PRACTICAL TWINEWORK FOR FISHERMEN AND GEAR TECHNOLOGISTS

by

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There are many books available today written on various aspects of netting materials, gear construction, and handbooks for fishermen or gear technologists. However, there are very few which address the process from start to finished product. Beginning with twine characteristics, this manual assists in developing the skills necessary to construct three different types of small-scale fishing gears: trawl net, gill net and fyke net. Net plans and construction of these gears are described in simple, easy to understand language, and illustrations are used to clarify wordy descriptions. This manual is designed not only for the neophyte twinesperson who has never handled a needle, but can also be employed by the professional as a teaching tool for any level of student or as a reference source for the fisherman.

CHAPTER 1

INTRODUCTION

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INTRODUCTION TO TWINEWORK

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INTRODUCTION TO TWINEWORK

Twinework encompasses all the knowledge and skills related to the construction and repair of fishing nets. Although it is based on the use of simple tools and a few knots, it can become as complex as the project demands. Selection of the proper materials, use of net plans, cutting, tapering and rigging of the complete fishing gear requires some knowledge of terminologies, formulas and basic physical characteristics of materials.

Chapter 1 reviews the basic tools required for twinework, raw materials and twines involved in net-making and their characteristics.

1.1 Net Making Tools

1.1.1 Needles

Although it is possible to hand-knit webbing, you'll need a considerable length of free twine which will need to be pulled through each knot. It becomes much easier and faster with the use of a netting needle or shuttle which can hold this free twine. Figure 1.1 illustrates the common features of a twine needle. As a general rule, these can be constructed of whatever material is available which is flexible, yet strong enough to withstand bending. Plastic needles are usually the most common, although wood, bone and metal can be reliable substitutes (Figure 1.2).

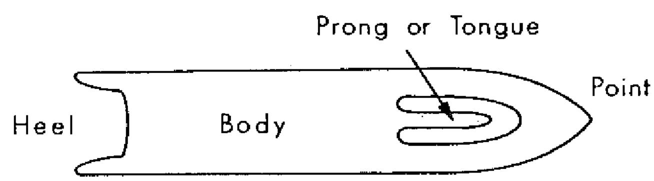


Figure 1.1. Features of a needle.

The twine is wound onto the needle (as described in Chapter 2) in a fashion that allows for continuous, uninterrupted hand motion as the webbing is being constructed. The appropriate size needle for the desired webbing must be selected. The loaded twine should pass through the meshes without hanging up. Within reason, the length of a needle isn't important as long as it can accommodate the needed length of twine. The usual manufactured size range is between 10.0 and 40.6 cm and is categorized as small, medium, large or jumbo.

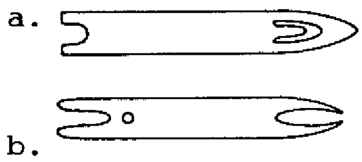


Figure 1.2. Types of needles: (a) Typical plastic needle (b) Plastic needle without tongue used for machine filling.

1.1.2 Mesh gauge

A mesh gauge is used to help the twineperson create equal-sized meshes when hand knitting. Although awkward at first, it is rapidly incorporated into the hand movements. The gauge is usually made of thin hardwood or plastic (Figure 1.3). The width of the gauge is easily calculated with a simple formula. Care should be taken to ensure the mesh gauge matches the mesh size designed.

WIDTH OF GAUGE (W) = (M/2 - 2T)

M = desired mesh size
T = thickness of gauge

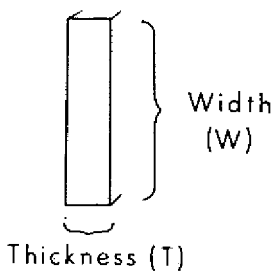


Figure 1.3. Determining the size of a mesh gauge.

For example, for a 7.6 cm mesh size, with 0.32 cm gauge thickness, the width is:

$$W = 7.6/2 - 2\ (0.32)$$
$$W = 3.16\ \text{cm}$$

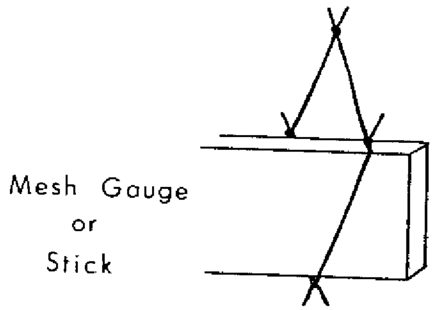


Figure 1.4. A mesh gauge is used to measure bar length to create appropriate mesh size.

1.1.3 Knife

There is probably nothing more inconvenient than going to cut your twine, and either misplacing your knife or having a dull knife that will not cut through the twine. A well maintained pocket knife, hanging on a lanyard from your belt loop is the most important tool for the twineperson (Figure 1.5). Riggers' knives and large sheath knives are usually too clumsy and do not sharpen to the fine edge needed to trim and cut small knots (Knife sharpening tips: Chapter 2).

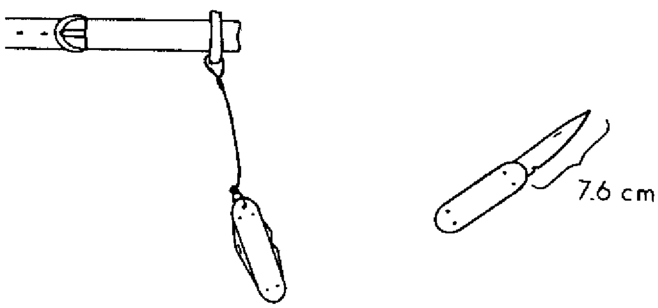


Figure 1.5. A good twine knife.

1.2 Raw Materials for Netting

The basic building unit in making netting material is the fiber. Fibers are spun or twisted into yarn, yarns are twisted into twine, and twine is used to construct nets by machine or handsewing (Figure 1.6).

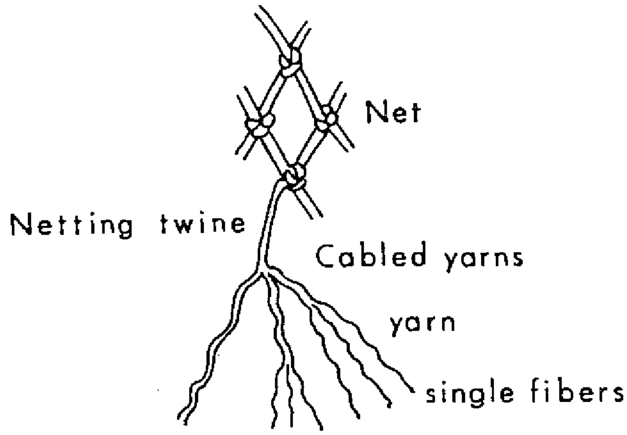


Figure 1.6. Building netting material.

Many types of materials have been employed in net-making, but the ultimate choice of material for a particular net is determined by availability and suitability. Natural fibers are still used in many countries, however, synthetic fibers are superior in terms of flexibility, durability and strength.

1.2.1 Materials

Natural fibers are predominantly vegetable fibers including cotton, manila, sisal, hemp, linen and ramie. Many countries still use them even though untreated fibers are susceptible to rotting from humid or wet conditions. Although preservatives such as waltar, wood-tar, copper sulfate, and tannin are available, they may have side effects on the physical properties of the net such as stiffness, breaking strength and others. In general, unless treated, natural fibers are sensitive to rot, wear and have low strength. Synthetic fibers are man-made materials manufactured from simple basic substances via a chemical process. A schematic outline for the manufacture of synthetic fibers such as nylon is illustrated in Figure 1.7.

1. Simple
   raw
   material

2. Chemical treatment to
   form polymer

3. Cut into
   Plastic chips

4. Melt-spinning
   at 300°C

5. Single yarn to netting twine

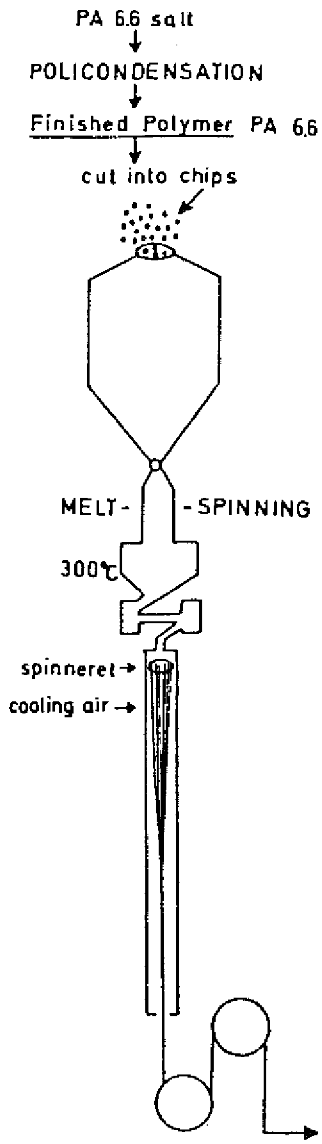


Figure 1.7. Manufacturing scheme for nylon synthetic fibers (Klust, 1982).

The main advantages of synthetic fibers are:

1. Rot resistance
2. Abrasion resistance
3. High strength

The following chemical groups or classes of synthetic fibers are used for fishing nets:

Chemical Name:	Abbreviation	USA Name
Polyamide	PA	Nylon
Polyester	PES	Dacron
Polyethylene	PE	Polyolefines
Polypropylene	PP	
Polyvinyl Chloride	PVC	
Polyvinylidene Chloride	PVD	Saran
Polyvinyl Alcohol	PVAA	

1.2.2 Basic fiber types by physical characteristics

Within the synthetic fibers there are various types or forms of fibers which provide different properties (Figure 1.8). Most synthetic fibers are found in the following basic forms:

continuous filaments
staple fibers
monofilament
split fibers

Continuous filaments

These are fibers of indefinite length, and have a silk-like appearance. A number of continuous filaments are gathered with or without a twisting to form a filament yarn or multi-filament.

Staple fibers

These are discontinuous fibers made by cutting filaments into lengths suitable for spinning yarns. These are bound together by twisting into spun yarn. These yarns have a "hairy" appearance which decreases the slippage of knots, making them better for knot holding. The spun staple fiber yarns have lower tensile strength and higher extensibility than continuous filament yarns.

Monofilament

Monofilament is a single filament which is strong enough to function alone as a yarn without further processing. It is usually a clear or lightly tinted color, and is used extensively in the sports fishery and in the construction of gill nets.

Split fibers

Split fibers are made from plastic film that is stretched and split longitudinally. A yarn contains split fibers of irregular fineness.

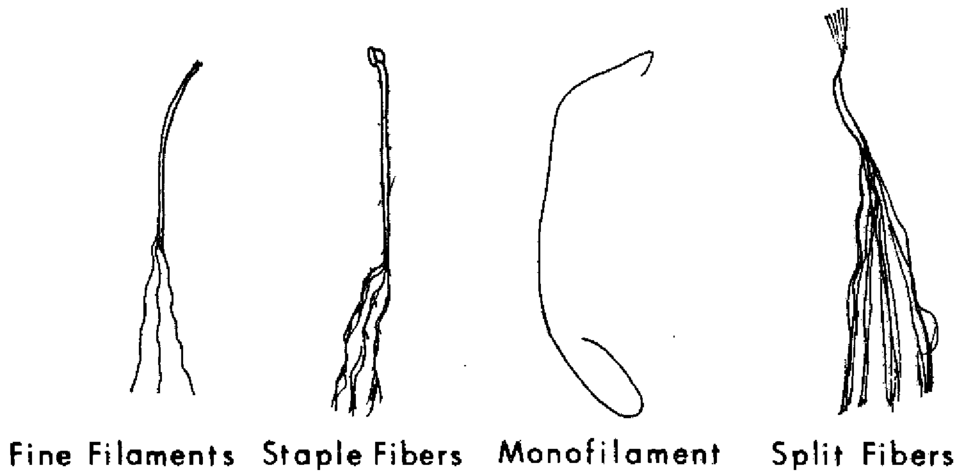


Figure 1.8. Types of synthetic fiber forms.

For netting yarns, not all fiber types are available for each chemical group.

Examples:

NYLON (PA)	continuous filaments, multifilament, monofilament, stable fibers
DACRON (PES)	continuous filaments, multifilaments
POLYETHYLENE (PE)	monofilament
POLYPROPYLENE (PP)	split fibers

Weathering of synthetic fibers is brought about by the combination of the effects of light, rain, wind, smoke and gases. The strongest degree of damage is brought about by the sun's radiation.

Dyeing synthetic fibers extends the life of net materials. Catechu can be used for PA nets. Other treatments such as coal tar, bilumen and black varnish are used to increase stiffness, sinking speed, abrasion resistance and knot stability.

1.2.3 Identification of fiber types

Each of the synthetic fiber groups has well-defined characteristics which can be used to distinguish it from other groups.

1. Water test:

   Density of fiber will cause it to float or sink in water. Fibers with densities below 1.00 g/cm^3 float in water and require more weights. For example, from Table 1.1, PP has a fiber density of 0.91 and will therefore float. In contrast, PA with a density of 1.14, will sink.

2. Visual Inspection:

   Since not all chemical groups are used in all fiber types, visual inspection can be used to deduce materials in some cases. For example, PE is not produced as continuous or staple fibers; PP is only produced in the form of split fibers (see Table 1.1).

3. Burning Test:

   By observing the reaction of netting material near a flame, the smell of the smoke, and the properties of the residue, it may be possible to distinguish chemical groups. For more information on this test, consult Klust (1982).

4. Solubility test:

   Chemical groups are soluble in certain substances (usually acids), and can be distinguished by this characteristic with fair accuracy.

Table 1.1. Synthetic Materials and Their Properties - (Fisheries Information Service, 1987.)

CHEMICAL GROUP	PA POLYAMIDE	PES POLYESTER	PE POLYETHYLENE	PP POLYPROPYLENE	PVC POLYVINYL CHLORIDE	PVD POLYVINYLIDENE CHLORIDE	PVA POLYVINYL ALCOHOL	COTTON
Common Names	Nylon	Dacron Terylene	Polyethylene	Polypro		Saran	Kuralon	Cotton
Fibre Density g/cm^3	1.14	1.38	0.96	0.91	1.35 - 1.38	1.7	1.3	1.5
Form used for nets:								
Continuous filament	yes	yes	possible	yes	yes	possible	yes	
Staple Fibre	yes	possible			yes		yes	yes
Monofilament	yes	possible	yes	possible	yes	possible		
Split fibre			possible	yes				
Applications:								
Gill net	yes	possible		yes		possible		
Purse seine	yes	yes		possible				
Trawl net	yes	possible		possible				
Fixed net	possible	possible		possible	yes	possible		
Breaking Strength: dry	very high	high	high	very high	low	low	medium	low
Breaking Strength: wet (% of dry strength)	85-95	100	110	100	100	100	77	115
Weight in water (% of dry air weight)	12	28	0 (buoyant)	0 (buoyant)	26 - 28	41	23	33
Extensibility when wet	high	low	medium	low	high	high	high	high
Weathering resistance	medium	high	medium	low/medium	very high	high	high	medium
Common trade names	Arylin Polyafil Herox Caprolan Monosheer Nytell Blue C Cordura Celon, Ulon Dimafil Duralon Perlon, Unel Amyd, Luron	Avlin Dacron Encron Fortrel Vitel Vycron Terylene Tetoron	Amcostrap Amerfil Dawbac Diamond Poly Ex Gold Metal Pex Polynet	Velon Tenite Profax Polygrit Beamette Durel Duracore Harvess Herculon Olefin Duron Meraklon Olane	Vinyon Dynel Velon	Darvon Saran		

5. Melting point test:

Melting points of synthetic fibers are significantly different, although the equipment needed to perform the test is not often available.

1.3 Yarns and Twines

Once the fibers are twisted into yarns, yarns are formed into twine. There are two main types of twines: twisted and braided.

1.3.1 Twisted

Twist refers to the spiral configuration of the yarns and/or fibers in the twine. The amount of twist is expressed in number of turns per unit of length (can be expressed as turns per meter). Twist can be either in the S or Z direction. The product has an S twist if when held in a vertical position, the spirals incline in the same direction as the central portion of the letter S. Otherwise, it has a Z twist if the spirals follow the same direction as the letter Z (Figure 1.9).

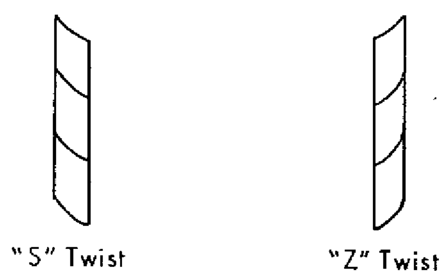


Figure 1.9. S and Z configuration.

Excessive twisting leads to low strength and in some cases braided twine is the stronger choice.

1.3.2 Braided

Braiding is the process of interlacing three or more threads so that they cross each other and are laid together in diagonal formation. The hardness of the braid is determined by the fineness of the fiber, number of strands and type of braiding. These are relatively classified into soft, medium and hard (Figure 1.10).

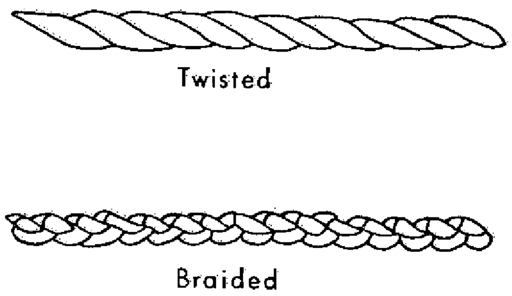


Figure 1.10. Twisted and braided configurations.

1.3.3 Designation of twine

The fineness or coarseness of the twine is expressed in a number of different ways (see Table 1.2). The designation of the fineness of a netting yarn refers to either the mass (or weight) per unit length, or the length per unit mass of a single yarn.

Tex System

The International Organization for Standardization (ISO) proposed a worldwide system based on metric units. The numbering system recommended by ISO is called the Tex system. The Tex system expresses the linear density of the twine or the mass of a certain length of twine. The tex is the basic unit and expresses the mass in grams of one kilometer of yarn.

1 tex = 1 g/1000 m

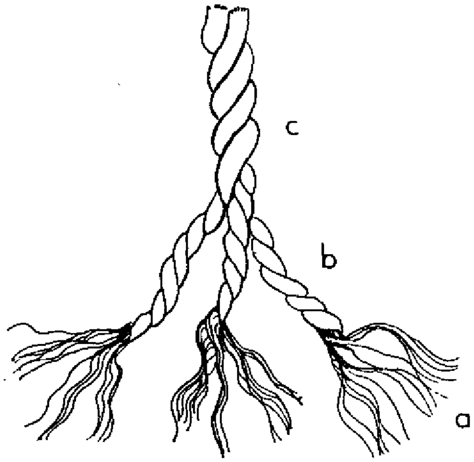
The higher the tex, the heavier the yarn.

Example:

23 tex twine designates a single yarn of which 1000 m has a mass of 23 grams.

23 tex x 3 is twine made by twisting 3-23 tex yarns.

23 tex x 3 x 3 is the further twisting of 3-23 tex x 3.



a = 3 strands (yarns) of 23 tex
b = 3 strands (twine) of 23 x 3
c = cabled twine of 23 x 3 x 3

Figure 1.11. Configuration of yarns and twines.

Total tex refers to the product of the yarn weight multiplied by the number of yarns per strand and the number of strands that form the twine.

Example: 23 tex x 3 x 3 has a total tex of 207

The R-tex or resultant-tex value refers to the value of the finished product after twisting. Due to the twist, the R-tex value of the finished product is not the product of the yarn tex value times the construction sequence, it is always a larger value; the harder the twist, the larger the value.

Example: 23 tex x 3 x 3 has an R-tex of 250 Z twist

Denier System

The Denier system (Td) is still used world-wide. The basic unit "Denier" refers to the weight in grams of 9,000 meters of a single twine filament or a yarn formed by the twisting of many natural or synthetic fibers.

1 denier = 1 gram per 9000 meters

Example:

210 den = 210 grams per 9000 meters

To convert to the tex system simply multiply by 0.111

tex = 0.111 x Td

Example: 210 den = 23 tex

Total Denier refers to the product of the filament (yarn) weight multiplied by the number of filaments per strand and the number of strands that form the twine.

Example: 210 x 3 x 3 = 1890 Total Denier

American Thread Count

This numbering system refers to the final diameter of the finished twine. The larger the diameter of the twine, the larger the thread count. This diameter can also be measured in millimeters where the final number refers to the diameter of the finished twine.

Other Systems

Runnage is expressed as meters per 1 kilogram (m/kg) or yards per one pound (yds/lb).

English cotton count (NE_c) is expressed as 840 yards (1 hank) per English pound (lb).

Example: Ne_c 20 = single yarns of 20 x 840

= 16,800 yds per 1 pound.

Table 1.2 gives some useful equivalents between the different systems.

Table 1.2. Multifilament Nylon Twine Designations.

Manufacturer (Catalog#)	Denier	Total Denier	Tex	Tex Total	Thread Count (American Sys.)	Diameter	
						mm	inches
--	210 x 2	240	23 x 2	46	--	--	--
# 69	210 x 3	630	23 x 3	69	--	.30	.012
#104	210 x (4) x 3	840	23 x 4.5	103.5	--	.38	.016
#139	210 x 2 x 3	1260	23 x 2 x 3	138	# 3	.43	.017
#208	210 x 3 x 3	1890	23 x 3 x 3	207	# 4	.55	.022
#277	210 x 4 x 3	2520	23 x 4 x 3	276	# 5	.68	.027
#346	210 x 5 x 3	3150	23 x 5 x 3	345	# 6	.76	.031
#415	210 x 6 x 3	3780	23 x 6 x 3	414	# 7	.86	.035
# 9	210 x 8 x 3	5040	23 x 8 x 3	552	# 9	1.03	.042
# 12	210 x 10 x 3	6300	23 x 10 x 3	690	# 12	1.13	.046
# 15	210 x 12 x 3	7560	23 x 12 x 3	828	# 15	1.25	.051
# 18	210 x 16 x 3	10080	23 x 16 x 3	1104	# 18	1.42	.058
# 21	210 x 20 x 3	12600	23 x 20 x 3	1380	# 21	1.6	.065
# 30	210 x 24 x 3	15120	23 x 24 x 3	1656	# 30	1.91	.078
# 36	210 x 32 x 3	20160	23 x 32 x 3	2208	# 36	2.10	.085
# 42	210 x 36 x 3	22680	23 x 36 x 3	2484	# 42	2.30	.093
# 48	210 x 42 x 3	27720	23 x 48 x 3	3036	# 48	2.50	.103
# 54	210 x 48 x 3	30240	23 x 54 x 3	3312	# 54	2.70	.109
# 96	210 x 92 x 3	57960	23 x 96 x 3	6348	# 96	3.90	.158

1.4 Webbing or Netting

1.4.1 Types of webbing

Webbing, or netting, is defined as a meshed structure of indefinite shape and size composed of one or more yarns interlaced or joined (Figure 1.12).

Examples include:

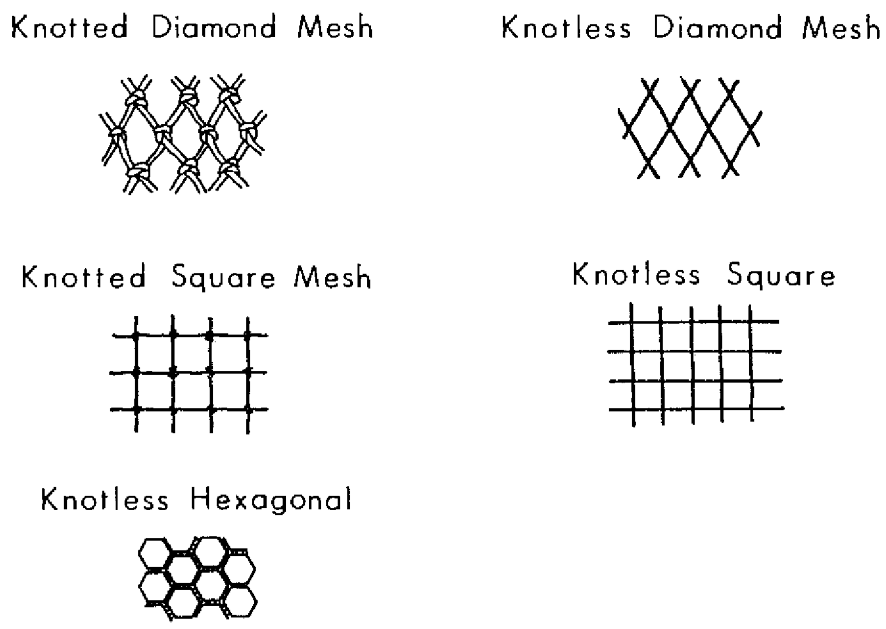


Figure 1.12. Types of webbing.

There are no limitations set by the material or the shape and size of the single meshes. The basic design of netting is the mesh, usually diamond or square. The size and shape of the mesh controls the sizes of those fish passing through. In order to ensure that the meshes maintain their size and shape with time, they are secured with knots. The most common knot used at present is the weaver knot or sheet bend (See Chapter 2).

As long as the yarn involved in net making is rough, (ie. hemp) knots do not tend to slip and deform the meshes.

However the smoother synthetic materials sometimes cause these knots to slip, and in some of the fibers, the weaver knot (single sheet bend) is being replaced by a double sheet bend knot or is fixed by thermal and chemical treatment. Knotless netting is also available and since the 1950's, has been used in many fisheries. Three types are available on the market: the Japanese style made by twisting the netting yarns; the Raschel style was developed in northwest Europe with longer joining points in the meshes enabling a rhombic or hexagonal mesh opening; a third method forming meshes from plaited netting yarns was developed in the German Democratic Republic. Knotless netting can only be manufactured by machine.

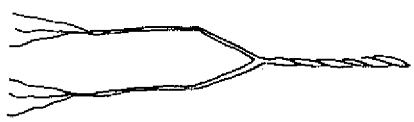
1.4.2 Advantages and disadvantages

Knotless netting has the advantage of lower water resistance and lower weight. For the same area, knotless is lighter, with less bulk producing a lower resistance to towing. Although knotless is generally cheaper to produce, in large meshes it becomes more expensive than knotted webbing. Because knots are weak areas, knotless webbing is stronger per unit area of twine size.

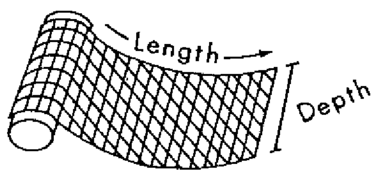
Knotted webbing, however, has been the traditional material used to construct nets. Knotted is easier to repair, and knots provide some protection from abrasion in the rest of the webbing.

1.4.3 Manufacturing process

1. Fibers are twisted (braided) into yarns and twines.

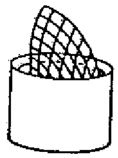


2. The netting is woven cross-twine along the depth to any length.



3. Webbing is stretched in the depth direction and knots are fixed.

4. Webbing is dipped and dyed.



5. Webbing is inspected and packaged.

Figure 1.13. The manufacturing process.

1.4.4 Terminology

A square piece of webbing is a piece of webbing cut along pickups (along the top and bottom) and siders (along the sides) (Figure 1.14).

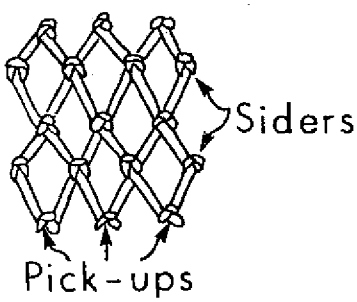


Figure 1.14. A square piece of webbing.

The size of the square piece is defined by the width (the # of pickups across the top or bottom) and the depth (# of meshes deep) (Figure 1.15).

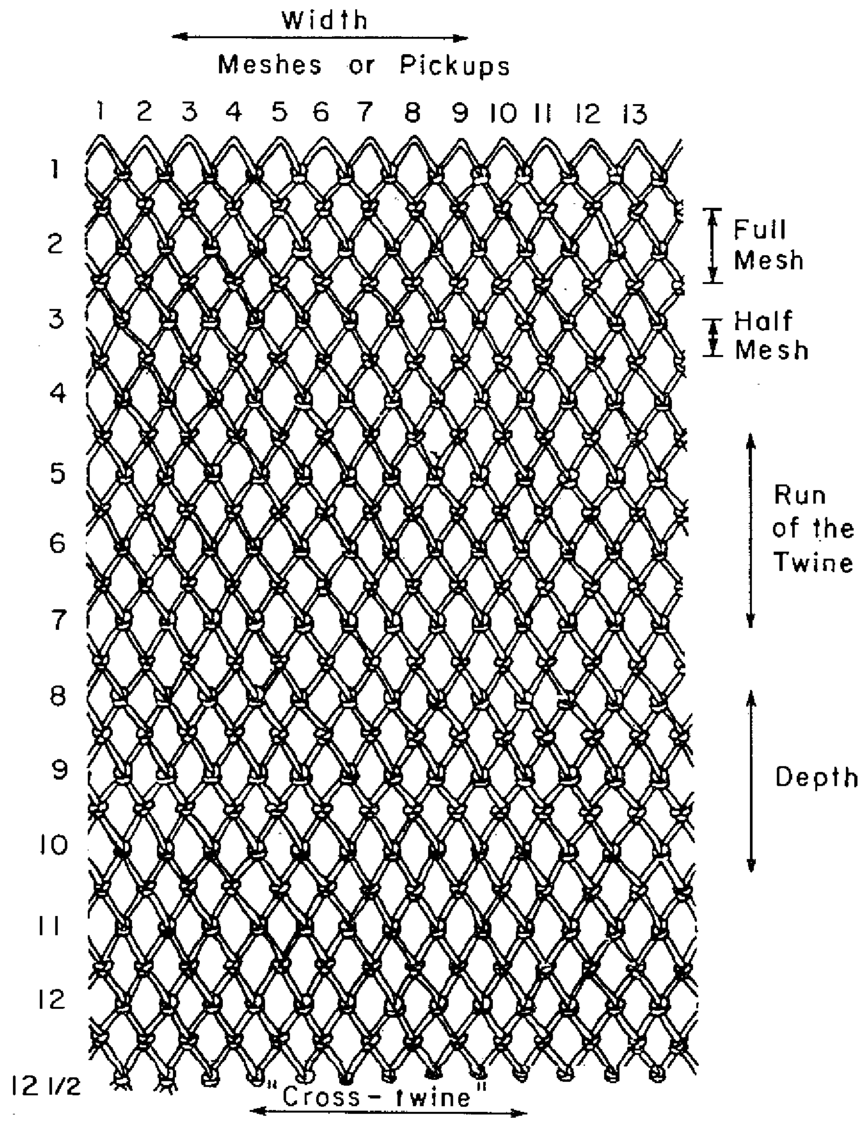


Figure 1.15. A square piece of webbing measuring 13 meshes wide by 12 1/2 meshes deep.

