ROPES, KNOTS AND TACKLES.

This E.I. describes the care of ropes and the uses of ropes, knots and tackles.

Index

1. GENERAL

1.1 Rope is one of the most mishandled materials; it is frequently dragged over rough surfaces which wear and out the outside fibres. Grit and splinters may sever the inner fibres when the rope is under load. Hitting a rope with a heavy implement to make it tighten its grip is a common practice which bruises and disturbs the strands. Overloading is a frequent occurrence. Ropes are also often damaged by being pulled around small diameter posts and sheaves or over sharp edges. Therefore it is essential to take every care in handling rope, as knots and tackles depend on the efficiency of the ropes used. This E.I. explains the correct selection and proper treatment of rope and associated gear.

2. ROPES, CARE AND USE

2.1 Most ropes are made of manila or sisal fibre. Manila is by far the better material, but it is in very short supply and in view of this, most of the rope used by the Department is made from sisal. Apart from its harsher feel and coarser fibres, sisal can be distinguished from manila by its colour - manila is light brown, whereas sisal is a white colour. Sisal makes a slightly stiffer rope, and for this reason, does not grip as well as manila when "tackle falls", "lashings", etc. "are made off".

In splicing there is very little difference between sisal and manila. The former, being less pliable, is slightly more difficult to work, but the splice is almost as satisfactory when made. Sisal deteriorates more rapidly in use than manila, and, consequently, more frequent inspections are necessary.

2.2 Fastenings. The success of an operation where rope is used depends to a great extent on the splice, knot or hitch. When fastening rope, use only accepted methods of knotting and splicing. These methods have stood the test of time, and by using them will get more service from the rope with a greater degree of safety. The question as to why ropes so often fail at the fastenings is sometimes asked. The reason is that, in the standing part of the rope each yarn and strand bears its proper share of the load, but in all fastenings the rope is more or less cramped, distorted or has a sharp bend. This will place an overload on the yarns most affected, and these yarns will part until cramping effect is overcome. In some cases, this effect is not overcome, and the rope is stranded and then parts.

2.3 Storage of Rope. All rope new or used should be kept in a cool, dry place, preferably on wooden grating-type shelves or on wooden pegs where air can circulate freely. To avoid rotting, see that ropes are dry before storing them. Rope should be kept away from direct sunlight. Knots are not to be left in rope.

2.4 Avoid Kinking. Kinking can be the cause of serious damage to rope. When, for example, a stiff wire rope is incorrectly removed from a coil, you have a hopeless mess. The fact that a fibre rope is more flexible than a wire rope does not alter the fact that it should be correctly removed from its coil.

The ideal way of removing rope from a coil is to put the coil on a spool supported by a shaft and unwind from the outside. This can most readily be done by using spools or drums with a removable side which can be replaced after the coil has been placed on them. When so uncoiled, the rope is in a neutral condition, free from twist. While this procedure can easily be adopted in stores, it is not so convenient on the job, where the maker's instructions should always be followed. To uncoil correctly, place the coil so that the label can be read from top to bottom. The top of the coil is then correctly placed. The end should then be taken from the centre, and the rope should uncoil in the anticlockwise direction. (See Fig. la.)

This has the effect of removing some of the twist from the rope, thus avoiding kinking. However, the rope still has a twist if it is coiled in a circle on the ground. The better plan is to flake down the rope in a figure-of-eight, in which case it will be neutral. (See Fig. lb.)

It is then ready for reeving tackle or other use. Never put a strain on a kinked length of rope as it will be permanently damaged.

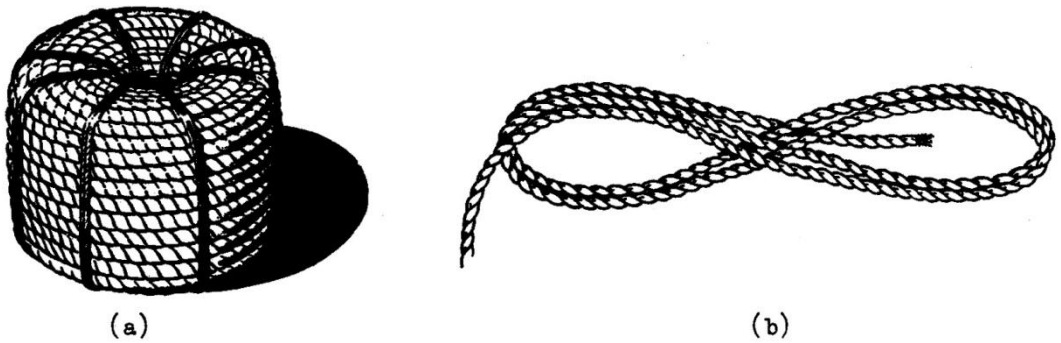


FIG. 1. ROPE COILS.

2.5 Wear of Ropes. To avoid wear of rope the following precautions should be noted –

(i) Avoid sharp bends, use soft wood, or the like for packing when a rope would otherwise have to pass over a sharp edge.

(ii) When securing the end of a rope, tie it around a smooth surface of sufficient size.

(iii) When it can be possibly avoided~ do not drag rope along the ground, around sharp corners, or over rough, sandy or splintery surfaces.

(iv) Do not carry rope in a truck compartment or tool box containing heavy or sharp-edged tools.

(v) Do not allow ropes to rub against one another when in use.

(vi) Endeavour to equalise wear over entire length by reversing rope, where possible.

(vii) Avoid contact with rusty iron, which is harmful to vegetable fibres.

(viii) When using blocks, make sure the sheaves are large enough and with plenty of clearance to avoid side wear on rope; also see that there are no cracked or broken sheaves and that sheaves and swivels are oiled and run freely. Blocks should be inspected frequently, and any sharp edges likely to wear rope are to be removed. Where possible, side plates of existing blocks should be given a flare in order to provide a good "entry" for the fall of the tackle. Avoid twists in tackle. Apart from reducing wear, this makes pulling much easier.

(ix) Never overload a rope; also avoid jerks, etc., which cause permanent, although invisible damages. Do not assume, because a rope once took more than its safe working load, that it will take it again. It probably suffered serious internal damage the first time, but the damage is not visible. It is very bad practice to hit rope with a hard implement to make it tighten its grip on an object. Where necessary, use packing to prevent a rope or sling slipping.

(x) Avoid contact with acids, strong alkalis, fumes, heat, steam, etc., as these are injurious and cause rapid deterioration. Never store rope near storage batteries; paint is also detrimental to ropes.

2.6 Inspection of Ropes. Periodical inspections of all rope should be made and the following defects looked for –

External defects.

(i) Abrasion (broken fibres of yarns).

(ii) Cuts.

(iii) Soft spots or general softness; this is a sure sign of badly worn rope.

(iv) Decay or burns by a hot substance, such as solder or chemical burns.

(v) Cutting in or drawing down of one strand.

Internal defects.

(i) Broken fibres or yarns.

(ii) Powdering in centre of rope at strand axis. (A sign of great strain or presence of grit.)

When in doubt about the condition of a rope on visual inspection, open a strand of yarn and take out several lengths of fibre.

Break this fibre across your thumb nail; do the same with a fibre of new rope, and note the difference. When the fibre from the used rope breaks quite easily and feels brittle and dry, the rope should be discarded.

2.7 Cleaning Rope. When a rope has, of necessity, been hauled through mud, sand or grit, do not store in this condition. Hang it up in loose coils and wash off with a fresh water hose, or flake it down on a floor and scrub it down while the fresh water is played over it, then hang in loose coils until dry, and replace in store.

2.8 Safety Precautions. As a summary of the above it is essential to safeguard life and property and to do this, it is necessary that the rope be properly used and well cared for and the following precautions observed –

(i) Under no circumstances use rope of doubtful condition.

(ii) Use proper methods of handling rope, with a method of definite fastenings for your various operations. The failure of a faulty knot, hitch or splice under heavy strain may cause serious damage.

(iii) Know the weight of the load, then select the proper size of rope. Do not overload a rope or never under-estimate a load. Avoid sudden jerks and strains when handling a load particularly on first lifting.

(iv) Avoid kinks and twists in rope. Kinks may damage or cause failure in a rope under moderate tension. Clear all kinks out of rope before using it.

(v) Inspect blocks for general condition each time they complete a Job. Look for cracked shells and misalignment of sheaves. Incidentally, the condition of sheaves is more important than many imagine, for, apart from the fact that the sheave bearing and pins can sustain injury the sheave sides may become so sharp that they will out a rope. Make sure that the proper size of rope is used in the tackle.

(vi) In making a length of rope fast; try to find a reasonably smooth surface around which to secure it, and, take sufficient turns to properly anchor the rope.

(vii) Do not wrap the hauling part of a working rope around your hand when applying force. When this type of hand hold is necessary, throw an open hitch in the hauling part.

