Knots for Climbers.

By C. E. I. WRIGHT and J. E. MAGOWAN.

FOR a long time past the question of the best knots for climbers' use has been regarded as settled. This may be inferred from the fact that writers on mountaineering are almost unanimous in their opinions. They recommend for the end and middle of the rope and for the join respectively :—

The Bowline and the Fisherman's Noose ;
The Fisherman's Noose ;
The Fisherman's Knot.

This is redolent of Izaak Walton, and might arouse a suspicion that one had been sent by mistake the journal of a very different club. The association of such widely divergent pursuits is hard to understand, unless Samuel Johnson has somewhere defined a climbing-rope and paralleled his famous definition of a fishing-rod.

Now it will be seen that there has been no advance since the Report of the Committee on Equipment in 1892, published in Volume 16 of the Alpine Journal. Rather there has been retrogression, for the Fisherman's Noose has invaded the domain of the Bowline, and fantastic methods of making it tend to supplant the simpler and sounder recommendations of the Report.

Brief as it is, the summary above fairly represents the position at present. For, even though an authority on climbing may mention some other knot, it is in such a diffident way that an impression is left that he has never put it to the test. A few knots so mentioned may be noticed at this stage and dismissed once for all. The Reef Knot is one, but it remains a mystery by what magic it can be used to make an end-noose without undergoing conversion into a slipknot at the first jerk and into a deathtrap at the next. The Double Bowline on the Bight, tempting to make in the position suggested by its name and offering the benefit of a double turn round the waist, loses every merit but some degree of safety, if the two parts of the rope are pulled in opposite directions, and should never be used in the middle of the rope. The Manharness, most delightful of knots to make, provided only that the neatest method be known, and excellent for a steady haul on a rope

which is itself under tension from end to end, may become a slipknot when pulled about by alternate straining and slacking. Now these are just the conditions that occur in climbing, and they exact as the first quality in a good knot that it shall be unaffected by intermittent strain.

The weakness in the knots hitherto recommended lies, in fact, in the middle noose. The Fisherman's Noose is a slipknot in one direction and it might well have been put out of court by such a grave defect, though it is said by optimists, a term necessarily including all climbers, never to be apparent in practice. Yet there seems to have been no serious rival, for the authorities are at one in condemning the Openhand Noose, although it is still in high favour with Swiss guides.

Dissatisfaction with the middle noose was, then, the origin of this inquiry. It seemed as if it ought to be possible with a little ingenuity to discover a reliable noose. But contempt for the Fisherman's Noose soon extended to dislike of the Fisherman's Knot. The prejudice, in face of reason and fact, became in time a conviction, and the inquiry, somewhat widened in scope, was definitely set on foot as an attempt to discover any good knots that might be of use in climbing.

THE END NOOSE.

The search for new knots ended in partial failure in the section, which, though tackled last, must be treated first on account of its importance. The Bowline, backed by its derivatives, could not be ousted from its position as the best noose for the end of the rope. In adaptability and convenience it surpasses the nooses devised for the middle of the rope and described further on, although they rival it in other respects and are quite reliable as end-nooses. The Rover Noose, in particular, is excellent in this position. It is a worthy compeer of the Bowline, quite as reliable and much stronger, and, when once tautened, shows no tendency to work loose.

In the Bowline the tendency to spring loose is usually met by taking some half-hitches round the bight at the waist. An absolute safeguard is the use of an eyed rope, for then there is no loose end to work through the knot. But this device does away with the great merit of the Bowline, the ease and speed with which the rope can be passed round the waist and the noose knotted, fitted and secured almost in a moment. It will be found that this can be done a trifle more quickly by the method given below than by that which is generally

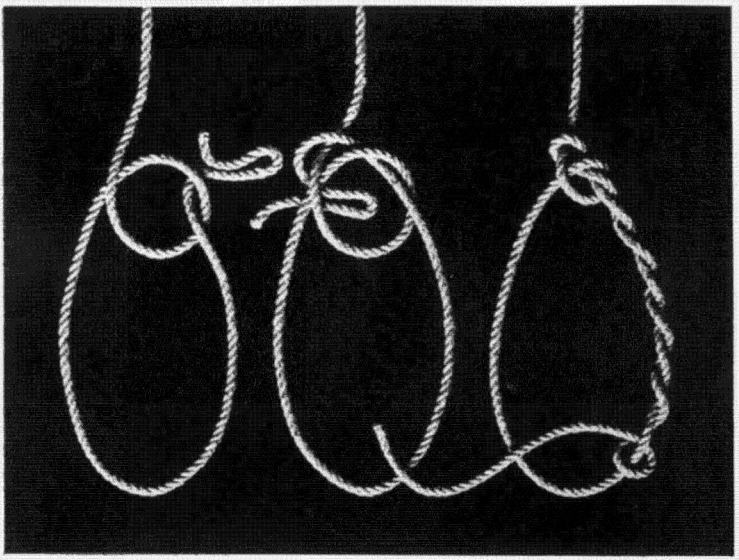
followed merely because it has been slavishly copied from one book on knots to another. The difference consists solely in the direction in which the initial loop is formed, and this is indicated, here and further on, by the terms, screw-wise and counterscrew, which have been preferred to others more ambiguous on the ground that most climbers are familiar with some form of screw. Sailing men, accustomed always to coil a rope right-handed, or with the sun, will probably begin instinctively with the righthand or counterscrew loop. A trial of the method will reveal the distinct advantage that one movement fewer is required, and further, that the movements are peculiarly natural and easy in forming a Bowline at waist-level.

The Bowline (Figure I).

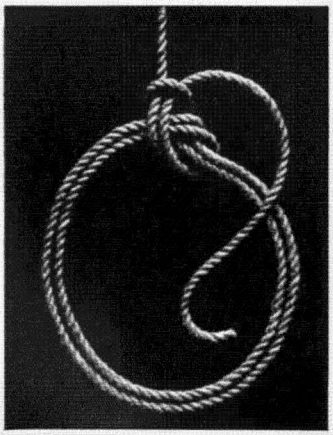
The standing part of the rope, running towards one from the rest of the party, is held in the left hand, and with the right hand a small bight is drawn out to the right between the thumb and fingers of the left hand. The bight is, at the same time, twisted upwards and over towards one with a counterscrew movement of the right hand and is formed into a righthand loop. The end must next be passed under the left shoulder round the waist and down through the loop. One movement of the right hand now suffices to bring the end round the standing part of the rope and up through the loop.

Those who care to splice an eye, a span or more long, on their rope can make the **Bowline on an Eyed Rope** in the same way, but after being passed through the loop, the eye must be drawn well down, the right hand is then passed through the eye, the bight of the noose grasped and drawn back through the eye, bringing the knot with it. The eye now encircles the rope above the loop and will slip into its place, if the noose be drawn out and stretched. Perfect security is given by this Bowline, but only with the sacrifice of a very great convenience, for it cannot be made directly round the waist, unless the climber himself is able and willing to pass through the eye of a rope.

