United States Department of the Interior, J. A. Krug, Secretary
Fish and Wildlife Service, Albert M. Day, Director

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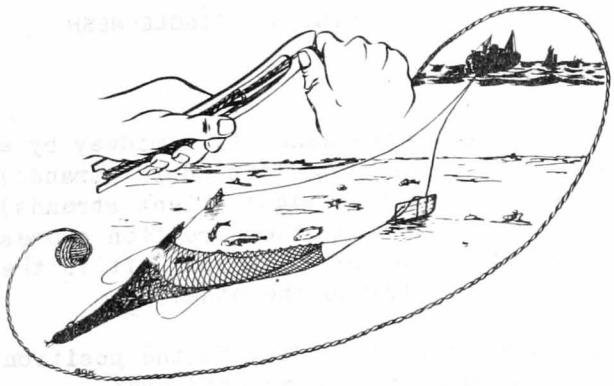
# METHODS OF NET MENDING -- NEW ENGLAND 1/

By Boris O. Knake*

## INTRODUCTION



Net mending has been practiced by fishermen for centuries. There are many known methods of mending nets throughout the world but all are basically similar. This publication describes the methods of net mending as practiced by the New England otter trawl fishermen.

In otter trawl fishing, the crew must mend the nets night and day under the difficult conditions of cramped space, awkward positions, rolling seas, decks awash, rain, snow, and bitter weather. Whenever a tear is found, which usually occurs every time the net is hauled in, it must be mended. Because of these conditions, a mending method suited to trawl fishing has been developed.

Most nets are made by machines, but since the mending of these nets must be done by hand, this probably will remain always a part of the fisherman's work.

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1/ This is Part I of a two-part article on this subject, which appeared in the March 1947 issue of Commercial Fisheries Review. The second part will appear in a subsequent issue.

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# PART I--FUNDAMENTAL PRINCIPLES AND SIMPLE MENDING

## TERMS USED IN NET MENDING

Fish netting or webbing is a sequence of loops, known also as bights or half-meshes, which are interwoven by knots. These form a series of meshes as shown in Figure 1. The knot is known as the sheet-bend-hitch, weavers' knot, fishermen's knot, or mesh knot.

FIG. 1 - FISH NETTING

FIG. 2 - DAMAGED AREA

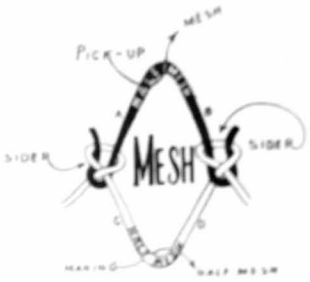



FIG. 3 - SINGLE MESH

A single mesh is the combined upper and lower half-meshes tied midway by a hitch. As illustrated in Figure 1, the weaving is from right to left (dark strands) to the number of meshes required, and back again from left to right (light strands) and so forth until the desired depth is reached. Reversing the direction causes the knots in one row to look different from those in the next row. It is the same knot, however--front view in one case and back view in the other.

In net repairing, the knot is referred to by name, according to the position it has in the damaged area. As numbered in Figure 2, the names used are:

(1) Mesh knot
(2) Pick-up knot
(3) Sider knot
(4) Starter three-legger
(5) Finishing three-legger

## DEFINITIONS OF KNOTS

1. Mesh knot--also referred to as a half-mesh knot; that is, in making a half mesh a mesh knot is tied. The white lower half (Figure 3) is the half mesh; C and D are the legs of the half mesh. After a knot is tied the legs are referred to as bars or strands.

2. Pick-up knot--a knot tied to a half mesh on the base or the lower part of the damage. Tying the lower mesh forms the pick-up knot on the pick-up mesh. The pick-up mesh is shown in black in Figure 3. The legs of the pick-up mesh are A and B.

3. Sider knot--refers to a knot of two separate strands as shown in Figure 3. These are only found on the sides of the damage; that is, on either side of the webbing when held or hung straight. Sider knots are of two types, called "sider on the left" or "sider on the right" depending on which side of the damage they are located.

4. Starter three-legger--a knot having three strands intact and only one strand cut off (4 in Figure 2).

5. Finishing three-legger--a similar type knot to the starter three-legger (5 in Figure 2). The importance of the three-legger knots is that the mending is started and finished on those knots. This particular point cannot be over-emphasized.

## NET SIZE

Netting is designated by the size of the mesh in a stretched form (Figure 4) and is measured by the number of meshes in length and in depth. The length is often expressed in feet or fathoms when a large quantity is ordered.

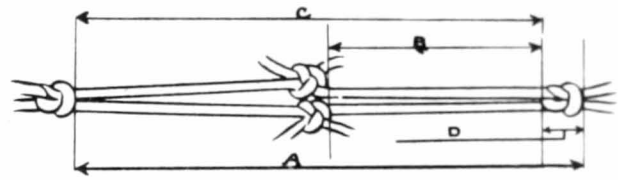


FIG. 4 - MESH MEASUREMENTS

The stretched mesh size (A in Figure 4) is a recognized method of measuring by the manufacturers. The length of the bar, leg, or strand (B in Figure 4), the actual inside opening of the mesh (C in Figure 4), and the size of knot (D in Figure 4), are units of measure which are sometimes used in netting specifications.

## NET DAMAGE INSPECTION

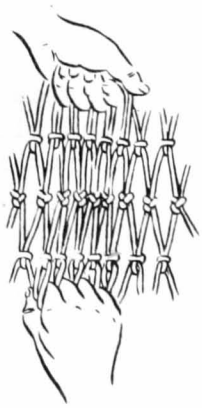


FIGURE 5
STRAIGHT TWINE

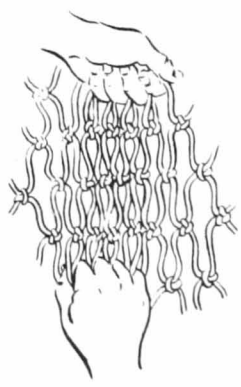


FIGURE 6
CROSSTWINE

The first step in repairing damage to a net is to determine the type and the extent of the damage, so that the best mending procedure can be decided upon. The proper procedure allows the mender to restore the meshes by weaving in an uninterrupted sequence. The next step is to determine the trimming necessary. To do this, the damaged section of the net is stretched so that the strands line up easily. This is referred to as "straight twine" (Figure 5).

The wrong way to stretch netting is known as "crosstwine" (Figure 6). Note how the strands tend to loop. To further illustrate trimming, Figure 7 shows a damaged section with several broken strands (dark section). In correctly trimming this type of damage all the dark shaded twine must be cut out as shown in Figure 8. Usually the resulting stumps in the half meshes and pick-ups are removed by cutting them out, when there is sufficient time for it. This serves two purposes. The mending will look neater because of the reduction in the number of bulky knots, and also in mending badly torn nets it helps the mender to avoid mistaking the half-mesh knot for the sider knot which would result in a disorder of the mesh sequences known as "getting into crosstwine." If this mistake is made it will be necessary to cut out the repaired meshes and start all over again. Figure 9 represents a correctly trimmed hole ready for mending. Note that knots 6, 7, and 10 are missing. A detailed description of the mending procedure is given later.