2.9 With regards to sizes of ropes, these are usually measured by their circumference, (for example, a 3" rope would be 3" in circumference and about 1" in diameter). To find the safe load a new rope will carry, it is taken as being equal in cwt. to the square of the nominal circumference in inches. For example a 3" rope squared would be 9 cwt. 3" x 3" = 9 cwts. or a 2" rope 2" x 2" = 4 cwts. Ropes which have been in use for a considerable time should not be subjected to more than two-thirds of the safe working load for new ropes. These figures may be taken as a guide when life is dependent upon the safety of a rope.

3. KNOTS COMMONNLY USED.

3.1 Knots are often used with various types of work in the Department and the following notes and figures will describe and show the knots most commonly used.

3.2 In Fig. 2 a common loop or half hitch is shown by which most of the following knots are commenced. Note exactly how the loop lies, and the letters mark the parts clearly for future reference. The part of the rope marked with arrow A is known as the standing part, the portion marked with the arrow B following round the loop is termed the bight and arrow C is known as the end.

FIG. 2. HALF HITCH.

3.3 Thumb Knot. A thumb knot (see Fig. 3) is used at the end of a rope, as a temporary measure to prevent unstranding and fraying, or as a stopper to prevent the rope running through the sheave of a block when the load is unhitched.

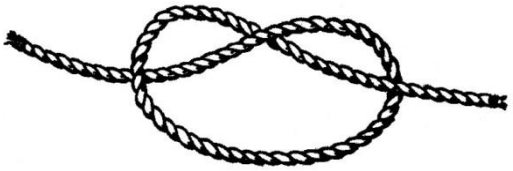


FIG. 3. THUMB KNOT.

3.4 Reef Knot. A reef knot (see Fig. 4) is used for joining two lengths of medium-size dry rope of equal diameter. The greater the stress the tighter the grip. This knot will slip if ropes become wet or are of unequal size. This knot is simply loosened by pulling on the end and the standing part. An easy way to learn this knot is, with one end in each hand take left over right and turn then right over left and turn. (See Fig. 4a, b, c and d.)

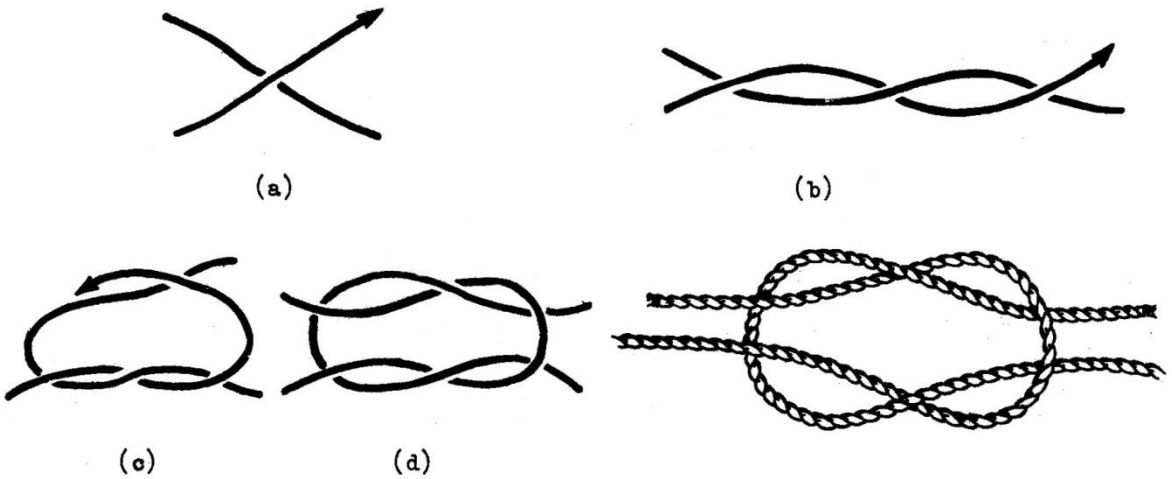


FIG. 4. REEF KNOT.

3.5 Single Sheet Bend. A single sheet bend (see Fig. 5) may be used in place of a reef knot where greater safety from slipping is required or the ropes differ in size, but it is not easily undone. It is often used for fastening a rope to an eye splice or the becket or eye of a block. See Figs. 5a, b and c for the method of making this knot.

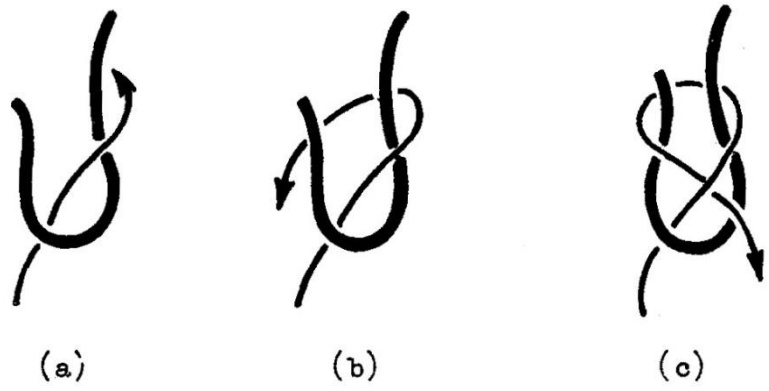
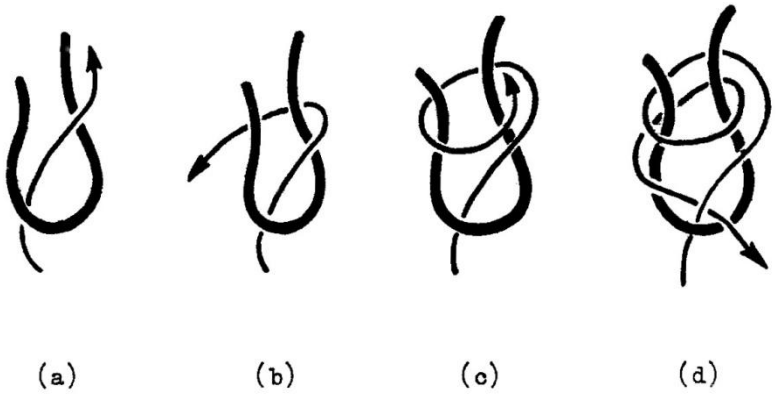


FIG. 5. SINGLE SHEET BEND.

3.6 Double Sheet Bend. A double sheet bend (see Fig. 6) is for use when it is necessary to connect a small rope to a much larger one or where the ropes are likely to be wet. It is formed like the single sheet bend, but the end of the smaller rope is passed twice around the bight of the larger one, as shown in Figs. 6a, b, c and d.



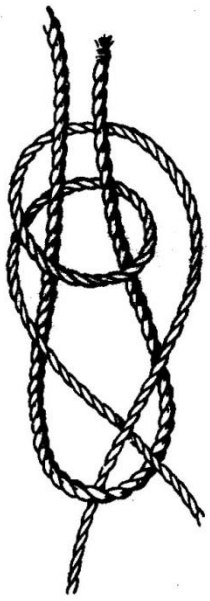
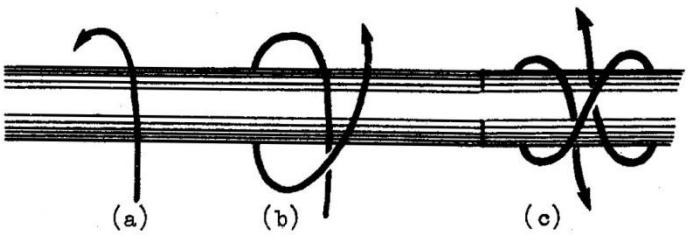


FIG. 6. DOUBLE SHEET BEND.

3.7 Clove Hitch. A clove hitch (see Fig. 7) is used to connect a small line to a large rope or spar at right-angles or for a two way guy during erection of poles. Figs. 7a, b and c shows the way to make this hitch.



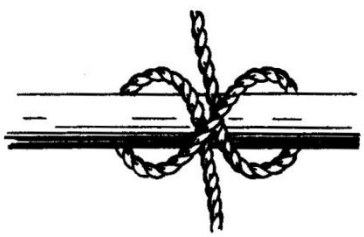


FIG. 7. CLOVE HIRCH.

3.8 Round Turn and Two Half Hitches. As shown in Fig. 8 this hitch is used for securing a rope to a spar or ring, often for fastening tackle rope to a block. The end of the rope should be secured to the standing rope with spun' yarn when used with tackle. See Figs. 8a, b, c and d for making this hitch.