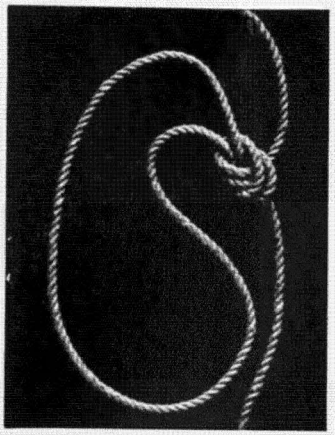
The adoption of the counterscrew twist in beginning the Bowline may appear at first glance to be only a trifling departure from the usual practice. But it must not be despised and ought to be mastered at once, for not only the modifications of the Bowline, but other knots to be described afterwards are begun with the same loop. This makes for uniformity and simplicity, and has the further very great advantage that the knots are made right-handed. Moreover,



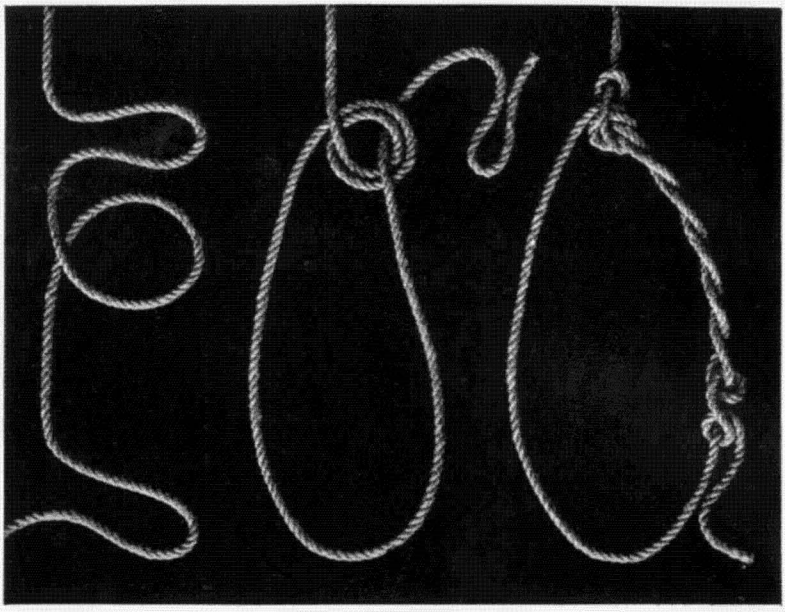
I. BOWLINE.



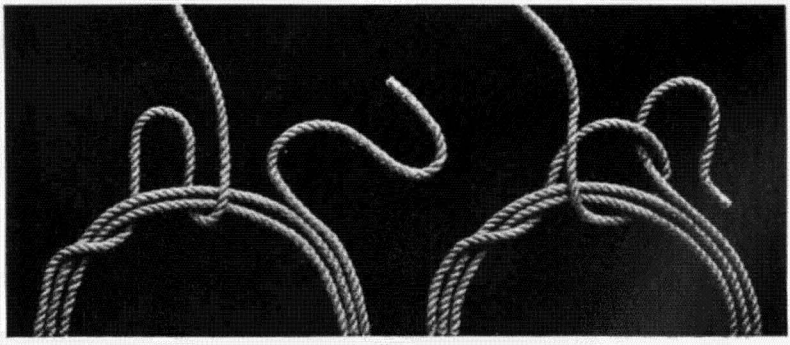
II. DOUBLE BOWLINE.



III. OPENHAND NOOSE.



IV. DOUBLE-KNOTTED BOWLINE.



V. BOWLINE AND COIL.

in the Bowlines it suits the lay of the rope, closes the knot more firmly, and controls the end better, than if the knot were begun with the reverse loop.

It is bad practice to make the common Bowline and leave the end hanging, for the spring of the rope may loosen the knot and the end work out. The end should be twisted in a few turns round the bight of the noose at the righthand side, or secured with some half-hitches. The latter have always been used by climbers, but the knot is much better, if they are preceded by a few turns in the same direction. The turns should be made to suit the lay of the rope, and with the usual lay they must be made upwards inside the rope at the waist (Figures I and IV). So made, they tend to keep the knot closed, as it lies in a better form. If, on the other hand, the Bowline be begun with a loop in the opposite sense, made with a screw-wise twist of the hand, the turns tend to keep the knot open. Thus in security, as well as in facility, there is a great gain in beginning the Bowline with a counterscrew loop.

Of the derivatives of the Bowline, which have now to be considered, the first and simplest is begun with a double loop, so as to form a double knot. The double turn seems to grip the end more tightly and to ease the strain on the rope at its entry into the knot. Whatever the reason, this slight modification, which adds only one second to the time required to make the knot, increases its strength out of all proportion to the extra time and manipulation. So much so that, where a single Bowline will serve the purpose, the common Bowline should always be replaced by the double-knotted form.

The Double-Knotted Bowline (Figure IV).

Begin by making a counterscrew loop just as in the Bowline. Take up a small bight in the rope just beyond the loop and turn it back in the same sense to form a second loop, which must be laid on the first. Pass the end down through the double loop, round over the rope and up through the double loop again.

Secure the end with a few turns and a couple of half-hitches made upwards inside the rope at the waist.

Another very strong form of single Bowline can be made by closing the common Bowline with the Waist-Rope Hitch, which is described later. The initial loop is made as before, the end passed to the left round the waist, and rove through the loop in a Waist-Rope Hitch instead of the usual knot. It makes a strong noose, included later in the table of tests

as the **Bowline with Waist-Rope Hitch,** and affords a fairly good way of dealing with the end, which may be left hanging free but not too short.

The **Double Bowline** (Figure II) affords another good way of making the end secure, but it is not a strong noose. It is equivalent to the Double Bowline on the Bight, but is made in quite a different way to enable it to be formed round the waist. A single Bowline is first made; the end is left long and passed back to the right round the waist to follow the lead of the noose already made; it is then threaded through the knot beside its lead and left to hang.

The Bowline round the waist is all the more comfortable for being double, as in the last knot, and were it still thicker, the pressure on the ribs might be greatly eased in a severe fall. In the next, the Bowline and Coil, it can either be made double, or, just as easily, several turns can be taken up and caught securely in the knot. This is probably the most convenient method of carrying surplus rope and enables an end-man to reduce an overlong rope by twenty feet without discomfort. The ease with which the coil can be made and the knot tied illustrates the adaptability of the Bowline, and gives this form of it the preference over any noose in point of convenience.

This application of the Bowline is as interesting as it is useful. With a single Bowline before one's eyes as a guide it would appear almost impossible by such a simple expedient to include and secure in a Bowline knot a coil of rope already wound round the waist.

The Bowline and Coil (Figure V).