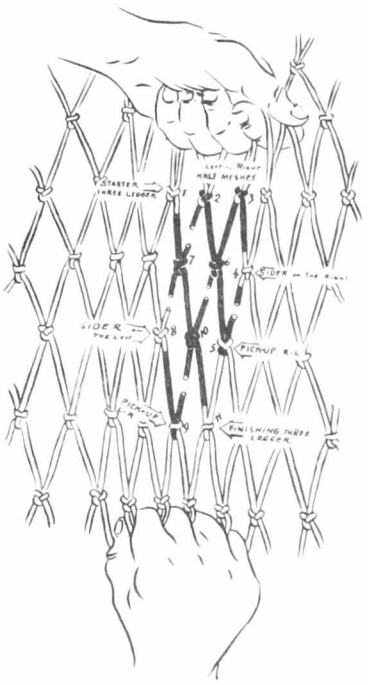


FIG. 7 - DAMAGED SECTION

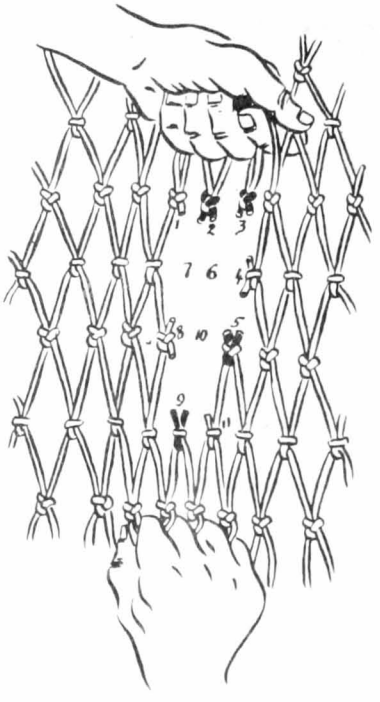


FIG. 8 - PARTIALLY TRIMMED

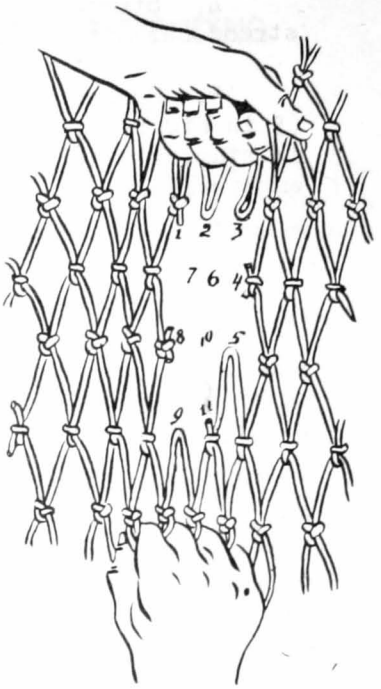


FIG. 9 - CORRECTLY TRIMMED

## METHOD FOR CUTTING OUT STUMPS IN THE HALF MESHES AND PICK-UP MESHES

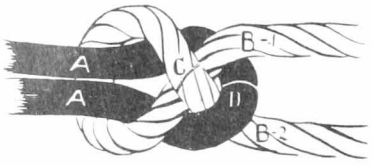



FIG. 10 - POINT OF CUTS

Figure 10 shows how the cuts are made when cleaning up the half meshes and the pick-up meshes. When the loop AA is to be retained, cutting out the strand BB is done quite simply, by cutting at point C where the strand leg B-1 serves as a cushion, thus preventing injurious cuts on the A strand. Figure 11-A shows the method of cutting and the position of the knife.

It is more difficult to cut off the A strand stump, which must be cut at point D, Figure 10. The knife is placed between the legs B-1 and B-2, so that the blade cuts between the two legs BB (Figure 11-B). This operation requires a little practice to get the feel of the snap, when the last fibre of stump AA has been cut without the knife reaching and injuring loop strand BB.

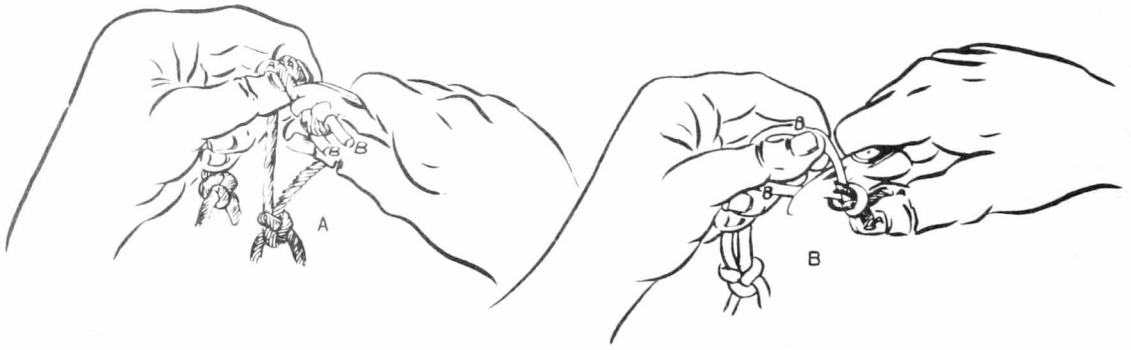



FIG. 11 - CUTTING OUT STUMPS

When trimming the unwanted strands, care must be taken not to cut the strands too close to the knot, on three-leggers and siders. These knots are not always firm and may untie. Therefore, at least a $\frac{1}{2}$ inch of strand should be left when trimming the knot. If cut too close they frequently will untie and it will then be impossible to retie them. Then the cutting of additional meshes will be required to regain the proper mending sequence.

## FILLING THE NEEDLE

Only one special tool is required in net mending. This tool is known as a net needle or shuttle and is made of wood (ash, hickory, bamboo, or dogwood),

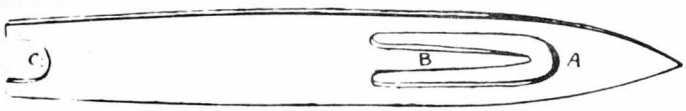



FIG. 12 - NET NEEDLE

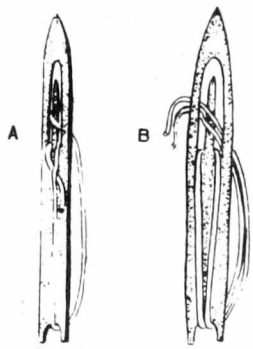
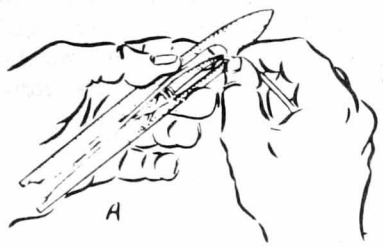



FIGURE 13
FILLING THE NEEDLE

metal, plastic, or even ivory. Figure 12 shows the shape of the net needle customarily used. A is the eye, B is the tongue, and C is the fork or heel. The size of the needle for mending depends upon the size of the mesh and the twine to be handled. The needle used to repair otter trawls is about 8 inches long by $\frac{1}{4}$ inch thick. Filling "single needle" means that single twine is wound on the needle (Figure 13-A). The twine is wound over the tongue so that the short end is jammed under the long end, then the twine is wound under the heel and over the tongue on the other side of the needle and back under the heel, turning the needle in a rocking fashion each time the twine goes under the heel of the needle, until the needle is filled. Filling "double needle," means that instead of single twine, double twine is used (Figure 13-B). In starting to fill "double needle" a length of single twine sufficiently long to fill the needle is measured off. The twine is then doubled. The middle bight is placed over the tongue of the needle and the filling is done the same way as when single twine is used. Some needles have a flexible tongue. This makes it possible to push the tongue slightly outward permitting the twine to slide under it (Figure 14-A). In other types the eye of the needle is flexible. In filling this needle, the right thumb pushes the eye downward, passing the twine over the tongue (Figure 14-B).