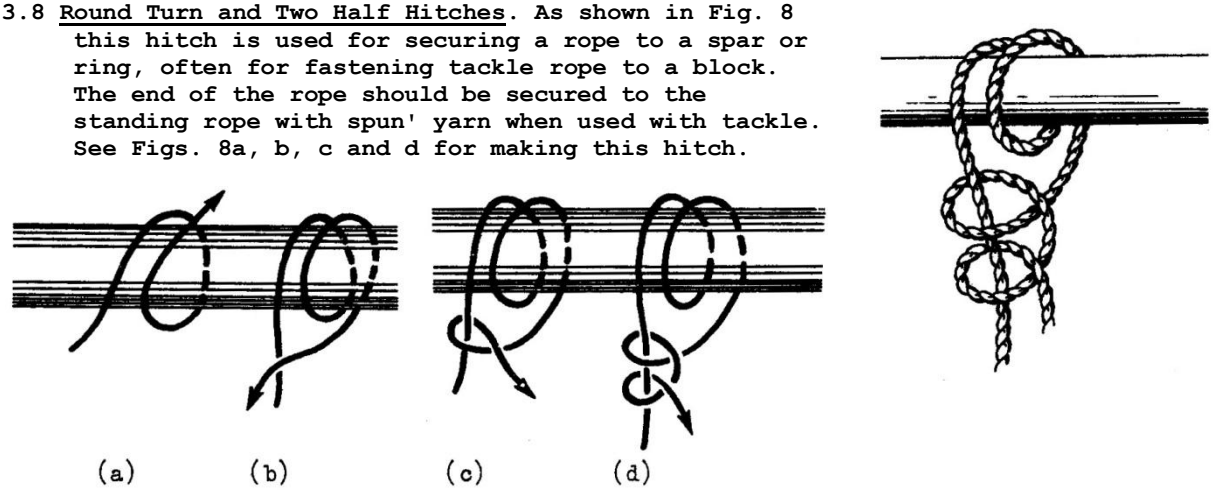


FIG. 8. ROUND TURN AND TWO HALF HITCHES.

3.9 Timber Hitch. A timber hitch (see Fig. 9) is used for hauling timber aloft. To prevent it swinging, a timber hitch is placed at one end and a half hitch at the other as shown in Fig. 9. Figs. 9a, b, c and d show how to make this hitch.

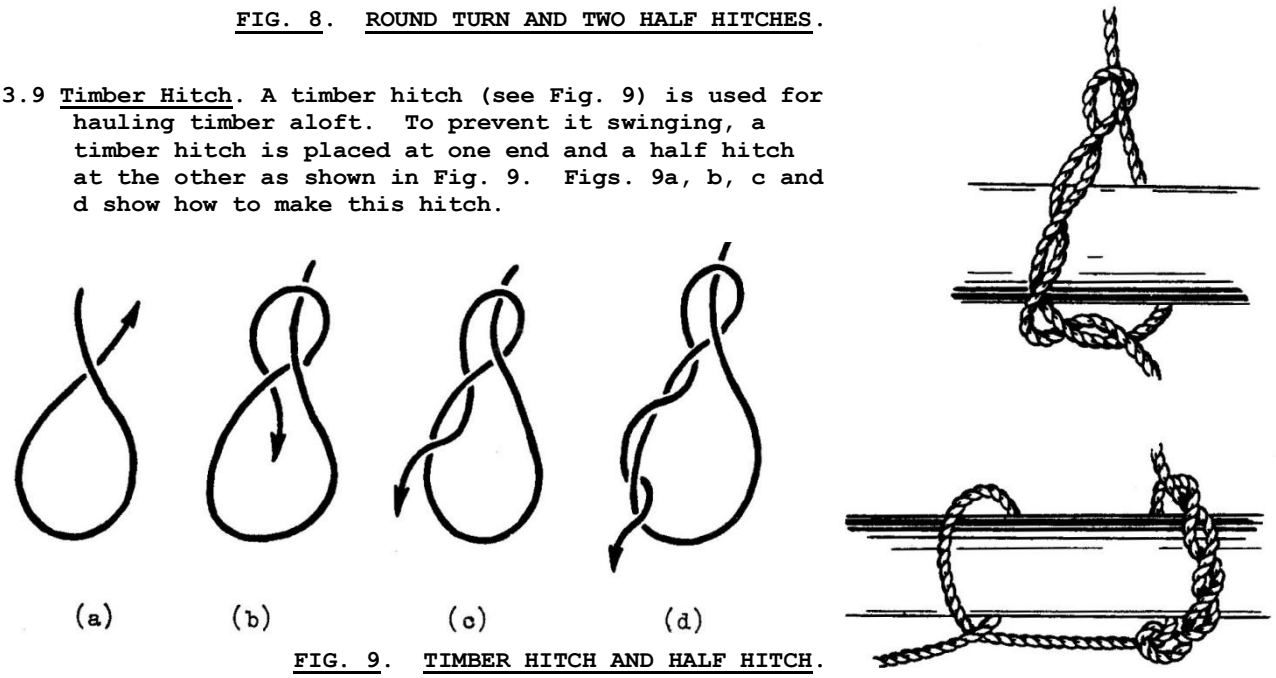


FIG. 9. TIMBER HITCH AND HALF HITCH.

3.10 There is another method for hauling timber aloft, where there is a hole in the timber. A bight is passed through the hole ,(see Fig. 10a) and another bight is placed through the first bight as shown in Fig. 10b.

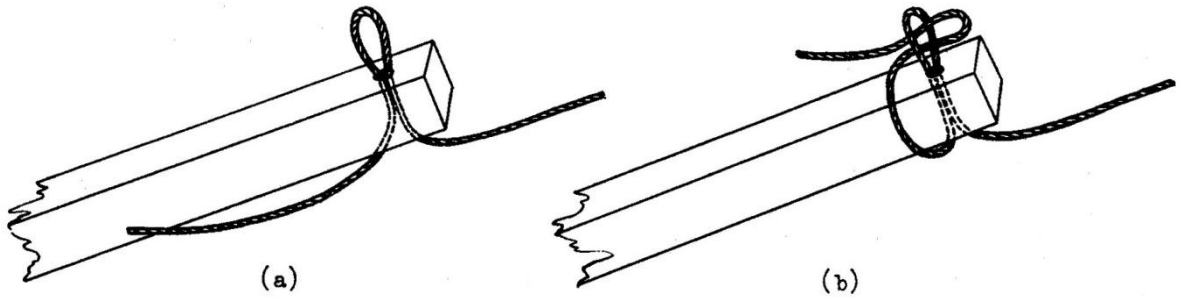


FIG. 10. TIMBER HITCH.

3.11 Bowline. A bowline (see Fig. 11) has many uses; such as to make a loop in the end of a rope where splicing is not necessary, for use as a sling and securing livestock among many other uses. Its main features being that it will not slip and is easily loosened. See Figs. 11a, b and c for method of making the knot.

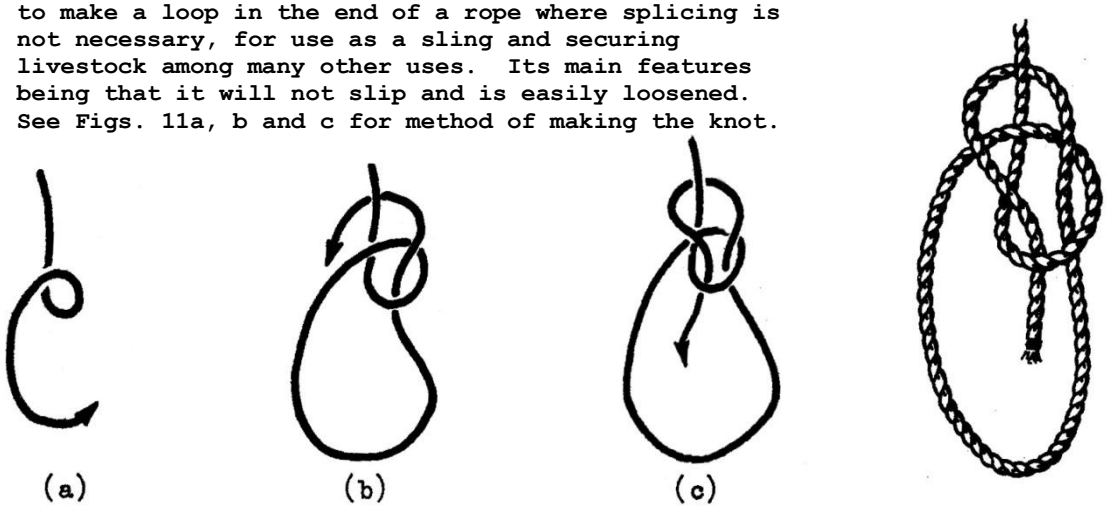


FIG. 11. BOWLINE.

3.12 Bowline on the Bight. A bowline on the bight is used when it is necessary to lift an unconscious person from a manhole. Figs. 12a, b, c and d shows the method of making the knot.

