Handbook of
Seaman's Ropework

SAM SVENSSON

Translated by Inger Imrie

Drawings by Kai Bäling

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Foreword

Through his work the sailor gained a practical knowledge of rope and its treatment that has not been surpassed by any other group of people. It is natural, therefore, that all the more important knots and work connected with rope have a nautical origin; they belonged to sailoring, and the fo'c's'l was the best possible school. Textbooks did exist and found their way on board ship where they were studied with admiration but also with distrust. The more knowledgeable seamen soon discovered that there were mistakes and contradictions in most of the books, and that recommended procedures were impossible to follow. These mistakes had a habit of surviving. Something described and illustrated would be repeated in other books and it became clear that the authors copied each other indiscriminately. As a result the sailor never knew what to believe and came to regard the written word with a certain amount of contempt.

The reasons for this lie partly in the fact that seamanship was and is a very technical trade, so specialised that someone who had not studied it and had no practical experience could not hope to have a proper knowledge of it, and partly in that the sailor was usually a poor writer, able to use a palm and needle better than a pen. So the writing was left to others, with the consequent results.

The author formed these impressions early in his career at sea and over the years found them to be largely correct. For example, an incorrectly drawn illustration of a serving with a mallet appeared in Darcy Lever's *Sheet Anchor* in 1808. It was copied and further distorted in a variety of publications, including several editions of Nares' *Practical Seamanship*. In 1872 it appeared in the Swedish *Lärobok i Sjömanskap*, and still survives in various books on the subject. It is probably impossible to eradicate. Nobody seems to have noticed that the skilled seaman did exactly the opposite of what the picture illustrated.

The texts were often biased, and there are examples of items published in one book being reprinted word for word many decades later, repeating out of date and incorrect information.

A young sailor therefore has great difficulty in learning anything in this specialised trade, and skills today are at a premium. Few seamen know, for example, how to use a hand lead when it is needed, and one has to search far and wide to find someone who can properly splice a broken wire. Today, however, seamanship requires different types of skills from those of former times. No seaman now needs to know how to bend in the deadeyes in thick hemp rigging. The tools have also changed. What used to be the sailor's best tool, the splicing horn, is now a narrow, oval steel spike, and the rust hammer has become more important than the knife. But in spite of all this certain traditional skills are still needed, and a seaman who can mend a tarpaulin or a sun awning, or replace a rusted guy on a lifeboat davit, is a valuable member of any ship's crew.

In the old days the seaman who had a thorough knowledge of the complicated rigging of the deep-water sailing ships, who knew all about knots and hitches, revealed his skill by always unhesitatingly making the correct hitch in the right place. The hitches he used were always simple and effectively functional. The unusual, complicated hitches have never had a place at sea, but like the incorrectly drawn items in the books they have long been associated with the seaman and he will never be able to escape them. He does, however, like to play with them and is amused by their intricate uselessness. No seaman has ever used the English (or is it the Turkish?) sack knot, but everyone enjoys the story of the bosun who entered the circus arena and used a sack knot to tie the hands of the escapologist, who had to admit defeat after an hour's exertion. Some authors who laboriously try to find a use for this knot claim that it is used to carry bottles—which is probably true. The so-called Greenland hitch also belongs in this category. It is found in all the books on the subject, but no seaman has ever used it for the prescribed purpose. The top-hitch, which with intricate turns pulls out bights tens of fathoms long on a large rope to serve as backstays or stays for an emergency mast, also belongs here.

Examples of the simple, effective hitch which belongs at sea, and reveals the skilled tradesman when correctly used, are the Blackwall hitch and the short (or common) bend, the bowline, fisherman's bend and clove hitch, as well as those shown in Figs. 47, 53, 54, 70, 71, 77, 83, 90, 148 and 152. What is relevant to the subject is the fact that these latter ones have seldom or never been illustrated in print; they are the property of the sailor, and outsiders are ignorant of them.

The seaman has always had his own language, which only he can speak and which he used to guard jealously. More than any other, this trade has its own passwords by which a tradesman immediately recognises a brother or exposes a landlubber who thinks he is a

seaman. It is more expressive than other trade languages and must be used in order to describe something as specialised as seamen's knots.

The author has, then, not been able to avoid using it entirely, nor has he dared to surrender to it completely, or the descriptions would be more difficult to understand than they already are. As to the names of the knots, the author has tried to use those which were most common in Swedish merchant ships. Many hitches, however, were known by several names while others seemed to be without names; a fact which is pointed out in a few instances. The illustrations have been made with unusual care and are exceptionally accurately drawn by the artist, Kai Bäling.

This book is aimed particularly at the young seaman of today and is intended to help him and improve his knowledge of his chosen trade. In spite of its industrialisation, seamanship remains a trade with many sides to it, and its practitioners must still have a knowledge of many of its aspects in order to succeed. A proper knowledge of the trade is still useful. It makes difficult tasks easier, helps towards better working conditions, enables better care to be taken of materials, and contributes to greater interest and understanding of this unique and demanding trade. The seaman does not need an overwhelming mass of unusual knots, but he does have to know the uses of the various knots—where and when a particular one is best and why. This knowledge is gained primarily through several years of work with wire and cordage, but written advice and directions also have their value.

The contents of this book may embrace more than is necessary to know on an ordinary merchant ship, in spite of the fact that much of what used to be routine work on board ship has been left out. Thus, for example, the notes on sailmaking have deliberately been kept very short. The requirements of merchant ships vary from ship to ship, from the simple motor-sailer to the large liner. I have therefore not thought it right to further condense the material, which has also been compiled with a view to assisting the keen boat owner who wants to gain some knowledge about the maintenance of his yacht. In the final chapter there is a summary of information on the maintenance of a ship, and even here the keen yachtsman will find something of interest. The short chapter on measures and tonnage has been included to show the relationships between the various systems of measuring materials, cargoes and tonnages. The short historical annotations have perhaps no direct value, but they have been included because I know from my own experience that they will be particularly interesting to seamen.

My knowledge of seamanship comes from generations of seamen who sailed all the seas under all flags. Their skill laid the basis of this book. If through it I can pass on something to others I will only be returning what was once handed down to me.

Stockholm SAM SVENSSON

Handbook of Seaman's Ropework

Materials and Tools

Cordage

Cordage used on ships is manufactured from a variety of natural plant fibres as well as from manmade fibres. The most common natural fibres are manila, sisal, coir and hemp. Cordage is to a lesser extent also made from cotton, jute and esparto grass, but is seldom found on board ship in this form. The choice of fibre is governed not only by strength but also by availability and cost. The cost factor, for instance, has meant that hemp, which requires good soil in which to grow, can no longer compete with other natural fibres although it was once used universally on board ship. Again, manila hemp, which is grown only in a limited area, has been replaced by sisal hemp, which is inferior but easier to grow.

True hemp, jute and coir are plant fibres and are usually known as soft fibres. Cotton, which comes from the fibres around the seeds of the cotton plant, differs from other textile fibres mainly because of its short length.

Manila hemp, manila or abaca, consists of the sheath fibres from the leaves of a type of banana, *Musa textilis* (Fig. 1), indigenous to the Philippines. The rough processing is very simple and is still done mainly by hand. The leaves are picked when the plant is three years old and the stems are cut into narrow strips 20–30 mm wide and about 5 mm thick. These are scraped against blunt knives fixed to wooden supports. In this way the soft, juicy parts are removed, leaving the fibres clean. They are then dried and are ready for packing and export. This treatment was first done in Manila, which gave this type of hemp its world-famous name. Manila hemp exported from the Philippines is under the control of United States inspectors, and is graded as follows: J1 and J2 for best quality rope and yarn; L1 and L2 for medium qualities; and M1 and M2 for the poorest qualities.

Fibres from other banana plants are also used for ropes, and the plant *Musa textilis* has been imported to the Sunda Islands (Sumatra manila), India and the West Indies, but nowhere else has manila hemp with the quality of Philippine manila been achieved.

The fibres taken from the middle of the stem are fine and white and could be taken for silk. The outer fibres, which are used for cordage, are coarser and harder. They are yellow-brown or whitish-brown in colour, up to 3 m long, fairly hard and smooth, and are only surpassed in strength by hemp and flax. The fibres are also very hydroscopic and swell considerably in water, where the rope will shrink, stretching again when it dries. A manila rope is identifiable by its slightly speckled appearance, due to the fact that both darker and

Fig. 1 Manila

lighter coloured fibres are used in its manufacture. New manila fibre is also smooth and slightly shiny, unlike sisal.

Manila fibre does not easily absorb tar, and so manila cordage is always used untarred. It is more flexible than hemp when wet and thus particularly suited for all running rigging. It was long known in the Philippines and from the middle of the last century began to be increasingly used at sea. Towards the end of the nineteenth century manila, because of its lower price, had as good as replaced hemp cordage, previously the most commonly used in Europe. An added reason for its popularity was that it was softer, which made it easier to

handle, and by replacing hemp rigging with manila it was sometimes possible to reduce the size of a ship's crew by one or two men. However, manila cordage is not as durable as hemp. Old manila cannot be spliced or repaired like old hemp and is useless for ship's purposes. Old manila ropes are, however, used in making paper (manila paper).

Sisal hemp, or agave hemp, consists of the fibres in the fleshy leaves of the various aloe and agave plants, in particular *Agava rigida var. sisalana* (Fig. 2), indigenous to the dry, high, stony plateaus of Central America and first shipped from the small port of Sisal on the north coast of the Yucatan peninsula. Around the turn of the century it was introduced into East Africa and later into Sumatra and Java.

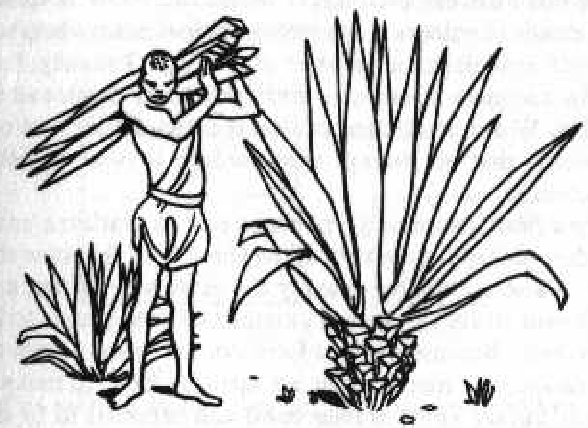


Fig. 2 Sisal

Nowadays it is grown in many tropical areas, particularly Tanzania and Kenya, where there are large sisal plantations.

The sisal plant has a long stem and the large, sword-like leaves grow in a big rosette near the ground. The leaves are first picked when the plant is three or four years old. About 70 are picked the first time and then about 25 are picked every six months until the plant is six or eight years old, when it flowers and dies. The leaves are put through a machine which washes and separates the fibres from the fleshy parts. The clean fibres are then dried on racks constructed from the long flower stalks, before being baled for export.

Sisal hemp has long, even fibres. They are lighter and more uniformly coloured—from pale yellow to almost white—than manila fibres. New sisal is distinguishable from manila by its uniform colour and the fact that it has a dull surface and is not as shiny as manila. However, because the fibre is oiled in the spinning process, its natural dull surface is not as noticeable in finished cordage as in the untreated fibre. New sisal cordage looks strong, but it is not as durable as manila and does not stand up to wear very well.

Sisal hemp was known to the Aztecs when the Spaniards conquered Mexico, but only in this century has it become a worldwide commodity. Its lower price and the fact that it is more easily obtained has resulted in it replacing manila for many purposes. It is now quite common to mix manila with sisal or other hard fibres, but the resulting cordage is generally poorer than pure manila. Rope manufacturers often use coloured thread to indicate different qualities, but as their choice of colours is not uniform this is of little help unless one knows each manufacturer's system of grading. Generally, however, it seems that the more thread used and the brighter the thread the better the quality. World production of sisal is about double that of manila, which means that on average sisal cordage is twice as common as manila cordage.

Coconut fibre, commonly known as *coir* in maritime usage (from the Hindustani *kayar*), consists of the fibres from the outer shell of the coconut. These are treated roughly the same way as flax and hemp, being allowed to rot for several months and then beaten to free them from the bast. Because of their hardness and short length the fibres cannot be spun by machine but are spun by hand to make a coarse rope yarn, kayar, which is then baled and exported to be made into rope in other countries. Coconut fibre comes mainly from the Malabar coast and Ceylon, where it is an important by-product of the copra industry. The fibres are light brown, impervious to mildew and damp and do not rot in water, but they are not as strong as sisal or manila. The finished rope is very elastic and always stretches, so it is not suitable for rigging. Because they are so short the fibres do not stand up well to wear and are soon damaged if used on winches or bollards. Coir rope floats and this, coupled with the fact that it will not rot if left to lie in water, makes it suitable for towing and lighter mooring warps, and it is used for these purposes to a great extent by smaller vessels. Because of their elasticity coarse coir ropes are sometimes used for towing springs and for mooring purposes in unsheltered harbours. Frequently coir mooring lines are owned by the harbour authorities and are left lying attached to the quayside so that

visiting ships can tie up to them. The ships pay for their use and harbour regulations often require that they be used.

Coir cordage must be shielded from strong sunlight as it tends to make the fibres brittle and weak. It is stronger when wet than when dry.

Coir ropes are only about a quarter as strong as manila ropes; a 4 in. manila rope has the same strength as an 8 in. coir rope. This is because the strength is calculated on the area contained by the circumference of the rope. For example, a square with a circumference of 8 cm is four times larger in area than a square with a circumference of 4 cm (Fig. 3), and the same applies to circles.

Hemp consists of the bast fibres of the hemp plant, which is indigenous to Persia but also grows in many parts of Europe. The hemp plant is an annual and its processing is similar to that of flax: it

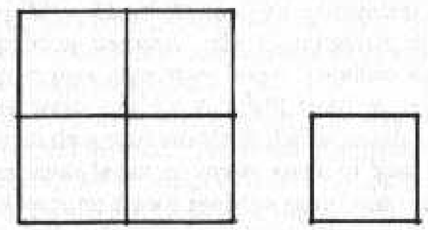


Fig. 3

is allowed to rot and is then beaten, swingled and combed. Beaten hemp is known as raw hemp. Combed hemp is in the form of threads, which are used for cordage of the highest quality. Tow is what is left over after combing, and when tarred is used for stuffing or, after further combing, for poorer quality ropes, spun yarn, etc. Untarred and laid into coarse, loose strands, hemp is also used as packing material for pipe joints, etc.

In the old days when hemp was used for both standing and running rigging on sailing ships there was a big export trade in it from Central Europe. Russia in particular exported large quantities, and shiploads of hemp went from Riga as far as America. The big American clipper ships, which made seafaring history in the 1850s, were rigged with Russian hemp. Although the Soviet Union is still the world's largest producer, the amount it exports to western Europe nowadays is insignificant. Italian hemp, which is the best in the world, is used primarily on yachts and naval ships. Well combed and untarred, it is the strongest of all hemp ropes.

The following grading symbols are used internationally for hemp cordage:

- L1 - Cordage made from long-fibred Italian hemp or its equivalent
- L - Long-fibred hemp cordage
- T1 - Cordage made from high quality tow yarn or from Italian tow
- T - Cordage made from hemp tow or tow

Hemp fibres are much finer and softer than manila fibres and absorb tar very well. Untarred hemp is extremely difficult to dry when it gets wet as its fine fibres retain the water. This makes it vulnerable to rot, and because of this hemp rope used on ships is tarred. Tarring burns the rope, decreasing its strength by 15 to 20 per cent, but by preventing rot it increases its life. Untarred good quality hemp is stronger than all ordinary ropes marketed, except nylon and good manila. The inner or heart fibres in old and worn hemp retain their strength and usefulness, which is not the case with manila.

Hemp is still used to some extent on naval ships and large yachts, but as a rule the only hemp cordage found on merchant ships is the obligatory log line, some heaving line and a little spun yarn. As recently as ten years ago rope ladders were always made from hemp; now they are usually made from manila or metal. Seizing stuff, spun yarn, marline and sailmaker's twine and tarpaulin cloth are also woven from hemp or flax.

Hemp was known in the Mediterranean in ancient times but was probably not used for rigging until several hundred years after the birth of Christ. It was considerably stronger than the materials used up until then—such as esparto grass, raffia and strips of leather—and did not stretch as much. It provided a more effective, seaworthy rigging without which longer voyages would not have been possible.

Cotton. Cordage made from cotton has about half the strength of manila cordage and is used mainly on small yachts. It is pliable, soft to handle and runs smoothly in blocks, but stretches quite a bit and so is not suitable for halyards. However, it is suitable for sheets and mooring ropes where elasticity does not matter. Cotton is largely used to manufacture the weaker ropes and yarns, particularly for the fishing industry which requires thin lines for nets and fishing lines.

Ropemakers do not spin the cotton yarn themselves, but buy it ready made from cotton spinners.

Sailcloth is still made from cotton, particularly in America, and because of its cheapness it has completely replaced flax and hemp cloth. Cotton cloth is still used for yacht sails, dodgers and awnings and for sails on motor-sailers and small barges. It is strong and dense but tears easily when old and worn, and is not as easy to repair as hemp cloth. It is also very vulnerable to mildew and should never be stowed away while damp. In adverse conditions a wet, finely woven cotton sail will mildew within a few hours. This not only spoils the look of the sail but weakens it, as old cotton cloth tears easily in the discoloured mildewed areas. Yacht sails are made from finer cotton cloth and the best qualities are of English and American manufacture. The English cloth is woven from Egyptian macco cotton. American cotton is whiter and harder than Egyptian cotton, which is yellowish and softer, but the strengths and qualities are about the same. English cloth is considered to be better for the Swedish climate as it does not mildew as easily as American cloth.

Jute is the bast fibre from a large plant grown in India. The stems are cut off and soaked in water. The fibres are stripped off and dried, ready to be marketed. Most jute is grown in Bengal and shipped from Calcutta. It is India's most important export and, after cotton, the world's leading textile fibre. Large quantities are imported to Dundee which has many jute weaving mills. Jute has considerably less strength than hemp and manila and is not used so much for cordage as for mats, and gunny sacking. Loosely woven jute cloth (hessian or burlap) is useful as a packing cloth and to protect fragile goods from damage in ships' holds, although paper has been used for this purpose since the war.

Flax is used only for finer, better quality rope and a variety of yarns, particularly sailmaker's twine, and for finer sail and tarpaulin cloths. Fire hoses and lifelines are usually made from high quality flax and are very strong. The plaited outer layer of log line is made of flax or hemp, but the inner yarn is of a cheaper material, frequently jute.

The following are some other textile fibres which are to a lesser extent used in ropemaking.

Sunn hemp is a bast fibre grown in India. It is cheap to produce but not as strong as true hemp. It is also known as Bombay or Madras hemp and is used for rope of secondary quality and for mixing with inferior manila.

New Zealand flax, known by its Latin name as formium, is a hard-fibre hemp, pale yellow and with long fibres similar to sisal. Apart from New Zealand, formium is also grown in St Helena and in the Azores.

Mauritian hemp is a type of sisal.

Henequen is also a type of sisal which grows in Mexico and Cuba.

Esparto grass grows in Spain and North Africa. It has long, round, hard leaves and its fibre is used in coarser weaves and for paper and inferior quality rope.

Ramie, or *China grass*, grows in China, Japan and India, and its long, strong and shiny white bast fibres are used for weaves, string and weaker ropes.

Nylon rope was first used in the Second World War for towing transport gliders. Thick nylon ropes are now commonly used for towing in harbour and at sea and for mooring purposes. Nylon lines are also attached to whaling harpoons now, and are superior to anything previously used. Nylon is also commonplace in fishing. Professional fishermen use it for gut, for salmon casting lines and for nets. It is particularly suitable for these purposes as it is supple, strong and almost invisible in water.

Nylon rope is very elastic. It can stretch up to 30 per cent, returning to its original length when the tension is released. This elasticity is particularly useful in whaling and towing, but also carries with it a certain amount of risk: if a rope breaks under stress it may act like a rubber band in contracting and catapult, say, a heavy shackle back to the point of attachment, which could be highly dangerous.

In recent years rope has also been made from synthetic fibres such as polyacryl, polyethylene and polyester, but the first of these is rather weaker and the last has less elasticity than nylon. Orlon is a polyacryl and Terylene and Dacron are polyesters.

The nylon fibres are manufactured in long threads the length of the rope. These ropes have a smooth, slippery surface and are marketed under the name of nylon silk. Weaker ropes and plaited ropes are made from spun threads largely manufactured from carded waste. This spun nylon has a vaguely fluffy surface, not unlike cotton. It is known commercially as nylon wool, and has all of nylon's desirable qualities except its strength (see table). Nylon wool is easier to grip than sprayed nylon and can be knotted and spliced like ordinary rope.

Cordage made from nylon silk is more slippery to handle and so knots, splices and seizings should be made with extra care. This applies particularly to lightweight fishing line which consists of a single coarsely-sprayed filament.

Nylon cordage has more than double the strength of good manila and weighs half as much as equivalent strength manila rope. This is very useful when towing at sea, as a 10 in. nylon rope can be used instead of 15 in. manila. The thick manila towing ropes become heavy and as stiff as a board in water. They sink when cast off and require an entire tug's crew to get them back on board. Nylon rope, on the other hand, is impervious to water and does not get mouldy or burn. It can be scrubbed if it gets muddied and does not have to be dried before being stowed away. It can be damaged, however, by high temperatures, and melts in temperatures over 200 degrees centigrade. Nylon ropes should therefore not be stowed on a hot surface or left lying on a hot deck in strong sunshine. In conditions of frost nylon stiffens insignificantly, but in normal weather it is supple and soft. Apart from towing, mooring and whaling, it is suitable for cargo loading slings and, in combination with Terylene or Dacron, which do not stretch much, for rigging in general.

Manufacture

Almost all rope is right handed, hawser laid and usually three-stranded, but it can be left handed and four-stranded (shroud laid) or plaited (Fig. 6). Fig. 4 shows, from the top: three-stranded right handed hawser laid rope; shroud laid rope; and three-stranded, left handed, cable laid rope.

Hawser laid rope is rope that has been twisted three times in the course of manufacture: the fibres are initially twisted to make rope yarn, the yarn is then twisted into strands and the strands twisted into hawsers. Hawsers can be tightly or loosely twisted, depending on what they are required for. Loosely twisted hawsers are stronger but tightly twisted hawsers wear better. Nearly all rope used at sea is hawser laid. The identifying characteristic of cable laid rope is that its fibres have been twisted four times—in other words, hawser laid rope is twisted once more and laid together. Coarse grass rope can be made similarly, its fibres being twisted five times. Cable laid rope is harder, stands up better to wear and does not absorb water as readily as hawser laid rope.

Tarred hemp cable laid rope was formerly used for towing springs and as anchor rope. Cable laid rope is, however, more expensive and not as strong as hawser laid rope.

Nearly all rope is right handed; that is to say, when making the rope the strands are twisted anticlockwise, which gives a right handed finished spiral (Fig. 4). It may help to remember that it has the same twist as a right handed screw thread.

Unlike the English, who describe a rope by the lay of the finished spiral, Swedish ropemakers name the rope by the direction in which the strands are twisted when it is being made. In English one cannot say one is coiling a rope clockwise against the twist if the rope is

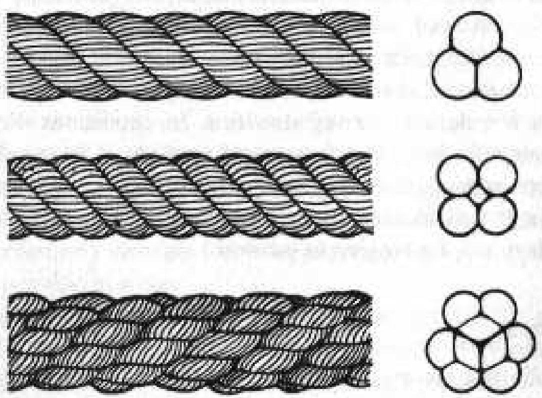


Fig. 4 Different ropes

described as left handed; nor can one put on a whipping clockwise against the twist if the rope is described as left handed.

Cable laid rope made from right handed rope becomes left handed, i.e. in making cable laid rope hawser laid rope is twisted clockwise. As there is no international rule in ropemaking, the textile industry uses the descriptions Z-laid and S-laid, which cannot lead to confusion. Rope twisted anticlockwise is Z-laid and when twisted clockwise it is S-laid (Fig. 5).

Left handed hawsers and right handed cable laid ropes are very rare but do exist, usually in the form of thick grass ropes for mooring or towing. The commonest rope is three-stranded, but four-stranded is also available and, in sizes 2 in. or thicker, usually contains a fifth strand, which is thinner and forms a core or heart around which the other strands are laid. Four-stranded hawser laid cordage made from

tarred hemp is also known as shroud laid because it was once used for hemp rigging. Lanyard cordage is also made from four-stranded, combed, tarred hemp. Bolt rope is loosely laid, three-stranded tarred hemp rope. Six-stranded cordage is sometimes obtainable in France where it is called septin (with a core or heart it has seven strands), but it cannot be used at sea.

Three-stranded rope is slightly stronger than four-stranded rope of the same thickness up to 5 in., but for dimensions of 6 in. and over four-stranded is stronger than an equivalent three-stranded. This is related to the problem of getting an equal load on all the yarn in the strands. When rope is stretched the outer, spiralling strands stretch

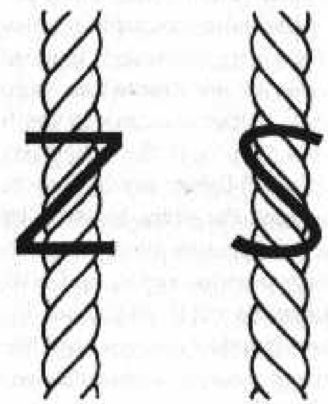


Fig. 5

more than the straight strands in the core and break first. This tendency increases with the thickness of the strands, and is disadvantageous to three-stranded rope which has thicker strands than corresponding four-stranded rope. Normal sized four-stranded rope is softer than three-stranded and is more suitable for use in blocks with several sheaves as it runs over the sheaves more smoothly. For this reason it is often used for lifeboat falls. Four-stranded rope also has the advantage of being rounder than three-stranded.

The fibres used in making rope yarn are spun anticlockwise. In hand spinning the ropemaker would tie one end of the hemp fibre to his apron and walk backwards and form the threads while a spinning wheel twisted the other end. In machine spinning, now the universal method, the fibres go through carding and stretching machines where they are formed into narrow ribbons which are twisted into rope yarn.

This is wound onto bobbins as it is spun. Yarn for a length of rope has to be about 180 fathoms long.

Hemp yarns which are to be tarred are immersed in warm tar, wiped off, rolled up and left to dry. Untarred yarn is used to make rope required for less demanding tasks. This rope is tarred after manufacture, but absorbs more tar and so is not as durable.

Manila yarns are not tarred, but their fibres are oiled before spinning in order to make them softer and easier to spin. The oil is retained in the finished rope and its presence is easily noticeable when the rope gets wet as the water tends to drive the oil out. After the yarn has been spun it is twisted clockwise into strands. In this process the bobbins holding the yarn rotate freely on spindles, the yarn being threaded through a plate with concentric holes and fastened to a machine which pulls the yarn and twists it together into strands.

The machine can also be constructed so as to twist three or four yarns at the same time. In the old days in the bigger rope factories horses were often used to propel the machines, but they are now driven by electricity. For all lighter cordage up to 3 in. in size special machines are used to twist the yarns together into strands and wind them onto reels. The finished strands are twisted together anticlockwise into three- or four-stranded ropes, and lastly, these may be put together clockwise to make cable laid rope. In the case of thicker cordage the strands are stretched and put together along the ropewalk, but for thinner cordage special automatic ropemaking machines are used. Each twisting is made in the opposite direction to the previous one, the tendency to untwist keeping the next laid strand in place.

In the course of manufacture the ends of the rope reveal knots where the yarns were fastened to the hooks on the machine. These are known as fag ends and are left on the rope to show that it has not been cut. Unevenly made cordage which has a shorter, tougher strand is called half-strong. The more the threads in the yarn are twisted the weaker they become. Therefore, plain yarn is stronger than that in a strand, hawser or cable. It is weakest in cable laid cordage, where the yarn has undergone four twistings. Twisting also reduces the length, so that 180 fathoms of yarn yields about 150 fathoms of strand, 120 fathoms of hawser laid rope and 100 fathoms of cable laid rope. One hundred and twenty fathoms (220 m) is generally called a whole hawser length, and 100 fathoms a cable length, and 60 fathoms (110 m) a half hawser. One hundred fathoms is equal to 600 ft, only

slightly less than a tenth of a nautical mile, and is also known as a cable length in navigation and hydrography.

Cordage is usually measured by its circumference in inches. For example: 3 in. for boom guys; 3½ in. for lanyards; and 1½ in. for heaving line. This generally applies to merchant ships, and yacht's cordage where, perhaps due to English conservatism, newer methods of measuring circumference or diameter in centimetres have not yet found favour. The metrication of naval standards in the UK and the variety of practices in the US and elsewhere now mean that description of cordage is undergoing changes and that uniform practice cannot be assumed.

Fig. 6

Ropes less than 2 in. in circumference are called lines, e.g. 1½ in. heaving line, 1¾ in. point line, etc. The term, however, can also be applied to certain bigger ropes and chains. For example, a boat's painter (which can be 4 in. for a lifeboat) or anchor lashing line.

Towards the end of the 1950s a new type of plaited cordage was produced by a ropemaking firm at Vlaardingen in Holland. It was perhaps not really new because plaited cordage such as log lines already existed, but the method of making it was new. The rope was laid from eight strands which followed each other two by two in four pairs, of which two pairs were twisted clockwise and two anticlockwise. This meant that the clockwise strands had to be laid anticlockwise and vice versa. The result was a rope that remained soft and free of kinks even when wet.

The cross section of such rope is almost square, and in manufacture the strands are plaited in pairs as in square plaiting (Fig. 6). It is now made in many places and is known as braided rope, square line or cross rope, and is manufactured from nylon, manila and sisal.

Hambro line is a three-stranded slender rope made from well combed tarred hemp. It is made in three sizes: 6, 9 and 12 thread. Hambro line is used for larger seizings, mostly on old-fashioned hemp rigging, and has now generally been replaced by seizing wire. It is, however, still used for canvas and some ropework.

Rope yarn is also made into spun yarn, marline and house line. Spun yarn is made of two, three or four yarns, often of poorer quality combed tow, and is mostly used for servings, not for seizings. Marline, which is two-ply, and house line, which is three-ply, are manufactured from better quality fibre and are used for smaller seizings and servings and sometimes for attaching bolt rope to sails. Sailmaker's twine is spun from the finest combed hemp or flax and is two, three, four or five-ply. The thickest is called roping twine. Sailmaker's twine is always tarred and/or waxed before use. Waxed cotton yarn is commonly used when machining American cotton sails. For hand sewing, waxed flax yarn is best. For small sails coarse seaming yarn is excellent.

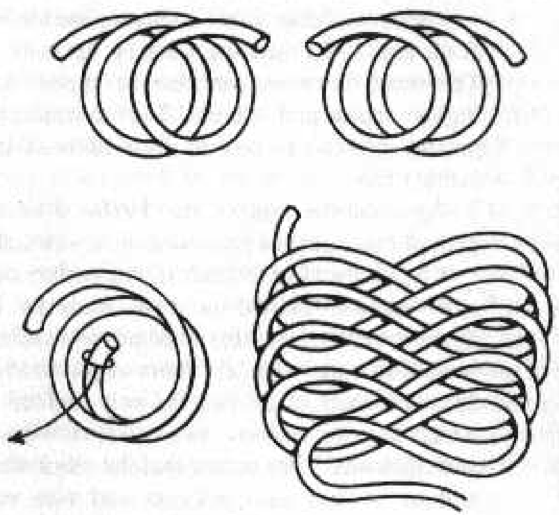


Fig. 7

Care of cordage

Cordage is always coiled against the lay—that is, clockwise for ordinary right handed rope. Fig. 7 shows, at the top, rope coiled clockwise on the left and anticlockwise on the right. To remove kinks in a loose end make one end of the rope fast, turn the coil upside down against the lay so that the loose end is underneath, and take the loose end up through the centre of the coil and uncoil it backwards with the lay (Fig. 7, bottom left). If you want a long end to run out freely without supervision the rope should be coiled in a figure of eight (Fig. 7, bottom right). This is basically the same method used for coiling rocket lines on the pegs in the boxes where they are stowed, and

enables the line to run out without kinking when the lifesaving rocket is shot. Even yarn must be coiled according to set rules. Left hand spun yarn is wound with the right hand extended, and right hand spun yarn with the left hand away from you or with the right hand towards you. Spun yarn which is used for servings is wound in a figure of eight on long reels giving alternate right and left coils (see Fig. 203).

Ordinary heaving lines are coiled in round coils of suitable size and are stowed flat on shelves in storage rooms. They should not be wound around the middle to form a skein and hung up, as is done with other smaller cordage, because this results in a loss of the uniform softness which is one of the requirements for a long throw.

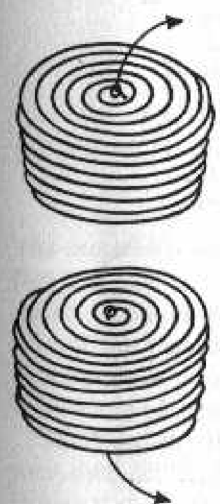


Fig. 8

A new coil of rope should be opened in a particular way, determined by the lay, to avoid kinking. In the case of a coil with a right hand lay the inner end of the rope is led straight off, but in the case of a coil with a left hand lay the end should be passed through the centre of the coil and led off from the other side (Fig. 8).

When rope is cut from a coil the ends should always be whipped. Cordage which is to be left for some time should never be stowed damp in closed quarters. Taking good care of rope also involves protecting it from unnecessary sunlight and water. Both soak out the oil with which manila rope is impregnated. Large mooring ropes should be coiled on long grids or on loose laths so as to allow the water to run off. They should be covered with tarpaulin specially sewn to protect them against sun, rain and snow. Rope which has become wet should be coiled in an open coil, preferably in a figure of eight (Fig. 7), and left to dry in an airy place. Tautly stretched cordage, such as flag halyards and various falls, should be slackened when it rains or when there is heavy dew as it will shrink when it gets wet. This is not true of synthetics.

Strength of cordage

Regarding the strength of cordage several generally valid rules have been worked out. Strength is, however, primarily dependent on material and quality and varies considerably, so that what can be

TABLE A

Breaking load in metric tons for various ropes; average figures produced by tests with stressing equipment

Circumference in inches	Du Pont nylon	Finest Italian cutter cordage	Untarred ordinary hemp	Prime manila	Tarred ordinary hemp	Sisal	Nylon wool	Cotton	Coir
1¾	3·7	2·6	2·2	2·0	1·8	1·4	1·1	0·8	0·3
2	4·5	3·0	2·6	2·4	2·2	1·7	1·4	1·0	0·4
2½	7·0	4·2	3·6	3·4	3·1	2·6	1·9	1·5	0·7
3	10·8	5·7	4·8	4·5	4·2	3·5	2·7	2·1	1·0
3½	14·5	7·4	6·1	5·8	5·4	4·5		2·7	1·4
4	18·8	9·5	7·6	7·2	6·7	5·7		3·4	1·9
5	28·6	14·5	11·5	11·0	9·8	8·2		5·0	3·0
6	41·0	20·0	17·0	16·0	14·0	11·0		7·0	4·3

regarded as a normal load in one case may be too much in another case.

Thin cordage is proportionately stronger than thicker cordage, due to the difficulty of getting an even loading on all strands as the size of the hawser increases. This is illustrated in Table A, which shows the strength of various ropes.

Because the strength of a rope is proportional to its cross-section, one factor must be squared in the formula for strength. It is easiest to use the square of the rope's circumference, as this is always known. Using the table and taking the values for, say, prime manila such a formula would give us:

1¾ inches	$0{\cdot}65 \times 1\tfrac{3}{4}^2$	=	2·0 metric tons
2 inches	$0{\cdot}60 \times 2^2$	=	2·4 metric tons
2½ inches	$0{\cdot}55 \times 2{\cdot}5^2$	=	3·4 metric tons
3 inches	$0{\cdot}50 \times 3^2$	=	4·5 metric tons
3½ inches	$0{\cdot}47 \times 3{\cdot}5^2$	=	5·8 metric tons
4 inches	$0{\cdot}45 \times 4^2$	=	7·2 metric tons
5 inches	$0{\cdot}44 \times 5^2$	=	11 metric tons
6 inches	$0{\cdot}44 \times 6^2$	=	16 metric tons

The decreasing value of the coefficient from 0·65 to 0·44 reflects the fact that rope becomes proportionately weaker as it increases in size. Although one cannot readily calculate with different coefficients, as a general rule one can take 0·5 as an average and say that for ordinary dimensions of prime manila the strength in tons is half of the square of the circumference in inches.

The Swedish royal proclamations for safety standards specify that rope used for loading and unloading must have a sevenfold safety factor; that is, the working load, A, may only be one-seventh of the breaking load, B. In the case of prime manila, if the circumference is given in inches = C, then $A = 0{\cdot}07 \times C^2$ and $B = 0{\cdot}5 \times C^2$, and in the case of poorer quality manila or sisal $A = 0{\cdot}06 \times C^2$ and $B = 0{\cdot}4 \times C^2$.

A general rule employed by the French to obtain a safe working load is 1 kilogram for each square millimetre of the cross-section of the rope. Following the rule that the surface of a circle is equal to 3·14 × radius², and with the radius equal to $\frac{\text{circumference}}{2 \times 3{\cdot}14}$, then for a rope of 3 in. circumference

$$3{\cdot}14 \times \left(\frac{3 \times 25}{2 \times 3{\cdot}14}\right)^2 = 448 \text{ kg}$$

This formula provides tenfold safety if it is applied to prime manila in the previous table. If it is applied to coir, the safety factor is only twofold. To avoid calculating with π one can increase the value of this rule to 1 kg per square millimetre of the square of the diameter. This is an easy rule for thin cordage. A rope with a diameter of 5 mm is safe for a load of 25 kg; one with a 10 mm diameter is safe for 100 kg, and so on.

Tackles

A tackle usually consists of two blocks with a cut runner between them.

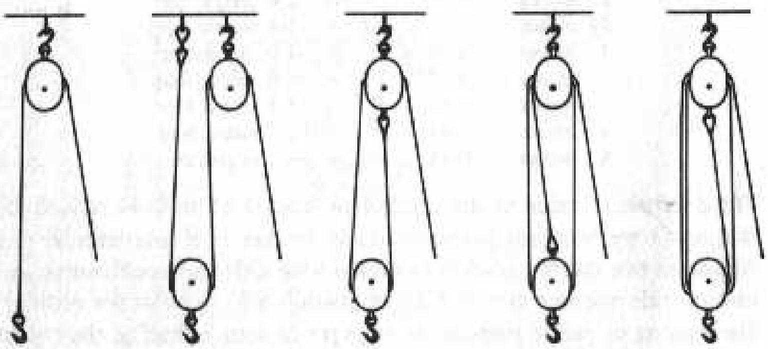


Fig. 9 Various tackles

Ordinary tackles are named after the number of sheaves the runner passes over. Fig. 9 shows, from the left, single whip passed through a fixed block, double whip with standing purchase and, in the third figure, a gun tackle. The fourth figure is called a watch or luff tackle and the fifth a double luff tackle.

Larger tackles are five- or six-sheaved, or occasionally more when used for very heavy weights or for salvage work. Fig. 11b shows a five-part tackle with three-sheaved and two-sheaved blocks. Tackles provide varying mechanical advantages, depending on how they are used. The ordinary single whip, for example, gives double or treble power. If it is arranged as shown in Fig. 9 the power gain doubles, and if the upper block is applied to the load the power is trebled.

Fig. 10 shows some special tackles. The arrangement on the left is

called 'cope with runner' because the runner referred to is the whip in the moving block. The arrangement gives double power and was generally used in the running rigging in sailing ships for falls, braces, etc. The second figure shows a simple Spanish burton. This tackle gives threefold power with only two single blocks.

The two drawings on the right show the double Spanish burton. This gives fivefold power. It was once in international use for loading and unloading heavier piece goods, especially the large sugar chests in the old important sugar trade from the West Indies to Europe, and was then generally called a sugar tackle. It was sometimes set up slightly differently, with two single tackles or a double tackle at the top, but the power gain always remained fivefold. It became more

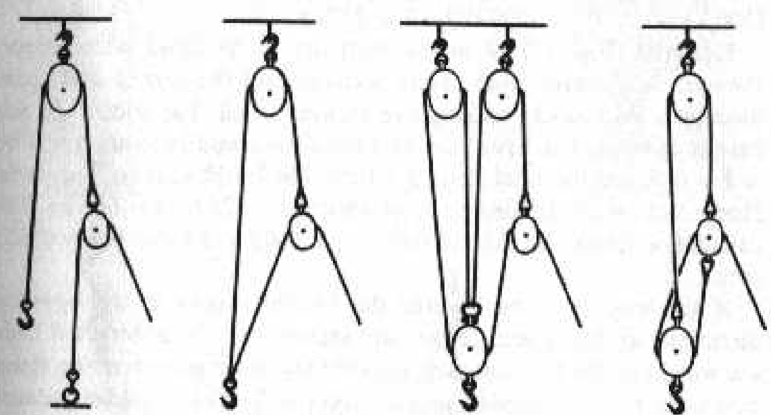


Fig. 10 Various tackles

flexible and there was less friction than when taken through only three single tackles as shown in the fourth figure.

The runner in an ordinary tackle is lead clockwise through the blocks, as in Fig. 11a. Five and six part runners are sometimes arranged so that the runner comes from the middle sheave. This way the two tackle blocks are set with their sheaves at right angles and the runner is arranged as shown in Fig. 11b.

In order to calculate the power gain of a tackle one merely has to divide the weight of the load by the number of parts from which it hangs. But because there is friction in a tackle, the load figure must first be increased by between 5 and 10 per cent for each sheave over which the runner passes. The lesser factor can be applied in the case of tackles with large blocks, patent sheaves and thin runners, and the larger factor for tackles with small blocks and thick runners and unpatented sheaves. The friction which has to be overcome not only comprises the turning of the sheaves but also the bending of the runner over the sheave and its subsequent straightening. This is why stiff tarred hemp requires more effort than soft manila, and hard wire more effort than flexible wire.

Example (Fig. 12): 500 kg is to be lifted with a three-part tackle. The runner goes over three sheaves and an allowance of 10 per cent for friction is made for each sheave. This gives a frictional equivalent of 150 kg, which is added to the net weight. The whole load then becomes 650 kg. The load hangs on three parts, and so 650 kg is divided by 3, which gives 217 kg. The calculation looks like this: $(500\text{ kg} + 3 \times 0{\cdot}1 \times 500\text{ kg}) \div 3 = 217\text{kg}$.

Example (Fig. 13): 2 metric tons are to be lifted with a four-sheaved tackle with good patent sheaves, and the runner must pass through a lead block, making five sheaves in all. The friction in this case is calculated at 5 per cent for each sheave and becomes $5 \times 0{\cdot}05 \times 2 = 0{\cdot}5$, and the whole load 2·5 tons. The load hangs on four parts. Hence 2·5 tons is divided by 4, which gives 0·625 tons = 625 kg. The calculation looks like this: $(2\text{ tons} + 5 \times 0{\cdot}05 \times 2\text{ tons}) \div 4 = 0{\cdot}625$ tons.

If the load is to be lowered the friction works in the opposite direction, so that 5 and 10 per cent respectively are subtracted from the weight of the load for each sheave the runner goes over. To lower 500 kg in the four-sheaved tackle a force of 117 kg is needed because $(500\text{ kg} - 3 \times 50\text{ kg}) \div 3 = 117$ kg. To lower 2 metric tons with the tackle in the second example the effort required is $(2\text{ tons} - 5 \times 0{\cdot}1\text{ tons}) \div 4 = 0{\cdot}375$ metric tons.

If the friction is greater than the load the sum in the brackets and also the answer become negative. This means that the load cannot lower itself and one must help by pulling on the tackle.

