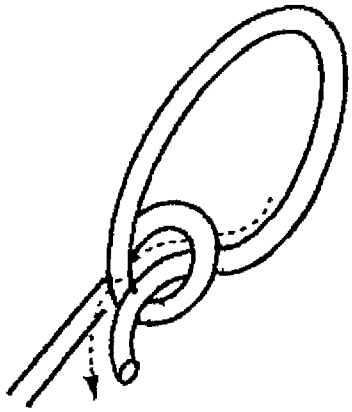
1. Knots

Knots are used in various rescue operations. They are essential for setting up a belay, and for securing one's own protection and safety. The knots shown here are introduced in many kinds of books and instruction guides. Though there may be 30 or more useful knots, the number of knots in actual use for rescue operations and drills is limited. Rather than learn them all vaguely, it is better to know just a few knots very well—the ones most frequently used. Hence, this guide.

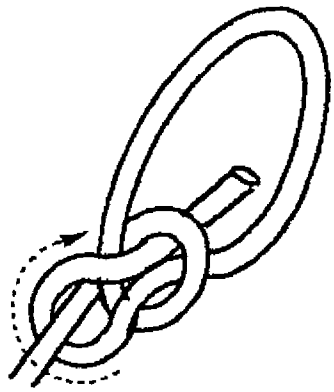
Single Bowline



Form a loop at an appropriate place near the tail end of the rope.

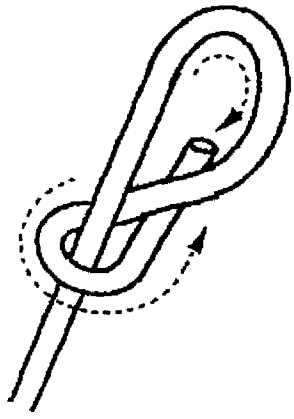


Insert the end of the rope through the loop. Extend the end behind the standing part of the rope, then insert it back through the loop.

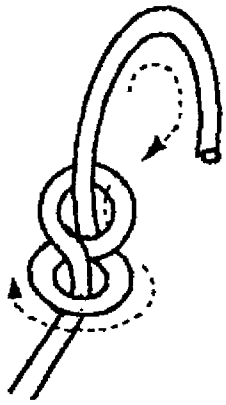


Form a loop at an appropriate place near the tail end of the rope.

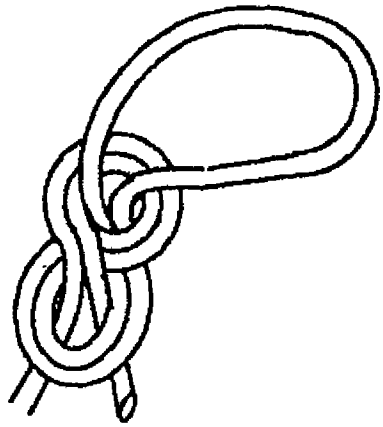
Rewoven Figure-8



Hold the bend of the rope in the left hand, and start the figure-8 by putting the end behind and around the standing part from the left side.

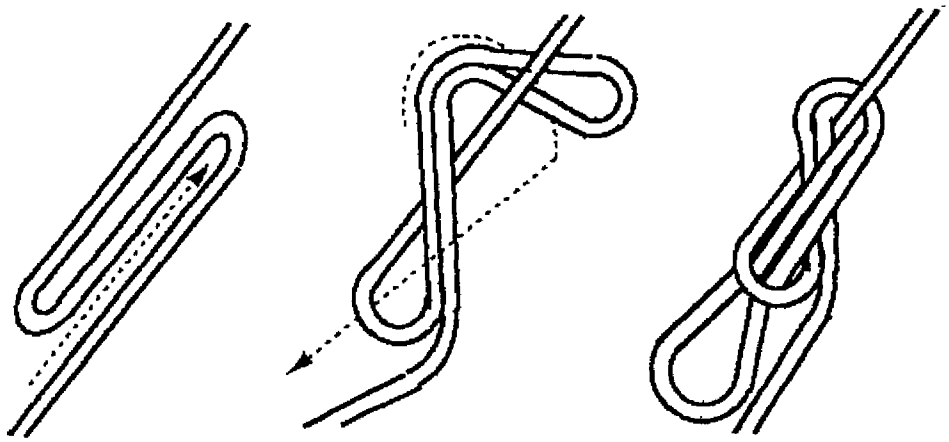


Pull through to form a loose figure-8 on the bight.



Weave the end back through, following the contour of the figure-8 just formed.

Figure-8 On a Bight

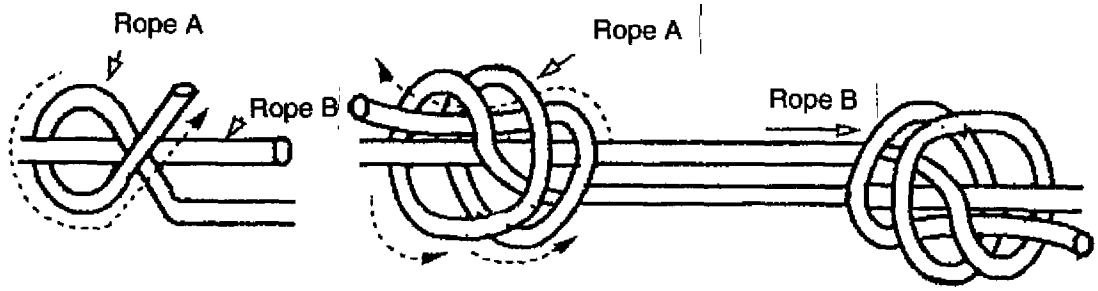


Bend in the middle of the rope as shown and draw out to the desired length.

Wrap the loop around one side of the rope and back through, forming a figure-8.

Pull the loop through in the direction that the sled or load will be attached.

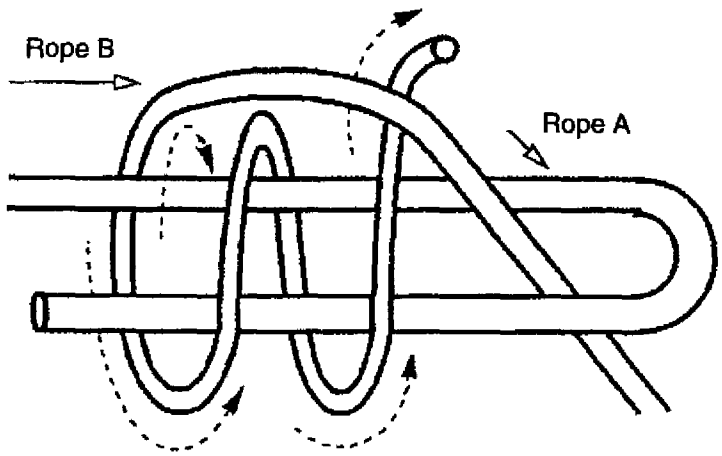
The Double Fisherman's Knot (Grapevine Knot)



Wrap the end of rope A around rope B.

With your right hand, wrap the end of rope A around twice from front to behind, then wrap the end of rope B with your left hand from behind to front.

Double Sheet Bend



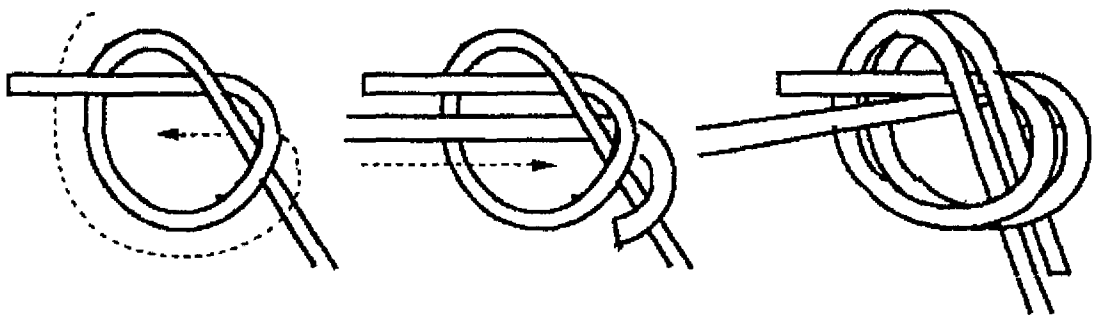
Bend rope A back on itself, and wrap it with rope B, considering how far the end needs to extend.

This knot can be used to join two ropes or to make a loop in one rope, but in principle a rope bent back on itself is going to be thicker.

It is also important to allow the ends to remain long.

Tape Knot (Water Knot)

Loops can be made in tubular webbing or cord using a double fisherman's knot or double sheet bend, but with flat webbing, this knot is preferred.

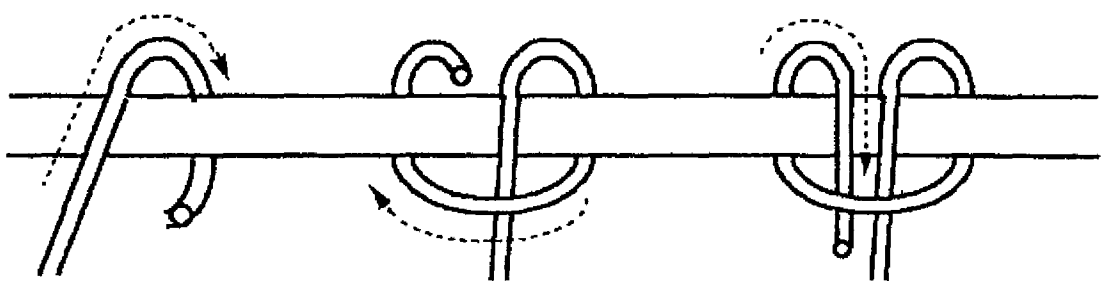


Start by creating a loose overhand knot at the end of one rope.

Thread the other rope through from the opposite direction.

Follow the contour of the knot and tighten. (Keep the ends long.)

Cow Hitch (Ring Knot)

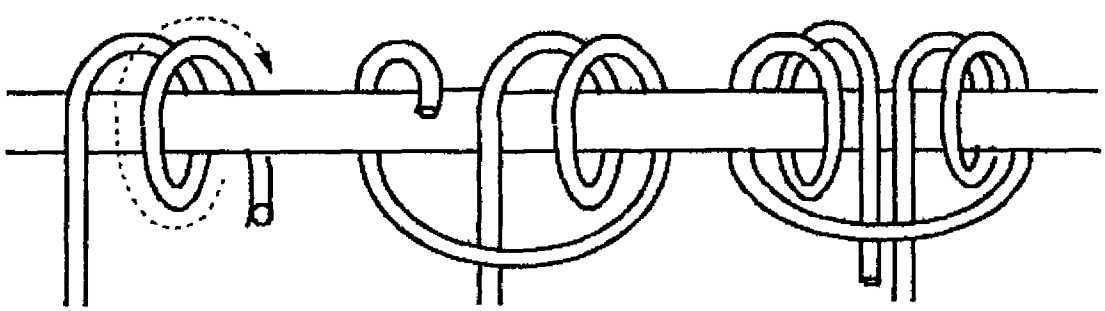


Wrap the rope around the object, drawing the end forward on the right side.

Cross over in front and wrap behind on the left side from underneath.