FLEXIBLE TONGUE NEEDLE

FLEXIBLE EYE NEEDLE

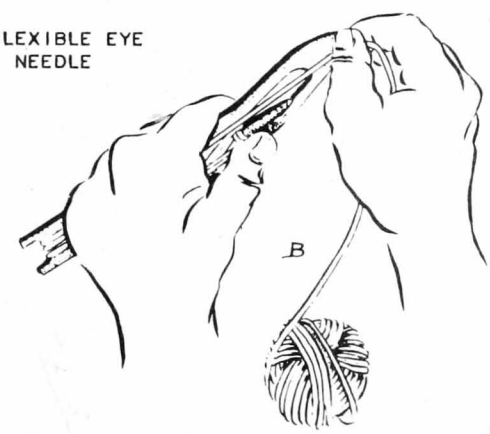



FIGURE 14

## MESH GAUGING

When mending nets the mesh size is gauged with the fingers of the left hand. The new mesh is constantly gauged for uniformity with the previous mesh. Figure

15 illustrates the use of the fingers in gauging the mesh size. Of course, this limits the size range of the mesh to the size of the hand, but this is quite satisfactory as the mesh sizes are usually more or less within that range. They can be varied a little by the tautness with which the twine is held. With some practice it becomes easy to gauge the mesh size almost precisely. When mending a wet net, it should be remembered that the twine has shrunk; therefore, the dry twine meshes mended in should be slightly larger than the wet net meshes.

FIG. 15 - GAUGING MESH SIZE

## HANDLING THE NEEDLE

Shuttling the needle through meshes of large size, the needle is always held in the hand in the progressive positions A, B, and C, shown in Figure 16. When mending smaller size mesh, the needle remains secure in between the meshes, without slipping out. Sometimes the left hand forefinger may aid in holding the needle while changing the grip for the completion of the shuttling.

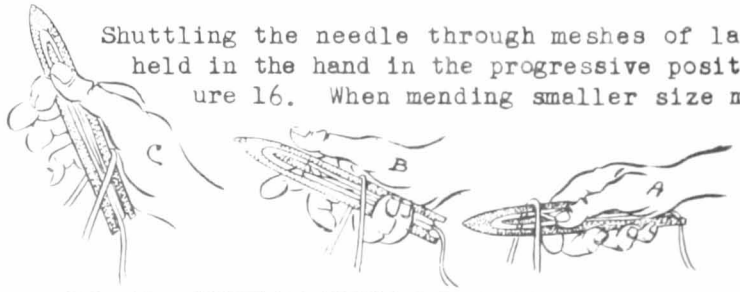



FIG. 16 - SHUTTLING NEEDLE THROUGH LARGE MESHES

## SUPPORTING THE NET FOR MENDING

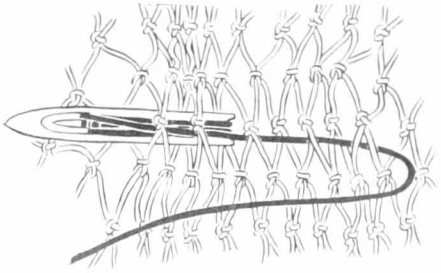


FIG. 17 - RUNNING SUPPORTING TWINE THROUGH MESHES

In starting to mend a damaged net, it is more convenient for the mender to tie the area of the damaged net section to something secure so that the meshes will line up easily. This is done very simply running a length of twine through the meshes about one or two meshes above the starter three-legger of the damage in the net (Figure 17). These meshes are tied in a bunch, and fastened with a slip-double-half hitch knot (A in Figure 18). The other end of the twine, B, is then secured to something solid that may be within easy reach. Often at sea when many meshes are damaged in a very large tear there will be someone who assists the mender by holding the net properly.

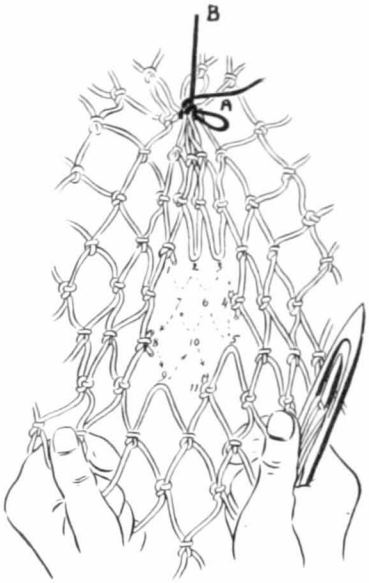



FIG. 18 - SUPPORTING DAMAGED NET

# HOW TO MEND

In repairing damage to a net, there must be a definite starting point and a finishing point, both of which must be three-leggers. Figure 19-A shows a simple tear with only two three-leggers, which become the starter three-legger (1), and the finishing three-legger (11). Figure 19-B shows the starter knot completed and Figure 19-C shows the finishing knot with the damage repaired. Figure 20-A illustrates a tear known as "tear on the siders." Here, in addition to the starter three-legger (1) and the finishing three-legger (11), is "sider on the right" (4) and "sider on the left" (8). Figure 20-B shows the damage mended. Sider knots are very important as a signal to reverse the direction of shuttling on the mending procedure. Often when mending badly damaged nets where the netting has been under severe strain, the knots become deformed and hard to recognize. It is then good policy to cut the knot open to find out whether it is a mesh knot or sider. Sider signifies the end of the row.

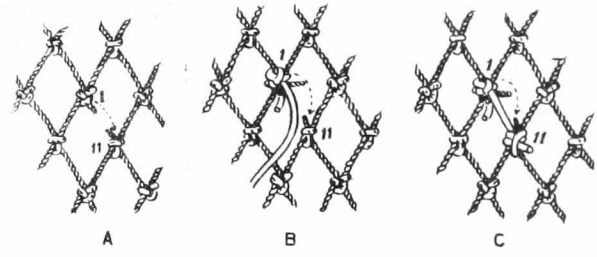



FIG. 19 - SIMPLE TEAR

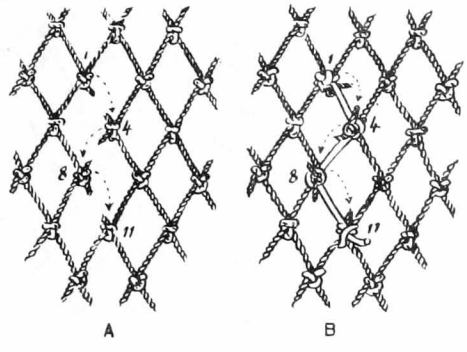



FIG. 20 - TEAR ON THE SIDERS

The tear shown in Figure 21-A is known as a "tear along the meshes." Here is the starter three-legger (1), and the finishing three-legger (11), in addition to the half mesh (2-3) and the pick-up mesh (9). In Figure 21-A the starter knot is on the left side of the tear, therefore, mending proceeds from left to right (Figure 21-B). In this case the needle is always taken from under the loop when making the tie. Figure 21-C shows a tear similar to that in Figure 21-A. The only difference is the location of the starter three-legger on

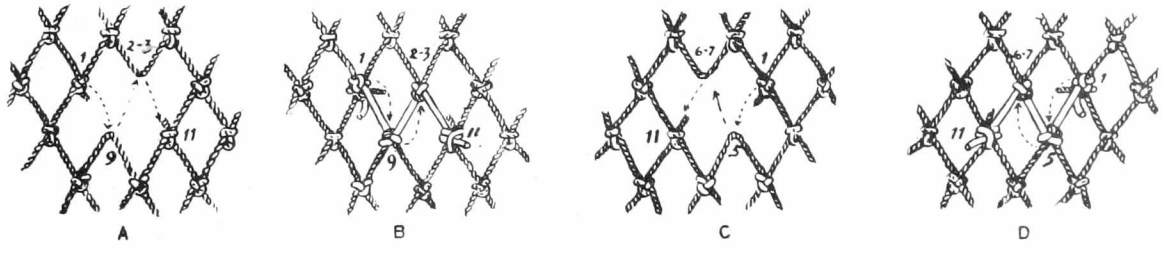



FIG. 21 - TEAR ALONG THE MESHES

the right side of the tear. Therefore, mending proceeds from right to left (Figure 21-D). In this case the needle is always inserted into the loop from above. If the mending direction is not carefully noted, the twine will not line up in the proper direction when each knot is made with the result that the knot will be upside down or twisted.