In the case of heavy loads it is not only necessary to consider the load and the force required but also the load on the blocks and the shackles. To lift 2 tons with a single wire, ignoring friction, one will have to heave with 2 tons of force at the other end of the wire. This is equivalent to 2 tons hanging at each end of the wire, and the load on the heaving block becomes 4 tons. To lift the same 2 tons in a four-sheaved tackle one only needs to exert a force of 0·5 tons on the pulling part of the tackle, and this brings the whole load on the hauling block and the shackle to 2·5 tons. From this it is apparent

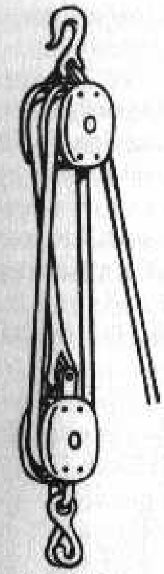


Fig. 11a

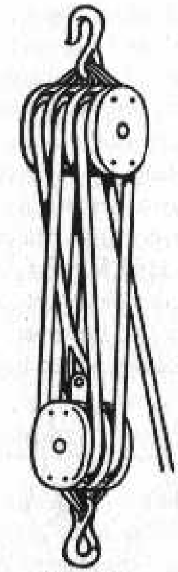


Fig. 11b

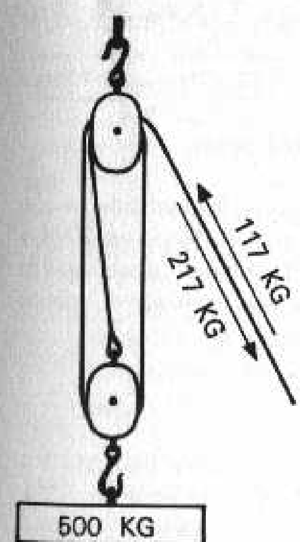


Fig. 12

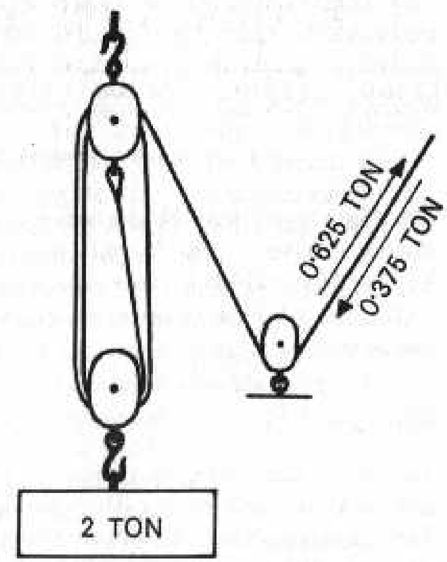


Fig. 13

that even if the winches can cope, heaving blocks, booms and top ropes can be saved by heaving on double or multiple tackles.

Fig. 14 shows the forces involved if friction is included. The figures next to the runner show the required power for heaving and lowering. A represents the force on the pin in the block when heaving, and B is the force when lowering a load. From this it is evident that even though there is a considerable power gain when heaving on a double or triple tackle, the more sheaves used the less is the gain, because of the added friction. In the weights given the weight of the shackles is not taken into account. The rigging, blocks, runners and slings for a heavy lift, however, weigh a considerable amount and this should in practice be added to the sums A and B.

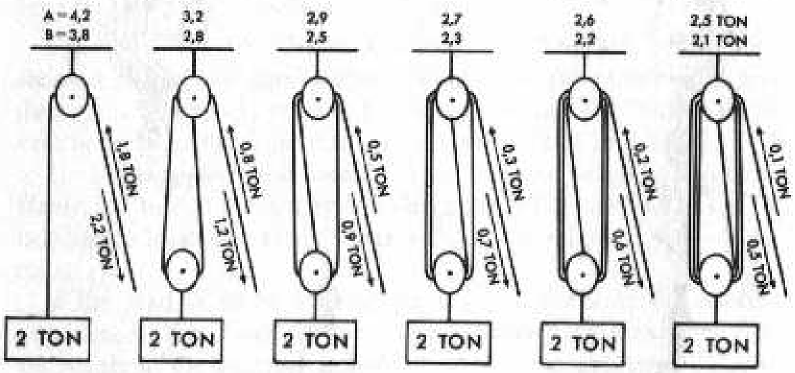


Fig. 14 Power requirements for different tackles

Gin blocks and iron blocks are measured by the diameter of the sheave, wooden blocks by the length of the shell. Rope requires a wooden block which is three times larger than the size of the rope in inches, i.e. a 2 in. rope needs a 6 in. block, a 3 in. rope a 9 in. block, and so on.

Wire rope

Wire rope used at sea is always Z-laid; that is, it has been twisted anticlockwise and is described as right hand laid, as with rope. Various designations do, however, crop up even here and Sweden's largest steel firm, Fagersta, calls its Z-laid steel wire right hand laid, although it has been twisted to the left. This is consistent with

English-language terminology, but opposite to normal Swedish usage, in which Z-laid rope is considered left handed.

Wire rope usually has six strands around a heart of hemp, manila or jute. The heart not only provides a cushion for the six strands to rest against but also serves to store the grease with which the wire is oiled. The heart of all new wire rope is thoroughly impregnated with grease or oil which is expressed between the steel threads of the strands when the wire is bent. Sometimes the strands consist purely of wire threads surrounding a heart of hemp in each strand. Wire rope is manufactured from a variety of qualities of iron and steel thread, and the manufacturers list many varieties. At sea, however, one only distinguishes between iron, which remains crooked when bent, and steel wire, which straightens itself out again. All running wire rope which passes over blocks, sheaves, etc. properly belongs to the latter category. Soft iron wire is seldom used now.

Thick-threaded wire rope with only steel threads in the strands is used for standing rigging and is known as rigging wire. Ordinary winch wire is steel wire without hemp yarn in the strands, and should not have a heart of hemp. In sizes of 2$\frac{1}{4}$ in. or above it must be certificated. Mooring wire is also made of steel, often has 72 threads (12 in each strand around a core of hemp) and is called flexible wire. Flexible wire with 144 small threads (24 in each strand around a core of hemp) is called extra flexible. It used to be employed at sea for bolt ropes in larger sailing ships and is now used for coarse running rigging and top ropes in large ships where ordinary flexible wire would be too stiff. Seizing wire is made from soft iron thread. Fig. 15 shows, from the left: 42-thread rigging wire, 114-thread winch wire, 72-thread flexible mooring wire, 144-thread extra flexible wire for running rigging, and 7- and 12-thread seizing wire.

Wire rope is also manufactured with five, seven and eight strands and in a variety of particular ways. These ropes are, however, seldom seen at sea but are used in various industries on land, e.g. ropeways, for hoists in mines, etc. However, one variety provides a very flexible rope and is used to a large extent as mooring wire on board small vessels. It is manufactured from thin spun wire strands with hemp cores, which are laid around strands of best quality hemp. A similar type, so-called combination line, with a heart of wire and outer yarn of manila or sisal, is manufactured nowadays and is used as sweeping line and footropes on fishing trawlers.

When opening a coil of wire take the outer end and unroll it. This is

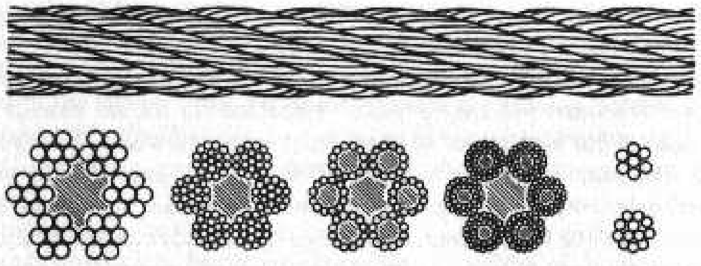


Fig. 15 Various types of wire

the first prerequisite to ensure that wire ropes are free of kinks. The easiest way to do it is to place the coil on a wooden cross hung from a hook with a swivel attached (Fig. 16). In the absence of such a cross the wire coil can be held on edge and rolled along the deck or hung on a winch crank arm which is slowly driven round while one man guides the coil and another unrolls the wire; and in the case of mooring wire it is taken directly onto its winch. Furthermore, a loose wire winched in should not be taken off the drum immediately it comes on board but should be heaved around the drum, so as to avoid kinks in the wire. If old mooring wires are full of kinks it is sometimes helpful to move the starboard wire to port and vice versa, or to drive the winch in reverse. Merely twisting the end of the wire will not serve to undo kinks but can be useful if the end is very worn.

When a loose wire has to be coiled flat it should be coiled clockwise with alternating round turns and half-hitches (Fig. 17). The outward twist in the round turn compensates the twist in the half-hitch, leaving the wire free of kinks.

All wire should be carefully whipped before being cut. The whippings must not be placed too close to each other as they can easily be broken when the chisel cuts through the wire. Thick rigging wire is best cut with a hacksaw, a light serving being wound on it first and the wire then sawed through the serving.

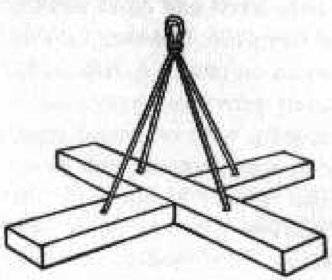


Fig. 16 Wire cross

All wire is now galvanised, which greatly increases its lasting qualities by preventing rusting. In the course of being wound onto winches and paid out round bollards the galvanising gets worn off, exposing the wire to rusting and salt water. Due to the local galvanic action which occurs when the zinc has worn off, the remaining zinc is sacrificed in protecting the exposed steel thread. Friction between the threads when wire is bent also causes the zinc inside the wire to wear. Because of this all wire should be oiled every now and again. This should preferably be done with oil which does not contain fatty acids, which are in several organic oils, as the acids corrode the zinc. It is therefore best to apply an appropriate mineral oil to galvanised wire. Raw linseed oil or whale oil is suitable for old wire which has lost its zinc.

The thickness of the thread naturally influences the flexibility of wire, and it therefore should not be run over too small sheaves. The diameter of the sheave should be at least 300 times the diameter of the threads in the wire. Therefore a wire laid from 1 mm thread

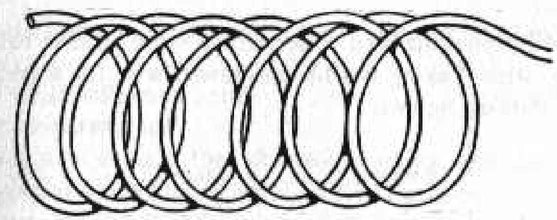


Fig. 17 Coiling wire rope

should not be used on a sheave with a diameter of less than 30 cm (12 in. lift wheel). For a wire with 0·8 mm threads at least 10 in. sheaves should be used. This applies to slow operations, which includes most work on board ship. For fast operations the diameter of the sheave must be increased.

Wire used on board ships is measured in English inches around its circumference, like rope. Thinner wire for use on yachts and in industry is now frequently measured by its diameter in millimetres.

The strength of wire varies considerably with the quality of the steel and the type of lay. Wire with only steel threads in the strands is naturally considerably stronger than wire with cores of hemp in the strands. As regards the strength of the different qualities, the following figures from one of Britain's biggest wire rope manufacturers, Bullivant of Cardiff, show the breaking strain of different kinds of 3 in. wire:

Extra plough steel	34 tons
Mild plough steel	30 tons
Best patent steel	25 tons
Bessemer steel	13 tons

Fagersta manufacture mine lifting ropes from tempered smooth steel with breaking points of 130, 160 and 180 kg/mm², and with only steel threads in the strands, which gives a breaking strain for 3 in. wire of 29, 35·6 and 40 tons respectively. At the same time 72-thread flexible wire is manufactured for ships' use, and with a breaking point of 130 kg/mm² has a breaking strain of 18·7 tons for 3 in. wire—indicating how different lays influence the strength. This ships' wire is always galvanised but because this decreases the strength slightly by weakening the effect of the heat treatment of the steel, it is not designed for a breaking point in excess of 130 kg/mm².

It is hardly possible then to formulate valid general rules for the strength of wire. Taking flexible galvanised wire for ships, Fagersta gives the following figures:

Inches	72-thread	144-thread	180-thread
2	8·1	11·9	10·3
2¼	10·6	14·6	13·3
2½	13·4	17·8	16·6
2¾	15·5	21·2	20·3
3	18·7	26·8	24·3
3¼	21·2	31·0	27·4
3½	25·1	35·3	31·1
4	32·4	45·0	41·4

Breaking load in metric tons for galvanised flexible wire with a breaking point of 130 kg/mm².

The Swedish royal proclamations for unloading and loading, referred to earlier, specify that for hoisting work on ships 144-thread or 180-thread wire made of tempered galvanised steel thread and with a breaking strain of 130 kg/mm² must be used, and that a fivefold safety factor must be adhered to.

The proclamation gives the following permissible load in tons for such wire, the figures giving a sixfold safety factor if applied to Fagersta's values for breaking loads for the same wire:

Inches	144-thread	180-thread
2	2·05	1·65
2¼	2·50	2·10
2½	3·05	2·65
2¾	3·65	3·25
3	4·60	3·90
3¼	5·30	4·40
3½	6·05	5·00
4	7·15	6·60

Permissible working load in metric tons for galvanised flexible winch wire.

These figures give the following formulas for breaking loads:
$B = 2 \times \text{circumference}^2$ for 72-thread mooring wire, and
$B = 3 \times \text{circumference}^2$ for the strongest 144-thread extra flexible wire.

If one calculates a sixfold safety factor the working loads become respectively:
$A = 0{\cdot}33 \times \text{circumference}^2$, and
$A = 0{\cdot}5 \times \text{circumference}^2$,
from which it is evident that the safe working load for wire corresponds approximately to the breaking load for rope.

Wire rope for ships' rigging was first manufactured in England more than 100 years ago. A ropemaking firm, Messrs Newall & Co of Newcastle-upon-Tyne, obtained a patent for its improved wire rope in 1840. In the 1850s most newly-built British ships were fitted out with wire rigging, a characteristic which enabled sailors to distinguish British ships from those of all other nations. As hemp in its day had contributed to the conquest of the seas, so wire has now contributed to the industrialisation of life at sea.

Chain

Chain can be short linked, long linked or be provided with stud links (Fig. 18). There is not much use for short linked chain in rigging on board ships now, but it was and is sometimes used for rudder controls, for lashing deck loads and in slings for unloading heavy crated goods, and as anchor chain on small vessels. Wire largely replaced its use in rigging. Nor was long linked chain used to any great extent at sea. It was, however, sometimes attached to the end of the wire top ropes to make it easier to shackle loading arms at a required height, and to lash down deck cargoes.

Chain used in rigging or on deck should be well greased if it is likely to shift under strain. This is to prevent wear when rusty links chafe against each other. Short and long linked chain is made from forged iron and can be hand forged, machine forged or electrowelded.

Forged short linked chain is test loaded and must have a safety factor of 25 kg/mm² of the diameter of an arm of the link, allowing about 25 per cent less if the chain is welded. Long linked chain is calculated to be 30 per cent weaker than equivalent sized short linked chain. Chain used for loading and unloading must be accompanied by a certificate if it is bigger than 16 mm. If it has not been tempered and is used on board ships of 300 tons or more it should be heat treated at prescribed intervals.

Chain is measured by the diameter of an arm of the link in British inches. In Swedish regulations measurements are given in millimetres. The general rule for forged short linked chain is that if A is the safe working load in metric tons, B the breaking load in metric tons, and C the diameter of the link in centimetres, then:

$A = C^2$ and $B = 5 \times C^2$

These equations provide for a working load with a fivefold safety factor.

Link diameter in mm	Short linked chain	Long linked chain
10	0·85	0·60
12	1·20	0·80
15	1·90	1·25
20	3·35	2·25
25	5·25	3·50
30	7·55	5·10
35	10·30	6·90
40	13·40	9·00
50	21·00	14·10

Permissible load in metric tons

The same proclamation also gives the permissible load for short and long linked chain. Note that here the permissible load on long linked chain is about 33 per cent less than for short linked chain. The following notice is posted in the machine shop of one of Sweden's biggest shipyards:

Good, faultless chain may be loaded as follows:

$\frac{3}{8}$ in.	1,000 kg
$\frac{1}{2}$ in.	1,600 kg
$\frac{5}{8}$ in.	2,500 kg
$\frac{3}{4}$ in.	3,600 kg
$\frac{7}{8}$ in.	5,000 kg
1 in.	6,400 kg

The permissible load, expressed in metric tons, is roughly equal to the square of the diameter of the link in centimetres and provides the fivefold safety factor given in the above formulas for breaking and working loads.

Stud link chain is used exclusively as anchor and mooring chain. It is hand forged from iron, and nowadays is also cast from steel without a welded joint in the links, which gives considerably greater strength. The studs not only make a stronger chain but to a great extent also prevent the chain from kinking.

Anchor chain is manufactured in lengths of 15 fathoms which are shackled together to obtain the required length for a ship. The rounded end of the shackle should always be towards the anchor to prevent the chain snagging in the hawse-hole or on the winch when it runs out. The shackle pin has a flattened oval or elliptical cross-section. It is locked in the shackle with a wooden pin driven through a conical hole in one end of the shackle and the pin. The shackle pin should be greased before being put into place (tallow and white lead are suitable) to prevent it rusting and seizing. The wooden pin should also be greased to prevent, as far as possible, the hole from rusting. The wooden pin does not have to be removed when the shackle is opened, but it is cut when the pin is taken out.

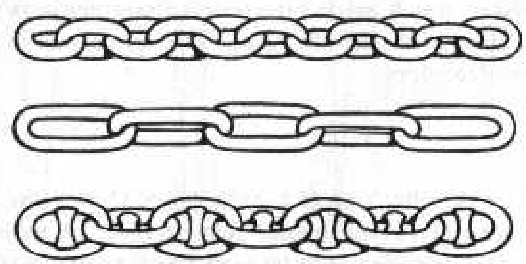


Fig. 18 Different types of chain

The various chain lengths are usually marked at the shackles to show how much chain has been let out. The marks should be made so that they are easily recognised. Several different methods are used, but a good, common method is to use thick iron thread or seizing wire to mark the first second, third, etc. stud from the shackle. In order to identify the marked stud more easily one can also paint it white, or paint one, two or three links adjacent to the shackles. White lead stays on surprisingly well, and a chain that has been marked is always a help, especially at night.

Forged stud link chain is about 50 per cent stronger than short linked chain. Modern steel anchor chain is about three times stronger than short linked chain. The best tempered chain is safe for a load of 75 kg/mm² of the cross-section of the link. Anchor chain of $\frac{5}{8}$ in. (16 mm) or bigger must be supplied with a certificate. This is issued by the manufacturer and the chain is then subjected to standard tests and declared passed. The Swedish testing regulations specify the following loads for testing stud link chain:

Smallest diameter of stud linked chain in mm	Proof load in kg	Breaking load in kg
16	7,100	10,660
19	10,240	15,290
22	13,700	20,550
25	17.720	26,570
30	25,520	38,210
35	34,700	52,050
41	47,630	66,700
49	68,000	95,200

Intervening values are proportional.

Anchor chain, which existed in ancient times and was sometimes used in large ships in the Middle Ages, came into use at the beginning of the nineteenth century.

Tools

A complete set of sailor's tools is quite large. During the old sailing ship times, when every able-bodied seaman used his tools daily, his toolbag was well provided with an assortment of fine marline spikes and palms and needles. Even today a seaman can benefit from using

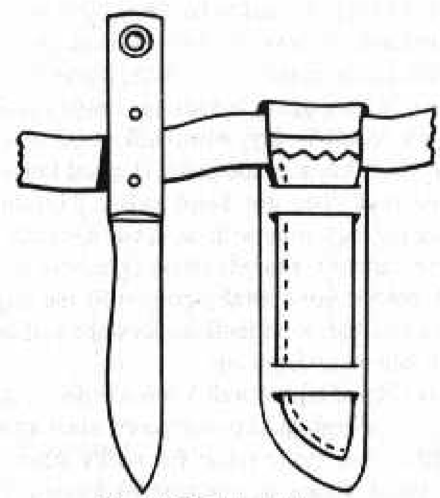


Fig. 19 Sailor's knife

his own tools, particularly as the ones on board ship are seldom very good. One does not need to know a great deal about the art of seamanship to realise that good tools do half the work, and that one's own tools will do two-thirds of it. When working with a palm and needle that are unfamiliar one always works on the edge of the cushion, whereas when using one's own palm and needle one always works the needle through one of the many holes in the cushion.

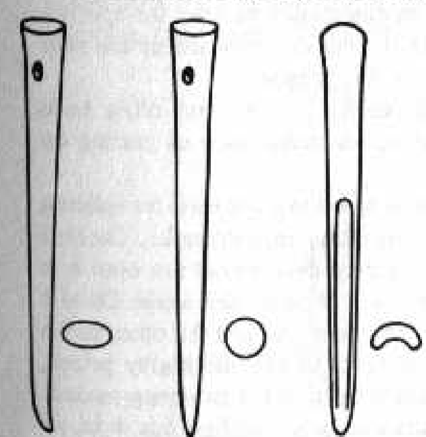


Fig. 20a Marline spike

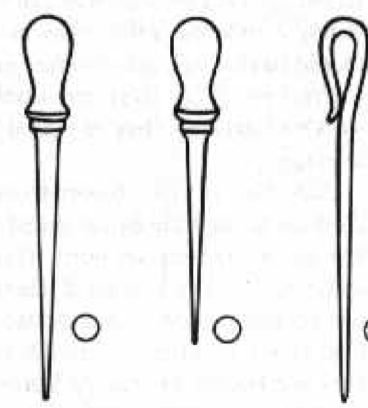


Fig. 20b Prickers

The *sheath knife* (Fig. 19) used to be the sailor's most valuable tool, and it was unthinkable to imagine him without one. It was always carried on his belt at the small of his back where it was least in the way when working in the rigging but always easily reached with either the right or the left hand. Today, when sailors no longer work in the rigging, a strong clasp knife is adequate. A good knife should have a thin, broad blade that does not blunt easily. Not only must it be capable of cutting through rope with ease, but it should also be able to cut pencil-marked sailcloth straight along or across the weave. When cutting sailcloth hold it horizontally and, with the edge of the knife pointing upwards and the point inclined forward and downwards, cut through the cloth and away from one.

Marline spikes (Fig. 20a) are well-known tools. A good wire spike should be made from high-quality tempered steel and have an oval cross-section which will make room for tucks when the flat end is slipped under a strand of rope and twisted 90 degrees. The point of the spike may be slightly bent, which makes it easier to put tucks under the strands. Professional riggers sometimes use marline spikes with a groove running along one side, so that the cross-section resembles a crescent moon. This kind of spike provides ample space for tucks when splicing but is not really necessary for work on board ship, and if it has to be specially made it can be rather expensive to buy. Round marline spikes are suitable for laying spun yarn and flax seizings. Thick spikes which do not taper to a long, fine point are used for screwing shackles, etc. and can in an emergency be used for splicing ropes. A marline spike used in the rigging or outboard of the ship should have a lanyard attached in case it is dropped.

Prickers (Fig. 20b) are smaller marline spikes and often have wooden handles. They are used for minor tasks, such as putting on seizings.

Fids (Fig. 21a) are turned from hard wood and are used for splicing cordage as they are better suited to this than a marline spike. The best fids are made from ox horn. This is heated over a coal fire until it is soft, when it is straightened, clamped and left to harden again. Once it has cooled a wooden plug is fitted to the open end and the other end is filed down to an even, smooth point. Once in use and highly prized, they are known as splicing horns. Light horn is not as strong as dark ox horn or buffalo horn. Tierce fids are large marline fids 4 in. or bigger at the thick end, and are used by sailmakers to stretch cringles when putting in thimbles, as well as to splice thick cables.

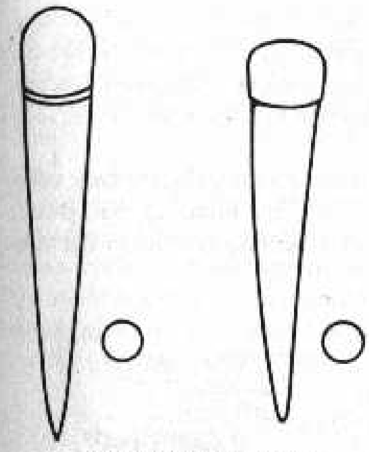


Fig. 21a Fid and horn

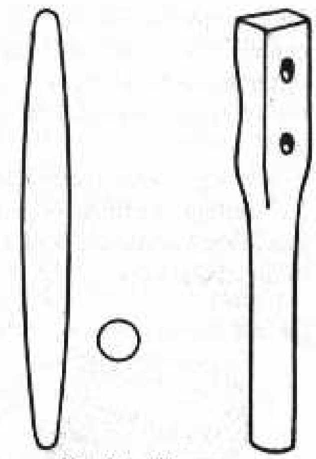


Fig. 21b Heavers

Heavers (Fig. 21b) are round, sometimes roughly bobbin-shaped, pieces of wood used when making seizings, lashing, etc. with cordage or wire. One specially-made heaver, which is particularly useful for making wire seizings, has a flat end which broadens out and has two holes drilled in it. See also Fig. 208.

Serving mallets (Fig. 22) are used for spun yarn servings. A cylindrical mallet has a semi-circular groove running along it and a handle attached. One end of the mallet should have a narrower groove where spun yarn can be laid when one wants to lay a serving close to thimbles, etc. Large serving mallets used in rigging lofts ashore often

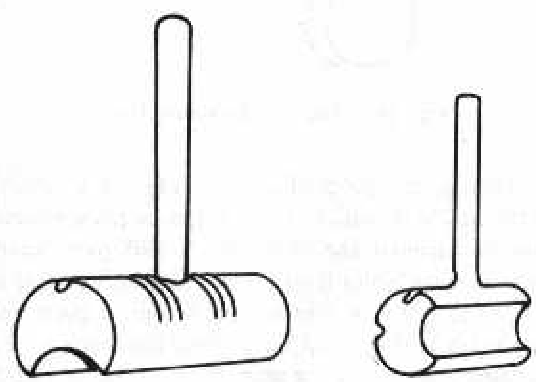


Fig. 22

have a reel for the serving yarn and this is carried round with the mallet. The mallet also has a hole in the upper part of the handle through which the yarn runs. A groove in the end of the handle serves the same purpose with the added advantage that the yarn can be laid in it.

Serving boards are smaller serving mallets with a shorter base used for putting servings on strops, etc. They are made in one piece, including the handle, and always have the serving groove on the side of the mallet head.

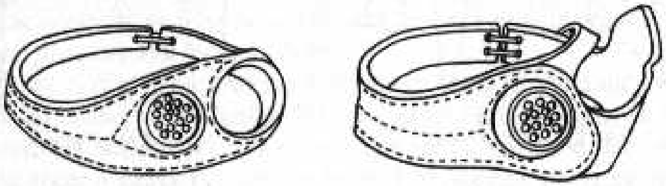


Fig. 23 Palms

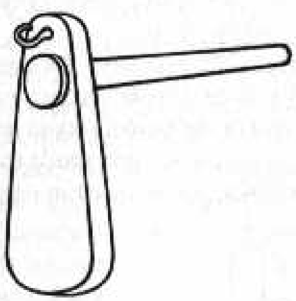


Fig. 24 Hand tool for twisting foxes

Palm or sailmaker's palm (Fig. 23). This is a 'glove' made of leather, on the inside of which is a cushion or plate which is used to push the needle through the sailcloth. A stiff palm made of thick leather generally sews better than a soft one which adapts its shape to the hand. A leech palm is a broad palm with a piece of leather to protect the thumb and is used for sewing the leech of a sail. In all sewing operations the size of the sailmaker's twine and the three-sided sail needle must correspond to the size of the sail.

Fig. 24 shows a small wooden hand apparatus consisting of a piece of heavy wood which moves eccentrically around a handle and is fitted with a hook at one end. It was used on the old sailing ships and is now very rare. It was used to spin short lengths of two-ply yarn, or foxes. A length of yarn, double the length ultimately required, is tied with a loop at each end and stretched between the hook on the apparatus and a nail or hook on a wall. The apparatus is whirled around like a rattle until the yarn has been twisted tight. The yarn is then doubled up and twisted in the reverse direction, using the other hand. It is better to spin clockwise with the right hand and anticlock-wise with the left hand, keeping the elbow pressed against the hip while spinning.

Work with Cordage

Whippings

Whippings are always put on against the lay of the rope to ensure a snug grip in the event of the rope tending to twist open. A *common whipping*, of sailmaker's twine, is employed for the smaller and simpler whippings. The twine is laid parallel to the rope with one end protruding from it. Using the other end take turns around the rope and the twine, working towards the end of the rope (Fig. 25). The turns should be laid tightly and close together. After about five or six turns make a bight at the end of the rope and lay the twine parallel to it in the reverse direction (Fig. 26). Then, using the bight, take another six or eight turns, this time around the rope and both ends of the twine. Finally, gripping the whipping tightly with the thumb and index finger of the left hand, put the bight through the whipping and cut off both loose ends of twine (Fig. 27).

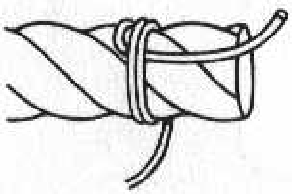


Fig. 25 Common whipping

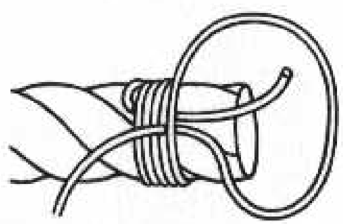


Fig. 26

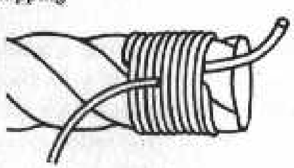


Fig. 27

Professional sailmakers always work from the end of the rope inwards (as in Fig. 28) when making this whipping. The advantages are that it enables one to make several whippings one after the other with the same twine, thus cutting down on time, and enables one to make more whippings with a particular length of twine and so save on material. Its disadvantage is that it does not fit the rope as snugly and consequently will not last as long. Also, it is difficult to lay the twine clockwise when working from right to left. Frequently when a man is on piece-work he will take the easiest way of making a whipping – that is, anticlockwise – with the result that it will fall off much more easily. This method offers no advantage for the seaman.

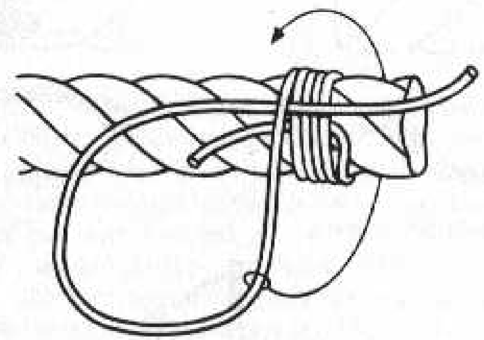


Fig. 28 Variation of the common whipping

Palm and needle whipping. Double a length of sailmaker's twine – the length should be at least as long in feet as the size of the rope in inches – thread it through a needle and make a knot at the end (Fig. 223). Push the needle under one of the rope's strands a suitable distance from the end (Fig. 29) and pull the twine through so that the knot is pulled well into the lay between the strands. Take eight to ten turns tightly and close together around the rope, working outwards towards the end. Then push the needle under or through one strand (Fig. 30) and pull it through, allowing the twine to follow the groove across the whipping. Push the needle again under the next strand inside the whipping, allowing the twine to follow the other groove. Then push the needle through the third strand outside the whipping, allowing the twine to follow the third groove over the whipping. Make another stitch and take the twine around the rope back to the first diagonal and secure it with a half-hitch as follows: turn the needle around and push it under the first diagonal against the final stitch (Fig. 31). The bight of the twine is placed behind the needle and the resulting half-hitch is pulled well into the worm between the strands. The length of the whipping should be slightly less than the diameter of the rope.

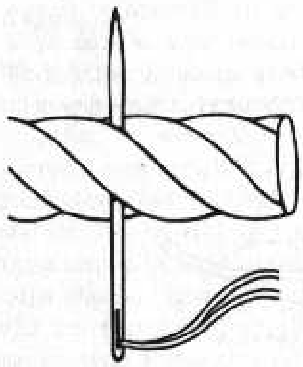


Fig. 29 Palm and needle whipping

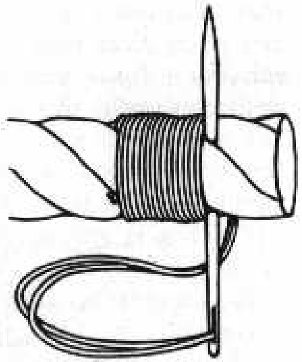


Fig. 30

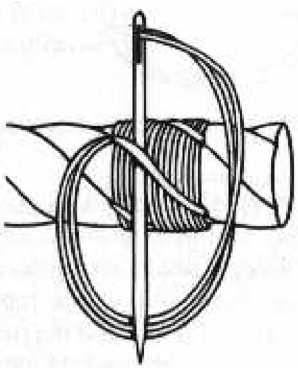


Fig. 31

If one end of a rope is to be permanently whipped two whippings should be made, the distance between them being approximately equal to the size of the rope – that is, three inches apart on a 3 in. rope. Where a four-stranded rope is whipped it should be crossed five times; which is to say that the first diagonal is crossed again in order to get the final fastening inside the whipping where it is best protected.

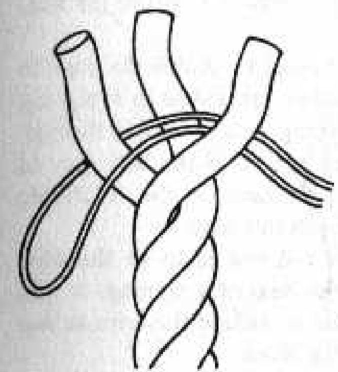


Fig. 32a Sailmaker's whipping

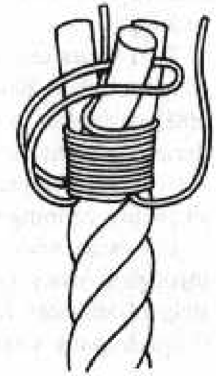


Fig. 32b

One can make a crossed whipping without using a palm and needle (Fig. 32). Take the rope which is to be whipped and carefully open up the end a couple of inches. Thread the bight of the sailmaker's twine loosely around one strand and between the other two. Lay the strands together again and with one end of the twine make the required number of turns around the rope and thread it between the strands as shown in Fig. 32b. then take the bight of the twine and loop it back over and inside the strand over which it lay (Fig. 32a). This forms two diagonals or cross turns which are pulled tight with the other end of the twine. The third cross is made by taking this end along the third groove and tying it to the first end inside the strands outside of the whipping. This is known as a *sailmaker's whipping*.

The *back splice* or *Spanish whipping* (Fig. 33) is suitable for thin ropes or short ropes, such as are used on fenders, as it forms a thick end on the rope which can be useful as a handhold. The rope should be opened up at its end to the length of two twists and the strands laid so as to form a kind of crown. This is done as follows: strand A is laid with the lay on the inside of strand B which is laid on the inside of strand C, and strand C is pushed under the bight of strand A, as in Fig. 115. The strands are then spliced back into the rope as in an eye splice (Fig. 180–182). After the first round of tucks the rope should be

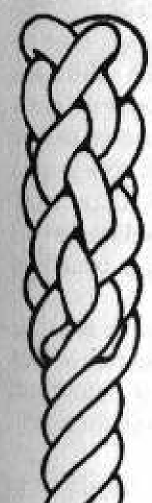


Fig. 33 Back splice or Spanish whipping

tapered or shaved down so as to provide a smooth finish to the final splicing.

Two ropes can be sewn together end-to-end to enable the rope to run through a block (Fig. 34). The stitches are made in a zig-zag fashion, similar to the diagonals in a whipping, and are sewed through the strands inside the whippings on each end. It is the best way to reeve a new halyard with the help of the old one. On the old sailing ships new running rigging was always rove in this way.

If a wire with a coarse, rough or frayed end is to be threaded through a block this is best done with the help of a serving. A thin strip of sailcloth is lashed over both ends to enable the wire to slip through easily when it is passed through the block.

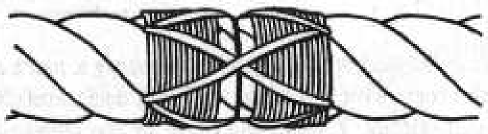


Fig. 34 Sewing ropes together

Knots, hitches and bends

The word *knop* (knot) in Swedish means bud or button and was probably used to describe only those knots which were made with the strands of a rope and formed a ball or bud on it. Other knots used to attach a rope to some object, or fasten two ropes to each other, are called *stek* (hitches). The line of demarcation has, however, been partially obliterated and many of what were known as hitches earlier are now referred to as knots while knots made with the rope's own strands are still called knots. The word *stek* is Dutch and, like a lot of other things that originated from the Dutch, it was introduced early into the Swedish nautical language. In German the word is *stich* and in Danish and Norwegian it is *stik*.

Since all ordinary cordage is laid in a spiral in a particular way the way it is bent when tying a knot is important. The general rule is that all half-hitches and bights should be laid clockwise when right hand laid rope is used. There are, however, some exceptions and these will be pointed out where necessary.

Overhand or thumb knots are the simplest of all and consist of a single half-hitch (Fig. 35). They are generally used to prevent a fall

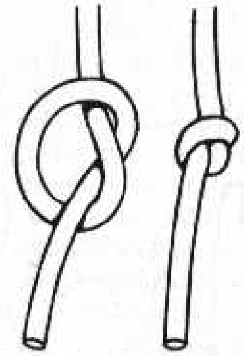


Fig. 35 Various overhand knots and thumb knots

from coming out of a block. They should never be made at the very end of a rope but, depending on the circumstances, usually about 1–3 ft from the end. This makes them more accessible in certain circumstances. The overhand knot is made at the end of sailmaker's twine to serve as a stopper knot, for example, when whipping. A more permanent and slightly smaller stopper knot can be sewn with sailmaker's twine over a small half-hitch at the end of a rope (Fig. 36).

The double overhand knot is bigger and more suited to weaker material or for a stopper knot on one end of a rope. It is made with two turns in the bight (Fig. 37) or, more commonly, as in Fig. 38. Two half-hitches are made and the end pushed through both.

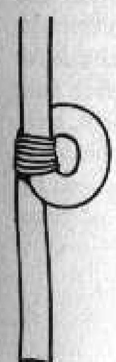


Fig. 36

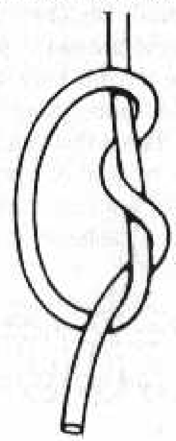


Fig. 37

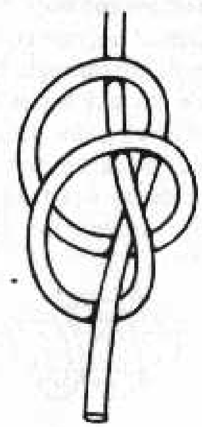


Fig. 38

Fig. 39

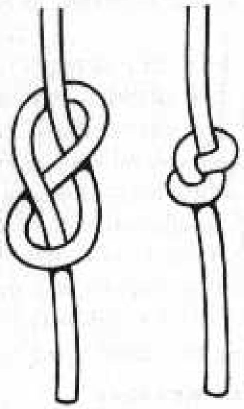


Fig. 40 Various overhand knots

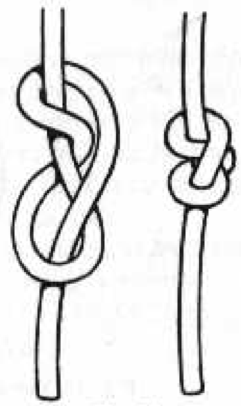


Fig. 41

A multiple knot can also be made with a number of half-hitches and, when correctly made, forms an attractive and symmetrical knot. This is best applied to thin ropes.

The *figure of eight* knot (Fig. 40) is only fractionally larger than an ordinary overhand knot but has the advantage that it does not tighten as much and is always easy to untie. It is also useful for a number of other purposes apart from a stopping knot and will be mentioned later. The figure of eight knot is also called a Flemish knot, and a useful variation is shown in Fig. 41.

The *heaving line knot* can be regarded as a variation of the overhand knot. The easiest way to make it is shown in Fig. 42. The heaving line is doubled up, one end wound around it, pushed through the bight and then pulled through. However, this knot is rather slender and it will perform its task better if it is made longer and then bent into a circle, the throwing line being threaded through the bight, as in Fig. 43. It can also be made over four lengths of heaving line, as in Fig. 44. Four reasonably sized lengths of line are doubled up and the loose end wrapped around the centre a suitable number of times

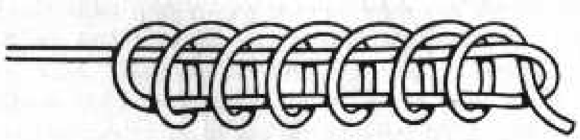


Fig. 42 Heaving line knot

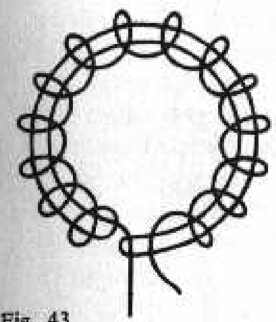


Fig. 43
Variation of the heaving line knot

before being threaded through both bights at the end of the knot. The knot is then gathered as shown in the illustration. A bight at one end is pulled tight, 1, in order to secure the end of the wrapping; part 2 is pulled tight to draw the ends of the line together; the whole line is threaded through as in 3 and pulled well into the base of the knot, 4; and finally, the remaining bight is pulled through the knot, 5.

A *bowline* forms a standing eye on one end of a rope, and is common on mooring ropes. The easiest way to make it is the method shown in Fig. 45. Loop the end of the rope over the standing part and hold in the right hand with the palm of the hand facing downwards and the thumb under the rope. By twisting the hand to face the palm upwards a round turn is formed on the rope and its end emerges through it correctly. The end is then taken around the back of the standing part, pushed back through the round turn and the knot pulled tight. This is the common turned-in bowline. A variation is the

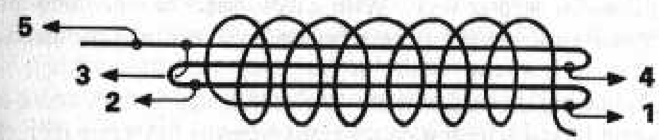


Fig. 44 Variation of the heaving line knot

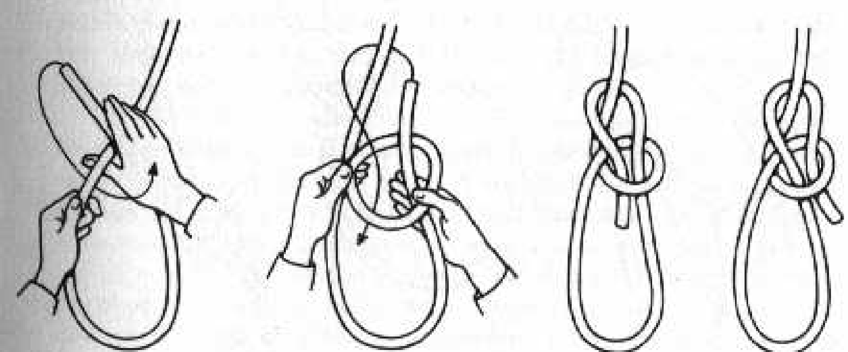


Fig. 45 Bowline

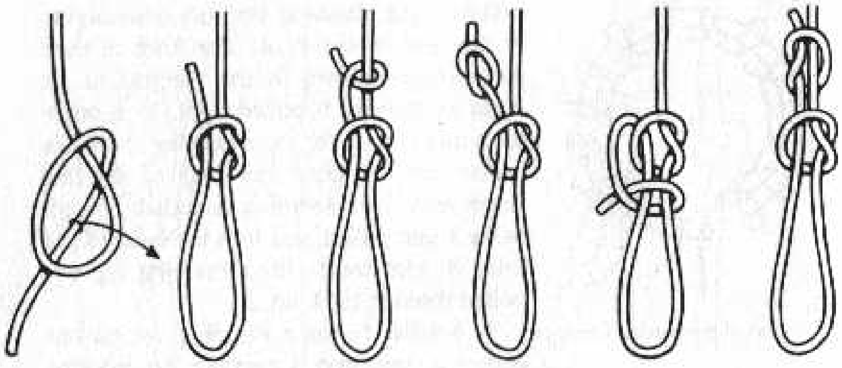


Fig. 46

turned-out bowline, but it is not as common and has no particular advantages. A seizing should be put on the end of the rope if a bowline is to be left for some time.

A *standing eye* is ideal for thin ropes but is also used on thick ropes. It is easily made, as shown in Fig. 46. Make an overhand knot without pulling the end of the rope through, and then complete the hitch in one of several ways. With a little practice this hitch can be quickly made and is very useful when one wants an eye of a particular size.