A selvedge in manufactured webbing is a reinforcement along the first and last row of pickups by using a double or heavier twine. Selvedge in a knitted webbing is handsewn reinforcement along the sides, formed by making a pickup and including the outside bar inside the knot or along the first and last row of pickups formed by using double or heavier twine (Figure 1.16).

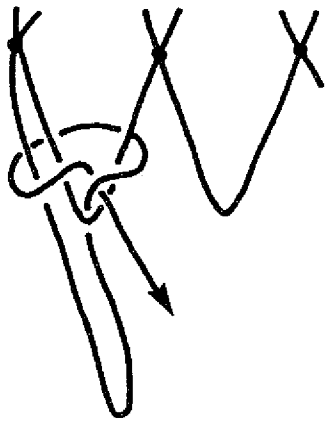


Figure 1.16. A selvedge.

The mesh size of the webbing is expressed in either inches or millimeters. Bar length refers to one side of a 4 sided mesh (Figure 1.17).

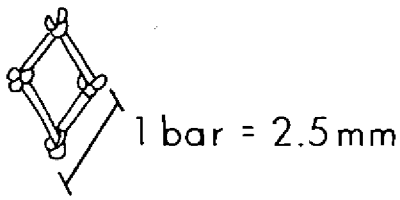


Figure 1.17. Bar length measurement.

The stretched mesh length refers to the length of two bars stretched tight from the center of the knots (Figure 1.18).

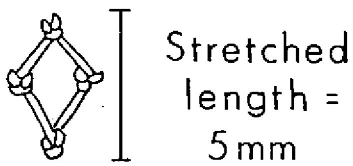


Figure 1.18. The stretched mesh length.

The run of the twine refers to the orientation of the meshes in a piece of webbing. The run of the twine is the direction in which, when the netting is pulled tight, the knots tighten up (Figure 1.19).

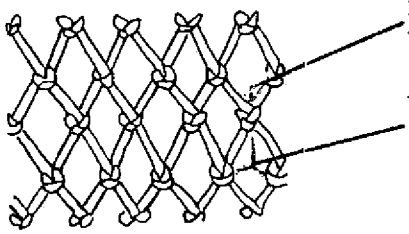


Figure 1.19. Run of the twine.

If the webbing is stretched cross-twine, the knots will loosen.

1.5 Ropes Used in Fishing Gear Construction

The most important raw materials for rope construction are vegetable fibers, synthetic fibers and metal wires. Until recently, vegetable fibers were the most important raw materials, although they have gradually been replaced by synthetic fibers.

1.5.1 Synthetic fibers

As with netting materials, synthetic ropes are man-made products produced entirely by chemical synthesis. The four main chemical groups are:

Polyamide	PA
Polyester	PES
Polypropylene	PP
Polyethylene	PE

Synthetic fibers are produced in different forms which influence the characteristics of the final product. These are continuous filaments, staple fibers, monofilaments and film tape fibers. For example, for polyamide ropes, fine continuous multifilaments and monofilaments are used.

1.5.2 Construction of fiber rope

Three main types of laid ropes are manufactured: 3-strand, 4-strand and cable laid. The steps for the production of laid ropes can be summarized in the following illustration (Figure 1.20).

(1) Fibers are spun and twisted with yarn in one direction (S or Z).

(2) Two or more yarns are twisted into a strand in the opposite direction.

(3) Several strands are laid into a rope in the opposite direction as the strands.

(4) For a cabled rope, three or more laid ropes are twisted together.

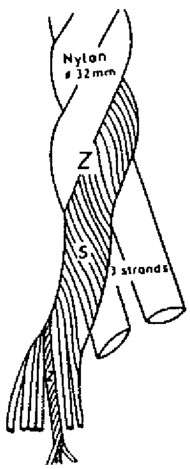


Figure 1.20. Example of the construction of 3-strand laid ropes.

1.5.3 Braided ropes

Instead of twisting as in the laid ropes, braiding requires the interlacing in diagonal patterns. The common braid constructions are:

(a) tubular (or round)
(b) solid (or American)
(c) 8-strand plaited ropes

Tubular rope, which is braided in the form of a tube, may have an inner core made of rope, or twines. By varying the number of strands, type and number of yarns in the strands, the tightness of the braid, structure of the braid and the type of core, many different types of ropes can be produced (Figure 1.21).

a

b

c

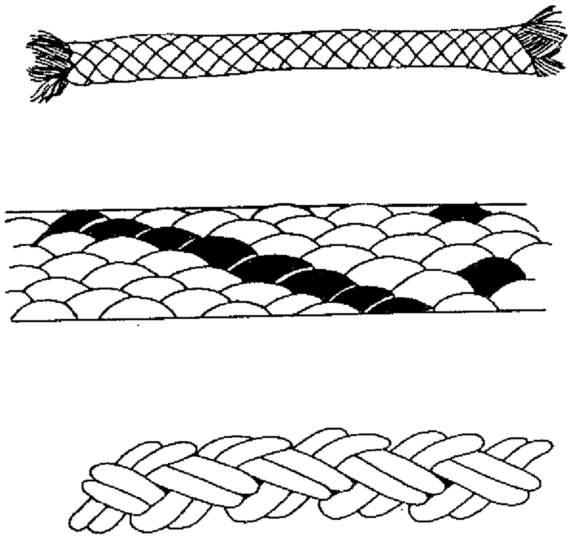


Figure 1.21. Examples of the main types of fiber ropes: (a) tubular braided rope (b) solid or American (spirally) braided rope (c) eight-strand plaited rope.

In solid braided ropes, all strands run either left or right in the same direction. To differentiate from tubular braided rope, in the solid braid, the strands not only cross but are twisted.

Eight-strand plaited rope is important in the construction of mooring ropes. These ropes are formed of 4 pairs of strands, which are made up of two strands twisted in the S direction, and then of two strands twisted in the Z direction.

Mixed ropes are made from yarns which contain different fiber materials, thereby combining desirable properties. For example, slippery PE monofilaments are combined with coarser PVAA staple fibers to prevent slippage. Combination ropes are those made up of fiber yarns and steel wires.

1.5.4 Fineness of ropes

Fineness is a general term for the size or the dimension of the rope as measured by diameter or circumference. The circumference can be measured with a flat measuring tape or by wrapping a paper tape around the rope. The circumference must be measured several times at different locations to obtain average values. The diameter can be calculated with the simple formula:

$$\text{Rope diameter} = \frac{\text{rope circumference}}{3.14}$$

A second approach to determining rope fineness is the rope mass (or weight). Rope masses should be given in kilograms per 100 meters (Kg/100m).

1.6 Choice of Netting Materials for Fishing Gear

The type of materials to be used in fishing gear depends on many factors including type and size of gear, species of target fish, nature of the fishing ground, fishing conditions, boat, local availability and the price of webbing. Many times, the ideal material is not selected due to economic considerations or other constraints. Natural vegetable fibers are not considered adequate for fishing gear due to the rot factor.

1.6.1 Specification of netting yarn

1. Must consider: The kind and type of fiber.

   Examples:

PA	continuous filaments
PVAA	staple fibers
PE	monofilaments
PP	split fibers
PA	monofilament
PES	dacron/continuous filament

2. The size, fineness and number using tex, T-tex, R-tex, American thread count, mm diameter.

3. Twisted or braided twine, monofilament.

4. Degree of twist or the tightness of the braid (soft, medium, hard). For example, some gill nets use soft twist; bottom trawls use medium twist; purse seines, hard twist.

5. Direction of final twist.

6. Core material for braided twine.

7. Weight

1.6.2 Specification of netting or webbing

1. If knotted webbing is used, the type of knot should be specified, i.e. weavers or sheet bend, double weavers, reef knot. If knotless webbing is requested, the type should be stated, i.e. Japanese, Raschel or braided.

2. The size of the mesh should be specified using bar length, stretched length and inside distance in metric dimensions.

3. The size of the netting (i.e. the length and depth) are specified in number of meshes. These values are joined by the multiplication sign (x).

    100 x 50D

    50 x 100D

4. If selvedges or reinforcing is specified, the following information must be included:

    a. fineness of twine used in selvedges
    b. single or double netting twine
    c. area where selvedges are located
    d. mesh size
    e. width of selvedge expressed in number of meshes

5. The direction of stretching, (L or D) that the net is to be stretched and stabilized should be stated. This process tightens the knots and gives a permanent shape to the net.

6. If any after-treatment is required, this should be specified:

- dyeing to diminish visibility of gill nets or increase the resistance to sunlight damage.

- treatment with tar to increase sinking speed, abrasion resistance and stiffness.

7. Anticipated gear application is an important component to relay to the manufacturer, including the size and type of fishing gear, size and power of the vessel, i.e. tuna purse seine, 900 m long, 80 m deep. 38 m vessel.

1.6.3 Choice of netting materials for bottom trawls

Bottom trawls make considerable demands on the type of netting material chosen: they should have high knot-breaking strength, high extensibility, small diameter and high abrasion resistance. Each of these characteristics will be discussed in more detail below.

1. Knot Breaking Strength

   Desired characteristics of trawl net material are strength, durability and a light weight to induce minimal drag. A thinner netting twine, however, usually implies a weaker and more breakable twine. PA continuous filament twine has the highest wet knot breaking strength, followed by PP, PE and PES. PVAA, PVC and PVD are not adequate for use in bottom trawls.

2. High Extensibility and Toughness

   The extensibility (stretch) of the netting twine for trawl nets is usually relatively high. A high degree of stretch combined with high elasticity creates a tough net capable of withstanding rough treatment. PA staple fiber is considered to have too high a degree of elongation (too much stretch will deform a net) and medium twisted PP and PES is too low.

PA	staple fiber	highest elongation
PVAA	staple fiber	↓
PA	continuous filament	
PE	monofilament	
PP	continuous filament	
PP	split fiber	
PES	continuous filament	lowest elongation

Those materials in between are adequate for trawl nets. PA continuous and PE mono are the best material.

3. Abrasion Resistance

Since bottom trawls are subjected to contact with bottom surfaces, and dragged onto rails and ramps, they suffer the most abrasion damage. PA appears to be the most abrasion resistant material, although PE mono is excellent.

4. Summary

Compromise usually is the matter at hand when selecting the proper material for a trawl net. PA (continuous filaments) and PE (monofilaments) are the most common materials because of their technical and economic advantages. PA continuous filaments have excellent characteristics: high wet knot breaking strength, high extensibility and elastically, small diameter and high abrasion resistance. Lower price is the main factor in favor of PE folded monofilaments. It can be manufactured easily and inexpensively. PE trawls are referred to as being cleaner with less spiny fish being caught in the meshes because of the stiffness of the twine. These also do not catch on small obstructions on deck, as soft nylon trawls tend to do. PE tends to float, therefore reducing the bottom damage to parts of the net and permitting reduced flotation of the net.

1.6.4 Choice of netting material for gill nets

A gill net can be defined as a wall of webbing, usually assumed to be invisible, which impedes the fish travel path. Fish become gilled or entangled in the mesh.

Synthetic (monofilament) netting is 2-12 times more effective at capturing fish than natural fibers (cotton or flax or synthetic multifilament) and is widely used. Because of numerous benefits, when affordable, it is the preferred material for this type of gear. Some of the advantages of monofilament are:

(1) Transparent and invisible in water.

(2) Smoother twine surface does allow for less "trashing" of the net.

(3) Twine is stiffer so that meshes remain open, it is less easily snagged and less surrounding area is affected by entangled fish.

(4) Higher elasticity, elongation recovery allows for easier removal of fish from the net.

(5) Good abrasion resistance

One of the major disadvantages of monofilament is related to its nonbiodegradable characteristics. When nets are lost, "ghost nets" are created which will continue fishing and destroying the resource. Additionally, because of the excellent fishing characteristics associated with monofilament, it has become too efficient at capturing fish and many areas have suffered from rapidly depleted stocks.

Some of the requirements for gill nets appear contradictory. Although monofilament is usually clear and invisible, it is generally too stiff to entangle fish. PA continuous filament is the softest of all synthetic materials, but due to its bright color, it may be visible in clear water. Therefore, in order to be effective, the net must be dyed either green, blue, grey or brown. PA monofilament is transparent but has a relatively low breaking strength with small diameter twine. Twisted monofilaments combine transparency of monofilaments with the high strength and softness of a multi-filament.

Most gill nets have bottom and top lines that act as a frame from which the webbing is hung. These lines must be strong enough to hold up in hauling and setting but must remain flexible. Synthetic lines are usually adequate for this purpose.

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CHAPTER 2

BASIC KNOTS USED IN TWINEWORK AND KNITTING PROJECTS

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BASIC KNOTS USED IN TWINEWORK AND KNITTING PROJECTS

2.1 Basic Knots

The following knots are most commonly used in twinework. Other knots are useful in the fisherman's world and many books are available to describe these (see Reference section).

2.1.1 Half hitch

The half hitch is used to secure twine to a line or rod. The twine is brought around the line and over or under the other part of the line. It is not used alone because it will easily slide free (Figure 2.1).

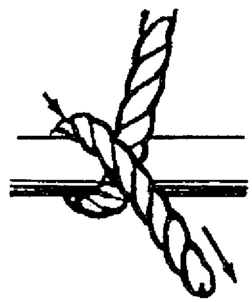

Figure 2.1. Half hitch.

2.1.2 Clove hitch

The clove hitch is a combination of two half hitches. This knot is more dependable and is commonly used to secure the initial loops to begin a knitting project (Figure 2.2).

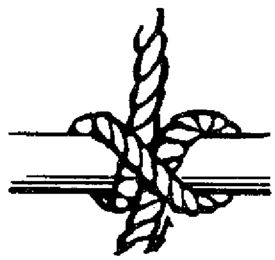

Figure 2.2. Clove hitch.

2.1.3 Sheet bend or weavers knot

The sheet bend is one of the best joining knots and is the basis for net making. Care must be taken to seat the knot around the foundation loop and not let it slip below the loop (Figure 2.3).

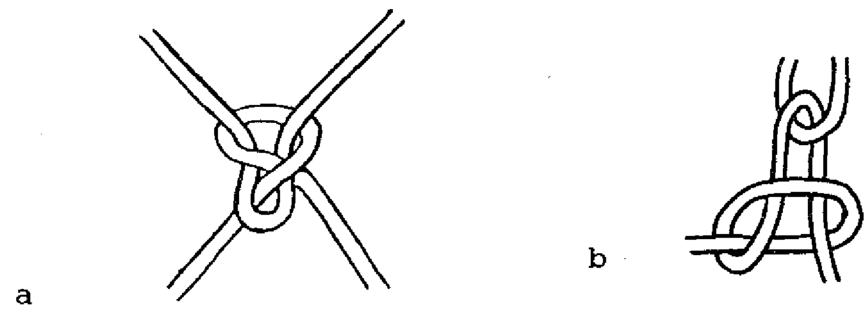

Figure 2.3. Sheet bend (a) correct (b) incorrect.

2.1.4 Double sheet bend

The double sheet bend is used when initially tying onto or finishing an area of patching or mending. It is also used when working with slippery twines which do not hold knots well (Figure 2.4).

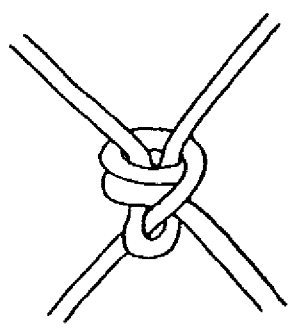

Figure 2.4. Double sheet bend.

2.2 Preparation of Tools

2.2.1 Sharpening knife

No matter how expensive the knife, it can only be as good as you make it by sharpening it. Ideally, knives would never rust, break or need to be resharpened. However, salt water and blood will even corrode stainless steel blades.

Knives can be sharpened on grinding wheels, flat stones, ceramic rods or steels, as well as in the patented "stick-the-blade-in-the slot" devices. Sharpening a knife on a wheel or stone is a very involved procedure. It requires many hours of practice to develop the right feel.

If the blade is severely damaged, it should be treated initially with a coarse wheel and then moved on to finer steel and buffing wheels.

Most commonly used in the field is the sharpening stone. The blade must be held against the sharpening stone at a fixed angle. In the proper position, the knife is stroked slowly against the stone in one direction. The angle must be changed slightly to hone the cutting edge. When one side has been completed, turn and do the other side.

Traditionally, sharpening stones have been oiled. The oil lubricates the stone and keeps steel dust from clogging the pores. Oil, however, is no longer recommended, because of the harm done to the knife by dragging it through oil with steel grit. Regardless of the lubricant used, the stone should be kept clean and can be washed in water or oil.

The best solution to the problem of sharpening your knife is to keep the blade in good condition in the first place. It should be kept clean and honed frequently, and dried after use.

2.2.2 Loading the needle

To eliminate any kinks in the twine, before loading the needle, cut off a long piece of twine from the roll and allow the twists to uncurl.

To wind the needle, follow the steps listed and shown in Figure 2.5.

1. Hold needle with point upwards.
2. Pass end of twine around prong and trap under the twine leading out (half hitch).

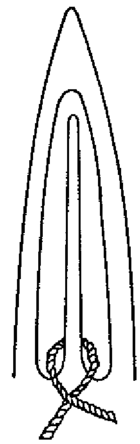

Figure 2.5a. Starting to load the needle.

3. Take twine down and around the heel of the needle and turn the needle 180° over, passing the twine through the prong and back down to heel; never turn 360° or it will cause kinks in the twine (Figure 2.5b).

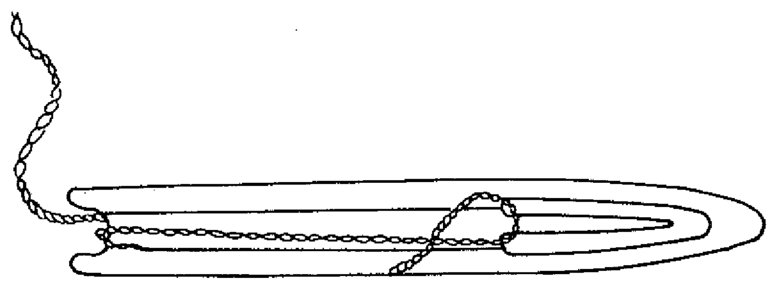

Figure 2.5b. Continue to load twine.

4. Repeat this procedure, filling needle tightly and turning the needle back and forth until it is loaded. Neither the prong nor the heel should be hidden (Figure 2.5c).

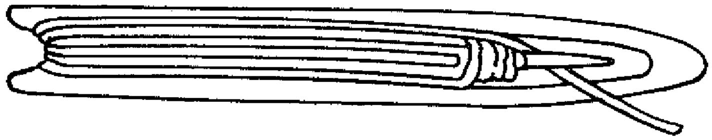

Figure 2.5c. The loaded needle should look like this.

If double twine is desired, pull the required length of twine from the spool, double in middle, make a hook over the tongue and load normally.

2.3 Knitting Projects

Webbing is constructed by hand by creating meshes in consecutive rows which increase in depth until the desired number of meshes are obtained. The basic knot used is the sheet bend, also referred to as the pickup knot. The following projects are designed to help the beginner to develop the skills necessary to accomplish larger projects.

2.3.1 Knitting a square piece of webbing (8 x 6D)

1. Begin by tying a piece of twine about 46 cm long to form a loop and secure on a hook or nail (Figure 2.6).

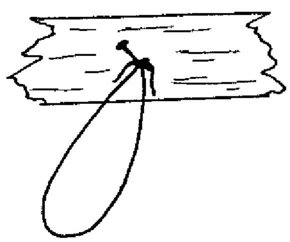

Figure 2.6. Form a loop.

2. Form a series of 8 loops on this loop using the mesh gauge and clove hitches (Figure 2.7).

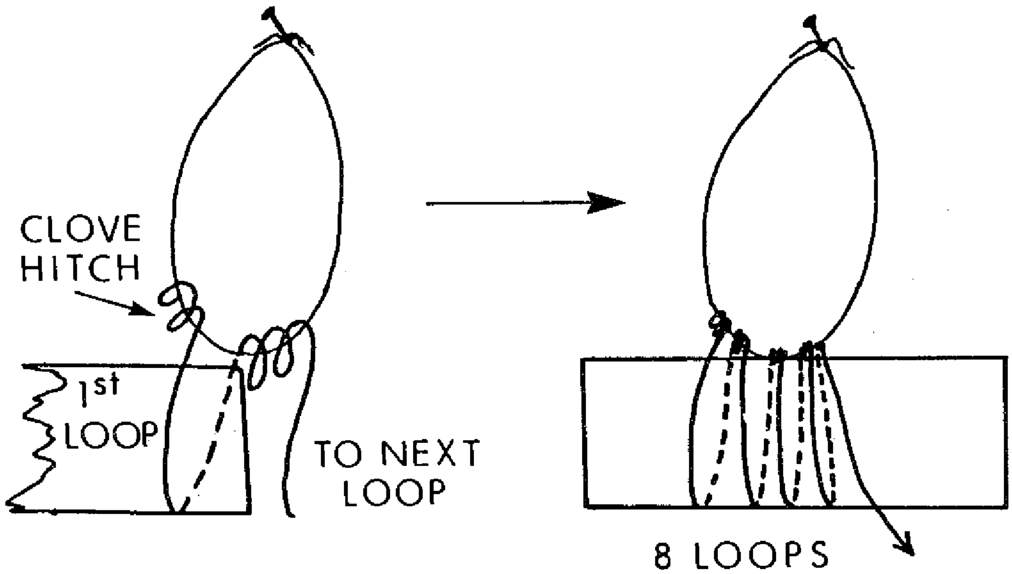

Figure 2.7. Form series of loops.

3. Turn loop over so that you will be knitting always in the left to right direction.

4. Using the mesh gauge, you will now create the first row of webbing using the 8 loops as a base. Remember the gauge only measures the bar length, not the entire mesh size (Figure 2.8).

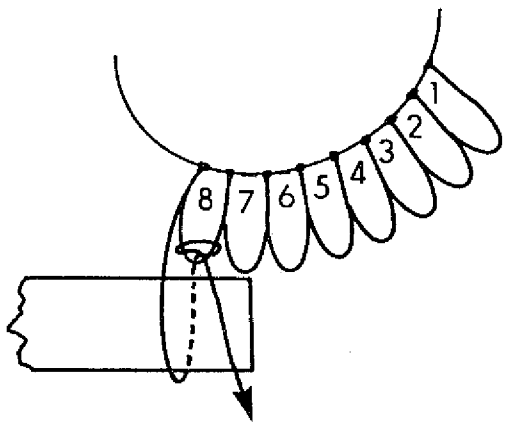

Figure 2.8. Creating the first row of meshes.

To form the sheet bend knot, enter the loop from beneath with the needle, go around the 2 sides and back through the incoming twine (Figure 2.9). Keep the knot in position with your fingers.

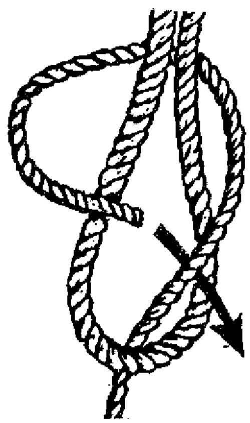

Figure 2.9. Enlarged view of sheet bend.

Use the heel of the needle to pull the knot tight but be sure that the knot does not slip below the loop (see Figure 2.3).

This is the first full mesh. Leave the gauge in position and repeat the same procedure for the remaining 7 loops.

5. When the last knot is completed, turn the loop over and knit the next row. Continue doing this until 6 rows have been completed. Cut the loop and pull through leaving the square piece of webbing open. The finished product should look like Figure 2.10.

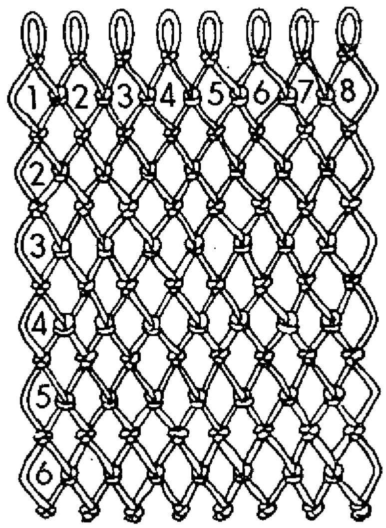

Figure 2.10. A square piece of webbing.

2.3.2 Increasing, widening or creasing

Increasing, widening or creasing are all terms used to describe the increasing in the size of the net by adding more meshes. Where this extra mesh occurs will ultimately determine the final shape of the net. A mesh consistently added on the last of the row will provide a net that slants at a 45° angle (i.e. rectangular tennis net). It is desirable to increase in the middle of a row and alternate so that creasings are not adjacent to one other.

To increase, make a mesh with the normal method, then take the twine and go around the gauge again, but instead of taking up the next mesh, you should go back through the mesh just made. Then continue in the normal manner to the next mesh (Figure 2.11).

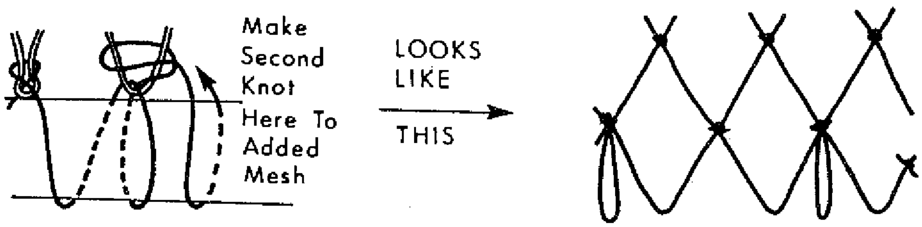

Figure 2.11. A creasing.

2.3.3 Narrowing or bating

Narrowing or bating means decreasing the size of the net by removing meshes. Bating should be done evenly, just as creasing, to avoid distortion of the net.

Bating is done by taking in two meshes (instead of one) and tying the regular sheet bend around both meshes (Figure 2.12).

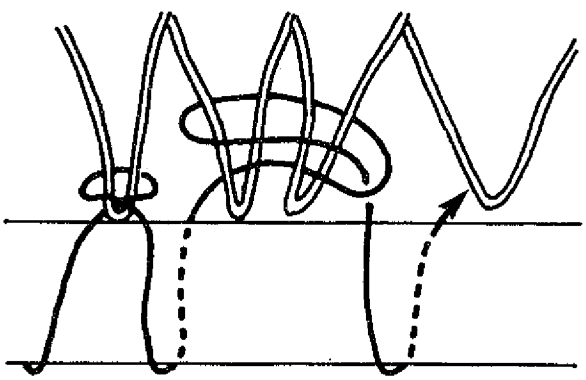

Figure 2.12. A bating.

2.3.4 Reinforcing with a straight selvedge

When knitting a piece of flat webbing, the outer meshes at the edge hang loose. This is the normal selvedge, but it can be strengthened by deliberately taking in the descending strand of the loose mesh with the first knot in each row. Then proceed to the next mesh in the normal fashion (Figure 2.13).

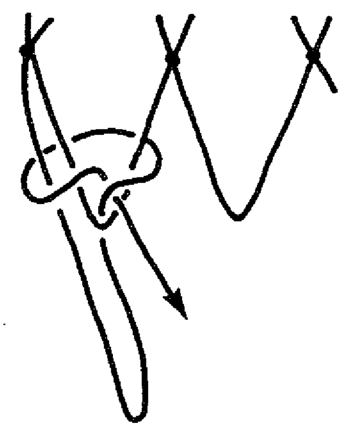

Figure 2.13. Knitting a selvedge.

Selvedges along the bottom or top of the net may be made simply by knitting the first and last rows with double twine.

2.3.5 Knitting a diamond or a square mesh piece

By knitting a diamond shape and turning it 90°, you will create a square mesh piece of webbing. The size of the webbing will depend on the number of rows knitted. Work is started at one corner by the formation of one mesh. The next row contains two meshes and so on. This is continued until the desired length is reached. Meshes are then reduced one by one by row until one mesh remains. This will form a square piece. If a rectangular net is desired (i.e. tennis net) then when the desired depth is achieved, meshes are reduced at one end and increased on the other end.

To knit the diamond (Figure 2.14):

1. Start by forming a loop and hook to secure.
2. Form two creasings to increase to 2 meshes in the next row.
3. Form a selvedge and end with a crease.
4. Continue with a selvedge and crease until fourth row.
5. Row five, regular row with no creasing or bating.
6. Last four rows, start with a selvedge and end the row with a bating until 1 mesh is left.