Make as many turns round the waist as may be desired, passing the end always to the left, until the rope where it enters the coil and the end where it leaves the coil come close together in front. Take the rope at its entry into the coil in the left hand and with the thumb push a bight down inside the coil. Bring the bight forward under the coil (Stage 1) and press the rope a little to the left to lie across the bight. This forms the same righthand loop as in the simple Bowline, but with the difference that the loop encircles the coil. Just as before pass the end down through the loop (Stage 2), then to the left over the rope and up through the loop. Finish off the end by giving it a few turns round the bight of which it is the continuation and a couple of half-hitches round the coil, passing the end upwards inside the bight or coil.

To make a **Double-Knotted Bowline and Coil** is easy and interesting, but the double knot, though it may be useful when

the coil is thick, has no strengthening effect in this combination. The bight is drawn out under the coil just as in the last knot, but much longer, and is then passed down inside it once more and drawn out underneath. The two turns thus formed round the coil to the right of the bight are loosened and laid down on the bight, with which they form the double loop.

With an eyed rope the advantage of taking up a coil of rope is partly lost, for the turns must be made and the knot finished, before the coil is put round the waist. It has then to be fitted by passing the spare rope round the turns towards and through the knot. The preparation of the noose takes a little more time, but it may be worth while to have the comfort of the double turn with the security given by the eyed rope.

Bowline and Coil on Eyed Rope.

Make a loop on the rope just as in the single Bowline and in the same direction. Pass the eye down through the loop to make the first turn. Bring it on round in the same direction and down through the loop to make another turn, and repeat this until the coil is complete. Draw the coil, bringing the loop with it, through the eye, which settles round the rope and can be drawn down into the knot.

The coil can also be made first and the loop formed by drawing a bight of the rope underneath the coil as in the knots just described.

The Bowlines have now been presented in all their variety, and they are a versatile family. At their best they have only one rival for the end of the rope. The Rover Noose, designed for the middle, and derived, as it was, from an improved Manharness, is still classed in the next section. But it fulfils quite as well, or even better, all the requirements of an end-noose, and must be considered with the best of the Bowlines, before a final choice is made.

With this important addition the series offers the climber who wishes to choose only among the best a noose of unrivalled convenience in the Bowline and Coil and two of great strength in the Rover Noose and the Double-Knotted Bowline.

THE MIDDLE NOOSE.

The noose hitherto accepted as the best for the middle of the rope is called the Fisherman's Noose. In some books on mountaineering it masquerades as the Middleman Noose, a misnomer adopted by devotees for the sake of implying that

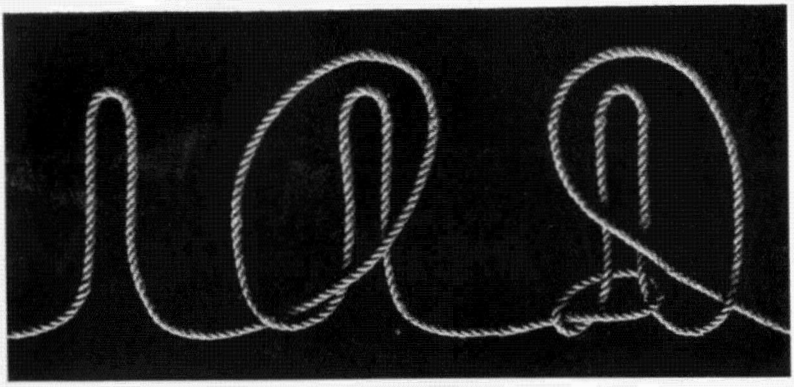
it stands alone. Now, so far from being the only middle noose, if the slight change of term be an improvement, there are in existence a few well-known nooses of this class and others may be invented. Among the latter at any rate, it may be said at once that there are several nearly as faulty and just as unsuitable for the middle of the rope, so that the Fisherman's Noose is by no means without a rival even at its own weight.

None the less it is a great favourite with climbers, and with the detached affection of Izaak Walton they deal with it as though they loved it. Their treatment of it is a remarkable commentary on the scant attention given to methods of making knots. There are eight ways, and may well be more, of making this too well-known knot, and it passes comprehension, by what mischance, for it can hardly have been deliberate choice, some of them have found their way into books on climbing. One distinguished climber gives a method which has no merit but slowness, not even the proverbial sureness. Another adopts the method of a puzzle-knot and offers the simple-minded climber a fisherman's knot as made by a conjurer. Climbing, fishing, conjuring! It sounds like a passage from Alice in Clamberland. Yet a third recommends the same method without the option of an alternative, but complains that it is hard to explain to his readers. Well, naturally. It was devised to prevent an audience from following what was being done, and it requires a little sleight-of-hand, that is as much out of place on rock or glacier as are all other manifestations of juggling and angling.

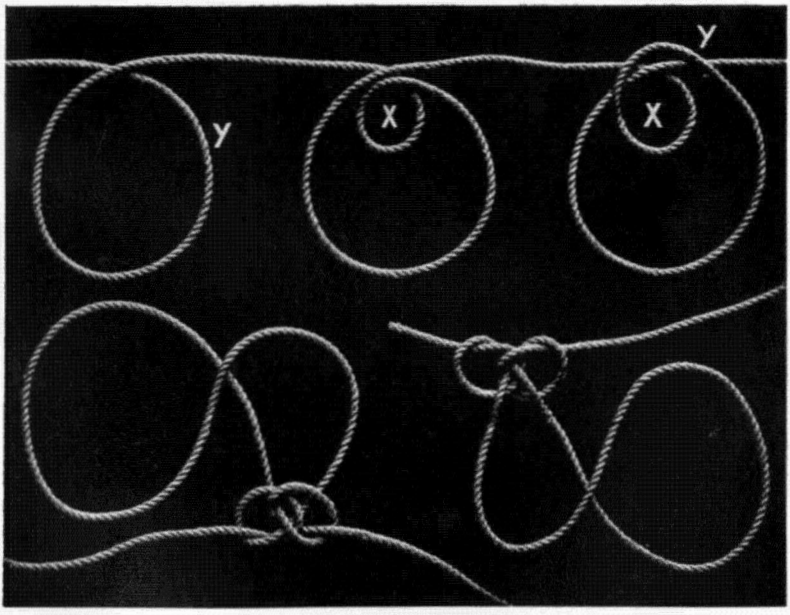
No greater contrast in manipulation could be found than the noose which is now described as the nearest equivalent. It is, perhaps, the best instance in this paper of exceptionally simple and natural movements in handling a rope.

The Half-Hitch Noose (Figure VI).