The smallest possible tear requiring all of the variations in mending is illustrated in Figure 22. Beginning with the starter three-legger (1), (also see Figure 23), the needle follows the arrow of the dotted line to the half mesh (2), (also see Figure 25), from there to another half mesh (3), then downward to the sider on the right (4), (also see Figure 27), which is the signal to reverse

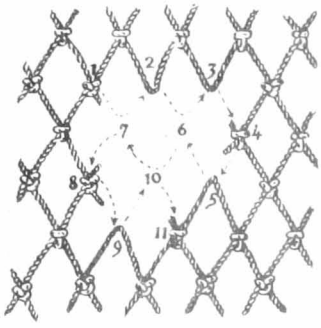
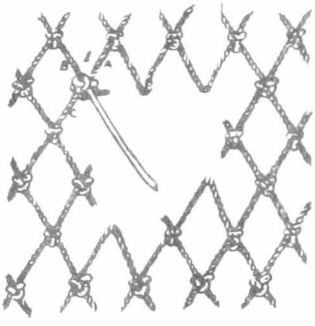



FIG. 22 - SMALLEST TEAR REQUIRING ALL MENDING VARIATIONS

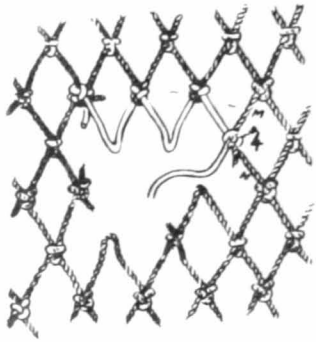
and mend from right to left. First the needle is shuttled through the pick-up mesh (5), (also see Figure 29), and then through the half mesh (6), (also see Figure 31), through another half mesh (7), and then downward to the sider on the left (8), (also see Figure 33), which is the indicator to reverse again and mend from left to right. Now the needle is shuttled through the pick-up mesh (9), (also see Figure 35), then through the half mesh (10), (also see Figure 25), and then downward to the finishing three-legger (11), (also see Figure 37). This completes the mending.

The sketches beginning on page 9 (Figures 23 to 38) illustrate step by step details of tying the various types of knots. The numbers in the sketches show the order in which the movements should be made. The tear illustrated is the same as the one shown in Figure 22. The knots as completed are illustrated below.



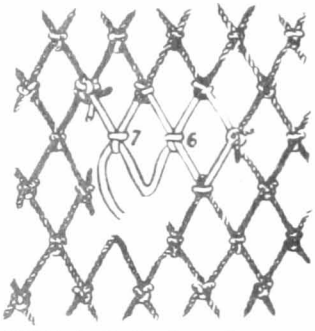

STARTER KNOT


HALF-MESH KNOT - L TO R

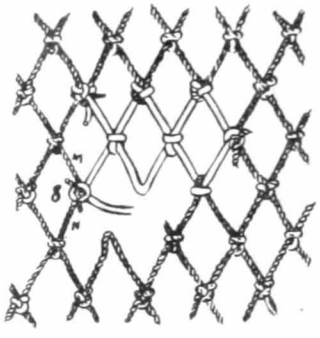



SIDER ON THE RIGHT

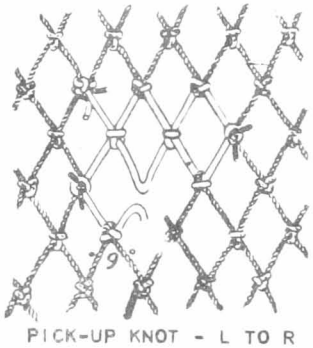

PICK-UP KNOT - R TO L



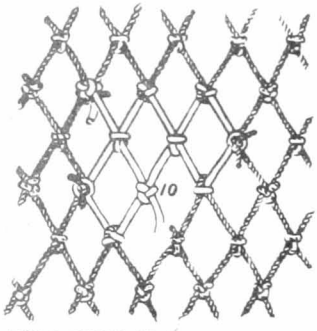

HALF-MESH KNOT - R TO L



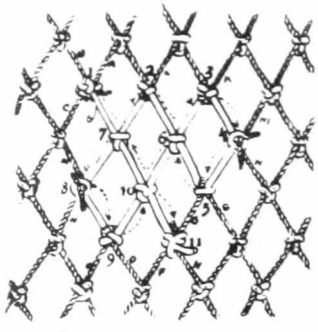

SIDER ON THE LEFT




PICK-UP KNOT - L TO R




HALF-MESH KNOT - L TO R




FINISHING KNOT

# STARTER KNOT

(Sketch A) Shuttle the needle with sufficient length of twine, between A and B legs from underneath (1), and with the left hand forefinger checking the twine at junction (2) allow the twine to slip by until only about one inch of the end (E) extends from the knot (D).

(Sketch B) Grip tightly at junction (3) with the left thumb. With sufficient slack of the mending twine form a loop to the left (4) and shuttle the needle (5) to the left under the A and B legs and over the twine loop (6) and follow through.

(Sketch C) Swing the needle to the right and downward tightening the hitch (7).

(Sketch D) Make another loop to the left (8) and shuttle the needle under one leg (B) and follow through to the left (9).

(Sketch E) Pull the twine downward to the right and tighten the hitch (10).