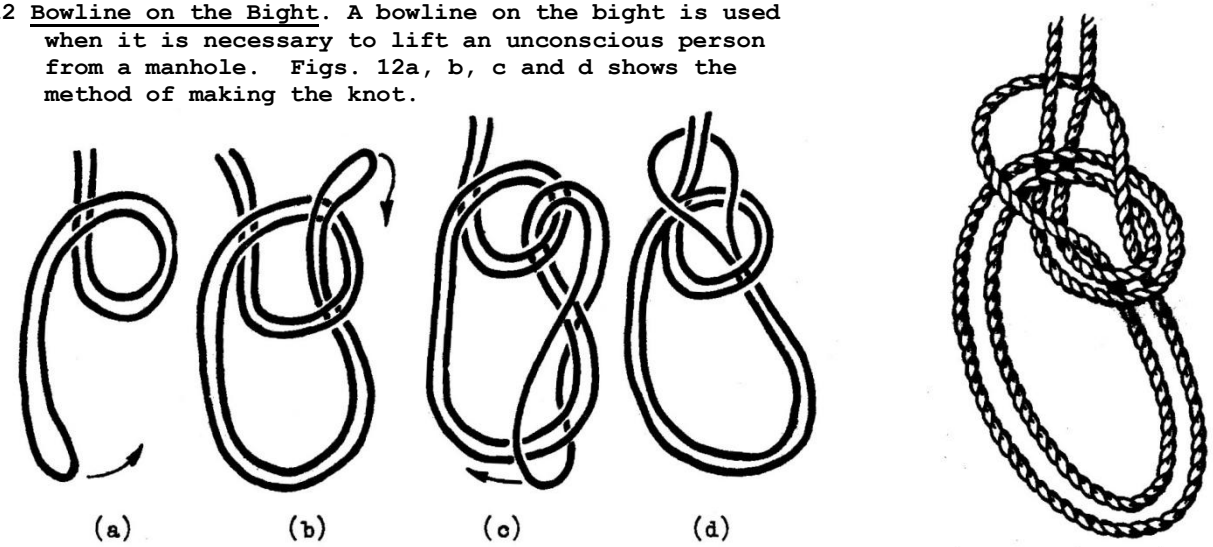


FIG. 12. BOWLINE ON THE BIGHT.

3.13 Sheepshank. A sheepshank (see Fig. 13) is used for shortening a rope without knotting or cutting. It can be made in the centre of a rope or when ends are inaccessible. See Figs. 13a, b and c for method of making the knot.

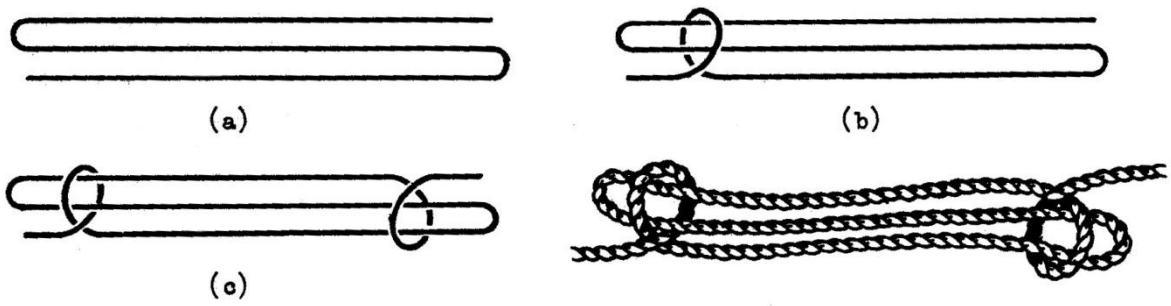


FIG. 13. SHEEP SHANK.

3.14 Boat Knot or Marline Spike Hitch. This knot (see Fig. 14) is used for securing small tools to a hauling line. It can be made quickly and easily undone. Figs. 14a and b shows the method of making the knot.

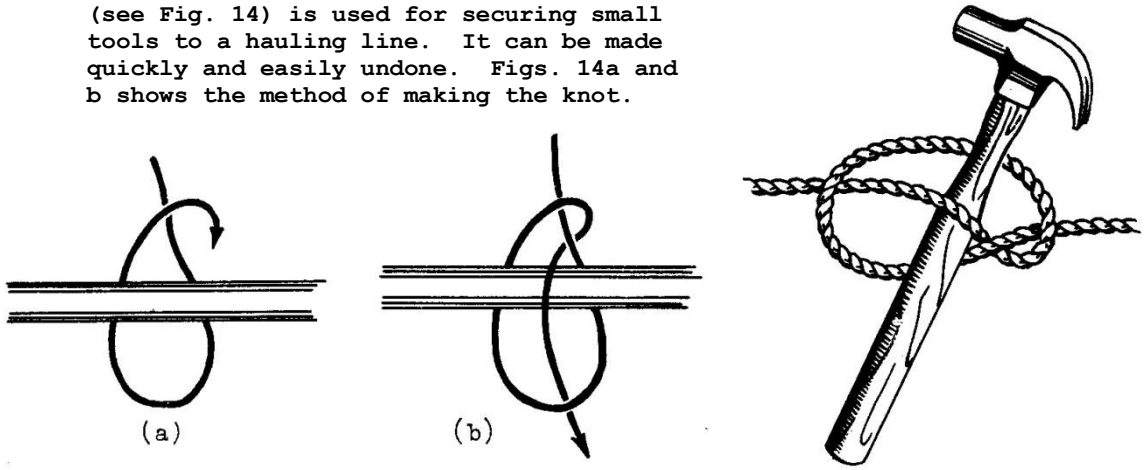


FIG. 14. BOAT KNOT OR MARLINE SPIKE HITCH.

3.15 Catspaw. A catspaw (see Fig. 15) is used for securing a rope to the hook of a pulley block. It is made as shown in Figs. 15a and b.

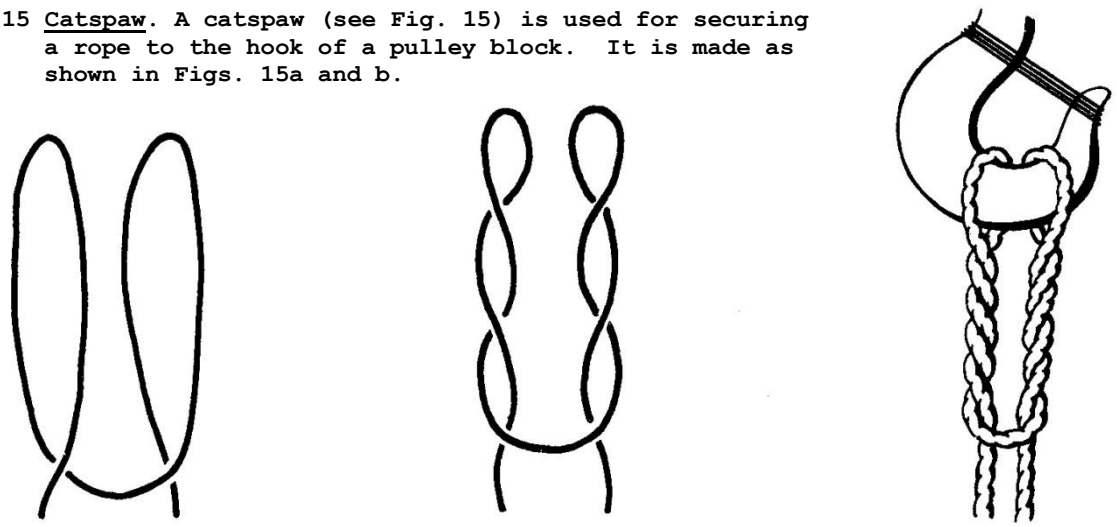


FIG. 15. CATSPAW.

3.16 Rolling Hitch. This hitch is useful when pulling out pipes or condemned cable; it is used also as a stopper on the fall of a tackle. Take a half hitch, against the lay, with the tail round the rope as shown in Fig. 16a. Then take the tail round the rope again, under the standing part of the tail and riding on the first hitch as shown in Fig. 16b, and is completed by taking three turns round the rope and the end being whipped as shown in Fig. 16c.

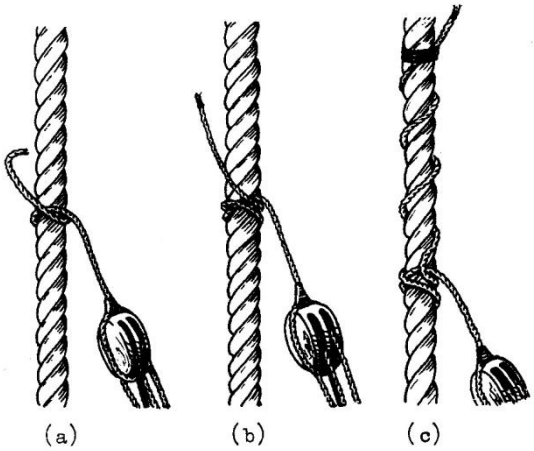


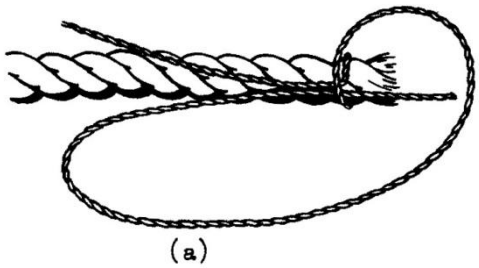
FIG. 16. ROLLING HITCH.