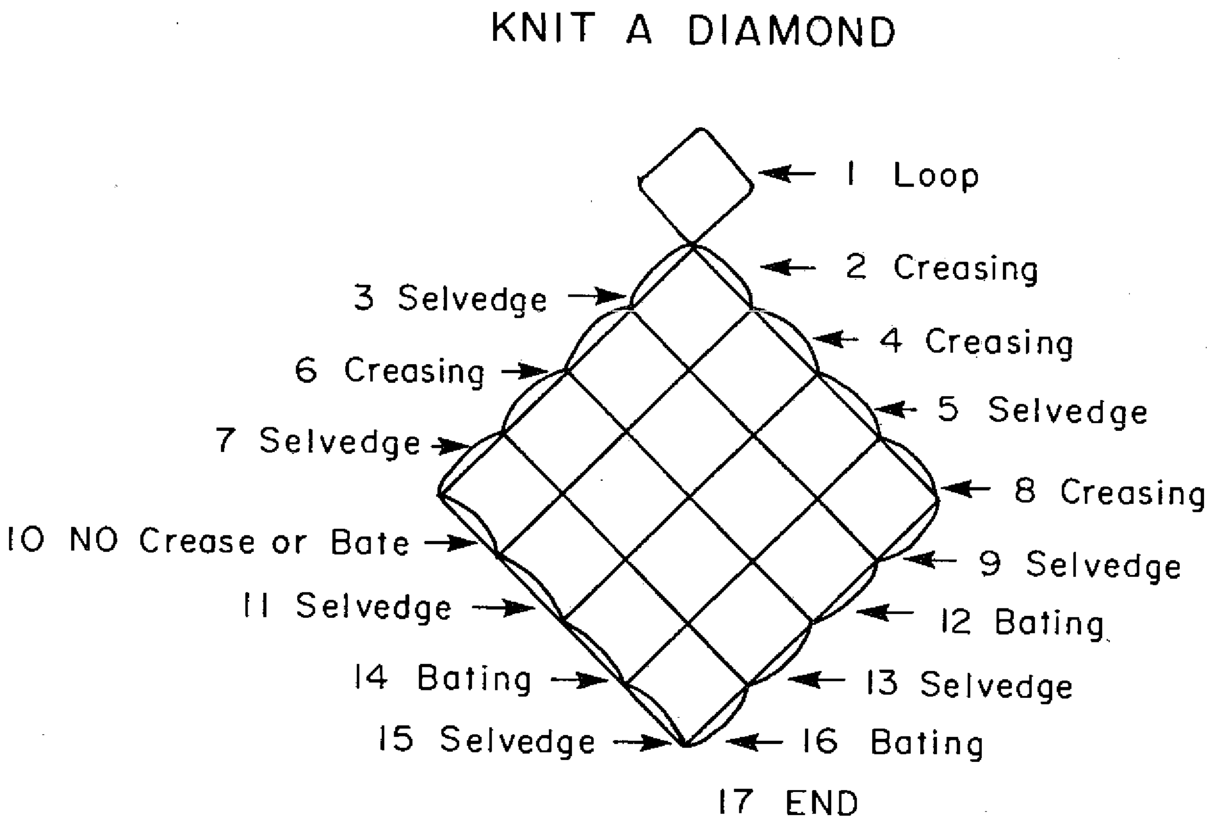

Figure 2.14. Knitting a diamond.

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CHAPTER 3

BASIC NET DESIGN

GILL NETS

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BASIC NET DESIGN: GILL NET

3.1 Basic Net Designs

A gill net is simply a wall of webbing of certain mesh size which interrupts the path of fish and captures them by "gilling" or entangling them. By attempting to swim through a mesh, the fish will become stuck when the circumference of its body is too large to pass through the mesh. This can occur at the dorsal fin, but most commonly it will be behind the opercula (gill cover) and the gills (Figure 3.1). Other larger or smaller fish may become entangled with spines, fins or other body parts. Entangling nets (or trammel nets) are designed specially for entangling fish.

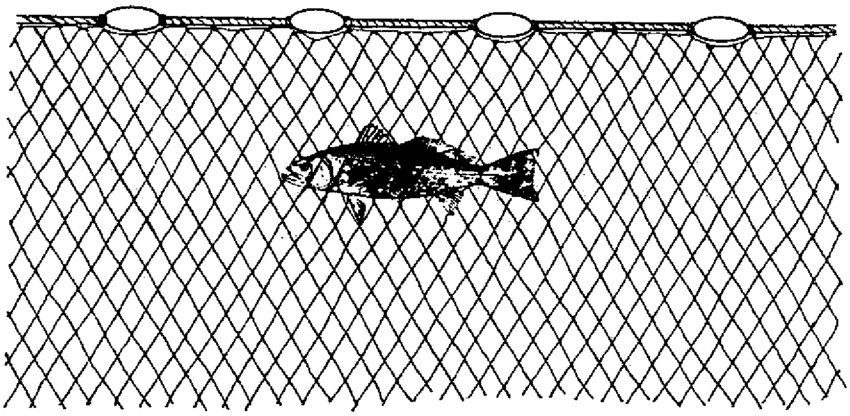


Figure 3.1. The typical manner in which a fish is "gilled".

Gill nets are maintained vertically in the water by floats on the upper line and by weights in the ground-line. Floats and leads should be evenly distributed. The number and type of floats and leads will vary according to fishing method and design.

3.2 Types of Gill Nets

Gill nets are usually set across the direction of the migrating fish. They can be placed in many different ways: there are bottom nets set on or near the bottom to catch demersal fish; there are anchored or free drifting nets; there are encircling and dragged gill nets.

3.2.1 Anchored nets

By using anchors, these nets are usually set across tide in places where they might be subject to heavy tides, currents, and fouling. Anchored gill nets may be used to fish the surface, bottom, or midwater by adjusting the length of the bridles, by the use of float or drop lines, and by adjusting the length of the anchor line (Figure 3.2).

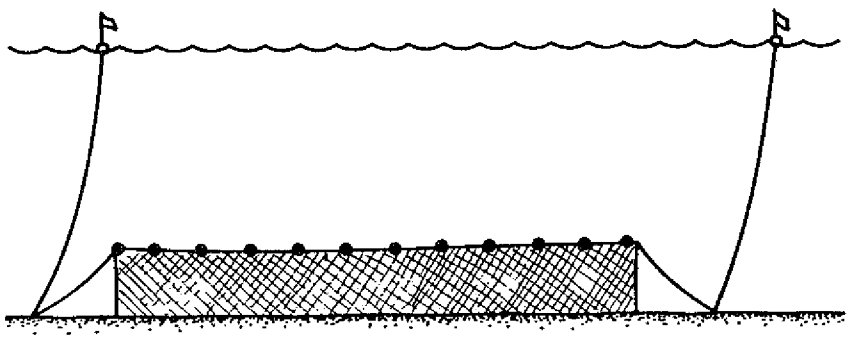


Figure 3.2. Anchored bottom gill net.

3.2.2 Coastal nets

Using a heavy lead line and float line will allow a gill net to be used in heavy currents and tides; this rigging is generally known as a coastal net. Extra floats and leads may be employed.

3.2.3 Drift nets

Drift gill nets, most often used in currents and tides, are allowed to drift freely and are not fixed or set. Usually, one end of the gill net can be secured to the fishing vessel, with the net allowed to drift past a selected area of good fishing ground. Depending on the abundance of sharks or non-target species in the area, fishing time can be determined to prevent fouling (Figure 3.3).

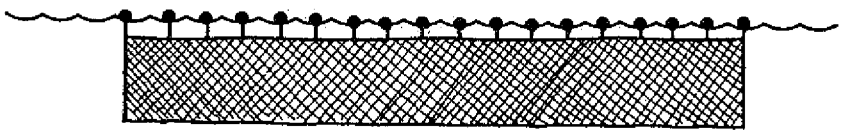


Figure 3.3. Drift net.

3.2.4 Drop line nets

A drop line net is an adjustable gill net, using drop lines to hold it below the surface. Drop lines are attached to the floatline, and prevent surface fouling from jellyfish, seaweed and other floating debris. The leadline is kept off the bottom, thus avoiding bottom fish and crabs that might otherwise become entangled in it (Figure 3.4).

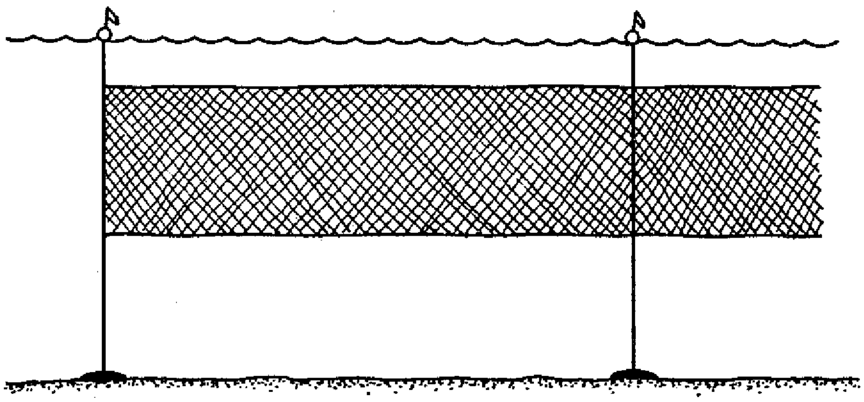


Figure 3.4. Dropline net.

3.2.5 Encircling or run around gill nets

This gill net is often set to circle a certain location or school of fish. Fish are then frightened into the net. Encircling gill nets are often hung full with extra webbing and can be operated by one or two boats (Figure 3.5).

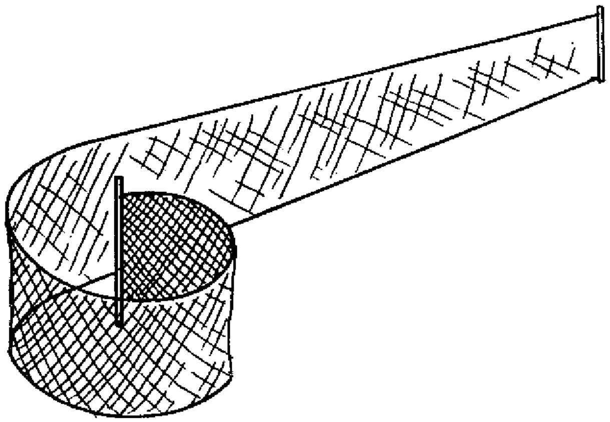


Figure 3.5. Encircling net.

3.2.6 Flag nets

Flag nets are constructed of limp, soft multifilament webbing, and use no weighted bottom line (leadline). They are designed for use in ponds and lakes where there is little or no current.

3.2.7 Staked nets

A staked net is a gill net set out along a series of stakes or poles driven into the bottom. The stakes provide a sturdy foundation for setting gill nets in strong currents, and keep the net set properly.

3.2.8 Trammel nets

Trammel nets consist of an inside wall of loose small mesh webbing and two outside walls of large webbing. All three walls are hung to the same float and lead line. The net's depth is determined by that of the outside walls. The inside net has a greater depth and hangs loosely between the outer panels of webbing. Fish are usually captured by entanglement. As the fish passes through the larger outer mesh, it hits the small mesh netting and carries it through one of the openings of the outer large-mesh webbing. A pocket of small mesh webbing is formed, trapping the fish. Most trammel nets are hung with a 0.5 hanging ratio. The hanging of trammel nets varies by area and type of fish (Figure 3.6).

Figure 3.6. Trammel net.

Once a suitable type of net has been selected, it is necessary to determine its optimum size, mesh size, twine thickness, hanging ratios, color, sizes of lines, warps, rigging and anchors. Local regulations and licensing restrictions must be considered.

3.3 Determination of Mesh Size

The size of target fish directly determines the mesh size used in a gill net. This must be carefully examined since if the mesh is too big, the fish will pass through the webbing; if too small, the fish will not gill.

Two approaches to determining the correct mesh size are suggested below:

1. Tie a piece of twine immediately behind the gill plates on a fish of the size you desire. Slip off twine loop and measure it.

2. A mathematical approach to estimating the mesh opening in terms of the maximum girth or circumference of the fish G.

$$Mo = K_G \cdot G$$

where

K_G is between 0.4 for long narrow bodied fish and 0.44 for deep short-bodied fish.

G = maximum circumference of fish.

Mo = mesh size.

For example; a herring of 10.2 cm circumference, would need a mesh size of 4.08 cm.

$$Mo = 0.4 \times 10.2 \text{ cm} = 4.08 \text{ cm}$$

3.4 Hanging Ratio

The hanging ratio refers to how the webbing is hung to the leadline or floatline. It compares the length of stretched webbing hung to the length of leadline or floatline and describes how slackly or tightly the webbing is hung to any rigid or flexible frame. Although other terminologies describe this relationship, the one most commonly used is the hanging ratio.

The hanging ratio is expressed as either a fraction or decimal and it refers to the ratio between the stretched rope length to stretched webbing length.

Example: 10 cm webbing to 5 cm of rope is equal to:

Hanging Ratio = 5 cm/10 cm = 1/2 = 0.5

For example, 120 m of stretched webbing hung to a line with a 0.5 hanging ratio yields a 60 m long net.

Hanging ratio determines how "open" or "closed" each individual mesh is.

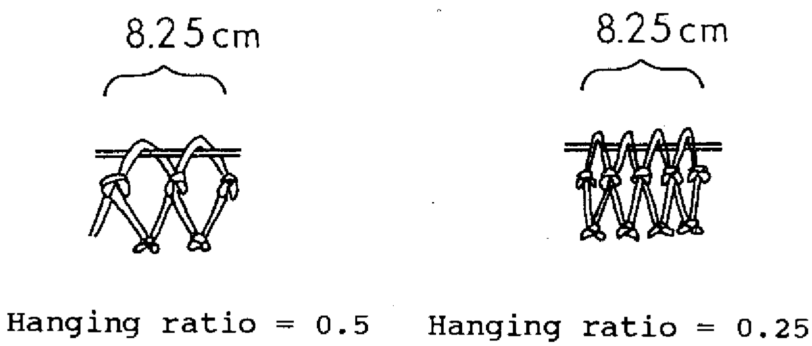


Figure 3.7. Examples of hanging ratios.

Drift gill nets are usually hung by a ratio of 0.5 to 0.7. Values as low as 0.3 are sometimes used to increase entangling in bottom set nets, although 0.5 is the usual value.

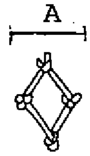
3.5 Determination of Net Depth and Length

The depth of a gill net is a function of the hanging ratio and the hanging coefficients. Hanging coefficients are the values used to calculate the width or depth of a given mesh size hung at various ratios.

The A hanging coefficient is equal to the hanging ratio. The B coefficient is calculated geometrically by the formula:

$$B = \sqrt{1-A^2}$$

To calculate the opening or width of a mesh, multiply the A coefficient by the mesh size.

width = 0.5 x 10.0 cm = 5.0 cm so 

= 5.0 cm

B will equal $\sqrt{1 - (0.5)^2} = 0.87$

To calculate the height of a mesh, multiply the B coefficient by the mesh size.

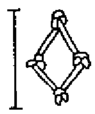
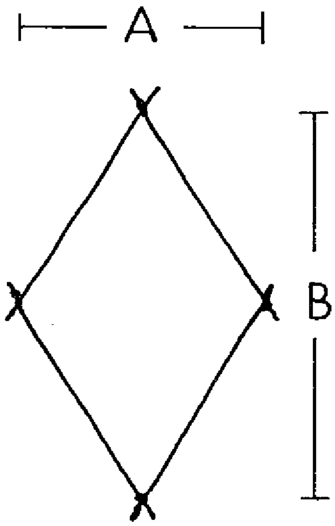
length = 0.87 x 10.2 = 8.7 cm so B  = 8.7 cm

Table 3.1. Hanging Terminology for Nylon Nets

Hanging Ratio	Hanging Coefficient		
	Primary A	Secondary B	
1	1	0	
0.8	0.8	0.8	
0.66	0.66	0.75	
0.6	0.6	0.8	
0.58	0.58	0.82	
* 0.5	0.5	0.87	Most gill nets
0.45	0.45	0.89	
0.4	0.4	0.92	
0	0	1.0	

HANGING COEFFICIENTS (A, B)



To calculate the opening of width of a mesh, multiply the A coefficient by the mesh size. To calculate the closure or height of a mesh, multiply the B coefficient by the mesh size.

Figure 3.8. Hanging coefficients.

When the width and length of each mesh is known, it is possible to calculate the number of meshes needed to attain the depth and length desired.

Example: To obtain a gill net of 3.3 m in depth, how many meshes deep should the panel be?

Hanging ratio = 0.5
Secondary hanging coefficient = 0.87
Mesh size = 10.0 cm stretch
Depth of gill netting = ?
Desired depth = 3.3 m

$$\text{Depth (in meshes)} = \frac{\text{Desired depth (in cm)}}{\text{B coefficient X Mesh Size}}$$

$$\text{Depth (in meshes)} = \frac{330 \text{ cm}}{.87 \times 10.0 \text{ cm}} = \frac{330}{8.7} = 38 \text{ meshes}$$

Depth of gill netting desired for this depth equals 38 meshes.

The desired length of the net is determined by the ability of the crew and boat to handle it efficiently on board. Usual net length is between 15 and 200 m depending on fishing conditions and handling facilities. Many times gill nets are not used as single nets; but can be linked together. These can be set up as straight-walls, bow-shaped or other patterns.

3.6 Determination of Knot Spacing

Once the hanging ratio and desired length have been determined, the amount of hanging line and webbing can be calculated and the hanging can begin. Distance between knots (tie length) per phase length can be calculated. The number of meshes per tie is based on the experience of the fishermen. Three meshes per tie is ideal, but requires many more knots than 10 meshes per tie. After specifying the number of meshes per tie, the tie length (TL) is calculated as follows:

TL = (# meshes per tie) x (stretch mesh length) x (hanging ratio)

Example:

For a gill net with a 10.0 cm mesh and a hanging ratio of 0.5 and a specified number of meshes per tie of 3:

TL = (3) x (10.0) x (0.5) = 15.0 cm

So 30.0 cm of stretched webbing (3 meshes) will be hung in 15.0 cm or three 10.0 cm meshes are hung in each 15.0 cm phase (Figure 3.9).

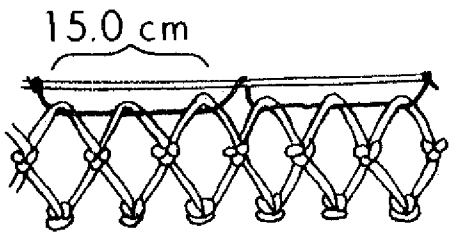


Figure 3.9. Determination of knot spacing.

Once the size and type of net is determined it is best to calculate the exact quantity of materials to purchase. You must know the following:

1. Mesh size desired
2. Length & depth
3. Hanging ratio
4. Twine type and diameter
5. Rigging considerations

You have decided that the desired gill net is 90.0 m long, 2.0 m deep, with a hanging ratio of 0.5. The twine type will be a multifilament nylon # 139 total Tex, and 8.25 cm mesh size. The webbing is available at depths of 30 meshes. There are 85 meters of webbing per Kg.

The following questions must be answered:

1. How many kilograms of webbing are needed?
2. Are 30 meshes deep sufficient for the net?
3. What is the tie length between knots to hang the webbing, based on a specified number of meshes per tie?

SOLUTIONS

1. To determine the weight of the webbing required to construct this net, first calculate the # of stretched meters of webbing needed to build the net.

$$\frac{1}{\text{Hanging ratio}} \times \text{length} = \text{Length of stretched webbing}$$

$$\frac{1}{0.5} \times 90.0 \text{ m} = 180.0 \text{ m of webbing}$$

Since there are 85 m/Kg of this material, you must determine how much 180.0 m of gill netting weighs.

$$\frac{180.0}{85} = 2.1 = 2.5 \text{ Kg}$$ (Since the marine suppliers request that you round up to the nearest 0.5 Kg)

2. The depth of the net is a function of the B coefficient (0.87) and the mesh length (8.25 cm). Each mesh has a depth of 0.87 x 8.25 cm = 7.18 cm. 30 meshes will have a depth of 30 x 7.18 cm = 215.4 cm or 2.15 m.

3. To calculate the tie length based on 3 meshes per tie, 8.25 cm mesh size, and 0.5 primary hanging ratio:

(3 meshes/tie) (8.25 cm) (0.5) = 12.4 cm

3.7 Rigging the Gill Net

The most frustrating task of rigging a gill net is the placement and calculation of the floats and leads. This is easier than it appears to be and prevents the embarrassment of having your bottom gill net float when you don't expect it to.

First, all positive buoyancies must be determined. This includes the webbing, lines and floats. We've determined that we will construct a 106 m long bottom gill net with 0.79 cm polypropylene lines and floats of 100 gram lift spaced 88.9 cm apart. The net will have 200 leads each weighing 50 grams. Will the net sink?

3.7.1 Positive buoyancy

212 m of PP line (float and lead lines) have a positive buoyancy of 154 grams/30 m therefore, 7 x 154 = 1078 g or 1.08 Kg buoyancy.

Each float has a buoyancy of 100 grams, and there are floats placed every 89 cm in a line of 106 m, therefore 120 floats are placed on the float line producing a buoyancy of 12,000 grams or 12 Kg.

Total buoyancy = 1.08 + 12.00 = 13.08 Kg

3.7.2 Negative buoyancy

200 leads x 50 grams = 10,000 grams or 10 Kg

There is not enough weight to set the gill net on the bottom, so it is necessary to increase the number of leads. 300 leads x 50 grams = 15,000 grams or 15 Kg would be sufficient for still water. However, environmental conditions such as swift currents, will require additional floats and weights to maintain the gill net in a vertical position (Figure 3.10). Trial and error will usually result in the proper relationship in these situations, although Fridman (1986) offers a mathematical solution to this dilemma.

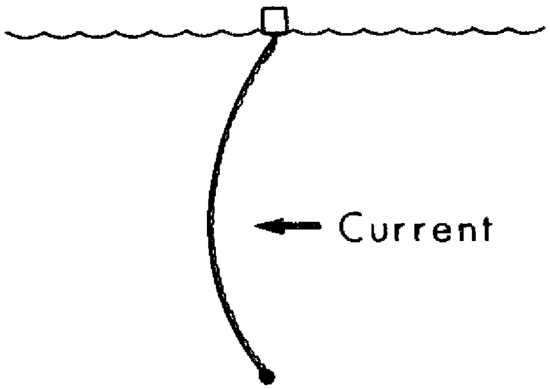


Figure 3.10. Configuration of a gill net in a current.

3.8 Net Plan for a Coastal Bottom Set Gill Net

The following net plan is for a coastal gill net, with a bottom set. It is a simple design and can be modified to meet the criteria for the size and species desired (Figure 3.11 A and B).

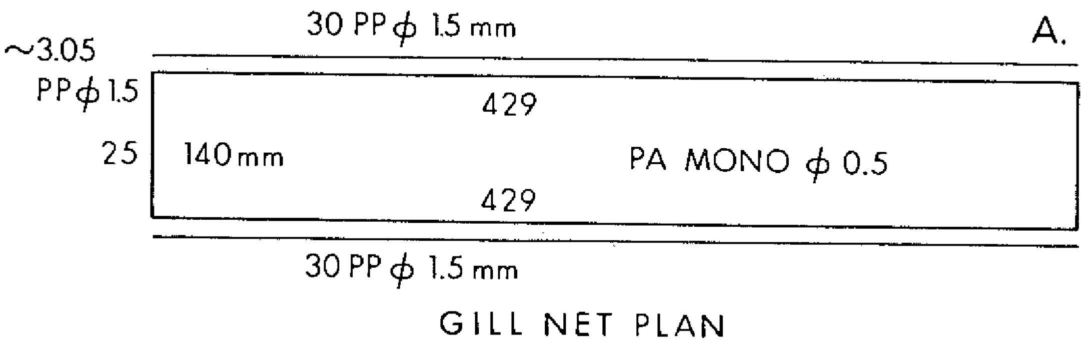


Figure 3.11. Gill net plan: View A.

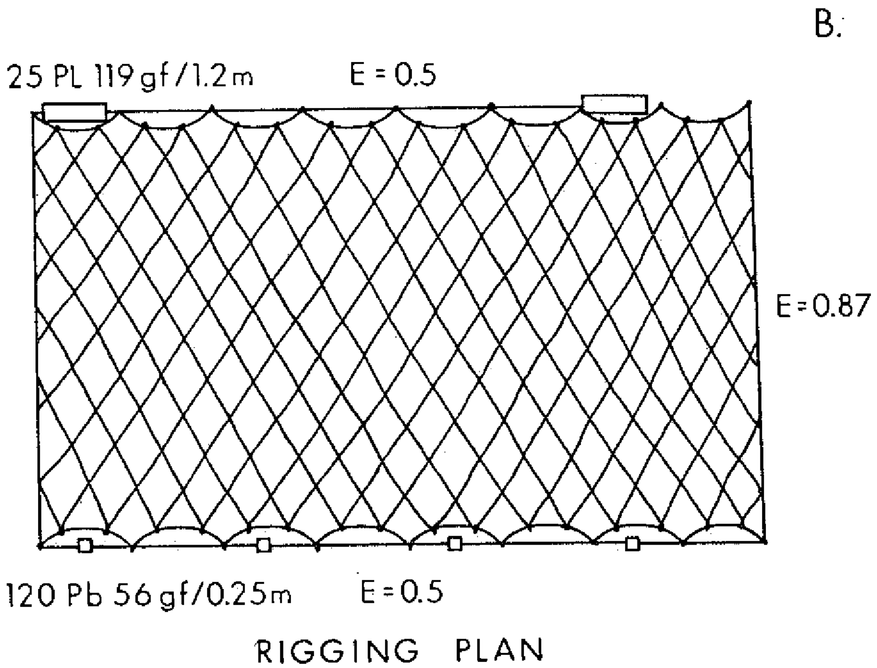


Figure 3.11. Gill net rigging plan: View B.

3.8.1 Explanation of net plans

PP	=	polypropylene
PA	=	polyamide (nylon)
PL	=	plastic
Pb	=	lead
ϕ	=	diameter
gf	=	grams associated with either lifting or sinking force
E	=	A or B hanging coefficient

The first net plan, (A), provides a view of the net indicating the number of meshes in width and depth, the size of the meshes and construction materials. The net will be 429 meshes in length, and 25 meshes in depth. The webbing will be constructed of polyamide monofilament with a diameter of 0.5 mm. The mesh size is 140 mm stretched mesh length.

The length of the float line and lead line will be 30 meters of polypropylene rope of 1.5 mm. The up and down line will be approximately 3.05 meters.

The second net plan explains the hanging and rigging of the net. The hanging coefficient along the float-lines and lead lines is 0.5; while the B coefficient along the up and down line is 0.87. There are 25 plastic floats of 119 gf each placed every 1.2 meters. There are 120 leads of 56 gf each placed every 0.25 m.

3.8.2 Construction

1. Choose #, size of floats and leads, material of construction, mesh size, length and depth. Make any adaptations to net plan.

The following instructions pertain to the net plan provided:

2. Take 1 rope 10 meters long and mark off every 140 mm. Hang taut between 2 solid posts.

3. On the same posts, extend the head rope and foot rope alongside the marked rope. Make marks on these to line up together.

4. Begin seizing webbing to float line starting with a float. Seize 2 meshes to a phase length, using a clove hitch. Place floats every 6 ties. If two persons are working, hang the float line and the foot rope at the same time. If only a one person operation, hang 10 meters of the float line first, then the foot rope. Continue the 10 m length, then retie the next 10 m, mark spacing lengths and continue seizing webbing until the 30 m are completed.

3.9. References

Atlantic and Gulf Fishing Supply Corp. Commercial fishing sport fishing and the marine supplies, equipment catalog.

Fridman, A.L. 1986. Calculations for fishing gear designs. Food and Agriculture Organization of the United Nations. Fishing News Books Ltd. Surrey, England 241 pps.

Visel, T and L. Stewart 1988. A guide to the construction of gill nets, University of Connecticut Sea Grant Marine Advisory Program. CT-SG-88-04.

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CHAPTER 4

BASIC NET DESIGN

TRAWL NETS

CHAPTER 4

BASIC NET DESIGN: TRAWL NETS

Page

BASIC NET DESIGN: TRAWL NETS

4.1 Introduction to Trawl Net Designs

The bottom trawl net is a funnel-shaped net that is dragged across the bottom of the sea and is designed to capture the fish in the near-bottom water. The mouth of the net is opened either by a set of otter doors in single boat otter trawling, or by the spread of the warps from two boats in pair trawling. This chapter deals with the construction and rigging of the bottom trawl net.

Except for the simplest nets, such as gill nets, most nets are made from a number of panels of webbing of the same or a different mesh size. These panels are cut out of a sheet of webbing to the correct sizes and shapes, and are then joined together to give the required shape. Of all the nets used for fishing, the bottom trawl net is probably the most complicated, in that it involves the use of a number of panels of webbing which are cut and joined in various ways.

There are many different designs of bottom trawl nets used in the modern ground fisheries. These include flat nets, high rise nets, balloon trawl nets, four panel box trawl nets, and others. Once the procedures for making the most basic trawl net are understood, it should be possible for the twineperson to make any net, providing that the appropriate net plan is available.

When learning to construct a trawl net, it is more practical to first work with a model. A model is a scaled-down version of a full-scale net. The model described in this chapter is for learning purposes only; it is not a properly scaled engineering model used to determine net performance.

The net designs used to illustrate the construction of a bottom trawl net in this chapter are a full-scale, modified 3/4 Yankee trawl net and a model Yankee trawl net. The Yankee trawl net is a basic flat net design used in the New England ground fisheries. The full-scale net is sometimes referred to as the 11.9 by 16.4 (39 x 54) net, however, the modified version described in this chapter is a 11.2 by 16.7 (37 by 55) net. These numbers refer to the length in meters of the headrope and sweep, respectively.

By scaling a net design up or down, changing the net section sizes and the headrope and sweep dimensions, nets can be built to suit the size and power of individual vessels (e.g., Yankee 35: 15.2 by 21.3 (52 x 72); Yankee 36 18.3 by 24.4 (60 x 80); Yankee 41: 24.4 x 30.5 (80 x 100)). The net itself is made up of a number of sections of shaped webbing. When all these sections have been joined together, the net is attached to the mouth frame. The frame around the mouth of the net consists of three different parts: the headrope, the hanging line, and the up and down line. Once the net has been hung to the mouth frame, the appropriate cod-end, working lines, sweep or footrope, rigging and otter boards for the particular application are arranged.

4.2 The Basic Yankee Trawl Net

The net is constructed of a number of sections of shaped webbing, as shown in Figure 4.1. As the headrope is 5.4 m shorter than the sweep, the top of the net overhangs the bottom of the net. This overhang is important in preventing upward escape of fish. The section of twine forming the overhang is termed the square.