Draw the end forward and insert under the crossed-over section.

Prusik Knot

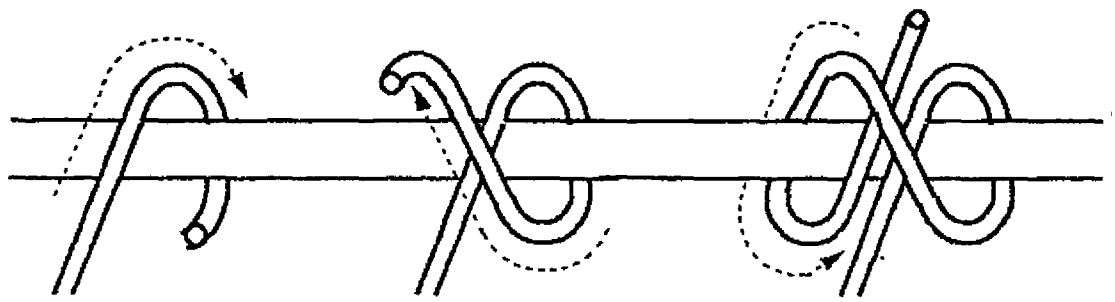


Wrap the rope twice around the object, working outwards, and draw forward.

Cross over in front, then wrap behind on the left side from underneath.

Wrap twice around the object, working inwards, then through, and align the knot.

Clove Hitch

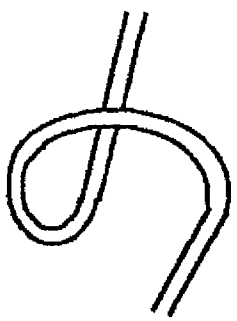


Wrap the rope around the object and draw the end forward on the right side.

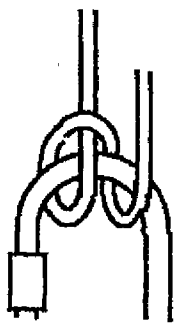
Cross over in front and wrap behind on the left side from above.

Draw the end around to the front and insert under the crossed-over section.

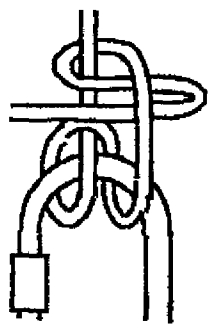
Italian Hitch



Create a loop in the rope as shown above.



Place a carabiner through loop (with the gate facing left).



Pull the end of the rope on the right side up through the carabiner, put behind the standing part, and then through in front, hitching with a slipknot.

Belaying with an Italian Hitch

The Italian Hitch, shown above, is used frequently in rescue operations (and in training) for belaying.

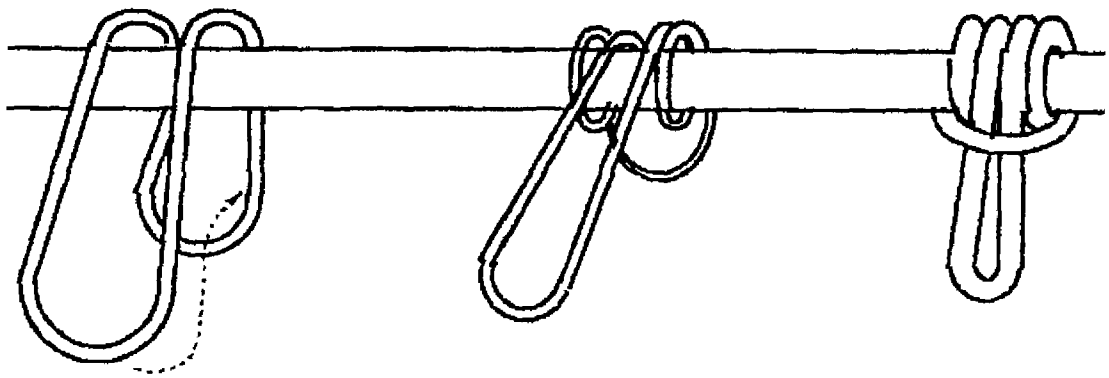
Belaying means to temporarily stop a rope or runner that is carrying a load. If it is stopped completely (fixed), it will be unremovable while the load is on, but belaying allows the rope to be undone easily, its key advantage.

The hitch must be practiced with repetition until perfected because it is being used for a belay and any loosening can cause a serious accident, particularly because it is being used for the stopper in raising operations or during a rappel when both hands are in use. (Never use if you are not confident that it is formed correctly.)

For an explanation of belaying using a figure-8 device, see the following pages.

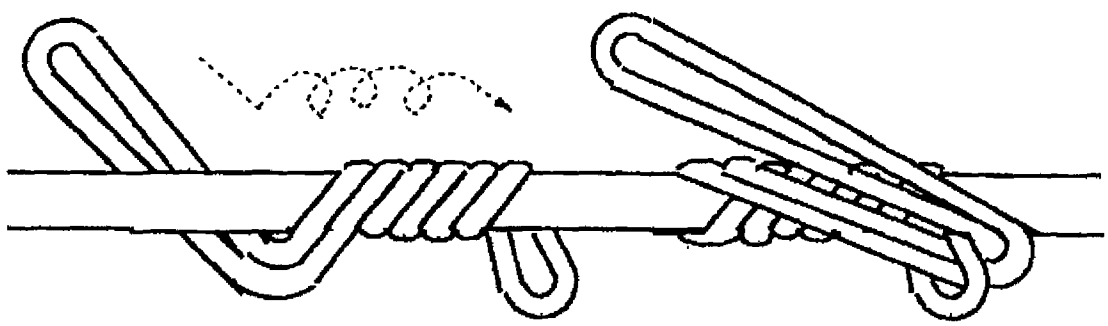
2. Runners (Loops)

Two-wrap Prusik Knot



Wrap the cord twice around the climbing rope in the manner shown and push the resulting knot together. (Make sure that the knot of the loop does not touch the rope.)

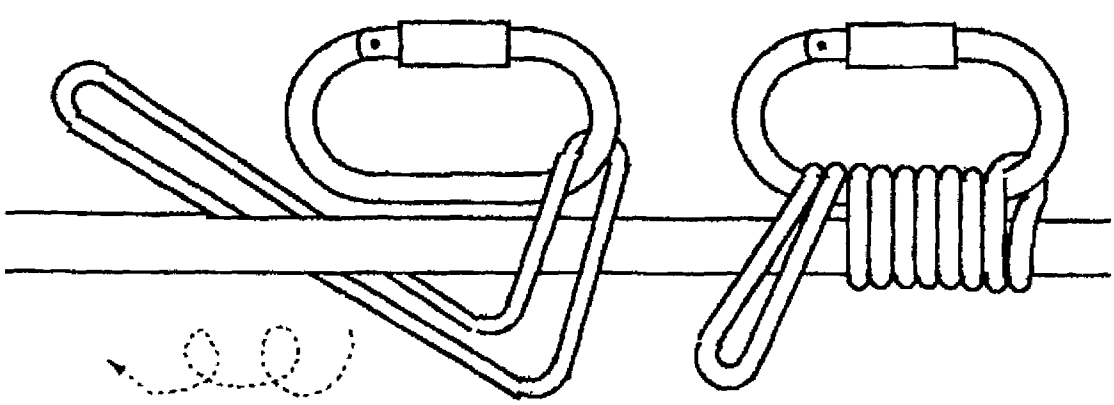
Bachmann Knot



Hold the two loop ends of runner and wrap diagonally several times around the climbing rope.

Insert the long end loop through the other loop and pull back in the direction of the load.

Bachmann Knot with Carabiner



Place the loop of the runner through the carabiner and wrap with the carabiner and climbing rope together.

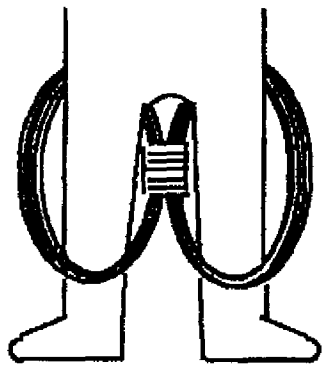
Align the knot precisely.

Knot Uses

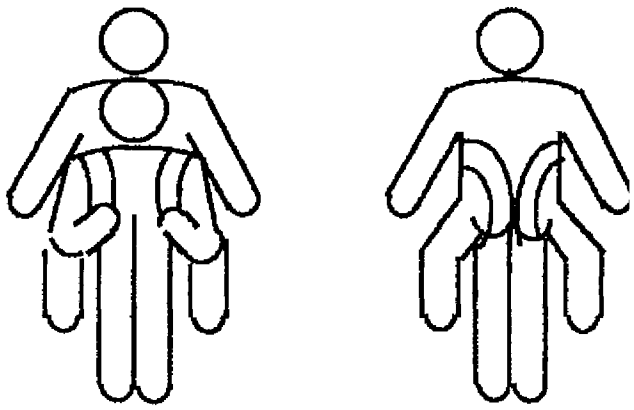
	40-meter rope	Cord cut to lengths of 5-10 meters; or runners
Single Bowline	① Attach to a tree for rappelling. ② Tie to a tree when the second or later climber climbs next for a self-belay.	① Used for a belay. • Tie the end to an anchor point (tree, etc.) • Use with a carabiner and connect to an anchor point. • If no safety belt is available, tie around the body.
Rewoven Figure-8	① When climbing, tie to safety belt. ② Attach to an injured person for raising or lowering.	① Used for a belay. • Use with a carabiner and connect to an anchor point. ② Attach rescue equipment. • Use with a carabiner and connect ascenders or other equipment.
Figure-8 On a Bight	① Use as a handhold when towing a snowboard. ② Set an anchor point at a suitable spot away from a tree.	
Double Fisherman's Knot (Grapevine Knot)	① Join ropes together. ② Tie the ends of a rope that is wrapped around a tree or rock used as an anchor point.	① Form a loop • A loop of 50~60 centimeters across is most frequently used in rescues. • Cord cut to lengths of 5~10 meters can be wrapped around a tree or rock four or five times to create an anchor point.
Cow Hitch (Ring Knot)		① Use in conjunction with a loop. • Wrap around a tree for a belay or anchor point.
Prusik Knot		① Use in place of an ascender. • Use as a stopper in place of an ascender like a Jumar or a Shunt.
Clove Hitch	① Wrap around a tree for a rappel.	① Close and hold items in place. • Use in transport using a sheet to wrap the casualty. (See pages 8 and 18 for reference.)

3. Transporting an Injured Person

Rope Coil Carry

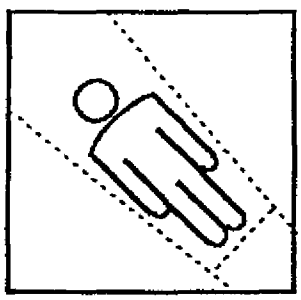


Halve the coiled rope and place one loop through each leg of the injured person.

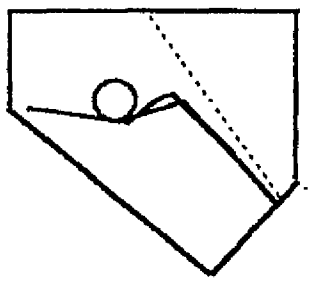


Carry the person on your back like a rucksack, passing your arms through the coils and onto your shoulders.