The following attractive hitch – the author has never heard a name for it – can be made with medium-sized ropes: a half-hitch (Fig. 47) is

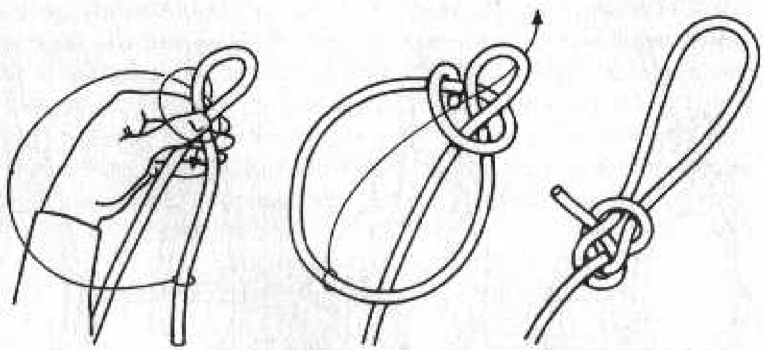


Fig. 47 Standing eye

held in the left hand, a large bight is laid over the wrist or the arm, a smaller one laid outside this one over the thumb and the end gripped with the middle finger and ring finger of the left hand. The big bight is then pulled over the small one and through the half-hitch. The bigger bight determines the size of the eye.

The *midshipman's hitch* (Fig. 48) is best suited for mooring hawsers and other thicker ropes. It is easy to make and holds well. The seizing is made with a length of flag line, heaving line or twine of suitable size.

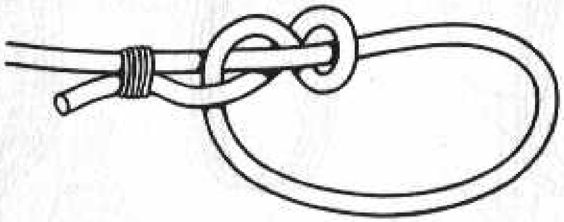


Fig. 48 Midshipman's hitch on a cable

A *bowline on the bight* (Fig. 49) forms the most common double eye on an end. A suitable length of rope is doubled up and the hitch is started in the same way as a bowline but is completed by taking bight *a* down and over both eyes and then round the standing part (Fig. 50). To stiffen the hitch the loose end is usually tied to the rope with a bowline just above the bowline on the bight (Fig. 50). It is easiest to make the bowline first, slightly more than twice the size of the required eye, and then lay it on the bight. The hitch can also be made the same way as the bowline with the bight by pulling it out and forming a third eye as big as the other two (Fig. 51).

These bowlines on the bight have little use at sea nowadays, but they can substitute for a bosun's chair. In this instance the bights are made so long that the knot hangs above the body and the bights are spread slightly apart to provide a broader base on which to sit. It can also be used if there is occasion to hoist a man up a pipe or narrow passage, in which case the bights are put under the armpits and are made small enough for the knot to be immediately above the head. In the event of the man being unconscious his hands should be tied together between his legs with a strip of soft material. The hands may alternatively be placed in his trouser pockets.

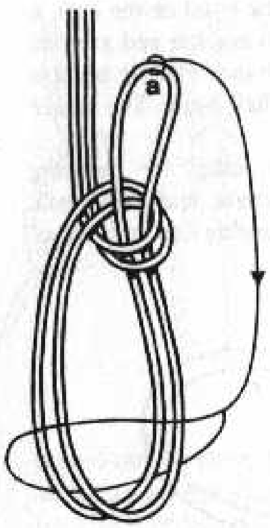


Fig. 49 Bowlines on the bight

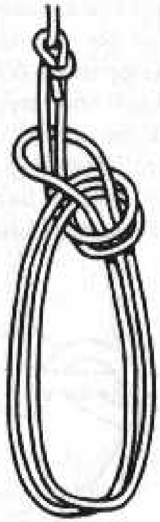


Fig. 50

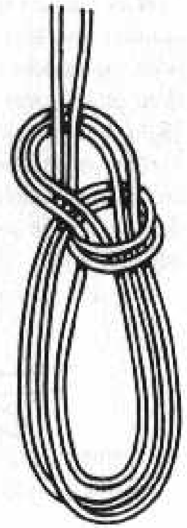


Fig. 51

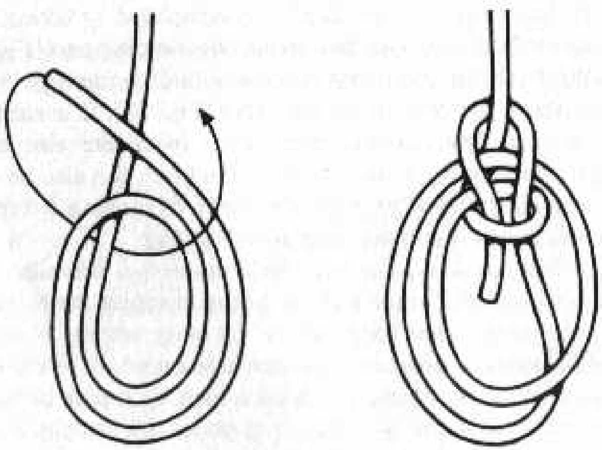


Fig. 52 French bowline

The bowline can be made in several more or less fancy ways. One variation of the bowline on the bight is the *French bowline* (Fig. 52). It is made like the normal one over two turns and is easier if the eyes are to be of a predetermined size. When made around a person the end is pushed from the front under the right arm, taken diagonally over the head – leaving a suitable amount of slack – and pushed from the front under the left arm, the hitch being made above the head or one bight taken under the arms and the other under the seat with the knot over the chest.

A good *running knot* can be made from a double overhand knot around its own standing part (Fig. 53). It makes a strong and

Fig. 53 Running knot

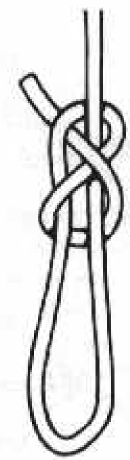


Fig. 54 Running figure of eight knot

attractive knot which runs easily or slowly, depending on how tightly it is finished off. Constructed so that it just carries its own weight it is ideal for retrieving an object such as an oar which has dropped overboard in harbour.

The *running figure of eight knot* (Fig. 54) also makes a good running knot which runs smoothly, and provides a less common use for the Flemish knot or the overhand knot. Both these knots are excellent for tying or lifting parcels. The bight of the running knot is taken around the parcel and tightened. The standing part is then taken around at right angles, a turn being made around the string where the two cross each other on the underside, and tied with two half-hitches when led back to the running knot (Fig. 55). If only one loop of string is required around the parcel, take a turn around the parcel, pull the running knot tight and fasten the standing part with a half-hitch around its short end where it emerges from the knot (Fig. 56). Both ends can also be joined by a reef knot pulled close to the running knot.

The classic *hangman's knot* provides a running noose which does not run as easily as those already mentioned. It is made in the same way as the heaving line knot (Fig. 57) and runs more or less easily, depending on how tight the round turns are made. As a rule it must be pushed together and never slides shut. Old seamen's talk, perhaps stemming from pirate tradition, has it that there should be nine round

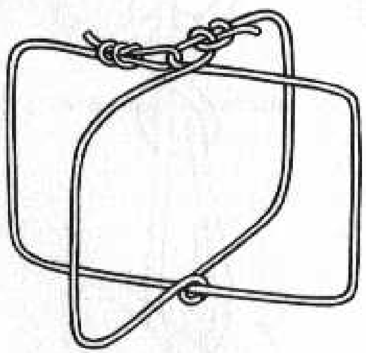


Fig. 55

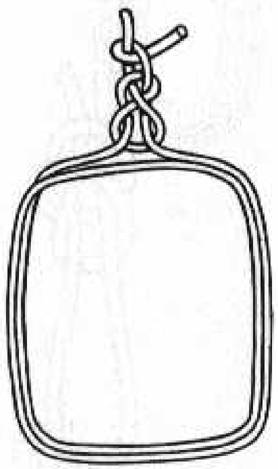


Fig. 56

turns in the knot, one for each life, so that if a man has nine lives like a cat, he will loose them all. The knot does, however, become more supple if it is made with fewer round turns.

A *harness hitch* or *butterfly knot*, where the ends point in opposite directions, is made as shown in Fig. 58 as a loop knot in a bight. It holds well as there is tension on all parts, and is ideal on small sailing vessels when one needs to rig a lead block, lift a work boat by its painter, etc.

The *sheepshank* is used to shorten a rope which is too long. Many different methods are used. The common sheepshank with two half-hitches is made as shown in Fig. 59 and if it is to be used for any

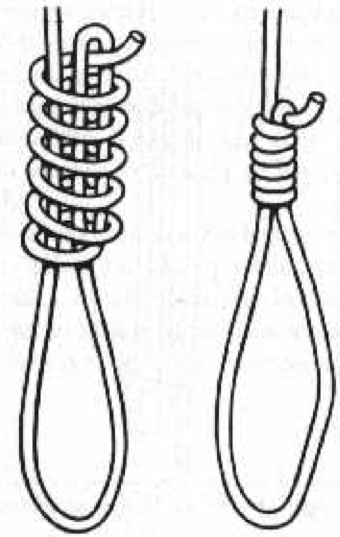


Fig. 57 Hangman's knot

long period of time is always provided with twine seizings at the end. The sheepshank with running knot and half-hitch (Fig. 60) is made from an ordinary overhand knot with the bight pulled out to a suitable length and a half-hitch made around its end. This sheepshank has the advantage that its size can easily be adjusted in order to obtain a desired length of rope.

On unloading whips, when beginning work at the hatch, it is often helpful to make a sheepshank just above the hook so as to retain the initially superfluous length of whip. This sheepshank is made with

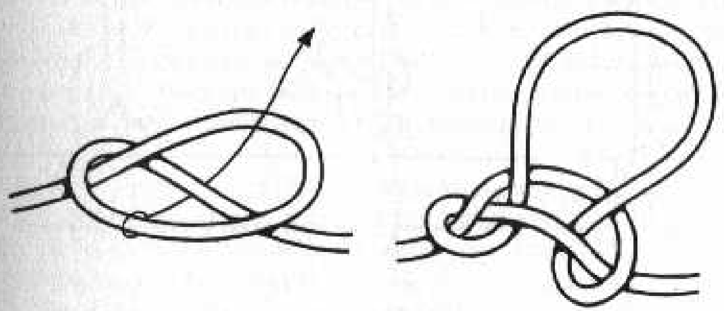
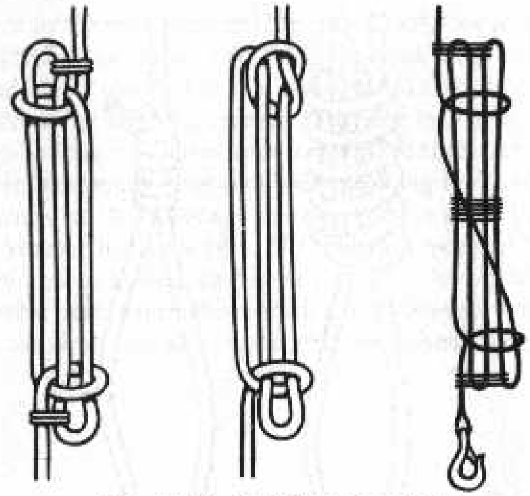


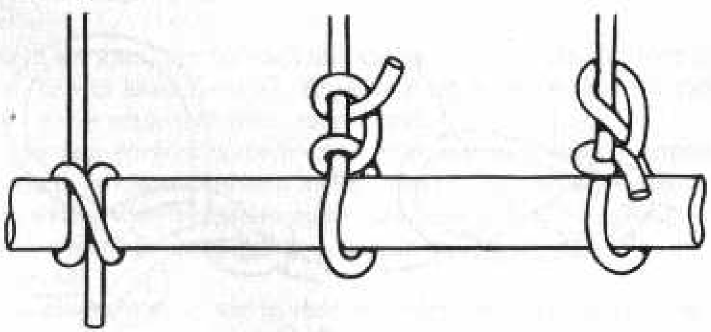
Fig. 58 Harness hitch or butterfly knot



Figs. 59, 60, 61 Various sheepshanks

numerous bights, with half-hitches, and twine frappings around each end and a seizing round the middle (Fig. 61). It is best to have the heaving part of the whip quite short and running through a swivel block above the deck. As one works progressively lower in the hold, or as the heaving parts become worn, a bight is taken out of the sheepshank which served to store the excess length of whip when operations started.

In sailing ships sheepshanks were made on the lower square sail sheets between the leading blocks at the top and the runner blocks, partly to be able to shift or replace the worn sections at the clew and



Figs. 62, 63, 64 Various hitches

blocks and partly to enable the lines to reach the deck when the sail was furled. Two half-hitches make a common and very useful hitch, the *clove* hitch (Fig. 62). It should be made clockwise with ordinary right hand laid rope. It does not hold well around very large objects.

A *clove hitch round the standing part* (Fig. 63) is most useful and holds well. It can be used for holding all sorts of objects, round or square, large or small.

The *buntline hitch* or stunsail tack hitch (Fig. 64) holds excellently but jams badly and is difficult to undo if subjected to strain, and so is seldom used on big ships. Its usefulness lies in the fact that it will not come undone when on a loose end of rope which is not subject to great or even stress, and it is ideal for mooring rowing boats in tidal conditions.

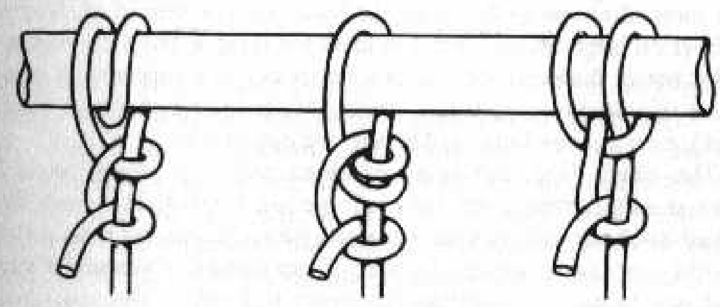


Fig. 65 Various half-hitches

The three basic types of clove hitch are shown above. They can be combined in a variety of ways, with or without round turns, with or without seizings. Figure 65 illustrates some variations. They are, from the left, a round turn with a clove hitch, a clove hitch with a round turn around its own part and a clove hitch with half-hitch around its own part. In the latter one the third half-hitch is made anticlockwise if the other two are made clockwise. All three hitches are suitable for large objects.

The *timber hitch* (Fig. 66) is also suitable for use on large objects. Make a round turn around the object and then snake the end of the rope four to six times around the standing part. Where a long spar is to be hoisted a half-hitch is often made at the end of the spar.

The *fisherman's bend* (Fig. 67) is one of the best hitches for tying a line to a thin object. It is important that the half-hitch, which is made

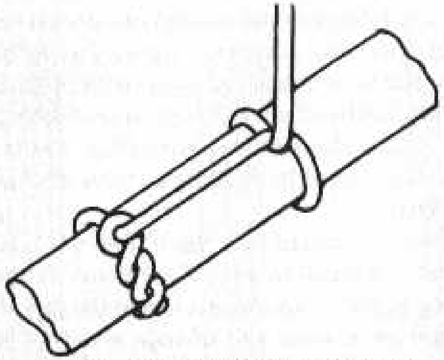


Fig. 66 Timber hitch and half-hitch

under the two round turns, is correctly laid. If it is made forwards, in the same direction as the turns, the hitch will not hold at all. Nor will it hold on large objects, but it is ideal for tying a line to a bucket or paint pot or fastening the end of a boom guy in a ring bolt. It can be made in a second, stands any amount of strain and is always easy to undo, even if it has been used in hoisting operations.

The *clinch* (Fig. 68) is an excellent and very strong hitch for permanently fastening the end of a rope to a ringbolt. It is made from a half-hitch around its standing part, which is secured with a twine seizing, and is also suitable for wire. It can stand any amount of strain and will loosen immediately the strain is lifted or the seizing cut. Clinches were used to secure lines to leech cringles on square sails. Because this hitch is shorter than others it was possible to get the sail closer to the yard when taking it in.

The same hitch was used to tie the anchors to the large anchor

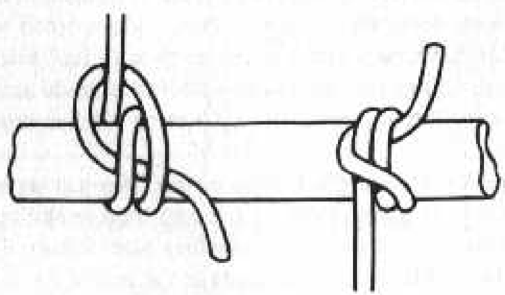


Fig. 67 Fisherman's bend—Left: correct Right: incorrect

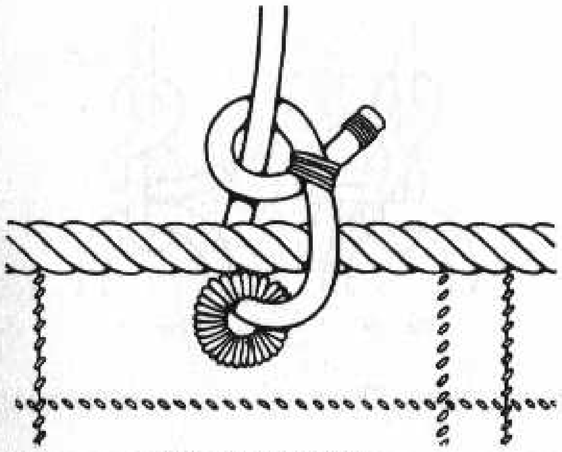


Fig. 68 Inside clinch

ropes. Its advantage was that because the hitch was so short the anchor could be raised with the ring close to the hawse-hole. It was then known as an anchor hitch. Some other hitches were also employed as anchor hitches (Fig. 69). They are very handy and may be described as, from left: a half-hitch around its own part and seizing; a round turn with half-hitch around its own part and seizing; fisherman's bend with seizing; and a backhand hitch with seizing. The last-mentioned is stronger if two round turns are made before making the back turn. The hitch can be varied in several ways.

The *figure of eight overhand hitch* comes a close second to the fisherman's bend for a handy hitch that is easy to make, holds well and is easy to undo (Fig. 70).

It holds excellently around thin or medium sized objects but not as

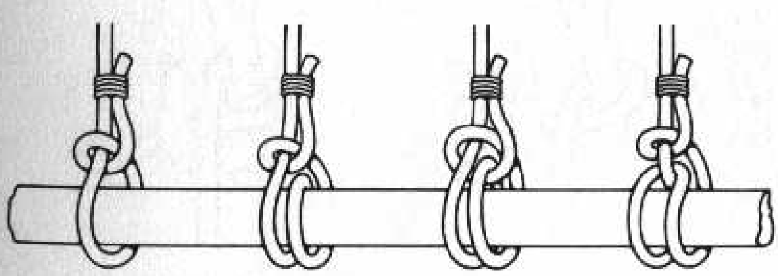


Fig. 69 Various anchor hitches

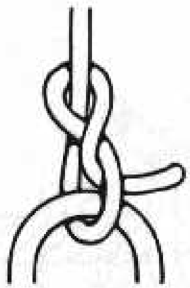


Fig. 70

Fig. 71

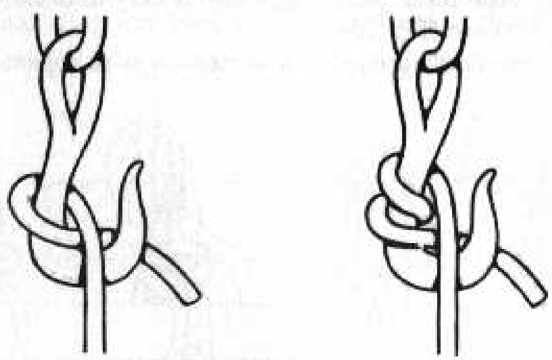
well on thicker objects. This hitch forms the beginning of a timber hitch.

Figure 71 shows a good variation of Fig. 70. Many years ago the author saw an old jib from a small coaster which had been scrapped a long time previously. The sail, which had lain untouched since 1860, had the single fall fastened with this knot.

Both these hitches are excellent for temporary fastenings and deserve attention. They hold well and are always easy to undo, even if they have been used for hoisting.

The *Blackwall hitch* is made by putting a half-hitch around the neck of a hook (Fig. 72). It holds excellently if correctly made and subjected an even strain, but loosens as soon as the strain is taken away. This hitch is particularly suitable for chain.

The *double Blackwall hitch* (Fig. 73) is similar but has two turns



Figs. 72, 73 Blackwall hitch and double Blackwall hitch

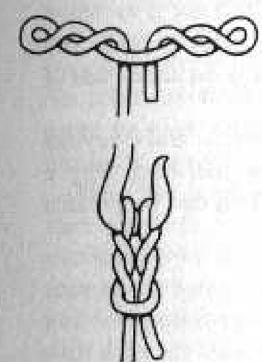


Fig. 74 Cat's paw

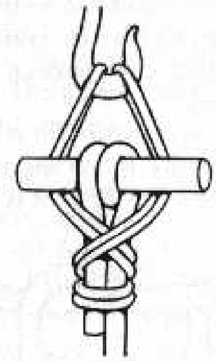


Fig. 75 Strap and toggle

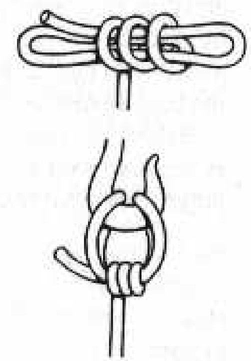


Fig. 76 Dog's shank

around the hook. This must also be laid with the turn correctly positioned if it is to hold.

The *cat's paw* (Fig. 74), the *strop and toggle* (Fig. 75) and the *dog's shank* (Fig. 76) are used to set up rigging with lanyards, etc. The strop and toggle is used when the end to be tied on is very short. The strop used should be a soft rope strop.

Fig. 77 shows a hitch which is an excellent *hook hitch*. It is made as shown in the illustration. It holds well and can be made with a relatively short end of rope and never jams.

The *reef knot* or *square knot* (Fig. 78) is the most common of all knots. It is ideal for slender lines and cord. In Swedish it is called a roband knot, originating from the robands or seizings with which the square sails were fastened to the yard. At sea the knot was mostly used for reefing sails. It is easy to undo, which is particularly advantageous when reefing. A reef must not only be taken in, it has to

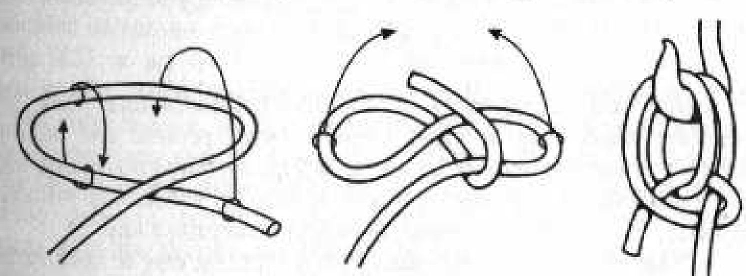


Fig. 77 Hitch for a hook

be taken out again after gales and bad weather. The knot is loosened by pulling out one of the ends, which causes the other to 'calf' and loosen so it can be pushed off, or by pushing the parts on either side of the knot against each others.

Ashore the reef knot is mainly used for tying parcels, and everyone is familiar with the neccessity of holding the first half-hitch with a finger to prevent it slipping when the knot is tied. This can be avoided

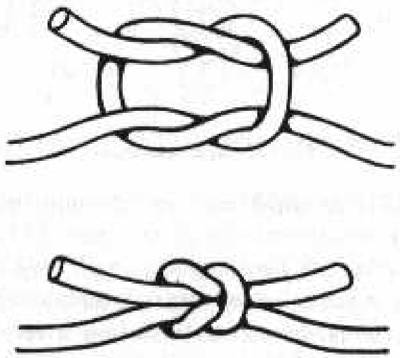


Fig. 78 Reef knot or square knot

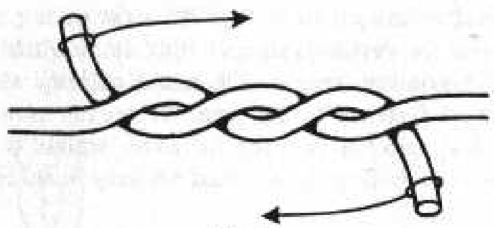


Fig. 79

by taking two round turns in the first half-hitch and then, by tightening them with a rapid circular twist, reverse the pulling direction of the two ends of string, as in Fig. 79. The knot which has now been started will not slip and it can be completed without difficulty. The result is sometimes known as a *surgeon's knot*.

The reef knot can also be made with a bight on one or both ends, and is commonly used on shoelaces this way as it can be easily slipped.

The *granny knot* (Fig. 80) is regarded contemptuously by seamen. It is made in the same way as the reef knot but both half-hitches are laid in the same direction. (In the reef knot one is laid clockwise and the other anticlockwise.) The granny knot does not hold and should never be used. One should, however, know about it – if only so as to be able to avoid it.

The *sheet bend* or *common bend* is suitable for thicker ropes but is also excellent for use with thinner ropes. It must be made in a particular way if it is to hold fast namely with both short ends of the rope on the same side (Fig. 81). A sheet bend is loosened by bending it and then pushing the bight down on the half-hitch. It can also be made with different sizes of rope, in which case the bight should be made in

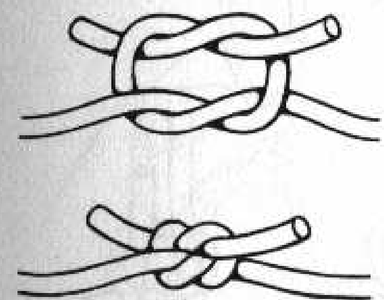


Fig. 80 Granny knot

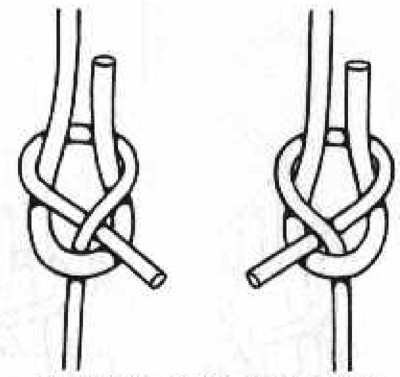
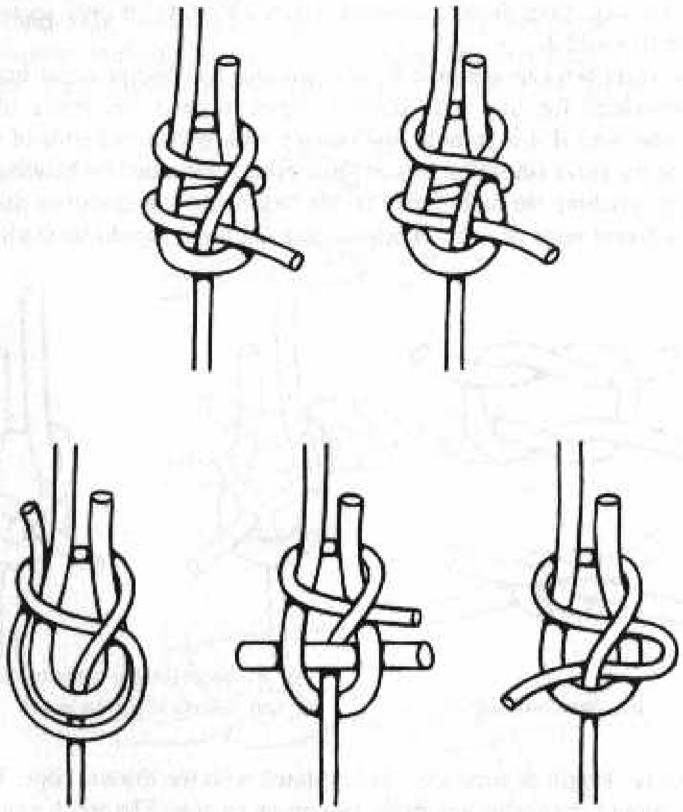


Fig. 81 Sheet bend or common bend.
Left: correct Right: incorrect

the thicker length of rope and the half-hitch with the thinner rope. The ropes should, however, not differ too much in size. The hitch can be doubled in various ways (Fig. 82–84) and can be made with a toggle (Fig. 85) or an eye (Fig. 86). Of the three doubled versions, the one in Fig. 83 is superior to the one in Fig. 82, particularly when thick rope is used, as it is easier to make, is not quite as clumsy, can never jam and is always easy to undo. However, the one in Fig. 82 is better if the difference in the size of the ropes is very great; one can then also take several, say between three and five, turns with the thinner line around the bight of the thicker one. The bend in Fig. 84 is initially an ordinary sheet bend which is doubled as shown in the illustration. It is an excellent bend and the best for towing at sea, towing overland or movement in general. The bight of the hitch is turned forwards in the direction of the movement so that the ends are left to trail behind.



Figs. 82, 83, 84, 85, 86 Various doubled sheet bends

The hitches in Fig. 85, 86 have no great significance but can sometimes come in handy when a hawser has to be lifted with a winch. As a rule the effect of the toggle is that the knot in which it has been introduced will be inclined to slip and therefore has to be secured with another half-hitch or a simple seizing on one of the rope ends, but it makes the knot easier to undo and to some extent prevents the rope breaking in the knot by making it take a less sharp bend.

With twine and string the sheet bend is made over the left thumb,

when it is known as a *weaver's knot* (Fig. 87). Both lengths of string are laid in a cross, the right hand string being placed underneath and held fast with the thumb and index finger of the left hand. The right hand string is then taken over and outside the thumb, under its own end and over the end of the left hand string. The left hand string is then bent over the right hand string towards the thumb and, when the thumb is taken away, taken through the eye formed by the right hand string. The bend is then pulled tight.

On thin and medium-thick ropes up to heaving line size, a *double sheet bend* is most easily made over the left hand. Take both lines in the left hand with the ends parallel and pointing outside the thumb (Fig. 88). One of the lines – if they are of equal thickness it does not

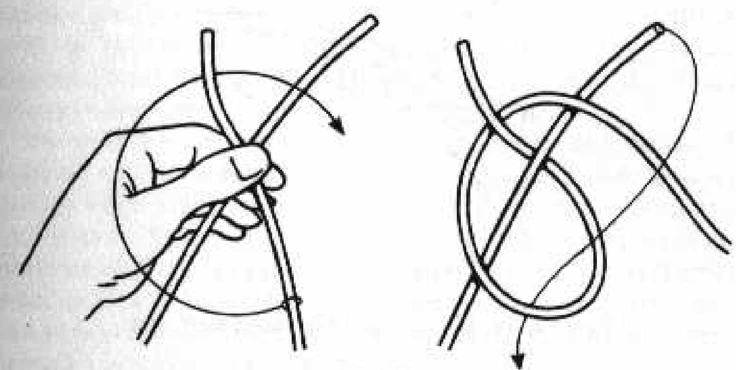
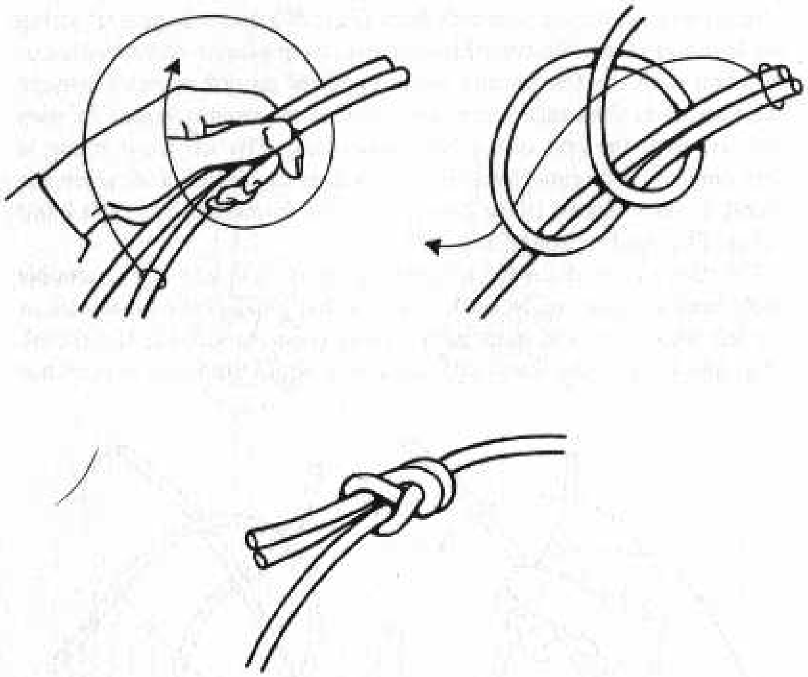


Fig. 87

matter which – is taken twice around the hand, the second turn outside the first. Both ends are bent back over the second turn and under the first (Fig. 89) and the hitch is then pulled together (Fig. 90). This is on the whole the same hitch as in Fig. 84. If the lines are of different sizes, the turns over the hand should be made with the thinner line.

The *rope yarn* or *spun yarn knot* (Fig. 91) is not very much used now as the practice of spinning spun yarn to use on board ship has been discontinued. It is made by splitting the rope yarn, laying the two against each other and making an ordinary round turn on the side that is bigger when split. The other ends go into the knot as shown in the illustration. This knot can also be made with two or three-stranded yarn. It is the smallest of all knots but not as strong as a reef knot.



Figs. 88, 89, 90 Variation of the double sheet bend

The *water knot* (Fig. 92), also known as the Englishman's knot, is suitable for use with all cordage, even thick hawsers. It consists of two overhand knots which act as stopper knots against each other. These knots hold well but are difficult to undo if they have been used for lifting. It is one of the best knots to tie together strops if there is no time to splice them. They can also be made with double overhand knots (Fig. 93), which makes them bigger and easier to undo and able even to hold slippery catgut.

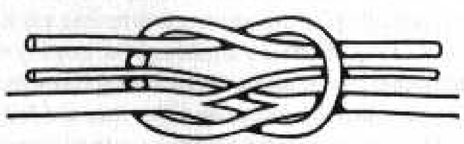
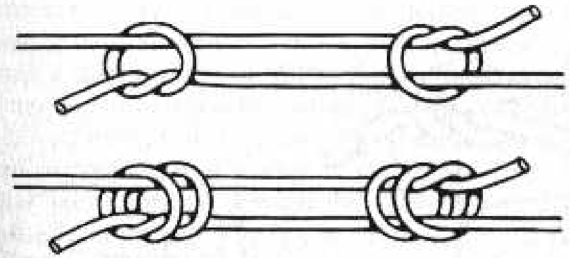


Fig. 91



Figs. 92, 93 Single and double water knots

The common *overhand knot* made on two parallel ends (Fig. 94) makes a simple knot but is not entirely satisfactory because the ends leave the knot in parallel. It is never used with rope but is a useful temporary knot on flag lines when signalling, as it is quicker to make than any other knot.

The *ordinary* or *overhand bend* (Fig. 95) is suitable for thin materials such as fishing line. It consists of a single overhand knot through which both lines are pushed, but in different directions. It can also be made from a double overhand knot or from a figure of eight overhand knot and is then one of the safest knots for gut; being rather larger, with soft bights, it does not break stiff nylon fishing line. A knot should first be made on one part and the other part then threaded through it in the opposite direction.

The *short end bend* can be made in two ways. In the first method, which is better, an ordinary running knot is made on the end which is

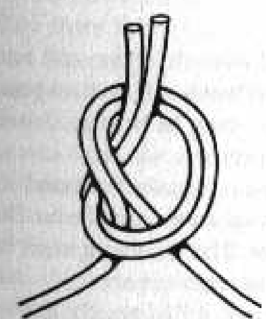


Fig. 94 Overhand knot

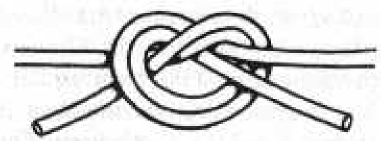


Fig. 95 Ordinary bend or overhand bend

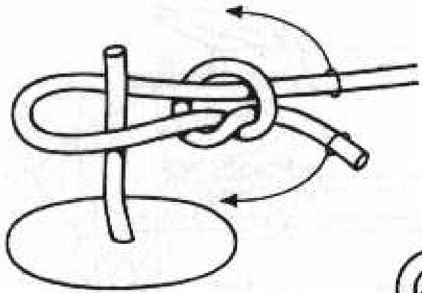


Fig. 96 Short end bend

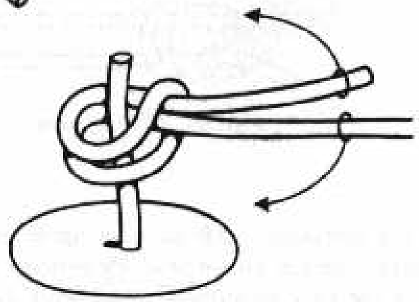


Fig. 97 Short end bend

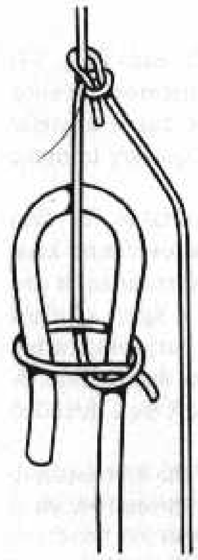


Fig. 98 Heaving line bend

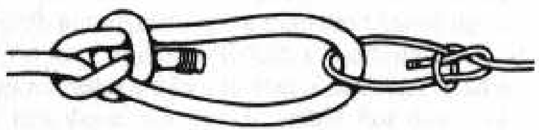


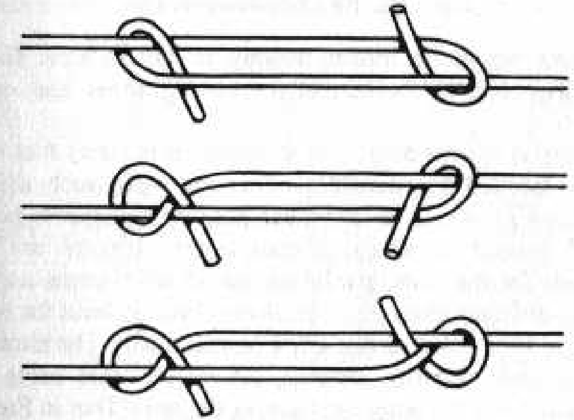
Fig. 99 Two bowlines in each other

to be knotted (Fig. 96). This is then pushed over the short end and pulled apart, the running knot sliding over and becoming a sheet bend together with the short end. The running knot must be held as shown in the illustration if the sheet bend is to be correct.

In the second method the bight of the rope is 'sneaked' around its own part forming a lark's head (Fig. 97). It is then threaded over the short end and pulled apart, forming a reef knot. The threading must be done in a particular way in order to achieve the correct knot.

The *heaving line bend* is used when two ropes differ greatly in size (Fig. 98). It can be made in an instant and is suitable not only for

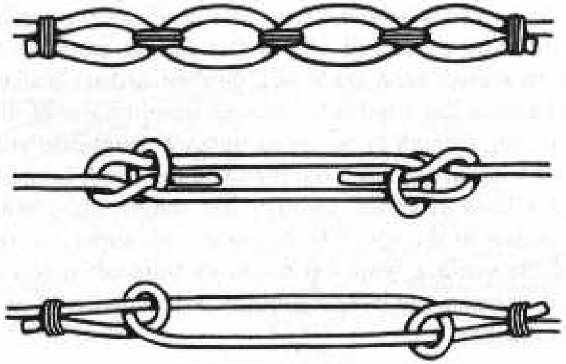
taking a mooring rope ashore but also for sending up a gantline with a flag halyard. The other end of the flag line is attached above the gantline with a sheet bend made as a bowline and serves for lowering with. The heaving line bend is far enough from the end of the gantline so that it is long enough to be pulled through the sheave at the top of the flagstaff without the hitch having to be loosened. Immediately the gantline has been threaded through the sheave an overhand knot should be made on the end. The flag line is loosened and fastened to the end of the gantline with a fisherman's bend or clove hitch made inside the overhand knot. The gantline is then lowered at the same time as the flag line.



Figs. 100, 101, 102 Wire bends

Two bowlines in each other (Fig. 99) make another useful hitch when there is a great difference in the thicknesses of two lines. It is used, for example, when boarding a ship from a lifeboat in open sea in bad weather. The bowline on the lifeboat's painter can be made in good time and a new bowline rapidly made with the heaving line thrown from the ship which is to be boarded. The hitch is of course also ideal for taking thick mooring ropes ashore with a heaving line.

On ordinary wire rope two half-hitches are best. They are laid with the ends pointing in different directions (Fig. 100). For leather thongs, bast, bamboo rope and similar semi-stiff ropes the hitches illustrated in Fig. 101 and Fig. 102 are used and frequently give better results. These hitches also hold well on ordinary wire and, if necessary, can be



Figs. 103, 104, 105 Hawser bends

used for tying together a broken hauling or shifting wire. The hitch shown in Fig. 102 is also useful for towing ropes and ordinary hawsers.

As hauling is always done with wire now, it is rarely that hawsers have to be knotted together. On occasions when such a hitch is required it has to be long so that it can pass through hawse-holes and be heaved around a winch. Consequently, seizings are almost always made on the ends, partly for the above reasons and partly because the ordinary hitch does not always hold without the help of a seizing. Figs. 103–106 illustrate a few hawser bends. The hitch in Fig. 103 is made entirely with seizings, the middle ones being laid in zig-zag fashion and the outer ones across the ends. That in Fig. 104 is stronger than two ordinary bowlines in each other (Fig. 99). Fig. 105 illustrates a supple hitch, but one which needs good seizings if it

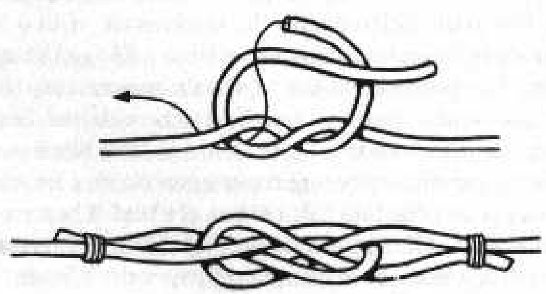


Fig. 106 Carrick bend

is to hold on wire. It holds excellently on ropes and is used to rig gantlines.

Fig. 106 illustrates a Carrick bend, but in the final half-hitch the one end is taken under its own standing part. The English name has its origin in Carrick Roads, outside Falmouth, where tens of thousands of deep-sea sailing ships sailed for orders and which was named after the west-European type of ships of the late Middle Ages.

Knots for nylon and synthetic ropes

Certain rules must be followed when knotting slippery synthetic lines and fishing line or the knots will slip easily. These materials tend to be rather stiff and will loose some of their strength and break in the

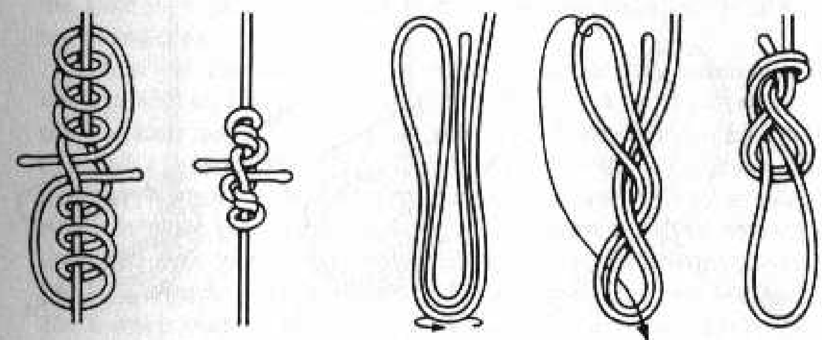


Fig. 107 Knots on nylon lines

knot if bent too sharply. The knots should therefore be made elongated with gentle bends if they are to hold. It is also frequently necessary to melt the ends of the line with a burning match in order to form a small knob to stop the ends of the line sliding out of the knot. The knots illustrated in Figs. 107 and 108 can be used on both ordinary nylon fishing line and on spun fishing line, and are easy to make. Two lines are knotted together as shown in the illustration on the left (Fig. 107). One is laid three or four times around the other and the end is bent back between both lines. The other end is then laid around the first and is pushed between both lines.

To form an eye, the line is folded twice and a round turn is twisted into the quadrupled part. The single bight, which is to form the eye, is then pushed through the double bight.

Fig. 108 illustrates fastening a leader to an object. The drawing on the left needs no explanation. A hook is best attached in this manner. After being threaded on the line is bent into two round turns and the end knotted with an ordinary overhand knot. The hook is then pushed through the bights, as illustrated, and the knot is pushed together. All these nylon knots can be varied.

On thicker fishing line these knots can be quite clumsy. The water knot (Fig. 93) can be used on multi-stranded line, or the double water knot may be used. This is made the same way as the single water knot (Fig. 95), but can also be made from a double overhand knot (Fig. 38). In this case the ends of the strands should also be fused into a ball to prevent the knot from slipping.