4. WHIPPING AND SPLICING ROPES.

4.1 Whipping. Ends of ropes should always be finished off in some way to prevent the strands unlaying and fraying out. According to the purpose for which a rope is used depends to some extent on the method adopted to permanently secure the end of the rope to prevent it from unstranding or fraying. Where it is necessary to keep the rope to the same diameter, such as through the pulley block then the end of the rope is secured by a whipping. In other cases, a back splice is made but, for a temporary purpose a thumb knot (See Fig. 3) may be used.

4.2 The whipping is made by binding a piece of twine firmly around the end of the rope. For example to whip the end of a 2" rope it is done in the following way –

(i) Select a piece of light twine about 2'6" in length.
(ii) Form the twine into a loop with ends passing by 6" to 8" opposite the end of the rope as shown in Fig. 17a.
(iii) Commence binding about 3/8" from the end of the rope and bind within the looped part of the twine working from the end.
(iv) When the loop becomes small or about 3/4" of whipping is made, the end of the twine nearest the loop is passed through the loop and the end away from the rope end is pulled to secure the whipping firmly, the ends of the twine now being cut off completes the whipping. (See Fig. 17b.)



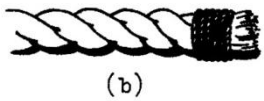


FIG. 17. WHIPPING.

4.3 Splicing. Various types of splices are made in ropes for different purposes, those most commonly used are as follows –

4.4 Back Splice. This splice is used to secure the end of a rope where diameter does not affect the use of the rope and is made in the following manner –

(i) It is formed by unstranding the rope end carefully to a distance of sufficient length to allow three tucks to be made with each strand. (Approximately 7" for a 2" rope.) (See Fig. 18a.)
(ii) A crown is formed by crossing each strand with an adjacent strand in such a manner as to have the strands coming out equally around the rope and pointing back on the main rope. (See Fig. 18b.)
(iii) After forming the crown (See Fig. 18c.), the splice is completed by tucking each strand "Over one and under one" until all strands have been tucked three times.
(iv) The ends of the strands are then cut away, leaving about 1/4" protruding from the main rope. It is then rolled on a flat surface to give an even finish, as shown in Fig. 18d.

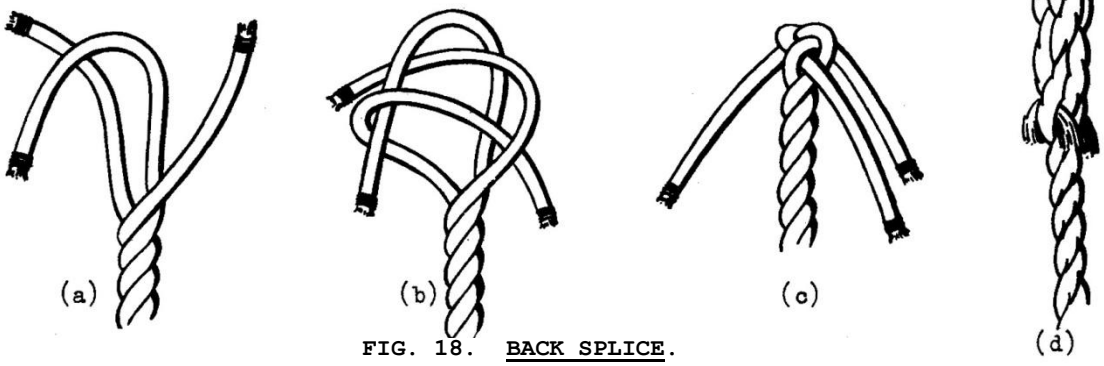
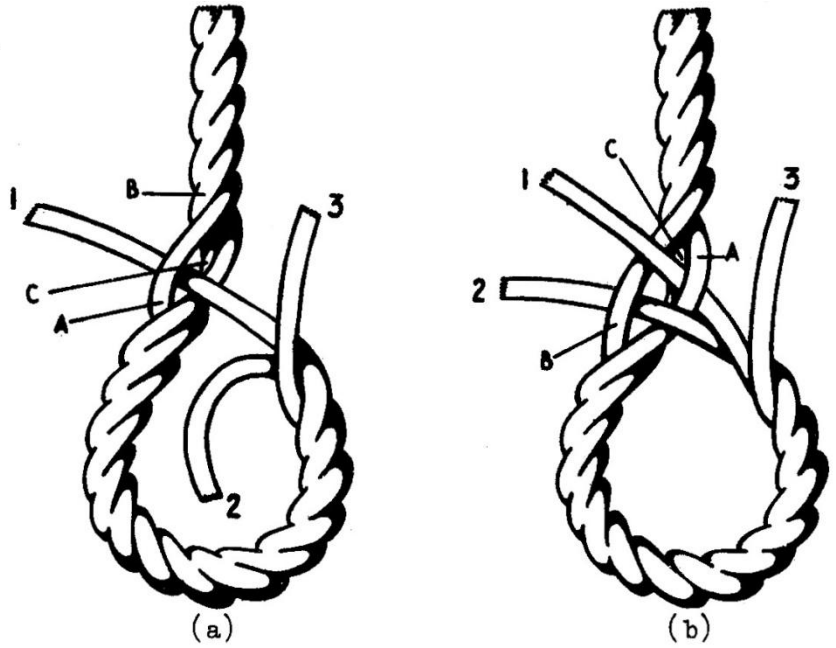


FIG. 18. BACK SPLICE.

4.5 Eye Splice. The eye splice is used to make a permanent loop in the end of a rope, it may be formed into any size loop required or around a thimble. The method of making this splice is as follows –

(i) The end of the rope is unstranded as for a back splice and laid back to form the required size of loop. No crown is required.
(ii) Pass strand 1 straight through under A as shown in Fig. 19a.
(iii) Pass strand 2 straight through under B as in Fig. 19b.



(iv) Turn splice over. (See Fig. 19c.)
(v) Now pass strand 3 around under C as shown in Fig. 19d
(vi) The splice is now completed in a similar way to the "Back Splice". Fig. 19e shows completed splice.

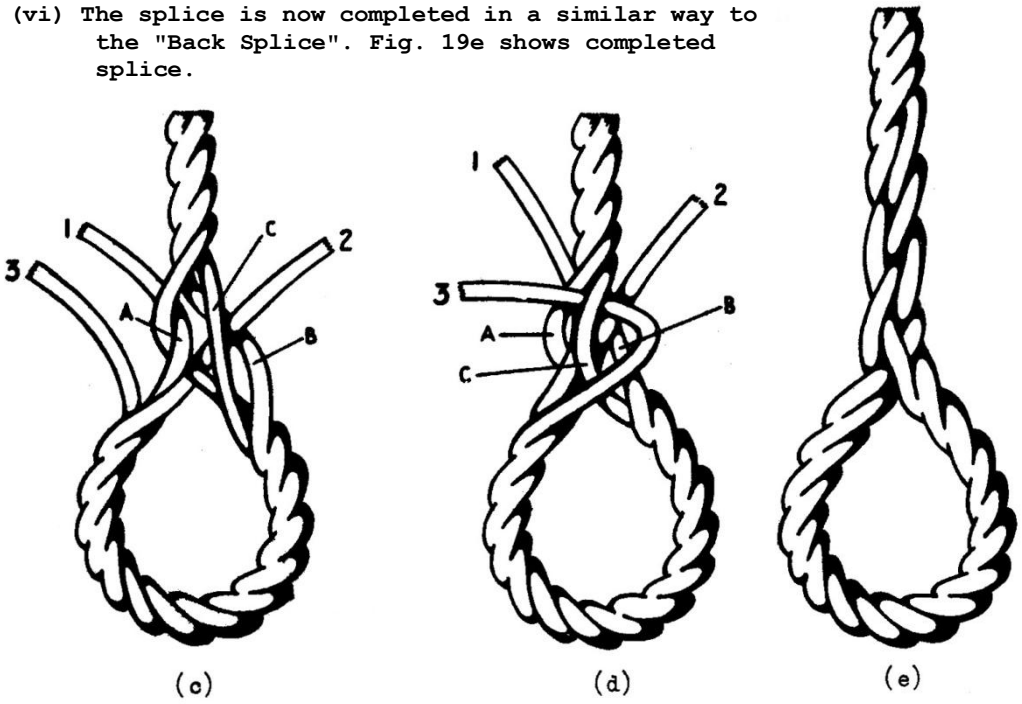
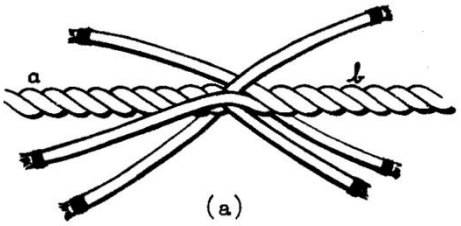


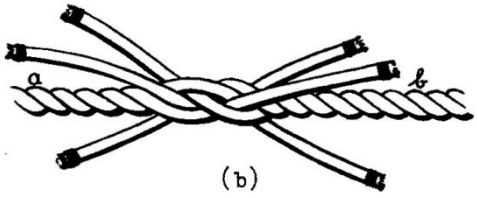
FIG 19. EYE SPLICE.