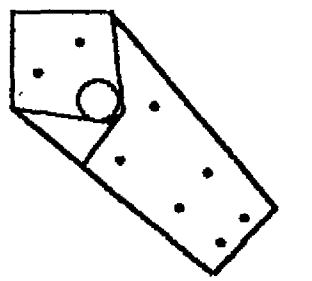
Transport Using a Sheet (for Dragging on the Snow)



Have the injured person lie diagonally on the sheet.

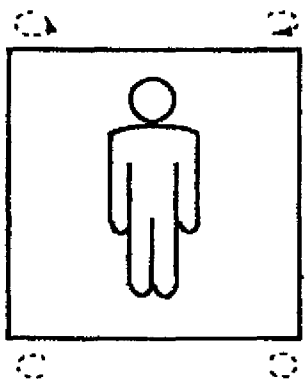


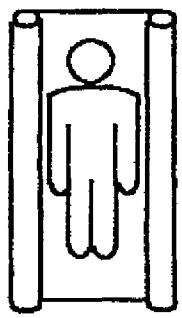
Fold as shown by the dotted lines to wrap the victim.

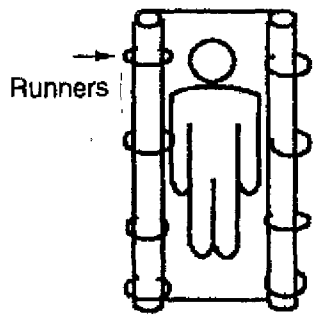


Attach runners and carabiners at the points marked with dots.

Transport Using a Blanket (for Lifting by Several People)

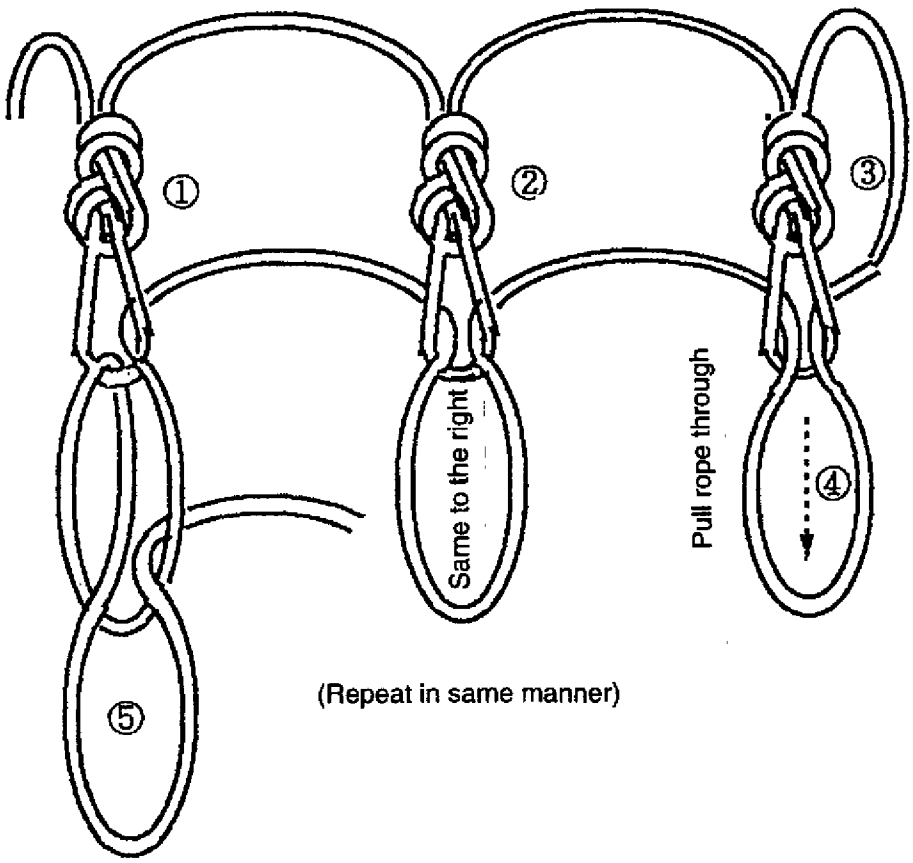






Roll both sides inward to form a rigid edge for gripping. The victim can be lifted and carried in this way by several people. Also, several holes can be put in the blanket at the edge and runners passed through to free both hands when carrying.

Rope Basket (Making a basket from a 40-meter rope)



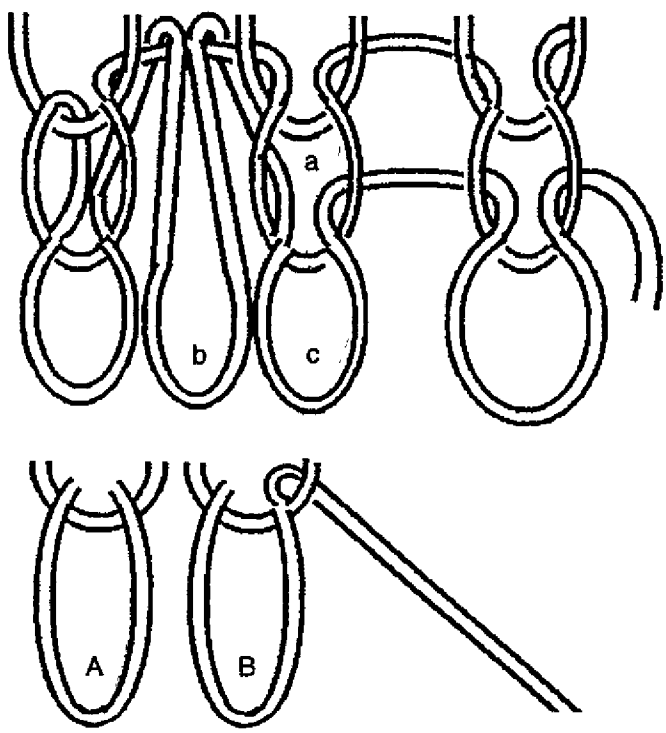
Form three figure-8 on a bight knots as shown (① ~ ③).

Draw the rope through loop ③.

Follow the diagram.

At the left side, pass the rope once more down through the loop formed and continue in the same manner back to the right.
(Repeat for the right side as well.)

When pulling the rope through with the right hand, hold lightly with the left hand around the crossover point.



When increasing the number of loops, draw (c) through (b) before drawing (d) through (a).

To reduce the number of loops, when moving to the next level, double up (d) and (c), and pull rope through the resulting loop.

At the final step, make loops A and B and tie these off using a square knot. Leave 3~5 meters of rope at the end. Use the remaining rope to tie the injured person into the basket, weaving through on both sides.

The rope basket consists merely of loop, so when lifting, always hold at least two parts of the rope. (Holding just one part will unravel the rope.)

4. Belay Hitches

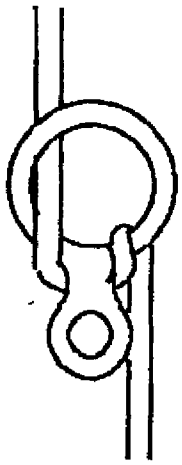
When rappelling or lowering another person on a belay, as a rule one never removes the braking hand (holding the rope) from the rope.

At the scene of a rescue, however, there are many instances where either both hands must be used or the scene must be left while a belay is on.

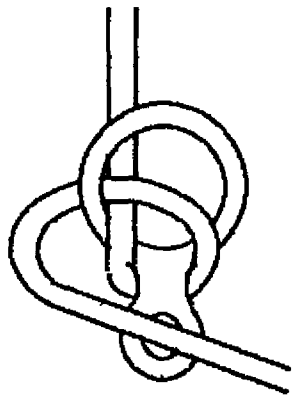
In this kind of situation, the rope is hitched around a figure-8 to hold it in place so that there is no movement. Permanently fixing the rope (tying a knot) would make the rope difficult to free (it becomes untieable), impeding the rest of the rescue operation.

This is why it is necessary to master the technique of belaying using belay hitches.

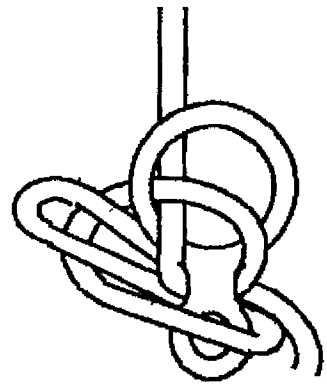
Belay hitches for rappelling



Stop the rappel descent using the right hand as the brake hand. (Grip the post of the figure-8 firmly with the left hand.)

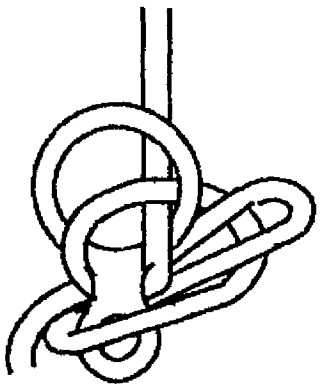


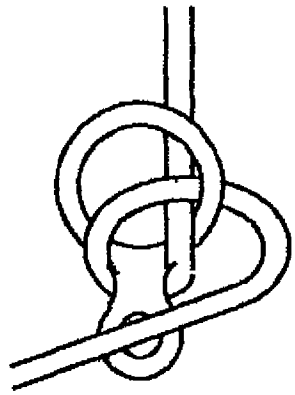
While gripping the post of the figure-8 firmly with the left hand, place the rope into the figure-8 so that it bites.

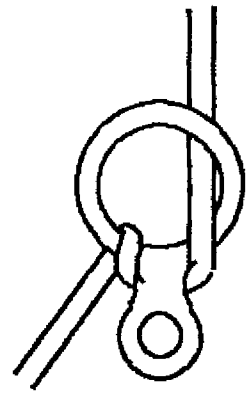


Wrap the extending rope twice around the post to the right and tie a slip knot at the post.

Belay hitch for lowering another person on a belay







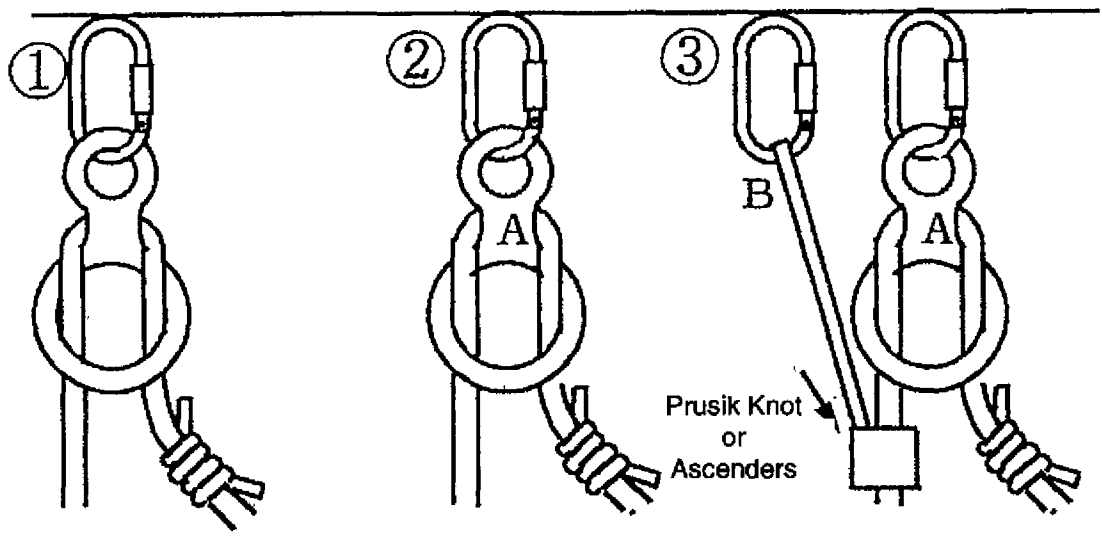
The brake system is basically the same as for rappelling, but the direction of the pull is different, so practice tying the hitch according to the diagram.