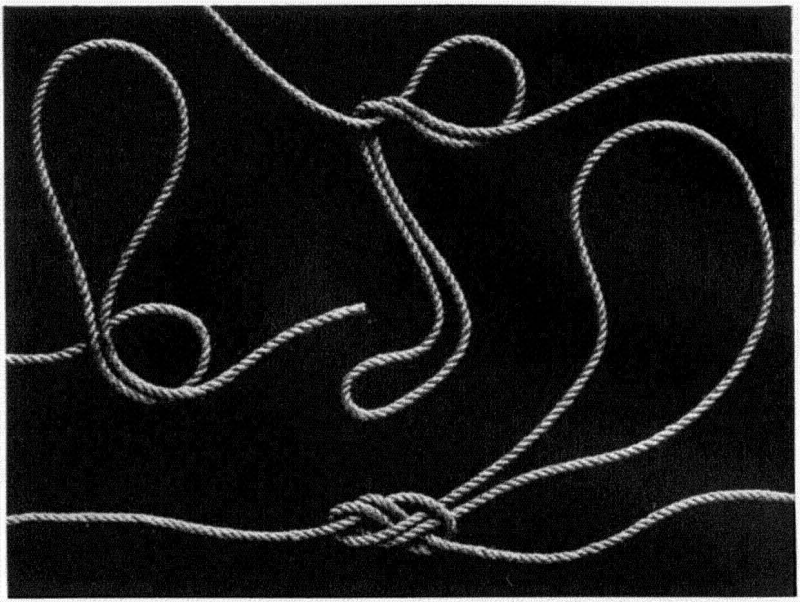
Take a short bight of the rope in the right hand and hold it pointing upwards, the parts of the rope running to the left and right (Stage 1). Stretch out the left hand and grasp the lefthand rope with the thumb outside pointing along the rope. With a sweeping movement bring the left hand round in front and inwards until it is just in front of the right hand (Stage 2). This movement forms a loose half-hitch. Lay it over the bight. Release it and take the bight in the left hand above the half-hitch. If the right hand be run down the bight, the half-hitch will follow it and settle



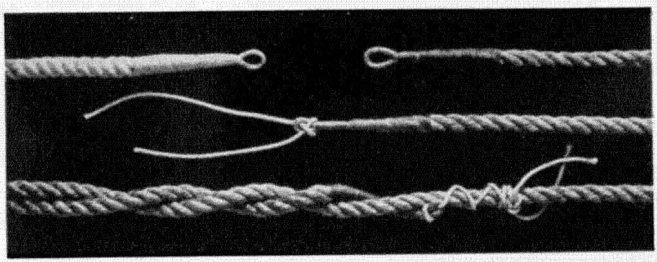
VI. HALF-HITCH NOOSE.



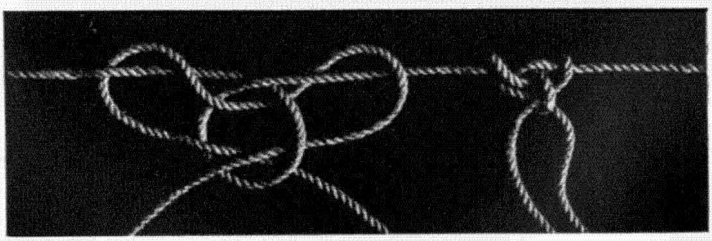
VII. BUTTERFLY NOOSE.



VIII. ROVER NOOSE.



IX. POINTED AND EYED ROPES.



X. TWO-WAY HITCH.

in its place. Now grasp the righthand rope with the thumb outwards, and bring the hand round and inwards to form another half-hitch (Stage 3). Drop it over the bight and let it settle into position just above the former half-hitch. Strain the rope a little and press the two half-hitches close together.

Better if put on with the parts of the noose crossing in the middle of the knot; otherwise they tend to stretch the knot.

The noose is named in order to impress on the memory the method of making it with two half-hitches. The looser it is left the better, for tautening weakens few knots more than this. With the least possible tautening and with the two half-hitches brought closely into contact, it is a satisfactory middle noose and much better than its barbarous prototype.

At first glance it would appear to be an easy task to supply a really good middle noose, for the **Openhand Noose** (Figure III) has not yet been quite discarded from the position and yet it is a good example of defects to be avoided. Made by a simple Overhand Knot on a bight of the rope, it is reliable and will not dislocate or shift its position. These are its merits; now for some defects. In respect of wear it is very severe on the rope. It is a tight knot and may be very difficult to open. Since it is a short as well as hard knot, it has no spring and will not help to ease a sudden jerk by its resilience. The two parts of the rope enter the knot together in the same direction, and consequently, when they are strained apart, either one or the other must take the strain at a very sharp angle. It is the same very serious defect, the lack of a straight entry, which also forbids the use of the stronger, but clumsier, Figure-of-Eight Noose in the middle of the rope.

These points give some idea of the qualities kept in view in the search for a suitable noose. Some of the neatest that were found resembled the Manharness in the ease with which they could be made, a very important quality, but had to be rejected, because they might suffer dislocation, even though it were only in very unlikely conditions. Some that were reliable and yet easy on the rope, two requirements rather hard to reconcile, were somewhat complicated to make. But all of them possessed in a straight entry the one quality that is especially desirable in a middle noose. The ropes should run into the knot without any sudden turn that would constitute a weakness under a violent strain.

Of the two knots about to be described both have this essential property, and the ropes enter them in opposite directions, which is the normal position of the rope when in

use. The Butterfly Noose, though slightly less strong, probably approaches the ideal more closely and is an excellent middle noose. It is naturally a very loose knot and nothing is gained by tightening it. The bights in the knot move on each other with a peculiar hinge-like freedom that makes the knot very easy on the rope. In spite of its looseness it keeps its position, and once it is nearly in its proper form, a severe strain in the rope merely tautens the knot without taking up any of the noose, even when the latter is quite slack. Neither very neat nor good to look upon, its merits will be better appreciated after long acquaintance.

The Butterfly Noose (Figure VII).

Hold the rope with the two hands, the thumbs pointing towards each other and separated by a length of rope more than ample for the waist. Bring the hands together, the right in front, to form a righthand loop, which hold hanging in the left hand with the fingers passing through the loop from behind (Stage 1). With the right hand take the righthand part of the loop at Y fairly close to the neck, and with a movement of the right hand make a small righthand loop or turn round the left fingers at X. Keep it in position by placing the left thumb over it and keep it open with the left fingers (Stage 2). Pass Y up over the rope (Stage 3) and through X from behind. In pulling it through, take it with the right hand and give it a half-twist screw-wise, which will cross the parts of the noose at the base and make it easier to draw the rest of the noose after it. In doing this do not pull the knot taut. It is better to strain the ropes and bring the knot into its proper form before tautening it.

Put the noose on and adjust it to fit by passing the spare through the knot, keeping its form by holding it firmly in the left hand.

The noose should always be put on so that its parts cross each other in the middle of the knot, the position into which they naturally fall.

Tauten the knot but little.

Open by drawing the wings of the butterfly apart, or pulling the noose back through the knot.