4.6 Short Splice. This splice is used to join together two lengths of rope of the same diameter. This splice increases the diameter of the rope at the splice and is thus unsatisfactory for use through a block. To make the splice -

(i) Unlay the two ends of the rope for a short distance, interlock the alternate strands and butt the unlaid portions closely together as shown in Fig. 20a.



(ii) Tuck the strands of rope "a" into rope "b" in a similar manner to that described in the "Back Splice" and similarly tuck the strands of rope "b" into the rope "a" as shown in Fig. 20b.



(iii) Roll the completed splice on a flat surface and trim ends off. See Fig. 20c.

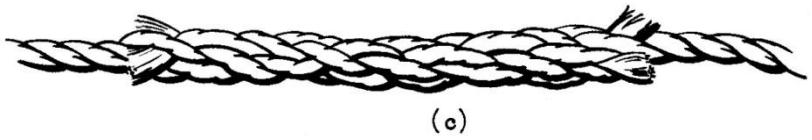
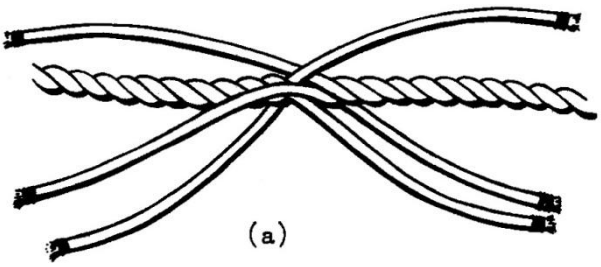


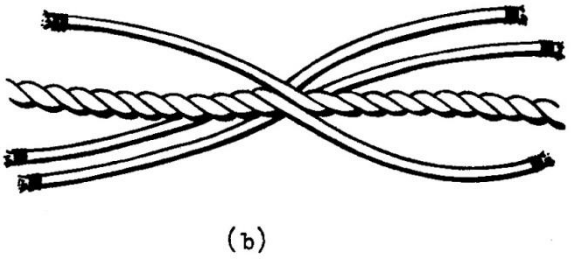
FIG. 20. SHORT SPLICE.

4.7 Long Splice. This is the most effective method of joining two ropes without materially increasing their thickness, it is employed when ropes are used for reeving through blocks or over grooved driving pulleys. To make the splice -

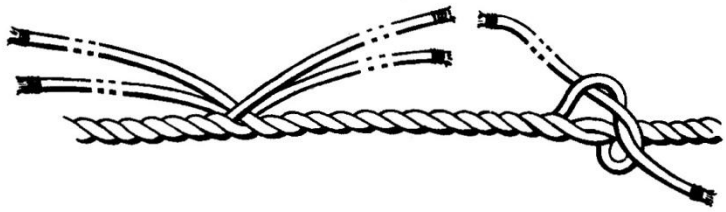
(i) Unlay the end of each rope for a length equal to about 5 times its circumference multiplied by the number of strands, and butt them closely against each other so that the strands of opposite ends are interlocked. (See Fig. 21a.)



(ii) Then carefully pair them, one from each side, and slightly tightening the strands meanwhile, lay up each pair together to prevent confusion during further operations. (See Fig. 21b.) To assist in keeping strands from fraying, place a whipping around the ends.

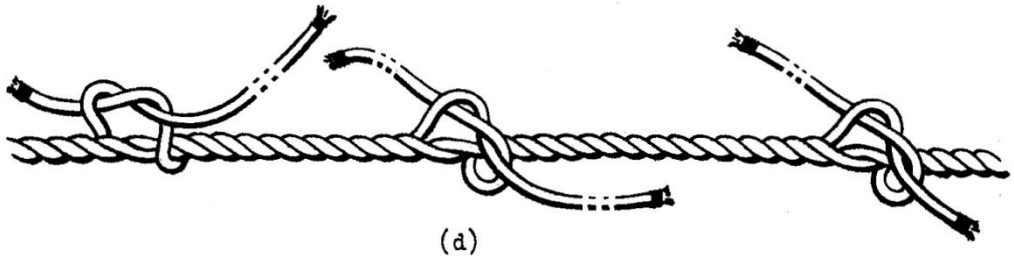


(iii) Next separate a pair and further unlay one strand while filling its place with the strand from the opposite rope and tie the two strands together with an overhead or thumb knot. (See Fig. 21c.)



(c)

(iv) This operation is then repeated with the next pair, but on the reverse side of the starting point. The remaining pair is similarly treated but stopped off shorter, leaving the three knots at equal distances apart. (See Fig. 21d.)



(d)

(v) Care must be taken that adjacent strands are not laid in the same direction. Take one pair, draw the knot tight and work it well into position, pass the strands three times over and under the strands of the rope on each side of the knot, finishing off by one backward turn under the strand and through the rope. When each of the ends has been turned in, the complete splice is well worked into shape and stretched, after which the ends may be trimmed off. The splice is rendered stronger and nearer if the strands beyond the knot are unlaid and the fibres loosened before threading. It is sometimes necessary to reduce slightly the thickness of the strand at and beyond the thumb knot, but, by doing so the strength is correspondingly reduced. Generally a splice may be assumed to reduce the strength of a rope by one-eighth. (Fig. 21e shows completed long splice.)

(e)

FIG. 21. LONG SPLICE.

5. BLOCKS AND TACKLES.

5.1 Blocks are used

(i) To raise or lower weights.

(ii) To change direction of pull.

(iii) To gain power.

Power is gained at the expense of speed in any arrangement of blocks.

5.2 Blocks are known as single, double, treble, etc., according to the number of sheaves or pulleys and are made with or without the eye. Fig. 22a shows a treble steel block and Fig. 22b a treble wooden block. For the parts of a block see Fig. 22a.

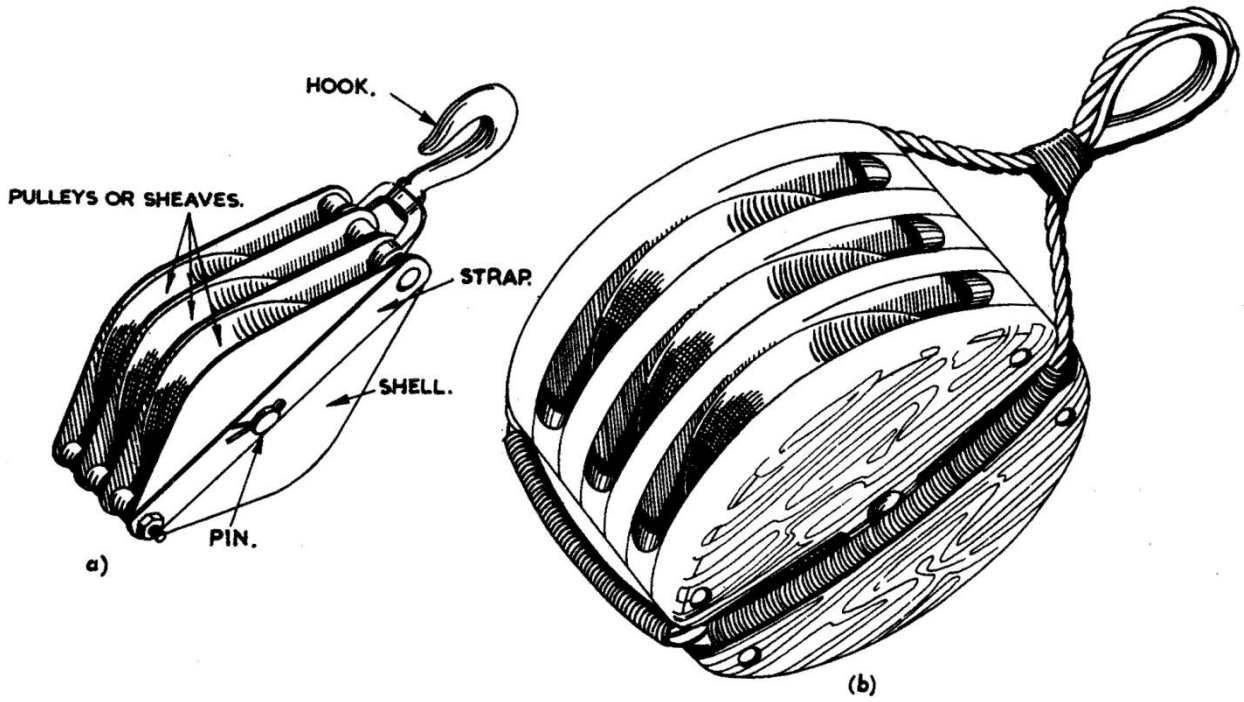
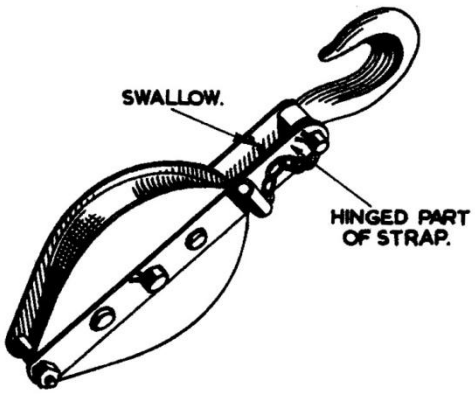