5. Applications of Belay Hitches (passing the knot)

Some rescue operations require ropes to be joined together. In such circumstances, passing a rope knot through a figure-8 is extremely difficult.

It can be done smoothly, however, using a series of brake devices.

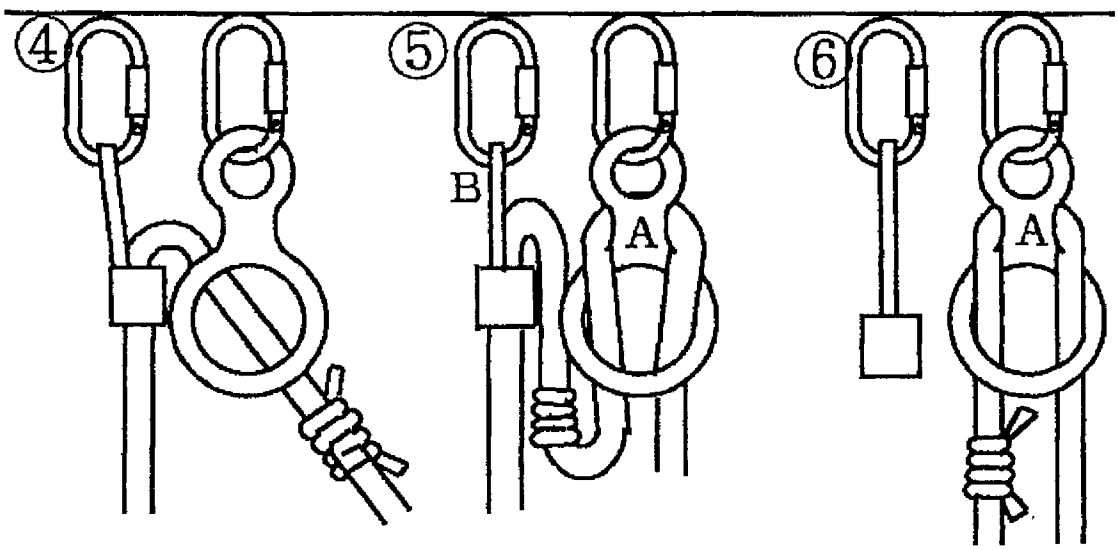
This section illustrates how to pass a knot through braking devices during the belay of another person, but the order of the steps is the same as for rappelling. Learn and master these techniques.



① Consider how to pass the rope knot through the braking device during a belay.

② First, hitch the rope as shown by position A.

③ With the rope hitched at A, attach a stopper. At this time also anchor at B.



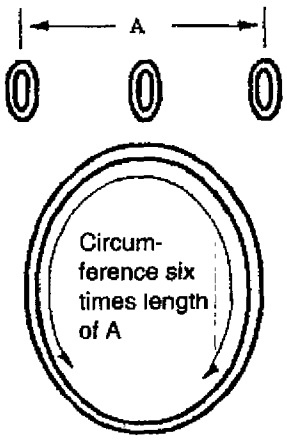
④ Remove the hitch at A, and gradually shift the load to the stopper side, at which time the rope will come free from the figure-8.

⑤ Pass the knot through, and again hitch at position A.

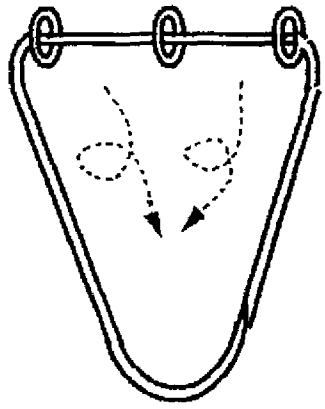
⑥ Remove the anchor at B, and gradually shift the load to the rope side. When the load is completely shifted, remove the stopper, and undo the hitch at A.

6. Anchoring through Equalizing Systems

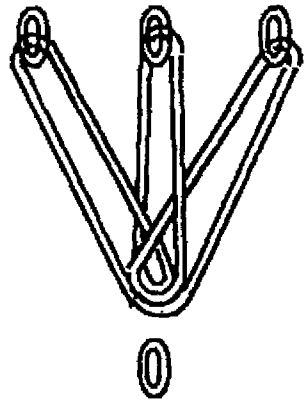
Equalizing means to distribute the weight of a load to multiple anchors. Then, even if the direction of force shifts (sideways swing, e.g.), the load is distributed equally among the anchor points.



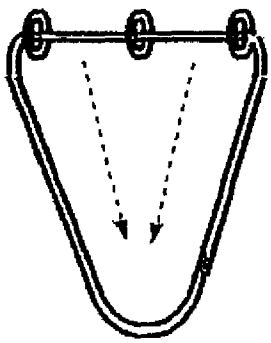
First, set up three anchors and prepare a runner or loop of cord six times the distance between the end anchors (A).

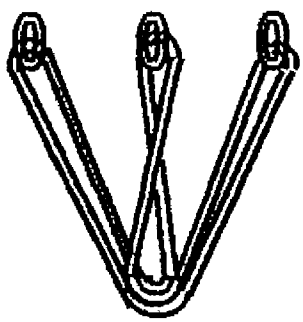


Clip the loop into the anchor carabiners, put two half twists in the same direction between the middle and end anchors, and draw forward.



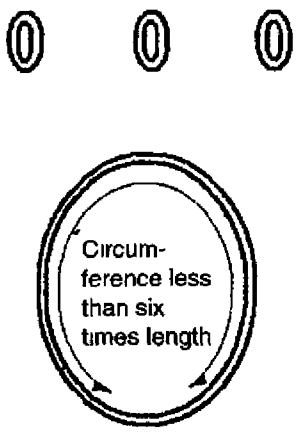
Bring together the loops and clip into a carabiner. The angle at the convergence point can be no greater than 60 degrees.

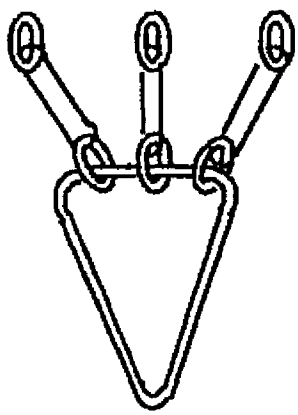


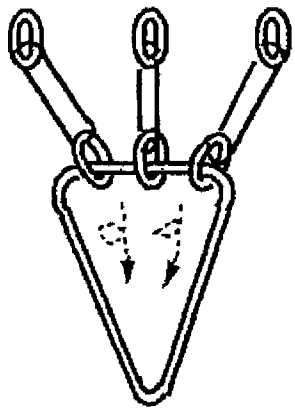


At left is an incorrect setup.
If no half-twist is put into the loop and one of the three anchors fails, there is no more equalization.

Also, to make the angle at the convergence point no greater than 60 degrees, one calculates the length of the loop by multiplying the number of anchors by the distance between end anchors, times two. That creates an equilateral triangle (all three angles are 60 degrees).







When using a loop that is not six times the length, it is best to use additional runners as shown above.

7. Protection Points (Belay Points)

On a multi-pitch route, protection points hold the key to the safety of your party. Completely secure protection points enable worry-free climbing. One may find such established anchor points at popular sport-climbing spots, but on multi-pitch routes one must determine safety on one's own, and possibly set up one's own anchors.

The leader must always set up a belay point for his or her climbing partners after walking off the pitch climb. The method for setting up a belay point differs according to the route and individual pitch. Common to any situation, however, is the necessity for the anchor to be 100% secure. In other words, even if the partners or leader falls, creating a shock load at the belay point, the anchor must never fail.

Some aspects may have been covered in the previous section, but here a thorough look will be taken at points of protection.

●Bolts

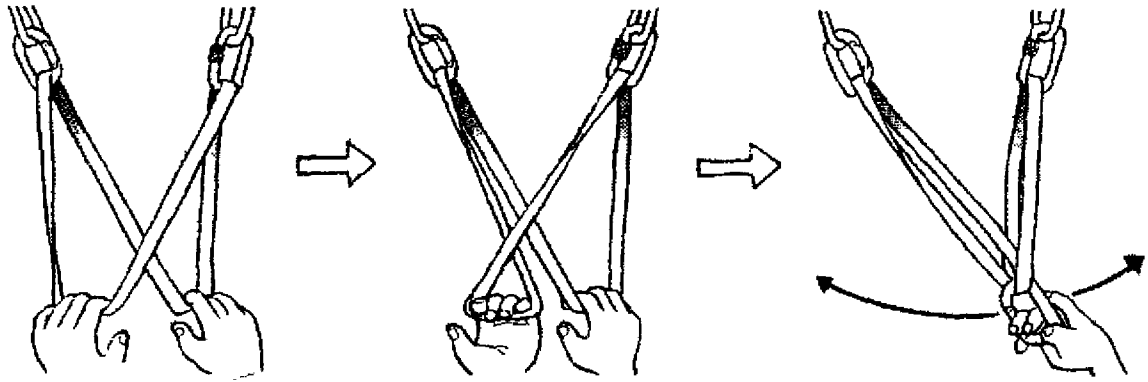
A bolt that is firmly driven into rock is the safest kind of anchor. But no matter how secure a bolt may look, relying on a single anchor for protection is unsafe. Bolts driven into eroded rock in particular can come loose easily. For any type of protection, it is important to secure multiple points.

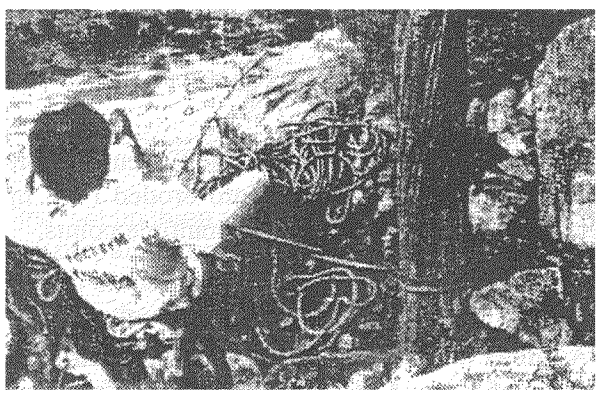
Equalization with Two Points

Two bolts are often used for equalized anchoring. A runner held with a sliding knot will distribute the load equally to both points no matter what the direction of force. And even if one anchor fails, the other will hold in case of a fall. So, even if you have more than two bolts, pitons, or other aid gear, quickly set up this type of anchor. Also, do not attach the runner directly to the bolt: use a carabiner.