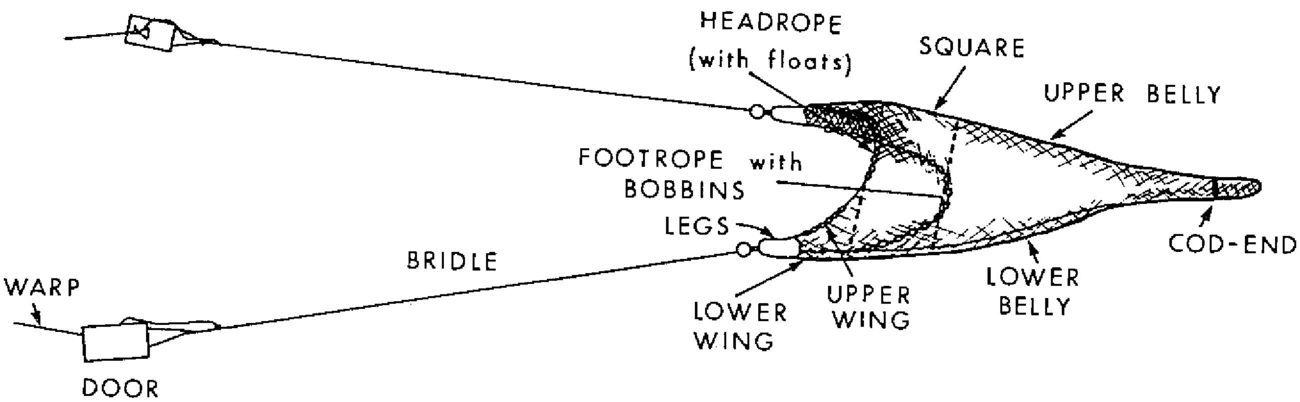

Figure 4.1. Basic trawl design.

The upper and lower panels of the net are built separately and then joined to make the complete net. The arrangement of the upper and lower panels is shown in Figure 4.2, which is the net plan for the full-scale 3/4 Yankee trawl net and Figure 4.3, which is the net plan for the model Yankee trawl net.

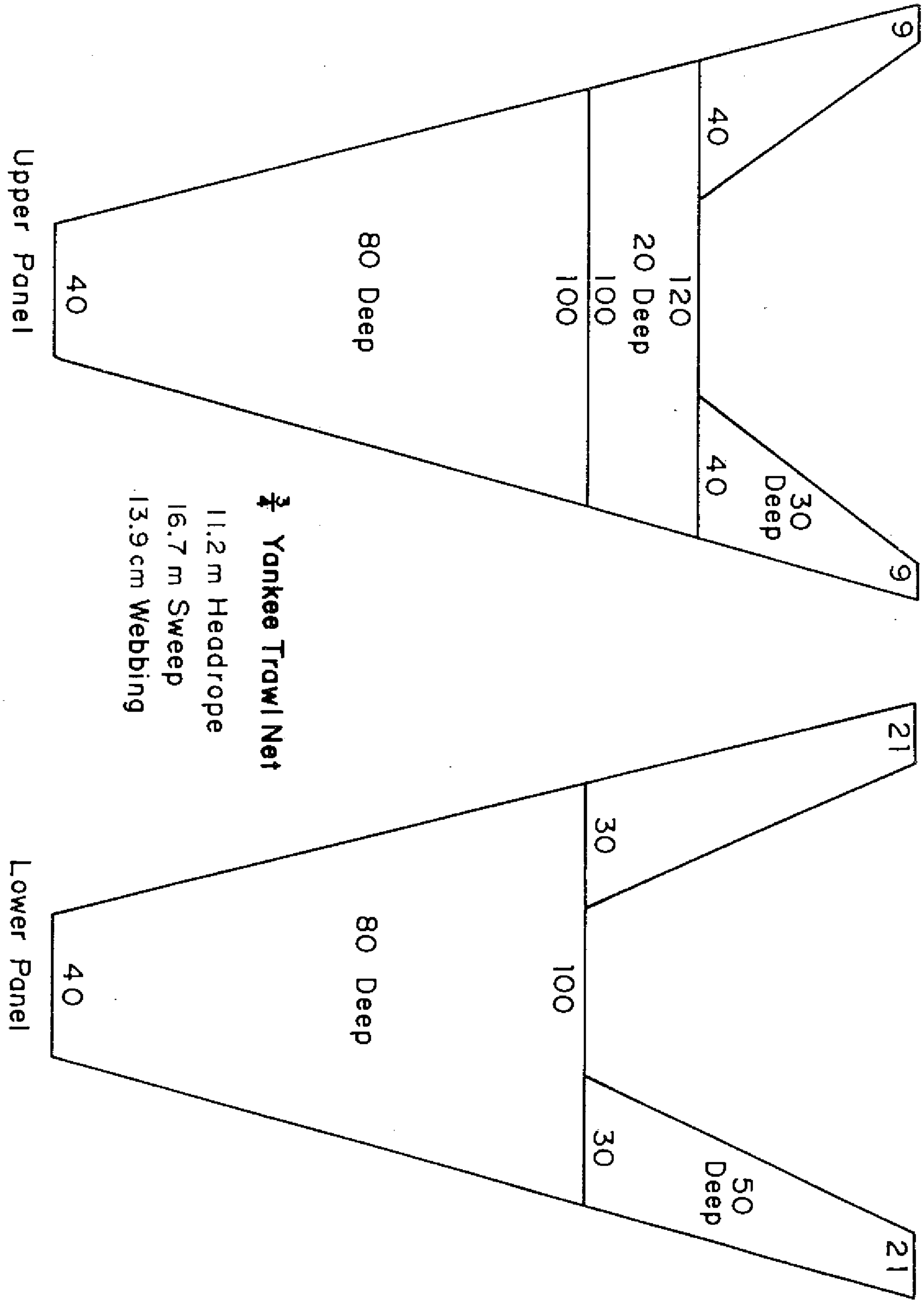

Figure 4.2. 3/4 Yankee trawl net.

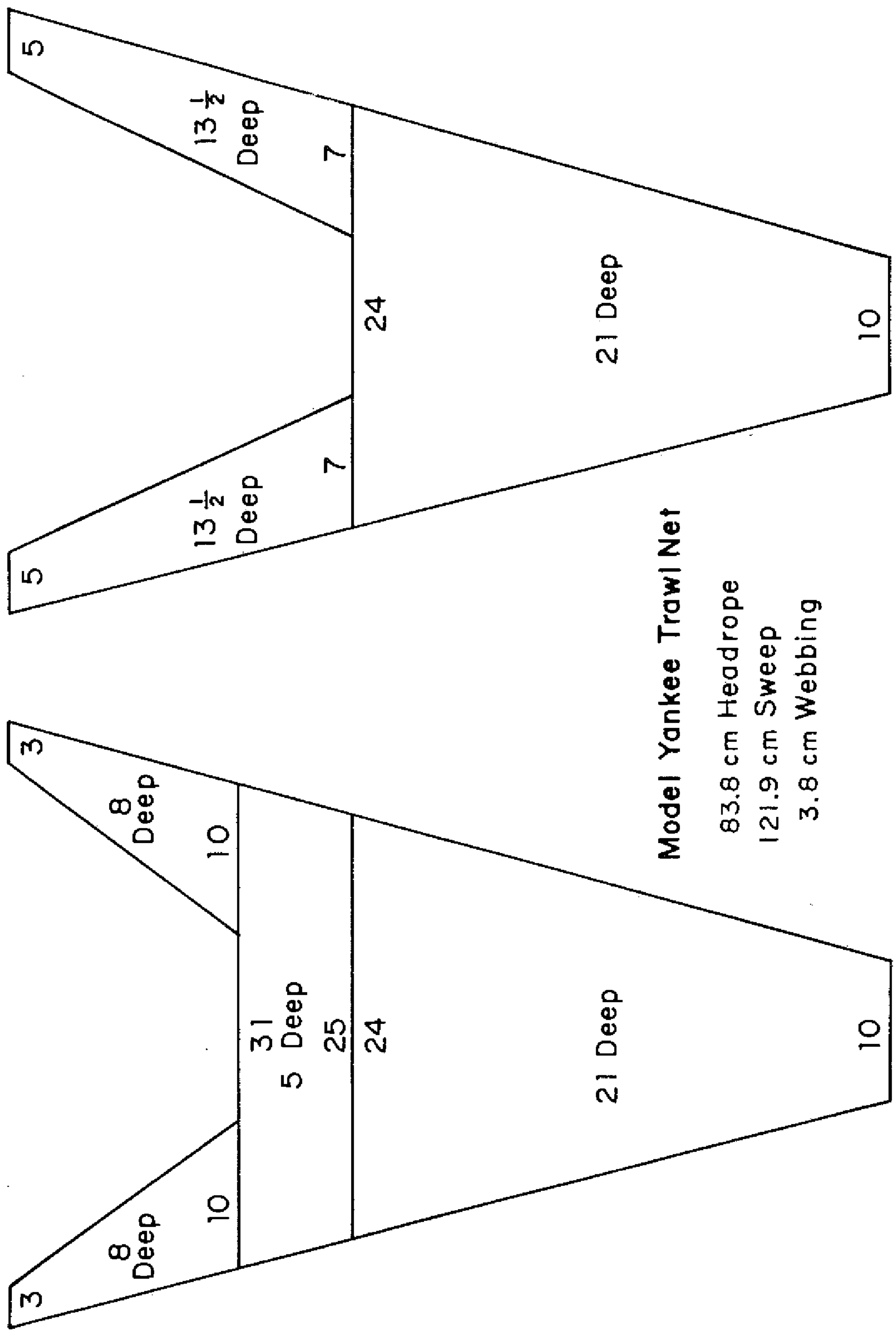

Figure 4.3. Model Yankee trawl net.

The upper panel of the net is made up of sections that include one square, one belly, and two top wings. The lower panel of the net is made up of sections that include one belly (identical to the top belly) and two bottom wings. Note that, due to the square being inserted to provide overhang, the bottom wings are longer than the top wings by the depth of the square.

The various sections may be made in several ways:

1.) The twine may be knitted to the required shape and size. This is a slow and monotonous task and very rarely is undertaken today.

2.) The sections may be purchased already cut to size. Most fishing supply houses keep a stock of the various sections for standard nets.

3.) The sections may be cut out from standard sheets of webbing.

The construction of a bottom trawl net from a net plan and a single sheet of webbing is described in this chapter, and includes the following operations:

1.) Determine the taper for each section of net.

2.) Calculate the minimum size of a panel of webbing required to cut individual sections or pairs of sections.

3.) Develop a cutting plan for all the net sections from a panel of webbing of standard depth.

4.) Cut the net sections.

5.) Reinforce the sections with heavier or double twine as required.

6.) Assemble the upper and lower panels of the net by sewing sections together.

7.) Lace the upper and lower panels, forming a gore seam and a complete net.

8.) Construct the mouth frame: headrope, hanging line, and up and down line.

9.) Hang the assembled net to mouth frame.

10.) Complete the rigging of the net, sew on the cod-end, knit on gussets, attach the sweep, etc.

Each of these topics are presented in the remaining sections of this chapter, with specific examples applied to the 3/4 Yankee trawl net, and the model Yankee trawl net.

4.3 The Tapering of Webbing

4.3.1 Introduction

Tapering is the art of shaping or cutting a section of webbing to specific dimensions. The twineperson usually starts with a panel of webbing cut along meshes (pickups) and siders (points). This is referred to as a square panel of webbing, although it may not actually be square (Figure 4.4). The webbing is oriented along the "run of the twine", or the direction that, when the webbing is stretched or pulled in, the knots tighten. "Cross-twine" is the direction at a right angle to the "run of the twine", where the knots loosen when stretched.

Mesh size for a panel of webbing is measured in two ways. The manufacturer of webbing refers to the mesh size as the distance between knots (center to center) when the webbing is stretched along the "run of the twine." Some fisheries regulatory agencies refer to the mesh size as the actual opening in the mesh. The mesh size can be expressed in inches, centimeters or millimeters. Twine size is usually expressed in terms of diameter in millimeters in the American thread count system.

Tapers are cut into webbing, leaving points, bars, and meshes (Figure 4.5). Tapers are divided into three types. The jib taper is cut leaving meshes and bars. The body taper is cut leaving points and bars. The all bars taper (actually one point and then all bars) separates the body tapers from the jib tapers.

If the webbing is hung such that the individual meshes are square in shape, the jib taper is between the all meshes or pickups taper and the all bars taper, and may be thought of as a taper between 45 and 90 degrees. The body taper is between the all points or siders taper and the all bars taper, and may be thought of as a taper between 0 and 45 degrees (Figure 4.6). The tapers that are cut in most trawl net sections are body tapers. Jib tapers are typically used in reinforcing wedges or gussets that are knit into the quarters of the trawl net.

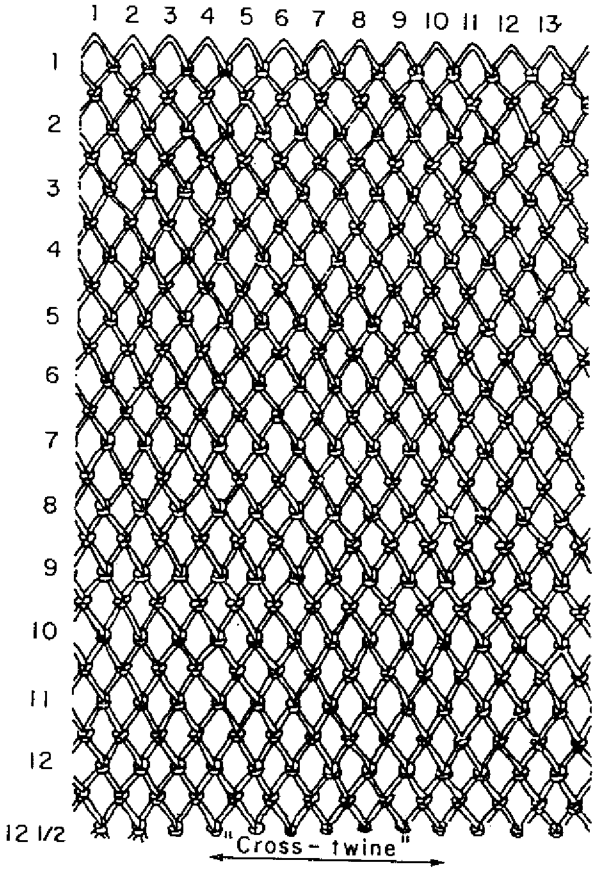

Figure 4.4. A square section of webbing, 13 meshes wide by 12 1/2 meshes deep.

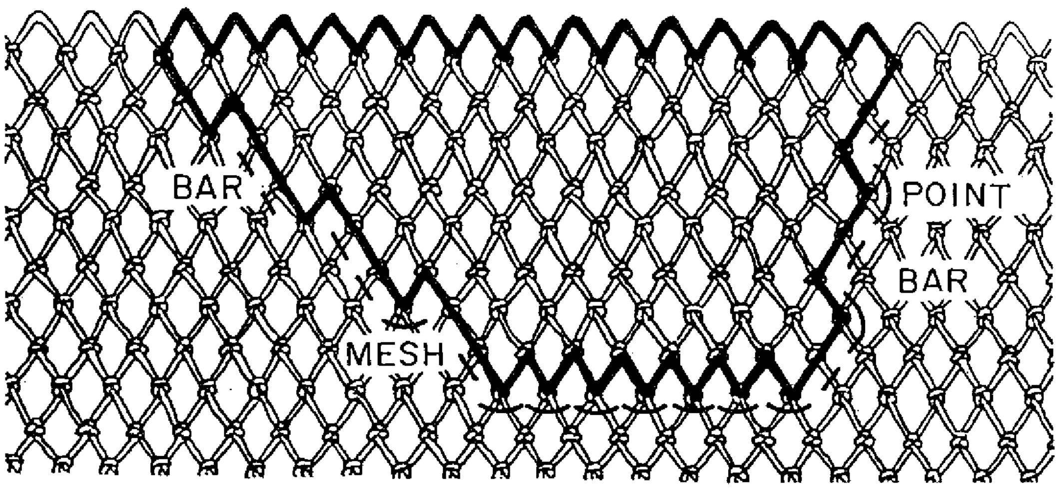

Figure 4.5. Meshes, points and bars.

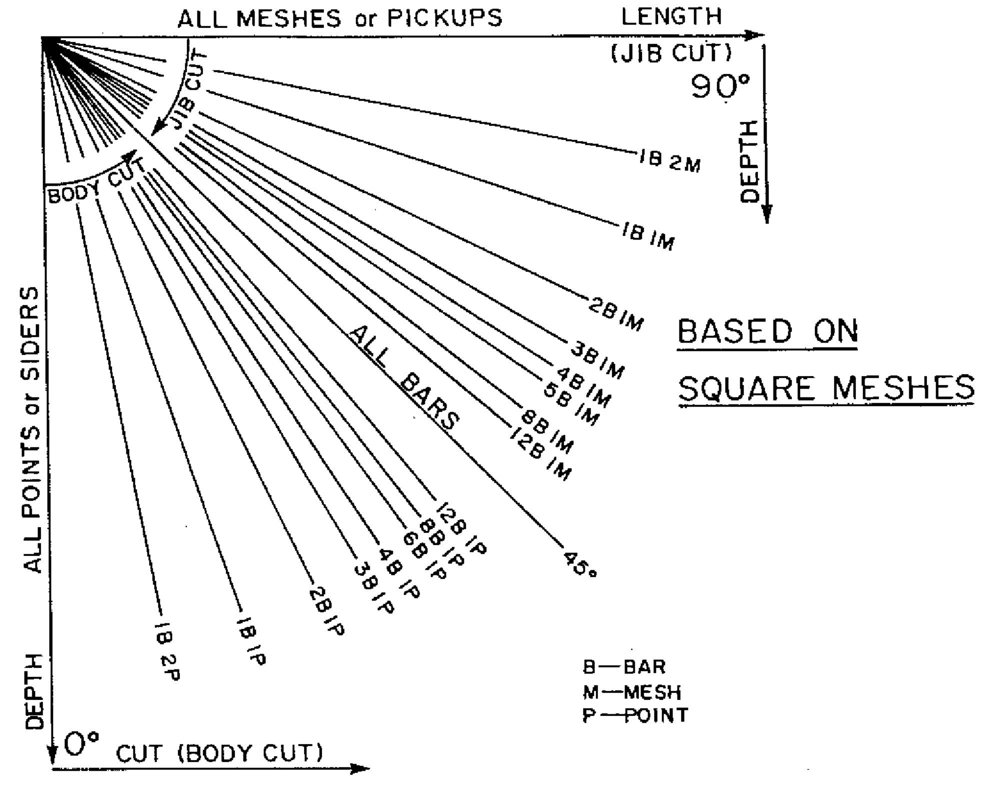

Figure 4.6. Angles resulting from cutting tapers.

4.3.2 Determining the cut

The cut is the number of meshes lost in making a taper in a panel of webbing of specified depth. To determine the cut of a section of webbing that is symmetric, and thus will have identical tapers at each end, the following formula is used.

$$C = \frac{WE - NE}{2}$$

where:
- C = cut of belly or square section in meshes
- WE = number of meshes in the wide end of the section
- NE = number of meshes in the narrow end of the section

This formula is useful in calculating the cut of a belly or square section taper because they are symmetric sections (Figure 4.7).

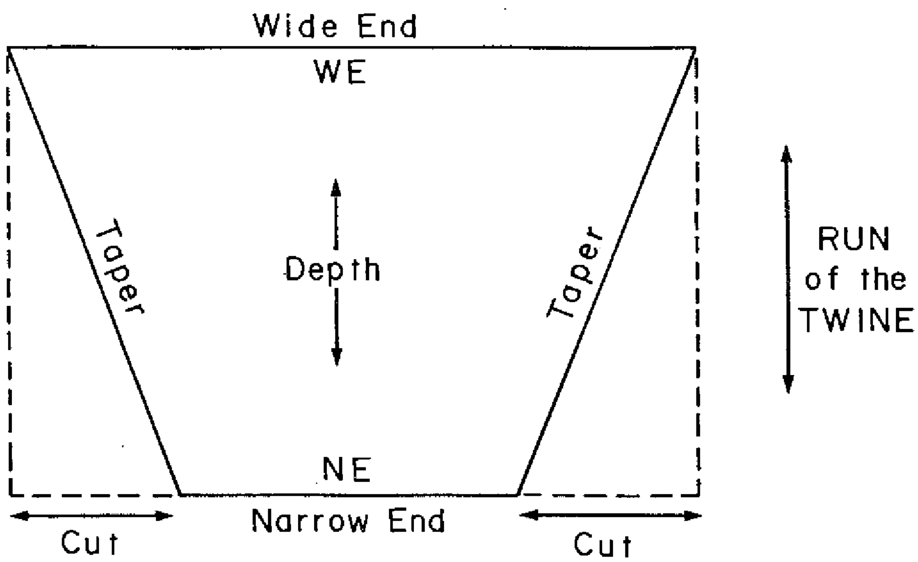

Figure 4.7. Symmetric section (belly or square).

For the 3/4 Yankee trawl net example:

1.) The belly section of the net is 100 meshes at the wide end, 40 meshes at the narrow end, and 80 meshes deep (100 x 40 x 80 D).

$$C = \frac{WE - NE}{2} = \frac{100 - 40}{2} = \frac{60}{2} = 30$$

C = 30 meshes

2.) The square of the net is 130 meshes at the wide end, 100 meshes at the narrow end, and 20 meshes deep (130 x 100 x 20 D).

$$C = \frac{WE - NE}{2} = \frac{130 - 100}{2} = \frac{30}{2} = 15$$

C = 15 meshes

The wings of a bottom trawl net are not symmetric. The inside edge of the section is cut with a straight bars taper. The outside edge of the section is cut with a body taper (Figure 4.8). To determine the cut of that outside taper, the following formula is used:

C = NE + D - 1 - WE

where:

C = cut of wing in meshes

WE = number of meshes in the wide end of the wing

NE = number of meshes in the narrow end of the wing

D = number of meshes in the depth of the wing

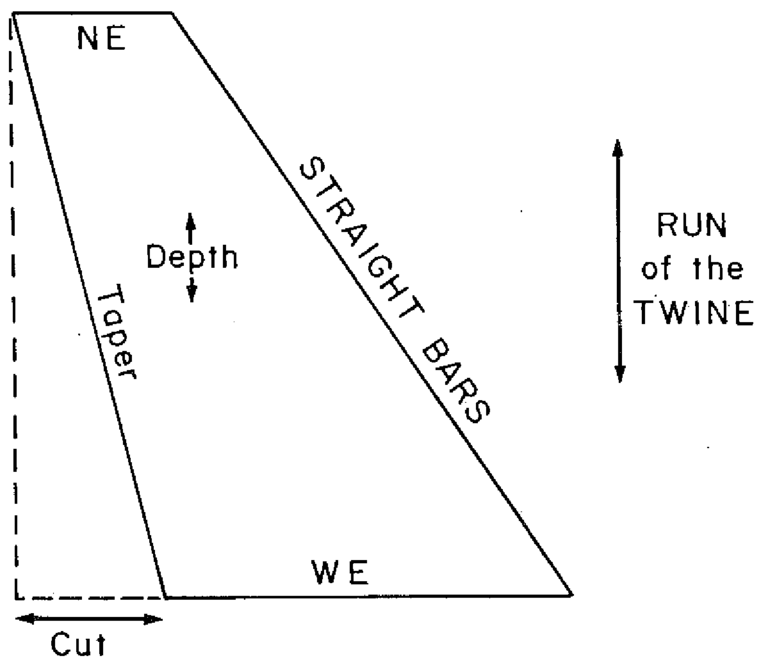

Figure 4.8. Asymmetric section (wing).

Note: if the cut is negative, use the absolute value of the cut, that is, ignore the negative sign.

For the 3/4 Yankee trawl net example:

1.) The upper wing of the net is 40 meshes at the wide end, 9 meshes at the narrow end, and 30 meshes deep (40 x 9 x 30 D).

C = NE + D - 1 - WE = 9 + 30 - 1 - 40 = -2

C = /-2/ = 2 meshes

2.) The lower wing of the net is 30 meshes at the wide end, 21 meshes at the narrow end, and 50 meshes deep (30 x 21 x 50 D).

C = NE + D - 1 - WE = 21 + 50 - 1 - 30 = 40

C = 40 meshes

For the model Yankee trawl net example, the application of the cut formulas results in the following:

1.) Belly section (24 x 10 x 21 deep)
C = 7 meshes

2.) Square section (31 x 25 x 5 deep)
C = 3 meshes

3.) Upper wing section (10 x 3 x 8 deep)
C = 0 meshes

4.) Lower wing section (7 x 5 x 13 1/2 deep)
C = 10 1/2 meshes

4.3.3 Calculating the taper

Having determined the cut or the number of meshes lost in making a taper in a panel of webbing of given depth, the taper sequence is calculated. The body taper formula is used when the cut is less than the depth, as is usually the case for trawl net wings, belly and square sections.

$$\text{BODY TAPER} = \frac{2 \times \text{CUT}}{\text{DEPTH} - \text{CUT}} = \frac{\text{BARS}}{\text{POINTS}}$$

The body taper is expressed as a fraction in bars and points. When cutting the body taper, the twineperson always begins at the wide end with the points. The taper fraction is always reduced to the simplest form, then subdivided into a sequence of bars to a single point or points to a single bar.

If the taper formula results in a whole number (3B/1P, 2B/1P or 1B/1P) then, the taper sequence is simply repeated as it is cut into the webbing, and is sometimes referred to as a straight taper.

If the taper formula results in a fraction that reduces to a mixed number (7B/4P = 1 3/4), then a taper consisting of an alternating sequence of bars to a single point is cut into the webbing, and is referred to as a mixed taper. In this case, to cut the smoothest or most uniform taper possible, the fraction is divided into a mixed sequence of tapers that, when taken together, result in the original fraction. This mixed taper sequence is determined from the mixed number. The denominator of the fraction indicates the number of tapers in the mixed sequence of 1 point each. The whole number indicates the base number of bars in each of the tapers. The numerator of the fraction indicates the number of tapers with bar cuts, 1 unit greater than the base. If the fraction is greater than one-half, the mixed taper sequence begins with the larger bar cuts; if the fraction is less than half, the mixed taper sequence begins with the smaller number bar cuts. Considering the previous example, the body taper formula results in 7B/4P; the mixed number is 1 3/4; the mixed taper sequence will be 4 tapers of 1 point each, the base number of bars to be cut in each taper is 1, however, 3 of the tapers will be 1 more than 1 bar, or 2 bars. Because 3/4 is greater than 1/2, the mixed sequence will begin with the larger bar cuts, or 2 bars. The resulting mixed taper sequence is 2B/1P, 2B/1P, 2B/1P, 1B/1P, or 3(2B/1P) and 1(1B/1P).

If the body taper formula results in a fraction less than one, 1B/2P or 4B/7P, the result is referred to as a reverse taper because the number of bars in the taper is less than the number of points. The reverse body taper can be repeated or mixed. The reverse taper (1B/6P) is repeated as it is cut into the webbing. The reverse mixed taper (4B/7P) is subdivided into a reverse mixed taper sequence as done previously for the mixed taper sequence, however, in this case the result is the reciprocal 3 (1B/2P) and 1 (1B/1P).

For the 3/4 Yankee trawl net example,

1.) In the belly of the net, the cut is 30 meshes and the depth is 80 meshes. Therefore, the taper is:

$$T = \frac{2 \times C}{D - C} = \frac{2 \times 30}{80 - 30} = \frac{6B}{5P}$$

This is a mixed taper, and the mixed number is 1 1/5. The resulting mixed taper sequence is 4 (1B/1P) and 1 (2B/1P).

2.) In the square of the net, the cut is 15 meshes and the depth is 20 meshes. Therefore, the taper is:

$$T = \frac{2 \times C}{D - C} = \frac{2 \times 15}{20 - 15} = \frac{30}{5} = \frac{6B}{1P}$$

This is a straight taper.

3.) For the upper wing of the net, the cut is 2 meshes and the depth is 30 meshes. Therefore, the taper is:

$$T = \frac{2 \times C}{D - C} = \frac{2 \times 2}{30 - 2} = \frac{4}{28} = \frac{1B}{7P}$$

This is a reverse taper.

4.) For the lower wing of the net, the cut is 40 meshes and the depth is 50 meshes. Therefore, the taper is:

$$T = \frac{2 \times C}{D - C} = \frac{2 \times 40}{50 - 40} = \frac{80}{10} = \frac{8B}{1P}$$

This is a straight taper.

For the model Yankee trawl net, the application of the taper formula results in the following:

1.) Belly, (24 x 10 x 21 deep), where C = 7 meshes, the taper = 1B/1P.

2.) Square, (31 x 25 x 5 deep), where C = 3 meshes, the taper = 3B/1P.

3.) Upper wing, (10 x 3 x 8 deep), where C = 0, the taper is all points.

4.) Lower wing, (7 x 5 x 13 1/2 deep), where C = 10 1/2, the taper is 7B/1P.

4.3.4 Summary of cutting and tapering formulas for body tapers of trawl net sections

Symmetric Section CUT (Belly and Square) = (WE - NE) /2
Asymmetric Section CUT (Wing) = NE + D - 1 - WE
TAPER (Body) = (2 x C) / (D - C).

Note: These formulas can be algebraically rearranged for special purposes. For example:

WE (Belly of Square) = NE + 2 (T x D) / (2 + T)

WE (Wing) = (NE + D - 1) - T x D) / (2 + T)

NE (Belly or Square) = WE - 2 (T x D) / (2 + T)

NE (Wing) = (WE + 1 - D) + (T x D) / (2 + T)

4.3.5 Cutting tapers in webbing

The cutting of tapers into webbing is straightforward if a few simple rules are followed:

1.) Always begin to cut the taper at the WE of the section of webbing.

2.) Always begin the taper sequence with the point or points.

3.) When cutting tapers in wing sections, if the NE + D is greater than the WE, the cutting of the taper begins at the NE in place of the WE. That is to say, the WE becomes the NE for tapering purposes. Conversely, if the NE + D is equal to or less than the WE, then the taper is cut from the WE as usual.

For illustration purposes, the tapering of individual sections of a model Yankee trawl net is presented.

1.) The belly sections of the model net are 24 x 10 x 21 deep and the taper is 1B/1P. The tapers are cut as shown in Figure 4.9. First, a square section of webbing, 24 meshes wide by 21 meshes deep, is identified in the larger panel of webbing. Then one corner of the wide end is located and the taper sequence is cut, beginning with the point or points, then the bar or bars. The taper sequence is repeated if necessary for the required depth of the section. Then, the opposite corner of the wide end is located by counting over the number of meshes in the wide end from the first corner mesh. The second taper is cut. If the tapers were calculated and cut correctly, the number of meshes in the narrow end of the resulting section of webbing should be the number specified in the net plan for that section.