FIG. 22. TREBLE BLOCKS.



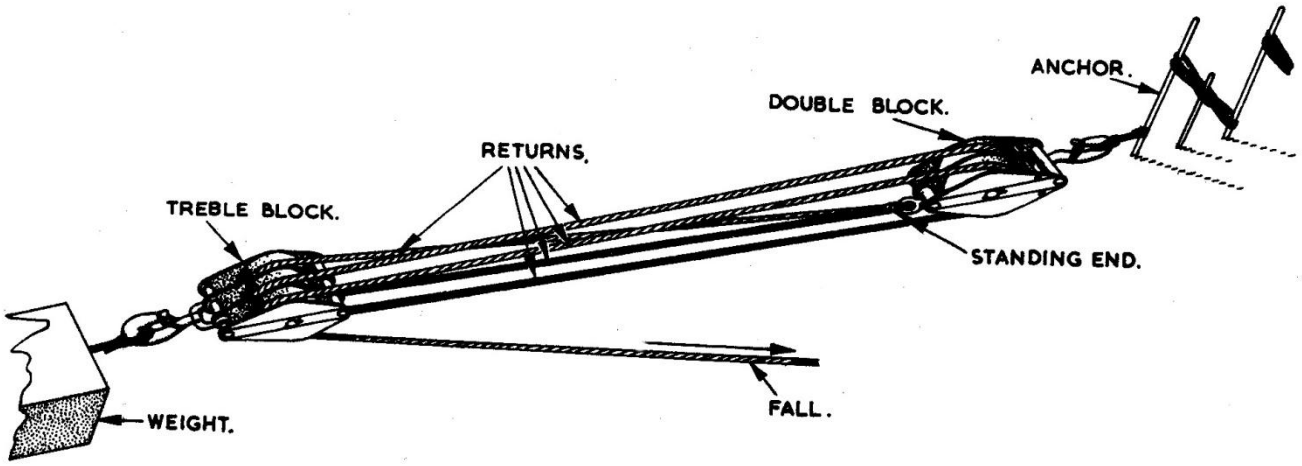
5.3 A Snatch Block. A snatch block is used to change the direction of pull. It has a hinged strap that allows the bight of a rope to be placed in "swallow". It is generally supplied without an eye. (See Fig. 23.)

FIG. 23. SNATCH BLOCK.

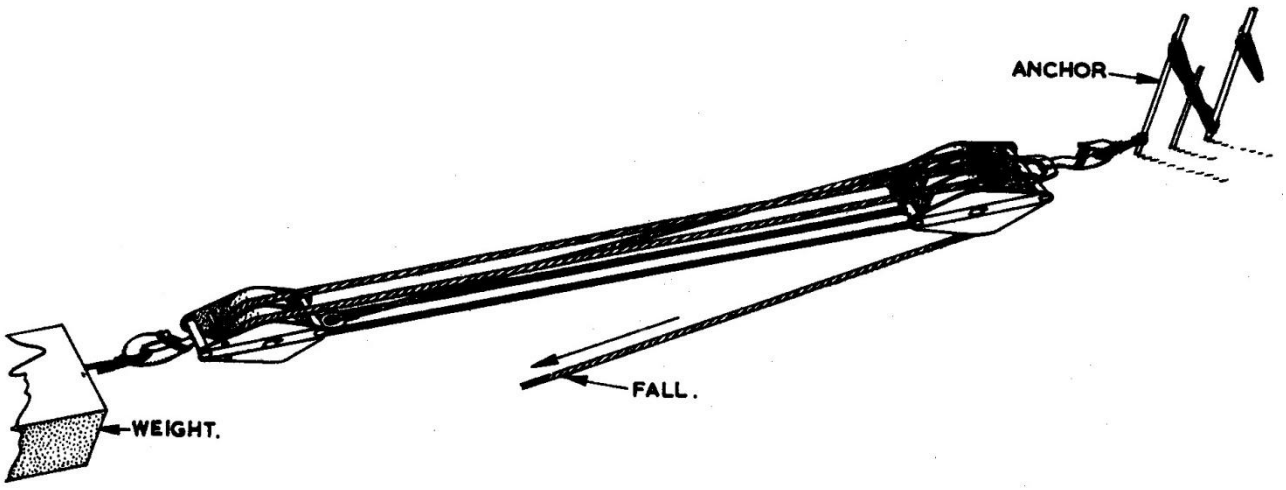
5.4 Tackle. A tackle consists of one or more blocks .rove with a single rope. The end of the rope attached to the eye of a block is known as the standing end, the other end is the running end or fall. Each separate rope between the two blocks of a tackle are known as "returns".

5.5 The mechanical advantage of a tackle depends on which of the two blocks is the moving block. It is therefore possible to have a tackle of a treble and double block to gain a mechanical advantage of 6 to 1 or 5 to 1.

It is usual to allow 10% per sheave for friction losses and the tackle in common use is a treble block with a double block. The mechanical advantage gained is then simply ascertained by counting the returns acting directly on the block attached to the object or weight to be moved, (That is known as the moving block.) In Figs. 24 and 25 are shown the difference in mechanical advantage by the changing of the tackle with treble block attached to the weight gives 6 to 1 gain and where the double is attached to the weight 5 to 1.

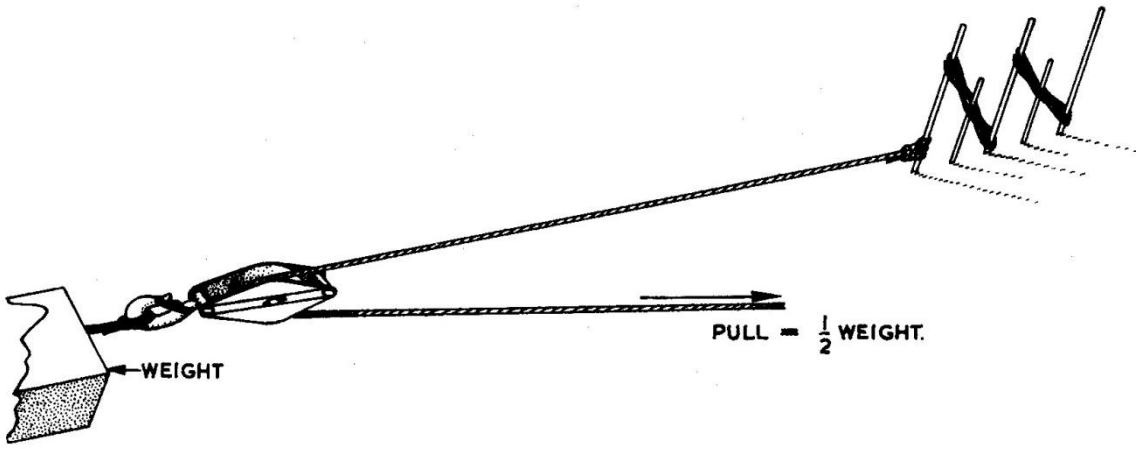


SHOWING TREBLE BLOCK ATTACHED TO WEIGHT (6-1 GAIN).
FIG. 24.