With multiple anchors connected by a runner, the degree of shock on the anchors will vary according to the length of the runner and the direction of force. The diagram shows the amount of shock in kilograms on the anchors for a total load of 1000 kilograms depending on the angle determined by the length of the rappel sling. In general, it is safest if the angle of the sling is less than 60 degrees.

■Sliding Knot

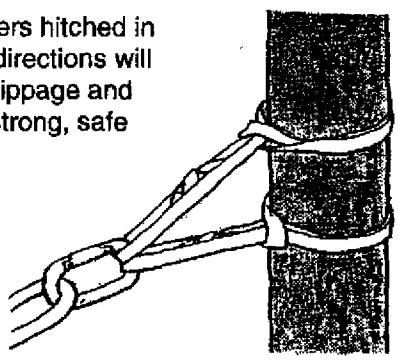


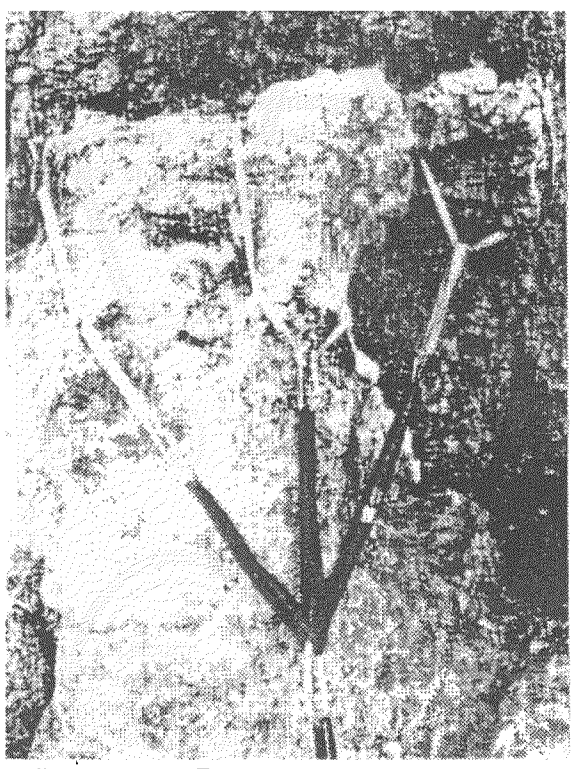


Belay from a tree anchor

■Tree Anchor

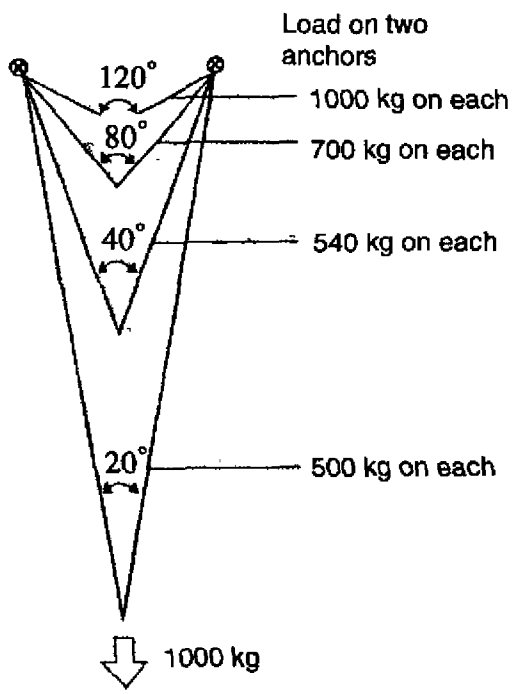
Two runners hitched in opposite directions will prevent slippage and create a strong, safe anchor.





Tree or Rock Feature Anchors

■Sling angle and strength



(AMGA Guides Manual, 1992)

●Tree or Rock Feature Anchors

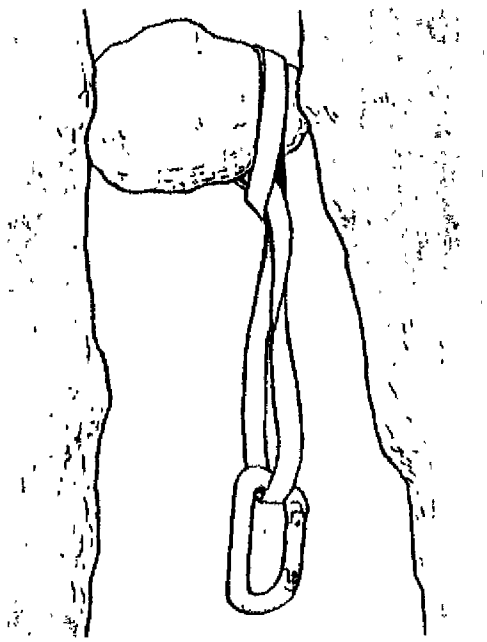
Other than artificial anchors such as bolts and pitons, many natural objects are used as anchors. A good-sized, well-rooted tree is sufficient for a single anchor in most cases, but an additional anchor or two can be added to make absolutely sure.

A tree is the best natural anchor, so if one does not have a long enough runner, the main rope can be tied directly to the tree using a Boulin (?) knot. If it is too complicated or difficult to tie the knot, it is also all right to secure the rope with a double fisherman's knot. In such case, to be safe, clip on a carabiner as shown in the diagram.

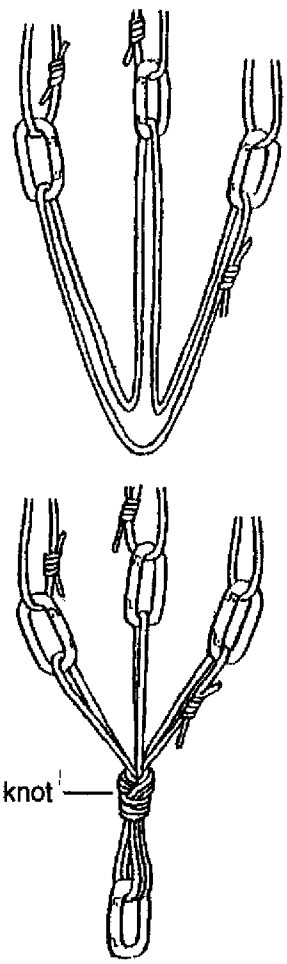
In any case, of critical importance is choosing an anchor that will not fail. Test a tree for whether it bends by pushing against it, or a rock by tapping it with the palm of the hand or a hammer, to determine if it is a safe anchor. When using a tree, use two slings placed in opposition for the anchor. This reduces the sway in the slings and feels safer.

Special caution must be taken when using a chockstone as a protection point or anchor. Sometimes a chockstone can come loose easily depending on the direction of force, so do not use any object that does not feel completely safe.

■Chockstone protection



■Equalized by three points



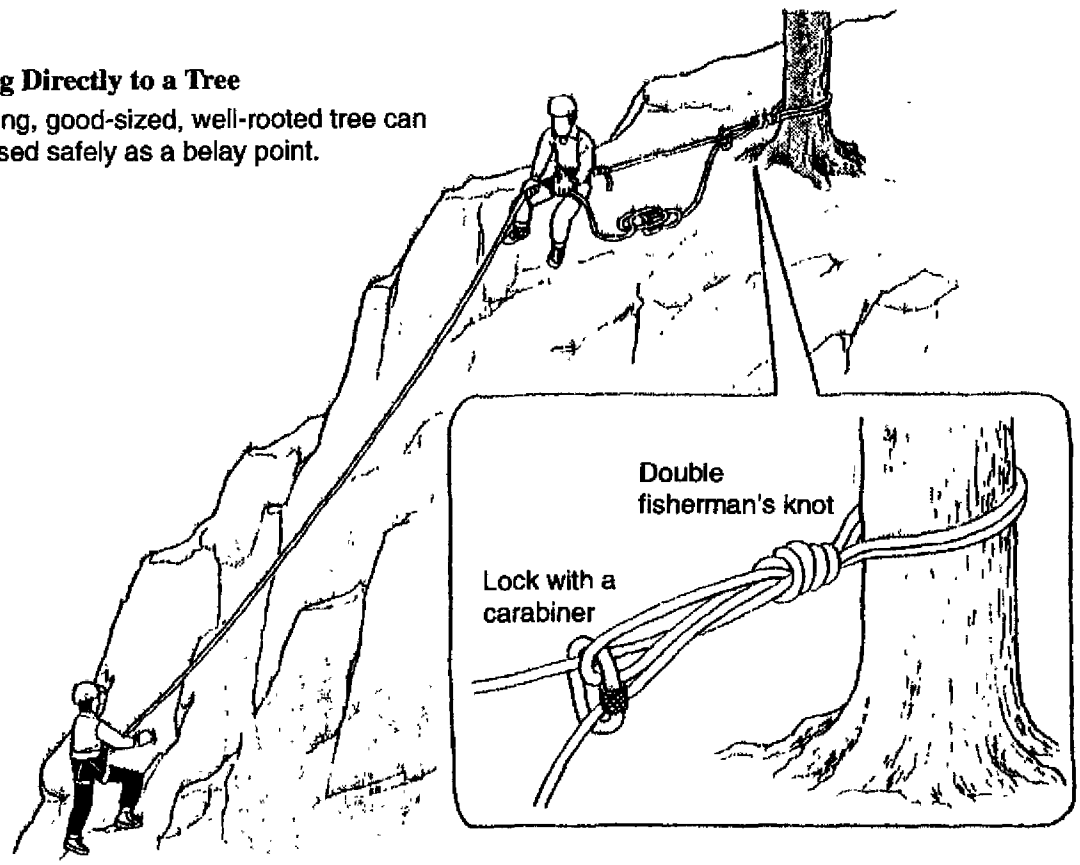
●Pitons, Nuts, and Friends

These permanent pieces of artificial protection can be either left over from a previous time or placed anew by oneself. Always check whether the piton is securely anchored. For placing anchors oneself, it is necessary to know how to correctly use many kinds of protection devices. Set up at least two anchor points, and three, four, or five if you are unsure.

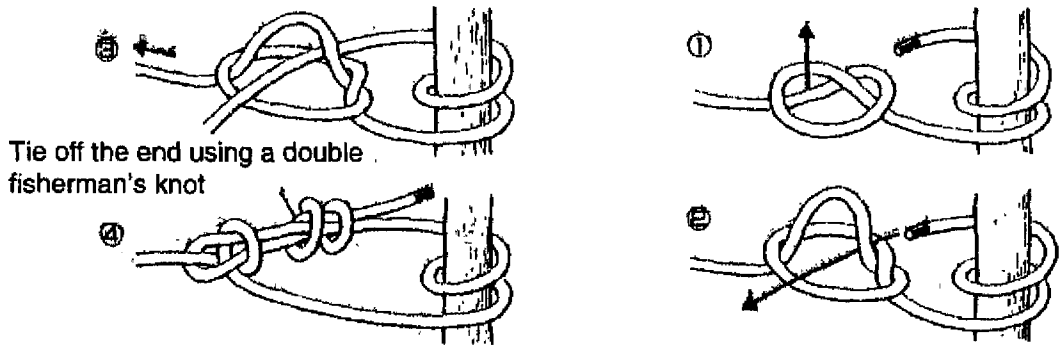
To equalize the load on three or more points of protection, use a rather long sling (five meters of 6-mm Spectra cord) tied with a figure-8 knot.