In the illustration the finished knot is shown twice. In the figure to the right the knot has been turned over merely to show the inner side. The figure to the left gives its normal appearance.

The Rover Noose is formed by a handsome knot, which should be drawn rather tight, but it bears tightening well and is quite easy on the rope. In pulling it into its final shape, it is well to watch that the rope coming from the climber's right lies always to the right of its lead in every part of the knot.

This means that, wherever two ropes lie parallel in contact in the knot, the rope entering the knot from the right should lie on the righthand side of that running side by side with it. If this precaution be neglected, the knot is still quite reliable, but it is looser and its appearance suffers. With this precaution, which is little trouble, it is much snugger and the two ropes are much more widely separated at their emergence from the knot, a distinct merit in a middle noose.

Both this knot and the last, though designed for the bight of the rope, make reliable end-nooses; but with neither of them is it possible to take up several turns of rope, as can be done so easily and quickly with the Bowline. The Rover Noose, as already stated, is an excellent end-noose. It is much stronger than the Bowline in the end position and may be much safer than the latter, unless the loose end of the Bowline is carefully secured.

If there were any advantage in having the same noose for all positions on the rope, were it only to save the novice the strain of learning a second knot, the Rover Noose would seem to be the most suitable as an all-round noose.

The Rover Noose (Figure VIII).

Take up the rope with the hands a span apart. With a swing of the right hand make a small righthand loop round the fingers of the left, and, continuing the movement upwards, draw the noose up past the loop; make the left thumb and fingers pass round the base of the noose and meet in the loop (Stage 1). Pass the noose backwards, release it, and let it hang down behind the left hand (Stage 2). Pass the right hand from the front under the ropes; grasp the noose and bring it forwards and upwards and through the loop from the front.

The knot is much better if the righthand rope emerges to the right of its lead through the knot, that is, the ropes come out of the knot as far apart as possible. This must be ensured at the beginning by using the left thumb to hold the righthand rope in the proper position against the loop. When this knot is made in an end-noose, it is essential that the lefthand rope is that running to the rest of the party and that the righthand rope is the free end.

The importance of the caution just given cannot be exaggerated. It is explained by the utter lack of symmetry in the knot. In one direction it forms the strongest of all nooses; in the reverse or righthand direction its strength falls by one-sixth and in this form it is quite unsuitable for the end of the rope.

Even in the reverse direction it is still good in the middle of the rope, but to get the best out of it, it is well before making it to consider a moment from which side the greater strain is likely to come and to work with the rope from that direction in the left hand.

The inequality in the reverse knot is characteristic of middle nooses, but it concerns the climber much less in those, like the Butterfly, that are nearly symmetrical from end to end. The difference in the symmetry of the two knots shows up clearly in their behaviour under breaking tests, in which it is advisable always to measure the extreme load of middle nooses in both directions and to determine once for all at which end they are stronger.

To meet the lack of symmetry it is better for the sake of consistency to make a simple convention with regard to the middle nooses. In making the knots one is supposed to work with the lefthand rope running to the leader, or more accurately, for the case is altered in a descent, in the direction from which strain more frequently comes.

This rule is important, because it ensures that the middle nooses are used at their full strength, while they are still made by the simplest methods ; but it has the complication that, when the noose is passed directly over the shoulders, the knot is found to lie at the righthand side. If the rope is required at the right, the procedure is correct and some untidiness in the knot must be tolerated. The fact is, rather luckily, for it might be just the other way, that both these knots lie much more naturally at the left side when the noose is round the waist. The lefthand rope in the illustrations will then run from the climber's left side towards the leader, as is the usual practice, unless there is a steep downward slope to the left of the party. To bring the knot into this position after it has been made it is necessary either to step over the rope into the noose and pull it upwards into place, or to pass the rope over the head to the left side and draw the noose downwards.

The nuisance of passing the rope across the body seems to be inherent in these nooses, for it can be avoided only by adopting complicated methods of making knots, a much greater inconvenience, or by reversing the direction of the knot by making it on a reversed section of the rope. Oddly enough a bad noose is immune. The explanation of the apparent paradox is that the defect, where it arises, is bound up with that best of good qualities, a straight entry. The ideal noose of this type is necessarily one-sided ; when it is

made by the simplest method, with the leader on the right, and then put on directly, the knot must lie in its neatest form at the left side. These are the conditions of the problem which the Butterfly Noose so nearly satisfies, but a full solution is likely long to elude climbers unpractical enough to take an interest in knots.

Meanwhile, until the ideal is discovered and the Rover Noose perhaps banished to the section to which it more typically belongs, some precautions must be taken. For strength and safety in making the Rover as end-noose it is essential that the lefthand rope leads to the rest of the party ; and for uniformity in making the middle nooses it is better to work with the leader to the left and to pass the rope to the other side before putting on the noose. Even the climber who is quite careless about the life of his rope and the neatness of his knots cannot afford to neglect the warning given above and make an end-noose wrongly. He may, however, regard as niggling the hints which follow about the Rover and the Butterfly as middle nooses. If so, let him ignore them and put the noose on anyhow, confident that with these excellent nooses he will at the worst be in no worse case than with the best of the old knots.

THE WAIST ROPE.

So far as memory serves, only one writer on climbing was found to make any reference to the use of a waist-rope, and in his opinion it was to be condemned as bad practice. Why it should be so was hard to understand, for there seems to be some convenience in two middlemen hitching themselves to the main rope by means of a separate rope round the waist. But a little consideration gave the clue to the mystery. None of the well-known hitches would quite satisfy a climber. He must have a hitch that will stand a strain in either direction. The Two-Way Hitch was designed to meet this requirement and nothing else was found that was both simple and effective.

The Two-Way Hitch is begun exactly like the knot in the Bowline and its principle is the same, but it is a symmetrical knot and takes a strain equally in either direction.

The Two-Way Hitch (Figure X).

With the right hand draw out a bight of the rope and with a counterscrew twist make it into a loop ; pass the cord down through the loop, then towards the right, up over and behind the rope and

up through the loop from below. This movement is just as in the Bowline, and the knot is now half made. Pass the end of the cord on over and round under the lefthand part of the rope and down through the loop. Tauten a little.

Once this knot can be readily made, the step to the next is easy. One great test of a knot is to try how it stands, when one cord is thicker than another. Now, if the Two-Way Hitch is made loosely, a condition in which it is still usually secure, of light cord on rope, and if there is a jerk or violent strain on the rope, while the cord remains slack, the loop in the rope may be pulled out flat and the knot dislocated. The conditions are not likely to occur in climbing, but it is better to be on the safe side. When the knot is half made, a couple of turns are taken round the cross of the loop, the knot is finished as before, and now affords a secure Waist-Rope Hitch.

The Waist-Rope Hitch (Figure XI).