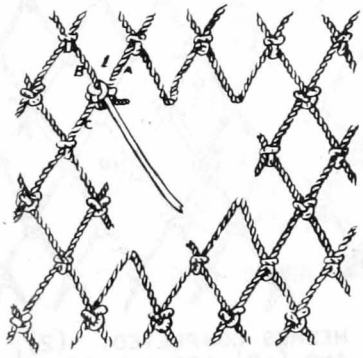


FIG. 24 - STARTER KNOT (1) COMPLETED

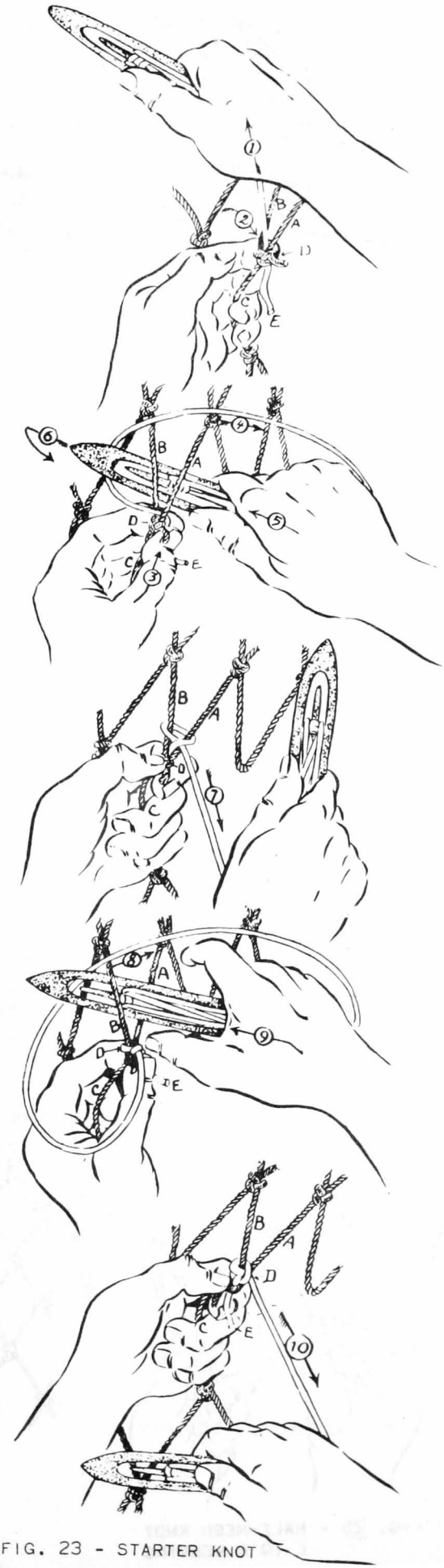



FIG. 23 - STARTER KNOT

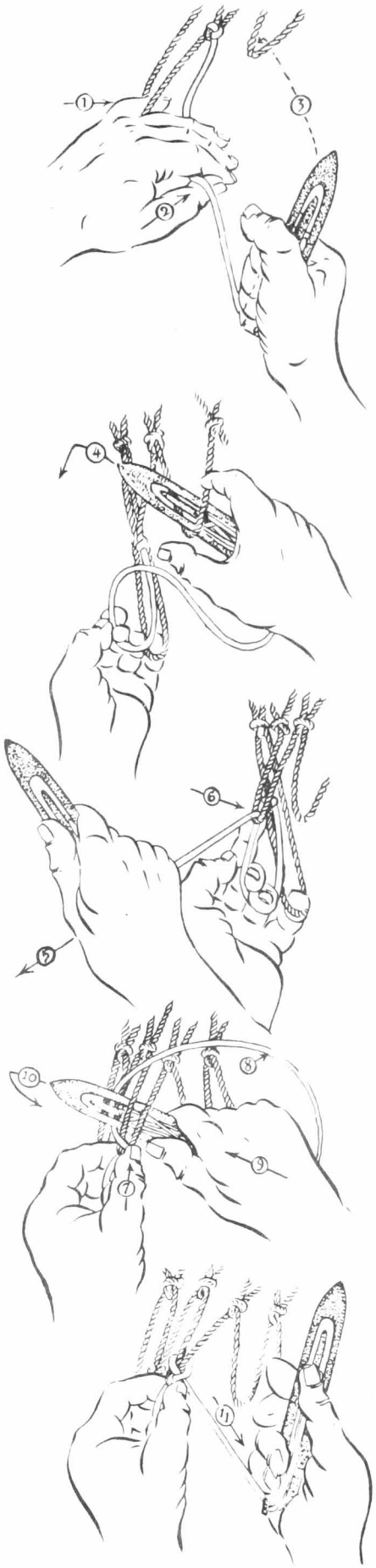


FIG. 25 - HALF-MESH KNOT
L TO R WEAVING

## HALF-MESH KNOT

(LEFT TO RIGHT WEAVING)

A (Sketch A) Holding the needle twine somewhat stretched, get hold of the twine with the left hand so that the little finger will be in the mesh (1) next to the one in the making; the twine is held between the forefinger and thumb (2), then shuttle the needle through the mesh loop (3) from underneath.

B (Sketch B) Follow through (4) and then downward.

C (Sketch C) Pull the twine (5), at the same time checking with the forefinger (6) until the loop in the making is of the same size as the one of the little finger.

D (Sketch D) Grip tightly with the thumb at the junction (7) and with sufficient slack twine form a loop (8) and shuttle the needle from right to left under the two legs, and over the mending twine loop (9) following through (10) swinging the needle to the right.

E (Sketch E) Pull the twine taut to the right and slightly downward (11).

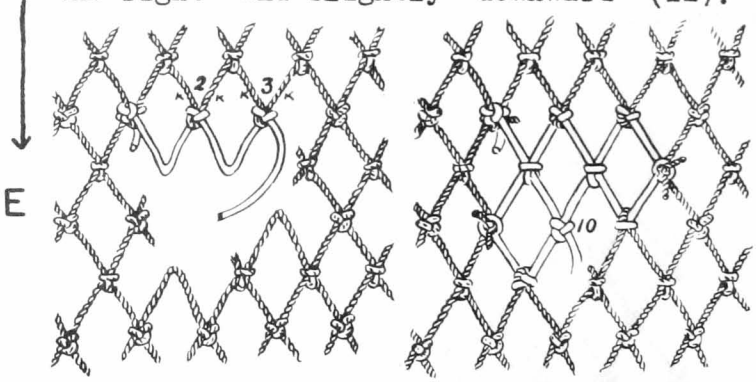



FIG. 26 - HALF MESHES COMPLETED. (2), (3), AND (10) ARE ALL OF THE LEFT TO RIGHT TYPE.

## SIDER ON THE RIGHT

(Sketch A) Grip the lower leg of the sider, so that the forefinger is under the knot (1). Swing the mending twine to the right holding it quite taut in a position close to the right side of the knot (2).

(Sketch B) With the thumb, roll (3) the sider knot over the mending twine and hold tightly (4), then begin to swing the needle with sufficient twine slack (5 and 6).

(Sketch C) Continue swinging the needle to form a loop to the left of the knot (7) and shuttle the needle (8) under the upper leg of the sider knot and mending twine, and over the twine loop; follow through.

(Sketch D) Pull the twine to the left and somewhat downward to tighten the hitch (9).