■ Tying Directly to a Tree

A living, good-sized, well-rooted tree can be used safely as a belay point.



■Boulin (?) knot for tying directly to a tree

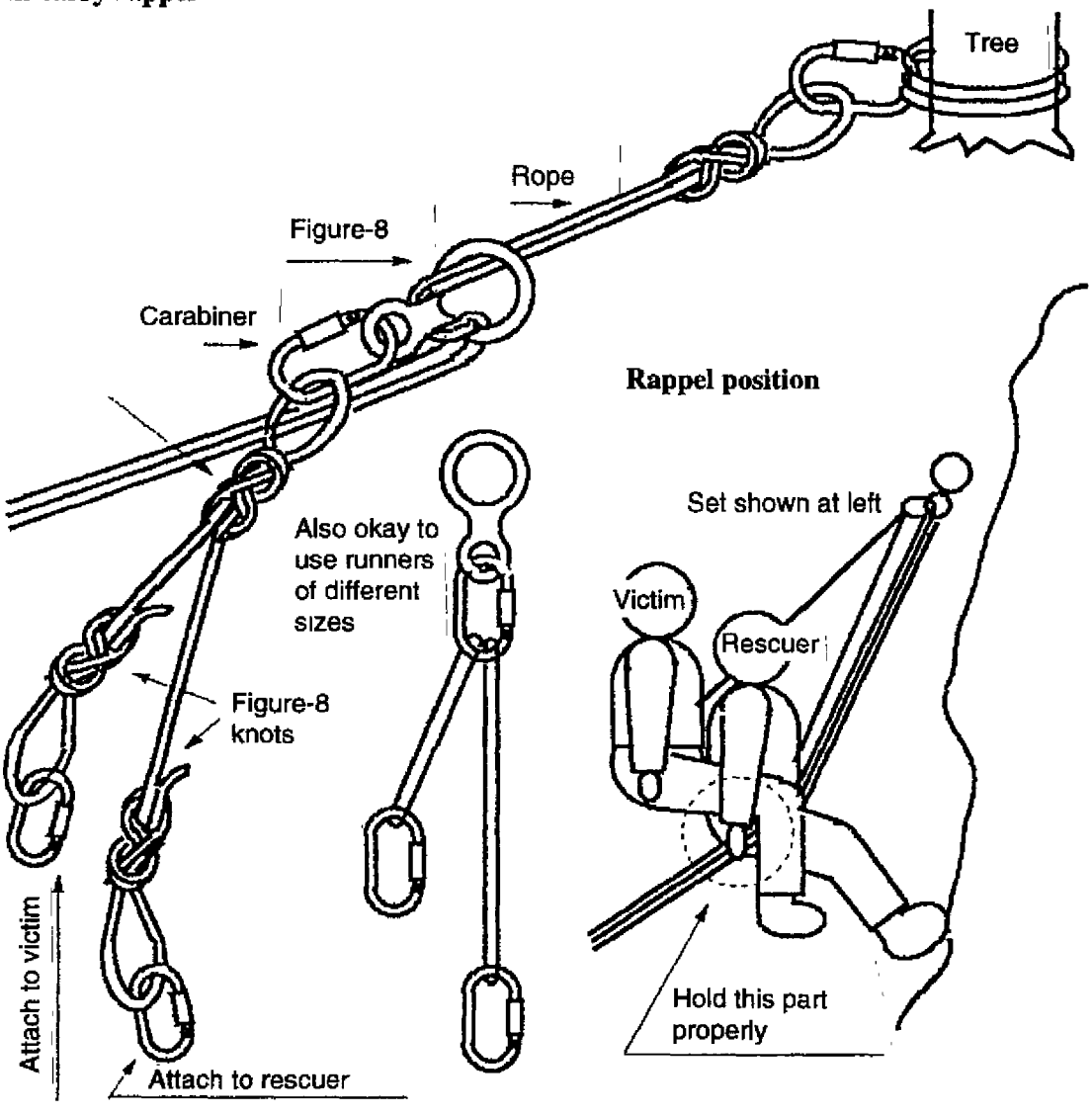


8. Double Carabiner Brake System 1

When belaying while carrying an injured person on one's back, if the rescuer clips a figure-8 device directly to his safety belt (doing a back carry on an ordinary rappel), a two-person load (body weight) must be supported, vastly increasing the burden on the rescuer.

To alleviate some of the burden, this distributed weight system was developed for a rescue involving lowering by rope. Using this system, the load is distributed, thereby reducing the burden on the rescuer.

Back-carry rappel



Points of Caution

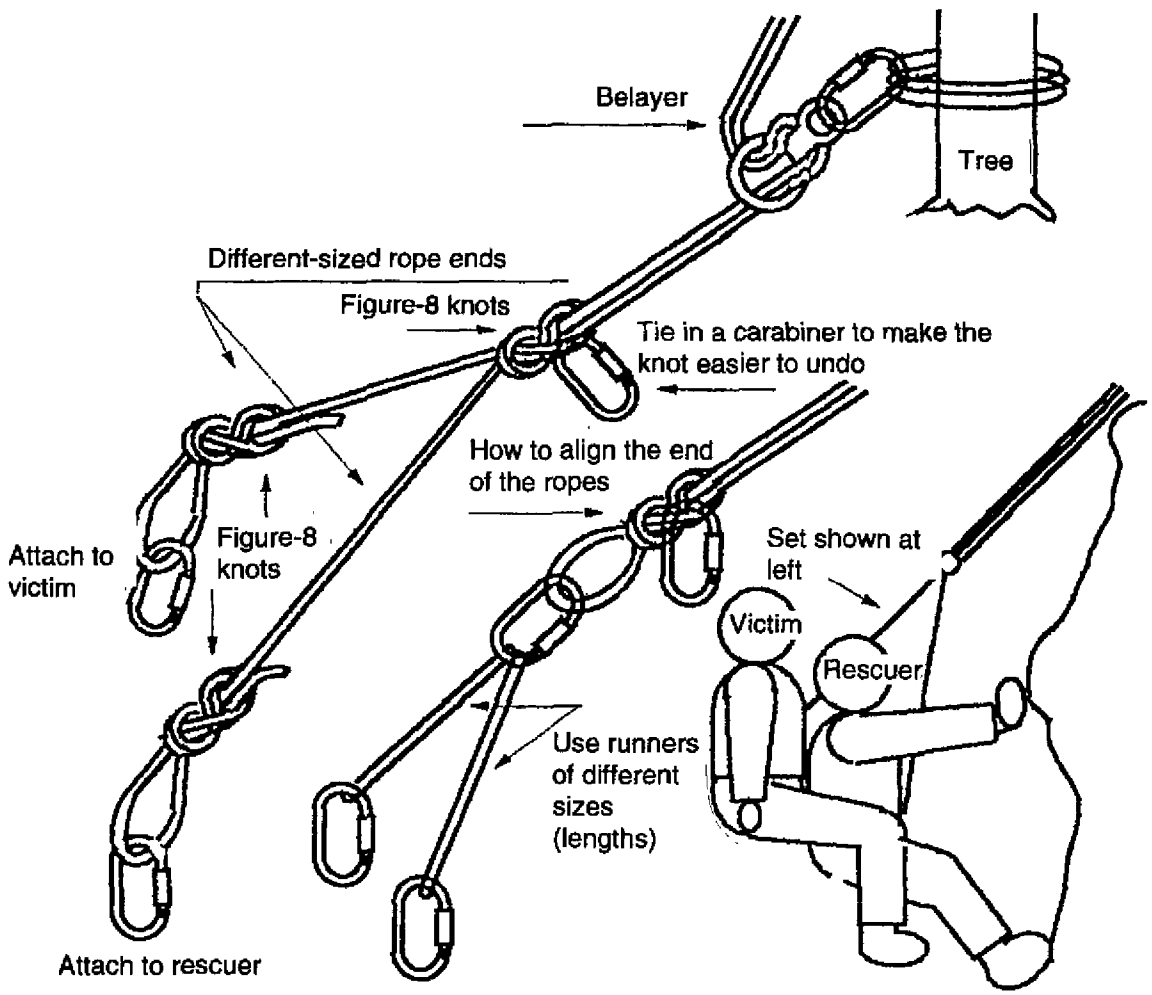
1. The length of the forked runners should keep the figure-8 within reach of the rescuer.
2. Change the lengths for victim and rescuer (shorter for victim, longer for rescuer).
3. When rappelling, pass the rope inside the leg of the victim, and control the rope by gripping it from behind the victim's leg (as shown in the diagram).

9. Double Carabiner Brake System 2

When lowering an injured person by back carry down a pitch, if there are few rescuers, the rescuer carries the victim on his back and rappels down, as described in the first double carabiner brake system, but in fact the following method (usually known as an alpine rescue) is most often used on the rescue scene.

This is a method of connecting the victim and rescuer at the end of the rope separately, and having them lowered by another rescuer positioned at the top.

Alpine rescue



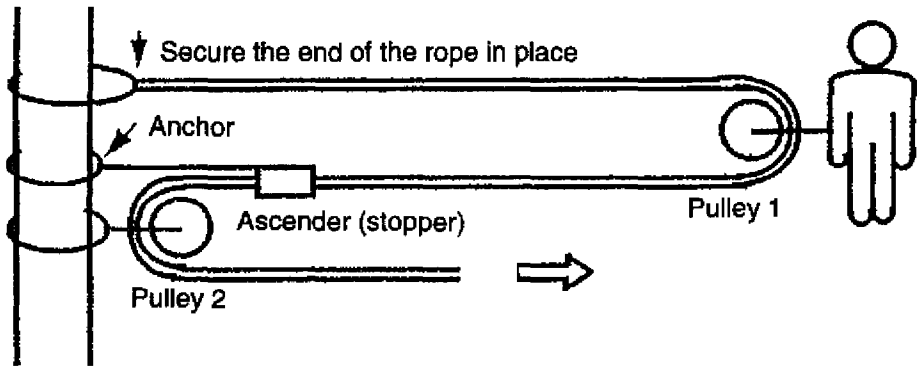
Points of Caution

1. The setup is the same as for "Double Carabiner Brake System 1".
2. The belayer must let out the rope smoothly. (Even small stops and starts will have a large jarring effect on the two people descending.)
3. Since the person descending on the rope (the rescuer) cannot control the speed of descent, he must yell to the belayer, communicating such things as speed and distance to the ground, and the belayer must always repeat. (If no reply comes, the person descending will feel unsure.)

10. Rescue by Hoisting

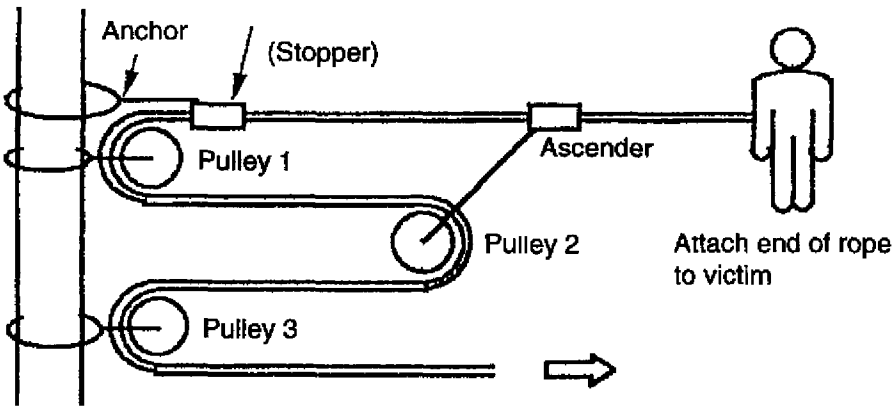
The pulley systems introduced here are rescue techniques that enable raising with the use of less power.