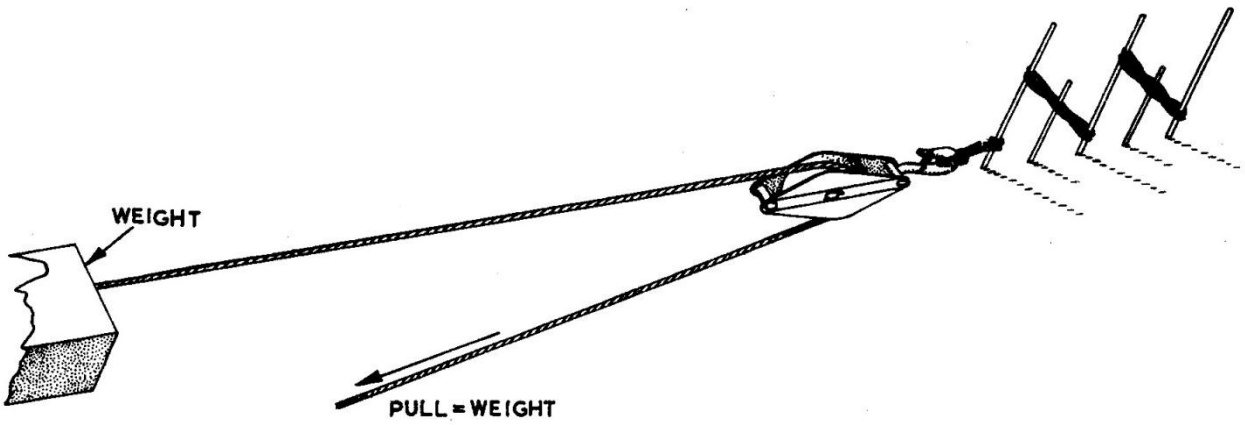
SHOWING DOUBLE BLOCE ATTACHED TO WEIGHT (5-1 GAIN).
FIG. 25.

5.6 A single block can likewise be used to gain power as shown in Fig. 26.



SINGLE BLOCK ATTACHED TO WEIGHT (1/2 WEIGHT GAIN).
FIG. 26.

In Fig. 27 no power is gained, the block merely changing the direction of pull.

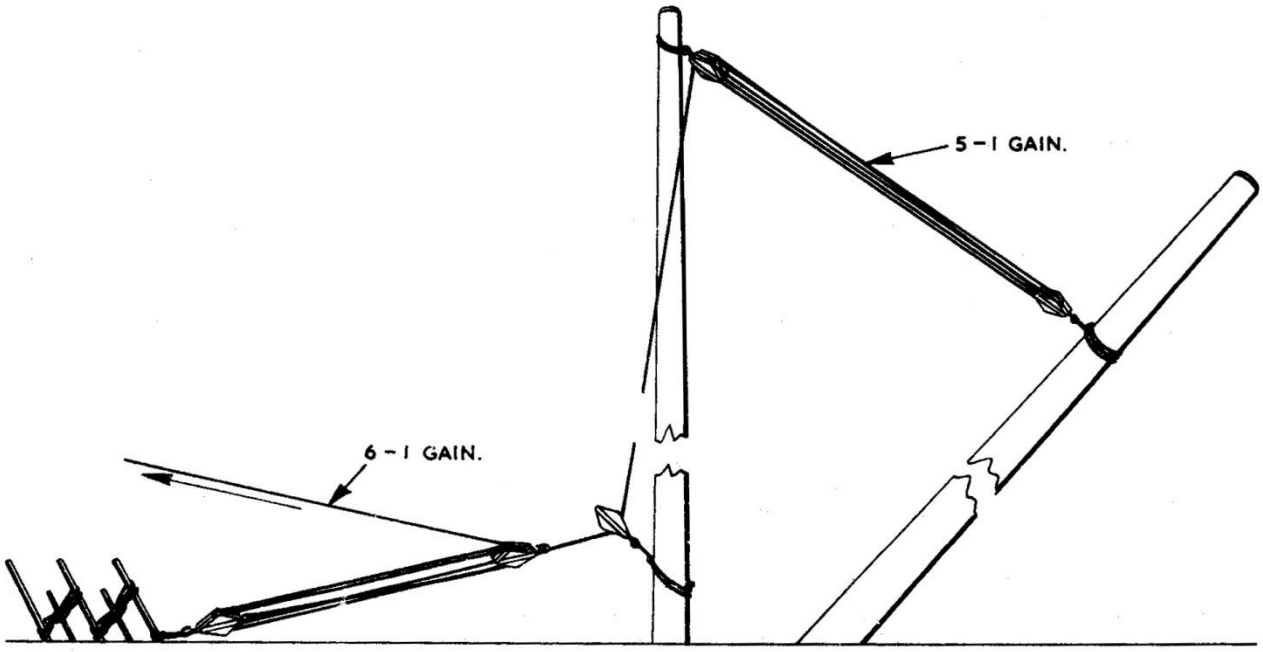


SINGLE BLOCK ATTACHED TO ANCHOR (NO GAIN).
FIG. 27.

5.7 For heavy lifts such as the erection of a heavy pole a combination of two tackles will provide a greater power gain with, of course, a great reduction in speed. The gain from such a combination of tackles may be 25 to 1, 30 to 1, or 36 to 1, depending on the position of the moving blocks as shown in Fig. 28. It should be specially noted when using such combinations that a great strain can be placed on the ropes and consequently these ropes must be in good condition and properly cared for.

5.8 When a tackle becomes tangled, the simple method of correcting it is to work from the larger block and firstly free the fall of the tackle, then work the tangle to the smaller block. In this manner it will only be necessary to pass the smaller block through the returns to clear the tackle. This can only be done when the fall is freed from the tangle.

5.9 There are many various methods of using the blocks and tackle and a variety of knots that are not shown in this Paper, but, the examples given are the most commonly used in practise.



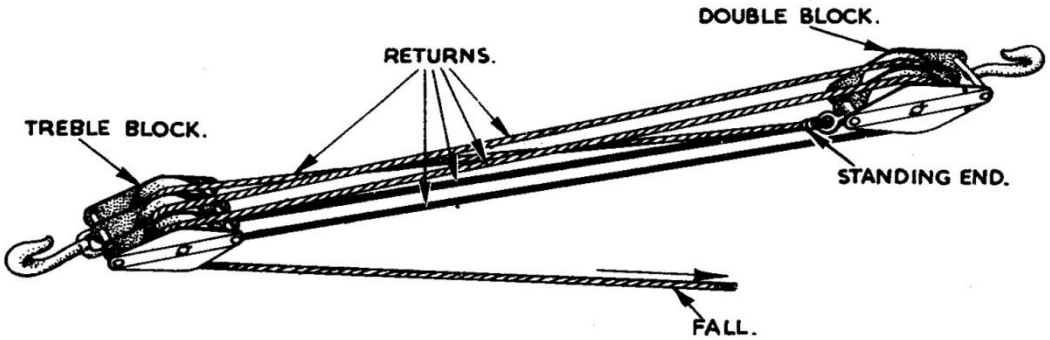
A METHOD 0P ATTACHING BLOCKS AND TACKLE (30-1 GAIN).
FIG. 28.

5.10 Reeving. The method most used in the reeving of a treble and double block is as follows –

(i) Lay out the double block with the eye towards the treble block and the hook away.

(ii) Lay out the treble block 3 to 5 feet distant, with the hook pointing directly away from the double block.

(iii) Starting from the treble block and facing the double block, pass the standing part of the rope over the right hand sheave in the treble block, then, follow on over the right hand sheave in the double block under and over the centre sheave in the treble block and following on in this manner until finally the rope is attached to the eye of the double block. (See Fig. 29.)



REEVING TREBLE AND DOUBLE BLOCKS.
FIG. 29.

5.11 Storing Tackles. Tackles should be "rounded in", that is, the two blocks are brought to within 3 to 5 feet of one another and two half hitches are made with the fall around the returns and passed over the larger block to the centre of the returns.

The fall is then coiled up neatly in a coil of suitable size for the rope concerned in the same direction as the lay in the rope. Most ropes are laid up right hand, that is, in a clockwise direction. Should there be any left handed laid ropes, these are coiled in anti-clockwise direction. The coil is secured in several places by light line or cord.

6. ROPES FOR LADDERS.

6.1 A ladder rope of approximately 1-1/2 inch circumference is used to raise and lower extension ladders. The length of the rope is approximately double the length of the ladder in the non-extended position.

6.2 The rope is passed through the pulley attached near the top of the fixed portion of the ladder and the end brought down the friar and secured by an eye splice to the third rung of the moving portion. The other end is passed over this third rung (in between the two parts of the ladder) and spliced to the weighted bar. This allows the ladder to be quickly and safely raised and lowered as required.

6.3 Tying Ladders to Scaffolds. A piece of 1 inch rope approximately 4' 6" in length is attached to the stile, between the chain at the top and the top rung of the ladder with an eye splice, to be used for tying the ladder to scaffolds, etc. As soon as possible after the ladder has been placed in position against scaffolding, it must be tied to the scaffolding with this rope which should be permanently attached to the ladder for this purpose. No one should work on an unsecured ladder.

END.