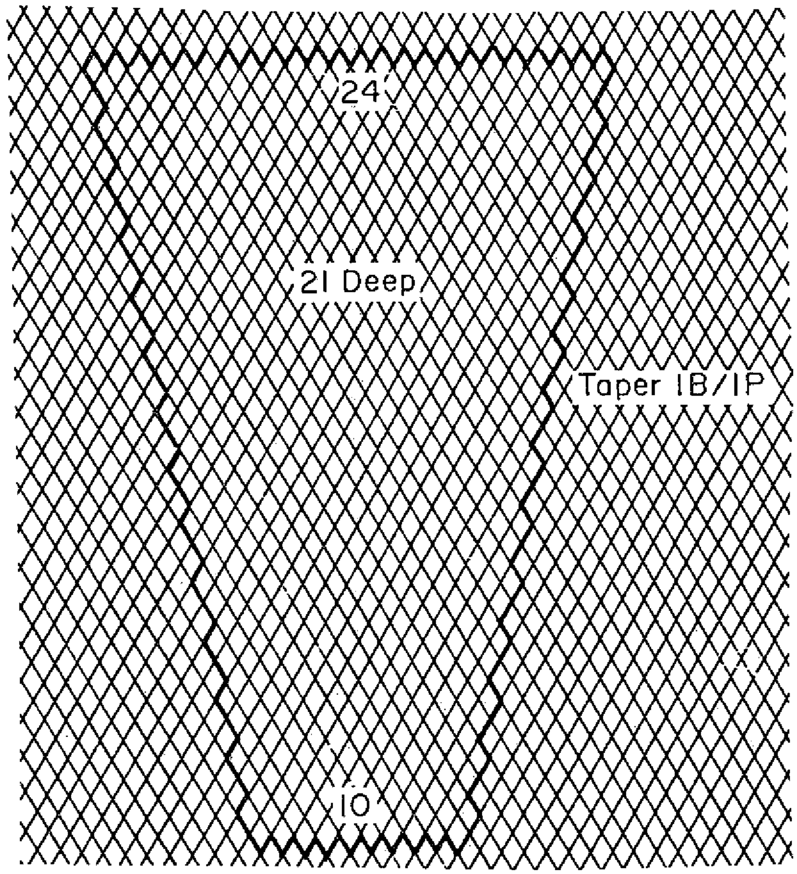

Figure 4.9. Model Yankee trawl net belly section.

2.) The square section of the model net is 31 x 25 x 5 deep and the taper sequence is 3B/1P. The cutting of the tapers is shown in Figure 4.10, and the procedure is similar to that described for the belly section.

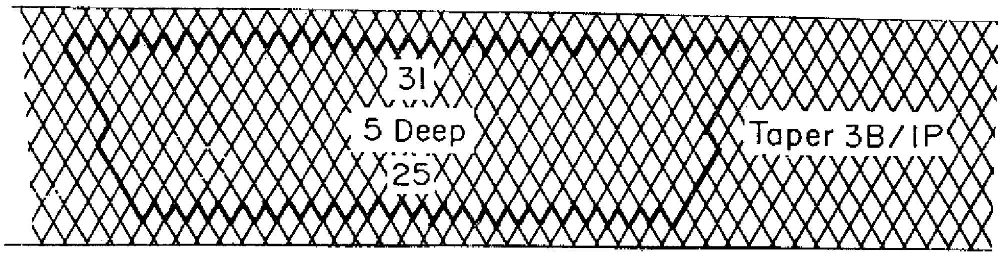

Figure 4.10. Model Yankee trawl net square section.

3.) The upper wing sections of the model net are 10 x 3 x 8 deep and the taper is all points. As noted previously, the cutting of wings requires special consideration. In this case, NE + D is greater than the WE; therefore, the tapering begins at the NE. The inside edge of the wing is tapered with a straight bar cut after the first point for the 8 mesh depth of the wing. The outside taper is cut from the NE starting with a point (Figure 4.11).

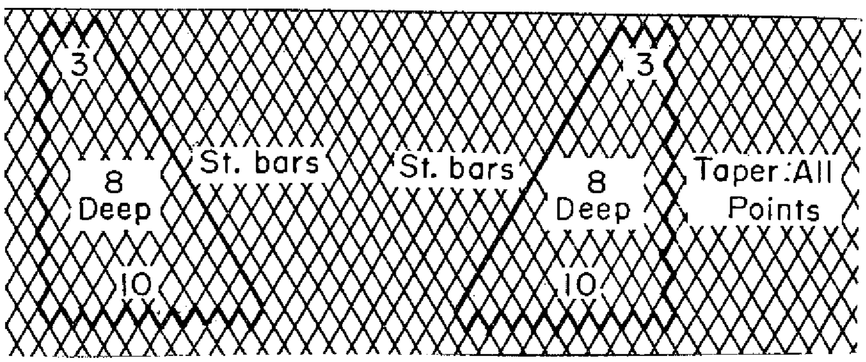

Figure 4.11. Model Yankee trawl net upper wing sections.

4.) The lower wing sections of the model net are 7 x 5 x 13 1/2 deep, and the taper is 7B/1P. In this case, the NE + D is greater than WE, therefore, the taper begins at the NE. The inside edge of the wing is again tapered with a straight bars cut after the first point for the 13 1/2 mesh depth of the wing. The outside taper is cut from the NE starting with a point, Figure 4.12.

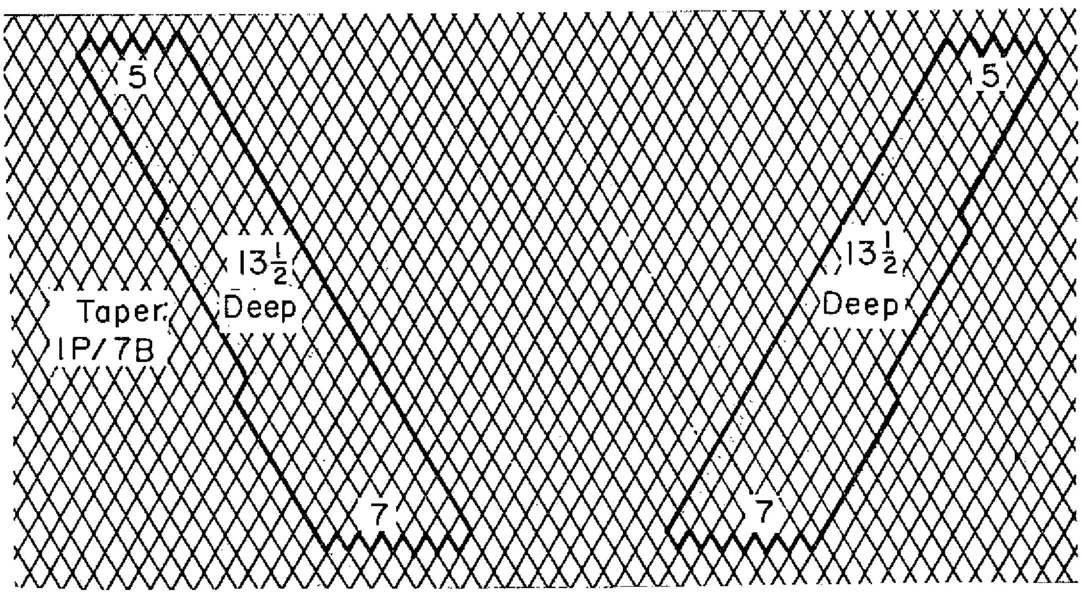

Figure 4.12. Model Yankee trawl net - lower wing sections.

4.4 Development of a Cutting Plan

4.4.1 The minimum panel size required for a single or pair of net sections

Having inspected the trawl net plan, and calculated the cut and taper for each section of the net, the twineperson must next determine the amount of webbing required for each section of the net, and then assemble these panels into a cutting plan. The objective is simply to determine how much webbing is required to construct the bottom trawl net with a minimum of waste.

The formulas for determining the minimum dimensions for a panel of webbing are based on the following:

1.) When joining two panels of webbing together by sidering, a half mesh is gained or added to the sum of the widths of the individual panels.

2.) When cutting tapers into a panel of webbing, a full mesh is lost from the panel, and from the sum of the two resulting sections.

A single symmetric section of a trawl net can be cut from a square panel of webbing with no waste and little additional effort. The minimum dimensions of a square panel of webbing required for this single net section is determined using the following formula:

$$\text{MINIMUM PANEL WIDTH (Single Section)} = \frac{WE}{2} + \frac{NE}{2} + 1/2 \text{ mesh}$$

Where: WE = the number of meshes in the wide end of the section

NE = the number of meshes in the narrow end of the section.

The depth of the panel of webbing is the same as the depth of the net section.

For example, the construction of a 3/4 Yankee trawl net requires a single square section. This section is 130 x 100 x 20 deep.

$$\text{MINIMUM PANEL WIDTH} = \frac{WE}{2} + \frac{NE}{2} + 1/2 \text{ mesh}$$

$$= \frac{130}{2} + \frac{100}{2} + 1/2$$

$$= 65 + 50 + 1/2$$

$$\text{Width} = 115\ 1/2 \text{ meshes}$$

The resulting minimum panel size is 115 1/2 x 20 deep.

The cutting and assembly of a single section from the minimum size panel is illustrated for the square section of the model Yankee trawl net. The dimensions of this section are 31 x 25 x 5 deep. The minimum panel width required is:

$$\text{MINIMUM WIDTH} = \frac{WE}{2} + \frac{NE}{2} + 1/2 \text{ mesh}$$

$$= \frac{31}{2} + \frac{25}{2} + 1/2$$

$$= 15\ 1/2 + 12\ 1/2 + 1/2$$

$$= 28\ 1/2 \text{ meshes}$$

The minimum panel size is 28 1/2 x 5 deep.

The procedure for cutting and assembling this panel into a single section is as follows (Figure 4.13):

1.) Count in from a whole mesh corner along the meshes or pickups about one half the number of meshes in the WE. This marks the wide end corner mesh.

2.) Cut the specified taper sequence into the webbing.

3.) Rotate one of the resulting sections, and sider to remaining section. Start on the three-legger, form a half mesh, sider to the bottom of the section, form the last half mesh, and finish the three-legger.

Note that when cutting two tapers simultaneously with one actual cut, one of the tapers will be out of sequence by a single bar or point, depending on the taper sequence.

A pair of symmetric or asymmetric sections for a trawl net can be cut from a square of webbing with no waste using the following formula for the minimum width of the panel.

MINIMUM PANEL WIDTH = WE + NE + 1 1/2 meshes
(Pair of Sections)

Where: WE = the number of meshes in the wide end of the section

NE = the number of meshes in the narrow end of the section

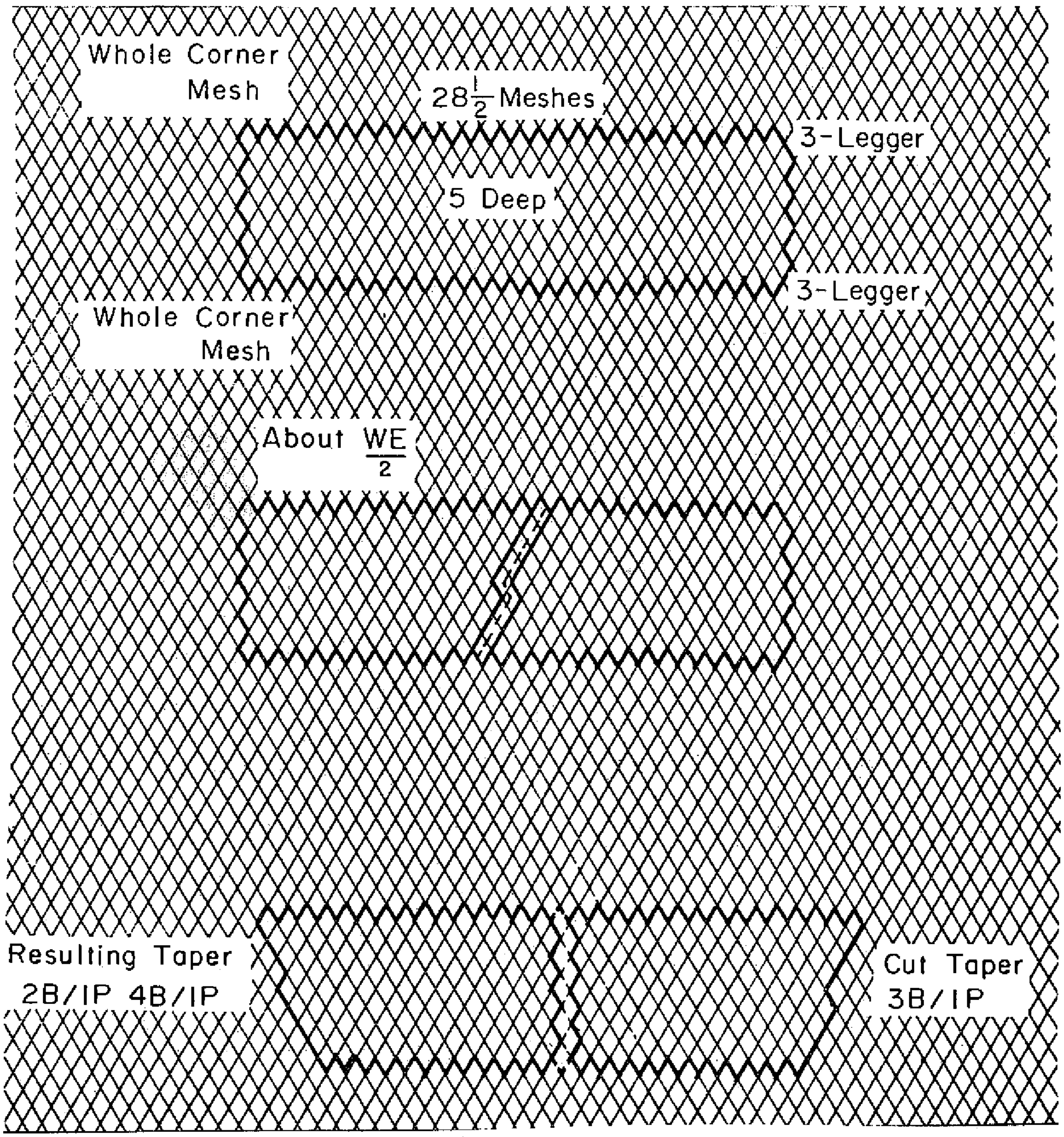

Figure 4.13. Cutting and assembly of the square section for the model Yankee trawl net.

The depth of the panel of webbing is the same as the depth of the section.

For example, the construction of a 3/4 Yankee trawl net requires a pair of belly sections. An individual section is 100 x 40 x 80 deep. The minimum panel width for a pair of belly sections is:

MINIMUM PANEL WIDTH = 100 + 40 + 1 1/2
= 141 1/2 meshes

The resulting minimum panel dimensions are 141 1/2 x 80 deep.

A pair of upper wing sections for the 3/4 Yankee trawl net requires a panel of webbing 50 1/2 x 30 meshes deep. A pair of lower wing sections for the 3/4 Yankee trawl net requires a panel of webbing 52 1/2 x 50 meshes deep. The cutting and assembling of a pair of belly sections is illustrated for the model Yankee trawl in Figure 4.14. The dimensions of this section are 24 x 10 x 21 deep. The minimum panel width is:

MINIMUM PANEL WIDTH = WE + NE + 1 1/2 meshes
= 24 + 10 + 1 1/2
= 35 1/2

The minimum panel dimensions are 35 1/2 x 21 deep.

The procedure for cutting and assembling this panel into the two belly sections is as follows:

1.) Count in from the whole mesh corner about one half the width NE of the section. The next mesh is marked as the first full mesh of the wide end of the belly section.

2.) Cut the specified taper sequence into the webbing.

3.) Returning to that first full mesh of the wide end, count across on the meshes or pick-ups the number of meshes in the wide end. This marks the opposite wide end corner mesh.

4.) Cut the specified taper sequence into the webbing. This leaves a full belly section, and two half belly sections that must be sidered together.

5.) Finally, sider the two half belly sections together. Starting on the 3-legger, form a half mesh, sider down, form the last half mesh, and finish on the 3-legger.

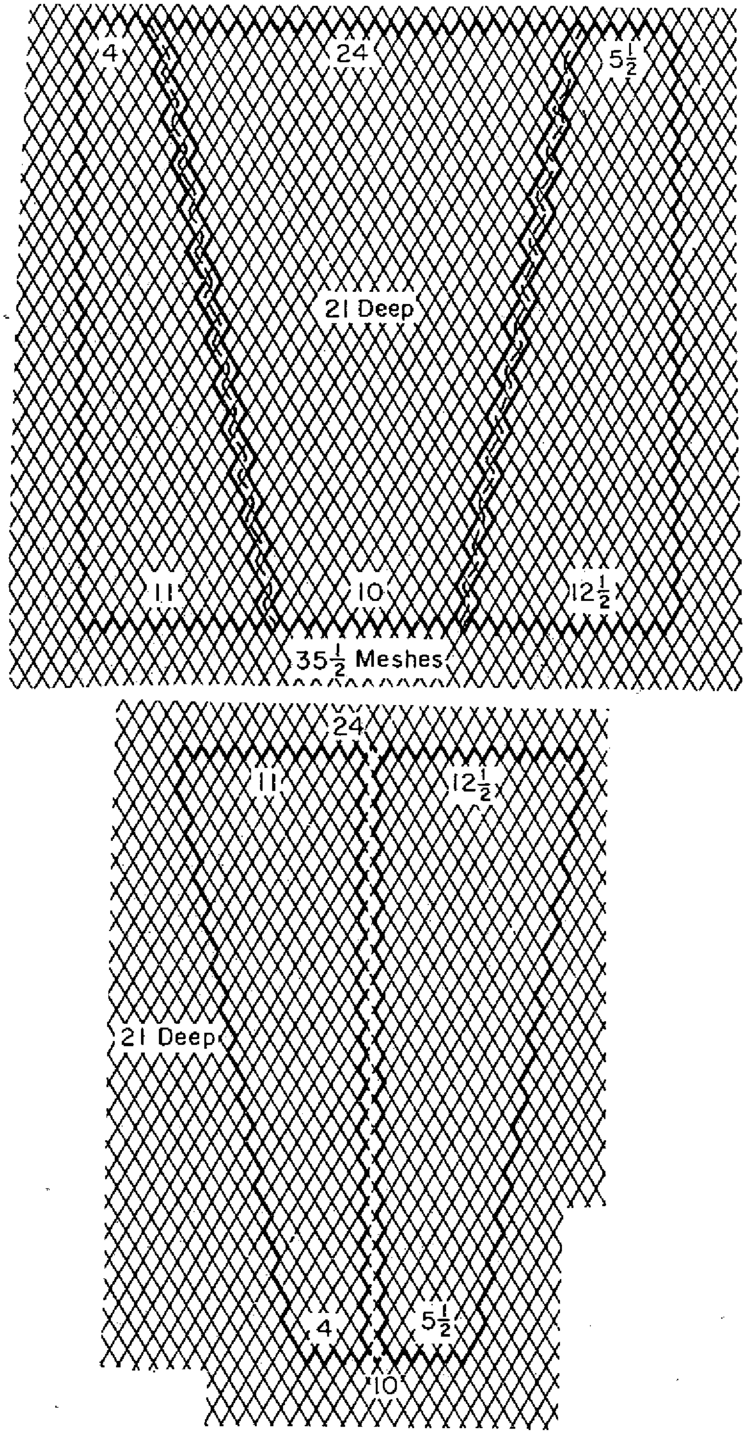

Figure 4.14. Cutting and assembling a pair of belly sections for a model Yankee trawl.

The cutting and assembling of a pair of wing sections follows a different procedure than described previously for a pair of belly sections. For the upper wing sections of the model Yankee trawl, the minimum panel size required for a pair of sections is 14 1/2 x 8 deep. The cutting and assembling for a pair of upper wing sections is as follows (Figure 4.15):

1.) Cut a straight bar taper from the second full mesh in the corner of the panel.

2.) Rotate the resulting section relative to the other, to form a parallelogram, and sider the sections together.

3.) For the upper wing section of the model, the NE + D is greater than the WE, therefore the taper is started from the NE. Identify the NE of the left wing on the parallelogram, count in three meshes; this marks the beginning of the taper.

4.) Cut the all points taper sequence for the depth of the webbing.

For a pair of lower wing sections for the model Yankee trawl, the minimum panel dimensions required are 13 1/2 x 13 1/2 deep. The cutting and assembly of a pair of lower wing sections is illustrated in Figure 4.16. The procedure is similar to that described for the upper wing sections.

4.4.2 The cutting plan

Sheet webbing from the manufacturer is available in standard depths of 25, 50 and 100 meshes, and other depths on special order. A cutting plan is the layout of each of the square panels of webbing required for a given net into a pattern for a particular standard depth of webbing, so that the twineperson can determine how much material to order. The goal is to lay out a cutting plan with a minimum amount of waste. A cutting plan for the 3/4 Yankee trawl net is illustrated in Figure 4.17, based on a sheet webbing 100 meshes deep. Note that a 1/2 mesh is lost at each all points or all pickups cut in the webbing.

Therefore, the square section will only be 19 1/2 meshes deep, not the specified 20 meshes deep. This will be corrected when a 1/2 mesh of reinforcement is added to the wide end of the square. This will be discussed in a subsequent section of this chapter.

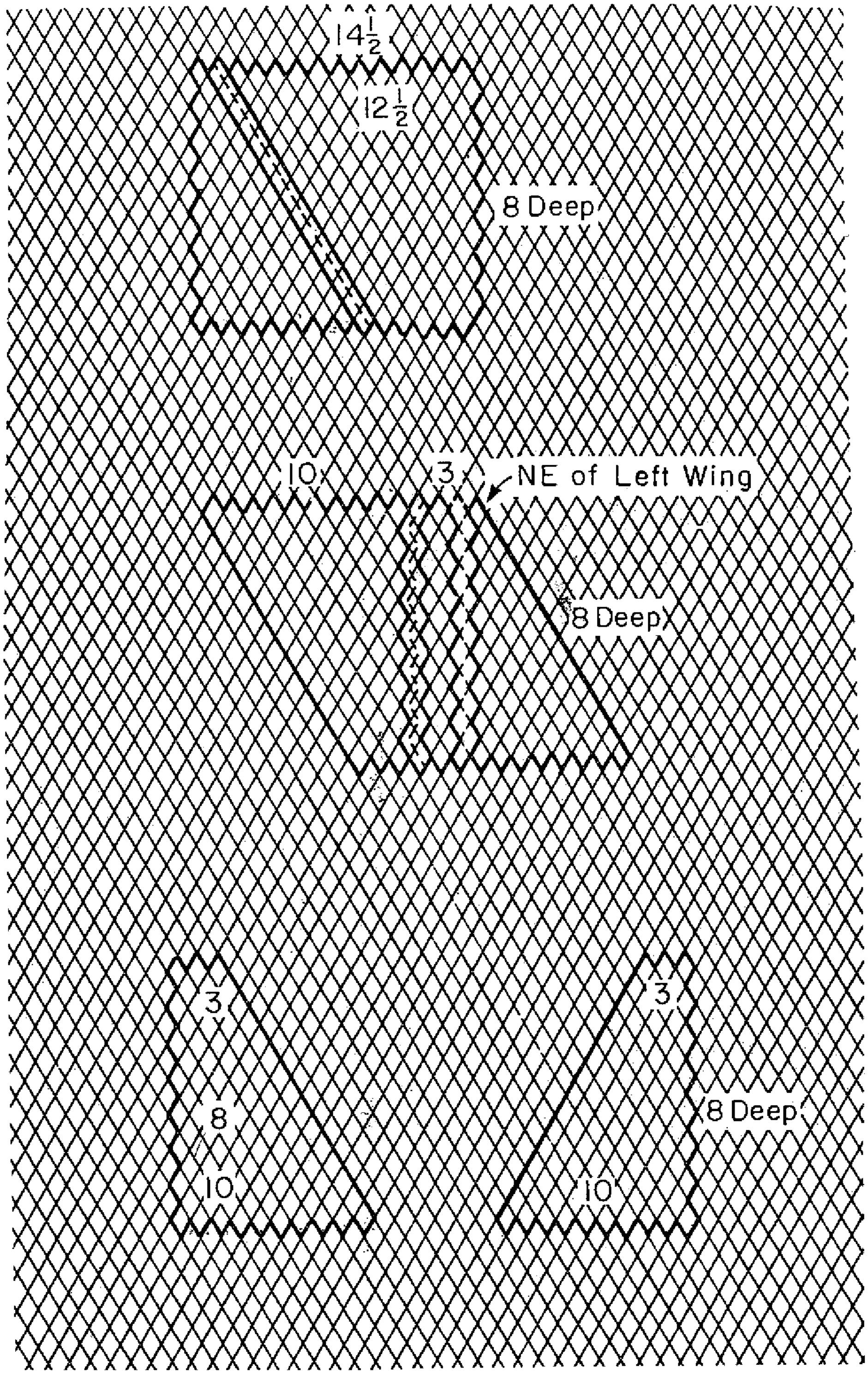

Figure 4.15. Cutting and assembly of a pair of upper wing sections for a model Yankee trawl net.

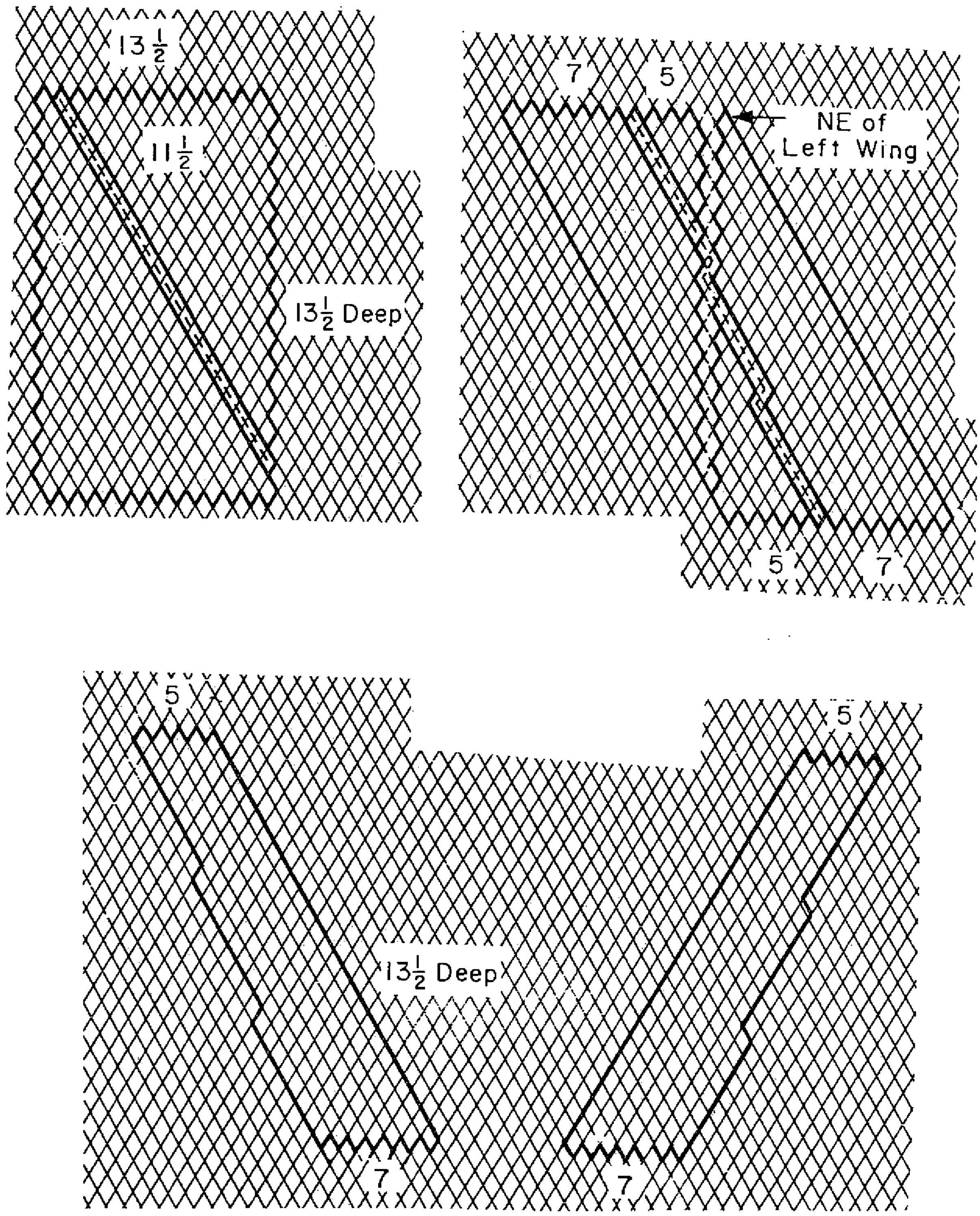

Figure 4.16. Cutting and assembly of a pair of lower wing sections for a model Yankee trawl net.

Square Panels Required:

2-Belly	141 ½ x 80D
2-Upper Wing	50 ½ x 30D
2-Lower Wing	52 ½ x 50D
1-Square	115 ½ x 20D

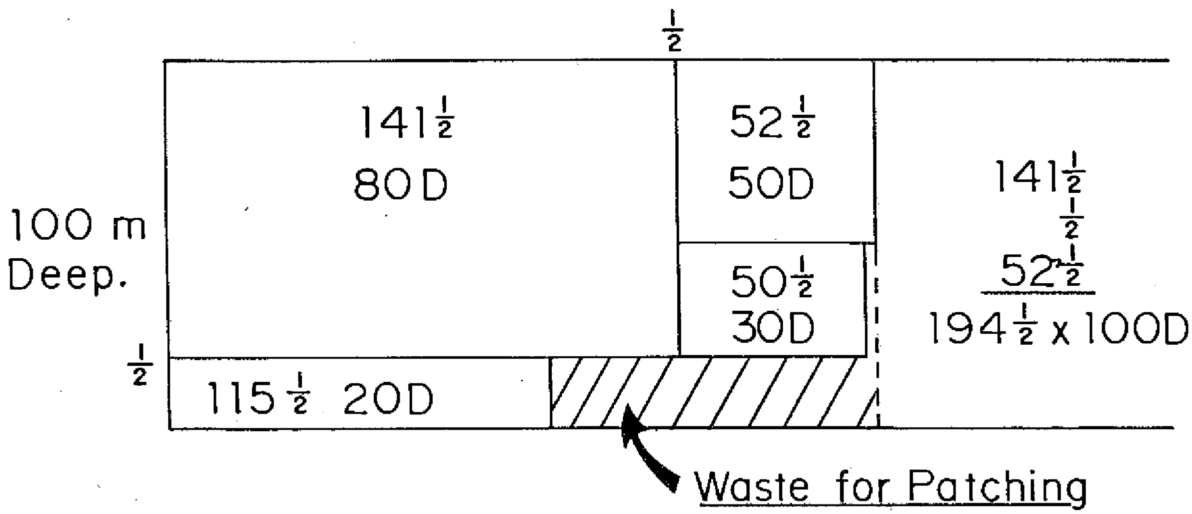

Figure 4.17. Cutting plan for the 3/4 Yankee trawl net.