(1) 2:1 System



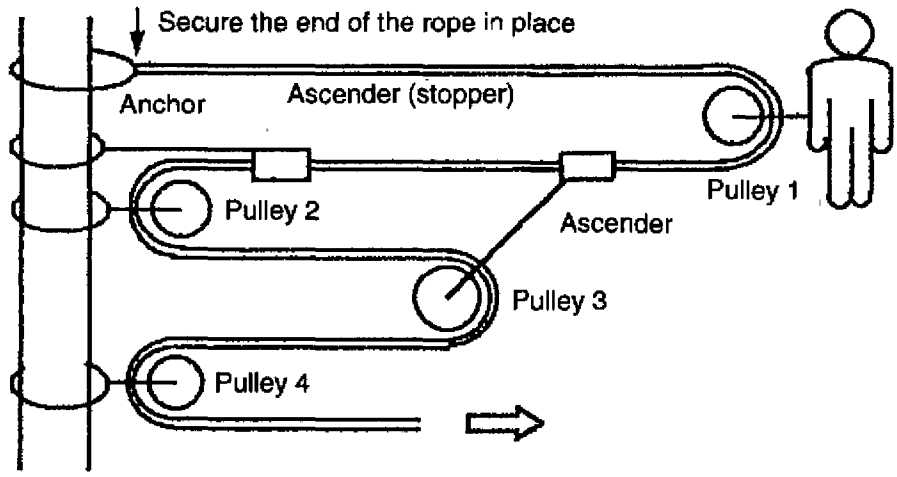
① Secure the end of the rope to an anchor point.
② At the bend in the rope install pulley 1, and attach to the victim.
③ Add an ascender (stopper).
④ Add pulley 2, which changes the direction of the pull.

(2) 3:1 System



① Attach the end of the rope to the victim.
② Add a stopper.
③ Install pulley 1 and bend the rope back.
④ Install pulley 2 and the ascender as shown in the diagram.
⑤ Add pulley 3, which changes the direction of the pull

(3) 6:1 System



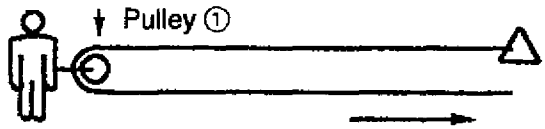
This method piggybacks the 2:1 and 3:1 systems.

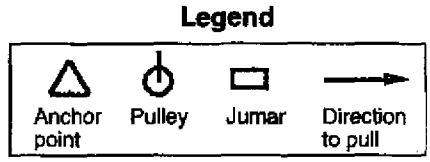
=Points of Caution=

Always install an ascender for use as a stopper.

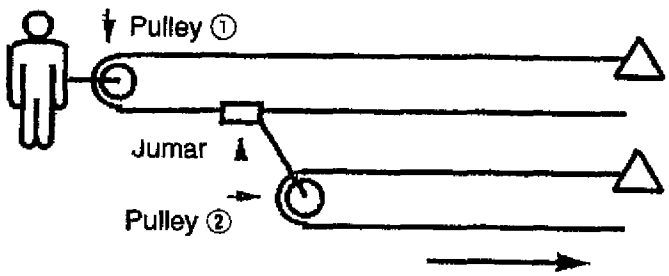
Use the pulley system best suited to the number of rescuers, degree of pitch to be hauled up, and other conditions.

11. Pulley Principles





Where do you attach the stopper?

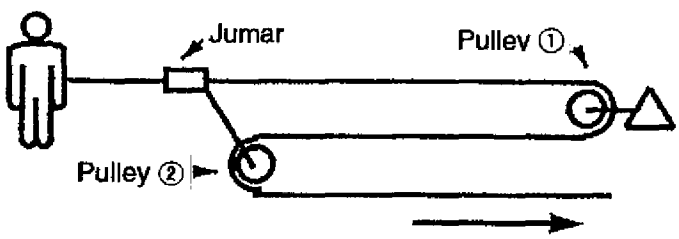


① Pulley is attached to the victim

When the rope is pulled two meters, how far is the victim raised? What is the ratio?

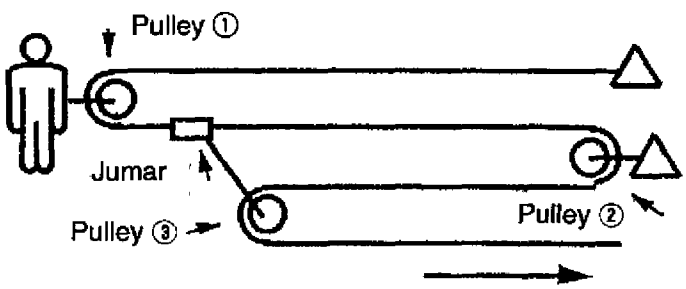
② Two of the above sets are piggybacked

When the rope is pulled four meters, how many meters are pulley ② and the Jumar lifted? How far is the victim raised? What is the ratio?



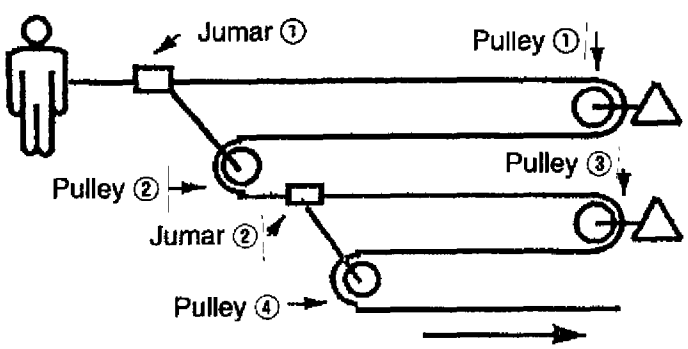
③ End of the rope is attached to the victim

When the rope is pulled three meters, how many meters are pulley ②, the Jumar, and the victim lifted? What is the ratio?



④ Methods ① and ③ above are piggybacked

When the rope is pulled six meters, how many meters are pulley ③ and the Jumar lifted? How far is the victim raised? What is the ratio?

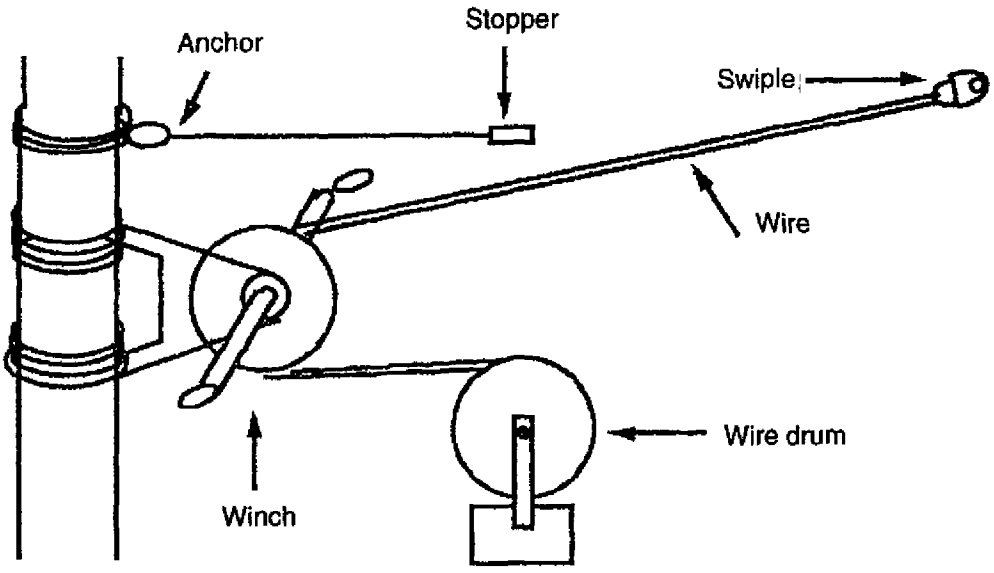


⑤ Two sets of method ③ above are piggybacked

When the rope is pulled nine meters, how many meters are pulley ④ and the Jumar ② lifted? How far are pulley ②, Jumar ①, and the victim raised? What is the ratio?

12. Rescue Using Wire

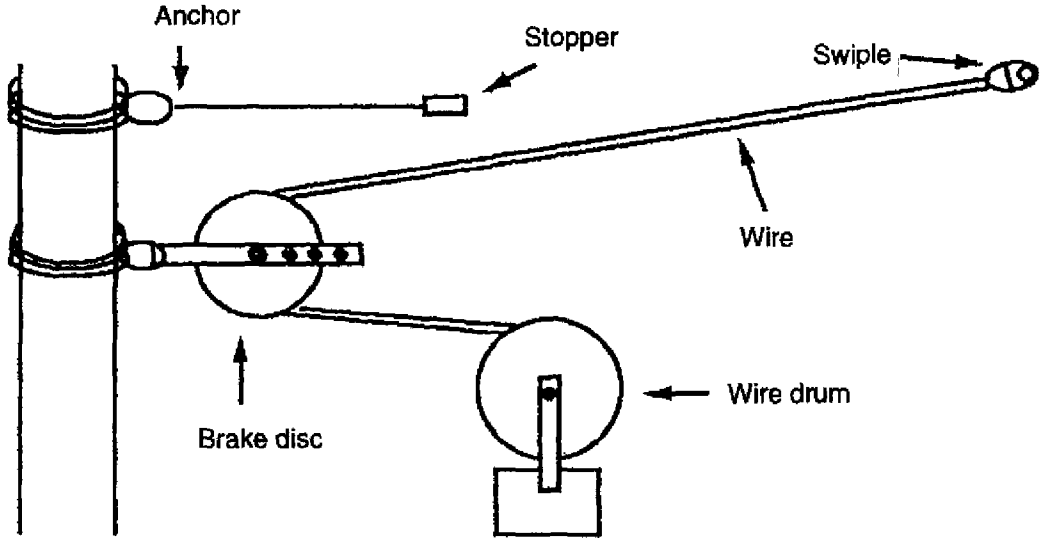
System for Raising



When winching an aerial cable (wire), it is dangerous if the cable becomes too taut, so be extremely cautious.

When there is no winch, use a pulley to help with hoisting.