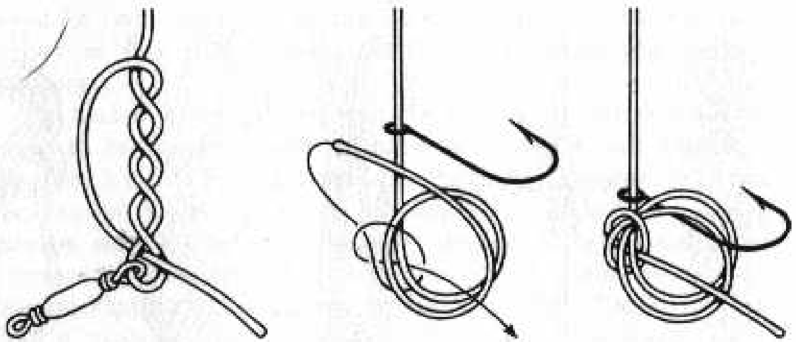


Fig. 108 Hitches on nylon lines

Knots with a rope's own strands

First a wall and next a crown
Now tuck up and then stick down.

Knots with a rope's own end are less often used nowadays. Modern merchant ships are rigged and fitted out without them, and the seaman who can make these knots has few opportunities to put his knowledge into practice. Some small vessels, however, do still have rigging fastened with deadeyes and Mathew Walker knots; many ships still have wooden buckets with rope handles; and modern liners use ropework guardrails for their big fore-and-aft ladders.

For these reasons it has been considered necessary to include some of the more unusual knots. A complete catalogue of all knots in this category would certainly run to between 200 and 300 and is not practical, so only the most common classic ones have been included. The oldest of these is probably the Mathew Walker knot, described in an English book, *The Seaman's Dictionary*, as early as 1644.

Hemp is ideal for making knots with a rope's own end and for making plaits. Cotton also gives good results, while manila, because of its fluffy nature, does not enable very neat work. If particularly neat work is required linen ribbon or thin sailcloth should be sewn over the strands before making the knot. This should be very carefully done and in such a manner that the weave spirals around the strand so as to avoid folds and wrinkles when the knot is made. When the strands are opened out it is best to make a small whipping around the rope to get the knot in a particular position and to get the right length of the remaining rope.

Almost all the knots can be made on three- or four-stranded cordage without altering its construction. Most such knots can also be doubled after they have been made single. Each strand is then allowed to follow a pre-existing strand around the knot up to the end point, so that the parts of the finished knot consist of double strands in pairs which form the plaitings of the knot. If a single knot is to be doubled, the single knot must first be laid fairly loosely to leave room for the subsequent tucks. The strands should be slightly pointed, whipped, and a sharp marline spike or pricker used to make openings for the tucks. In the knots with a rope's own strands which we will describe here, the strands are identified by the letters *a*, *b* and *c*, counted anticlockwise around the rope, presuming that the rope is laid right-handed. The lettering is shown in Fig. 109 and may be considered applicable to all knots with a rope's own end described here.

The *Mathew Walker knot* on a three-stranded rope is the simplest of all knots with a rope's own end. It is laid as shown in Fig. 109. The rope is opened to the length of two turns, and the knot is laid anticlockwise with the lay of the rope. Strand *a* is laid outside strand *b* and up and between it and strand *c*. Strand *b* is laid outside *c* and up and between strands *c* and *a*. Finally, strand *c* is laid outside *a* and tucked from underneath up through the bight formed by *a*, and all parts are pulled tight.

The knot is laid the same way with four-stranded rope and is then four-sided.

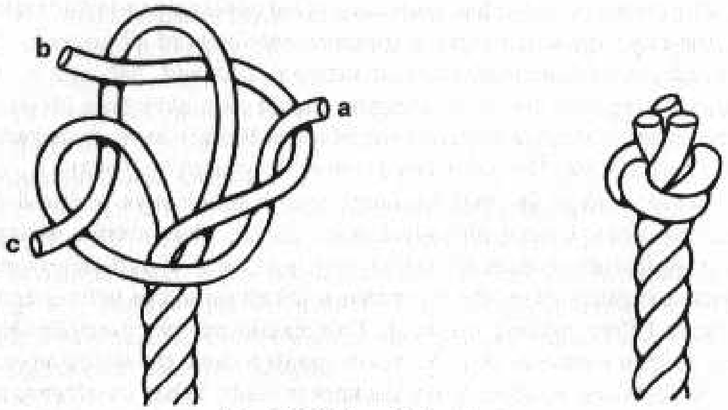


Fig. 109 Mathew Walker knot

This is not a particularly big knot and is seldom used simply as described here, but forms the beginning of a number of other knots. For this reason it is important to thoroughly understand it and be able to make it.

If a longer length of rope is opened, the strands can be laid back again after the knot has been made, leaving the knot in the middle of the rope. This applies to all knots where the strands come out in the centre of the upper side of the knot. One should, if one wishes to lay the strands together, handle them with care to preserve their twist. Otherwise it is common with this type of knot, where the strands come out in the centre of the knot, to make a short palm and needle whipping as close as possible to the knot and then trim the strands off, as in Figs. 110 and 113.

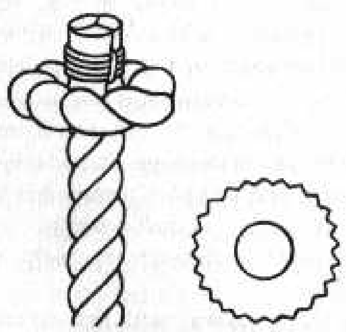
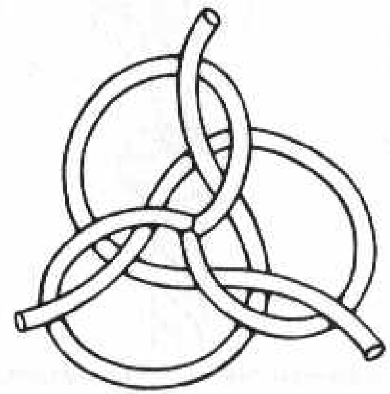


Fig. 110 Doubled Mathew Walker

The single knot can be doubled in two ways. One way is to take strand *a* (Fig. 109) once around strand *c* and tuck it from under through the bight of *c* next to *b*. Strand *b* then is allowed to go around *b* and is tucked up through *b* next to *a*. This doubling results in a flat knot which becomes round or six-pointed (Fig. 110). A palm and needle whipping is put on the strands as close as possible to the knot and they are cut off as short as possible. This knot is one of the most suitable for bails for wooden buckets. Used for this purpose it is usual to fit a leather strip under the knot. The different parts should be carefully and evenly gathered to achieve a symmetrical knot.

In the second method the knot is doubled so that strand *a* follows outside all the way and under strand *c* and is tucked up in its



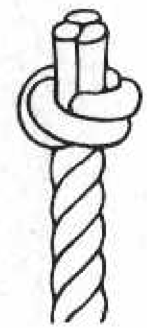


Fig. 111 Doubled Mathew Walker Fig. 112 Doubled Mathew Walker

own bight. Strand *b* follows *a*, and *c* follows *b*. This produces a taller knot and one that is more triangular than one made by the first method (Fig. 111).

Fig. 112 shows a Mathew Walker knot which has been made double initially. Strand *a* is laid anticlockwise under *b* and under *c* and is tucked up between *c* and *a*. Strand *b* is laid over and outside the bight of *a* and up between *a* and *b*. Finally, strand *c* is laid outside the end of *a* under *a* and *b* and up through the bights of *a* and *b*, so that it comes between *b* and *c*. The knot is then tightened up and the strands are whipped. Lanyard rope was always four-stranded and this knot, made on four-stranded cordage, produced the common Mathew Walker knot used on the standing part of lanyards used with deadeyes

(Fig. 113). The ends were not usually cut off but were left outside the whipping until the knot had been fully stretched. After a few weeks' sailing the whippings had moved closer to the knot, which was then hard and tight. The strands were then cut off close to the whippings and the ends tarred. On four-stranded lanyard rope the knot can be made with each strand laid under three, which makes the knot even fuller.

The *double Mathew Walker knot* (longshoreman's knot or snake's head in Swedish) is made in a similar way to the Mathew Walker, but each strand is laid completely around the rope and up through its own

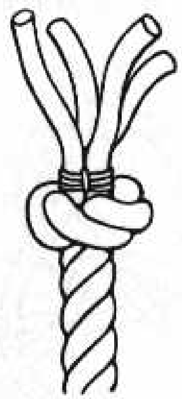


Fig. 113 Mathew Walker on lanyard

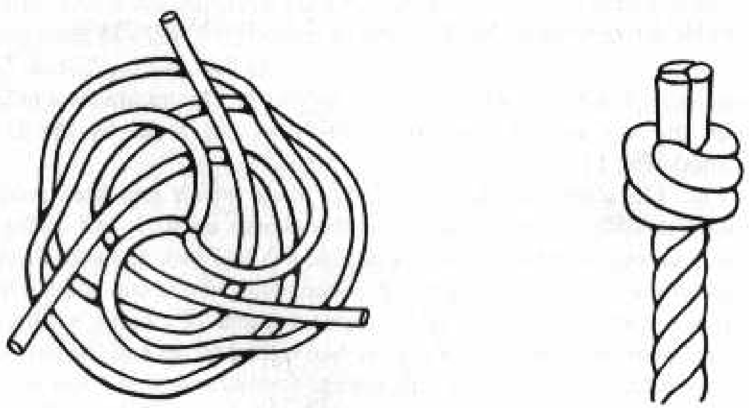


Fig. 114 Double Mathew Walker

bight. Strand *a* is laid under *b*, under *c* and under *a* and up between *a* and *b*. Strands *b* and *c* are laid in the same way and the knot then tightened (Fig. 114). If the knot is made with four strands it is called a turban knot in Swedish and becomes very elongated. It can be rolled between two planks, which results in an even, smooth cylindrical knot with quite a unique appearance. It is fairly difficult to tighten but the strands bind well and can be cut off close to the knot without having to be whipped. When making more intricate knots it is a good idea to grease the strands lightly so that the knot will be easier to tighten.

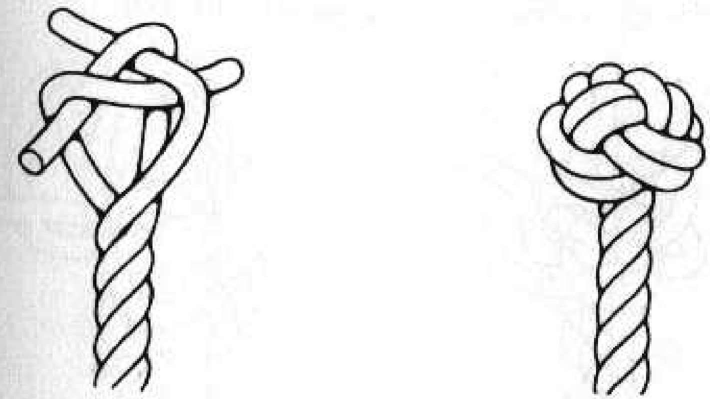


Fig. 115 Crown or crown knot and manrope knot

The *manrope knot* (Fig. 115) is an attractive flat, oval knot which gets its name from the old manropes – the ropes which served as handrails for ladders outboard and gangway ladders. The knot is first laid single. Begin with a single Mathew Walker (Fig. 109) over which lay a crown, as in the drawing on the left in Fig. 115. Strand *a* is bent down inside *b*, *b* is bent down inside *c*, and *c* is tucked through the bight formed by *a*. The crown is gathered to the existing simple Mathew Walker and together with this forms a simple manrope knot. In practice, however, this knot is never used as a stopper as it holds poorly, because the strands easily come loose from under the crown if they are cut off. The knot is doubled by letting the strands follow one strand each through the Mathew Walker and then through the crown. The final tucks are made not only under the parts of the crown but right down through the whole of the knot so that they come out on the underside close to the rope, where they are cut off. The knot must initially be laid fairly loosely so as to leave room for later tucks.

The *diamond knot* (Fig. 116) is started by bending the opened strands down along the rope. The strand *a* is taken outside *b* and up through the bight of *c*. Strand *b* is taken outside *c* and up through the bight of *a*. Finally *c* is taken outside *a* and up through the bight of *b*. The doubling is done in the usual manner by allowing the strands to follow the parts around the knot to emerge in the centre of the upper side, where they can be cut off. This knot is attractively symmetrical and is one of the best knots for laying in the middle of a rope. The strands are opened to the desired length, the knot is made single or double and the strands are laid together again (Fig. 117).

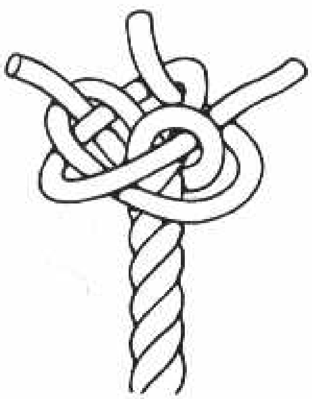


Fig. 116 Diamond knot

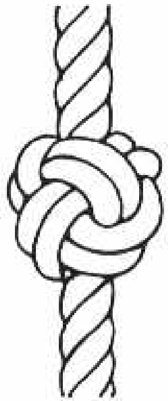


Fig. 117 Diamond knot in the middle of a rope

The *rose knot* can be made in two ways. The first method is to start it with a crown knot, below which a simple Mathew Walker is made (Fig. 118). The crown knot is first doubled and then the Mathew Walker. The strands then come out of the centre of the knot on its periphery where they can either be cut off or be tucked by the shortest way out through the middle of the crown knot. They could also follow the crown knot round to a third doubling and then be pushed straight through the knot and cut on the underside. This rose knot becomes quite similar to the manrope knot but assumes a more spherical shape.

In this second method the knot is also begun with a crown knot, under which a diamond knot is laid (Fig. 119) and the knot is then

doubled in the usual way. The strands here also emerge from the middle of the knot on its periphery and can be tucked by the shortest way out through the middle of the crown knot, where they are cut, or otherwise be allowed to follow the crown knot to a third doubling and then tucked out through the knot on its underside, where they are cut. This knot is larger than the previous one and a more raised oval shape. It assumes a more attractive shape if a large filling whipping is made close under the crown knot, which forms the core of the knot.

The *star knot* (Fig. 120) is very easy to make. It can be made from three to six strands and becomes three- to six-pointed. It is most attractive if made with five strands. If it is made on rope the missing

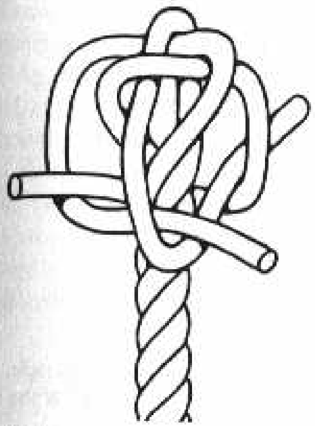


Fig. 118 Smaller rose knot

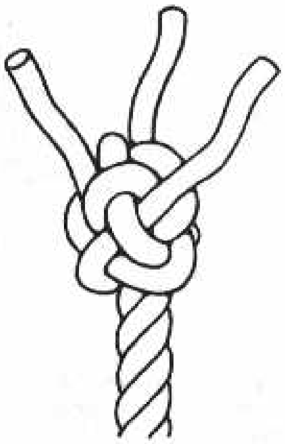


Fig. 119 Larger rose knot

strands must be sewn on in the whipping under the knot, or part the strands of the rope into the required number of smaller strands. It requires care to get these strands round and uniform but this is the best method if the knot is to be made on thick rope. Sometimes the strands are sewn over with cloth.

The bottom of the knot is made with a half-hitch on each strand, the ends being tucked from the bottom up through the half-hitch nearest to the right (left figure). The strands are bent towards the left and a half-hitch is made around the nearest strand where it emerges from the half-hitch at the bottom, so that all ends of the strands point inwards towards the middle of the knot (see centre illustration). Each strand is then laid over the nearest strand and is tucked down through

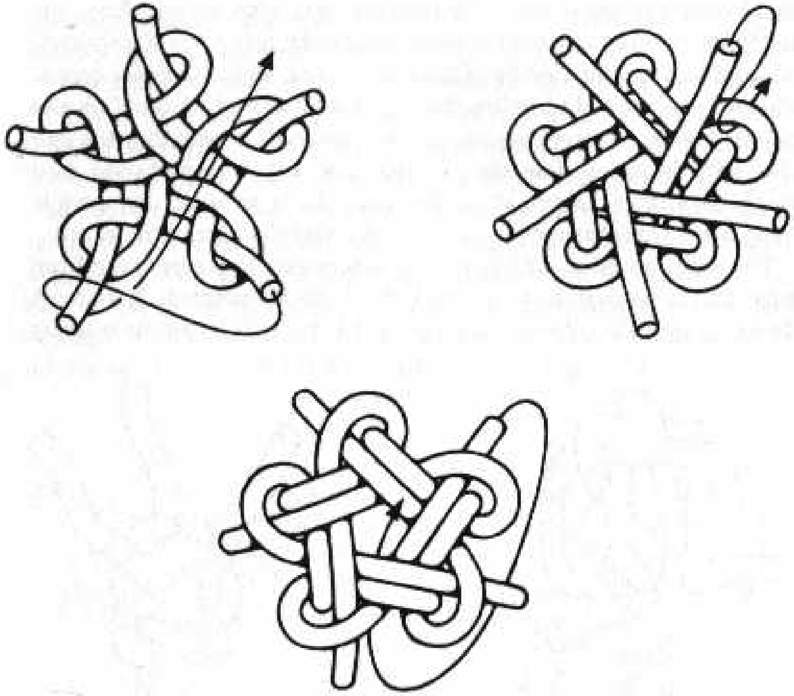


Fig. 120 Star knot The drawing on the top left shows the bottom layer, the top right drawing shows the upper layer and the bottom drawing shows the completion of the knot

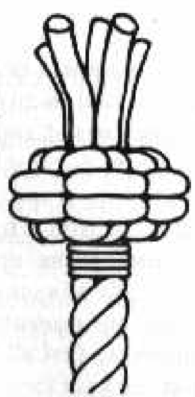


Fig. 121 Side view of star knot

the next pair of half-hitches to the right (see right hand illustration). Finally, the strands follow the adjacent part on the underside of the knot back towards the left and are tucked up through the knot so that all the strands emerge through the middle of the knot, where they are cut short, and perhaps whipped together as shown in Fig. 113. Fig. 121 shows the knot from the side. Sometimes the strands are allowed to form an upside down or inverted crown knot by being taken over the nearest strand to the right and tucked down through the middle of the knot, after which they are cut under the knot.

Plaiting and ornamental ropework

Ordinary *common sennits* are made with three strands by laying the outermost strand from each side in the middle between the other two (Fig. 122a). The sennit is always held with the thumb and index finger of the left hand and the strands are laid with the right hand. The multi-stranded common sennit is made with an odd number of strands – five, seven or nine – seldom more. The strands are grouped in two, so there is always an extra strand in one half. The strands are laid alternately from one side to the other, the outermost strand being taken from the side with more strands. Fig. 122b shows a common sennit with seven strands.

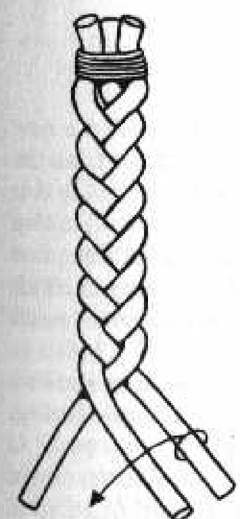


Fig. 122a Common sennit

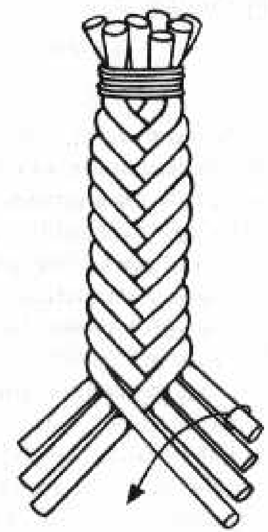


Fig. 122b Common sennit with seven strands

Bag-o-wrinkle was commonly used to protect the sails against wear from both standing and running rigging, particularly in the large latter-day sailing ships which had wire rigging. The sennit is made from 10–15 cm (4–6 in.) lengths of manila or hemp yarn around two parallel lengths of taut spun yarn or marline. The short lengths of yarn are usually used two by two to achieve a tighter sennit, and are slipped around core yarns as shown in Fig. 123. A wooden pin holds the taut yarns apart where work is being done and the yarn ends are pushed tightly together as they are put on. The sennit is made in long lengths and is wound around shrouds and other rigging which the sails are likely to chafe against. The completed sennit looks like a shaggy bottle brush after it has been put on.

The flat sennit and the bag-o-wrinkle were often made from short yarns only. There were various methods, one of them resembling an

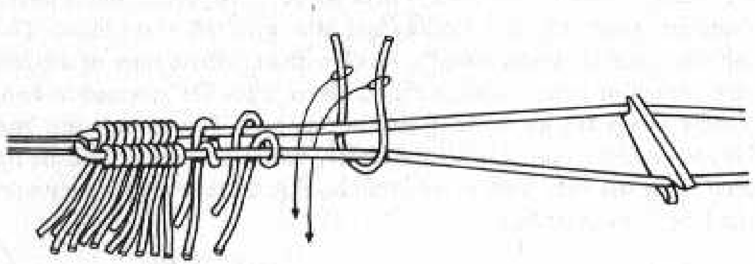


Fig. 123 Bag-o-wrinkle

ordinary plait with three, four or five yarns. For each round a new short yarn was laid in the sennit. Each time yarn was put in from the right two yarns – the outermost and the one laid in last – and to this was added a new yarn so that three yarns were laid into the plaiting from the right. Each time yarn was laid from the left the two outermost yarns were excluded, forming the brush in the sennit. This type of sennit was, however, not very strong and could be pulled apart if stretched tightly.

A better way of laying a sennit with four yarns, two long and two short, so that the short ones are constantly renewed, is shown in Fig. 124. The plaiting is laid continuously from right to left. Yarn No. 1 is laid across the others towards the left. Yarn 2 is laid behind the others and over yarn 1. Then a new short yarn is laid in parallel to 1 and is called 5. This comprises one round in the plaiting, and is repeated.

Yarn 3 is laid over yarns 4 and 2 to the left. Yarn 4 is laid behind 2 and over 3, and yarn 6, a new short yarn, is laid parallel with 3. This completes the second round. Now yarn 5 is laid behind 6 and over 2 and 4 to the left, and so on. The drawing on the right shows the completed sennit. It can also be made with three long and three short yarns, which makes it firmer. To make the laying easier, work with moderate lengths of yarns 2 and 4 and knot in new yarns as the need arises. The ends of the knots are allowed to go into the bush of the sennit. This sennit is similar in use to the bag-o-wrinkle first described.

The *French sennit* is also laid from an odd number of yarns, the number varying according to the thickness of the yarn and the

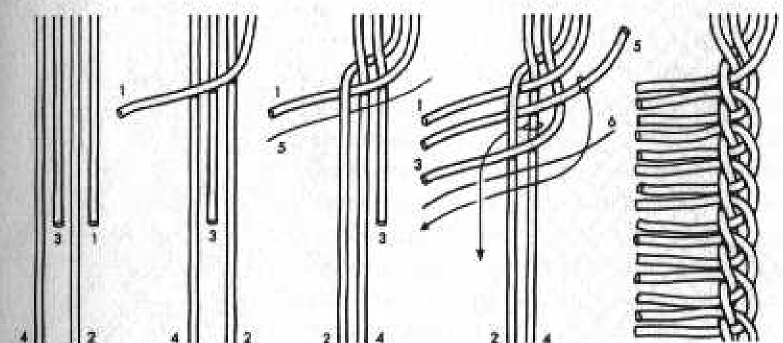


Fig. 124 Flat sennit

required width of the sennit. The number of yarns is halved so that one side always has one more yarn than the other. The outer yarn is taken alternately from the bigger side and laid in towards the middle, being plaited over-under-over the other yarns on the same side. Fig. 125a shows a nine-yarn French sennit drawn fairly open to make the illustration clearer. If the sennit is broadly made, with many yarns, it is called a French sennit. If it is laid with tarred hemp yarn it is very difficult to achieve denseness and has to be pushed together with a special wooden knife.

The *paunch mat* or *wrought mat* (English mat in Swedish) is a good chafe mat. The material for the mat depends on its size and intended use, but the best result is obtained if it is laid from strands that retain the twist they had in the rope. For a more unusual mat the strands from a heaving line are suitable, and for a bigger mat strands from a 2–3 in. rope are used. As with all work of this sort hemp will produce the best result. The strands should be about two and a half times longer than the desired length of the mat and should be hung from the centre over a horizontally strung spun yarn or line. The mat is made as shown in Fig. 125b. Each pair of adjacent strands is taken a half turn anticlockwise around each other. The mat is laid alternately from either side in towards the middle, so that it forms a central point during the laying. In order to be able to hold the mat tightly enough it

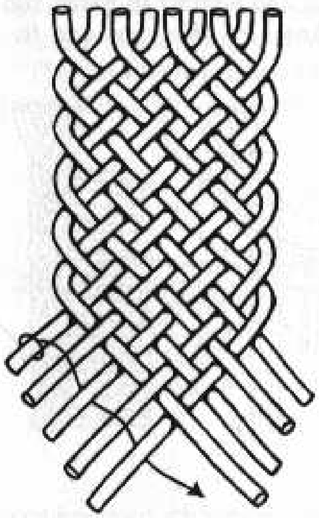


Fig. 125a French sennit

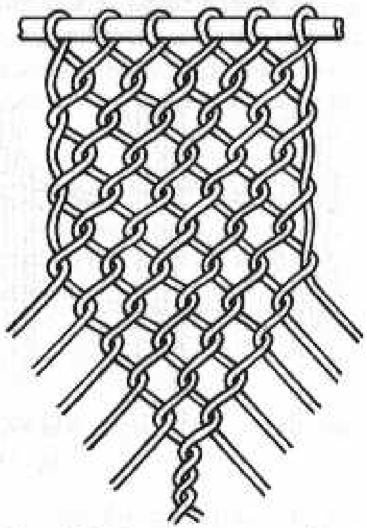


Fig. 125b Paunch mat or wrought mat

is necessary to lay together the two middle strands with several turns which must be remade for each new strand laid down towards the middle. The middle strands can also be knotted together with a half-hitch, which is moved from strand to strand, but this tends to destroy their twist. When the mat has achieved its full length at the point, both middle strands are halved and the halves are knotted to each other with a half-hitch around a spun yarn or other suitable thin line, which is laid across the mat and forms its finish. As the side strands are laid down to the spun yarn they are fastened in the same manner and finally the yarn ends outside the half-hitch are put back

into their strands with a couple of tucks with the help of a marline spike. This finishes the mat. The yarns over which the mat is begun and finished are not cut off short but are used for a seizing to prevent chafing. If the mat is to be fastened to wood, it is nailed on with copper nails. Paunch mats always used to be manufactured on board ship and were lashed on the outside of the shroud lanyards to prevent chafing by the clews and sheets of the lower sails. It was always the pride of the seaman to have pretty and even mats in the rigging. Fig. 125b shows the mat drawn fairly open.

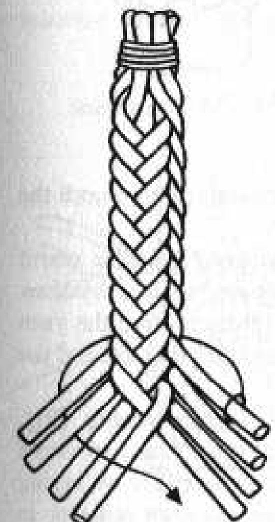


Fig. 126 Square sennit with eight yarns

The *square sennit* can be laid with eight, twelve or sixteen yarns. With eight yarns it is made as shown in Fig. 126. The yarns are divided into four on each side. The outermost yarn is taken alternately from each side and laid behind the plaiting over to the other side and up in the middle between the four yarns on that side, so that two remain outside and two inside, and then taken back to its own side. Twelve and sixteen yarn plaiting is made in a similar way. When taking up the yarns on the opposite side they are always taken in the middle so that respectively three and four yarns remain outside each lay. This plaiting (sennit) is actually a machine packing which is usually made from linen yarn for packing cold water pumps. It has now been almost entirely replaced by other packings. It was very seldom used in sailing ships.

The *half-round sennit* is laid in a similar manner but using only six yarns. It is of no significance where the yarn is taken up between the three yarns of the opposite sides. If it is taken up in front of the furthest yarn the half-round side of the sennit is formed upwards; otherwise it is formed downwards.

The *round sennit* (Fig. 127) is made from thinner yarns around a thicker core. They are laid parallel around the core and fastened in the middle by a strong short whipping. The yarns on one side are then folded over those on the other side. The sennit is laid in the same way as a crown knot (Fig. 115). Each yarn is laid inside the nearest yarn

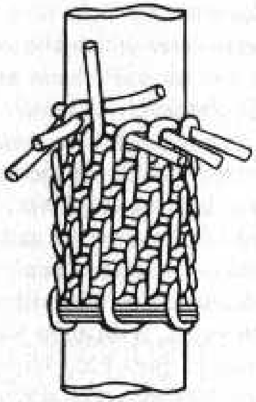


Fig. 127 Round sennit

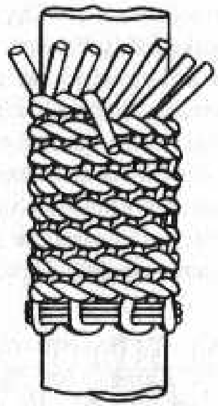


Fig. 128 Round sennit

to the right and one works towards the right around the core until the sennit is the right length.

Using another method (Fig. 128) which produces a similar sennit but one that is not as attractive, the yarns are laid as in a Mathew Walker – that is, each yarn is laid from the bottom around the yarn nearest to the right, working continually towards the right around the plaiting.

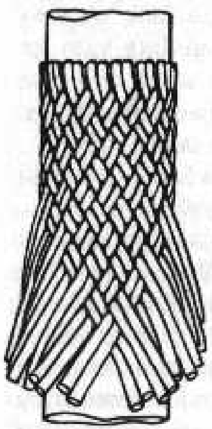


Fig. 129 Cross pointing coach whipping

Cross pointing or *coach whipping* (Fig. 129) is also made with several yarns around a thicker core. It can be made either by laying the yarns individually across each other or in parallel around the plaiting in pairs, like a log line. The plaiting can also be made with a ribbon (for example, inch-wide strips of sailcloth for a handrail or ordinary shoelaces for a sack-lock) and looks very attractive. The plaiting is always difficult to make and get tight. One way is to lay all the yarns which go in a right hand spiral first, then fasten their ends and thread over and under with the left hand spirally yarns. The best result is obtained, however, if the plaiting is done by two people. It is then worked from one side of the core to form a peak on the other side

of the core during laying. This leaves only two yarns or one ribbon to grip at the point, which the person who is helping can easily do while the other person fills out the plaiting by laying the yarns alternately from right and left. When doing smaller work on a soft core the ends of the yarns are fastened with pins as the plaiting progresses.

Half-hitch pointing (Fig. 130) is laid as above with a number of thinner yarns around a thicker core. It is started as in the round sennit (Fig. 127) so that the working yarns are fastened under a short whipping and all the ends are bent in the same direction. The yarn which forms the whipping is not cut but its end is left long and spiralled around the core like the weft in a weave which is being

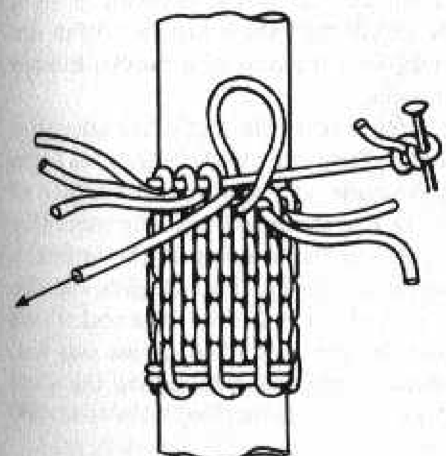


Fig. 130 Half-hitch pointing

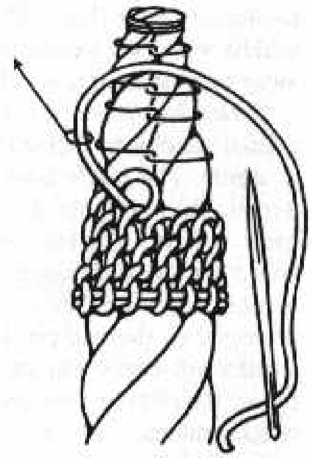


Fig. 131 Pointing

covered. The pointing is done by taking the working yarns one by one in order and laying them around the long yarn spiral with a half-hitch. It is best to lay the half-hitch facing outwards, but it can also be laid facing inwards, which will produce a somewhat different pattern in the pointing. Fig. 130 shows pointing made with outward-facing half-hitches.

Pointing of a rope or half-hitch pointing (Fig. 131) is best made with the aid of a sail needle and yarn (marline) around a thicker core. It is constructed with repeated half-hitches, each one made in the previous half-hitch, working in a spiral around the rope which is to be pointed. The beginning is made over a short whipping which is laid around the rope with the working yarn. One or two tight turns may be sufficient since the end has been fastened to the end of the rope as in a palm and needle whipping (Fig. 29). Pointing is often substituted for finer whipping at the end of a rope, and here it is usual to point the end by taking some yarn out of the strands towards the end of the rope in order to achieve a conical shape. If necessary the pointed rope may be marled with spun yarn to keep it together. The pointing can be made clockwise or anticlockwise. The illustration shows it laid anticlockwise.

The pointing is completed by leap-frogging half-hitches when it becomes too narrow. This progressively reduces the number of half-hitches in the row and closes the end of the pointing as in a sailmaker's darn (Fig. 226). The end of the yarn is fastened off in the middle with two half-hitches and, with the help of a needle, hidden away by pushing it down into the rope.

Turk's heads are ring-shaped braids laid with a thin line around a cylindrical object, such as a hawser. They can also be laid flat to form a rosette. The turk's head can be made with almost any number of parts in the braid, but three, four or five are most frequently used. (By parts is meant the number of yarns in the braiding of the ordinary knot.) Turk's heads can also have a varying number of bights, e.g. the number of yarn bights counted around the end of the knot and which are equal to the number of points on the knot when spread out flat. Finally, all knots may be doubled or multiplied by letting the yarn follow the parts of the braiding one or more times. Triple knots are the most common.

Turk's heads can be made around a cylindrical object or laid flat like a rosette. It is always best to use the method most appropriate for the occasion. Both methods are shown below, some knots being drawn cylindrical and some circular and flat.

The *three-part Turk's head* (Fig. 132a) is started with two parallel round turns over the object around which the knot is to be made. The two round turns produce three parallel parts where the ends meet, and the braid is laid with these, the outer part being laid alternately between the other two. The number of crossings is optional and depends on the thickness of the yarn in relation to the circumference of the Turk's head. In this laying the number of bights becomes 5, 8, 11, etc. If the knot is commenced as shown in Fig. 132b, the number of bights produced becomes 4, 7, 10, etc. As a rule the knot is filled

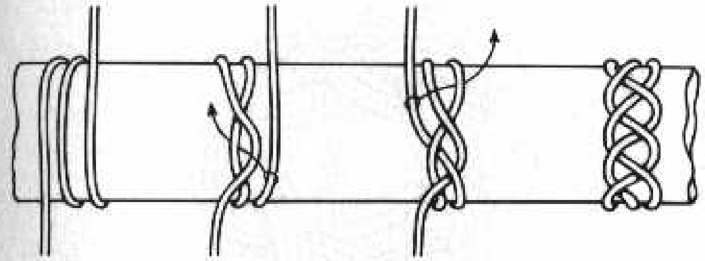


Fig. 132a Three-part Turk's head

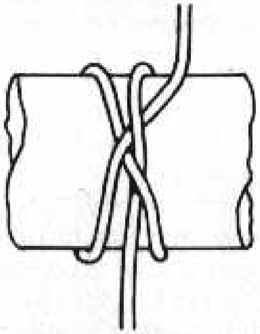


Fig. 132b Three-part Turk's head, beginning

until the parts are tripled. Made flat like a mat, the knot appears as in Fig. 133 when completed.

The *four-part Turk's head* can be laid with three or five bights. Both can be laid around a cylindrical object or laid flat. Fig. 134 shows the Turk's head of four parts with three bights. It is begun with an ordinary half-hitch and is laid, as shown in the illustration, around a cylindrical object. The join at the back is done with parallel turns so that the whole knot is visible at the front. In the third illustration both ends are joined and the knot is doubled. In the right-hand illustration the knot is shown flattened like a rosette.

The Turk's head of four parts with five bights is illustrated made flat (Fig. 135). It is commenced with a half-hitch, the end *a* being taken under *b* and through the knot as shown. *A* is then laid over *b* and pushed through the knot, as indicated by the arrow in Fig. 136, and joined to the standing part *b* which ends the knot (Fig. 137). The knot is doubled until all parts are trebled. It is considered to be the

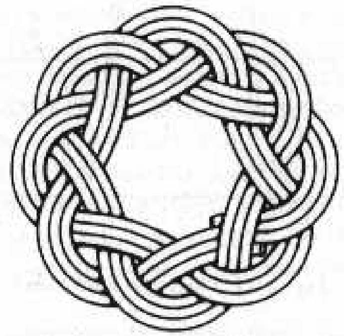


Fig. 133 Three-part Turk's head, laid flat

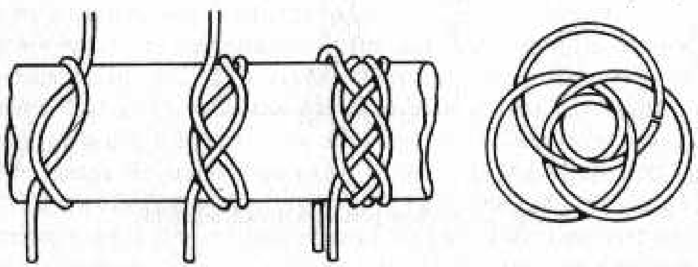


Fig. 134 Four-part Turk's head with three bights

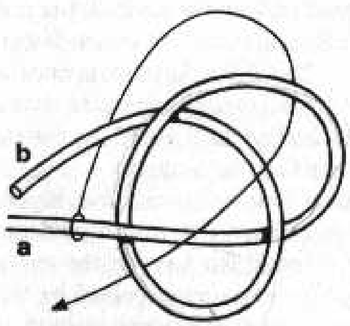


Fig. 135 Four-part Turk's head with five bights, beginning

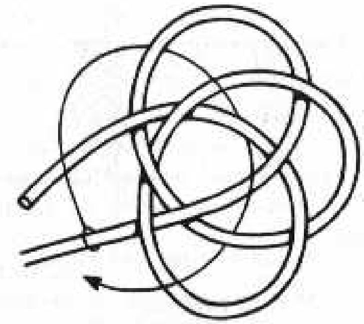


Fig. 136 Turk's head of four parts with five bights, continuation

most attractive of all Turk's heads and forms a pretty rosette if laid flat. Fig. 137 shows the knot from the side.

The *Turk's head of five parts* is most easily explained if it is drawn around a cylindrical object (Fig. 138). The whole knot is drawn at the front of the stick so that all parts form straight parallel turns at the back. The knot is commenced with a round turn and the laying is done as shown in the illustrations. In the final illustration both ends are fastened together to complete the knot, and then it is doubled in the usual way. Fig. 139 shows the front spread out flat.

Long Turk's heads are best made around a wooden stick or similar shape. In order to keep track of the bights while laying one should put two rows of nails in the stick to lay the bights over. The nails in one side of the stick should be staggered between the nails of

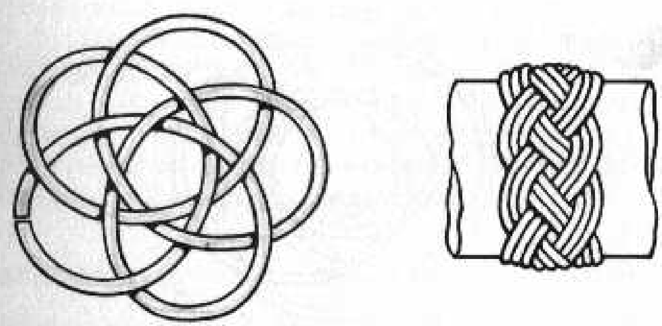


Fig. 137 Turk's head of four parts with five bights

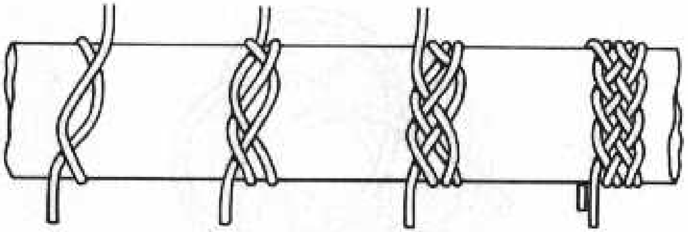


Fig. 138 Five-part Turk's head

the other side, as shown in Fig. 140. The number of nails used determines the number of bights, and the number of rows of yarn laid around the stick determines the number of parts in the knot. The number of rows and the measurements in general should be chosen to enable as far as possible the yarn to go at right angles over the stick in order to obtain right angles and hence a check pattern in the finished Turk's head.

The knots can be made in different ways, depending on whether they are laid over an even or odd number of nails on each end. A start is always made at a nail on the left hand side, and a yarn laid across the knot is called a part, the first part going from left to right, the second back from right to left, the third to the right, and so on. One should ensure that there are an equal number of rows on both parts of the stick and that the yarn is laid so that when the second part returns to a nail nearest the nail where work commenced (as in Fig. 140) it makes no difference whether it is in front or behind. This way the work is always done next to the previous part, which makes the laying easier.

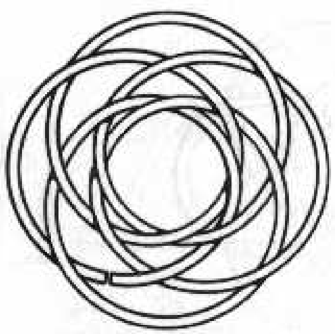


Fig. 139 Five-part Turk's head

If there is an even number of nails at each end the first part is laid from left to right and the next towards the left outside the first one. Fig. 140 shows this operation. The third part is laid completely outside the other, as the arrow in the illustration shows, but the tuck with the fourth part is commenced under-over-under-over, which always brings it against the lay of the adjacent part which it follows. Sometimes the tucks go under-over-over-under-over-over-under but this corrects itself as the knot fills out and one continues until the initial nail is reached again.

With an odd number of nails at the ends of the stick the second part is laid over-under-over-under as it crosses the first part and all the consecutive parts are tucked in the same way, always opposite to the adjacent part so that a check pattern is formed in the knot. Attention

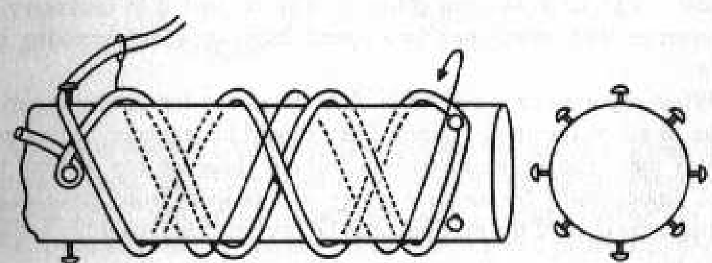


Fig. 140 Long Turk's head with four bights

must be paid to the tucks closest to the nails to get the braiding correct.

The nails are removed after returning to the starting nail. The knot is doubled in the usual way by following around all parts one, two or more times, and if necessary it can be shellacked, oiled or painted to get the required stiffness. If it is to be laid around a handrail or something similar made from iron, sailcloth is wound around the rail a few times and pins inserted into the sailcloth for guidance. When the knot is finished the sailcloth can be removed. The knot shrinks when doubled so that it will grip the surface it is on.

Sundry work

Fastening to a bollard is done with relatively thin and short ropes and lines, such as stage lines, barge warps, and so on. The rope is

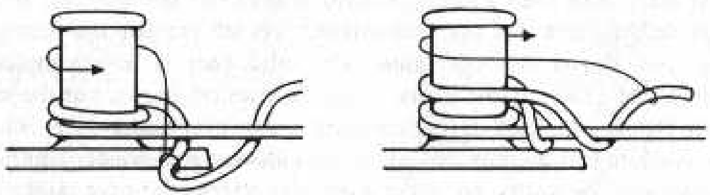


Fig. 141 Fastening to a bollard

taken two turns around the bollard (Fig. 141), its bight pushed under its standing part and laid one turn in the opposite direction. The end is then taken a final round turn around the bollard in the initial direction. This fastening will never jam. It is also used to temporarily attach warps to a warping drum. If wire is used it is necessary to commence with more than two round turns to avoid breaking the wire.

When mooring to a quay it is often necessary for several mooring wires to go on the same bollard. They should be arranged so that any one of them can be removed first without those on top locking the ones underneath. Subsequent wires are pushed from underneath through the eyes of the original ones before being laid over the bollard (Fig. 142).