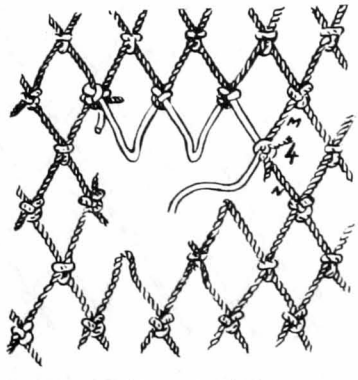


FIG. 28 - SIDER KNOT (4) COMPLETED

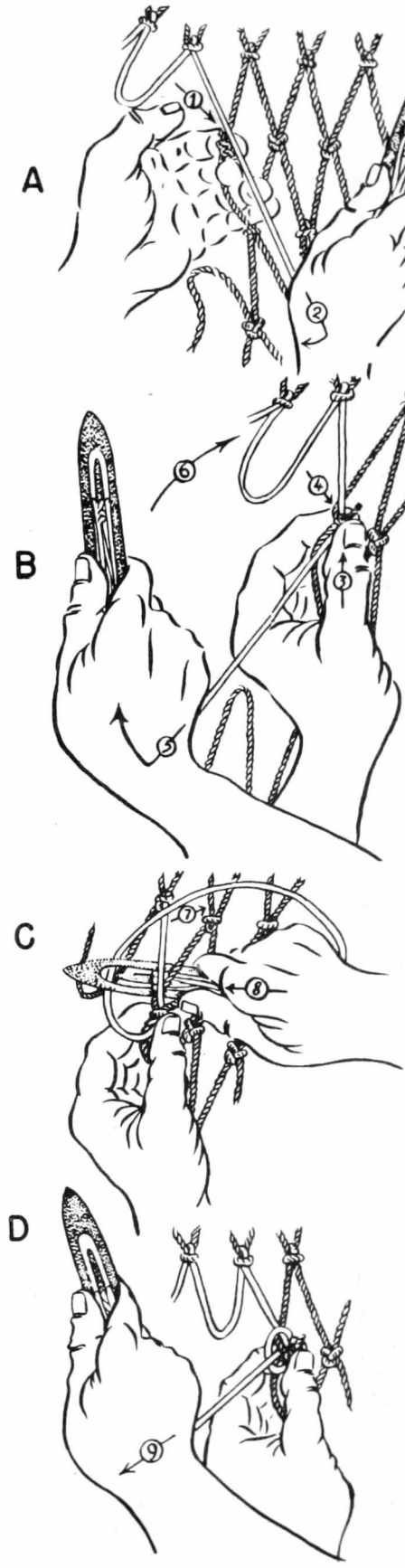
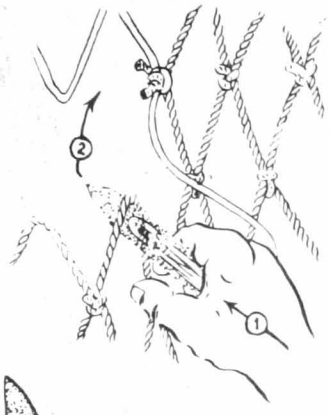



FIG. 27 - SIDER ON THE RIGHT

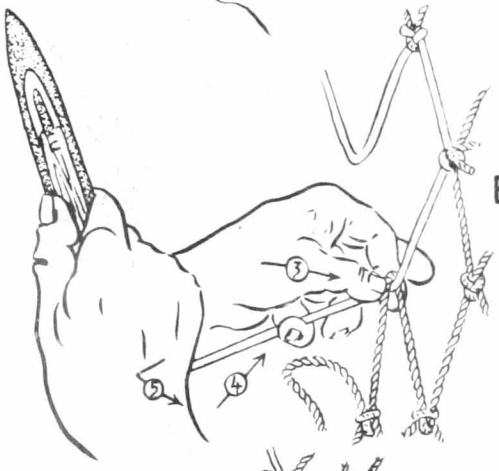
## PICK-UP KNOT

(RIGHT TO LEFT WEAVING)



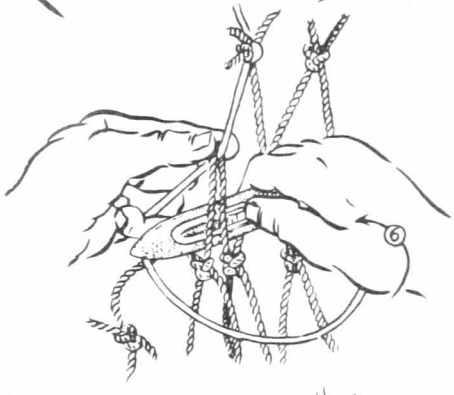

A

(Sketch A) Shuttle the needle through the pick-up mesh (1) following through and upward (2).




B

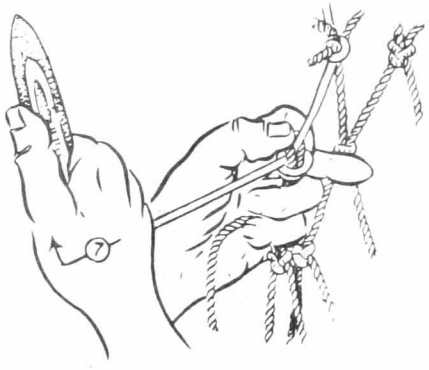
(Sketch B) With the left hand, grasp at the junction (3), pull the twine until all sides of the mesh are equal, then tighten the grip and pick up the mending twine with the little finger (4). Swing the needle downward (5) to the right, and with sufficient slack twine form a loop.




C

(Sketch C) Still supporting the twine with the little finger shuttle the needle under the pick-up mesh legs following through and over the twine loop (6) while holding the twine clear of the needle with the little finger.

(Sketch D) Pull the twine to the left and upward (7) to tighten the hitch.




D

FIG. 29 - PICK-UP KNOT
R TO L WEAVING


FIG. 30 - PICK-UP KNOT (5) COMPLETED

# HALF-MESH KNOT

(RIGHT TO LEFT WEAVING)

(Sketch A) Place the left hand little finger into the mesh next to the one in the making (1), and throw the twine under the third finger for the size check. Hold the needle to the left and move upward (2).

(Sketch B) Shuttle the needle from above (3) and follow through.

(Sketch C) Pull the needle and mending twine slightly downward (4) checking the twine at the junction (5) with the forefinger until the bight being made is the same size as the half mesh (6) held by the little finger.

(Sketch D) Clamp tightly with the thumb (7), then with sufficient slack twine form a loop to the right (8) and shuttle the needle (9) under the two legs of the mesh and over the twine loop, then follow through.

(Sketch E) Tighten the hitch to the left and downward (10).