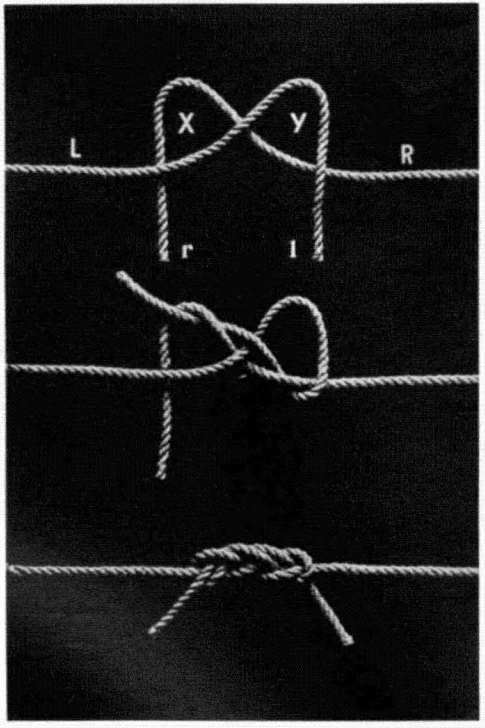
Proceed as in the Two-Way Hitch, but at the half-way stage take two turns with the cord round the cross of the loop to remove the possibility of its being flattened out by tension. Tauten the cord, but it is better not to tauten the loop in the main rope too much.

The waist-rope had better be of thinner rope, two-thirds the girth, and doubled exactly in two so that it ends in a bight. The hitch is made by reeving the bight through the loop on the main rope, one turn round the cross being sufficient, if the waist-rope is double. The rope is now brought to the side preferred without regard to the direction of greatest strain, which is immaterial with a symmetrical knot. The waist-rope is passed round the body in such a way that its parts cross each other in the middle of the hitch, and is closed by fastening the ends to the bight with a sheet bend (Figure XI).

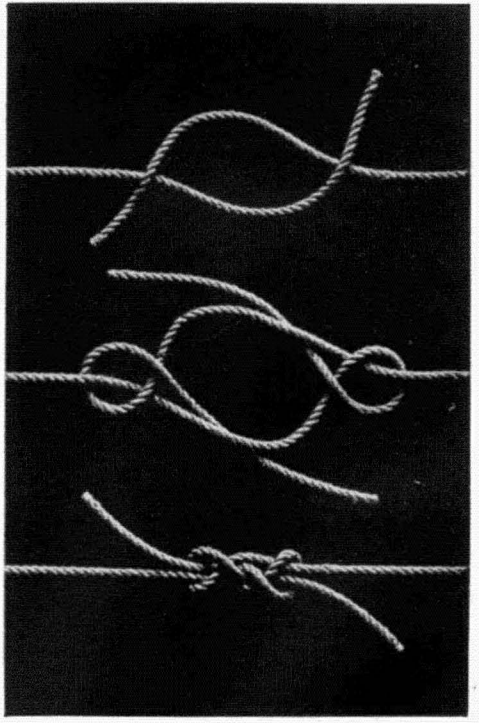
The great strength and reliability of this hitch should remove any objection to the use of a waist-rope. As it is symmetrical and equally good in either direction, it would seem to be stronger on the whole than any of the middle nooses.

THE BEND.

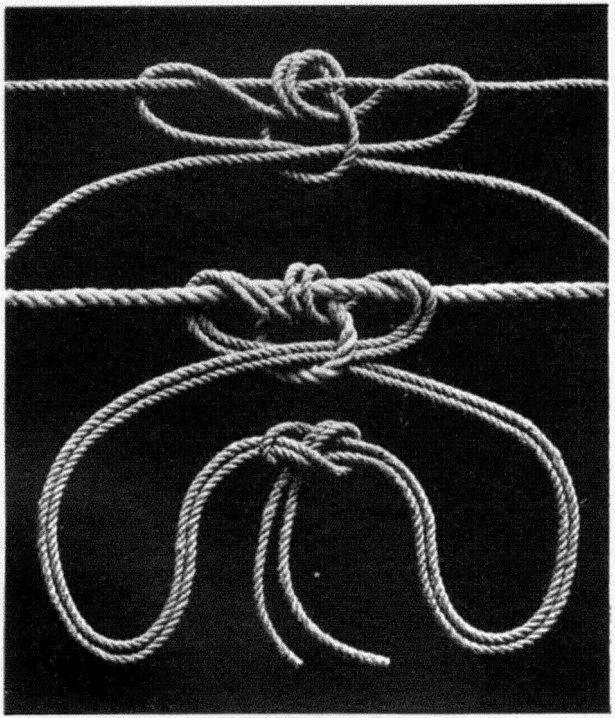
The Fisherman's Knot has long stood alone as a tie for two climbing-ropes. It is used by anglers to join two pieces of gut. On one end of gut an overhand knot is made which



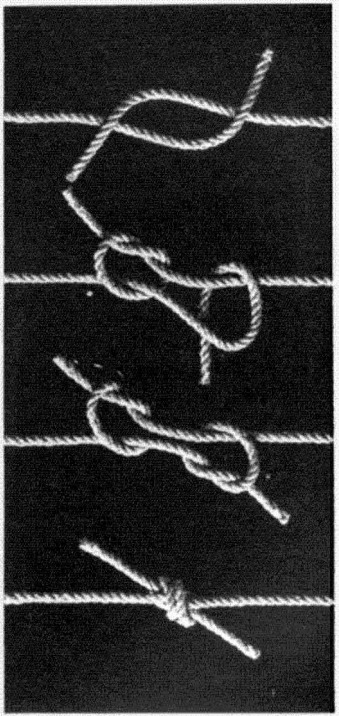
XIII. THE SENNIT KNOT



XIV. THE REEVER KNOT.



XI. WAIST-ROPE HITCH.



XII. FISHERMAN'S KNOT.

encircles the other piece. The two are then turned round and a knot made on the other loose end to encircle the first piece of gut. This device of reversing the gut at the half-way stage ensures that both knots are made with the same hand, and the knot is in the concordant form, which is slightly stronger. It is the form adopted in the Report of 1892, which recommends the making of two separate righthand knots even when it is used to form a middle noose. Now it is not uninteresting to note that in recent syncopated methods of making this noose it is always the discordant form that arises, consisting of a righthand knot on a lefthand knot, and further, that this weaker form, for a reason which quite escapes its advocates, is slightly the better in a middle noose.

The Fisherman's Knot (Figure XII).

Either of the following methods gives the concordant form and ensures that it is made with the lay :

1. Half-knot method.—Begin with a half-knot just as in the Reef Knot, with the righthand rope behind (Stage 1). The lie of the ends now shows the direction in which each end must be brought on round the other rope in forming the overhand knots.

2. Threading method.—Turn the righthand rope back towards the right, and on its end make a righthand overhand knot. Turn the knot back towards the left and thread the lefthand end through it (Stage 2 of method above). On this end make a righthand knot encircling the other rope (Stage 3 of method above).