A sling is usually shortened, as shown in Fig. 143, by making a half-hitch in parts *a* and *b*. This halves the length of the sling. If a very short sling is required this can be done as shown in Fig. 144. The parts of the sling are folded close to the loop and tied with a half-hitch. This positions the hook nearer to the loop.

A length of *chain is shortened* as shown in Fig. 145. The hitch is made by hanging the bight of the chain in the ring and then making a half-hitch on the other side of the chain.

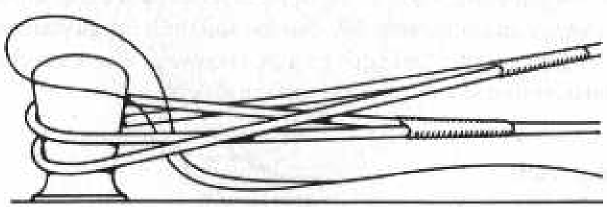


Fig. 142 Fastening to a quay bollard

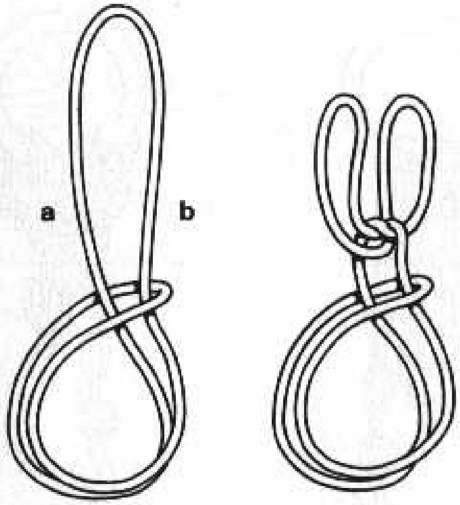


Fig. 143 Shortening a sling

A *scaffold hitch* is used on scaffold planks, one part going over and two parts going under the plank (Fig. 146) and the hitch tightened so that the single part on the upper side comes in the middle over the yoke. On clinker-built ships the yoke of the scaffold plank is nailed to the underside to prevent it pulling loose if the yoke happens to snag while working on the plank. A plank will, however, hang steadier if the yoke is nailed to the upper side, and on ships with smooth welded hulls the scaffold is turned so that the yokes come over the plank.

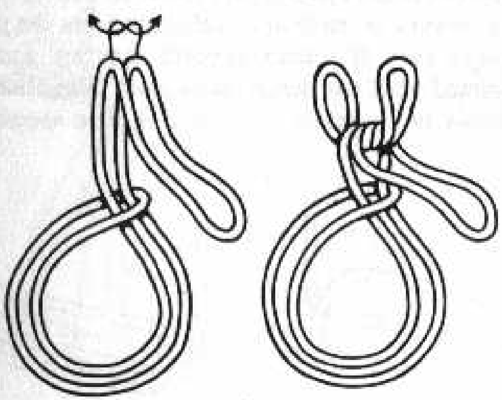


Fig. 144 Shortening a sling

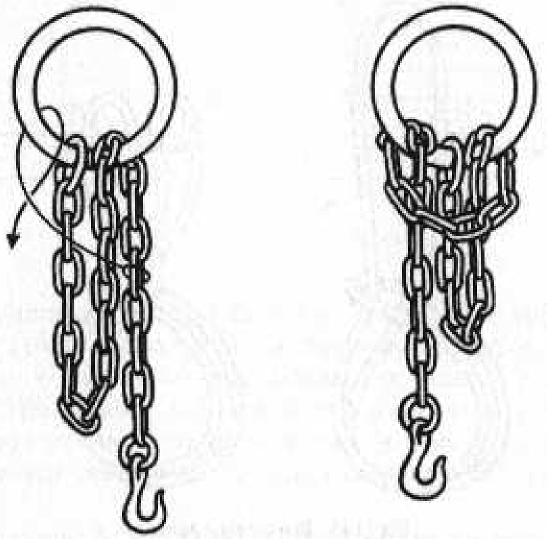


Fig. 145 Shortening a length of chain

An attractive symmetrical scaffold hitch is shown in Fig. 147. Two round turns are taken loosely around the end of the plank, leaving three parts over the plank. Part 1 is then laid between parts 2 and 3, and part 2 is taken out and over and under the end of the plank. The hitch is then tightened (Fig. 148). The hitch can also be made in the hand and threaded over the end of the plank when complete.

With thin planks both rope ends are taken on board, whereas with thicker ones a bowline is made at chest height from the plank and is hung on a single part. If spliced scaffold ends are used the hitch should be adjusted until the plank hangs level. When work is being done on the bows and quarters of a ship it is often necessary to take

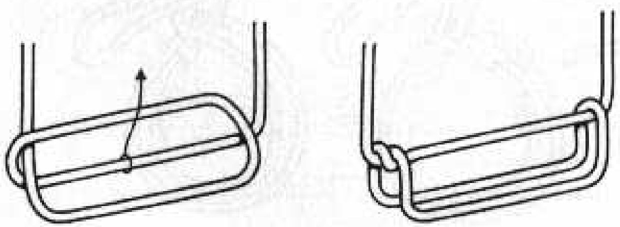


Fig. 146 Common scaffold hitch

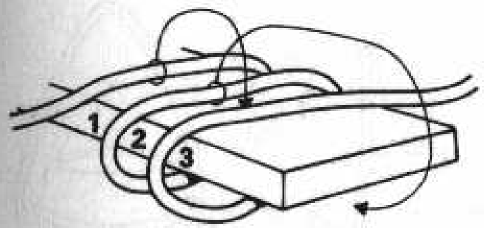


Fig. 147 Symmetrical scaffold hitch, beginning

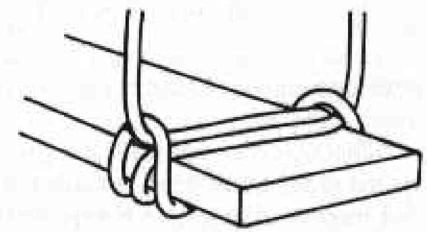


Fig. 148 Symmetrical scaffold hitch

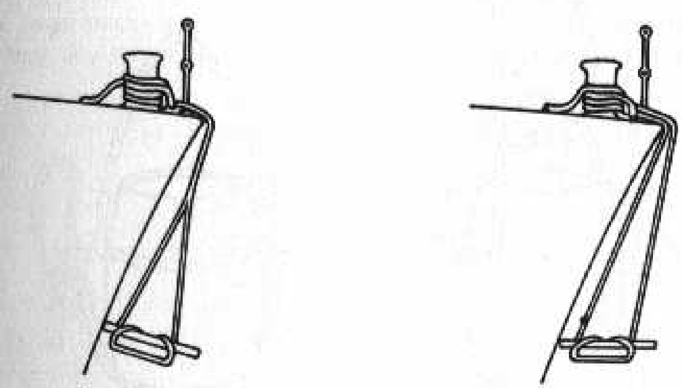


Fig. 149

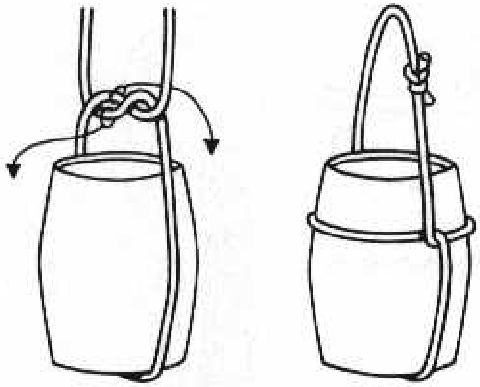


Fig. 150 Loose end on a cask

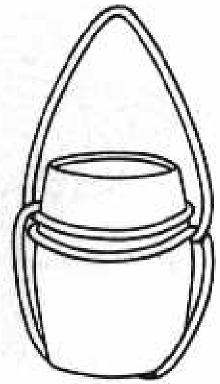


Fig. 151 Sling on a cask

both rope ends on board in order to keep the scaffold horizontal (Fig. 149).

Slinging a cask upright is done with a loose end. The cask is stood on the rope, a half-hitch is made over it (Fig. 150) and the ends are tied together. The knot is always made on one side so that it is free of the lifting hook. A *single gantline* is put on in the same way but is completed by joining the end to the gantline with a bowline in the middle of the cask. A half-hitch is made with a sling on each side over the cask (Fig. 151). If the sling is too short for the two half-hitches,

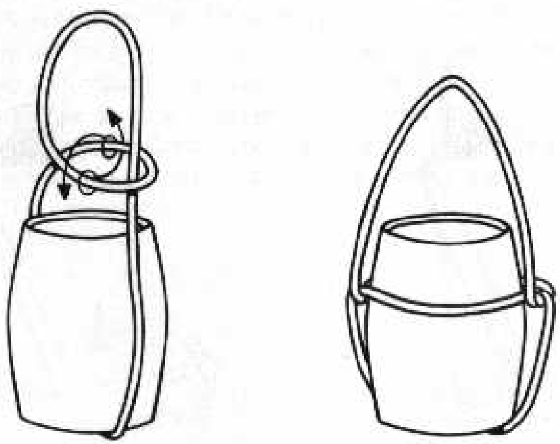


Fig. 152 Sling on a cask

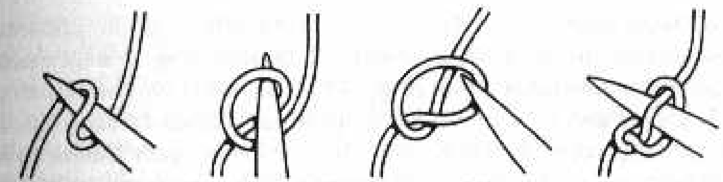


Fig. 153 Marline spike hitch

which is often the case, a round turn is twisted into it from one side. The round turn is turned 180 degrees and tightened down over the cask, as shown in Fig. 152.

A *marline spike hitch*, used when a seizing or frapping is tightened with a marline spike or heaver, is made as shown in Fig. 153. A round turn is made around the marline spike which is then withdrawn so that only the tip holds the round turn. This is then moved with the tip of the spike over the standing part, and the marline spike is again pushed forward under the standing part and over the parts of the round turn.

A *swab* is made from yarns which when doubled up are as long as the length of the swab when it is completed. Ordinary hemp rope yarn is used for larger swabs and cotton or linen yarn for smaller ones. Manila and sisal are not suitable. The tar in the hemp yarn is initially of some disadvantage but it soon washes out; if necessary a new swab can be towed in the sea and this will soon remove the tar. The yarns from a length of cotton rope or a piece of frayed sailcloth are ideal for smaller swabs. The strap is made from a suitable material – thick line for large swabs and cotton yarn laid in a four or five yarn braid of fishing line for smaller swabs. The ends of the strap are joined with

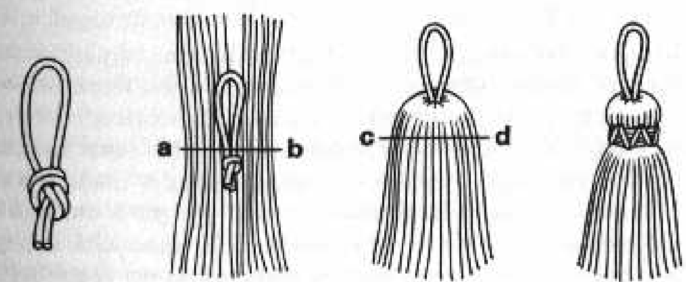
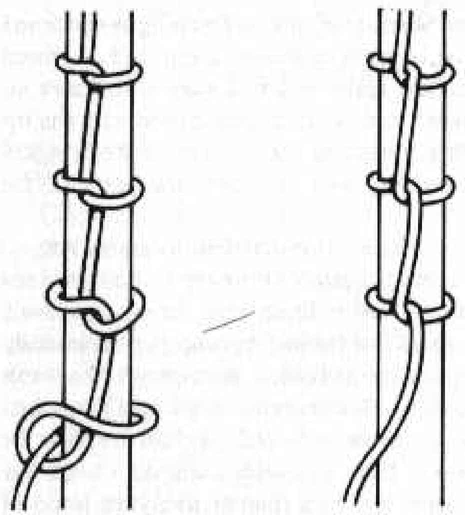


Fig. 154 Swab

an overhand knot and the strap is laid in the middle of the gathered yarns so that they enclose it evenly. A stout lashing is then made around the whole lot at *a* – *b* (Fig. 145). The yarns are then taken a few at a time and bent to one end – an equal number on each side – until the strap becomes free in the midst of the bent yarns. The strap is pulled well out of the yarns and these are laid evenly and smoothly downwards. The swab is then finished off with seizing, *c* – *d*, close underneath the knob of the strap, and this forms the kernel of the round head of the swab. Finally, when the swab is complete the ends of the yarn are trimmed to give it a neater look.



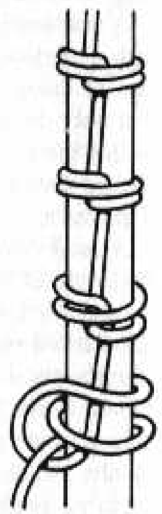


Fig. 155 Fig. 156 Double marling

Correctly done on the left and incorrectly on the right

Marling hitches are used to hold together bundles of yarn or rope, as well as for tying small sails to gaffs and booms and for sewing wire bolt ropes to bigger sails – known as marling. The marling hitches are tucked under the round turns, and are not the same as usual half-hitches (Fig. 155). Marling hitches are always made towards oneself and the laying is more easily done if a bight is made in the marling yarn with the left hand and the end is taken with the right hand around the item and through the bight, as shown at the bottom of the illustration. If the marling hitches have to be more durable they can be made with double round turns, as shown in Fig. 156.

Worming a rope is done by laying marline, spun yarn or fishing line of a suitable thickness in the worm around the rope, making it cylindrical. The object of worming is to prevent water channelling along the worm under a serving. However, it is done merely for decorative purposes on items like block strops, banisters, railings and eye splices (Fig. 183). One can also get certain decorative effects with worming by using different materials; for example, black or coloured string used on white cotton rope or white or black yarn on tarred hemp rope. There is hardly any use for decorative work like this on merchant ships nowadays (a wormed banister on a long ship's ladder can also be painted) but it can sometimes be effective on yachts.

If a long rope is to be wormed it is strung horizontally at waist height. After the worming has been laid on it is stretched by working a serving mallet and a suitable strand around the rope in a spiral with

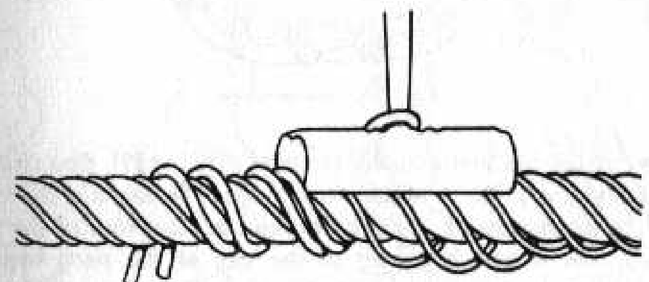


Fig. 157 Worming

the worming (Fig. 157). In this operation one man pulls the serving mallet around while another holds the end of the strand and allows it to drag suitably roughly behind the mallet.

A *selvagee strop* is made from rope yarn reeled off into large bights corresponding to the size and thickness of the strop required. The various lengths of yarn needed for the strop are tied together with rope yarn knots (Fig. 91) and the strop is marled with double marling hitches (Figs. 156, 158). If possible, new rope yarn should be used as it is stronger than yarn taken out of a rope. The strop will be more flexible than a spliced rope strop and therefore easier to use. It is also stronger than a rope strop of the same thickness, particularly if made with new untwisted rope yarn, because all the yarns are evenly loaded, which is not the case with a rope (see page 23). Thick strops used for lifting machinery always have sailcloth sewn over them.

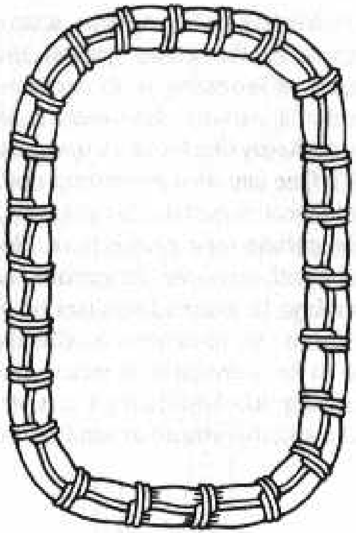


Fig. 158 Selvagee strop

Short strops are best laid like grommets (Fig. 159). One strand is carefully removed from a suitably thick rope. The length of the strand should be approximately three times the circumference of the strop required. The strand is looped to the size of the strop required, ensuring that the twist which it had in the rope is maintained. The ends are then laid in the spiral twice around, so that the strop looks

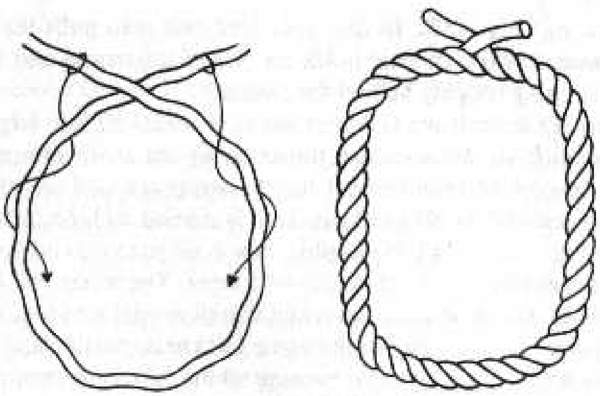
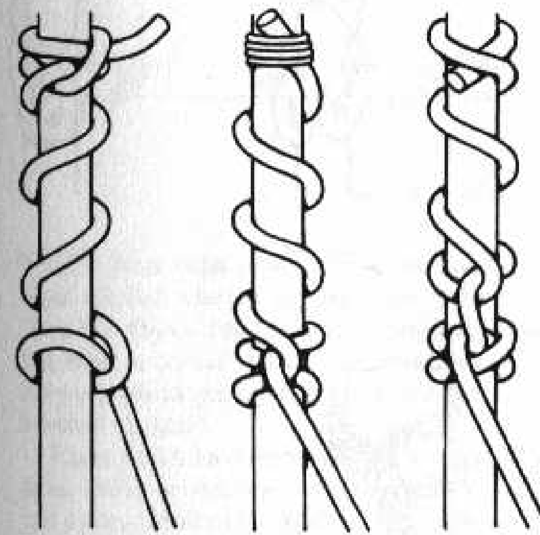


Fig. 159 Laid strop

like a rope. The two ends of the strand, where they meet, are spliced together like a part splice in a long splice (see page 130). If the strop is to be used as a block strop the splice is placed at the bottom of the block. If it is to be used for a hook block this must be threaded on the strand before the strop is laid together.

A *tail* is made on a rope with some of the hitches shown in Figs. 160–162. Their endings can be secured in a variety of different ways. For temporary use it is often enough to hold the end with the hands.

The *shroud hitch* (Fig. 163) is of the same type as those already mentioned. It is ideal for fastening the shrouds when rigging a lifeboat.



Figs. 160, 161, 162 Fastening tails

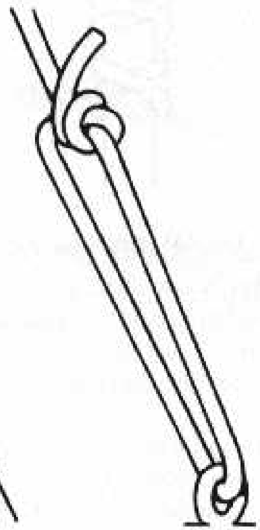


Fig. 163 Shroud hitch

The hitch holds excellently as long as there is a strain on it, but loosens immediately the tension is released. The end can be fastened with a half-hitch.

Strops are put on by halving around the rope used, one end of the strop being alternately tucked into the other around the rope (Fig. 164) or tucked once and then snaked around the rope in the direction of the pull (Fig. 165), or merely snaked around the rope (Fig. 166). A *chain strop* is put on by snaking around the object and then making a half-hitch around it (Fig. 167). *Chain stoppers* are made on mooring wires with a series of single half-hitches which should not be able to

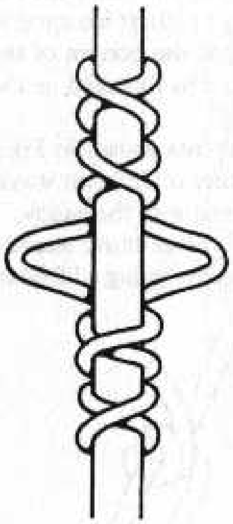


Fig. 164 Putting on strops

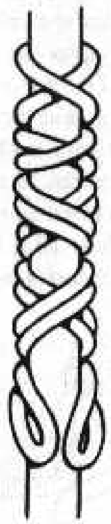


Fig. 165

Fig. 166

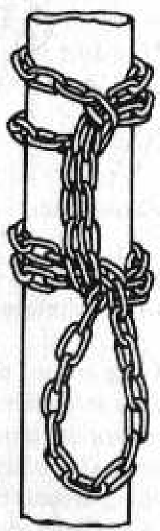


Fig. 167 Fastening a chain strop

slide close to each other as this can cause them to jam (Fig. 168). The simple hitches shown in Figs. 160 and 161 can also be used. Of these, that illustrated in Fig. 160 is the easiest to make. It consists of one simple half-hitch and therefore can never jam. Any chain stopper should have a short tail of heaving line spliced into the end so as to make it easier to make the half-hitches which complete the chain stopper.

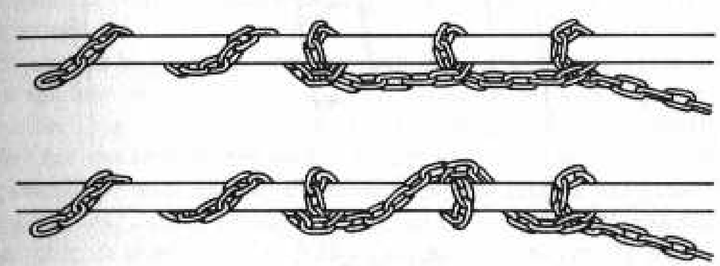


Fig. 168 Putting on chain stoppers

New *flags* twist easily due to the turns in the halyard which has been stitched into the flag bolt rope. After a new flag has been in use for a few days – and preferably been wet at least once – the stitches in the bottom corner should be opened and the turns taken out of the halyard, which should then be stretched evenly with the flag cloth and stitched up again.

Flags which have metal swivels are put on with a fisherman's bend (Fig. 169a) or with the hitch shown in Fig. 70. If the flag has a rope tail a sheet bend or the hitch in Fig. 98 should be used. When dressing a ship overall a full set of signalling flags is displayed, and the top ones are inclined to twist. This can be prevented if when putting on the top flag a small end is left on the flag line and this is used to tie a small bowline around the downhaul so that the bowline can slide up and down (Fig. 169a). (This presupposes that both parts of the flag line come down to the same side of the deck.) Instead of a bowline a small shackle can be used so that the flag line slides in the bight of the shackle – not against the bolt or it may unscrew.

Flags should be furled with their markings showing, and preferably with the darker colours facing outwards. Signalling flags are always furled with a slipping hitch which can be pulled out (Fig. 169b). They are best hoisted aloft 'in a ball' and broken out when

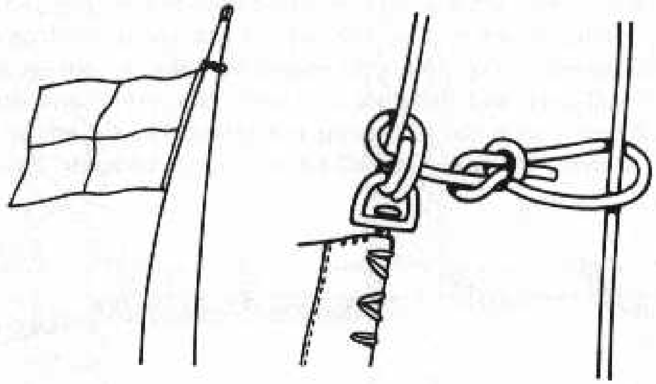


Fig. 169a Putting on a flag

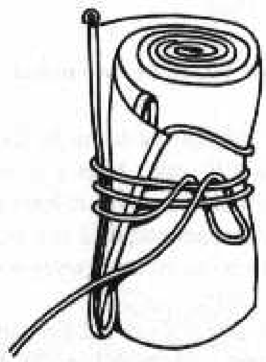


Fig. 169b Furled flag

they have reached the top of the mast. National flags are never hoisted in a ball.

A *bosun's chair* is always stropped so that the strop crosses under the seat (Fig. 170a) so that one can sit in the strop if the seat breaks. The spliced part of the strop is always placed under the seat. An eye is seized on the two bights over the seat and the gantline is attached with a sheet bend. However, it is often necessary for a person working in a bosun's chair to have to raise or lower himself. The best and most secure hitch for this is made by putting the bight of the hoisting part of the gantline through the strop of the chair below the seizing and looping it around the whole chair. Then the hitch is tightened around

the four parts of the chair strop as shown in Fig. 170b. The person sitting in the chair lowers himself by lifting the loosely hanging downhaul, causing the hitch to slide around the strop. Otherwise the weight of the hauling part of the gantline causes the hitch to hold securely. In order to make the hitch the person sitting in the chair should seize together both parts of the gantline above the strop with one or two seizings of spun yarn (Figs. 201, 202). Once the bight of the gantline has been taken around the chair and strop the seizings will loosen.

If one has to go up an unrigged mast or a flagpole this is best done with the help of two bosun's chairs – sitting in one and standing on the other (Fig. 171). The top chair is an ordinary bosun's chair (Fig. 170a) but the bottom one should be 25–30 cm (10 in.) wide as it is impossible to raise oneself if the feet are too close to the mast. To hang steadily, a piece should be taken out or a couple of blocks put in front of it. It should also be fairly short – about 40 cm (16 in.) – so that one can easily keep the knees outside the strop when sitting in the other chair.

Both chairs are kept in place with a short line taken around the mast. This is best done with a snap hook (spring hook) or shackle, but a spliced eye can also be used, in which case it should be first taken around the mast and then fastened to the strop of the chair with a sheet bend.

One hoists oneself by standing on the bottom chair and pushing up the strop of the top chair to bring it close under the seat. Then,

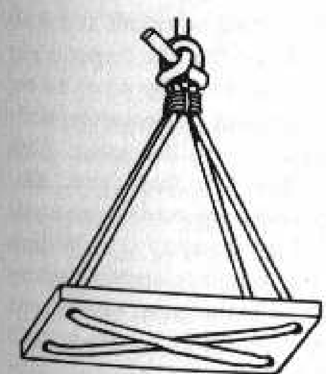


Fig. 170a Bosun's chair

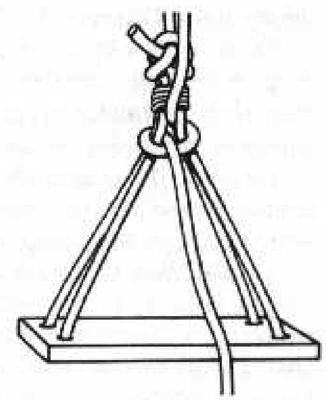


Fig. 170b

sitting down, the legs can be pulled up and the bottom chair hoisted up. By moving the fastening to the side one can easily work sideways around the mast. The strops should be made short so that one can work – scrape and paint – above the upper knot.

A *hand log line* is usually made of six-yarn untarred hemp line. The part nearest the forerunner should be as long as the ship or at least 60 m (approx. 190 ft) for big ships. The forerunner mark is made from a piece of bunting of any colour – the English maintain that it ought to be white. The knots are marked from the forerunner mark. On Swedish hand log lines this was done with the aid of a 30-second

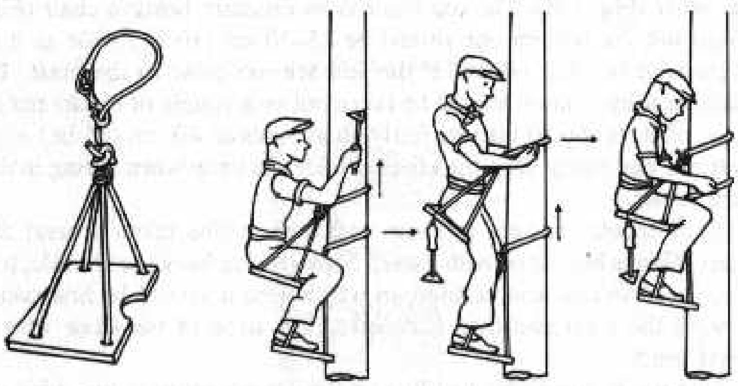


Fig. 171 Bosun's chairs

timing glass. Theoretically the knot lengths should work out at 1,850 ÷ 120 m = 15·4 m. It has, however, been found that the torpedo log drags in the water and therefore the knot length is usually set at 14 m. If carefully calculated it will be found that the drag is greatest to start with and diminishes as more of the log line enters the water. This means that the lengths between knots should in fact vary. The following measurements for the first eight knots are considered to be accurate: 13·3, 13·7, 14·0, 14·3, 14·5, 14·7, 14·9 and 15·0 m. With a 60 m forerunner the length of the whole line becomes approximately 175 m (about 574 ft) or about 100 fathoms. The line must be wet and should be well stretched when it is marked. The marks are made with coarse roping twine, marline or something similar and are tied with single or double overhand knots on double lengths of the marking yarn. This makes any seizing unnecessary and stops the ends on the

knots from being frayed out in the water. The knots are usually made 1,2,3,4,5 and then started again with knots 1,2 and 3 corresponding to knots 6,7 and 8. Midway between the knots a mark is made with doubled yarn to indicate a half knot (Fig. 172). The end of the log line on board should always be attached to the log reel.

As ships became bigger and achieved higher speeds it became common to use a 15-second glass when logging, but the old markings were not altered. The line was therefore suitable for 16 knots; the knot markings became even numbers and the half-knot markings became odd numbers. The half-knot markings are no longer included, but as the knot now measures approximately seven metres, half a knot-length is now about two fathoms and can therefore easily be measured from the nearest mark.

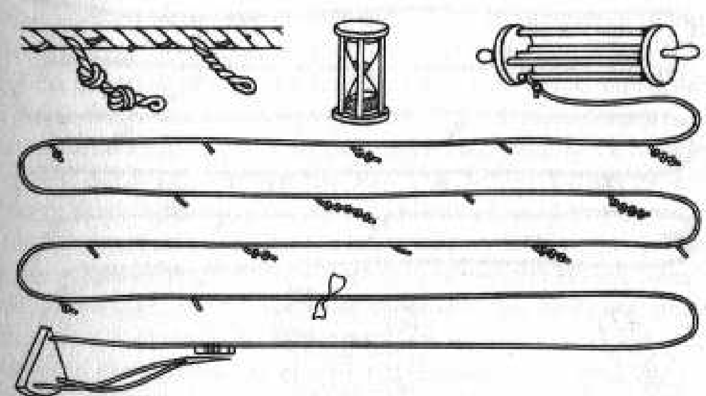


Fig. 172 Hand log line

Logging was always done on the leeward side so as to avoid the wake which – except when running before the wind – always pulled the log to windward. The officer in command, the mate, threw the log while another man held the log reel above his head to enable the line to run over the taffrail with the minimum amount of friction. A boy held the glass with his hand reversed, ready to turn the glass. The mate threw the log and a few bights of the line well out on the leeward side of the ship's wake, called 'Turn!' when the forerunner mark passed over the taffrail, and the boy then quickly turned the glass. When the sand ran out the boy would shout 'Stop!' The mate would then read how much line had run out and, with a hard tug on the line would jerk the pin from the capsule so that the line could be pulled in.

Finally, it may be pointed out that the speed in knots – sea miles per hour is the same word as knot – stems directly from the knots in the log line. When logging, the ship pulled out so-and-so many knots on the log line, and was said to make so-and-so many knots.

The *deep-sea lead* line (Fig. 173) is 120 fathoms long (Swedish regulations for the construction and equipping of ships specify at least 200 m) of $1\frac{3}{4}$ in. cable laid untarred hemp. At the bottom end it has a large spliced eye into which the strop of the lead is looped. Knot markings of double marline are made on the line every 10 fathoms, so that 10, 60 and 110 fathoms have one knot, 20, 70 and 120 fathoms

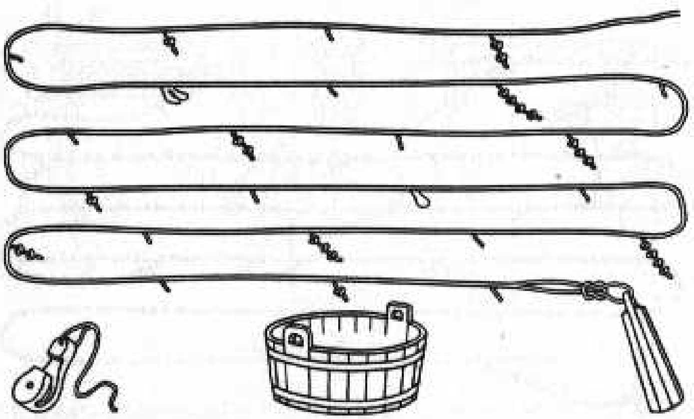


Fig. 173 Deep-sea lead or 'dipseylead'

two knots, 30 and 80 fathoms three knots and 40 and 90 fathoms four knots. A leather marker is put at 50 fathoms and a leather marker with two legs at 100 fathoms. In addition, a small marker, made from double marline so that it will not wear out in the water, is put every five fathoms. The line, which is always left hand laid, is coiled anticlockwise. It is best to keep it in a tub which has a few holes drilled in the bottom to allow water to escape. A small wooden snatch block with a tail also belongs with the line. The deep-sea lead is armed with tallow in the same way as the inshore lead, in order to obtain a sample of the sea bottom.

When sounding, speed must be reduced or the ship stopped.

Sounding is done on the windward side because the ship drifts towards the lee. The line is run forward, outside of everything. Several men are stationed along the side with a suitable number of bights, according to the depth, in their hands. When everything is ready the man in charge calls out 'Watch there, watch!' and the lead is thrown over the side, the bights of the line let out progressively as the lead sinks. The difficulty when the ship moves lies in getting the lead to touch the bottom on a taut line that stands straight up and down to a place aft on the deck. The man who does the sounding pulls the lead up and down a couple of times to touch the bottom with certainty before the ship drifts leewards so much that the line slants up on the windward side. The wooden snatch block is hung in a convenient position on a railing, ship's davit or backstay and the lead line is lead through it so that it will be easier to haul in.

The hand lead line must by Swedish law be 50 m long (28 fathoms). It is hawser laid from thin 12-yarn untarred hemp line. The markings are done in various ways, and lead lines are often found with different markings from those commonly used. The old-time seaman, who sounded his way in towards an unlit coast on a pitch-black night with no lights on board, marked his lead line with a variety of knots, different shaped pieces of leather and pieces of wool and linen cloth, so that he constantly read off the depth by feel. If necessary he would test the pieces of cloth in his mouth to distinguish between linen and wool. Nowadays, when it is no longer as dark on deck, one trusts to sight, and it is common to mark the line with different coloured strips of bunting. Here are two most common methods.

The hand lead lines used in the Swedish Navy are marked in metres, the marking being done as follows (Fig. 174):

At 10 m, marline with one knot, at 20 m two knots, at 30 m three knots, and so on

At 2, 12, 22 m, etc. a white marker of bunting

At 4, 14, 24 m, etc. a blue marker of bunting

At 6, 16, 26 m, etc. a red marker of bunting

At 8, 18, 28 m, etc. a leather marker, and at all odd metres (except 1) up to 20 a plain marker.

Merchant ships often have hand leads marked in the English manner in fathoms (Fig. 175), which is also used in the US.

At 1 fathom a single leather strip

At 2 fathoms a leather strip with two legs

At 3 fathoms a leather strip with three legs

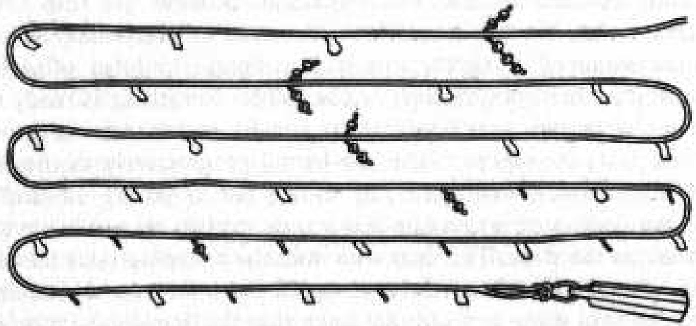


Fig. 174 Hand lead, Swedish metric markings

At 5, 15 and 25 fathoms a white marker of bunting or linen
At 7, 17, and 27 fathoms a red wooden marker
At 10 fathoms a leather strip with a hold in it
At 13 and 23 fathoms a blue wooden marker
At 20 fathoms a line with two knots
At 30 fathoms a line with three knots

The unmarked fathoms – 1, 4, 6, 8, 9, 11, 12, 14, 16, 18, 19 – are called 'deeps'.

All measurements are made when the line is wet and suitably stretched and are made from the bottom of the lead.

About 2 m from the lead a small wooden pin or toggle is attached to the line with a marline spike knot (Fig. 153) to serve as a handle for the man who throws the lead. The thrower always takes the bight of the line over his thumb and closes his hand over both parts, a secure,

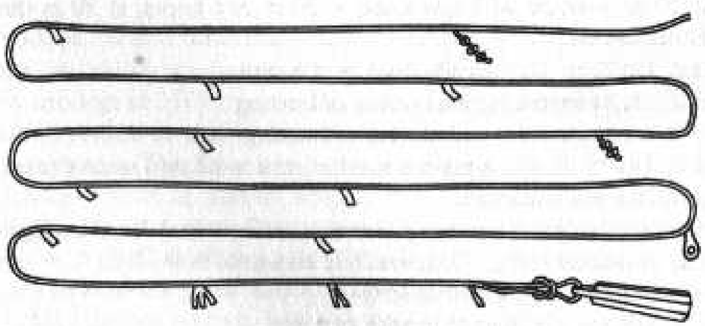


Fig. 175 Hand lead, English fathom markings

non-slip grip which loosens immediately he opens his hand. The sounding was always done from the widest part of the ship or from a boat swung out on its davits, and always on the windward side. In modern ships the sounding is most easily done from the platform of the gangway ladder. A good lead thrower should therefore be able to throw with either right or left hand. According to the rules the lead is swung around in a vertical circle so that it can be slung towards the bows at great speed – the deeper the water and the greater the speed of the ship the further it should be thrown, so that it has time to reach the bottom before the line is hanging vertical.

This is now a lost art and nowadays the lead is probably swung back and forth in a pendulum arc until it gathers enough speed to be thrown. The lead should be first let down to the surface of the water and the distance measured between the water and the level of the hip where one is standing. On a dark night swing the lead back and forth until the resistance of the water indicates that it has reached the surface of the water. The depth is then sounded to the hip and then the previously measured distance from the hip to the water's surface is subtracted to obtain the depth of the water.

The depths are called out loud as they are sounded: 'Eight fathoms! Nine metres! Under eight! Over thirteen! Twelve-and-a-half!' and so on, the terms 'under' and 'over' referring to quarter-fathoms.

Sounding and logging used to take up a greater part of the seaman's time than they do now, and to be able to do them correctly was considered so important that an inept professional was called a 'logger to windward and a sounder to lee' by seamen.

Ratlines were introduced in the early Middle Ages and for centuries have been a necessary item in rigging to make it easier to work aloft. Nowadays ratlines are only used on motor-sailers and small ships. In all larger ships ratlines have been replaced by iron ladders on the masts. Initially tarred hemp line was used for ratlines. It was usually $1\frac{1}{2}$ in. thick and was known as ratline line. During the latter part of the nineteenth century it became more common on larger sailing ships to use wooden laths as ratlines – at first together with hemp lines, but later alone. Exceptionally big iron ships and older steamships had ratlines of tubular bar-iron, iron pipes or gas pipes.

Ratlines of hemp line used to be made with a space of 14 in. between them, while wooden ratlines on large ships were made 18 in. apart. For smaller ships 16 in. between wooden laths is considered suitable. Nowadays, when all wire rigging is bare, a serving is put on each shroud where the seizing is to be made, or at least a parcelling of a small strip of sailcloth.

When making ratlines with line always work from left to right. The end of the line is taken up to the left, astern in starboard shrouds and ahead in port shrouds. The following description is for work in the starboard shrouds. At the end of the ratline line a small eye is spliced, with two complete tucks in each strand. A clove hitch is then made with the line clockwise around the shroud, beginning with the one second from aft, and is seized with the eye to the foremost shroud. The seizing is made with strong marline or house line and is attached to the eye as shown in Fig. 176, either by threading it through the

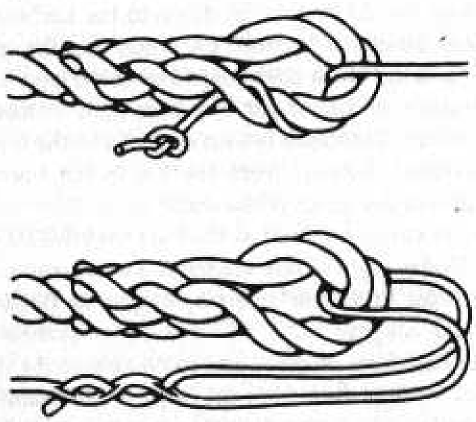


Fig. 176 Hemp ratline with seizing

splice with an overhand knot on the end or through a long eye, which makes the first turn double (see also Fig. 196, yarn splices). The ratline is seized to the foremost shroud so that the seizing turns lie parallel around the shroud and in a cross inside the eye. Ten to twelve turns are made, pulled tight with the pricker, and the marline is taken under the turns in the eye and fastened with a half-hitch around the same turns and an overhand knot on the rope's end (Fig. 195). The ratline line is then stretched to the next shroud(s) and the clove hitches are well tightened. The stretched line is then measured off, cut, spliced and seized to the aftmost shroud.

Wooden ratlines are seized with thin seizing wire. Ordinary seizing wire is often opened out and three threads taken and pulled over the

edge of a plank to make them even. An overhand knot is made on the end and jammed between the shroud and the wooden lath. The seizing is made so that it goes diagonally over both shroud and wooden lath, first five times one way and then five times the other way, and then the end is fastened with a bow in the cross in the middle of the wooden ratline, as shown in Fig. 177. When making the seizing a round heaver of hard wood is used, with a hole in the middle through which the seizing is threaded and rolled up on the heaver, where it is held fast while the seizing is made (see also page 143). The ratlines are often made over only two or three shrouds and not over the whole width of the shrouds.

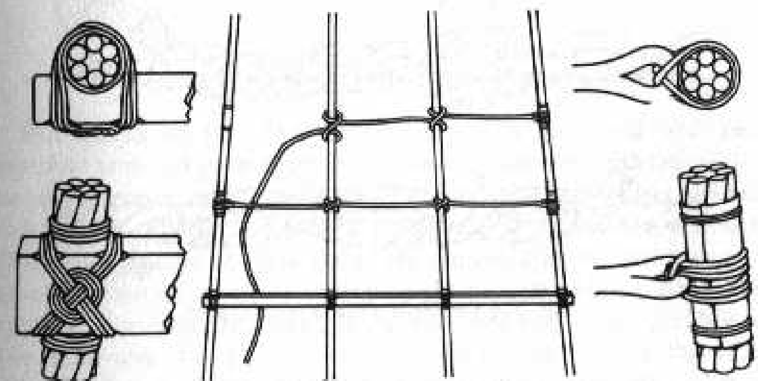


Fig. 177 Ratlines with hemp line and wooden lath

Splices

When right and left are referred to in the following discussion of splices, the splice is meant to be held so that the opened strands point away from the body and lie on top of the rope into which they are to be spliced.

Splices are used to permanently join two ropes. A splice can, however, be open or be 'drawn' by pulling out the tucked-in strands with a marline spike or using the fingers to pull them out of their lays. A rope is always slightly damaged where a splice has been and as a rule one should try to avoid pulling out a splice. In sailmaking it is sometimes necessary when altering a sail, but hardly when making and maintaining the simple rigging of modern ships.

The cobbler's splice or tailor's splice (Fig. 178) is mostly used as an eye splice and is the simplest of all splices. It is made by tucking the whole rope twice or three times under a strand of the rope and is used when it is necessary to temporarily fasten a rope to a chain or a spliced wire in order to pull it through a block. It is also used to splice thin two-strand yarn, marline for seizings, etc.

As an eye splice the cobbler's splice has no great use in cordage. It can, however, be used to join thin hauling ropes which have to be pulled around a winch or a capstan. Two tucks in each direction are sufficient. On shroud laid rope the splice is tucked under two strands and straight through the rope.