System for Lowering

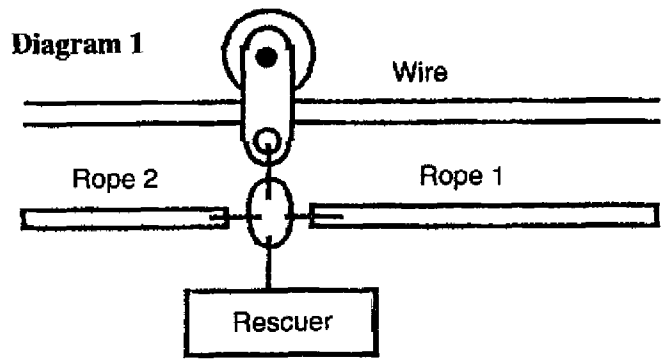


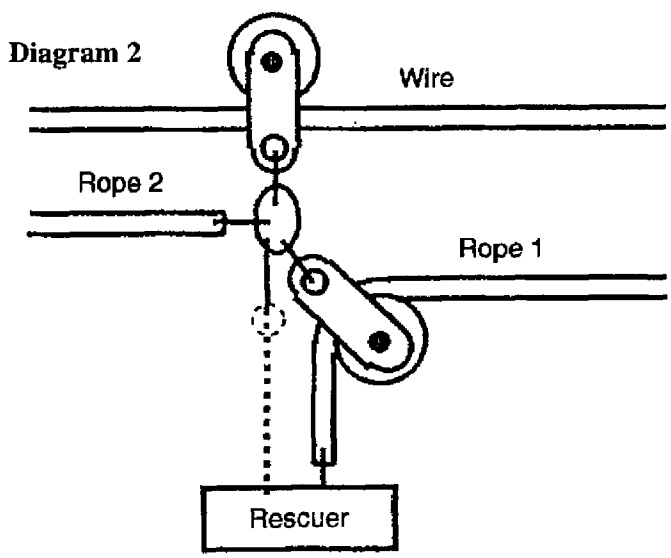
With wire, it is not possible to brake using a figure-8. Instead of the figure-8, wrap the wire around a brake disc 3~4 times to control the braking.

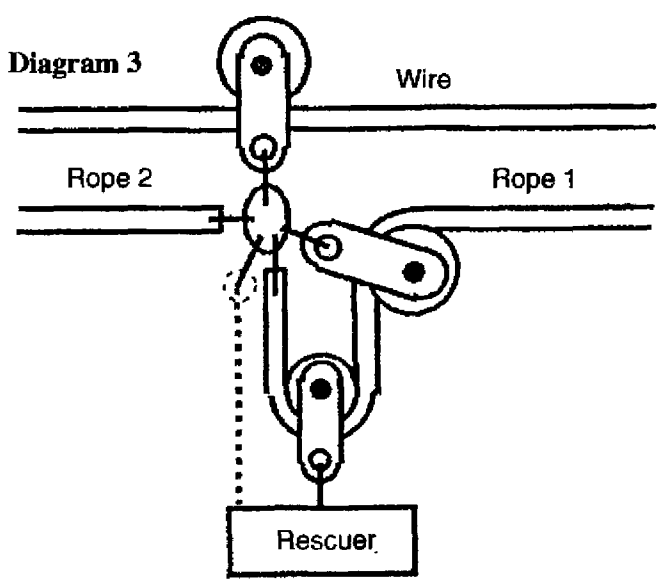
Put the stopper (wire clip) in a position where it can be attached quickly.

13. How to Set Up an Aerial Cable

An aerial cable is like an extended wire or rope. By placing a pulley or other device along the cable, various rescue methods are made possible.







This aerial cable is for rescue operations that involve moving through the air, as its name suggests.

It is used for valley and river crossings, or to transport a victim and rescuer over a slope that has many fallen rocks.

The rescue methods incorporate all of the methods that you have studied, including anchors and pulleys.

Diagram 1 shows a system for straight-line movement.

For horizontal movement, rope 2 is needed, but if there is an incline, a second rope is not necessary. The aerial cable cannot, however, be slackened to allow an injured person to touch the ground.

Diagram 2 shows a system for lowering victim and rescuer without slackening the aerial cable.

In this case, rope 2 is extremely important. (If there is none, there will be a drop when the anchor is released.)

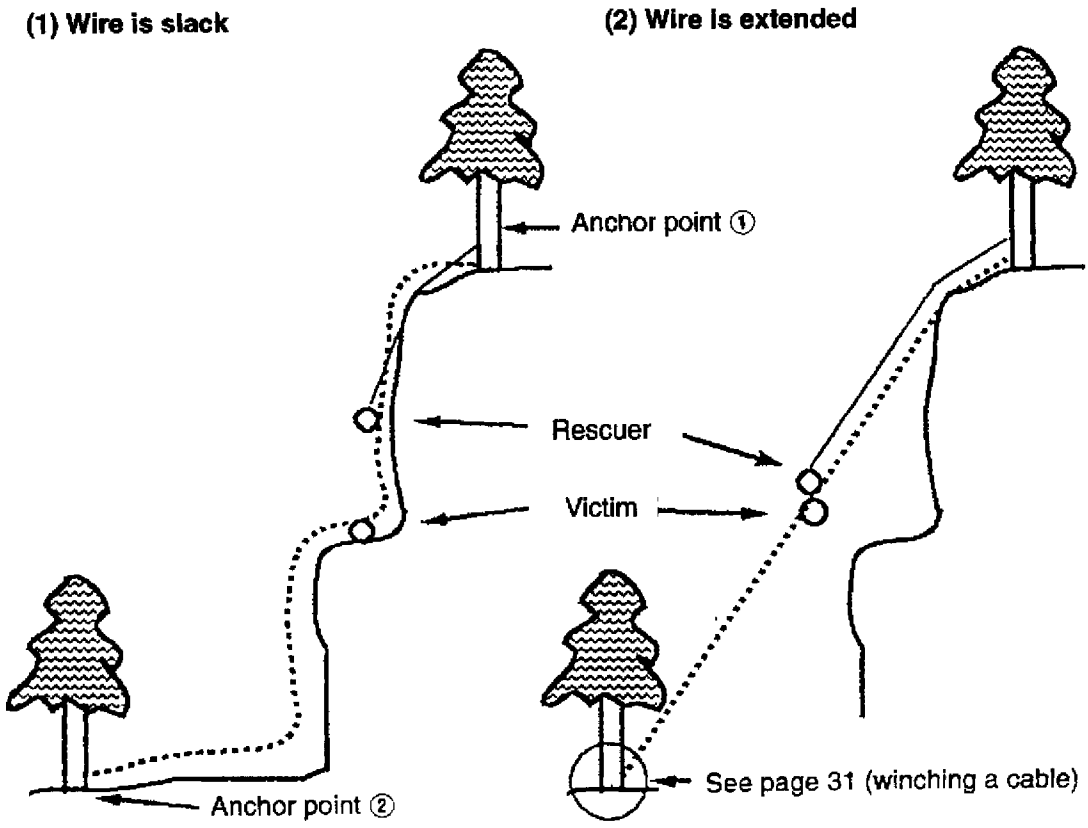
Diagram 3 shows a pulley system for hoisting.

It is very effective for lifting a rescuer into the air.

14. Rescue Using Aerial Cable

In places with a lot of fallen rock, it is safer to rescue an injured person by moving the person through the air using an aerial cable. But with the aerial cable in a protracted position, the rescuer cannot reach the victim.

Therefore, with this system, the cable is slackened, and once the victim is reached it is then extended, and the rescuer and victim are hauled through the air to safety.



<Rescue Method>

Anchor the end of the cable at anchor point 1. Set up a figure-8 device to lower the rescuer in that vicinity and lower the rescuer by rope. The setup is shown in diagram 1 on page 17. (Because of the angle, there is no need for a second rope.)

When the rescuer reaches the victim, protract the cable using a winch or pulley system set up at anchor point 2.

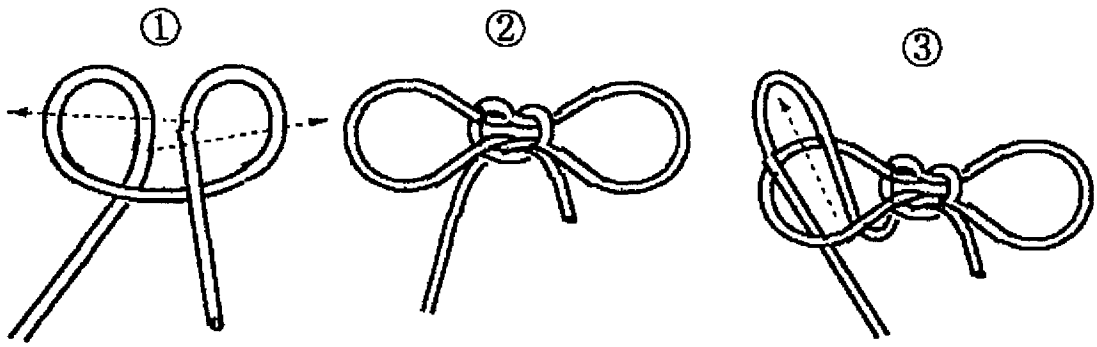
When the rescuer and victim are lifted into the air, secure the cable in place, slacken the rope, and lower the two to the ground below.

<Rescue Applications>

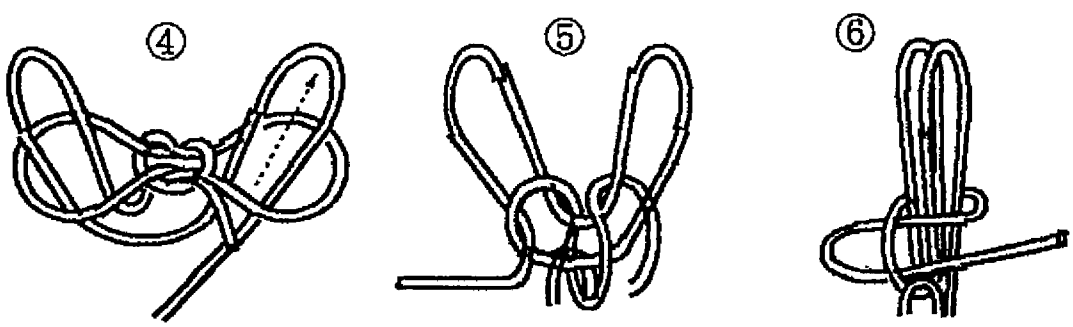
This rescue method can also be used for rescuing victims from building windows. If there is danger of falling rock striking the victim, the cable can be extended to move the rescuer into position through the air before slackening to allow the rescuer to pick up the victim before protracting again.

15. Coiling the Rope

There are many ways to coil a rope. The most popular method is the "loop and part" (?) method but for carrying from place to place, loops take a long time to form, and they must be undone or else the rope can become tangled. Instead, use the following method for coiling.



1. Form a single pitcher knot (?) at the end. (Steps 1 and 2)
2. Form the loops so that your hand can just fit through it. (Step 2)
3. Extend the rope through the left side.
4. Put your left hand through the left loop (from the front), and pull the rope through a little. (Step 3)



5. Next, put your right hand through the right loop (from the front), and pull the rope through a little. (Step 4)
6. Then put your left hand through the bend of the left-side loop that was pulled out and pull another loop of rope through.
7. Do the same on the right side, and continue alternating sides, in this way weaving a chain with the rope
8. Weave until the last 1-2 meters of the rope remains. (Step 5)
9. Gather all the loops pulled through on both sides and tie at the end. (Step 6)

Advantages of this method of coiling

1. No kinks. (With ordinary coiling, old ropes in particular kink.)
2. Can be put into a rucksack easily.
3. Rope can be extended (pulled out) while still in rucksack.
4. Very quick to coil with practice.