Tauten the knots before drawing them together.

In climbing it is the stronger concordant form that should always be used as a join. Though better than the discordant form, it is lumpy and not very neat in appearance, and it is severe on the rope. The last point, however, important as it may be in a middle noose, matters less in this case, for the ends can be cut away when they show signs of wear. It must be well tightened, and is then a hard knot, in which the strain is taken solely by the touching surfaces of two overhand knots. The knot is without any spring or resilience, but none the less it is reliable and effective.

If a knot is to possess resilience, there must be some interlacing of the ropes, which will distribute the strain among the various turns in the knot and spare the rope. This involves a longer knot, but length, unlike thickness, is no disadvantage, provided neatness be not sacrificed.

Of the knots now suggested as suitable for use in climbing,

the first is particularly neat and handsome. If left loose and open, and then strained, it may take a form that is without neatness, though still quite secure. It ought to be thoroughly tautened by pulling on the ends and on the ropes alternately and by kneading it with the fingers, until it is flat and compact. It has then the reliability and much of the neatness of a splice.

In view of suspected defects its behaviour under breaking tests was closely watched. In spite of the high tension it finally withstood, it retained its handsome form to the last and no signs of collapse were apparent when the cord snapped.

The Sennit Knot (Figure XIII).

Take up the ropes with the ends towards each other so that in either hand there is a bight with the end hanging down; bring the right over to the left hand and behind it; then change hands on the bights, overlap them and bring them into the form shown (Stage 1). If the bights have been made small, this arrangement can easily be held in the left hand. With the right hand pass *l* backwards under R, through Y from the back, over the crossing ropes and through X from the back (Stage 2). In the same way pass *r* from the front through X, forwards over the cross and from the front through Y. Tauten well by pulling on the ropes and the ends alternately and by working the knot with the fingers.

Make sure that either end is passed through both bights from the same side, in one case through both bights from the front, in the other case through both from the back.

To open, if very taut, grasp the ropes and the ends together just outside the knot and compress it a few times. The ends are then easily withdrawn.

The next knot is simpler than the Sennit Knot, and at first trial would appear to be easier to make, but it offers some scope for error.

The Reever Knot (Figure XIV).

Bring the ends together as in beginning a reef knot, but keep the centre of the half-knot open in the form shown. Note that the ends lie above the ropes (Stage 1). Next give each end a turn round the other rope and bring it back towards the centre and down through the space. At this stage, to avoid the chance of a mistake, which might lead to a reef knot, keep each end pressed into the angle of the opening and well away from its own rope (Stage 2). Now pass each end on through the eye at the other end of the knot to lie beside its own rope.

Tauten by pulling ends and ropes alternately. Opened easily by compression.

Only a short reference need be made here to the rule that knots should be made with the lay of the rope. The joins, like the reef knot, are begun with the righthand rope behind the other for the sake of conforming to the usual lay. Since the strands run screw-wise in the rope, the ropes should lie together counterscrew-wise in the knot. The run of the rope through the knot may be reversed as an experiment by beginning with the left hand behind. The point is well illustrated in the contrast between the two edges of the flattish Sennit Knot, which is made with the lay along the thinner edge, where the strain is greatest. Along this edge the ropes enter and are spirally twisted in such a way that the strands lie in the general direction of the ropes and knot. Along the thicker edge, on the contrary, the ends lie spirally counter to the lay in such a way that the strands run across the knot and are more opened by the slighter strain. In the Bowline, as already explained, the knot holds better for being made with the lay in direct opposition to the practice of the authorities. On the whole, however, the principle is of little account in climbing, for it must be violated, when, as in the middle nooses, it clashes with more important considerations. One eminent authority, in fact, seems tacitly to recognize this. After laying down the law that knots must be tied with the lay, in his illustrations he shows them, either out of facetiousness, or unconsciously for a more obvious reason, made left-handed and consequently always against the lay.

The knots just described have been preferred to others equally strong, because they grip the ends firmly when the rope is slack. The repeated slacking which is inevitable in climbing tries a knot severely, tending to ease the nip on the ends and let them work loose. In this respect the knots are safe, even if the projecting ends be left quite short. Moreover, the ends emerge side by side with the ropes and are less liable to catch in obstacles. For that matter they can be tied in smoothly, if, instead of the usual whipping, they are pointed and finished off with an eye or becket, through which a short piece of string may be rove. This may be a refinement, but there are rare occasions, lassoing, for instance, or throwing a rope with any object, when it might be useful to fasten a light cord to the rope, and that cannot be done neatly and securely, unless there is an eye in the rope.

It should be noted in favour of the pointed and eyed rope that no neater or safer finish can be given to any of the Bowlines than by passing the end as usual in a few turns round the rope at the waist and then lashing the two together by means of a cord rove through the eye (Figure IX).

The small eye or becket used as a neat finish to a pointed rope is quite different from the spliced eye or loop mentioned in connection with the Bowline. The latter, a span long, is awkward, and has for sole advantage the security it gives to the Bowline. The former, no wider than the diameter of the rope, is never in the way, is no hindrance to any use of the rope, and enables a cord to be attached to it securely and very quickly.

CONCLUSION.

Now that the methods of making the new knots have been given, climbers who have borne the tedious descriptions with patience will probably be glad to have the comments that are scattered through the notes brought together in a summary :

I. The Double-Knotted Bowline and the Rover Noose, of nearly equal merit, are the best nooses for the end of the rope. The Bowline and Coil, though weaker, provides the most useful and adaptable end-noose.

II. If there is any gain in having the same noose for end and middle of rope, the Rover Noose is the best all-round noose.

III. In the middle of the rope the Butterfly Noose surpasses the Rover Noose. The Half-Hitch Noose, though effective, is much inferior to either.

IV. The use of a waist-rope is justifiable with a strong and reliable hitch like the Waist-Rope Hitch.

V. For bending two ropes together the Sennit Knot is neater than the Reever Knot, which is otherwise equally strong and good. The Fisherman's Knot is also reliable and only slightly weaker.

This summary may be put more practically in a series of hints, which will enable the climber to suit his own aims and to confine his study of knots to a small selection. Thus novices who wish to learn one knot and no more will find their heart's desire in the Rover Noose. Expert climbers who wish to go further, but take little interest in the vagaries of

knots, who like the Bouvier, but object to the bottle, would do well to master and apply the Bowline and Coil for the end of the rope and the Butterfly Noose for the middle. Others who value strength in a knot and wish their rope to have the greatest margin of safety on difficult and exposed routes have their requirements met by the Double-Knotted Bowline or the Rover Noose for the end of the rope and the Waist-Rope Hitch for the middle.