The cutting plan for the model Yankee trawl net is illustrated in Figure 4.18. Note that because of the small dimensions of the panels, there is considerably more waste in the model net cutting plan compared to the full scale net cutting plan.

Square Panels Required:

2-Belly	$35\frac{1}{2}$ x 21D
2-Upper Wing	$14\frac{1}{2}$ x 8D
2-Lower Wing	$13\frac{1}{2}$ x $13\frac{1}{2}$D
1-Square	$28\frac{1}{2}$ x 5D

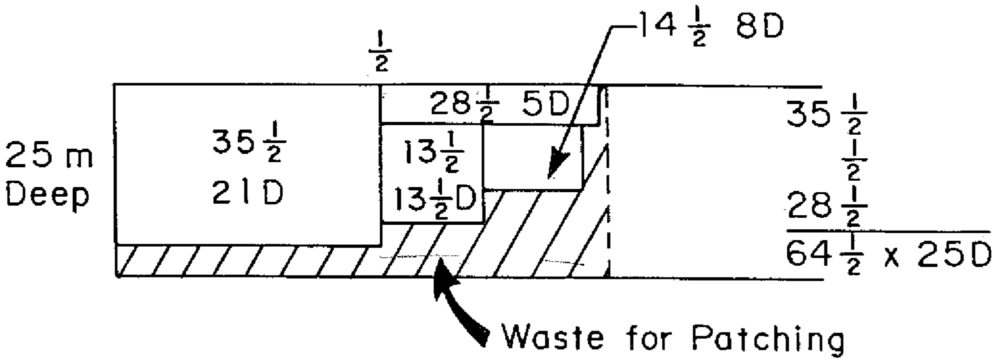

Figure 4.18. Cutting plan for the model Yankee trawl net.

4.5 Reinforcing Net Sections

4.5.1 Introduction

Prior to sewing the various net sections together to form the upper and lower panels of the net, it is advisable to reinforce the sections of webbing in areas of high stress and abrasion. The general rule is that the webbing is reinforced with double twine or extra heavy single twine wherever the webbing is attached to the mouth frame; that is, along the headrope, hanging line, and up and down line. This implies then that the wide end of the square section, the wide end of the lower belly section and the inside edges of the upper and lower wing sections are reinforced.

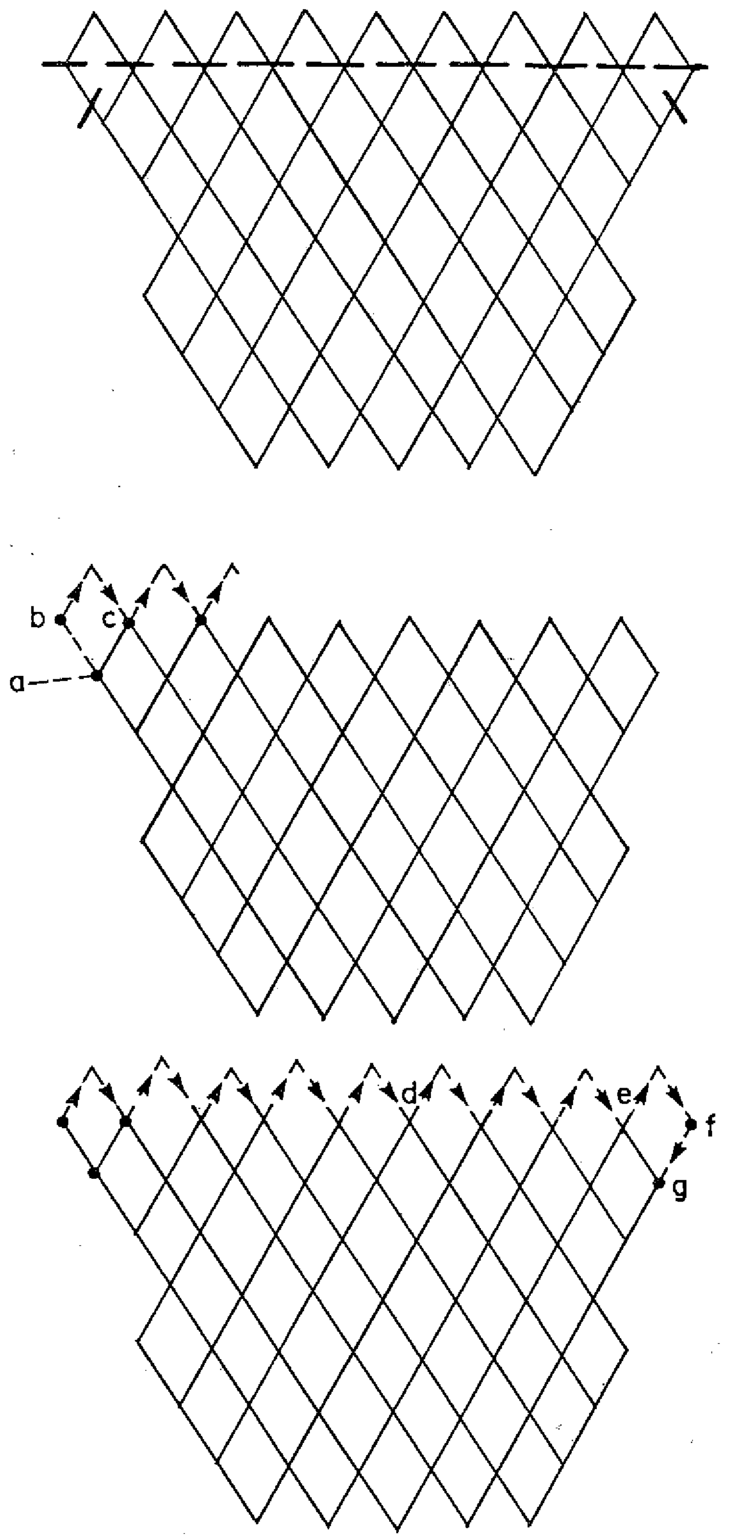

Figure 4.19. Preparation and reinforcement of a belly or square net section.

4.5.2 Reinforcing the belly and square net sections

In general, only the upper row or last half mesh of the wide end of the belly and square sections are reinforced. Although only the lower belly actually contacts the mouth frame, both the upper and lower belly sections are reinforced. The reason is that the upper and lower belly sections are interchangeable because they have the same dimensions. If a spare belly section was to be cut and reinforced, it could be used as either an upper or lower belly section.

The procedure for reinforcing a miniature belly or square net section is presented as follows and illustrated in Figure 4.19.

1.) Beginning with the complete net section, cut off the upper row or half mesh and pull out the remaining pickup knots.

2.) With double or extra heavy twine on the needle, start on the corner sider (a), make a dummy sider (b), then form a half mesh by making a pickup knot on the first mesh (c).

3.) Continue across, knitting on the 1/2 mesh with pickup knots.

4.) Make the last pickup knot on the last mesh (e), form the last half mesh (2 bars length), make a dummy sider (f), and finish on the sider (g).

4.5.3 Reinforcement of wing net sections

The inside edge of both the upper and lower wing sections of a trawl net is usually reinforced with either dog ears, dog ears plus a mesh, straight bars, or straight bars plus a mesh. To illustrate the procedure for reinforcing a wing section in detail, a miniature wing section will be prepared for reinforcement. One miniature wing section will be reinforced with dog ears, another miniature wing section will be reinforced with dog ears plus a mesh, and another miniature wing section will be reinforced with straight bars plus a mesh. Other methods of reinforcing wing sections follow from these techniques.

To prepare the wing section for reinforcement, the procedure is as follows (Figure 4.20):

1.) When cut from the webbing, both wings (upper and lower) appear as shown in Figure 4.20a. This shows a miniature wing having 7 meshes (pickups) at the wide end, 4 meshes at the narrow end and 4 meshes (siders) in depth. The inside edge is cut along the straight bars, to which dog ears are to be knitted.

2.) Starting at the first full mesh of the wide end of the wing, alternate bars are cut, and the pickup knot pulled out, (Figure 4.20b).

3.) The miniature wing section, when prepared for reinforcement, appears as illustrated in Figure 4.20c.

Dog ears are knitted onto the wing to strengthen the straight bar edge and prepare it for hanging. The knitting is always started at the wide end and proceeds toward the narrow end. The procedure is illustrated in Figure 4.21 and is described below.

1.) A needle filled with doubled twine is used (broken lines indicate double twine). The needle is tied on at (a); strictly speaking, a left sider should be used, but in practice a sheet bend is often substituted. A full mesh (dog ear) of double twine is formed and a pickup knot made at (b), the double twine is then taken to the point at (c) and a sider knot is made; from here a second dog ear is formed and the pickup knot made at (d).

2.) The procedure for dog ears is continued until the final one is made at the narrow end mesh, with its pickup knot at (e). If work stopped at this point, a three-legger would remain and it would not be possible to hang the narrow end properly. It is usual, therefore, to continue with double twine and knit an extra row on to the narrow end. From (e) the double twine is used to knit (f), (g), and (h) in turn. The knitting is finished at (h), where a three-legger remains; this location is suitable as it will later be taken up in the gore seam when the upper and lower panels of the net are joined.

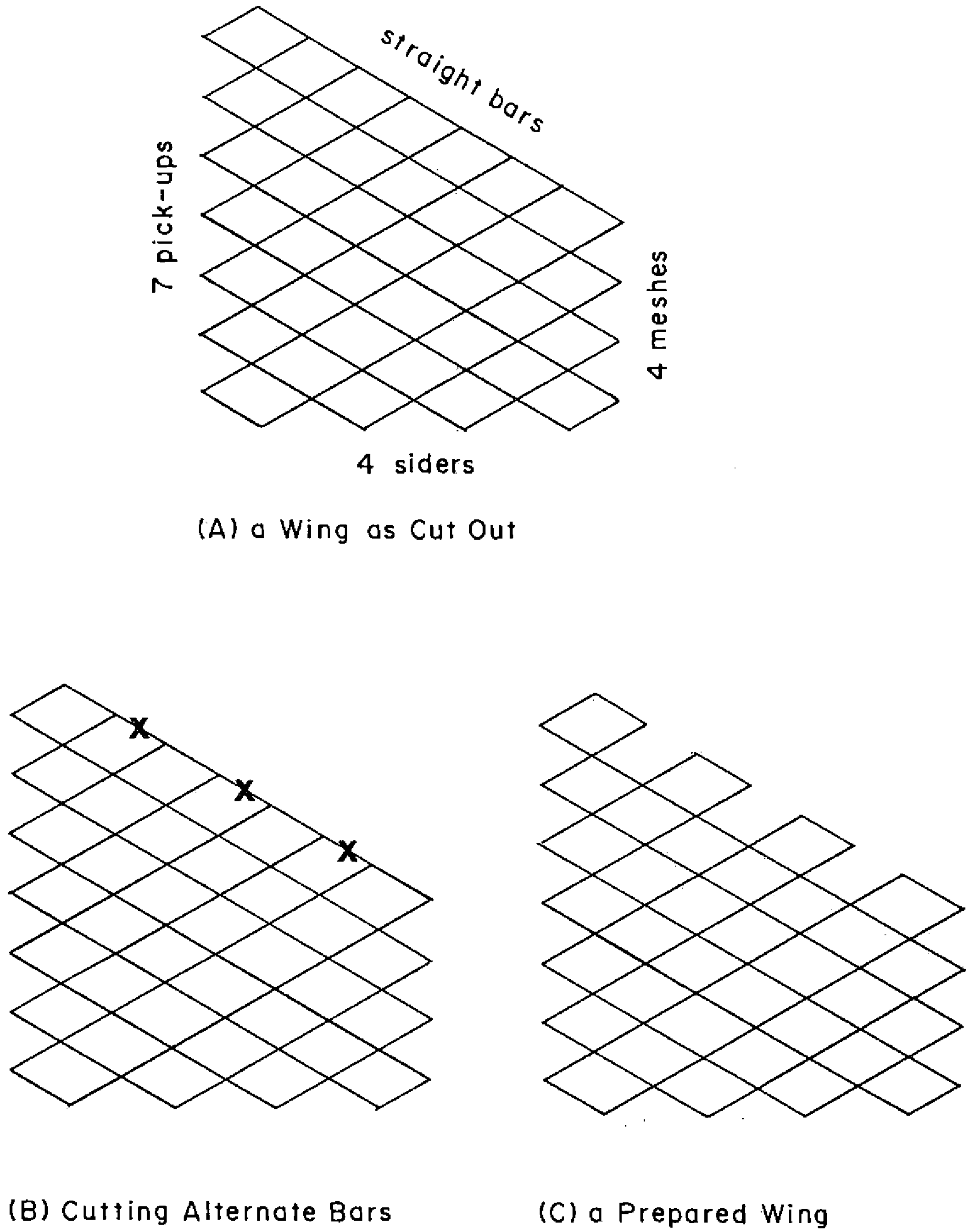

Figure 4.20. Preparation of a wing for reinforcement.

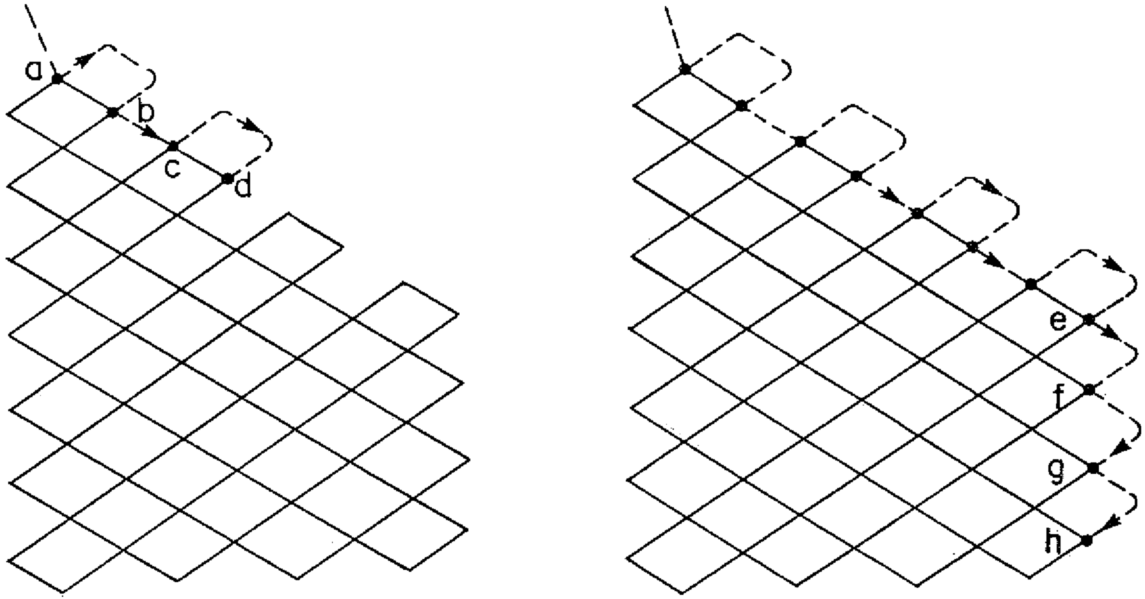

Figure 4.21. Reinforcement of a wing section with dog ears.

In some nets, a full mesh of double twine plus the dog ears is used to reinforce the wing section, although this practice is becoming less common today. If it is desired to use this arrangement, then the wing section must be cut with one less pickup in its dimensions so that when the extra double twine mesh is knitted on, it becomes the correct size. The procedure for knitting on the extra double twine mesh plus the dog ears is shown in Figure 4.22 and presented below:

1.) To begin knitting, an extra mesh must be created at the wide end to ensure the correct number of pickups are in the wing. A sheet bend of doubled twine is made at (a) leaving a long tail. The procedure for creating the mesh is to make an "around the thumb" or inverted sheet bend at (b). In practice an over-hand knot is often substituted at (b) as it is simpler.

2.) From (b) a dog ear of doubled twine is formed and a pickup knot made at (c), then to(d) with another pickup knot.

3.) The twine is now taken to (e) where a sider knot is formed, and then around to (f) with a pickup knot. Alternate bars are removed throughout the length of the wing as shown, and described previously.

4). From (f) the second dog ear is formed with a pickup knot at (g) and the procedure repeated to (h), (j), (k), (l), (m), (n), (p), (q). At this point the final dog ear has been formed and it remains to knit down the narrow end to (r), (s) and so on to the final three-legger at (t).

Many of the modern net designs specify straight bars plus a full mesh for reinforcement of the wing sections. If the net plan requires this reinforcement, the wing section must again be cut with one less pickup in its dimensions, so that when the extra double twine mesh is knitted on, it becomes the correct size. The procedure for knitting on the extra double twine mesh plus straight bars is similar to the previous example, but each dog ear is tied down to form a selvedge mesh, and this half mesh must be picked up in a baiting as the reinforcement proceeds to the narrow end. The procedure is described in detail below and illustrated in Figure 4.23.

1.) To begin the work, an extra mesh must be created at the wide end to ensure the correct number of pickups are in the wing. A sheet bend of double twine is made at (a) leaving a long tail. The procedure for creating the mesh is by making an "around the thumb" or inverted sheet bend at (b). In practice, an overhand knot is often substituted at (b) as it is simpler.

2.) A selvedge mesh is formed at (c) and a half mesh formed with a pickup knot at (d).

3.) From (d), a sider knot is made at (e), completing a mesh; a half mesh is formed and a baiting made at (f), with a pickup knot taking both the half mesh and the selvedge mesh.

4.) The knitting is continued to the narrow end, adding the extra half mesh of reinforcement, and finishing by leaving a three-legger.

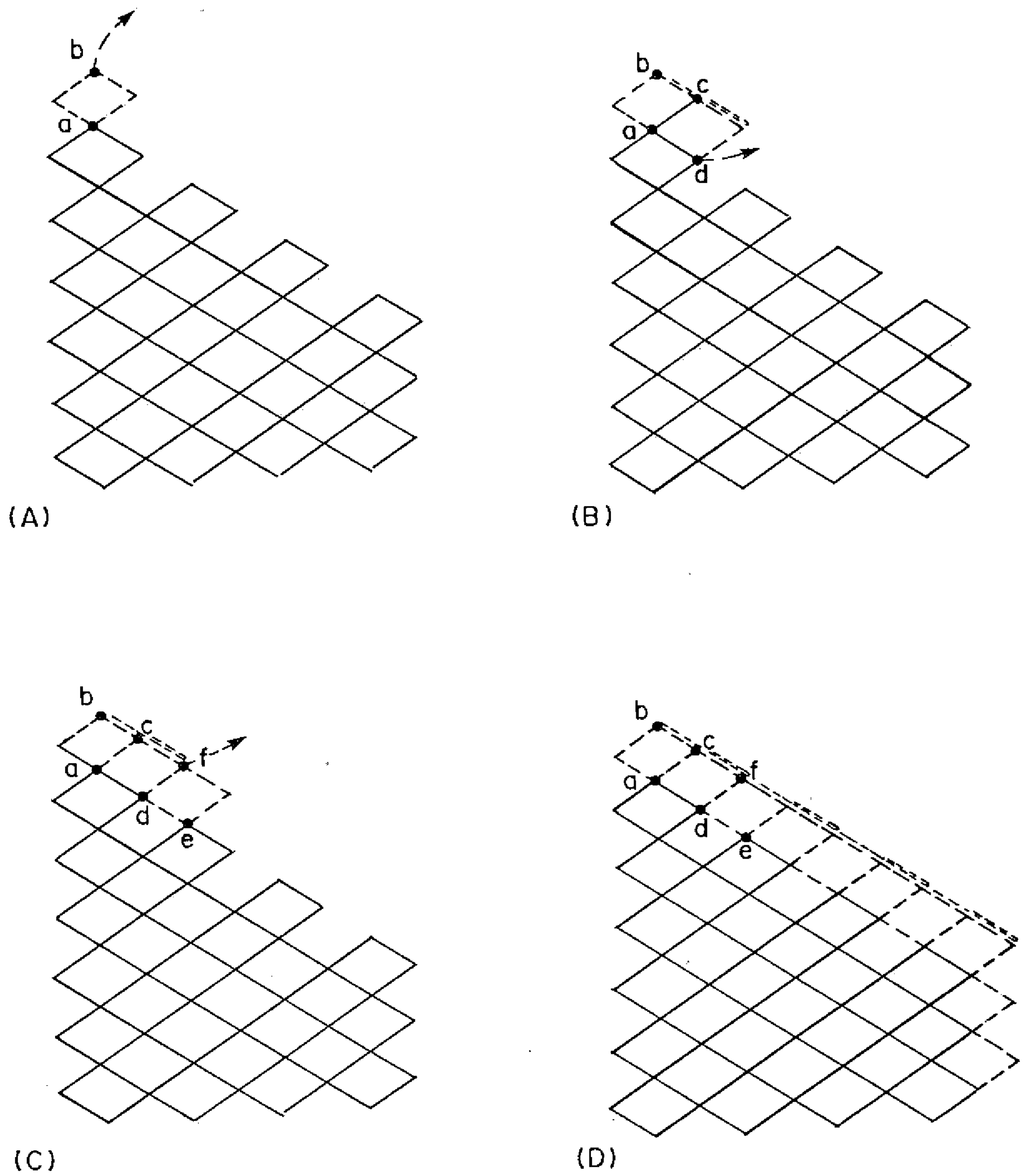

Figure 4.22. Reinforcement of a wing section with dog ears plus a full mesh.

4.6 Assembly of the Net

The net sections are made up into two panels, upper and lower, and then these are laced together. The cod-end is added later. The net sections are always sewn together with double or extra heavy twine; both for strength and to aid in the identification of the seams at a later time.

4.6.1 The upper panel

The upper panel of the net consists of two top wing sections, one square section and one belly section. Assembly is begun by laying out the square section and sewing on the two top wing sections. Sewing is started at the selvedge and proceeds toward the middle of the square. It is very important to ensure that there is a three-legger on the last dog ear or straight bar of the wing sections, so that work finishes on the three-legger. Whenever mending or sewing twine together, the needle is considered a three-legger, so that a three-legger is left on the wings to permit finishing with a square mesh.

In sewing a wing section to the square section (or to a belly section as in putting together the lower half of the net), all the meshes are first picked up, and then it is not possible to go directly to the three-legger because it will not form a square mesh. Therefore, an additional half mesh must be made on the square or belly section, then a mesh completed in the opposite direction, finishing on the three-legger of the wing section.

The procedure for sewing an upper wing section reinforced with straight bars plus a mesh to a square section is described below and illustrated for a miniature net section in Figure 4.24.

1.) Tie on with a sheet bend (pickup knot) to the outside mesh on the wide end of the wing section (a).
2.) Make a pickup knot to the outside mesh of the wide end of the square section, leaving a single bar length of twine (b).
3.) Continue sewing across the seam.
4). Make the last pickup knot on the wing section, make the next pickup knot on the square (c), form a half mesh, making a pickup knot on the next mesh of the square (d).

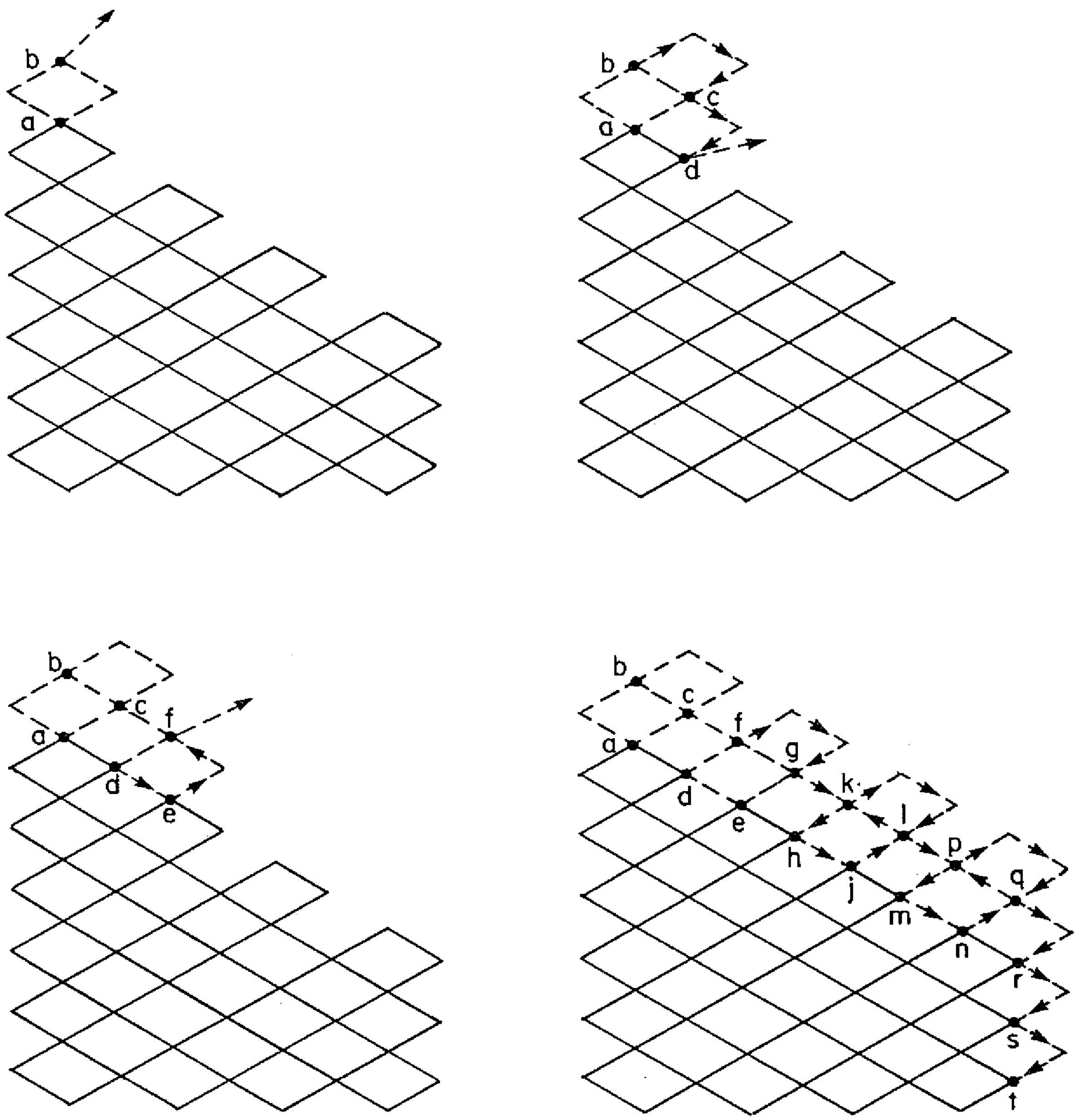

Figure 4.23. Reinforcement of a wing section with straight bars plus a full mesh.

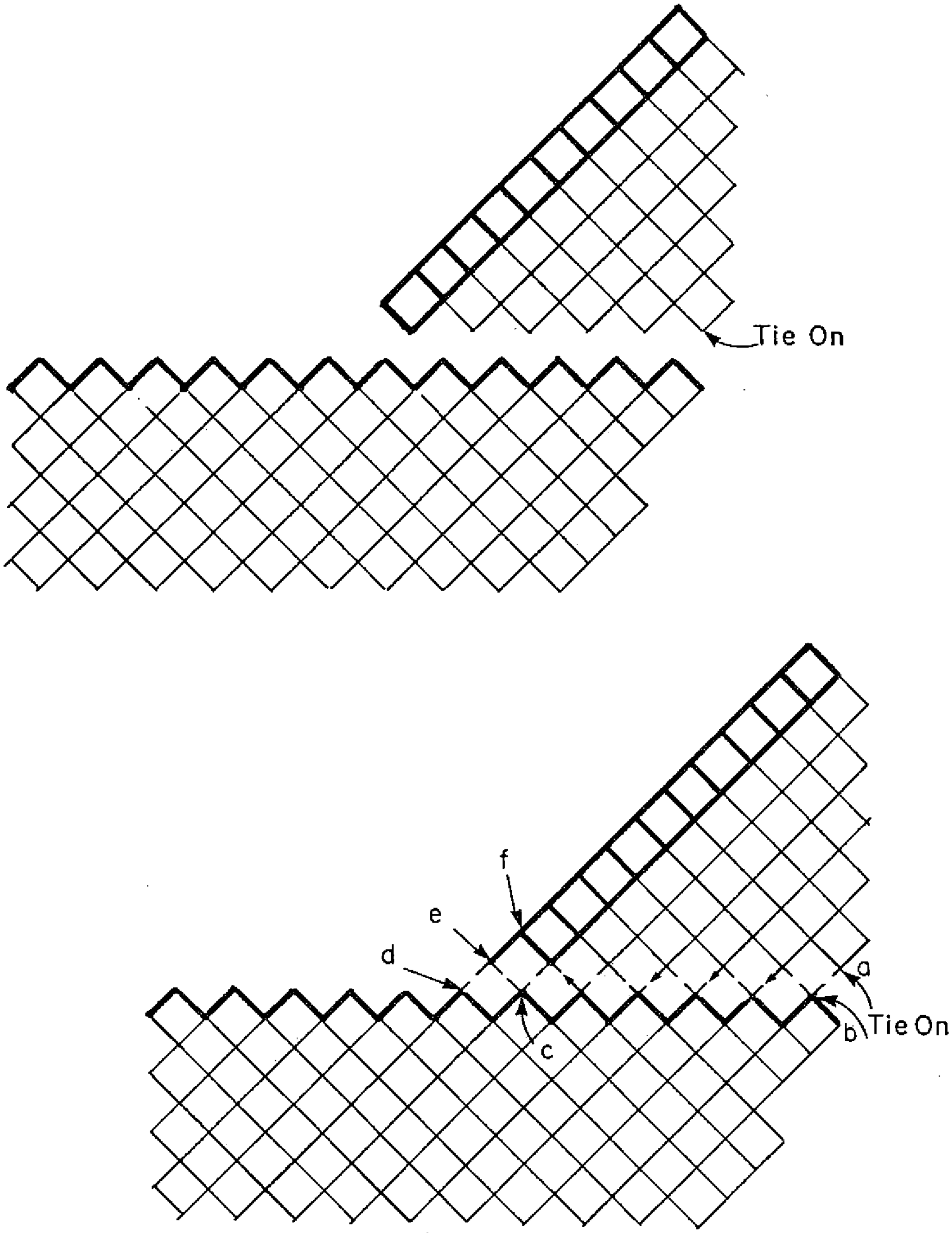

Figure 4.24. Sewing a reinforced (straight bars plus a mesh) wing section to a square section.