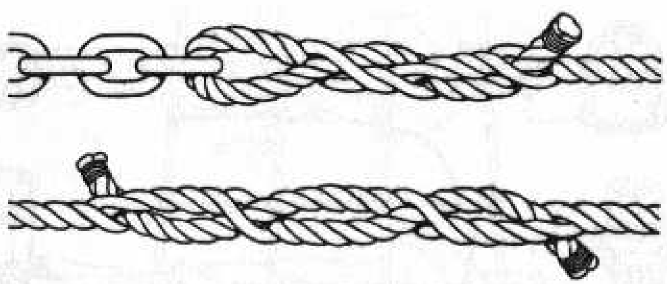


Fig. 178 Cobbler's splice or tailor's splice

Eye splice. Three or four turns of the strands are opened up and a whipping made to prevent the rope from opening up further. The rope is bent so that the eye gets its correct shape. Before beginning the splice the strands should surround the standing part of the rope as shown in Fig. 179. The middle, uppermost strand is spliced in first and is tucked under the middle strand in the rope against the lay (Fig. 180). Then the right hand strand is taken – also against the lay – under the right hand strand in the rope and a half-hitch is made in this 'M' (Fig. 181). The left hand strand is finally taken against the lay, and in this is made a half turn *out* so that it falls smoothly along the rope (Fig. 182). Then the strands are tucked over one and under one in a spiral against the lay. Two whole tucks are made, and then the splice is tapered by taking yarn from the underside of each strand. These yarns can either be cut off as they are taken out or when the splice is finished. The advantage in the first instance is that it is easier to disguise the cut-off yarns under the remaining yarns and make a tidier

splice. Three or four tucks per strand are made after the first two complete ones, so that the splice gets five to six.

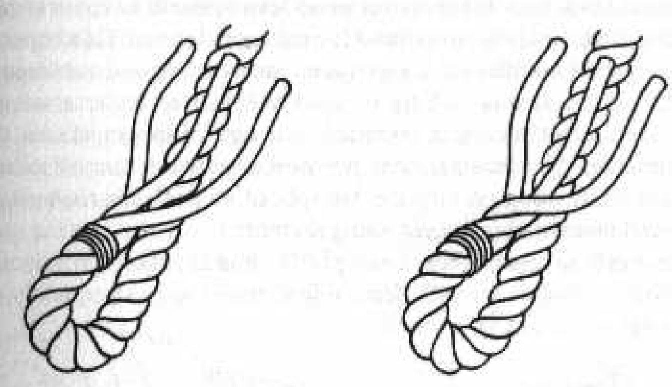


Fig. 179 Laying together for a eye splice. Left: correct Right: incorrect

Eye splices on thin lines of $1\frac{1}{4}$ in. or less are made with two complete tucks on each strand; otherwise simpler splices, particularly on thinner ropes, can be made with three or four more or less tapered tucks. As a tidying up measure a well-laid splice can be wormed. Three yarns should be taken out of each strand after the first tuck and left outside the splice, which is completed in the usual manner. The yarns are then spun together three and three to hard and evenly-laid house line ends, and the splice is wormed tightly, after which the yarn ends are each tucked under one strand, or better, are pulled with a

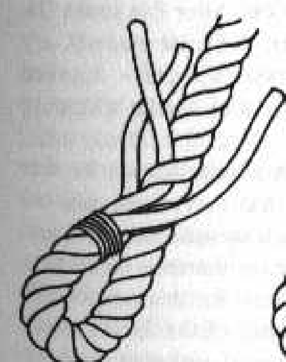


Fig. 180 Eye splice. The first tucks

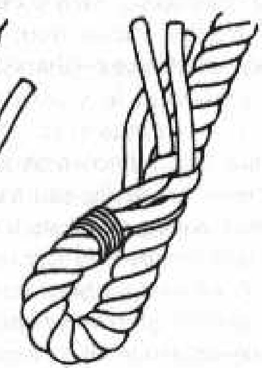


Fig. 181

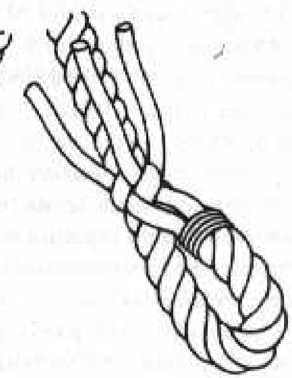


Fig. 182

sack needle or roping needle under one and through one strand or two strands and then cut off (Fig. 183).

A small trick to achieve a neat and clean splice is to quickly burn the splice with a blowlamp or hold it over a gas burner. This burns off the loose yarns and fibres. A more even look can also be achieved on a badly-made splice by rolling it under the foot or under a wooden plank. Doing this was once regarded as a sign of incompetence, and the seaman of 50 years ago was too proud to lower himself to such practices as standing on a splice. He spliced all ordinary rope evenly, neatly and fast with his fingers, using no tools.

'The horn is used when one splices thicker than three inches, otherwise the fingers are sufficient,' a first mate used to frequently say in the days of the author's youth.

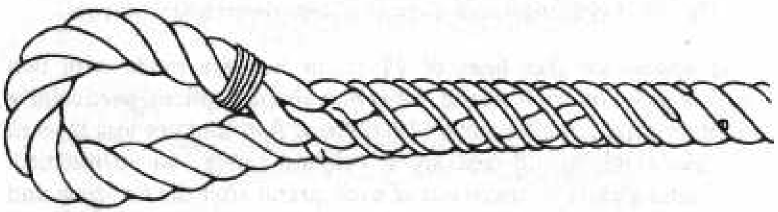


Fig. 183 Wormed eye splice

On thick cordage, mooring lines, etc. the splice is not thinned but all tucks are made with whole strands. In making the splice a half-turn is made in each strand before making each tuck. After five tucks the strands are halved and adjacent halves from different strands are paired and seized together with strong sailmaker's twine – doubled several times – which is crossed as in a palm and needle whipping (Fig. 184a).

Thick nylon hawsers are best spliced with whole strands by this method. At least seven tucks are made and the halved strands are seized securely together with strong nylon yarn or sailmaker's twine. For added security a hot iron can be held against the ends to prevent the strands creeping out. A soldering iron is ideal for this purpose. It is held lightly and briefly against the severed ends of the fibres, which melt and fuse together; they are, so to say, rivetted and stay in place. Care should be taken with the melting as prolonged or excessive heat can easily produce hard, sharp and unpleasant ends. Some profess-

ional riggers find it sufficient merely to seize together the halved strands, as shown in Fig. 184a.

An attractive finish can be achieved on very thick hawsers if after six tucks a piece is taken out of each strand in such a way that half of the section removed is taken to the right and half to the left. One or two more tucks are made with the rest. The strands are then halved and seized together. The first sections removed are also seized together in pairs with parts from adjacent strands. Figure 184b shows this kind of splice.

Sometimes cable laid nylon is so large that each strand consists of a hawser with three ducts. The splice is then made so that after six

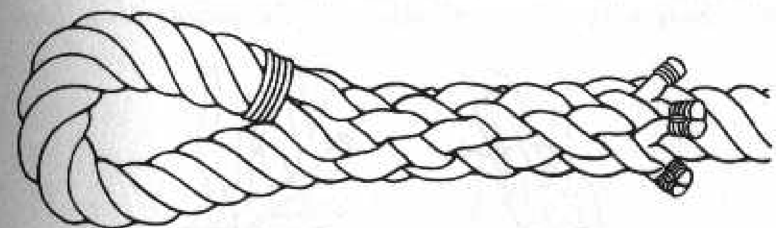


Fig. 184a Eye splice on a thick rope

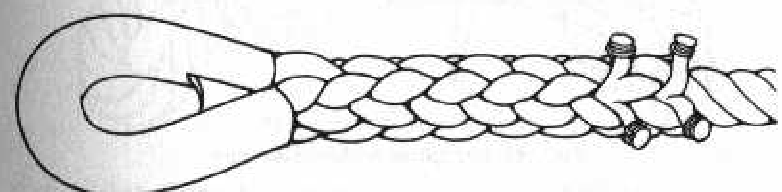


Fig. 184b Eye splice on thick nylon rope with pipe thimble

tucks one duct is taken out of each strand, after another two tucks the second duct is taken out, and then another two tucks are made with the last duct. Each duct is halved and the halves seized together in pairs to obtain three rings of seizings two tucks apart from each other.

Because nylon stretches considerably, a thimble can easily creep out of a spliced eye. Towing hawsers of nylon are therefore mostly furnished with eyes made of piping, as shown in Figure 184b. Large eyes on towing hawsers are protected by leather sewn onto them, or a strip of rubber or a suitable length of tough plastic tube.

Thinner nylon ropes for use on board yachts are spliced with five or six tucks with whole strands, and the short severed ends of the strands are carefully 'fused' with the edge of a hot soldering iron close to the worm of the rope. The rope itself should not be touched by the hot iron.

Ropes of spun nylon can be spliced in the same way as ordinary ropes, perhaps with an additional tuck to prevent the splice slipping.

On shroud laid rope the core is cut away close to the whipping and when laying together two strands are placed on each side of the rope (Fig. 185). Both strands on the right hand side, No. 1 and No. 2, and No. 3 on the left-hand side, are tucked in as with three-stranded rope. The fourth strand is tucked in at the same place as the third and is taken against the lay under two strands. Before it is laid into place, the

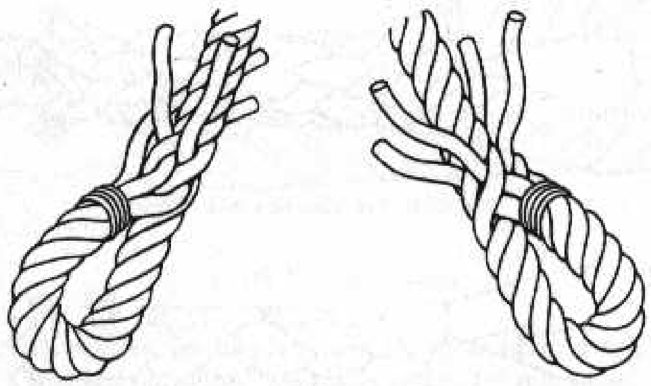


Fig. 185 Eye splices on shroud laid rope

turns are twisted out of it so that it falls into place smoothly. After the first tucks the splice is completed in the same manner as a three-laid splice.

There are other methods of starting a splice on shroud laid rope. One is to tuck the fourth strand under only one strand against the lay; another is to tuck the two middle strands to cross under one and the same strand with the one from the right uppermost and to tuck the other two each under one strand – the one on the right to the right and the one on the left to the left. The method shown in Fig. 185 is however considered to be the best.

If a thimble is to be spliced in, the rope is hammered well into the groove of the thimble, and the best result is obtained if the bight of the

eye is lashed to the thimble. The fid used for the splicing is also used to tighten the tucks in the splice. The strand is laid in a round turn around the fid, which is twisted, so that the strand jams its own part, and the fid is then used as a lever, as shown in Fig. 186.

If an eye is spliced without a thimble, the strands should not be pulled too tight after the first tuck, as this results in the tucks wandering along the worm on the fixed part of the eye, twisting the eye into a spiral. If a whipping is not made on the end to prevent the rope opening up, it may open up more than is desired after the first tuck, producing kinks in the eye.

Instead of making the tucks over one and under one against the lay, the strands can be tucked with the lay after the first tucks have been made, so that each strand goes around one and the same strand in the

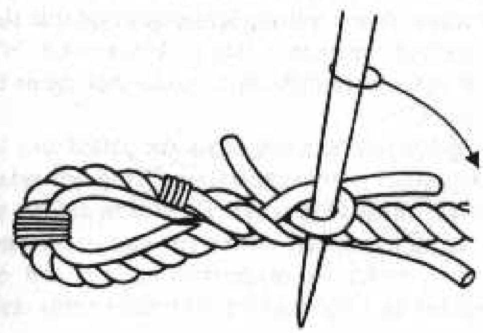


Fig. 186 Splicing in a thimble

rope. When using this method yarn is also taken out from the underside of the strands in order to get a thin, even splice.

Sailmakers always splice bolt ropes in this manner, and the splice is usually called a *sailmaker's splice*. The beginning is often done differently from an ordinary eye splice. Many years ago the author was taught the following method by an old sailmaker in Kalmar. The right hand strand is taken first and tucked under the middle strand of the rope from the right towards the left. The middle strand is then taken under the same strand from left to right, and then another tuck is made with this strand with the lay in order to lock the tucks. Finally, the left hand strand is taken against the lay under the strand on the left side of the rope, and the splice is then continued with the lay. Yarn is removed for every tuck after the first two.

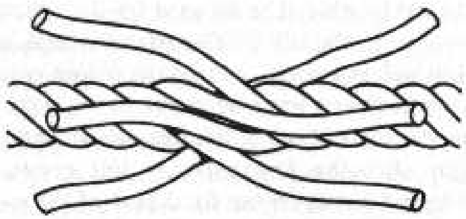


Fig. 187 Marrying ends for a short splice

If an eye is to be spliced on a very thick rope, the rope should be lashed to a bollard and a thick toggle and maul used to open it up. Whip the ends of the strands well to keep the yarns together, tuck them through in the splice, get a purchase on them with a strop, tighten them with a tackle or winch and, finally, hammer them into place with the maul. When splicing it is important that the strands are twisted in the correct direction so that no kinks result. With the aid of suitable tools it is no more difficult to make this splice than it would be on thinner ropes.

For a *short splice* two or three turns are unlaid and both ends are laid against each other so that each strand from one side lies between two strands of the other (Fig. 187). Then each side is spliced in the same manner as an eye splice – over one and under one against the lay. Three or four tucks are made with each strand on each side. Yarns are removed and the splice tapered before it is completed. The

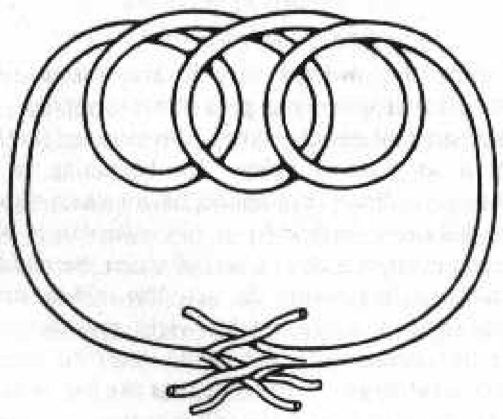


Fig. 188 Splicing a strop

short splice is the easiest of all splices on rope, and the only difficulty lies in keeping the twist in both ropes so that the splice will be hard and tight. In all splicing of strops a couple of turns are taken *out* of the rope before the ends are laid together. This is done by pushing a few small bights clockwise in the rope and keeping them there while splicing (Fig. 188). Otherwise turns are produced in the rope, because the lay of the rope is reversed in the splice. Yarn is never removed when splicing slings for loading, but the splice is completed with whole strands, and when cutting off the yarn ends at least an inch is left outside the splice to allow for stretching.

A short splice can also be started by first knotting the strands together in pairs. Each knot is laid with the lay of the rope yarn in the strands (Fig. 189) and the splice is completed in the usual manner. However, this method does not have any advantage over the method first described. The author cannot decide which method is the oldest.

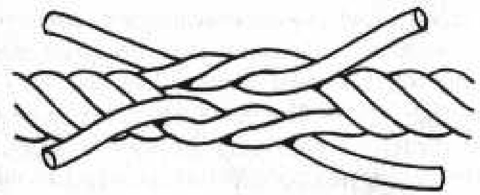


Fig. 189 Variation of marrying strands for a short splice

A short splice made round about 1640 was discovered, when inspected, to have been made in the manner first described here, without knots in the strands.

A short splice can also be made with each strand spliced round one and the same strand in the rope. This method is used when ropes of different sizes are spliced together, such as different sized bolt ropes, and is known as a *bolt rope splice*. In making it the ends are thinned out so that the splice goes from the thicker rope to the thinner one without swelling. It requires lots of practice to do it well and is only of use to sailmakers.

The *long splice* is used to splice together ropes which have to run through blocks and, if it is well made, should not be thicker than the rope itself. Nine turns are opened on each rope and the ends are laid together, as with a short splice. Then one strand is taken out in each direction to the length of six or seven turns and a suitable strand from

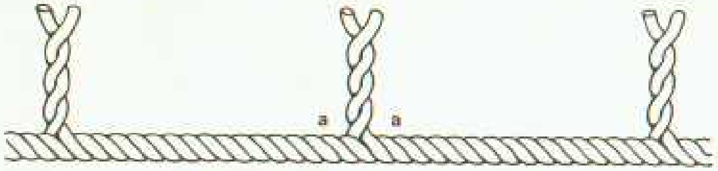


Fig. 190 Laying together a long splice

the opposite side laid in so that the six strands meet in pairs in three places six or seven round turns apart. Excess lengths are cut off and the strands are temporarily laid together so that they do not get mixed up during splicing (Fig. 190).

The pairs of strands are then spliced separately, and to prevent the splices becoming too thick half of the yarn should be removed from each strand. With new or only slightly used rope of normal thickness all the heart yarns are cut away so that the surrounding yarns hide the severed ends. On very thick ropes the heart yarns comprise more than half the yarns, while on thin ropes they comprise less than half. Depending on the circumstances more or less yarn may be removed to leave half of each strand. The yarns which are to be removed are cut out a short distance from where the strands meet, so that the distance between the cutting points is about equal to the circumference of the rope, *a-a* (Fig. 190). The remaining thin strands are knotted around each other with a half-hitch (Fig. 191), laid in the same direction as the rope yarn in the strands, and then tucked in against the lay as shown in the illustration. Three to five tucks are made, depending on the thickness, and yarn is removed from the underside in order to finish the splice evenly. After the first tuck has been made against the lay, the subsequent ones can be made with the lay around one and the same strand. The completed splice is then well

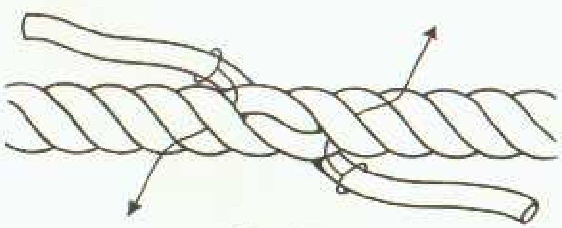


Fig. 191

stretched and any yarn ends showing are cut off. On old rope the heart yarns are not removed, because they are the least worn, but the strands are halved by taking out most of the outer yarns. If the rope is very old and worn, it is spliced with whole or nearly whole strands, and, as an emergency measure, whippings can also be sewn over the part splices to keep them together.

With shroud laid rope twelve turns are laid open and the strands are laid in ten and three turns in each direction, so that four pairs are obtained with six or seven round turns between each. Otherwise it is spliced in the same way.

A *mariner's splice* or *cable splice* is a long splice made on a cable and consists of three separate long splices, one on each hawser, which

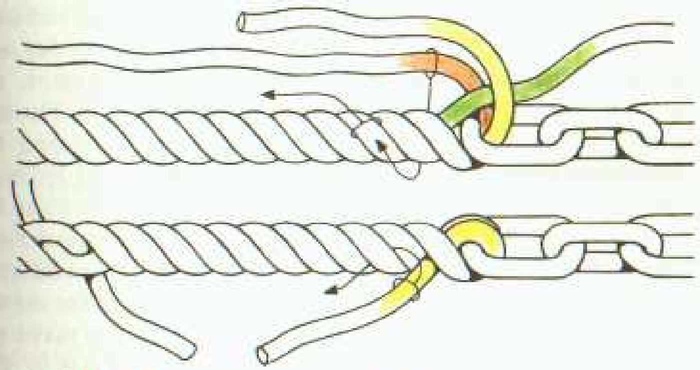


Fig. 192 Chain splice Fig. 193

form the cable. The splice therefore consists of nine part splices which should be evenly distributed over the length of about 24 round turns of the cable. This splice is one of the most difficult things to make with cordage. It has now become part of history, along with hemp rigging, cable laid anchor cordage and sailing ships. Few living seamen have ever seen it made and probably fewer are able to make it.

The *chain splice* is used to splice a rope to a chain when the rope is too thick to go through the chain. One strand is laid open about seven turns and the two other strands are threaded through the last link of the chain (Figs. 192, 193) and allowed to form the smallest possible eye in the chain. The first strand is taken out a further five round turns and the most suitable one of the other two strands is laid in its worm and joined to it as in a long splice. The third strand is then spliced in next to the chain as in an eye splice. If the whole rope fits through the chain link, an ordinary eye splice is made. The chain link should be served with yarn or leather if the job is intended to last.

Splicing together three-stranded rope and shroud laid rope. Although sometimes necessary, these splices are not attractive and are always considered to be emergency measures. For a short splice three turns are opened on the shroud laid rope and six on the three-stranded rope. About a third of the yarns are removed from two strands which are carefully laid together into a fourth strand which should then be as thick as the other two from which it has been made. The rope is then laid together as a shroud laid rope to the length of three turns and is married with the shroud laid rope. The splice is then completed as with shroud laid rope.

A long splice is made by opening nine turns on the shroud laid rope and 15 turns on the three-stranded rope. It is then put together and one strand of the three-stranded rope is taken out six turns, the corresponding strand on the shroud laid rope being laid in. The one strand is taken out 12 turns from the shroud laid rope, and the corresponding strand from the three-stranded rope is laid in. Now there are two strands from the shroud laid rope and one from the three-stranded rope left in the middle of the splice. The strand from the three-stranded rope is divided into two parts, approximately one-third and two-thirds, The smaller part is tied to one of the shroud laid strands where they meet, the last shroud laid strand is taken out six turns, and the larger part of the three-stranded rope is laid in. The splice is then made in the usual way.

A *braided log line* is seldom repaired, but if a new log line has been damaged it can be spliced in the following manner. The braided outer layer is opened up with the aid of a sail needle for about 6 in. on either end and the exposed heart yarns are spliced together with an ordinary short splice, which should be made as short as possible. Two or three tucks in the whole splice are sufficient, and the remaining strands are cut away. The splice, which does not have to be longer than about 3 in., is then covered with a coach whipping made from the outer yarns in the same manner as their machine-made braiding. When the pointing meets in the middle over the splice, the yarns from both sides are braided together with the aid of a sail needle further into the cross-pointing, thus stretching it taut around the heart yarns. The splice is not particularly difficult to make. It will be as strong as the line but not much thicker.

The splicing of rope braided as described on page 25 must be done in a particular manner. The two pairs of strands which are laid clockwise must go anticlockwise in the splice and vice-versa. Usually only eye splices are made on this thick rope, which is normally used for mooring purposes, but the same principles apply when making both short and long splices, with two strands going clockwise and two going anticlockwise as the rope is laid.

For the eye splice the rope is bent into an eye of the right size, with the two pairs of clockwise laid strands standing vertically and the anticlockwise ones lying horizontally, as shown in Fig. 194. When referring to 'up and down' and 'right and left' the rope is imagined as being held as described on page 121.

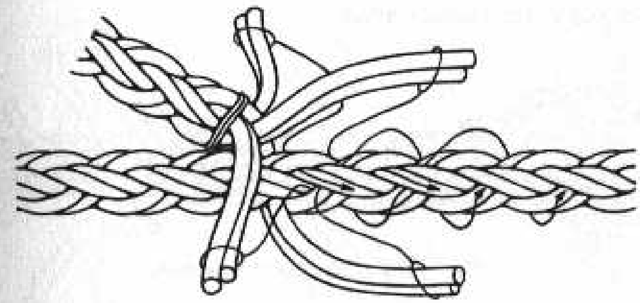


Fig. 194 Laying together a splice on braided rope

To get the beginning of the splice correct, a whipping, which determines how far the rope is to be opened up, should be made over the pair of vertical, clockwise strands. This is on top of where the horizontal, anticlockwise strands cross each other in the rope.

The first tuck of the splice is made with the upper pair of strands which lie under the whipping. This crosses the other clockwise pair immediately outside the whipping and points straight down to the left of this. The tuck is taken straight through the standing part of the rope between the two pairs of strands which twist clockwise around each other, as shown in Fig. 194.

This first tuck is decisive for the whole splice. The rest is easy. The two horizontal pairs, which go anticlockwise around each other, are then whipped. The pair which points to the left is taken first and tucked to the right and along the top of the other anticlockwise pair of strands in the rope, and under the crossing clockwise pair of strands in the rope. We are now left with the fourth pair of strands. These come up to the right of the first pair which were tucked straight through the rope. The fourth pair is bent forwards and downwards to the left and are allowed to go over the nearest right-hand-going pair in the rope (see also Fig. 194). The continuation merely requires each pair of strands to follow over the corresponding pair in the rope and under all crossing pairs. It is best to start with the pair of strands which have been tucked straight through the rope, allowing them to follow the remaining free right-hand-going pair in the rope forwards and upwards on the right hand side of the rope.

After the two first tucks another three tucks are made with each pair of strands. Then one strand is excluded from each pair and the splicing is continued with two tucks forwards with each single strand. Fig. 195 shows the finished splice.

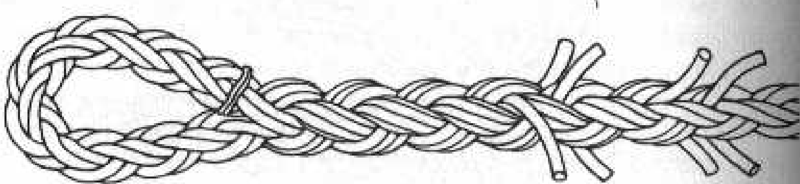


Fig. 195 Eye splice on braided rope

Because the rope has its strands laid in pairs, the strands which are spliced in cannot be suitably halved and seized, as shown in Fig. 185. On synthetic rope they should therefore be carefully fused with a hot iron or soldering iron, and with manila or sisal they should be cut off short as in an ordinary splice.

Seizings

Seizings are used to join two ropes running parallel, to make an eye on a bight, or generally to join items together. Nowadays, when a block has iron strops and standing and well as running rigging is manufactured from wire, yarn and flax seizings are not used to the same extent as they used to be, but they do still form an important part of maintenance work on board ship. Depending on size and quality, seizings can be made with sailmaker's twine, rope yarn, marline, spun yarn and seizing stuff or, for special occasions – salvage work or repairs after shipwreck – from whatever thicker rope

is available. These thick seizings are usually called *lashings*. In making seizings a distinction is made between single and double seizings and round and crossed seizings.

The line or marline from which seizings were made used to be called seizing stuff. Apart from a suitable length of line, yarn or seizing stuff, a small marline spike or fid is needed when making a seizing. An eye is made on one end of the seizing – in the case of seizing stuff it is spliced like an ordinary eye splice with only two whole tucks, but with marline or spun yarn it is made as shown in Fig. 196. A and B are used with two-thread yarn, A being made when there is access to both ends of the seizing. C is made like a common sennit and is mainly used on three-thread spun yarn. If this consists of

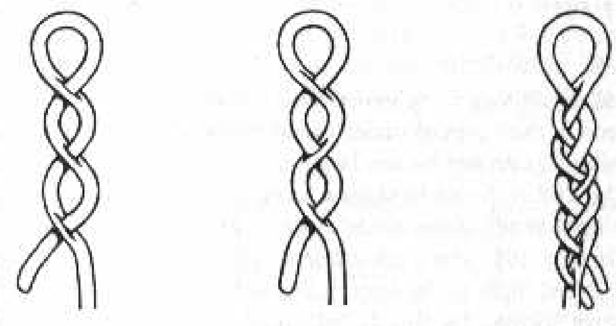


Fig. 196 Yarn splices

yarn of different thickness, which is often the case, the thickest is taken on its own and the thinnest together.

As a general rule all seizings are made against the lay of the rope; that is, clockwise for ordinary right-hand laid rope, with the parts of the seizing falling close together. When an eye is to be seized in the seizing is always made towards the eye, which makes it easier to determine the size of the eye, and the seizings are tighter (Fig. 197).

A *round seizing* (Fig. 198) is the simplest of all seizings. It is very useful when an easily laid seizing is needed, particularly when lack of space makes working difficult. The seizing stuff is taken around the two parts which are to be seized together, so that the eye comes on the flat between them, and the required amount of turns – usually seven –

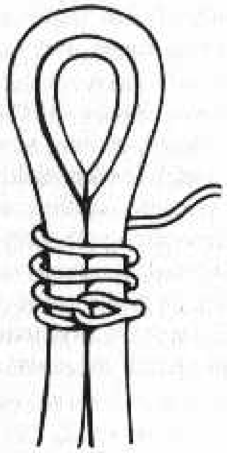


Fig. 197 Seizing an eye

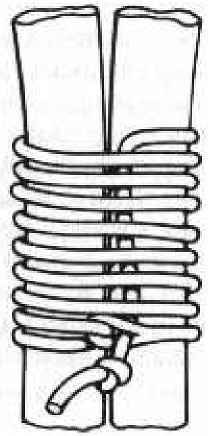


Fig. 199

are made. Each turn is tightened with a marline spike (Fig. 153). The rope's end is then tucked under the whole seizing and up through the eye, which should not be too large, and is secured with an overhand knot. Fig. 198 is drawn to show a loose seizing for the sake of clarity, but the knot is of course made close to the eye. This is best done as shown in Fig. 199. The knot is laid loosely, the hauling part kept taut and the initial bight of the knot pulled tightly down and around it. The round turn formed by this is held tightly under the thumb and the hauling part is pulled through, forming the knot close to the base.

A *double seizing* is always made with a line and spike, and is a thick seizing of great strength. It was always used on old-time hemp rigs and is still called a rigging seizing. It is made with an odd number

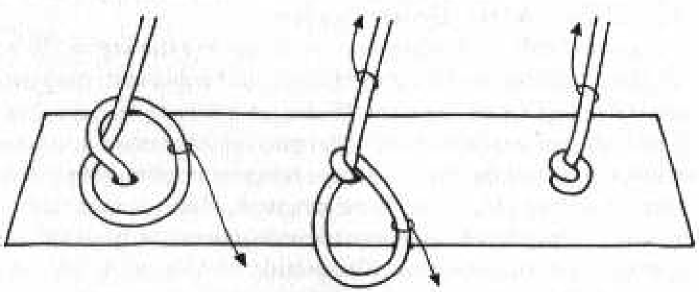
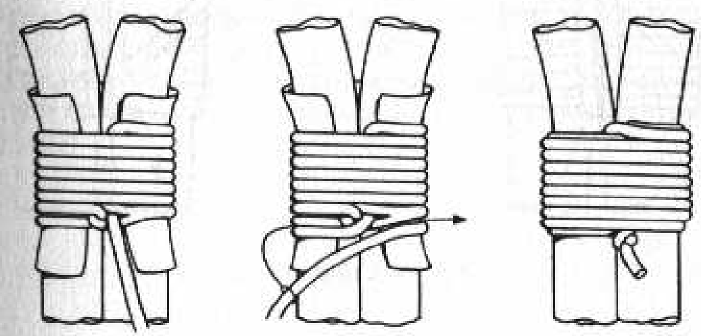


Fig. 198 Round seizing

of turns (seven or nine) in the bottom layer which produces an even number (six or eight) in the top layer. Under the seizing a single row of tarred canvas is laid, which can protrude well outside the ends of the seizing but should not meet completely on the side where the seizing stuff is tucked under the turns, because the canvas easily blocks the groove. The under layer of the seizing is laid in the same way as a round seizing, but with one round turn less than intended (Fig. 200a). Each half turn is tightened with a marline spike, so that the under layer becomes hard and tight. After the line has been tucked up through the eye and hauled well through, the final round turn is made in the bottom layer outside the eye, bringing it into the seizing where it cannot be seen (Fig. 200b). This final round turn is tightened well with a marline spike, and the turns of the upper layers are then laid in the worm of the under layer, but not so tightly as to pass through it. The end is tucked the same way as before under the seizing, if possible through the eye and out on the other side of the seizing, and is finished with an overhand knot (Fig. 200c), after which the excess canvas can be cut off.



Figs. 200a, 200b, 200c Double seizing or rigging seizing with line

A *crossed seizing* (Fig. 201) is the most common of all seizings and is commonly used where the two parts seized together are not tightly together, for example on a block strop or a thimble. The seizing is begun the same way as the previous one and after the required amount of turns have been made holes are pricked between the parts which have been seized together. The end is tucked between them and is taken two round turns across the seizing. The fastening is done as shown in the illustration. The end is tucked from right to left under both of the cross turns and pulled tightly down between the ropes which have been seized together. The end is then tucked from the right towards the left, under the right hand cross turn, so that it comes up between the two parts. The knot, which resembles a reef knot, is tightened well and the end cut short. The seizing can also be made as a round seizing before it is crossed, although the end is not taken through the eye.

A *double crossed seizing* is very seldom seen nowadays. It is used on very thick work where the parts do not come close to each other or where stresses are applied in different directions. It is begun like a round seizing (Fig. 198) and is immediately doubled and crossed as a crossed seizing.

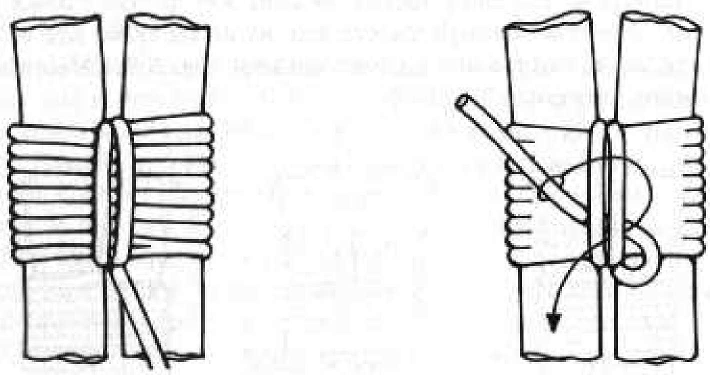
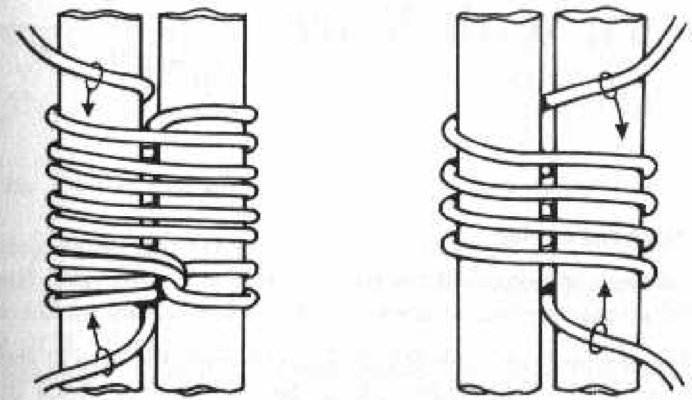


Fig. 201 Crossed seizing

Simpler seizings of rope yarn and smaller ones of sailmaker's twine are made with the yarn doubled (Fig. 202a). The bight is taken around the ropes which are to be seized together, and a sufficient number of turns are made tightly by hand. The one yarn is then taken half a turn in front of the other. They are then tucked between the parts seized together, are crossed one turn over the seizing and tied together with a reef knot where they meet. Small seizings can be made even simpler with single yarn (Fig. 202b). The yarn is laid between the two parts, the required number of turns are made and the yarn tucked back between the parts so that the ends meet. Both ends are crossed one



Figs. 202a, 202b Yarn seizings

turn around the seizing and tied together where they meet. If possible, the knot is placed between the parts.

Small, well made seizings are best sewn with a sail needle and doubled waxed sailmaker's twine in a similar way to whipping. The yarn is fastened by taking it through the one rope, and then the required number of turns are made around both parts, pulled taut and the seizing completed with crossing turns and fastened, as shown in Fig. 201.

Work with Wire

Parcelling and serving

Worm and parcel with the lay
Coil and serve the other way.

Serving of wire is as a rule the work of two men. The man in charge does the serving, the helper taking the yarn around. They place themselves on each side of the wire, which is strung up at waist height, and facing each other so that the wire runs under their left arms. As both press against the wire with their left hips it is well stretched.

The wire is first parcelled with oiled sacking cut into 2–3 in. wide strips along the weave. These are wound on in an anticlockwise spiral following the lay of the wire, with each turn covering half the previous one.

The serving is always done clockwise against the lay of the wire. In doing this it is important to commence at the end of the wire opposite where the parcelling began (Fig. 203). Parcelling is done towards the body and serving away from the body. This way the serving mallet pushes the parcelling evenly in front of it, so that it lies close and tight around the wire.

The serving yarn is fastened by laying the end along the wire and holding it with a couple of round turns which are hammered with the

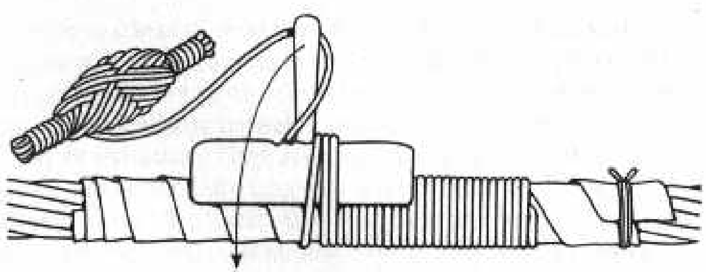


Fig. 203 Serving with a mallet

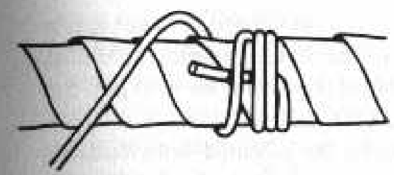


Fig. 204 Start of the serving

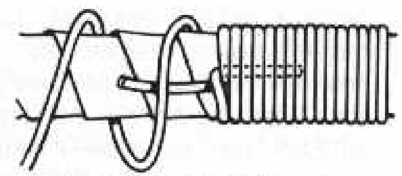


Fig. 205 Joining serving yarn

serving mallet until well stretched before being put on. Then the end is served (Fig. 204). The yarn is taken two or three times around the wire and the mallet head and then a couple of times around the handle (Fig. 203), where it is held so that it runs out suitably tautly while the serving mallet is taken round. The assistant who takes the ball of yarn around rotates it to prevent twists in the yarn. If the work is done by one person a serving mallet is used which has a bobbin mounted on a spindle parallel to the handle or in the angle of the handle. The yarn is wound on the bobbin before work commences. When engaged on large jobs a bobbin divided in two can be used, placed on the wire which is to be served.

Joining the yarn is done as shown in Fig. 205. The end of the new yarn is fastened under a few rounds of serving and the end of the old yarn is laid one half turn around the new yarn and served over with the new yarn. The join can also be made by 'splicing' the new yarn to the old. Both ends are split and laid together and a common sennit made in both directions (Fig. 206), or the yarns can be stuck in as in a cobbler's splice (Fig. 178).

When the serving has been done up to the end point, the last four to six turns are eased so that the end of the yarn can be pushed under them. The turns are then laid back over the yarn as tightly as possible

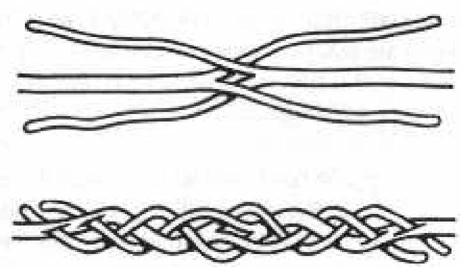


Fig. 206 Yarn splice

and held while the remainder of the yarn is pulled through. The yarn is laid in a half turn around the handle of the serving mallet, so that it overlaps and holds itself, and the mallet is used as a lever to jam the fastening as tight as possible (Fig. 207.

Thick wire and thick cordage should be wormed with suitable hemp yarn before parcelling, so as to prevent channels of water forming along the strands. Very thick materials can be wormed on top of the parcelling. All standing rigging or wire which stands vertical should be parcelled upwards and served from the top downwards. This inhibits the water from getting in under the serving.

Splices are always parcelled towards the thinner end and served towards the thicker end to make the serving tighter. In order to serve

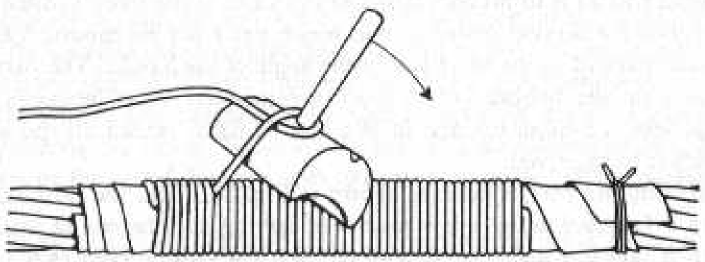


Fig. 207 Finishing off the serving

close to a thimble the yarn is laid in the notch on the one end of the serving mallet and taken behind the handle and a couple of times around the mallet and the wire.

Wire which is to be served should always be oiled under the parcelling. Standing rigging and splices which have had their galvanizing damaged and are vulnerable to rusting should, if the work is to be permanent, be greased with tallow and white lead or red lead before being parcelled and served.

Seizings

Wire seizings are generally made in the same way as yarn seizings. A small knot is made at the end of the seizing wire and with the aid of a rigging screw or screw vice is jammed between the two parts which are to be seized together. Because a marline spike knot cannot be made in the wire without damaging it, a round wooden pin is used

when making the seizing. The wire is rolled on the pin which is then used as a lever to tighten the rounds. The seizing is made with seven to nine turns and is always crossed. The fastening is done in the same way as a yarn seizing. Very small seizings can advantageously be made with three or four single wires, which are taken out of the seizing wire and pulled over an edge to get them straight. If the seizing wire is very short, a filing vice can be fastened to its loose end to serve as a handle when making the seizing.

Double wire seizing (rigging seizing). This is almost exclusively used on thicker rigging wire, which is always served with sailmaker's twine. To make this, a suitable length of seizing wire, a piece of sailcloth, a length of sailmaker's twine, a rigging screw, a small sharp marline spike, a heaver or lever of wood, and a smaller hammer or maul are required.

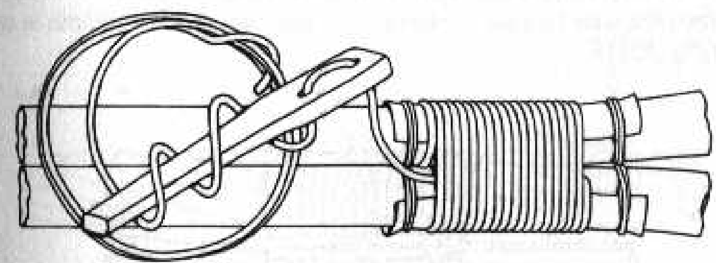


Fig. 208 Double wire seizing, the bottom rounds completed

On the outside of the two parts which are to be seized together a couple of strips of sailcloth are lashed, and the seizing is made over this to prevent the seizing wire from being pulled down through the sailmaker's twine in the serving. The two parts are then screwed together with the rigging vice but, before coming together completely, the end of the seizing wire, in which a small knot has been made, is put between them so that it is held fast when the rigging vice is tightened. The seizing wire is rolled up on the heaver which is used to lay the wire in tight, well-stretched turns. A specially made heaver which is flat with two holes in the one end is very useful (Fig. 21b). It is used in such a manner that the wire is allowed to run through both holes when the seizing is made. As the turns are made they are knocked together with the hammer, so that the rounds are tightly and evenly laid. The seizing is made clockwise, 15–21 turns being made. The well-tightened bottom turns are held fast while the wire is taken from the heaver and tucked under the whole seizing through the groove along the seized-together parts (Fig. 208). To be able to do this one must ensure at the beginning that the sailcloth over which the seizing is made does not fill the groove under the seizing. Then the heaver is threaded again and the last tuck is pulled tight under the turns of the seizing and hammered with the hammer until it jams. The outer turns are then laid in the grooves between the underlying turns. The seizing wire is again tucked under the whole seizing the same way as before, and is then tucked between the parts seized together and the seizing is crossed with two frapping turns. The end is fastened in the same way as in a yarn seizing. After each tuck under the seizing the heaver is threaded on and the frapping turns are tightened as quickly as possible and hammered, which is the best way to prevent them from slackening. When the seizing is finished the wire threads are twisted off and any excess sailcloth is cut off (Fig. 209).

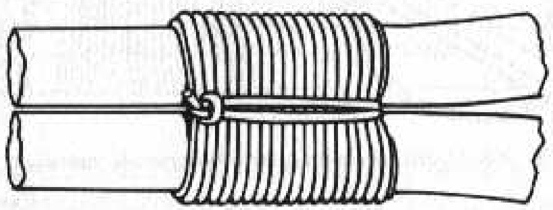


Fig. 209 Double wire seizing

The seizing can also be begun from the middle of the seizing wire. The middle of it is fastened and the bottom layer is made with one half, the end of which is fastened under the turns. The upper turns are laid with the other half of the seizing wire and crossed with frapping turns as described above.

It is usual to measure out the amount of seizing wire needed before it is cut. Marline can be used to measure around the area to be seized. This measurement is multiplied by twice the number of turns in the bottom layer of the seizing, and to this add three times the circumference of the frapping turns plus 1 ft for fastening.