For the sake of referring briefly to the new knots it was inevitable that they should be given distinctive names. In making the selection, which proved a critical and troublesome matter, regard was had to the purpose or appearance of the knot, so that the name might be suggestive and easily remembered. Usually the difficulty was to coin an appropriate name without sacrificing simplicity. Thus Rover Noose is simple in form, but is cumbered with the far-fetched implication that it will go anywhere on the rope. The term, Bowline and Coil, is briefly descriptive of this useful adaptation of the Bowline. Two-Way Hitch and Waist-Rope Hitch convey the purpose of the knot. The Reever Knot is named rather at random, because there is some reeving in the making of it and because it has some analogy with the reef knot. The Sennit Knot is very close to the flat plaited rope called sennit. The Butterfly Noose is so styled on the basis of a more or less fanciful resemblance imagined in the form of the knot.

Running through this paper there will have been traced an heretical idea that climbing is worthy of its own knots. It is a short step to the belief that knots specially designed for use in climbing must inevitably surpass casual adoptions from tamer and duller pursuits. But, none the less, it must not be thought that the new knots have been put forward without due consideration. The merits of old and new have been weighed and the preference given to those that were fairly simple to make, neat in appearance, easy on the rope and reliable under intermittent strain.

To follow out the methods of the Report in making a selection the new knots were submitted to a breaking test, which had to be conducted on a small scale with cord instead of rope. The cord selected was an excellent line of Italian hemp, laid up like rope and resembling it closely in every particular. It turned out to be exceptionally strong, for with a diameter of only $\frac{1}{37}$ of an inch its average breaking strain in fourteen tests was 21 lb. 1·3 oz.

As a check on the results some of the older knots were included, and they all showed much higher percentages than in the Report. In one case, the Openhand Noose, the difference is so great that it may be questioned whether the same knot was used. In other cases the higher figure may be explained in part by differences in pliability and roughness, which would greatly affect the nip of the knot, and in part by the great difference in thickness between cord and rope, which may tell in favour of the former. In any case the discrepancy must be due to some cause which affects all knots in common, and the use of a fine cord need not invalidate the results, since, in all probability, the relative position of the knots is unchanged.

The nooses were all tested as end-nooses, but their proper

STRENGTH OF KNOTS.

Recommended.	Use.		Report of 1892.	Percentage Strength.	Percentage Variation.	Breaking Strain.
		Cord		100	4·3	3373
		Joins				
		Reef Knot	53·4	62·8	9·6	2118
		Carrick Bend		63·2	9·4	2134
		Thumb Knot	57·7	69·7	9·4	2351
		Diamond Bend		69·9	1·2	2358
		Fisherman's Knot, Discordant		70·9	7·1	2392
*	J	Fisherman's Knot, Concordant	61·7	81·2	9·5	2741
**	J	Sennit Knot		86·2	10·8	2908
		Unnamed Knot		86·3	5·3	2910
**	J	Reever Knot		86·4	8·9	2914
		Carrick Bend laid up		94·2	8·5	3178
		Nooses				
	E	Double Bowline		72·5	6·3	2445
	E	Fisherman's Noose	65·0	73·6	12·0	2482
	M	Rover Noose, Reverse		76·5	6·8	2580
*	M	Half-Hitch Noose		77·6	11·5	2617
	E	Bowline	72·4	77·8	7·6	2626
	E	Double-Knotted Bowline and Coil		79·1	13·2	2670
**	E	Bowline and Coil		79·5	5·4	2681
		Openhand Noose	64·1	79·6	8·6	2686
**	M	Butterfly Noose		84·9	8·2	2865
	M	Butterfly Noose, Reverse		85·1	6·9	2870
	E	Bowline with Waist-Rope Hitch		87·6	5·6	2956
**	M	Waist-Rope Hitch		89·3	6·5	3013
**	E	Double-Knotted Bowline		92·0	7·3	3103
**	E M	Rover Noose		92·5	5·0	3121

position on the rope is indicated in the table by the letters E and M. The middle nooses were in two cases tested in both directions, and the result on the righthand rope is entered against the reverse knot. A perfectly symmetrical knot like the Waist-Rope Hitch would, of course, not show any difference.

The fourth column of figures gives the average weight which the knot just bore without breaking, measured in tenths of an ounce and based on some seven to thirteen tests in each case. The smaller unit has been adopted instead of the ounce, because the figures as they stand can equally be read as the weight in pounds which the knots would bear, if made on a full-size rope equivalent to the cord. In the second column the breaking weight for each knot is expressed as a percentage of the breaking load of the cord. In the next column is a percentage derived from the range covered by the results for any one knot and giving approximately the possible deviation of a knot from its average strength ; the smaller the number the better and more consistent the knot.

As a further test the average time which it takes to make the knots was ascertained to the nearest half-second, and may be of sufficient interest to be recorded here. It was thought that the times might be some guide to the usefulness of the knot, but they were not much help, for they differed less than was expected, and after all, provided a knot holds well, it matters little to a climber whether it takes five seconds more or less to make.

TIME OF MAKING THE KNOTS.

	Secs.		Secs.
Fisherman's Knot . .	10½	Manharness . . .	6
Sennit Knot . . .	17	Fisherman's Noose . .	8
Reever Knot . . .	13	Half-Hitch Noose . .	8
Carrick Bend laid up .	91	Rover Noose . . .	7½
		Butterfly Noose . .	9
Bowline . . .	14		
Double-Knotted Bowline.	15	Two-Way Hitch . .	11
Bowline and Coil . .	28	Waist-Rope Hitch . .	16½

The Bowlines, though easy, take an unexpectedly long time, but much of it is spent in securing the end. The middle nooses have still to be adjusted. They differ by little, but all

take more than the six seconds of the Manharness, which was included for the sake of comparison.

The Fisherman's Noose compares favourably with others of its class. But it did not show to advantage at first, for it was made by a novel and ingenious method, recommended in a work on climbing, which took no less than twenty seconds. This seemed so needlessly long in comparison with similar nooses that other methods of making it were devised. Not only were they simpler, but much quicker, taking 8, 8½, 9 and 10 seconds respectively. Thus, although speed cannot be used to discriminate between knots, it is a good test of method. A knot cannot be made quickly, unless the movements required by the method are easy and natural, and the great difference just noted shows that it is well worth while to seek and learn the best way of making even a widely known knot.

In the case of the new knots no pains have been spared to discover the neatest and simplest methods, and climbers who learn and apply them should be safe from the annoyance of having ultimately to discard them for better.

These knots are new in the sense that no earlier record of them has been traced. But it might be rash to claim that they have never been used before. To echo a well-known writer, very old are all knots. Their age was recently brought home to our minds by the discovery of a clove hitch that had been made in the Valley of the Kings three thousand three hundred years ago. In comparison with such antiquity mountaineering is a thing of yesterday, and the knots are new, at least, in their application to climbing. They have been devised to satisfy the exacting requirements of a pursuit in which life might depend on the security of a knot, and they are now left to the judgment of others in the belief that they will not be rejected without a thorough test, and in the hope that the approval of climbers may make amends for the time and labour devoted to the inquiry.