5.) Make a double hitch or rolling hitch at one bar length on the half mesh (e), and finish on the three-legger of the straight bar selvedge of the wing (f).

After the sewing of the wing section to the square section is complete, the seam between the square and belly sections is made by sewing in the usual manner. In many of the modern net designs, the narrow end of the square section is one mesh greater than the wide end of the belly section. Therefore, the needle is first tied on the narrow end corner mesh of the square section, then tied at one bars length to the wide end corner mesh and sewn across from there; the wide end of the belly section will lie evenly within the narrow end of the square section following the general trend of the net tapers. If both the narrow end of the square section and the wide end of the belly section are the same number of meshes, then when the sections are sewn together, one section will be offset by a half mesh from the other.

The assembly of the upper panel of the model Yankee trawl net is illustrated in Figure 4.25. Note that the upper wing sections were reinforced with straight bars plus a mesh. The upper wing sections are sewn to the square section using the procedure described above.

4.6.2 The lower panel

The lower panel of the net is sewn together in exactly the same manner as the upper panel. However, in this case, the lower wing sections are, of course, sewn directly to the lower belly section. The lower wings in this example are reinforced with dog ears plus a full mesh, and the procedure for finishing the sewing is slightly different. This is described below and illustrated in Figure 4.26.

1.) The sewing begins by tying onto the outside mesh on the wide end of the wing section (a).

2.) A pickup knot is made on the outside mesh of the wide end of the belly section, leaving a single bar length of twine (b).

3.) Continue sewing across the seam.

4.) Make the last pickup knot on the wing section (c), make the pickup knot on the belly section (d), form a half mesh making another pickup knot on the next mesh of the belly section (e).

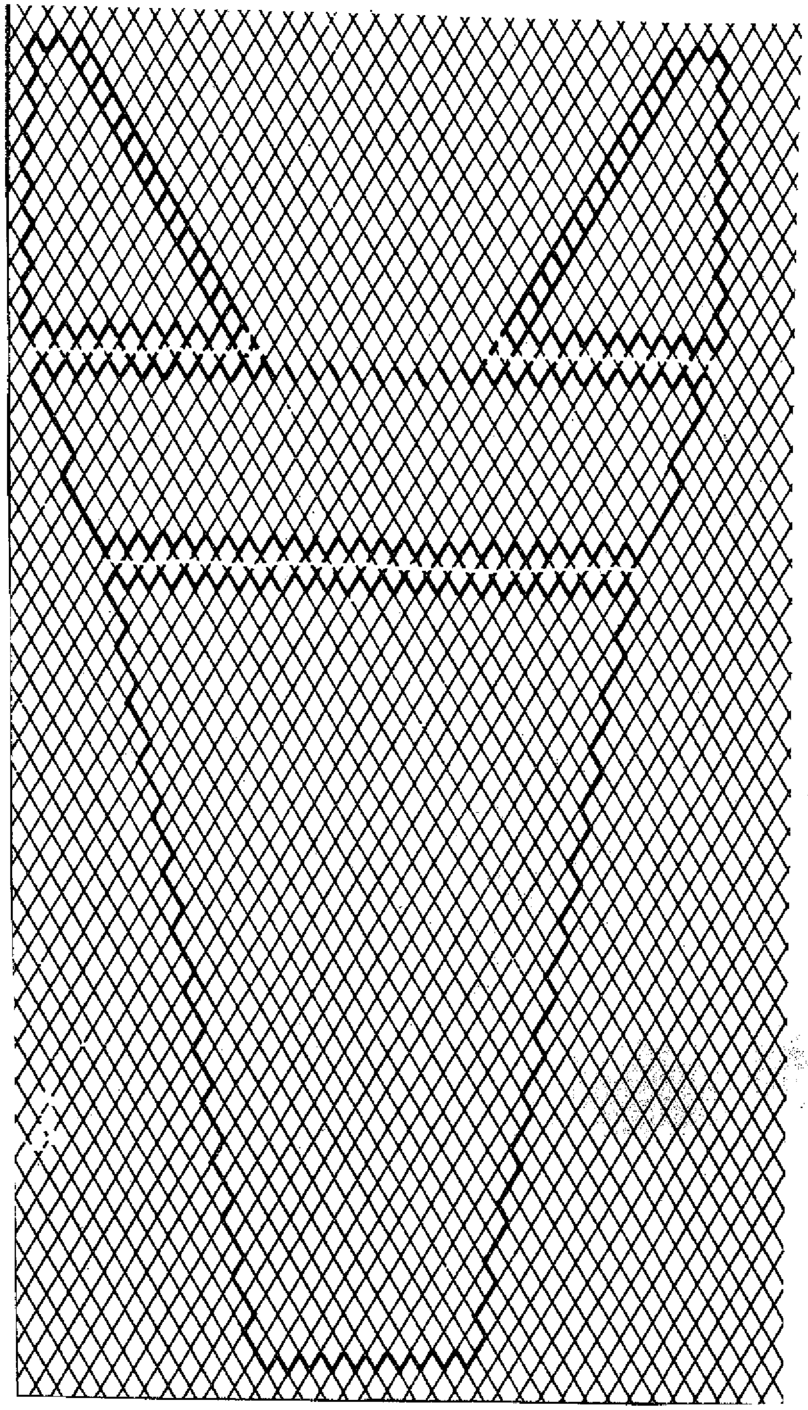

Figure 4.25. Assembly of the upper panel of the model Yankee trawl.

5.) Form the quarter dog, with three bars length of twine, and make a pickup knot into the half mesh previously formed; (f) finish on the three-legger of the dog ear reinforcement on the wing section (g).

The assembly of the lower panel of the model Yankee trawl net is illustrated in Figure 4.27. Note that the lower wings were reinforced with dog ears plus a full mesh. The lower wing sections are sewn to the lower belly section using the procedure described previously.

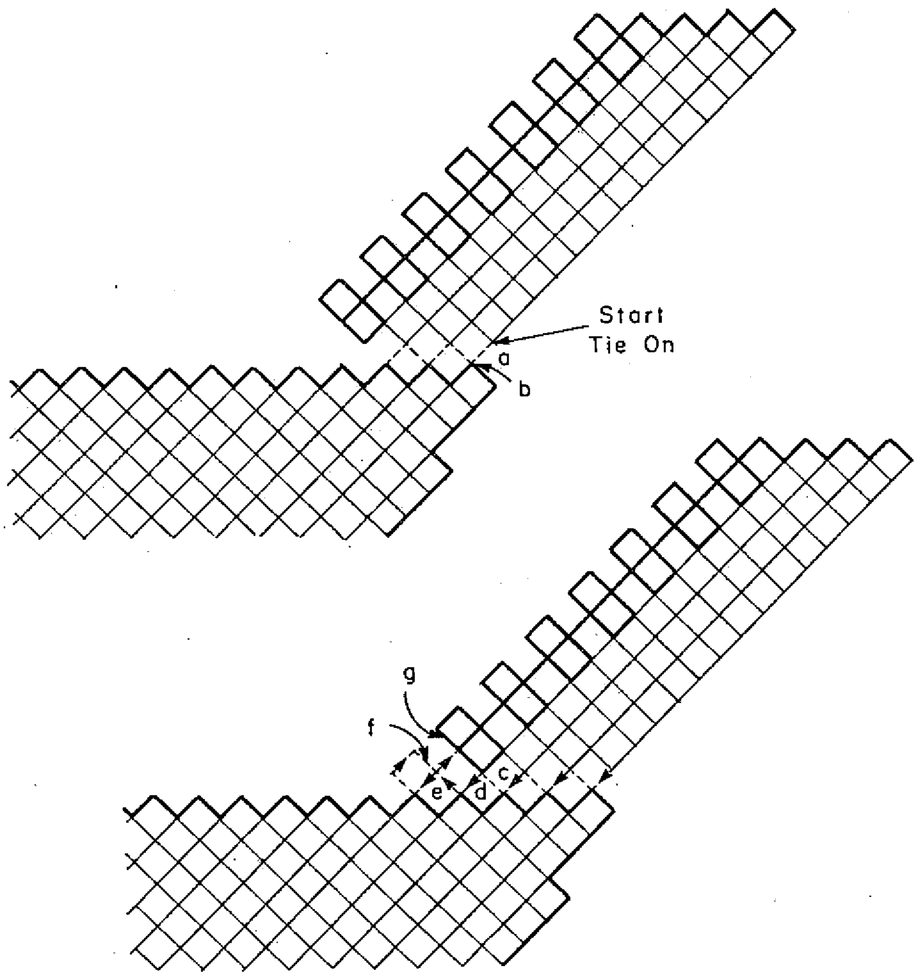

Figure 4.26. Sewing a reinforced (dog ears plus a mesh) wing section to a belly section.

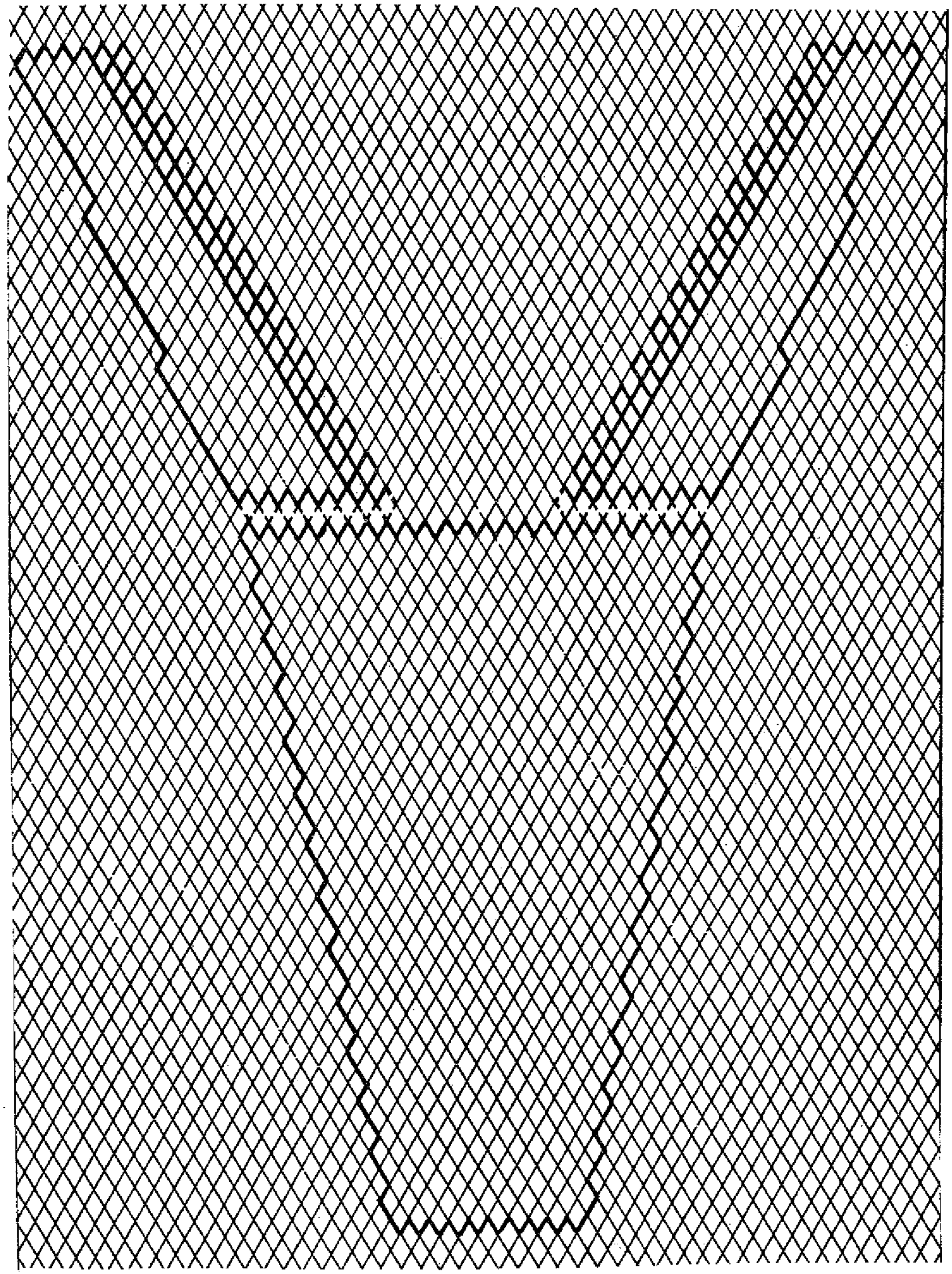

Figure 4.27. Assembly of the lower panel of the model Yankee trawl.

4.6.3 Lacing the upper and lower panels together

Once the upper and lower panels have been assembled, they are laced together, resulting in a gore seam (Figure 4.28). To prepare for this, the lower panel is stretched out lengthwise and the narrow end of the belly section hung on a nail or cleat, allowing three meshes on each side for laceage. The upper panel is then placed adjacent to the lower panel and hung up in the same way. Both belly sections are now stretched out together, care being taken to ensure that the wide ends are exactly even.

To begin lacing, three mesh widths of twine from each of the upper and lower belly sections are gathered, brought together, and the needle tied on with half hitches or a rolling hitch. At a distance of about one foot along the seam from this position, the hitches are repeated and the length of seam between these locations laced together using round turns. The procedure is continued for the length of the gore seams. It is done in this manner so that in the event of the twine becoming broken between the secured points, the whole seam does not open up.

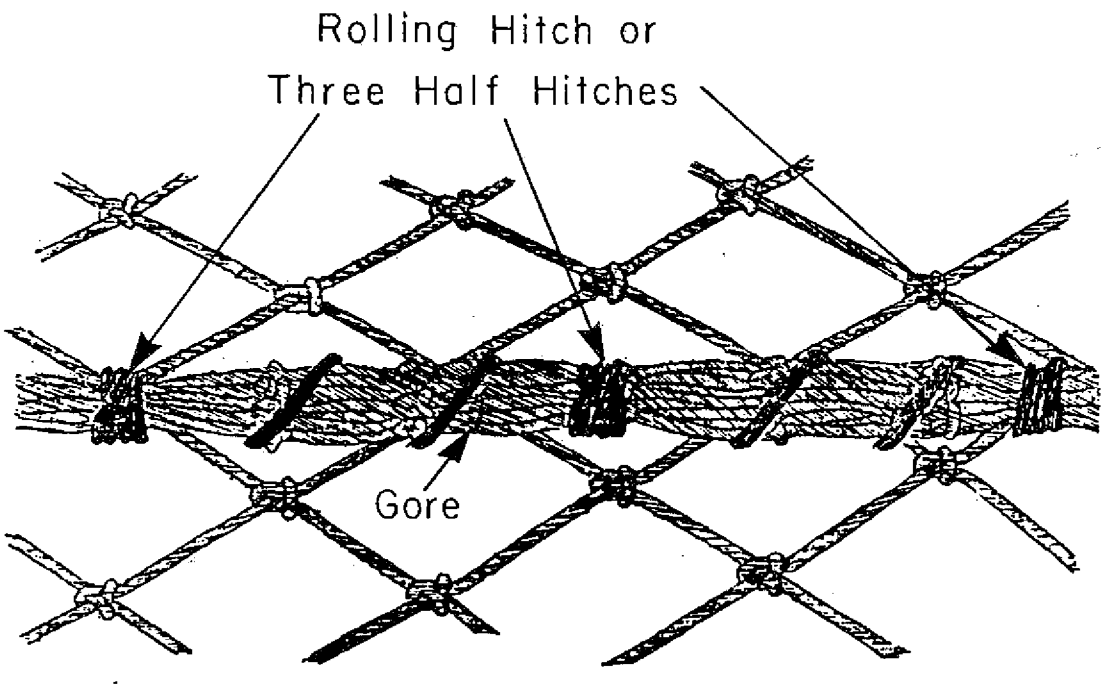

Figure 4.28. Lacing the upper and lower panels with the resulting gore seam.

When lacing of both sides of the belly sections is complete, the wing and square sections are stretched out and laced. The same operation is carried out for these sections with three meshes from each of the upper and lower wings gathered on the seam.

4.7 Hanging the Net to the Mouth Frame

The assembled trawl net is now ready for attachment to the mouth frame. But, first the dimensions of the mouth frame pieces (headrope, up and down line, hanging line) must be determined.

4.7.1 Hanging ratio

When attaching webbing to rope, the twineperson must determine the amount of webbing to hang to a given length of rope. The Hanging Ratio is the ratio of stretched rope to stretched webbing. For example, in the 3/4 Yankee trawl net described in this manual, the stretched webbing mesh size is 14.0 cm. If one mesh of 14.0 cm webbing is attached to 14.0 cm of rope, the hanging ratio is 1:1. Likewise, if two 14.0 cm meshes are attached to 14.0 cm of rope, the hanging ratio is 1:2. In general, the wing sections of most trawl nets are attached to the mouth frame with a hanging ratio of 1:1. The meshes in the bosum of the lower belly and square sections are attached with a hanging ratio of 1:2, as are the meshes in the door ends of the wings of the Yankee trawl nets.

4.7.2 The mouth frame dimensions

The frame around the mouth of the net consists of three different parts: the headrope, the hanging line, and the up and down line. Normally, the mouth frame is made from combination wire rope, (a six stranded wire with each wire strand covered with a fiber wrapper). The size of wire used depends on the size of the net, although the most common sizes are between 1.27 cm and 2.5 cm in diameter. On a smaller trawl net, Poly Dac, a synthetic fiber rope, is sometimes used for the mouth frame. This type of fiber rope has minimal elongation, high strength, and good abrasion resistance.

The dimensions of the mouth frame parts must be determined in individual sections based on the hanging ratio, the number of meshes, and the mesh size in the net section. The total headrope length consists of two upper wing sections along the dog ears or straight bars of the wings, and a bosum section for the meshes of the square.

The hanging line consists of two lower wing sections along the dog ears or straight bars of the wings, and a bosum section along the meshes of the lower belly. The up and down line of the Yankee trawl net series is a single section along the door ends of the upper and lower wings.

For the 3/4 Yankee trawl net, the upper wing sections are 30 meshes deep, plus a half mesh of reinforcement at the door end. The mesh size is 14.0 cm and the hanging ratio is 1:1. Therefore, the wing section of the headrope is:

(30 1/2 meshes) (14.0 cm) (1 m/100 cm) (1/1) = 4.26 m.

The wide end of the square section of the 3/4 Yankee trawl net is 120 meshes. Each of the upper wing sections has a wide end of 40 meshes, and these are attached to 40 meshes each of the square section in sewing the sections together. One additional mesh is lost in the sewing process at each quarter. Therefore, the bosum of the square section is (120-40-40-2), 38 meshes. The mesh size is 14.0 cm and the hanging ratio is 1:2. The length of the bosum section of the headrope is:

(38 meshes) (14.0 cm) (1 m/100 cm)(1/2) = 2.65 meters

The total length of the headrope along the webbing is (4.26 + 4.26 + 2.65) = 11.17 meters.

The length of the hanging line of the 3/4 Yankee trawl is determined in the same manner. The lower wing sections are 50 1/2 meshes deep after reinforcement. The length of the wing section of the hanging line is:

(50 1/2 meshes) (14.0 cm)(1m/100 cm)(1/1) = 7.05 meters

The bosum of the lower belly sections is (100-30-30-2), 38 meshes. The bosum section of the hanging line is:

(38 meshes) (14.0 cm) (1m/100 cm) (1/2) = 2.65 meters

The total length of the hanging line along the webbing is:

7.05 + 7.05 + 2.65 = 16.75 meters

The length of the up and down line for the 3/4 Yankee is based on the number of meshes in the door end of the upper and lower wing sections, less the meshes laced into the gore seam. In this case, there are 30 meshes in the door ends, less 6 meshes in the gore seam, which leaves 24 for the up and down line. These meshes are attached with a hanging ratio of 1:2. The length of the up and down line along the webbing is:

(24 meshes) (14.0 cm) (1 m/100 cm) (1/2) = 1.68 m.

The mouth frame of the model Yankee trawl net is made following the same procedure as was outlined for the full scale trawl net, except that the mesh size of the webbing is 3.8 cm, and the dimensions of the sections are also smaller.

The headrope is made from three sections:

Wing Sections = (8 1/2 meshes) (3.8 cm) (1/1)
= 32.4 cm

Square Bosum Section = (9 meshes) (3.8 cm) (1/2)
= 17.15 cm

The total length of the headrope is 81.95 cm.

The hanging line is made from three sections:

Wing Sections = (14 meshes) (3.8 cm) (1/1)
= 53.34 cm

Belly Bosum Section = (8 meshes) (3.8 cm) (1/2)
= 15.24 cm

The total length of the hanging line is 121.92 cm

The length of the up and down line is:

(7 meshes) (3.8 cm) (1/2)
= 13.34 cm

4.7.3 Headrope and hanging line construction

The headrope and hanging line may be made in a number of different ways. Each arrangement has advantages and disadvantages.

A one piece headrope or hanging line has some advantages. There are only two splices, thus saving time and money. There are no wire-ends to catch the hands except at the very ends. However, this arrangement has some particular disadvantages. Marks must be put in the middle and at each quarter where the wings start. Very often these marks wear out, get moved or covered up by a float. In such a case, the position for the quarter may easily be changed during mending so that the net tears up due to uneven strain. This means that constant measuring and marking is necessary. Also, if the headrope breaks, it means replacing the complete rope.

A three piece headrope or hanging line has some advantages. If one length breaks, it can be replaced easily and with a minimum of work. The top wing sections are hung on the one piece of the required length and the bosum sections are hung on another piece of the required length. There is no need to mark the headrope or hanging line at the quarters, as the position is clearly and permanently marked by the eyes joining the pieces, and it is simple to check the position of the quarters at any time. The disadvantages of the method are clear. Greater costs because more rope is needed to make the three piece headrope or hanging line due to the six eyes involved. Two sizes of spare lengths must be carried, or alternatively must be made up at sea.

4.7.4 Hanging the webbing to the mouth frame

The method of attaching the webbing of net section to the mouth frame depends on the type of reinforcing used on the wing section. If the wing section has been reinforced with dog ears, then the webbing is generally hung to the rope with yorkings and a rolling hitch. The length or distance between the hitches is the same as the mesh size, and two half dog ears are hung per tie, resulting in a hanging ratio of 1:1 (Figure 4.29a). When the wing sections are hung in this manner, the same procedure is used to hang the meshes of the bosum, except that the tie length, or distance between the hitches, is half a mesh length, resulting in a hanging ratio of 1:2 (Figure 4.29b).

If the wings were reinforced with straight bars, then the webbing is generally hung by seizing the reinforced edge of the webbing directly to the rope with rolling hitches and a round turn. The tie length is one half the mesh size, but only one bar or half mesh is hung per tie, resulting in a hanging ratio of 1:1 (Figure 4.30a). When the wing sections are hung in this manner, the same procedure is used to hang the meshes of the bosum. The tie length is one half mesh length, and one pickup is seized per tie, resulting in a hanging ratio of 1:2 (Figure 30b).

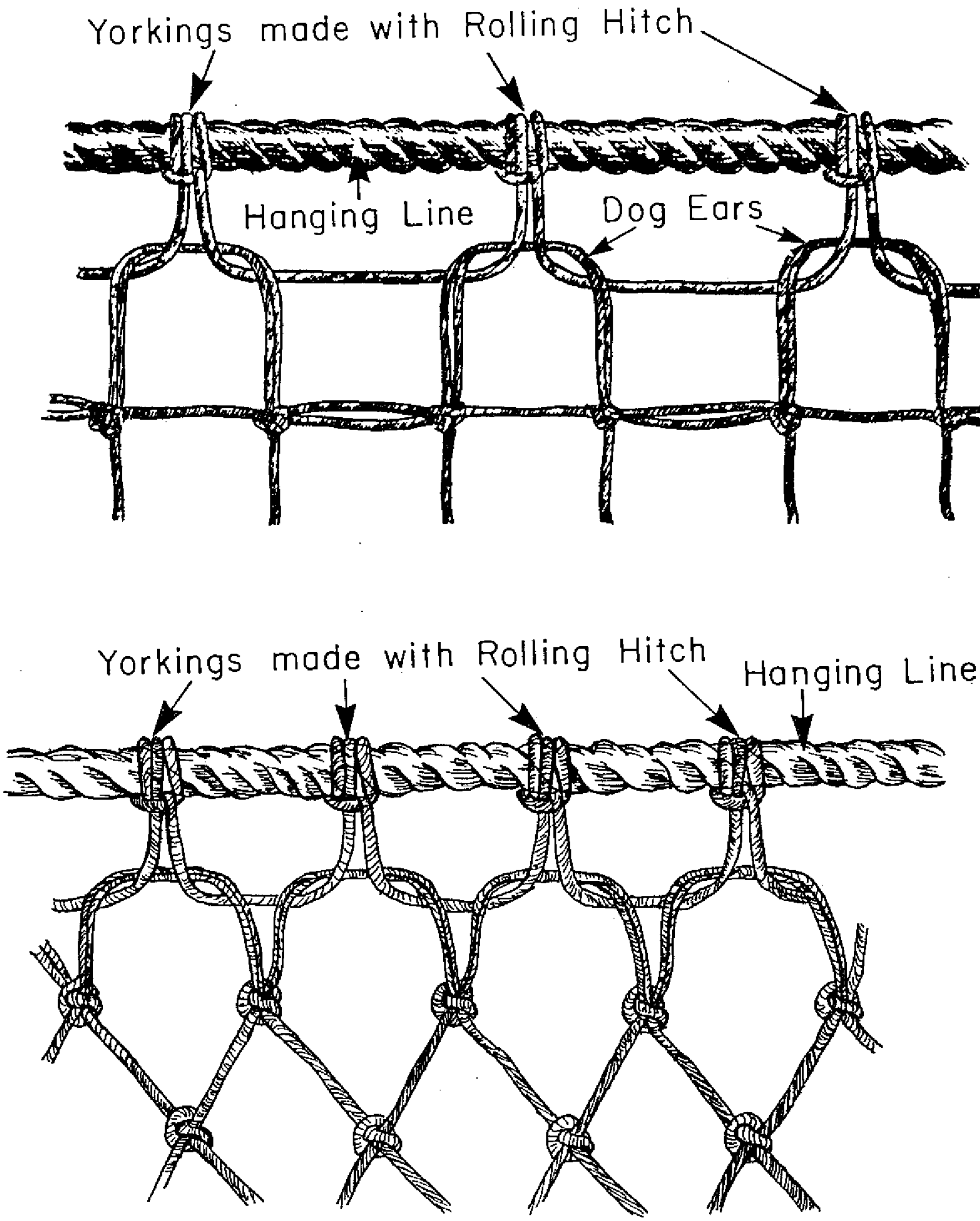

Figure 4.29. Hanging dog ears and meshes with yorkings and rolling hitches.

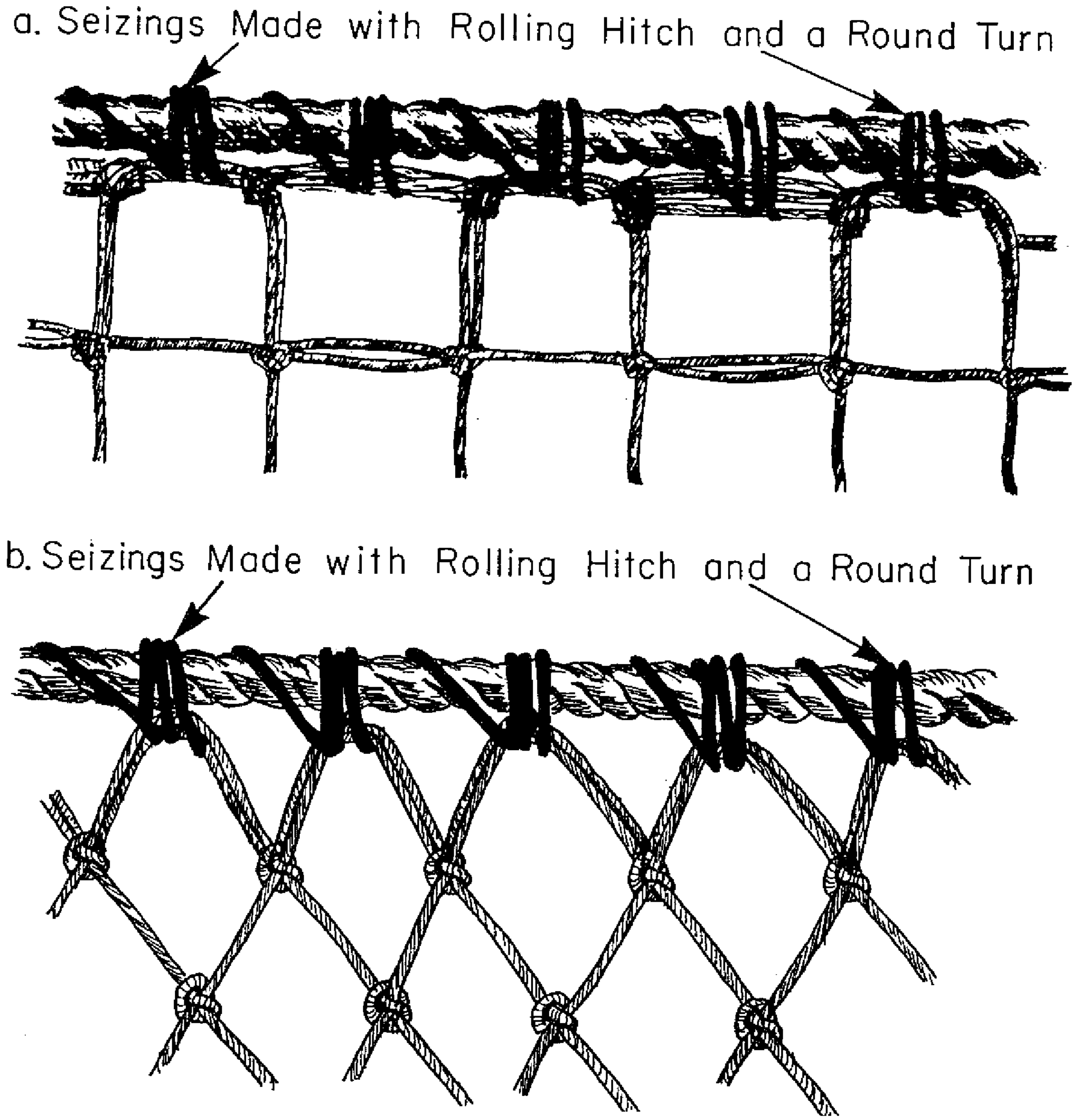

Figure 4.30. Hanging straight bars and meshes with seizings.