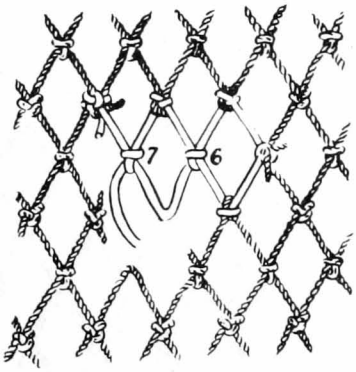



FIG. 32 - HALF-MESH KNOT (6 AND 7) COMPLETED

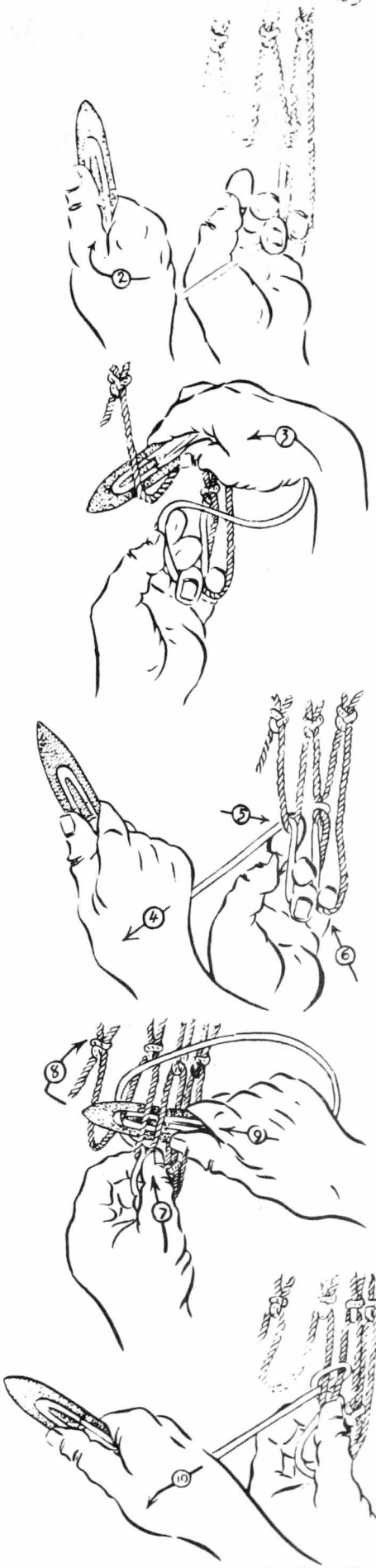



FIG. 31 - HALF-MESH KNOT R TO L WEAVING

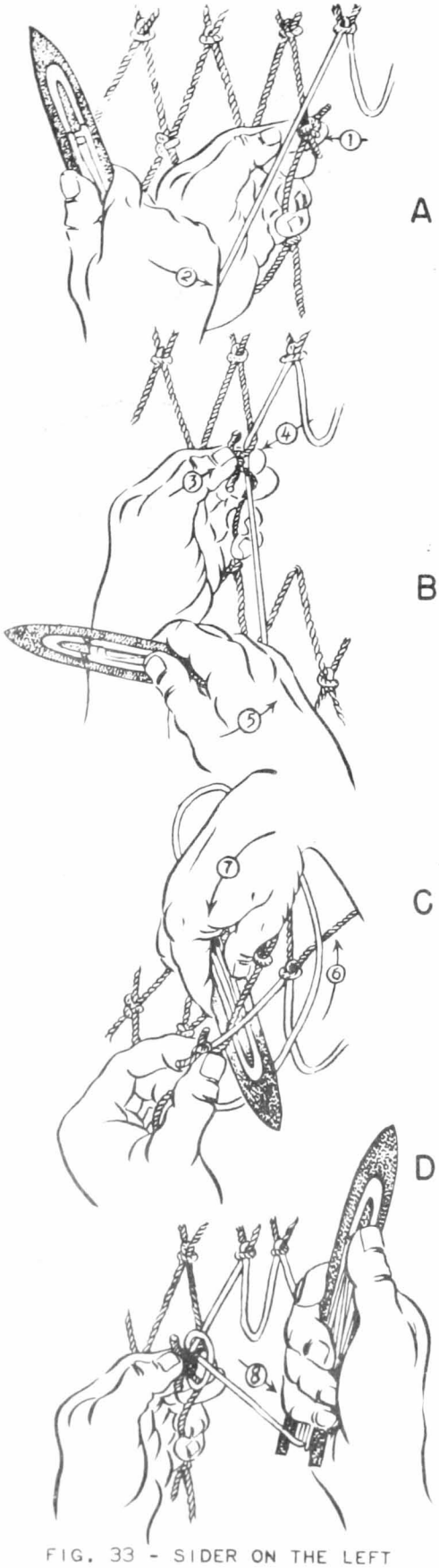



FIG. 33 - SIDER ON THE LEFT

## SIDER ON THE LEFT

(Sketch A) With the left hand get hold of the sider lower leg, and with the forefinger under the knot (1), swing the needle and twine to the right (2), with the mending twine somewhat taut place it on top of and to the left of the sider knot.

(Sketch B) With the thumb, roll the sider knot to the left over the mending twine (3) and hold tightly (4). Swing the needle to the right and upward (5).

(Sketch C) With sufficient slack in the mending twine form a loop to the right (6) and from above shuttle the needle (7) under the upper leg of the sider knot and mending twine, and over the twine loop, then follow through.

(Sketch D) Pull the needle and twine to the right and downward to tighten the hitch.

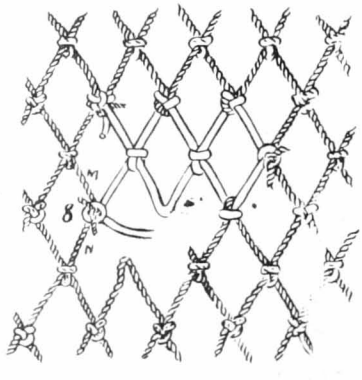


FIG. 34 - SIDER ON THE LEFT (8) COMPLETED

## PICK-UP KNOT

(LEFT TO RIGHT WEAVING)

(Sketch A) Hold the top of the pick-up mesh with the left hand (1) shuttling the needle (2) from underneath and follow through.

(Sketch B) Pull the twine to the left and slightly upward until all sides of the mesh are of equal length and hold tight at junction, (4), then swing the needle downward to the right.

(Sketch C) Hook the mending twine on the little finger of the left hand and with sufficient slack twine form a loop, then shuttle the needle (7) under both pick-up mesh legs, and over the twine loop. The little finger keeps the loop clear for the needle to pass over.

(Sketch D) Drop the twine off the little finger and pull the needle upward to the right, tightening the hitch (8).