Splicing

Wire can be spliced in several ways, and in the foc's'ls of the old sailing ships there were often heated arguments over the advantages and disadvantages of the different methods. Experimentation with the various forms of splicing had already finished in England by 1850, but it took several more decades before this skill was considered obligatory for Swedish seamen. During the eighties, when knowledge of wire splicing began to spread, the man who could accomplish this was called an 'iron seaman' by those who were unable to – often without admiration and with ugly adjectives.

All wire splicing is preceded by whippings on the wire. These are best made with doubled, waxed sailmaker's twine. The bight of the twine is taken around the wire and after the required number of turns have been made as tight as possible, the ends are fastened with a

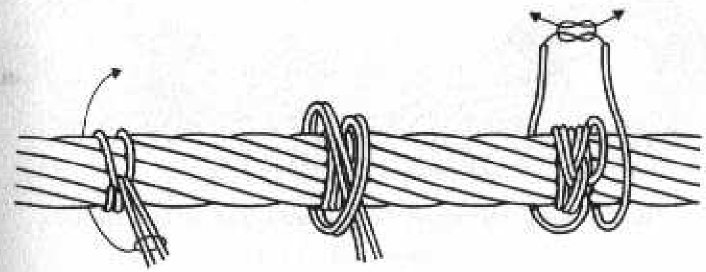


Fig. 210 Whipping on wire

couple of half-hitches, taken in opposite directions for a couple of turns and tied together where they meet (Fig. 210).

The *eye splice* is the most important of the existing wire splices. At a distance of three or four round turns from the end a good whipping (*a*, Fig. 211) is made to prevent the wire from opening up more than intended. A simpler whipping, *b*, is made about 2 in. from the end and the strands are opened up to this and then whipped. These are simple round whippings (Fig. 27) which are commenced so that the end of the twine is caught fast in the spiky ends of the wire threads, and thereafter taken around the strand. If there are heart yarns of hemp in the strands they are left outside when the strands are whipped. If a thimble is to be spliced in, a strip of oiled cloth is first laid in its groove and the thimble is lashed to the wire with the seizing *c* placed at the right distance from the whipping *a*. Then the thimble is strung

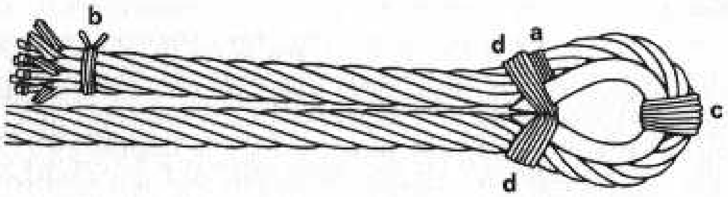


Fig. 211 Seizing in a thimble for an eye splice

tightly in the wire with a rigging screw or, better, with a screw vice, the jaws of which are put over both wires at *d-d*, close to the thimble. A well tightened figure of eight, *d-d*, is made so that the thimble is held completely secure. Only then is the whipping *b* cut, the strands opened up to *a*, and the heart cut away.

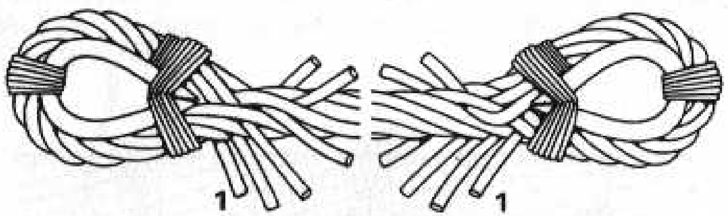


Fig. 212 Right side Left side The first tucks of an ordinary eye splice

The strands are divided symmetrically vertically so that three go either side of the wire, and are numbered here so that the one lowest on the right-hand side is No. 1, shown in Fig. 212, and the others are numbered consecutively anticlockwise to No. 6. The work is held and viewed as described in the beginning of the section on the splicing of cordage. The splice is commenced by tucking the first and lowest strand on the right-hand side under three strands of the wire i.e. it is tucked straight through the wire but to the right of its core. The appearance of the whole splice depends on this first tuck, and a lot of practice is needed to place it in the right position. The strand should be tucked into the worm closest to the right of the mid-line of the wire close to the thimble. The strand is, however, not forced through the wire close to the thimble but the tuck is made some distance away from it. The strand is tucked through the wire behind the marline spike, and with a spiral movement it is pushed along the worm down against the thimble. Strand No. 2 is tucked in at the same place but

under only two strands to the right. Strand No. 3 is also tucked in at the same place and under one strand to the right. The three strands on the left side of the wire are taken each under one strand in the wire. All tucks are made from the left to the right with the lay, as shown in Fig. 212.

After the first tucks the hemp core yarns are removed. This can be done without disturbing the whippings on the ends of the strands. Each strand is then spliced around its own strand in the wire, the tucks going in the same direction as the wire threads go in the strands. A half-turn is twisted out of each strand for each tuck. The tucks are made long and the strands are pushed down to their positions with the help of the marline spike. If there are no heart yarns of hemp, two complete tucks are made with each strand after the first and before the wire heart yarns are removed. After four or five tucks with each strand they are halved and another two tucks are then made to taper

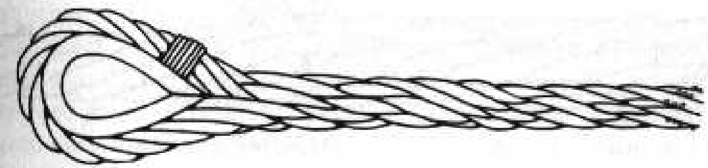


Fig. 213 Liverpool splice

the splice. Splicing according to this method is the most common and is known as the Liverpool style. Fig. 213 shows the completed splice.

When the splice is finished all wire threads are chopped off with a sharp chisel as close to the wire as possible. The threads can also be twisted off one at a time, as this gives good results. The wire thread then breaks close to the wire and by twisting a small hook is formed on the end which prevents the thread from slipping out of the tuck. The splice can be parcelled and served, but the eye around the thimble is not served nowadays.

On a cargo fall which drags under the edges of holds, etc. it is unsuitable to thin the splice; the whole splice is made with whole strands. To lock the last tucks they are taken under two strands of the wire with the lay to the right, and this jams the threads better (see Fig. 214). Splices like this are not served. They are always spliced with rather large eyes which are more easily pulled around edges and corners without a thimble. A thimble usually snags and is then broken out.

The Swedish safety regulations specify that wire splices used when loading and unloading must have at least three tucks with whole strands before they may be halved; thereafter at least two tucks must be made with halved strands. It is, however, best to make all five tucks with whole strands.

If there is no access to a rigging screw or a screw vice the eye must be laid together. After the thimble has been lashed to the wire with the lashing *c*, the strands are opened to the whipping *a* and the three strands on the right hand side are tucked into their positions. By holding their ends so that the wire hangs free, and hammering on this with the marline spike where the strands emerge, the splice is driven together as tightly as possible. The tucks of the three strands then bind so that the other three can be tucked in and the splice completed. The

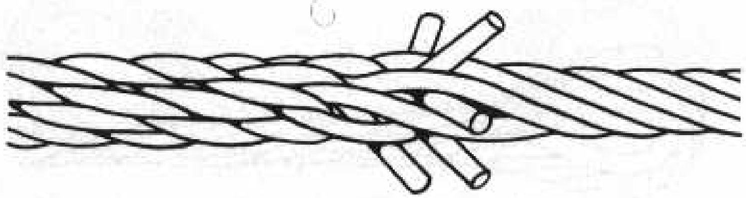


Fig. 214 Locking tucks on a cargo fall

eye does not, however, become as tight as with the aid of a screw vice when the splice is made in this manner.

A simple way of thinning the splice is to make four or five tucks with whole strands and then another one or two with alternate strands.

If a larger eye is to be spliced on a mooring wire, it is bent together to the size of the eye and before the splice is commenced a good lashing is made around both parts close to the whipping *a*, and the splice is laid together after the first three strands have been tucked in. Once the splice is finished the lashing can be replaced by a crossed seizing of wire. This is not made on the naked wire but on two 4 in. servings of sailmaker's twine which are made before the splicing.

Wire can also be spliced against the lay, as with cordage. This is the *crane splice*. The commencement is slightly different from a Liverpool splice because all tucks must be done side by side in rounds.

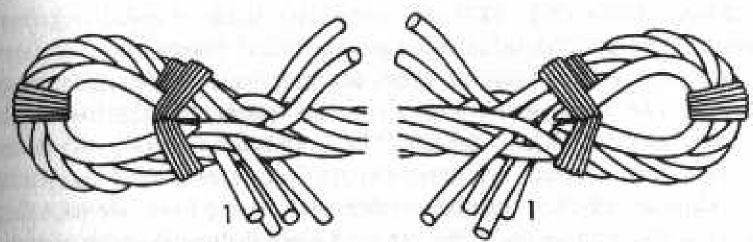


Fig. 215 Right side Left side First tucks on a crane splice

After the thimble is seized in, the first strand to the right is tucked under two strands on the right side of the wire. Strand No. 2 is tucked in at the same place and under one strand to the right. Strand No. 3 is tucked in at the same place but to the left under the next strand. No. 4 is also tucked under this strand but from the left to the right so that No. 3 and No. 4 cross each other under the same strand with No. 4 underneath. Strand No. 5 is tucked downwards to the left under the next strand and No. 6 also under this and the following one towards the left (Fig. 215). But the strands can also be tucked in the following order: No. 1,2,6,5,3 and 4. This is slightly easier on very hard wire. The core yarns of hemp are taken out and the splice is finished by taking each strand over one and under two strands in the spiral of the wire against the lay (Fig. 216). The last strand of each round is always difficult to get into place. Three to four tucks are made, the strands halved and another couple of tucks made with each strand. The splice at first appears clumsy but falls nicely into place if pounded. The splice is secure on thick crane wires which, despite swivels, sometimes twist themselves and would pull a Liverpool splice loose.

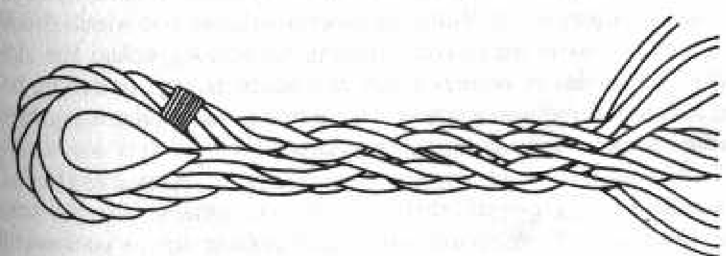


Fig. 216 Crane splice

Short splices (Fig. 217) are sometimes used to splice together slings. The splice is difficult to get tight and strong and has now virtually gone out of use as slings are more and more replaced by lengths. The two wires which are to be spliced together are each whipped three turns from the end. The strands are whipped with heart yarns of hemp outside and spread apart. The cores are cut away and the wires are married together so that each strand from one rope lies between two strands from the other. A tight lashing is made around the middle of the whole bundle, and the strands on one side are whipped to prevent them creeping open when the marline spike is stuck through the wire on the other side. This is necessary in order to get the splice tight and strong. If there is access to a wire vice, this does better service than the best lashing. Then the first whipping around the wire is cut and the free strands are spliced in as for an eye splice after the first tuck has been made. The strands on the other side are freed, the other whipping is taken off and the other side of the

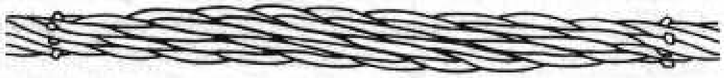


Fig. 217 Short splice

splice is finished as the first. The last tucks can be made under two strands with the lay. The splice should be served, which covers the needles.

Such a short splice holds badly on mooring wires because when the splice is bent around a bollard or a winch the strands creep backwards until the whole splice pulls loose. Spliced as a crane splice with the tucks made over one and under two against the lay, it does, however, become stronger. It will then hold around bollards and winch drums, is insensitive to twisting and breaking in heaving holes, but does easily become full of needles which can cause damage to hands. It is also excellent for slings, and everywhere that a short splice is needed it should be made by the crane splice method.

Broken mooring wires are often repaired in this way, with the ends laid somewhat past each other and each end spliced into the other wire like an eye splice so that the two wires form an eye between the splices (Fig. 218). Made with rope it used to be called "cut and splice" in the navy, from the English *cut splice*. It has also been called a

basket splice because it was used on slings for ballast and coal baskets, perhaps more often for coal baskets because coal always used to be unloaded in baskets and still is in small places.

Originally this splice was intended for completely different purposes, and is one of the worst jobs with mooring wire. It is stiff and clumsy, always full of needles, and if the eye between the splices is only slightly too big there are plenty of opportunities for it to snag on bolts and pipe flanges or even over lips on bollards when the ship is to be checked, and the result is yet another broken wire or damaged fingers. Many nasty words have probably been uttered about this splice, and when one is used a seizing should be made over the middle of the eye to prevent it, if possible, from hooking onto something at a quick turn. It is inferior to a short splice made as a crane splice, and should never be used.

Splices on mooring wires should never be served. The serving is soon cut in the heaving holes, the yarn ends jam under the turns of the

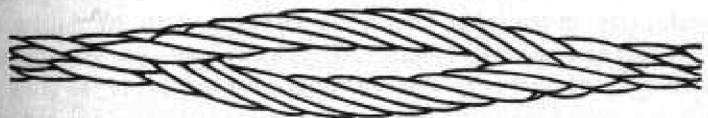


Fig. 218 Cut splice

wire on the winch drums, the wire rides tight and someone damages their fingers.

Long splice. The two wires which are to be spliced together must be of the same thickness and have the same rise on the lay. The strands are laid together two by two, and 24 or more turns are opened on each end. By holding together the strands in pairs their lay is preserved and they are easier to handle. The cores are cut off and the two ends laid together. Then one pair of strands is taken out of each side and a corresponding pair is laid in the same manner as with a long splice on three-stranded rope. During the laying together the strands are kept together two by two, and only after the first pair are laid together are they parted, so that they meet in single pairs in six places at equal distances from each other. They are then whipped and chopped off to the correct length (Fig. 219). If the wires have been opened as much as 24 turns, there will be eight turns between where the strands meet, and each strand should be four turns long.

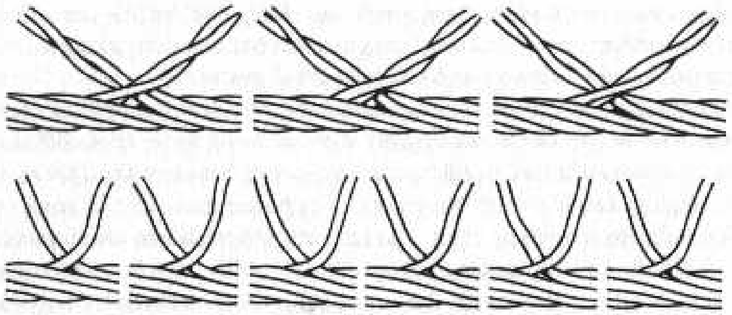


Fig. 219 Laying together for a long splice on wire

After the laying together has been done, the six part-slices are made so that one strand is tucked straight through the other where they meet and straight through the wire. The other is tucked at the side of the other and also straight through the wire, so that they emerge next to each other on the other side of the wire (Fig. 220). By pulling up both with one hand and hammering with the spike on the wire the strands are pulled well down between the other strands of the wire, so that it is almost impossible to see where they meet. With the aid of a marline spike the core is caught and cut off where the strands leave the wire. The spike is then taken under two strands in the wire so that its point emerges behind one of the splicing strands, as shown in Fig. 221. By twisting the spike with a spiral movement it can easily be made to move along the strands of the wire and push the splicing strand in front of it. The severed core is pulled out at the same time, and the splicing strand falls into the space left by the core. By putting the marline spike under two other strands from the other side of the wire, so that its point emerges behind the second splicing strand, this is also laid into the wire to its full length. The splicing is repeated with all six pairs of strands, the core being picked out progressively along the whole splice and the strands laid in. The length of the strands must be measured so that they meet in the wire without pushing on each other; if this happens they are pushed back and form a bight on the outside of the wire. It is also important to ensure that their ends are well whipped or the threads will easily escape and form needles in the wire.

With a little practice the splice is easy to make and takes no longer

than an eye splice. It will be almost unnoticeable if well made and completely free of barbs. Because it can be pulled around a winch drum or around a couple of bollards it is the only practical splice for broken mooring wires. If the splice is made on new wire great care is needed to get the first laying together correct as the oily, slippery strands easily slip apart and loose their twist. On old wire the laying together is relatively easy to do.

If the strands are entirely of steel without a core of hemp yarn, as in cargo falls, it is often impossible to tuck one straight through another. They will then have to be passed over each other so that they form a half-hitch before being tucked straight through the wire; then the splice is completed like an ordinary splice. Three tucks are made with each strand and each tuck over one and under two with the lay, like the last tuck in Fig. 214. Leftover threads are twisted off. The splice is

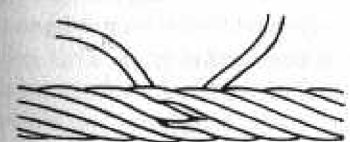


Fig. 220 Long splice on wire

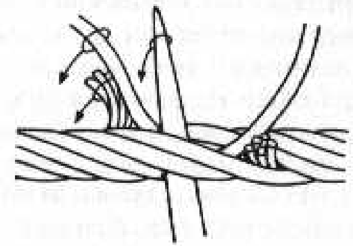


Fig. 221

hammered well so that the wire will keep its shape. These long splices hold on cargo falls, even when the turns on the winch drum ride hard on each other.

Splicing rope to wire is seldom necessary now but it was common on large sailing ships which had wire running rigging with one end towards the stern, often made of manila. The clews of the lower sails and the sheets were often made of wire.

For a *short splice* the strands of the wire are whipped together in pairs and laid open three turns to a permanent whipping which is left on the wire after the splice is finished. The three pairs of strands are laid together with the rope and spliced the same way as an ordinary short splice. The splice is thinned towards the ends in the best practice and the ends of the wire strands served with sailmaker's twine. The splice becomes as stiff as a wooden nail and no seaman likes it.

The *long splice* or *tail splice* is a little better. The wire is opened ten turns, a good whipping made, the core cut out and three strands (every second one) are laid together to the length of eight turns as a central thinner wire. The heart yarns in the wire strands are taken out at the beginning of the splicing. This thin wire is whipped tightly after being laid. The rope is opened two turns and put together with the wire as in a short splice, the thin wire being passed in like a core in the rope to its entire length. If the rope is shroud laid its own core is removed. A good whipping is sewn on the rope over the end of the thin wire. The three free strands of the wire are spliced into the rope with the lay, and the wire strands are tucked through the rope strands for each tuck. Four tucks are made and the wire strands are cut off. The two long ends of the other laid together wire strands are taken out between the strands of the rope and spliced in the same manner. Finally, the rope strands are spliced into the wire, the tucks being made under two strands with the lay or thinned and the rope strands marled around the wire and served with marline. If necessary, larger or smaller parts of the splice can be served. One or more whippings help to keep the wire core in the three-stranded rope. This splice becomes quite supple and is the best method of joining wire to manila by splicing. It does not, however, become completely supple; the severed ends always become as stiff as wood.

Another good way of joining wire and manila so that they can run over a block is by putting in a short piece of three links of thin chain between them. The rope is spliced in with a chain splice at the one end (Fig. 192) and the wire with a chain splice at the other. Chain splices in wire are relatively simple. The wire is split to at least the length of 12 turns. Three strands are taken through the chain link and are allowed to form the smallest possible eye. The other three strands are pulled away and the first three laid in after them so that they meet in pairs in three places at different distances, and then the three part-splices are made as in a long splice. Because of its flexibility this method is preferred where the join has to run through blocks.

Small wire slings are best made from one strand, in the same way as rope slings. Often the thickness of the wire is so chosen that the sling has sufficient strength if three-laid or four-laid, because it is very difficult to get more rounds with the strand without the sling getting ugly and uneven. Both ends of the strand are spliced around each other with the lay where they meet. Three- or four-laid wire slings are parcelled as a rule, and are served with sailmaker's twine. The serving

is done with a serving board, which is always easier to take around the crooked sling than a long serving mallet.

The real wire sling should, however, be made with six strands and look like an ordinary wire without a visible join. From wire of the thickness required for the sling is taken a strand at least seven times as long as the circumference of the sling. The sling is first made three-laid, then four-laid without difficulty, the last strand being knocked in with a hammer to make the sling completely even. Then another piece of the same strand is cut as long as the sling and with strength and cunning this is forced in as a core between the four strands in the sling. These are then opened enough to enable the fifth and sixth strands to be laid in their places in the sling without difficulty – using a hammer all the time so that the sling becomes neat and even. The meeting points of the ends of the strands are arranged to agree with both ends of the core, and the sling is finished as a long splice. One strand is tucked through the other and both are tucked through the sling. The core is pulled out and the strands each laid in its place for half the distance, so that they meet inside the sling opposite the palce where the tucking through was done. The ends are not allowed to be so long that they push on each other. The sling is not easy to make but when finished it is a nice piece of seaman's work.

On modern ships the standing rigging is always fastened with sleeves to the rigging screws instead of being spliced or seized. Such taper sleeves have conical holes through which the rigging wire fits. The wire is fastened once it has been taken through the sleeve by being opened so that the threads can be folded back a short distance to form a head on the wire which locks inside the taper sleeve.

The fastening is done by knocking a conical wedge into the core and filling the sleeve with molten zinc to solder the sleeve to the end of the rigging wire.

On larger ships this is done with special equipment but it is not difficult to do on a smaller scale. Bend the wires back with a pair of pliers so that they form a thicker wire. Lock them in the sleeve and solder them. Pure tin is better than soldering tin. Where the wire leaves the bottom of the sleeve it is tightened with asbestos twine and the tin is melted in with a blowlamp or soldering torch. A soldering liquid free of acid should be used as a flux.

Sewing Work

General considerations

Sailing ships have all but vanished. The numerous motor-sailers use their engines more than their sails. But a modern motor vessel or steamship has so many tarpaulins, bridge screens, dodgers and covers that skill in the use of the palm and needle is a valuable asset to every seaman who is in charge of or takes part in the running maintenance of a ship. The tasks mentioned here only require a few tools: a palm, some sail needles and a sailmaker's hook. An ordinary wire nail is adequate to serve as a sailmaker's hook if the tip is filed sharp and bent into a hook and a piece of marline is fastened to the head of the nail.

The cloth of sails, tarpaulins, etc. is stitched in seams with a *flat seam* or *satin stitch*, which consists of two simple stitches sewn on each side of the sail. The seam is made wider on large sails and narrower on small items, but as a rule guidance is taken from the coloured row of stitches which follows the selvage at a certain distance on all sailcloth.

When two cloths are stitched together they are first held up together so that they are equally stretched, and both selvages are marked with a pencil every half metre. When sewing the cloth is held over the lap with the edge of the one cloth folded up inside and over the other (Fig. 222). The edge is held tightly with the left hand, with

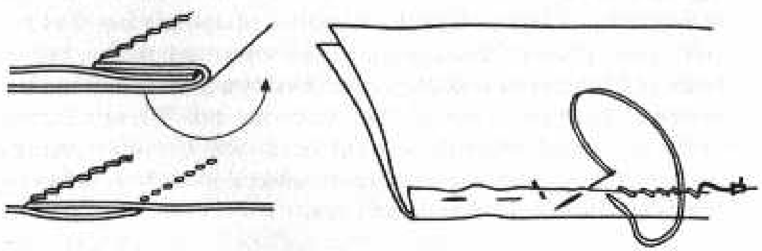


Fig. 222 Stitching a flat seam

the thumb on the upper side of the seam close to where the stitching is to be done. The sailmaker's hook, which is always kept on the right hand side, holds the work so that it does not shift under the needle. The seam is made from right to left and the needle is always first struck into the cloth underneath, which will tend to slip towards the left and stretch more than the cloth on top. It requires some practice to prevent this. The pencil marks serve as a guide for the cloths to match up and stretch equally. A loose needle holding the cloths in front of the seam also helps to keep them steady while working. All work is done with doubled twine, which should be tarred and waxed for hemp cloth but only waxed for cotton cloth. The seam is commenced without a knot on the twine and with one stitch up

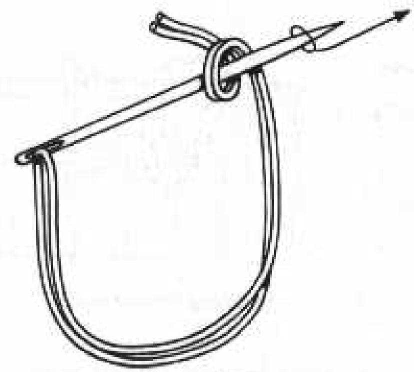


Fig. 223 Knotting sail twine

through the top cloth, the end of the twine being stitched over with the two first stitches and then tucked into the seam. When one length of twine is finished, the twine is cut in the eye of the needle and the last stitch is poked out of the top cloth. The new piece of twine is stitched up through this last stitch in the top cloth and the four ends of twine are then twisted together, tucked into the seam and sewn over. If, when engaged in other tasks, a knot is required it is best done as shown in Fig. 223. A round turn is made with the end of the twine around the sail needle. The round turn is held with the thumb and index fingers of the left hand and the needle pulled out, the round turn travelling along the twine and ending in a knot at its end. The advantage here is that both twines become equally long and any unevenness can be smoothed out. The knot is also easy and quick to make.

Sailcloth stretches when used. Therefore, if old and new cloth are joined, the old, stretched cloth is laid uppermost and the new, unstretched cloth underneath. It is then easier to hold the new cloth taut and the old cloth slack, so that when the new cloth stretches the old cloth can follow suit without tearing. By allowing the bottom cloth to creep to the left under the needle and by pulling each stitch to the right it is possible to stretch the new bottom cloth and pucker the old top cloth. How much must be decided in each separate case, and with the pencil marks one can control the way the cloths match each other.

Work on which the back will not be visible is often done with a round seam (Fig. 224). Before commencing, the edges are folded down about half an inch, the fold is ironed flat and the cloths are

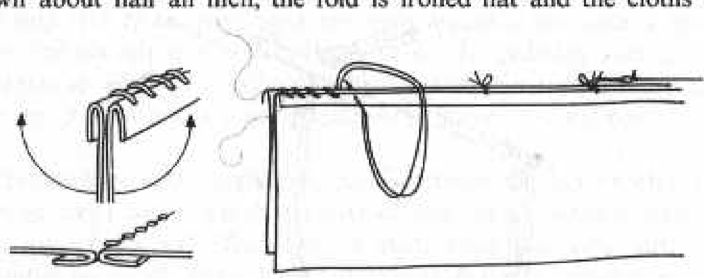


Fig. 224 Stitching a round seam

fastened together with small knotted stitches placed as needed. The seam is always made from left to right towards the sailmaker's hook – which is positioned on the right – and with the needle being pushed away from the body. The seam is always made on the reverse side, the work then turned right side up and the seam hammered flat.

Tarpaulins and covers

Small tears in old tarpaulins are mended with a *herringbone stitch* (Fig. 225). The seam is made from the left to the right, so that all stitches are made away from the body. The twine is fastened without a knot by making a few stitches in the cloth. The tear is stitched together as shown in the illustration and the seam is completed with a few stitches in the cloth.

Smaller holes or 'rat holes' are mended with a *sailmaker's darn*,

which is stitched around the edge in half-hitches until the hole has been filled (Fig. 226). The darn is made from the left to the right, so that the needle is stuck from the top down and up the middle of the hole, so forming the half-hitch. The first round of half-hitches is stitched in the cloth, and the next in the previous half-hitches. When working towards the middle of the hole the stitches become too small, and then one works in every second or third stitch according to need. The twine is fastened in the middle of the darn with two half-hitches and the darn is hammered flat with a mallet against a piece of wood.

A *patch* is placed over larger holes. It is made to a suitable size, right-angled, with the edges folded under half an inch if they don't have a selvage, and the folds hammered into sharp creases. The patch

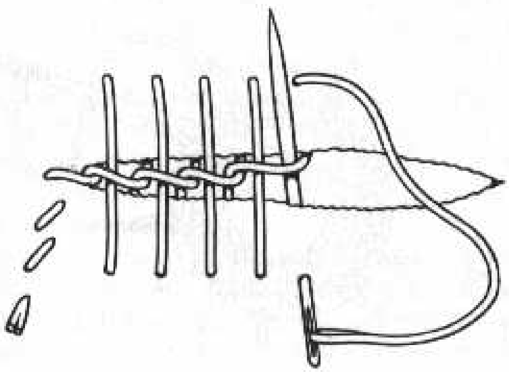


Fig. 225 Herringboning

is then fastened with one stitch at each corner and one or more stitches down each side, depending on requirements. These stitches are commenced with a knot in the twine (Fig. 223). The stitch is taken down and up through patch and tarpaulin and is pulled tight, after which a new knot is made close to the cloth. After the patch has been fastened it is stitched evenly around the edges. Then the hole is trimmed on the reverse side, its edges turned under and stitched to the patch. Such patches are preferably made with the tarpaulin spread out on deck and the workman sitting on it with the work in front of him. A number of small holes can sometimes with advantage be covered with one big patch. All patches are placed on the upper side of the tarpaulin. Patches and darns should be greased, as are old unimpregnated tarpaulins. Wood tar and linseed oil are used during summer and whale oil in winter to keep the tarpaulins soft.

Large tarpaulins always have seams going athwartships and should be turned so that they are stitched from port for hatches on the foredeck and from starboard for hatches on the afterdeck, so that the seams face away from the breaking seas. Smaller tarpaulins, where the width is a whole multiple of the cloth, often have seams going fore and aft. On these the seams are made from the middle fore and aft and athwartships to allow the water to run off along the seams as much as possible. This helps to keep the tarpaulins watertight.

Smaller *covers* are not difficult to make if the correct steps are followed. Frequently covers made on board become too small and tight, while those made ashore are always too big and fit badly. The reason is that the seaman on board always wants to make a decorative and neat job and does not always calculate the shrinkage of the cloth correctly, while the sailmaker ashore seldom has the correct measurements and hence tries to be on the safe side. The amount by which the measurements taken should be increased depends to some extent on what measurements they are, but as a rule 10 per cent extra should give a safe size.

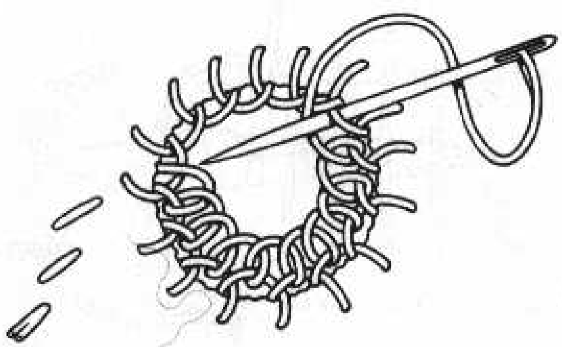


Fig. 226 Sailmaker's darn

A *cap* for an air vent is easy to make and only requires two measurements – the vent's circumference and the height of the cap. The first measurement is increased by one-tenth to allow for shrinking, plus an extra 3–5 cm ($1\frac{1}{4}$–2 in.) for the seam, depending on the size. Add to the latter the width of the upper seam and the hem at the bottom.

The skirt is cut in straight angles to these measurements so that the circumference goes along the cloth and the lower edge follows the selvage. The side which will face inwards on the finished cover is turned out and the hem around the lower edge is turned up once to about 2–3 cm ($\frac{3}{4}$–$1\frac{1}{4}$ in.) and stitched fast. On very small caps no hem is made but the selvage is merely left. The upper edge is then divided into four equal parts with pencil marks in the following manner: the stitched together skirt is smoothed out so that it lies flat and doubled up, and marks are made with a pencil inside the two folds. Then a sail needle is stuck from the outside in through one mark and from the inside out through the other, so that the marks meet at the needle, and the skirt is smoothed flat towards the sides and pencil marks are made in the new folds. If eight marks are needed on a larger cap, the needle is put through two adjoining marks and a pencil mark is made in the fold between them.

When the marking has been done a fold 1 cm wide is made along the upper edge. If the bottom is to be sewn on with a round seam, the most suitable method for small covers, it is folded outwards on the skirt which has been turned inside out; if it is to be sewn with a flat seam it is turned inwards.

The skirt is now ready for the bottom, which is drawn without compasses in the following manner. Take a length of sailmaker's twine as long as the doubled-up skirt. Cut one-twentieth off the twine. This can be done by eye. If for example the twine is 80 cm long, 4 cm is cut off, if 60 cm long then 3 cm is cut off, and so on. The remaining length is divided by folding the twine into three equal parts and this measurement marked with a pencil. Now make two overhand knots on the sailmaker's twine, the distance between them equal to a third of the length of the twine and coinciding with the pencil marks. The cloth for the bottom is spread out flat. A needle is stuck through the twine inside one knot and into the middle point of the cloth. With the pencil through the twine inside the other knot the bottom is drawn on the cloth with the twine as a radius. If the bottom is to be sewn with a flat seam, another circle is drawn about 2 cm inside the first. The bottom cloth is cut out about 1 cm outside the outermost circle. The needle is now stuck up through one circle line and downwards through the opposite side of the same circle line. The fold formed this way is creased and marked with a pencil inside the fold at both ends. The needle is then put up through the place where one mark cuts the circle and down through the other intersection point. The new fold is then creased and marked. The bottom is now divided into four. If it is to be stitched with a round seam, the edge is folded over at the pencil marks and the bottom is fastened to the inside-out skirt with knotted stitches at the four pairs of marks. If necessary several fastenings are made between these four, and the bottom is sewn to the skirt. Then the cap is turned right side out and the seam is hammered flat. If the bottom is to be sewn with a flat seam, the skirt is fastened to the inner circle, and when sewing the slack is sewn into the skirt so that the marks match. Then the cap is turned right side out and the edge of the bottom is turned under and stitched. When doing this the bottom seam lies overlapping the skirt and is then more watertight. A seizing belongs to a cover which on small caps are sewn to the seam at the middle of the skirt near the lower edge, but on large ones are used loose. These covers are painted the same colour as the bollards, etc. on board the ship. Before being painted they should be wetted with water, and should be painted while wet so that they will remain soft after the paint has dried.

All round bottoms are drawn up and sewn in the same way. A *seaman's bag* should be on $2\frac{1}{2}$ in. seam widths. If it is to be well made blind seams are made in the middle of the whole cloths so that the sack has five half cloths. A strip 15–20 mm is cut away from all selvages and the blue stitching is turned in so that all seams become equal. The upper hem is made towards the inside and is made $2\frac{1}{2}$–3 in. wide. Eight holes are sewn in this near the edge for the drawstring, the holes placed as described above. It is best to sew these holes with quadrupled twine around a ring of brass thread or a small laid grommet of twine. It is also common to use eyelets in the holes. The bottom is laid on the inside so that the side of the sack goes outside the seam, which then wears better and is more watertight. Across the bottom sew a strip of triple thickness sailcloth as a handle, or otherwise a five-pointed star with one point towards each of the five seams as a wear patch on the bottom.

Covers for wire rolls, leads, etc. are made in a similar manner. They give the best protection if they go all the way down to the deck. They are separately measured and an allowance made for shrinking. The cover should not go outside the ends of shafts or long bars; a hole should be cut and a special cap stitched on for these. If the covers are to be painted they are always first wetted and painted while wet. If they are sack shaped and watertight they can be hung up

full of water (seawater is all right) and painted. They will then be free of creases or folds and will remain soft. Covers, dodgers, screens, etc. require seizings and tails with which they are tied in position and laced together where they are open. These foxes are spun with a hand tool (Fig. 24) and are stitched into place so that the closed end of the seizing is free. It then holds without whipping and without tangling.

Sails

Sailmaking is a craft which takes many years to learn. The following short notes are only intended to provide a few general guidelines for making sails and maintaining them.

When putting together the cloths remember what has previously been said about seams – that the new cloth is held taut and the old cloth held slack so that when the new cloth stretches the old cloth can follow without breaking. New cloth is often wider than old cloth and should therefore be sewn on the old cloth at joins across the cloth, the lengths placed so that selvages and seam lines go in the same direction. If an odd piece of cloth or a few new pieces are put into a sail it is best to sew both joins first and the seams afterwards. It must be carefully established how much shorter the new cloth must be, and then the extra length of the old cloth can be divided evenly along the new. How much is to be sewn in depends on the age of the sail. If old, well-stretched cloth and new cloth are to be sewn together, 1 in. per ft can be taken in (never more); for not so old cloth $\frac{3}{4}$ in. per ft or $\frac{1}{2}$ in. per ft. If an old sail is joined with an old cloth of better quality, a little bit can be held in on the old cloth – about $\frac{1}{4}$ in. per ft or thereabouts – so that the strain comes on the better material. Patches are always put on so that warp and weft match those in the old cloth, and are always stitched flat, even if they are of better quality than the sail which is being patched, otherwise holes may appear next to the patch. Patches should preferably be the width of the whole cloth and sewn so they are attached to the seams.

When the cloths in a new sail are sewn together, usually an entire side of the sail is sewn first and then it is turned and the other side sewn. Very large sails are usually sewn in two parts which can be finished off with reinforcing patches and cringles before they are sewn together, as this way it is easier to handle them, particularly if space is limited. On a fore-and-aft sail the port seam is made first, starting at the upper bolt rope, and the after cloths stitched onto the fore ones. Square sails are sewn from the upper bolt rope.

When the new sail has been stitched together it is laid out flat so that the hems can be made straight or with an even curve where it is required. The port side is laid downwards on fore-and-aft sails, the aft side on square sails. All hems and strengthening patches are laid on the starboard side on a fore-and-aft sail and on the fore side on a square sail. Tablings in square sails, which protect against wear on the upper edge and from leech lines are, however, sewn on the aft edge of the sail. Sheet, clew and head patches are laid on the outside, whereas reef points and patches are tucked under tabling and hems.

After all hems have been sewn, the eyes are made. If the eyes are not sewn over rings of metal or galvanised iron, rings are made of spun yarn in the same way as grommets are made (Fig. 159). The yarn is twisted clockwise against the right thigh and laid together anticlockwise into a small ring. The ends are knotted together with a half-hitch like the commencement of a part splice in a long splice (Fig. 191), and the grommet is driven over a fid so that it is well stretched. The grommets are laid on the starboard side on fore-and-aft sails and on the forward side of square sails, and the eyes are sewn from the same side. The distance from the edge is only large enough to leave space for the bolt rope. The hole in the canvas is best made with a cutting pipe not larger than half the eye, because the sail stretches while being sewn. The sewing is started by taking the first stitches over the half-hitch in the grommet, jamming the ends, and the stitches are started and ended around the hole at the inside edge of the sail, thereby protecting the end fastening of the stitching against wear.

On smaller sails brass hoops or eyelets substitute for sewn holes, and these are fixed directly to the sailcloth, but if eyelets are required in bigger sails they should only be put in sewn holes.

When the sail has had all the eyes sewn the bolt rope is put on. When putting on a hempen bolt rope it is held in the lap and the work done from left to right. The sailmaker's hook is always put into the sailcloth whereas the bolt rope is allowed to lie loose. The needle, which can be a little blunt, is coaxed between the strands and under one strand and pushed right through the cloth. At all eyes, splices and corners double stitches are made. Particularly at the corners a row of double stitches should be made. These fasten the bolt rope to the sail like seizings. Some sailcloth is also gathered in at the corners so that

the sail becomes a little baggy. On the sides of the sail the stitches should be lightly pulled towards the left when tightening them. This causes the sailcloth to gather slightly so that it has a little 'give' when the bolt rope stretches. If a bolt rope goes along the weave or diagonally across it, it is not necessary to gather in as much as if the bolt rope goes straight across the weave. In the latter case the bolt rope can with advantage be left to stretch overnight with a tackle before it is sewn on. The difficulty in sewing on bolt ropes is to get the cloth to go straight along the bolt rope and in a spiral around it, and to make all stitches equally deep in the cloth (Fig. 227a).

Sailmakers always splice a hempen bolt rope because it is easier to sew over splices. The short splice, which joins bolt ropes of different thicknesses, is called a sailmaker's splice (page 127).

Wire bolt ropes are determined by the measurements aloft but as a general rule bolt ropes which go along the weave are made longer than

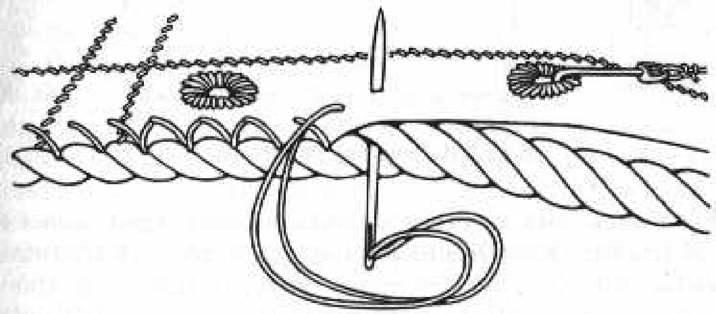


Fig. 227a Sewing on a bolt rope

this, and bolt ropes which go across the weave are made equal to this. The wire bolt rope is spliced at both ends, parcelled and fastened to the corner of the sail to the right length and stretched horizontally at waist height. If the cloth is too long it is fastened to the stretched bolt rope so that the slack is evenly distributed. If it is too short, the bolt rope is stretched with a tackle until the cloth stretches as the bolt rope is stretched. When sewing on bolt ropes the sail is always held under the left arm and the cloth between oneself and the bolt rope, and the sewing is done towards the body as one goes backwards. The bolt rope should be thickly parcelled with clean sacking and neither the parcelling nor the wire is oiled. Over the parcelling is sewn a strip of trebled sailcloth with stitches up and down through the sail. Wire bolt ropes used to be served thinly with spun yarn and the roping yarn was allowed to creep in between the rows of spun yarn, so protecting it, but this method has now been completely abandoned. Fig. 227b shows the wire bolt rope stretched in the correct position and how the protective strip of sailcloth is sewn on.

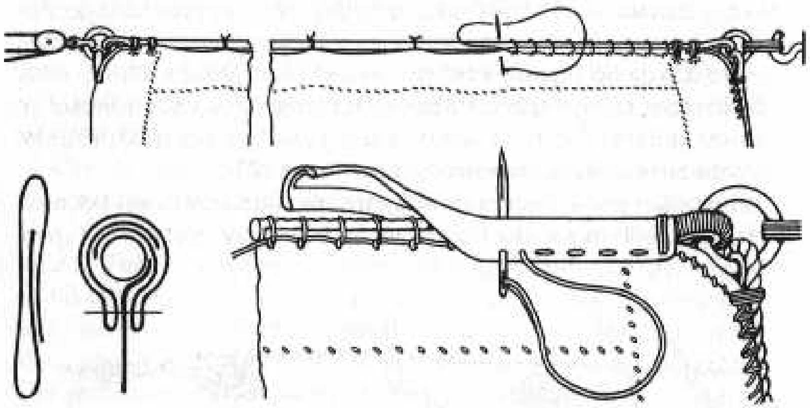


Fig. 227b Sewing on wire bolt ropes

Small sails, such as yacht sails, do not have roped leeches but sometimes have a thin line let into the hem to give it a little stiffness. Hoisting bolt ropes, the fore leeches on square sails or the luffs on fore-and-aft sails should be taut to allow the sails to set well and are therefore provided with wire bolt ropes, which on small sails are put inside the hem and sewn with narrow stitches up and down through the hem close to the bolt rope. Such bolt ropes are provided with thimbles for halyards and clews. Short pieces of hempen bolt rope are put in such thimbles, which support the other bolt ropes in the luff and foot of the sail. The clew is also provided with a short hempen bolt rope which strengthens the sail where the sheet and outhaul pull and reaches past the reef points. In all such bolt ropes the rope is thinned so that it comes to nil where the bolt rope ends, and the point is tucked into the hem with a needle.

If the bolt rope is damaged or broken it can be temporarily repaired with a stopper (Fig. 228). A length of rope of suitable thickness and about 2–4 ft long is given a Mathew Walker on each end and with

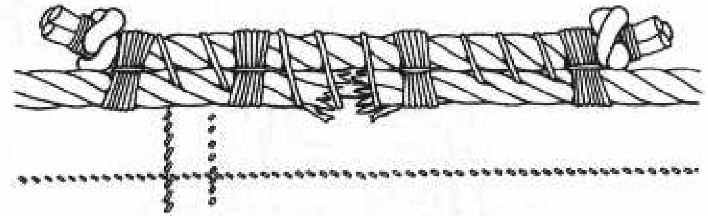


Fig. 228 Stopper to repair bolt rope

thick roping twine and needle it is sewn to the damaged bolt rope When doing this many stitches are taken together around the bolt rope and stopper in several places, particularly at the ends, so that strong seizings are formed. The stopper is made very tight, so that about a 2 in. slack is formed on the bolt rope, with gathers in the sail, because the seizings always stretch.