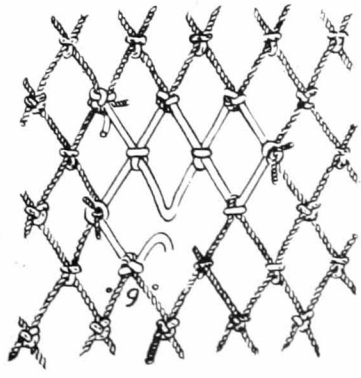



FIG. 36 - PICK-UP KNOT (9) COMPLETED

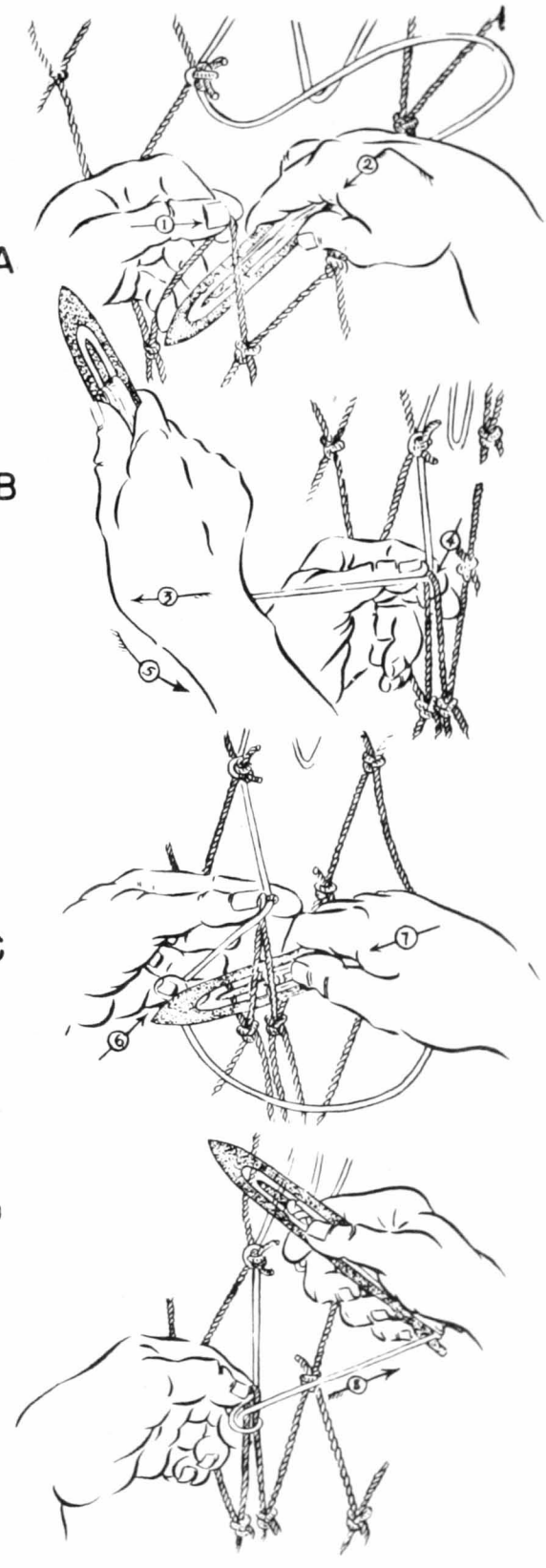



FIG. 35 - PICK-UP KNOT
L TO R WEAVING

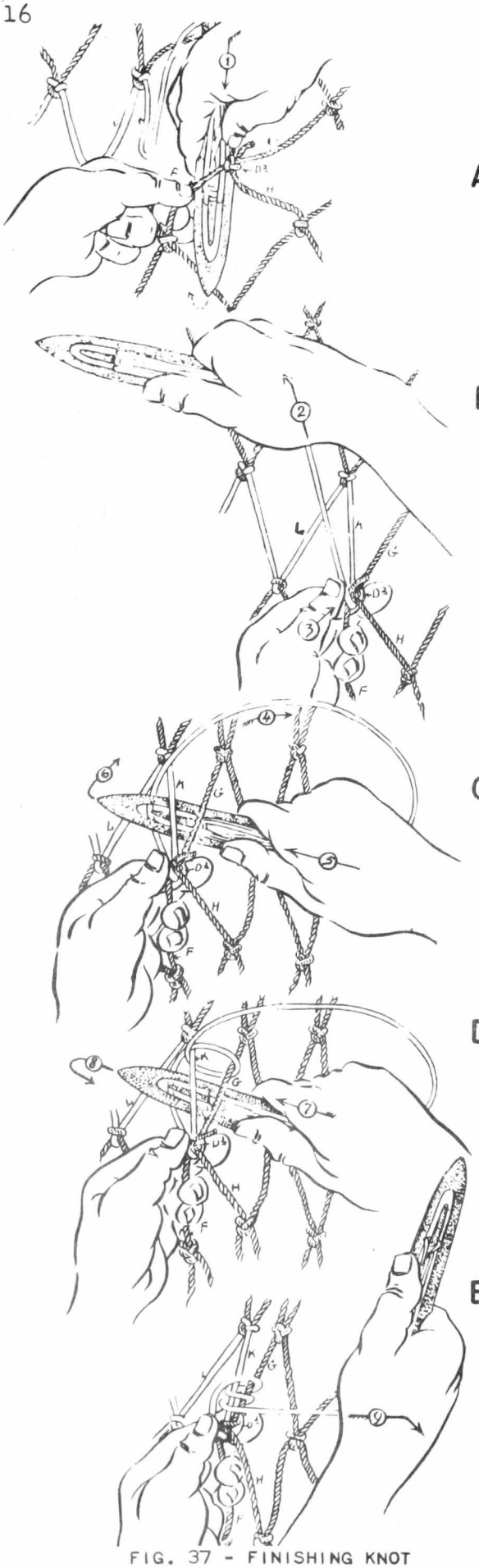


FIG. 37 - FINISHING KNOT

## FINISHING KNOT

A (Sketch A) Hold the leg (F) of the finishing three-legger as shown (1). Shuttle the needle from above, between legs F and H and follow through.

B (Sketch B) Pull the twine (2) upwards until leg K (in the making) becomes equal in length to the legs L and G. Then hold fast with the left thumb at junction (3).

(Sketch C) Form a loop with sufficient slack of the mending twine (4). Shuttle the needle under legs G and K and over the mending twine loop (5), and follow through (6). Do not tighten the hitch.

C (Sketch D) Repeat for the second time, shuttling under (7) legs G and K, making another hitch (8). Be sure that the second hitch is below the first one, otherwise it will not tighten smoothly, the overlapping hitch will jam.

D (Sketch E) Pull the twine to the right slightly downward to tighten the hitch evenly (9). When cutting off the twine leave about a half-inch stump.

E

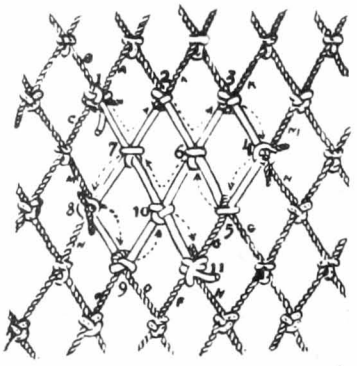


FIG. 38 - FINISHING KNOT (11) COMPLETED AND THE TEAR MENDED.

## DOUBLE HITCH SIDER KNOT

Often in a damaged net that has been under extreme strain the sider knots have become loose or defective in some other way. Then the double hitch knot is used for additional security.

(Sketch A) Bring the mending twine into position to the left of the knot as shown in the sketch, hold firm with the left thumb (1), shuttle the needle from underneath between the upper leg of the mesh and the twine (2), and follow through, then swing the needle to the left and slightly downward (3).

(Sketch B) Pull the twine (4) until a half hitch is formed under the knot, then hold fast (5) by pressing the mending twine with the thumb against the knot, then with sufficient slack in the mending twine form a loop to the left of the knot (6).

(Sketch C) Shuttle the needle (7) under the sider leg and twine then over the mending twine loop and follow through.

(Sketch D) Pull to the left (8) and slightly downward to tighten the hitch.

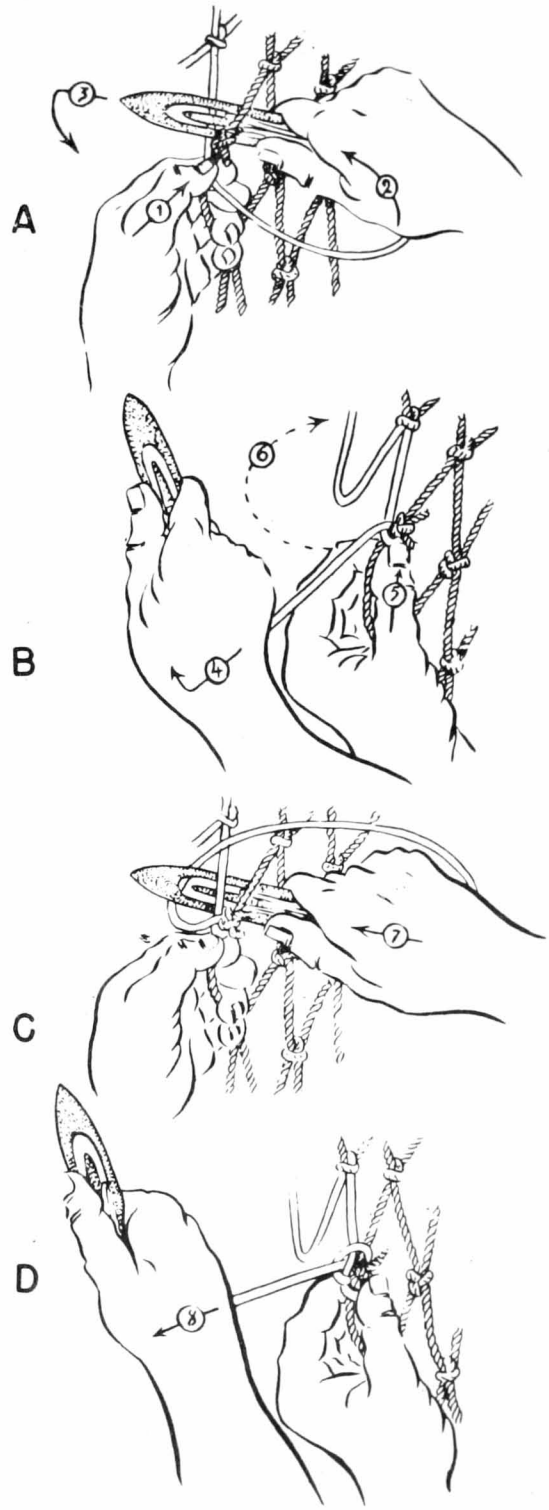



FIG. 39 - DOUBLE HITCH SIDER KNOT