A *cringle* is made with one strand and is started with two half-hitches which are laid clockwise in the two sewn eyes (Fig. 229). Then the ends follow the lay around a whole round turn one to each side, and are tucked through the sewn eyes outside the first half-hitch and then through it, so that they come through on the inside of the cringle (Fig. 230). They then follow the lay up to the middle of the cringle where they are tucked under the two middle bights of the strands, both in the same place and from each side without crossing each other (Fig. 231). The length of the cringle must be exactly fitted to the thimble it is to hold. The cringle is driven over a large fid and

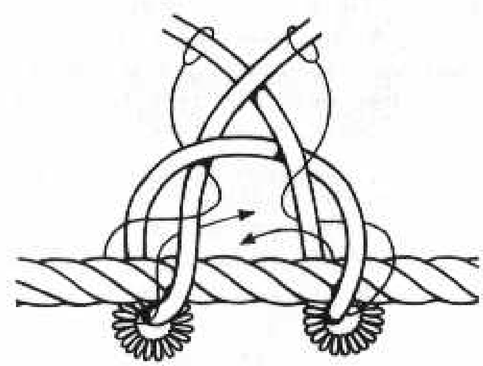


Fig. 229 Cringle, 1

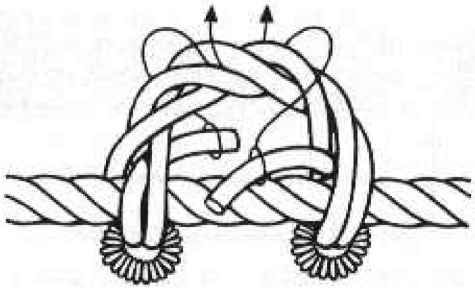


Fig. 230 Cringle, 2

the thimble is fitted into the well-stretched cringle immediately the fid has been taken out, before the cringle has shrunk back. The thimble can also be laid into a loosely laid cringle and then bight after bight is tightened with a marline spike, beginning at the middle and working towards the ends, so that the whole cringle fits tightly around the thimble. This method has the advantage that the length of the cringle does not have to fit exactly and gives good results with some practice. It was regarded, however, as not quite Bristol fashion in the old days.

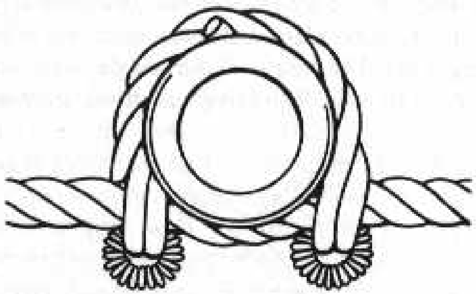


Fig. 231 Cringle with thimble

Maintenance

Protecting iron against rust

Daily maintenance work on a ship is routine. The work done varies according to the type of cargo carried, the nature of the voyage and the season, and follows a set pattern.

In harbour most of the work is done outboard; at sea it is done inboard. During a voyage in ballast the holds are prepared to receive the next cargo. Tankers have no problem here, as they usually return with water ballast to the producing countries, but on other ships, for example a freighter which has off-loaded coal and is on its way to load timber in another port, the holds are cleaned and arranged so that they are ready to receive the new cargo on arrival. An important aspect of this work is to ensure that dunnage is spread for cargoes requiring it and stowed away if it is not needed.

The seasons affect shipboard maintenance. In winter work is done below, in the holds and cabins, and in summer it is done on deck. When cargo is carried on deck the superstructure is painted; when it is carried in the holds the decks, bulwarks, etc. are attended to. When a ship is going to windward in a fresh breeze, operations are conducted on the afterdeck in the lee of the wind, and on the foredeck when running before the wind. In a coal-fired vessel one has to bear in mind that when running before the wind in moderate weather soot falls on the foredeck, and vice versa. This can be ruinous to fresh paintwork, particularly if it is white paint.

A great help in dealing with these never-ending maintenance tasks are the mechanical aids such as pneumatic rust hammers and paint sprayers which, with special nozzles attached, can also be used to limewash holds for salt cargoes. All ships have electric power, and electric rust hammers are particularly useful. In addition there are chemicals for preventing rust and preserving wood, as well as paint removers, steel wool and waterproof sandpaper. The cost of these materials generally pays in time saved and better results achieved. But good results require a certain amount of professional skill, which can only be got with practice.

The corrosive action of rust on ships' hulls is too well known to need emphasis. The battle against it starts in the shipyard, where the vessel is given several coats of rust resisting paint before being launched. On board, the seaman is constantly engaged in protecting the ship and its equipment against rust. Good weather is an important element in the lasting qualities of these maintenance measures. Ships rust more in winter than in summer, and work done in the winter months does not last as long as maintenance carried out on clear summer days in a dry atmosphere.

However, work frequently has to be done in unfavourable conditions if it is to be done at all. In damp conditions the best results are obtained if ironwork is painted with boiled linseed oil progressively as the rust is removed, allowing minimum exposure to the air. An old, worn brush with short, stiff bristles is ideal for this task. The oil should be brushed well into the ironwork. If it is mixed with a little red lead it will dry faster and provide better protection. After the linseed oil has dried, the surface should be given a coat of red lead and then painted in the usual way.

Even when the weather is good and the atmosphere is dry red lead should be applied as soon as possible after the rust has been removed from the iron. To ensure that the red lead dries properly it is best to apply it as early as possible in the day, so rust removing operations should be completed in time to allow all exposed ironwork to be painted before the onset of evening dew, which can be quite early on winter afternoons.

Machines remove rust much faster but do not always leave as clean a surface as a good job done by hand. Therefore ironwork treated this way should always be closely examined afterwards, gone over manually, and the surface then brushed with a wire brush. Machine brushing using rotating stiff wire brushes is better than hand brushing. It should be kept up as long as it takes to get the surface completely clean and free of rust. It is important to remove all rust, as every bit left under the paint becomes a source of new rusting. Loose, powdered rust is just as damaging, and a surface that has been brushed clean should be wiped with a duster before being painted with red lead. This little bit of extra attention pays off as the end result is better.

Nowadays paint manufacturers supply ready-mixed paints for shipboard use which are usually manufactured for a specific purpose,

such as under-coat paints. With their vast resources and often international connections the big paint firms turn out good products in suitable colours for a variety of jobs. Today, one merely has to open a tin on board, stir the paint and start applying it. To get a uniform look to their vessels the larger shipping companies have their own regulation colours, the decks, hulls and funnels being painted in specified shades and qualities of paint supplied by a manufacturer under contract; but some of the smaller shipping companies still mix their own paints, and the following notes outline how paints should be mixed and applied.

Different paints vary in the degree to which they prevent rust. The best protection is given by red oxide of lead and white lead. The poorest protection is given by black paints. They consist mainly of carbon black pigment, which conducts electricity and does not insulate well against galvanic currents after the oil has oxidised to a dry film. This is why black painted ships rust more externally than vessels painted grey. This was known a long time ago. I was once told by Captain W. H. Bennett, a senior captain in the 1870s and 1880s in the Scottish Loch Line, whose vessels' portholes were always painted black, that one could always see where they had been painted black, even after the entire side of a ship had been chipped clean of paint. Where the ship had been painted white the plating was smooth, whereas the portholes were always pitted from rust.

Hulls should always be treated with a primer coat of patent anti-corrosive hull paint, usually dark brown in colour, to prevent rusting, and then be given a coat of antifouling to counteract marine life. Antifouling is usually redder in colour. It is also poisonous. Many brands contain copper and perform the same task as the copper sheeting on the wooden hulls of the old-time ships. Copper attacks iron through galvanic action when in contact with salt water, so it is important that the primer coat covers thoroughly and is allowed to dry before applying the antifouling. Other antifouling paints contain arsenic, mercury salts or DDT. Another class of products contains metallic zinc and has a film-forming medium. Another method of preventing corrosion is to melt a dry oil-free powder and spray it under heat onto the metal where it forms a good, light, adhesive, protective layer. Metallising, in which molten metal – usually zinc – is sprayed onto the steel, is also used on hulls and the interior of tanks. As with all surface treatments, good results are only obtained if the plating is clean and dry when the paint is applied. In drydock the hull is scraped and scrubbed clean of seaweed and barnacles, hosed with fresh water and left to dry thoroughly. Scuppers and exhaust pipes should be plugged to prevent water trickling onto the area to be painted.

Large liners, which seldom if ever carry deck cargo today, use special paints on their iron decks. Like anticorrosive hull paints they protect against rust, but in addition they provide a hard, long-wearing and non-skid surface. They often come in clean colours, reds or greens, and are aesthetically attractive. Smaller ships plying the North Sea or the Baltic with coke or timber as deck cargo have more trouble with their decks and usually grease them before loading. Decks always rust badly when there are deck cargoes.

A good preparation for iron decks, and one that dries easily, is a mixture of anticorrosive hull paint and slushing oil, about 50–50 of each, adding a little more oil in summer and a little less in winter. This mixture does not turn completely black. It does not stand up very well to hard wear, but adheres well under other paints and affords excellent protection against rust. Many shipowners use only anticorrosive paint on iron decks. It does not wear as well, but it dries rapidly and is easy to apply over worn patches, which enables one to keep the decks looking good.

The old method of simply greasing the decks with slushing oil has probably died out. The oil not only dirtied wooden decks and cabins but destroyed the paint on the bulwarks and bulkheads if the vessel happened to ship water within a few days of the decks being greased. However, slushing oil can be used before coke is loaded on deck. Coke and salt water together are particularly harmful to decks and a thick coating of oil provides protection against their worst effects.

Coal tar and black varnish give similar results to slushing oil and have the advantage of not harming surrounding oil paint and wooden decks. But they do tend to form hard patches underneath which rusting continues, and so are not among the best methods of protection. Coal tar, however, provides good protection against rust for small surfaces which can be heated in a fire or with a blowlamp. The tar can be applied first and then be burnt onto the iron, or the surface being treated can be heated and then dipped into the tar. The second method is suitable for items such as anchor shackle bolts, and gives good results.

A number of chemical rust preventives have been marketed in recent years and they have several advantages. They are mostly thin,

oily liquids which effectively penetrate the iron and chemically bind or combine with the rust. Damp weather does not prevent their use, which makes them particularly suitable for ships. They can be painted on or applied with a spray gun. However they do not provide a weatherproof surface, and any treated metal should be painted in the usual manner after drying. A priming coat of red lead gives the best results. There are also chemical preparations which dissolve and remove rust. They are not practical for treating an entire ship because of the big surface area involved, but are very useful for parts of machinery and for loose pieces of metal. It is best to soak the item to be treated in the cleaning fluid for a few hours first. These preparations do not provide protection against new rust forming and it is necessary to grease and/or paint the treated metal in the usual manner afterwards.

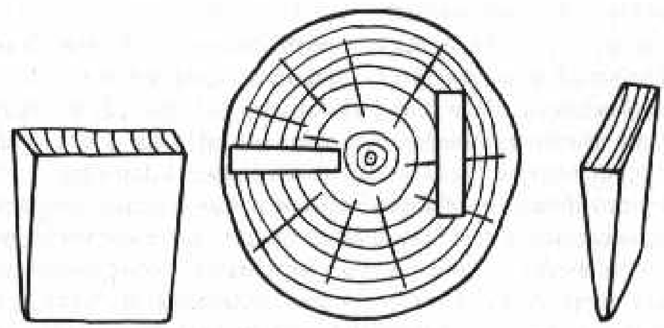


Fig. 232 Wedge for tool handle. Left: correct Right: incorrect

When fitting a new handle to a chipping hammer it should be carefully shaped to fit the hole and a fine saw used to make a deep cut for the wedge.

The wedge should be cut across the grain from a piece of hardwood, not along the grain (Fig. 232). It should be the same length as the hole and fairly thin. It is dipped in glue or varnish before being hammered home, where it will stay permanently.

Treatment of wood

Unpainted wood is protected by treating it with linseed oil and varnish. Use raw linseed oil and a good outdoor spar varnish. To obtain a satisfactory result dry the wood thoroughly before oiling it. It is best to put off oiling until a few warm and sunny days have passed. The oil not only preserves the wood but dries inside it and makes it harder and more durable. Old, discoloured, wooden decks can be painted with raw linseed oil mixed with Stockholm tar, the worse the condition of the deck the more tar being used. Painting with tar alone requires very warm weather to enable it to penetrate the wood. Most tars are too thick and need to be diluted: this can be done with methylated spirits, only 5–10 per cent needing to be added to thin the tar sufficiently. Spirits have the disadvantage of evaporating quickly in warm weather, leaving the tar as thick as before. Turpentine can be used and does not evaporate as quickly. Raw linseed oil does not evaporate at all. Paraffin should not be used as it does not mix well with tar, but penetrates the wood first, leaving the tar on the surface. To prevent old decks from turning completely black they should be oiled only with raw linseed oil.

New, light coloured decks of Oregon pine or other pine should be scrubbed with a strong soda solution, scraped while still wet and hosed thoroughly. After the deck has dried completely it should be given a generous application of raw linseed oil, using a large brush or rag. Weather permitting, it should be oiled again a day later.

Unpainted pine woodwork should be scraped clean, sanded, given two applications of raw linseed oil, allowed to dry and then be given a coating of boiled linseed oil. This provides a strong, weatherproof surface adequate for most purposes. Varnishing, however, gives a stronger and better looking finish and can be done instead of the boiled linseed oil treatment or in addition to it. In the latter case it should be delayed until the oil has dried hard enough for sanding, and the surface lightly rubbed over with sandpaper or steel wool before the final coat of varnish is applied.

Teak is the only wood which can withstand the sun unprotected without being harmed, and teak decks are therefore never oiled. They are scrubbed and left bare, the sun bleaching the teak, which is naturally dark, until it becomes completely light in colour. Teak decks are usually the whitest and most beautiful of all decks. Teak woodwork, such as doors, staircases and railings, should always be varnished. If the old varnish has retained its light colour and is undamaged it should be washed and gone over with sandpaper on a cork block. Waterproof sandpaper used with water gives good results, but be careful not to sand through the varnish as the water will

make the wood swell and result in an uneven surface. Sanding with paraffin will prevent this and also enable one to use ordinary sandpaper.

If old varnish is cracked, stained, dirty or bleached it should be removed completely. This used to be done by sanding with wet sand and canvas, a painstaking procedure but one which produced good results. A common method is to apply a strong caustic soda solution, which softens the old varnish, and then scrape. Caustic soda, however, destroys any oil paint with which it comes into contact, and must be rinsed off completely.

The best results are obtained from the now common paint strippers used to dissolve old oil paint and varnish. They can be bought under a variety of names. The method is to apply the stripper twice, allowing an interval of five minutes between coats, and then scrape off the softened varnish. After removing most of it this way, apply more stripper and go over the wood with a soft wire brush or coarse steel wool, and then clean the surface with a cloth soaked in petrol.

If teak is dark and stained it can be left in the sun for several days to bleach. Teak does not require oiling but can be varnished directly. This gives it a lighter appearance than oiling. Varnishing should be done on a warm, dry day. Sand the surface with a No. 1 or No. 2 sandpaper, dust it off thoroughly and varnish with a soft brush. When the first coat has dried, lightly sand with a No. 2 sandpaper or steel wool and varnish again. Teak treated in this way acquires the desirable light golden-brown colour that is so seldom seen. To get a perfect result, varnish four times, using a thinned-down varnish for the first coat.

Oak, which is not as common in shipbuilding now as it was in the old days, should be constantly oiled or it will bruise easily. As a rule one tries to avoid having oak in contact with iron as its tannic acid content attacks the metal. If it is laid against iron all accessible points of contact should be well oiled to prevent as far as possible the iron rusting away and the oak discolouring. Pine is also liable to severe discolouration by oak, and joins between the two should be oiled to prevent water penetrating and being sucked from one wood to the other.

Several good commercial wood preservatives are now available which afford effective protection against rot and fungus. Those that flow more easily and are colourless are the most suitable for ships. They are used for trimmings, cabin floors, hatch covers and areas exposed to damp and poor ventilation, which causes rot and mildew to spread. The preservative should be applied with a brush to dry surfaces, concentrating on end grain, cracks and joints. This usually pays dividends in prolonging the life of the wood. Treated wood can be oiled or painted. Arsenic and preservative impregnated timbers are now available. They are highly resistant to rot and mildew and are particularly suitable for cabin floors.

Painting

If paints used on board ship are not ready mixed, they are likely to be paste paints, usually pigments suspended in thick linseed oil. Before being used they are stirred with boiled oil and an agent to hasten the drying process. The amount of drying agent added depends on the time of the year and the colour of the paint: white paint, for example, dries well and only boiled linseed oil need be mixed with zinc white in high summer or in the tropics. Black paints do not dry as well and lamp black always needs large quantities of drying agent, particularly in winter when thick paint needs to be diluted almost solely with terebine if it is to dry in a reasonable time.

Dry red lead should if possible be mixed the day before it is to be used and stirred relatively thin, as it thickens in oil. It does not require a drying agent and dries very well when mixed with linseed oil. Freshly mixed red lead tends to run easily when applied to vertical surfaces. This can be prevented if the dry red lead is first stirred to a paste in clean water, adding small amounts of linseed oil. The red lead mixes with the oil and the water can then be decanted. When all the water has been poured off the rest of the oil can be added to bring the red lead to a consistency suitable for painting. Ready-mixed red lead is commonly sold homogenized so that it does not sink to the bottom of the tin or harden in the tin, which red lead mixed on board ship tends to do.

Research into rust prevention is constantly producing new discoveries. In addition to red lead there are a number of other paints which prevent rust. Grey chromate, unlike red lead, is weather resistant and does not have to be painted over with another protective paint. Another rust preventive is light yellow or grey-green chromate paint. When manufactured with a synthetic resin base without linseed oil it makes the best primer paint for light metals which cannot tolerate linseed oil. The oil oxidises, producing acids which attack

these metals, causing paints to flake off. One of the recent rust preventing compounds is calcium plumbate, which will in future probably be widely used in protective paint on ships.

But in spite of the competition between these various paints it seems that red lead is still considered the most reliable, and new qualities continue to be marketed. The thixotropic paints, which are jelly-like, do not drip and are therefore ideal for painting interiors and exteriors in most weathers. Red lead can also be obtained in thixotropic form. It works well with a brush, can be thickly applied and dries rapidly. It covers so well that one coat does the same job as two coats of ordinary paint.

White paints used outdoors should never be mixed with blues or blacks to counteract the brownish-yellow discolouration of the oil, as the discolouration is not light fast and disappears after a couple of days, leaving the paint whiter than if it had been mixed with black or blue. Indoor paints, particularly if they are to be used in dark areas, can be mixed with a drop of ultramarine to counteract yellowing of the paint.

To obtain good results from white paint calculate the amount required for the whole job in advance and prepare it in a suitably sized vessel before commencing to paint. The paint will improve and become smoother as it gets a few days older. An added advantage is that all the coats will be identical in colour, a considerable help in future cleaning. The final layer can, however, be mixed with a white lacquer-type paint to improve its consistency, shine and durability. As little as 5 per cent of lacquer added improves oil paint markedly, while an addition of 25–50 per cent will be sufficient for the most demanding job. On passenger ships and the larger liners the final coat is usually a pure lacquer paint.

It is well known that the easiest method of painting is up and down and from left to right. To get a good result it is necessary to paint along the grain of wood surfaces, vertically on bulkheads and walls and horizontally on exteriors. It is essential to follow this procedure from the first application to the last.

The paint should first be brushed on in the appropriate direction, brushed back across the surface and finally smoothed out in the direction of the initial stroke. For extra fine work two brushes should be used: a round brush to apply the paint and a flat brush with which to gently smooth it out. Move the brush from the unpainted area to the painted surface, as spots are liable to be left where the brush first makes contact but not where it is removed from the surface. The flat brush should not be used for applying the paint and should be kept as dry and as free from paint as possible.

It is essential to paint on a clean, dry surface in order to get a good finish, and to use clean paint containers and stirring sticks. It is seldom possible to start painting outdoors before 8 a.m., and the early morning is best employed by washing the surfaces to be painted with fresh water to remove any salt or dew, and by hosing down the deck area where painting is to be done so as to get rid of any dust or rubbish.

The paint is prepared with a stirrer in clean containers, and round and flat brushes issued. Rags or cotton waste are also useful, especially below deck, but oily cotton waste is self-combustible. A lining fitch and straightedge are needed where painting to a defined line.

At the end of the day all paint is poured back into the storage container, using a stirrer or flat knife to push down any paint which has adhered to the inside of the container. Then cover the surface of the paint with turpentine or linseed oil to prevent a skin forming. Only a little oil is required: by blowing it can be spread over the whole surface. The resulting dilution is negligible, and in any case the paint will have to be diluted towards the end of operations. Clean the empty paint pots – which at sea are invariably empty food tins – with a brush and paraffin, dry them with a rag or cotton waste and store them upside down overnight. Dry the stirring sticks and store them in water, as with the brushes. These procedures do not take up a lot of time and the effort is rewarded, especially in big ships where painting can be a long process if white paint is used.

Paint brushes are important tools, and are an expensive item in the equipment of large ships. To get the best out of them they must be properly looked after.

The best brushes are made from hog bristles, and the next best from horsehair and a variety of vegetable fibres. The latter can be identified by the fact that they burn, while hog bristles and horsehair do not burn but curl up in a flame. Horsehair brushes have even bristles with a square-cut end, while hog bristles thin towards their ends and are often split. Buy only the best brushes and look after them well. Their higher price will be offset by their longer life and the fact that they enable one to paint better and faster. With a hog bristle brush one can paint more evenly than with horsehair, and lift more paint at a time

when dipping the brush, thus enabling one to obtain a larger spread of paint with each application. It is also better to use large brushes. They cost more but enable one to work faster and so pay in time saved. When working outboard on the ship's side it is worthwhile taking the precaution to attaching to each brush a seizing of sailmaker's twine which the painter can slip over his wrist.

New brushes are usually first used for white paint. Once they are worn they can serve for outdoor paints or brown paints and eventually for red lead, hold paints and Stockholm and coal tars. When used continually oil paint brushes should be stored in clean water in clean jars. They should not be stood so close together as to bend or damage their bristles but can be placed close enough to support each other and should stand vertically. Put only brushes used for the same colour in the same jar, i.e. one jar for brushes used for white paint, another for grey, a third for red lead, and so on. After the work is finished the brushes should if possible be cleaned by rinsing a couple of times in paraffin or turpentine and washing with soap or detergent. Paint remover can also be used, and is the best course with a brush that has dried out. It should be left to stand overnight in a tin containing the paint remover. Do not store brushes used for varnish work in water but put them in raw linseed oil diluted with turpentine. New brushes or ones that have been thoroughly washed should be stored wrapped in paper to keep dirt and dust out of the bristles. Before a new brush is used for the first time the bristles should be well dusted.

Smaller brushes used for bronze paints, lettering, painting lines and so on should be thoroughly washed in paraffin or turpentine after use, dried and dipped in machine oil or vaseline. Then smooth out the bristles with the fingers and store on a shelf in oiled paper or in a tin with the bristles upwards. Before using again wash them in paraffin or something similar so that they will be in condition for good work.

As large brushes become worn, their wrapping should be removed. The bristles on new brushes, especially American ones, are too long to paint well. They should be wrapped with a rag 20–25 cm wide and 30–35 cm long, depending on the size of the brush. Wrap the rag tightly around the brush, covering it completely, and then put a whipping around the middle of the rag over a suitable section of the brush. Fold the end of the rag back to expose the length of bristle you require, and lash the folded-back flap to the handle of the brush, cutting away any excess cloth (Fig. 233). A flap covering a seizing like this is particularly useful when painting ceilings.

It is now common to use a roller instead of a brush when painting large, smooth surfaces, particularly outboard. Rollers are usually made of metal encased in coarse towelling or sheepskin. Professionals use them for stippling as well as painting. They require special paint trays, which are rectangular in shape, the same width as the roller and with a slanted bottom where the roller gathers the paint. Rollers are not washed after use but are prevented from drying out by being placed in a special cylinder with a tight-fitting lid. A drop of turpentine in the cylinder helps to keep the roller in good condition. Each roller is therefore used only for one kind of paint. They come in small sizes, 6–8 in. wide, for white paint, and larger sizes up to 12 in. for work outboard. They can be manipulated far better than brushes with long handles and make the work considerably easier, particularly when painting the exterior of big ships.

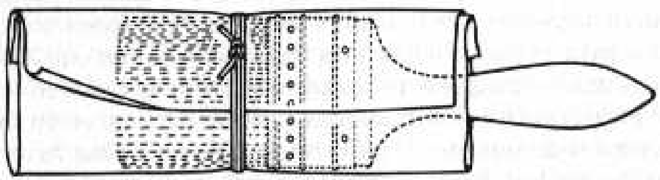


Fig. 233 Putting a cloth wrapping on a brush

Where pressurized air is available time can be saved by using a spray or paint gun. Spray painting is ideal for holds and other storage spaces as all the nooks and crannies can be reached. By using different nozzles and air pressures one can spray any kind of paint.

Galvanised iron should not have oil paint applied to it directly as the acid in the oil oxidises the zinc and causes the paint to peel off after a while. This can be avoided by first priming the zinc with varnish or aluminium paint or a shellac solution. The same applies to light metals. The best primer for zinc and aluminium is yellow zinc chromate.

New wood which is to be painted is treated rather differently, depending on whether it is indoors or outdoors. On indoor wood all big knots should be shellacked and then primed with a lean oil paint. Alternatively, they can be painted with aluminium primer. After drying, fill the larger holes and uneven areas with putty, using a stiff paint putty. When the putty has dried and been sanded and dusted off,

the entire surface should be filled up with a smooth stopping. This is one of the painter's most difficult jobs. A thin coating of stopping should be applied and skill is needed to avoid ridges forming. Allow the stopping to dry, apply a thick but lean coat of paint, and while it is still wet use a pumice stone to rub it in the direction of the grain and then even it out with a flat brush. When the paint is quite dry go over it with sandpaper on a cork block. This can be followed by fine stopping, after which the surface is sanded again, painted, left to dry, finally sanded with a No. 2 sandpaper, dusted off and painted in the required colour. Be careful to avoid ridges forming at the corners or leading edges. Once this coat has dried and been sanded and dusted off, everything is ready for the top coat. This should be stirred with linseed oil and mixed with lacquer paint to make it flow better and provide a smoother finish. For ceiling work use thick oil paint containing lots of turpentine but no lacquer. After the paint has been well smoothed over the ceiling stipple it by dabbing it carefully with a clean brush. This provides an attractive granular surface which will not shine. A paint roller can be used for stippling large flat surfaces.

On outdoor wood knots are shellacked, the wood oiled with a mixture of linseed oil and a little ochre, and left to dry. Hollows are filled with filler, everything is left to dry again and then primed with a mixture of turpentine and ochre. Allow to dry and fill any unevenness remaining. Leave for a day and then go over the surface with a coarse sandpaper, dust off, apply the primer coat of paint and follow up with two or three coats of oil paint.

Thick, old paint is best removed with a blowlamp. A large blowlamp can be used outdoors in quite windy weather. Heat the paint until it swells and becomes soft enough to be removed with a scraper. It is important to spot the right moment when the hot paint loosens, because if it is heated too much the paint hardens again, burns into the wood and is more difficult to remove. Prolonged heat in one place can also damage the wood or caulking.

Old paint can also be removed with paint stripper, which should be liberally applied twice, leaving a few minutes between applications. Where practical, movable items should be placed so that the surface to be treated faces upwards to accommodate a thicker coating of stripper.

The modern cellulose paints have not so far been used very much on merchant ships, for a variety of reasons. They are as a rule difficult to apply with a paint brush and should be sprayed on with compressed air. Nor can they be applied over old oil paint, which they dissolve. Cellulose paints therefore have to be applied to clean iron or wood surfaces, but because they are not rust preventing they are not suitable for ironwork. They are more suited to new wood and laminated tiles, particularly indoors where they find their greatest use. These ready-painted cellulose surfaces are harder wearing and easier to keep clean than oil painted surfaces and cellulose paints will probably be increasingly used in new building. One drawback, however, is that cellulose paint is highly inflammable, even after it has dried, and can cause serious fires.

Paints

At sea one invariably uses ready-mixed paints, and seamen very seldom mix the colours which they use. It is, however, useful to know something about the lasting properties of the various paints and how they are mixed.

Black paints, which consist of carbon black, last indefinitely. Vegetable black is used exclusively on board ships. Due to the lightness of their constituents, black pigments do not sink to the bottom of their containers and seldom need stirring. Vegetable black does not dry very well mixed with oil and needs to have a lot of terebine added to it. It is also a poor rust preventive and needs a good undercoat when applied to ironwork.

There are not many white paints; white lead, white zinc and occasionally titanium white being used on ships.

White lead, which is basically lead carbonate, has good coverage and rust preventing qualities and makes the best primer for ironwork. It also dries well with oil. It is easily distinguishable from zinc white by its heaviness, and feels slippery under a paint brush, rather like soap. It is poisonous and should not be used in cabins or living quarters. It tends to darken if the air contains sulphureted hydrogen, and is never used where the air is not always pure, and is never used as a top coat. Various safety regulations cover the use of white lead and other lead-based paints to prevent lead poisoning.

Zinc white or zinc oxide does not provide the same coverage and is not as durable outdoors. Although it weathers faster than white lead this is not important on a ship, where paint is exposed to such hard wear that it is not left to weather for a long time, but it is significant

when painting a house. Zinc white dries well with oil and is suitable for all indoor painting as well as top coats outdoors.

Titanium white, from ilmenite, is made by a relatively newly discovered Norwegian process. It provides great coverage but is better suited to indoor use as outdoors it attacks the oil and flaking occurs. Titan white is the whitest of all whites.

Red colours used at sea include Venetian red and other red oxides of iron. They have great coverage and last indefinitely. Venetian red is mixed with ultramarine – not with black – to make it darker, and with light ochre to make it lighter.

Red lead has an attractive orange colour but fades quickly if left exposed. It can be mixed with white lead as a second primer. This gives it better coverage and disguises the fact that there are two coats.

Port hand lights on ships need a clear red for their surrounds, but clear red paints are seldom light fast. Vermilion is a good shade but frequently soon turns grey. The best answer is to buy a small tin of signal red, which is usually light fast. Starboard hand lights also require a pure green colour, and here again it is best to buy a small tin of ready-mixed signal green.

Other greens include chrome and zinc green, which are marketed in different colours and are not entirely light fast. Chrome green was used as outdoors on sailing ships (winch green), and more than a hundred years ago the beautiful but poisonous eau de nil (Paris green, also known as emerald green) was commonplace, particularly in cabins where its use was linked with its poisonous effect – it was generally known as 'bedbug green'.

Viridian green is light fast but has translucent properties. Chrome oxide green, which is dark, rather greyish in colour, is very durable, light fast, covers well and is ideally suited for ships where a green paint is needed for all-round use.

Among the blue paints ultramarine and cobalt should be mentioned. The first is light fast, has a strong colour and is durable. It cannot be mixed with chrome yellow. Cobalt is a pure blue colour, light fast and durable. Genuine cobalt is expensive but imitations are sold which are lightproof and suitable for use on ships. Monastral blue is a new colour discovered accidentally by an English chemist in 1928 and marketed commercially since 1936. It is the clearest of all organic pigments and makes paint of a high quality. It consists of copper phthalocyanin, which has a structure which appears similar to chlorophyll.

Gold ochre and light ochre are light fast and durable in all conditions. The ochres dry well in oil without terebine and are the best primer colours for new wood. What red lead does for iron, ochre does for wood. Gold ochre is translucent; light ochre is opaque. Cadmium yellow, which has a strong yellow colour, is used in finishing paints. It is sold in light, dark and orange shades. It is quite expensive but is light fast, and should be used for surfaces which require a good paint.

Chrome yellow and zinc yellow are both strong colours. They are suitable for mixing in oil but are not entirely light fast and tend to fade in the sun.

Zinc chromate yellow is a pale yellow pigment which is a co-precipitate from zinc salts and potassium chromate. It is a good rust preventive and has to some extent taken over from red lead. Mixed with a synthetic lacquer without linseed oil it is the best anticorrosive for aluminium and zinc, which corrode when painted with ordinary paints.

For urgent jobs one can make a quick-drying paint – which takes 30–60 minutes to dry – by mixing the paint with dry zinc white and equal parts of varnish and turpentine. It will start drying while painting is in progress and to avoid spoiling the finish the brush should not be returned to a surface where the paint has already been applied and smoothed out. It therefore takes some practice to use. On passenger ships, where the decks are touched up early in the morning, quick drying paint is used so that they are dry when the passengers emerge later. A dark blue-grey colour, suitable for decorative purposes, can be made from equal parts of lamp black, ultramarine and white lead, adding a little extra white lead if a lighter shade is required. White, gold ochre and a dash of black produce a warm grey colour. White mixed with black only produces an attractive grey, tending towards blue. Chrome red lead is also a practical grey paint, as it does not need another paint as a primer, which makes touching-up considerably easier.

Many colours are suitable for use on funnels. A durable yellow which is slightly reddish can be obtained from three parts white lead and one part gold ochre, while a light brick-red colour is produced using four parts white lead to one part brown ochre. To obtain a warm terra-cotta, use eight parts white lead and one part Venetian red. A pale yellow funnel paint is obtained from a 4:1 mixture of white lead and chrome yellow, adding a little gold ochre if a warmer shade is required.

Swedish blue can be obtained from two parts cobalt, one part zinc white and a little emerald green, while light cadmium or zinc yellow is used as the Swedish yellow colour. Gold is best achieved by mixing equal parts of gold ochre and chrome yellow or, if a lightproof colour is desired, cadmium yellow. To get the best gold effect, it should be varnished.

Putty filler for ironwork can be obtained from equal parts of red lead and white lead mixed with boiled linseed oil on a strip of canvas and then beaten with a hammer until completely smooth. Putty for outdoor wood is obtained from a mixture of chalk and equal parts of varnish and turpentine, or from a mixture of chalk, linseed oil and a little varnish, adding any particular colour required. A putty for varnished teak can be made with chalk and unburnt terra, adding a dash of brown umber if the teak is dark and a dash of gold ochre if it is light. For mahogany, use burnt terra with brown umber.

For indoor wood use a putty made from glue, chalk and boiled linseed oil. The glue is made by stirring flour in cold water, then pouring the mixture evenly into boiling water and boiling for a couple of minutes before leaving to cool. The glue can be used after it is several days old, even if it has turned sour. Remove any skin or crusted edges and mix well with an equal amount of boiled linseed oil. An old, tough, fatty linseed oil – the dregs of the tank – is better than fresh oil. Stir the chalk into the mixture in small quantities until it acquires a thick, porridge-like consistency. Then turn it out on a strip of tarpaulin or a flat wood or metal surface and using a putty knife work more chalk into the mixture until it is suitably thick and absolutely smooth. When puttying use two putty knives, one to apply the putty and the other to work it with. The putty should be stored pressed well down in a tin and covered with a tight-fitting lid or with a rag which must be kept damp. Making smooth putty is, however, difficult and it is best to buy it ready made and in small quantities at a time as large amounts dry out before they are used up. The paint manufacturers also supply a synthetic putty with a plastic or cellulose base. It is waterproof and can be used outdoors on iron or wood, but should also be bought in small containers such as tubes.

Wooden putty knives are better than steel ones for difficult work. New wooden knives should be soaked for a few hours and left to dry. Before being used they should be sanded down with a fine sandpaper on a flat surface to ensure that they are completely flat with a perfectly straight edge. Do not store putty knives in water, but leave them to dry and sand before using again.

Notes on Weights and Measures

A Swedish foot measures 296·9 mm. It is divided into 12 inches, each one measuring 24·74 mm. Each inch is divided into twelfths or, more commonly, into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{16}$. When the decimal system was introduced in 1855 each foot was divided into 10 decimal inches and 100 decimal lines. However, this system never really came into use and was replaced by law by the metric system introduced in 1879. But the old system of feet and inches has survived and wooden and iron items, nails and screws, wire and cordage, thimbles and shackles and a host of other things are still manufactured and sold in inches, the English measurements mainly being used.

Wood is cut to English measurements, so that when it has dried out it will approximate to Swedish measurements. English measurements are always used for the dimensions of ships.

An English foot measures 304·8 mm and is divided into 12 in., each measuring 25·4 mm. The statute mile equals 5280 ft or 1,609·3 m. This statutory or land mile was originally intended to be a minute in the curve of the earth's surface; that is, the same as the present sea mile. An Englishman, Wright, took some degree measurements at the entrance to Plymouth in 1589 and found that one minute equalled 1,625 m, but this figure was later reduced and is still the basis of the English land mile. The sea mile, or what the English call the Admiralty knot, is 6,080 ft or 1,853·17 m. It is the mean of the meridian minute (1,852·01 m) and the longitude minute measured at the equator (1,854·3 m). In Sweden a minute of distance is equal to one meridian minute which is equal to 1,852·01 m. A cable length, 185 m, is approximately 200 yards.

English sailcloth is 24 in. wide, while Swedish sailcloth is 2 ft wide. English tarpaulin cloth is 1 yd, while Swedish is often 1 m wide. English sailcloth comes in 40 yd lengths. American hemp cloth is 22 in. wide but the ordinary cotton cloth is 24 in. wide and comes in 42 yd lengths. Thinner cotton cloth for use on yachts is usually 15–18 in. wide and comes in 100 yd lengths. This also applies to both American

and English (Egyptian, macco) cotton. Cordage comes in a variety of lengths but the most common, half a hawser length, is 60 fathoms or 100 m, and a hawser length is 120 fathoms or 200 m. Cordage and wire are also often sold by weight.

The imperial gallon is the basic measurement for all dry and liquid goods in England. It holds 10 lbs (avoirdupois) of distilled water at 62 degrees fahrenheit, which is equivalent to 4·5348 litres.
Also:

1 gallon = 4 quarts = 8 pints = 32 gills
1 pint = 0·568 litres and
1 gill = 0·142 litres

One United States gallon is $\frac{5}{6}$ of an imperial gallon or 3·786 litres. This is divided as in England into 4 quarts = 8 pints = 32 gills. One US pint equals 0·477 litres.

In commercial transactions in England avoirdupois weight (Av.W.) is used. One ton Av.W. equals the weight of 35 (English) cubic feet of salt water with a specific gravity of 1·025. One cubic foot of this water weighs 64 (English) pounds, and therefore 1 ton = 2,240 lbs.

One ton is also divided into 20 hundredweight, each weighing 112 lbs.

1 ton = 20 cwt = 1,016 kg
1 cwt = 8 stones = 50·8 kg
1 stone = 14 lbs = 6·35 kg
1 lb = 16 ozs = 453·6 grams
1 oz = 16 drams(drs) = 28·35 g
1 dr = 1·77 g

The ordinary English ton, weighing 2,240 lbs, is frequently called a long ton in America. This is distinct from the American ton of 2000 lbs. Two stones are known as a quarter, which is equal to 12·7 kg. In England ready-mixed paints often come in tins of $\frac{1}{4}$ cwt. Red lead and similar heavy paints are usually packed in $\frac{1}{2}$ cwt or 1 cwt tins. Otherwise provisions and stores are measured in stones and pounds.

One ton of drinking water in England is equal to 210 gallons and weighs 2,100 lbs. One barrel of water = 36 gallons = 360 lbs, so there are approximately six barrels to a ton. A cubic foot of fresh water weighs 1,000 oz. and occupies 35 cu. ft.

Similar weight measures are used in the United States as in

England except that a hundredweight weighs 100 lbs or 45·36 kg. One US ton weighs 20 cwt or 2,000 lbs or 907·2 kg and is also known as a short ton. The metric system is used to some extent in the US.

A so-called metric ton, which is 1,000 kg, is also called a French ton or tonne.

Ships are measured in many different ways, both by weight and by capacity. Capacity is measured in cubic tons of 100 English cubic feet (registered ton) which is equal to 2·83 cubic metres. Hence a hold of 42,550 cubic feet in volume, for example, is 425·5 tons. This cubic measurement is used internationally by all countries which have official registers of ships and is therefore always called a register ton. A distinction is made between gross tonnage and net tonnage. The former concerns the totai volume of all closed-in space above as well as below deck. Net tonnage concerns the volume of the holds and passenger areas and is arrived at by deducting from the gross tonnage the area provided for crew, navigation and manoeuvring operations, stores and ballast tanks, and for engine and bunker rooms. There are a variety of ways to calculate the deduction of all engine and bunker spaces, etc. but nearly all maritime nations use the British Rule in which the deduction is calculated as a percentage of the gross tonnage of the ship and not according to the actual size of the engine and bunker rooms. The amount deducted is always greater than the actual size of the unearning spaces, which means that the net registered tonnage arrived at by the British Rule is always less than it is in reality.

With a few insignificant alterations – due partly to experience and partly to changes in ship construction and the development of new types of ships – the British Rule has become the basis of an international convention for measuring ships which was signed in Oslo in 1947. This rule has been in force in Sweden since 1955, prior to which the so-called German Rule had been used. There are also rules for determining net tonnage which apply in Black Sea ports and in the Suez and Panama canals, but these do not appear in official registers of ships' sizes.

As a ship's cubic measurement provides a measurement of its capacity to carry freight, charges and dues are calculated from the net registered tonnage.

The size of a ship is also expressed in tons weight, which can either be the tonnage a ship can carry, or its deadweight capacity, or its (unloaded) displacement – that is, the weight of the water it

displaces, which is equal to the weight of the entire ship. As a rule the deadweight tonnage is calculated on the summer freeboard and includes cargo and bunkers but not stores. Deadweight is usually calculated in English tons (Av.) of 2,240 lbs. The loaded displacement expresses the entire weight of a ship including cargo and stores and is given in English tons of 1,016 kg in Anglo-Saxon countries but otherwise in metric tons of 1,000 kg. The loaded displacement is not usually given for merchant ships as it changes with every cargo and with the change in draught.

It is obvious that the weight of an empty ship plus its deadweight is equal to its displacement when fully loaded. The displacement of an open shelter-decked ship when empty is calculated to be about 30 per cent of its displacement when loaded. A slightly higher figure, about 35 per cent, is allowed for two-deckers.

Naval ships and large power-driven luxury yachts with a more fixed draught are measured in displacement tons, expressed in metric tons for Swedish naval ships and English tons for English ones. Displacement is calculated for the ship when fully loaded and with all stores or – and this usually gives the same result – according to its designed waterline. Displacement can also be expressed in cubic metres – cubic displacement – which is equal to the weight displacement in metric tons in fresh water.

The cubic measurement of the holds themselves is expressed in English cubic feet and is important to know when loading, as it is essential to know how much room there is available for a particular cargo. The cubic capacity of the holds is also referred to as the ship's cubic capacity, and a distinction is made between cubic capacities for general cargo, bales, and other cargoes, such as grain, which fill the holds better. For bale capacity the holds are measured inside the cargo battens and from the tank top ceilings to the underside of the beams, and for grain capacity the holds are measured to the hull plating and all the way up to the deck, with deductions made for the cubic capacity of the frames, beams and shores. These deductions usually amount to about 0·1 per cent of the cubic capacity of the hold. In calculating cubic capacity for grain the hatches to underlying holds are also included. Bale capacity is usually about 10 per cent less than grain capacity but the difference may vary from ship to ship.

If the total cubic capacity of a ship is divided by its deadweight one gets the cubic feet per ton of load which fills the ship. This usually comes to about 50, or more for big ships. It is obvious that if a ship takes a cargo on board with exactly this cu.ft/ton load all holds will be full when the ship has been loaded down to its waterline. If the load is heavier the ship will be loaded without the holds becoming full. These loads are known as deadweight cargoes. If the load is lighter the holds will be full without the ship sinking to its waterline. The cargo can then often be increased by loading on deck as much as the ship will tolerate of cargoes such as timber, containers, vehicles, etc. It is always advantageous to have a large cubic capacity, as the ship can then take bigger, lighter cargoes as well as dense cargoes. It can only take its deadweight in heavier cargoes.

Example. A modern, medium-sized fast liner with refrigeration machinery can have the following different tonnages:

International gross	3,140	registered tons
Panama gross	3,584	” ”
Suez gross	3,602	” ”
International net	1,755	” ”
Panama net	2,494	” ”
Suez net	2,766	” ”
Deadweight	3,090	English tons
Displacement empty	1,840	” ”
Displacement loaded	4,930	” ”
Grain cubic	183,000	English cubic feet
Bale cubic	165,000	” ” ”

If the bale capacity is divided by the deadweight of the ship the quotient becomes 53, which is the so-called stowage factor of the load that fills all holds when the ship is loaded down to the waterline. The grain capacity shows that the ship's holds are 1,830 registered tons in capacity.

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