4.8 Rigging the Trawl Net

4.8.1 Sweep

The footrope, or sweep, outlines the bottom of the net mouth. It is attached to the hanging line along the forward edge of the bottom belly section and the lower wing sections. The twine may be connected directly to the sweep, but usually is attached to a hanging line which is in turn connected to the sweep. This latter arrangement allows the sweep to be changed easily, depending on fishing conditions. A number of different types of sweeps are in use today, depending upon the bottom being fished. Several of the most common types are described below:

1.) Simple Combination Chain Loop and Wire Sweep, (Figure 4.31a). A length of combination wire rope similar to that used for the hanging line and a length of chain in loops are used as the sweep. Chain is used to provide the weight necessary to ensure that the sweep tends bottom. The chain is fastened each 30.5 cm by a split link hammered flat around the double wire rope. The depth of the chain loops and the weight of the chain determines the distance between the bottom and the webbing of the trawl net.

2.) Rubber Hose Sweep, (Figure 4.31b). A rubber hose is cut in pieces 30.5 cm in length and the wire rope passed through it. In order to attach the chain to the hanging line, a shackle is placed around the wire, and a scallop ring is attached to the shackle on the net side of the wire. This scallop ring lays along the hanging line and may easily be seized to it. The shackle may also be passed through appropriate links of a continuous piece of looped chain (to provide the weight). Normally 0.79 cm to 1.3 cm chain is used, hung in bights about 35.6 cm in length for each 30 cm of wire. Chain may replace the wire through the hose, especially in the case of smaller vessels.

3.) Rubber Cookie Sweep, (Figure 4.31c).

A modern rubber cookie or disc sweep is constructed from discs that are stamped from old car and truck tires and are usually available in diameters of 5, 7.6, 10, 12.7, and 15 cm. Holes are stamped through the center, of 1.3 cm up to 7.6 cm. The rubber discs are strung on a chain. Rings are usually seized to the hanging line at appropriate intervals (approximately 30 cm) and shackles used to connect the chain to each ring. This allows quick changeover of sweeps if necessary. The chain is sometimes replaced with wire, and lead cookies are alternated with rubber cookies to provide the necessary weight.

4.) Roller Sweep (Figure 4.32).

The roller sweep is designed for use on hard bottom. The modern gear employs rollers and spacers made of solid rubber. Rollers may vary in diameter from 25.4 to 50.8 cm, and the spacers are usually 15 cm. Depending on fishing conditions, a roller sweep extending up to the full length of the hanging line may be used; often a roller sweep is used only at the bosum (between the quarters) with a rubber cookie sweep used for the wing sections. Both rollers and spacers are extremely expensive, so that in order to minimize the loss should a sweep part, roller sweeps are often made in short lengths of 2.4 to 3.0 m and then shackled together. Basically, the roller sweep is constructed by stringing the rollers and spacers on a wire. The method of attachment to the hanging line is important. It must allow easy placement and removal, since the fisherman may decide to change from rollers to a lighter sweep, or vice versa, between tows. Commonly, either a fishing line or a zipper chain is used. With the former, drop chains are used as shown in Figure 4.31a, to connect the wire running through the rollers to the fishing line, a permanent wire which is then seized at appropriate intervals to the hanging line. If it is desired to remove the sweep, the seizes are cut and the sweep removed in one piece. In the case of a zipper chain, rings are seized to the hanging line as shown in Figure 4.32b. A free length of chain is then passed through these rings and the rings of the drop chains that are connected to the sweep. If it is desired to remove the sweep, the zipper chain is disconnected at both ends and pulled out of the sweep rings, so that the roller sweep may be removed in one piece. The zipper chain is sometimes replaced with a wire.

The sweep is usually attached to the hanging line with the following procedure. The first step is to determine the exact centers of the hanging line and sweep, and seize the

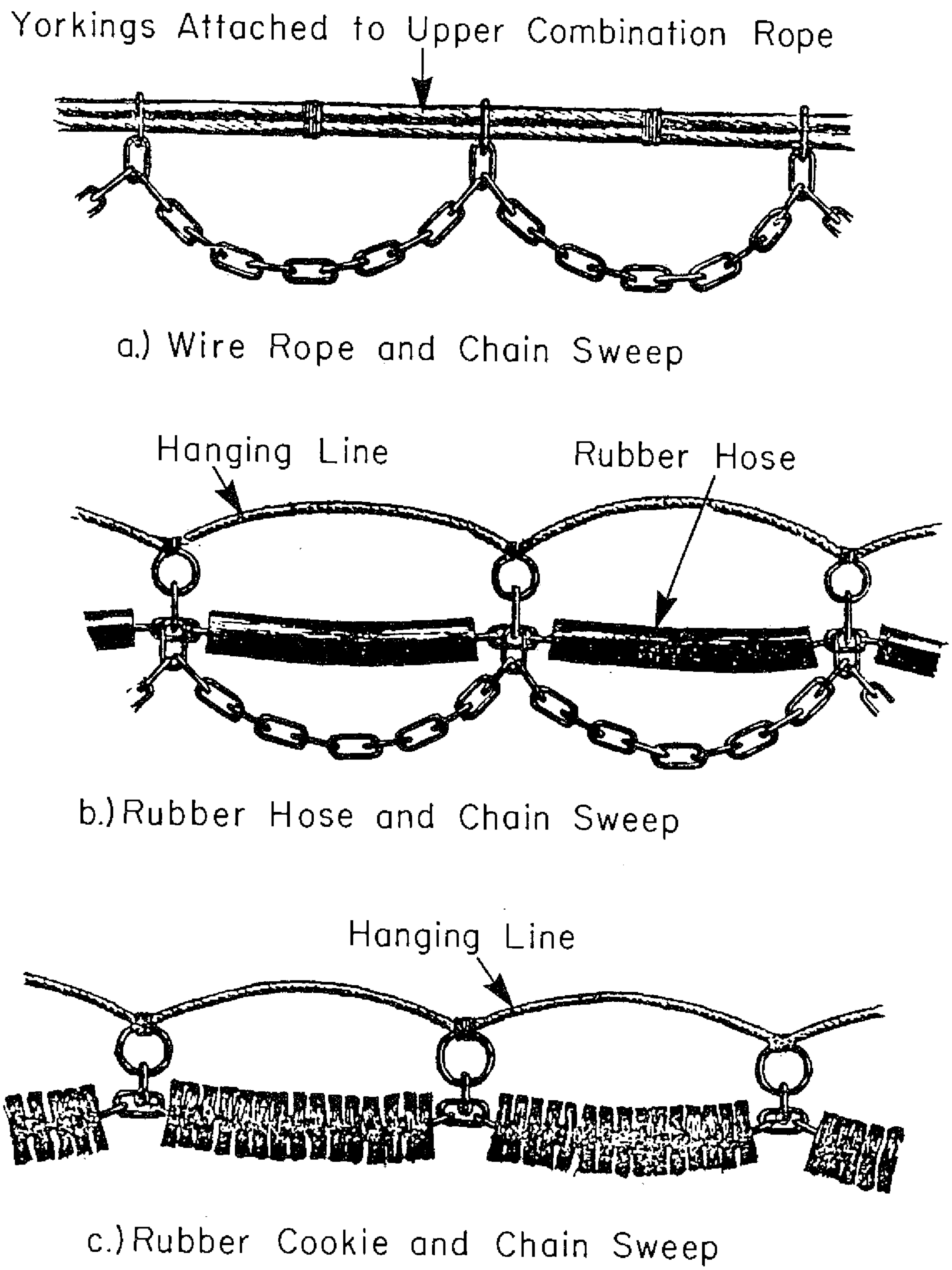

Figure 4.31. Sweep arrangements.

two together. The quarters are then positioned and stopped in place. If a chain sweep is being used, the hanging line will be attached by closing split links. If heavy rollers are used, the hanging line will be seized to a fishing line, or to rings for a zipper chain. In these cases, the rings or chain links must be "cross seized" (stopped across the rope) in order to keep the chain straight and provide a firm seizing.

To seize on a ring to the hanging line in this manner, a piece of twine about 2 meters in length is used. The ends are passed through the ring and back out through the bight of the twine forming a cow hitch. The rope is then placed on the ring, the twine taken over the rope and two half hitches made on the opposite side of the ring. The twine is then taken over the rope again to the other side, and two more half hitches formed. This procedure is repeated until about 25 cm of the doubled twine remains. The ends are now separated, one being passed one way and the other the opposite way between the hanging line and the chain several times, pulling it taut. The work is completed by tying two square knots, one on top of the other.

4.8.2 Floats

The purpose of the floats (or "cans") is to provide initial flotation to raise the headline of the net and so provide an effective open mouth area. In addition to the vertical flotation force on the headline, the floats cause drag when towing, which tends to pull the headline back and reduce the headline height. This drag effect increases markedly with the speed at which the net is towed through the water so that the number of floats to be used in any particular case requires a rather delicate balance between the benefits of buoyancy and the detriment of drag.

Standard modern floats used with trawls are approximately 20.3 cm diameter spheres constructed from aluminum or hard plastic and have about 3.2 kg of positive buoyancy. These materials have proved effective in resisting the crushing pressures exerted by the depths in which trawls work. At the same time, they are sturdy enough to resist the heavy treatment, abrasion and impact forces to which they are subjected when the net is being set and brought aboard.

4.8.3 Extension pieces

In some fisheries, it is common to extend the overall length of the net through the use of extension pieces. These are placed between the bellies and the cod-end, and

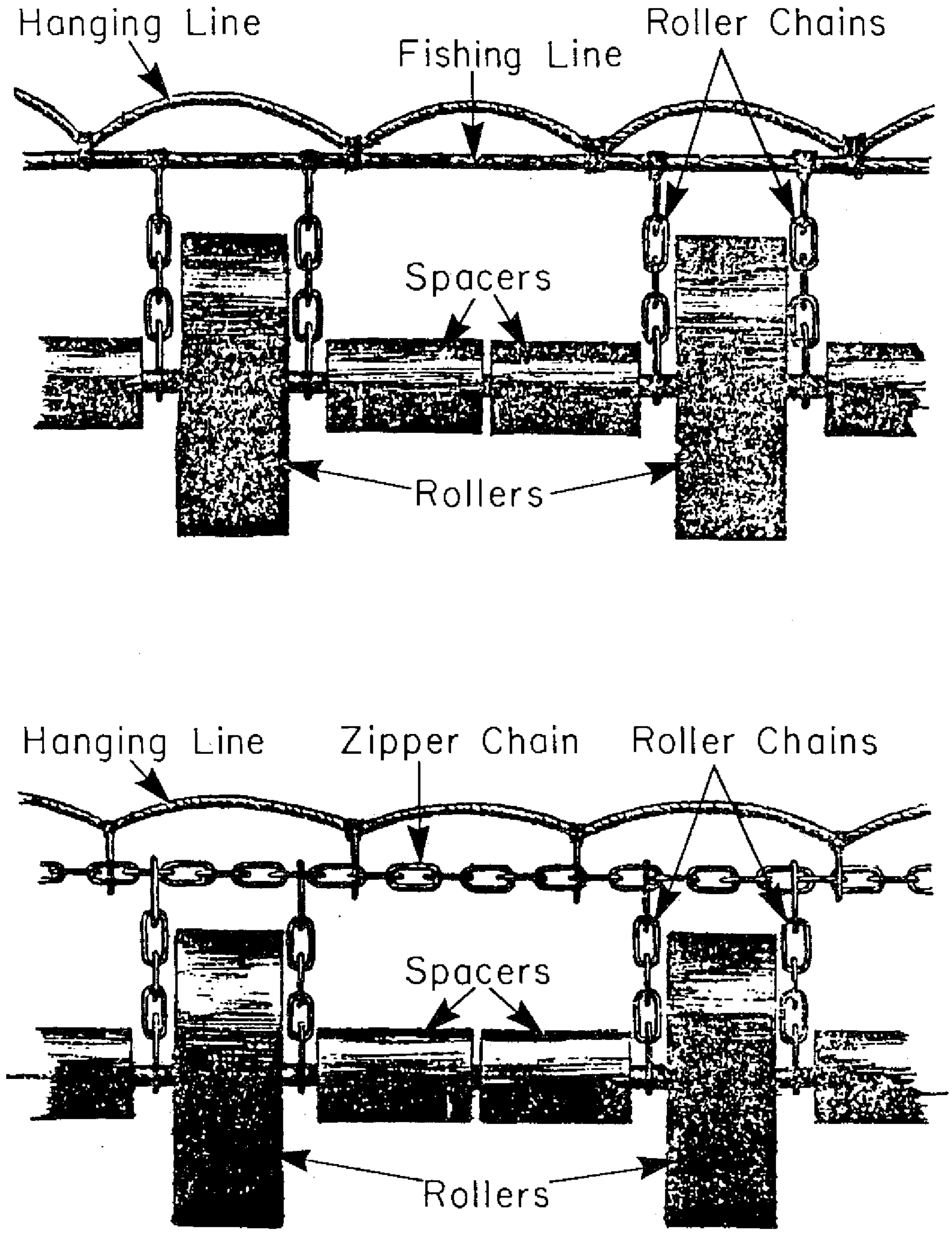

Figure 4.32. Roller sweeps.

are usually made in two sections, one for the top half and one for the bottom half of the net and then laced together in the usual manner when the net is put together.

Extension pieces may be shaped (i.e., have a taper) between the belly and the cod-end, especially in the case of larger nets, or may alternatively be square pieces of webbing of either the same or a different mesh size from the bellies. Their length will vary according to the fishery and the requirements of individual net designs or skippers.

A typical extension piece for the 3/4 Yankee net would have a depth of 50 meshes and would taper from 40 meshes in width at the belly (equal to the belly dimension) to 30 meshes at the cod-end (half the cod-end circumference). The taper of the two sections (upper and lower) required to make the complete extension tube is calculated with the same formulas presented previously. The extension section dimensions are 40 x 30 x 50 deep.

The cut is:

$$\frac{WE - NE}{2} = \frac{40 - 30}{2} = \frac{10}{2} = 5$$

The taper is:

$$\frac{2 \times C}{D - C} = \frac{2 \times 5}{50 - 5} = \frac{10}{45} \quad \frac{5B}{9P} = 4\ (1B/1P)\ /\ 1\ (1B/2P)$$

A good extension for the model Yankee trawl net is 9 x 9 x 10, with the resulting taper being all points.

4.8.4 The cod-end

The cod-end is made of extra heavy twine of a suitable mesh size. The size of the mesh must conform with any regulations which are in force to permit the escape of undersized fish. A typical inshore ground fishery uses a mesh size in the cod-end of 7.6 cm. For a 7.6 cm mesh cod-end, the standard size is 60 meshes around by 50 meshes long. As the extension sections are made 30 meshes wide at the narrow end, the 30 meshes of the cod-end can be sewn directly to the narrow end of the extension.

The tail end of the cod-end is closed up by a cod-end rope. To take this rope, rings often two inches in diameter are knitted on, one ring to two meshes. A rope, often 1.3 cm, is then passed through the rings and tied with one of the regular cod-end knots, or a cod-end tripper.

In some cases, a liner of much smaller mesh may be fitted inside the cod-end in order to retain fish or other sea life which would normally pass freely through the cod-end mesh. The liner is usually of cylindrical shape and sewn directly to the inside of the webbing, forming the cod-end at its forward end. The length of the liner should be about 30.5 cm greater than the cod-end itself. When tying, the liner should be brought out through the cod-end opening, and the rope in its rings tied tightly around it so that a "tail" remains outside the net.

When fishing on an abrasive bottom, the weight of fish trapped in the cod-end causes the twine in contact with the bottom to wear out rapidly due to the chafing effect. The harder the bottom, the more important it is to provide "chafing gear" to protect the cod-end webbing. A common technique is to use short lengths of unlaid synthetic rope tied in at each knot of the underside of the cod-end. These short lengths are tied in using a cow hitch with the free ends unraveled to provide an extended wearing surface. These wear out with the abrasion and must be replaced as necessary.

4.8.5 Working and strengthening ropes

Depending on the particular technique being used to fish the trawl, various working ropes are necessary. Typically, these may include: quarter ropes, splitting strap, bull rope, and gore lines.

The splitting strap is always fitted. It has two main purposes. First it allows easy splitting of the catch when necessary; secondly, in the case of a bad tear up when both bellies are torn off, the cod-end can be saved.

The splitting strap is placed some six feet ahead of the cod-end rope. Rings may be stopped to the twine every other mesh around the cod-end, or beckets seized on only at the gore seams. A rope (1.6 cm to 2.5 cm in diameter) is then passed around the bag through the rings or beckets and spliced or tied together (Figure 4.33). A bullrope (1.6 cm to 2.5 cm) is either tied or spliced into the splitting strap on the upper side of the net, to be taken loosely to, and tied at, the headrope.

Quarter ropes are used to lift the sweep and headrope (the net mouth) aboard a vessel which uses this technique for handling the net. They are connected to the sweep at locations which are dependent on the positioning of the quarter rope blocks aboard the vessel. Usually, they are positioned between 1.5 and 3 m each side of the center of the sweep.

Each quarter rope is taken from its fastening at the sweep rope very loosely around the outside of the net, through a becket (usually a 10 cm ring stopped to the headrope the same distance each side of its center) at the headrope, and made fast at the wing.

Connection of the quarter rope to the sweep is made by use of a quarter rope cup or bucket. These buckets are cone shaped and sized to fit the rope being used. The quarter rope is passed through the small end and knotted so that it jams when pulled tight, to avoid its chafing on the bottom. The bucket is attached by a pear link to a swivel, which is, in turn, stopped or shackled to the sweep.

When large or heavy catches in the net are anticipated, and in the case of some heavily rigged gear operating under rigorous conditions, strengthening ropes are fastened to the net to help avoid distortion and the carrying away of twine and whole parts of the net.

The most common is a gore line which is fastened along the laceage, or gore, to take the longitudinal strains at this seam. A gore line usually runs from the forward end of the wings along the laceage to the rear of the cod-end. It is particularly important in the case of nets which are designed for use with three bridles, where much of the towing strain is taken along the laceage.

Other longitudinal strengthening ropes may be used as necessary in the top and bottom panels of the net to relieve the strain on the webbing and allow it to take up a natural, unstrained shape. In order to prevent a net bursting, circumferential strengthening ropes may be used, especially in nets which are used to catch fish in bulk. In some cases, the arrangement of longitudinal and circumferential strengthening ropes may be quite sophisticated.

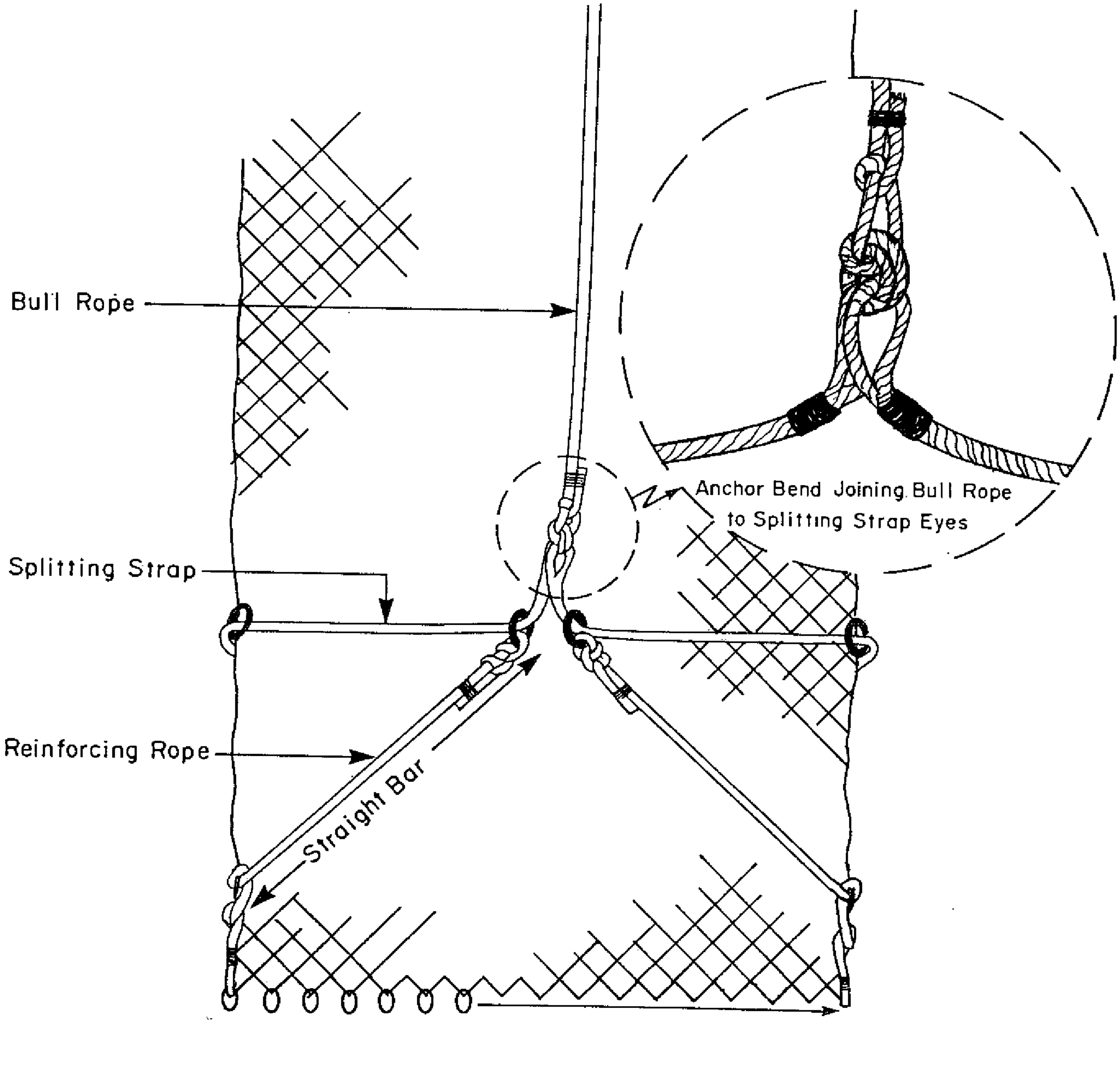

Figure 4.33. Cod-end rigging.

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BASIC NET DESIGN: FYKE NETS

5.1 Introduction

Fyke nets are traps made from netting, which are placed in bays, rivers and other inshore areas. There are many variations in the design, size and fishing methods of the fyke net (Figure 5.1).

The fyke net originated in Europe and was introduced to the East Coast of the USA in the late 19th century. Although proven effective at capturing eels, it has been modified to effectively capture flounders, white perch, sea bass, cod, and bluefish.

Fykes can be fished at water depths of 10 to 50 ft. Similar to other passive fishing gears, fykes are fuel-efficient, and easily managed and modified. The catch usually will remain alive and in good condition until extracted from the net.

5.2 Materials and Construction

Fyke nets have three distinct parts: leader, barrel, and two wings (optional). The leader and wings act to guide fish into the main body, or barrel. The barrel is essentially a hoop net constructed of frames covered with web netting or wire mesh. Fish pass through funnel shaped throats or non-return devices in the barrel and are trapped in the last section.

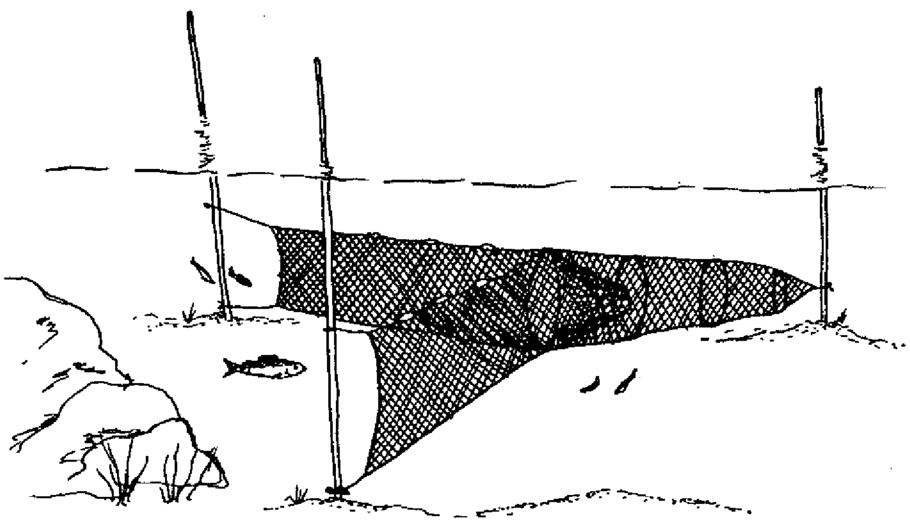

Figure 5.1. Typical arrangement of a coastal fyke net.

5.3 List Of Materials for Fyke Net

4 hoops with indicated measurements (fiberglass or other)
webbing: 136 x 168 D, 5.0 cm x 1.6 mm for the barrel
webbing: 240 x 46 D, 5.0 cm x 1.6 mm for wings and leader.

Sewing twine: 1.6 mm
Lines and anchors to set leader
Line and anchor to set end of fyke

5.4 Fyke Net Plan

The details of the fyke net plan are illustrated in Figure 5.2.

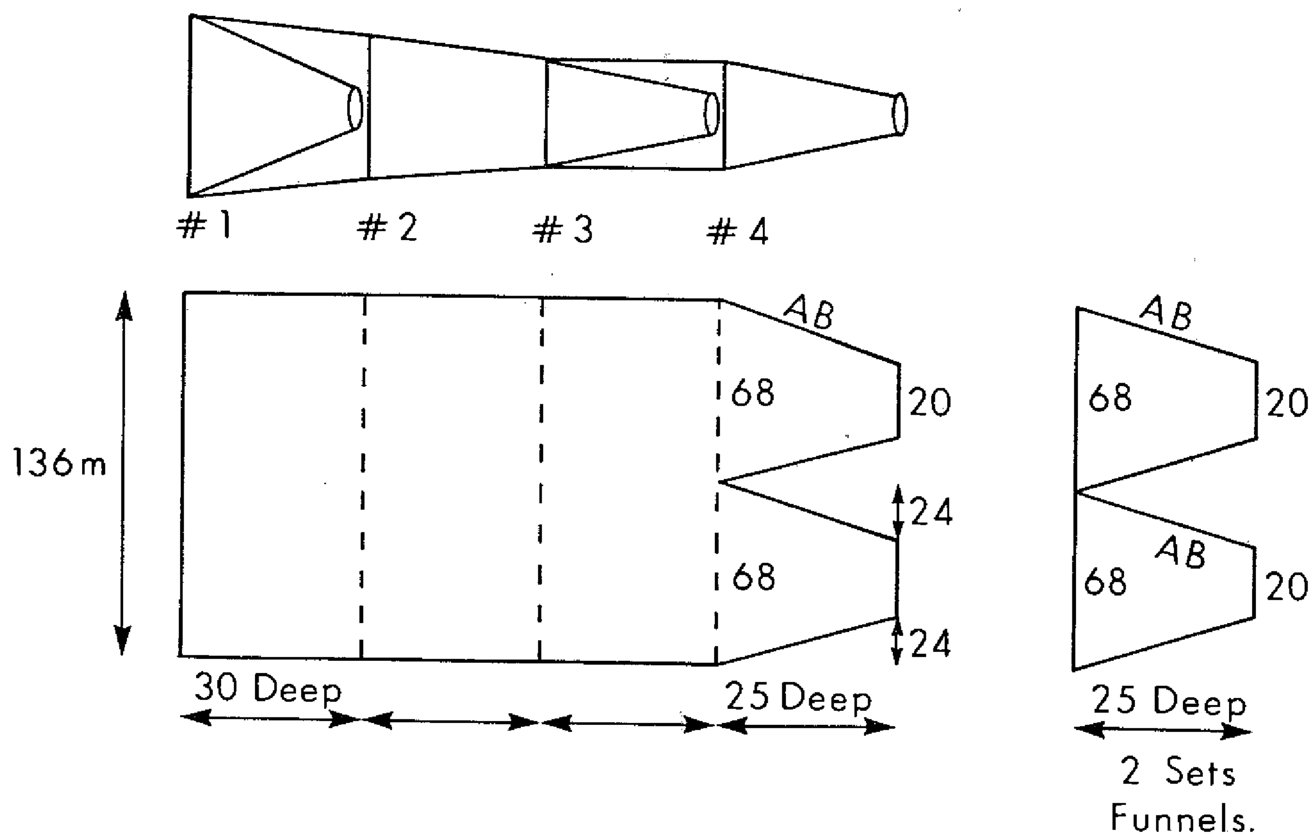

Figure 5.2. Fyke net plan.

5.5 Construction Details

5.5.1 Hoops

The net plan presented in this chapter is for a small four-hoop fyke net. Fiberglass hoops can be purchased in the diameters indicated in Table 5.1. Since fiberglass tends to splinter, it is recommended that each hoop be wrapped with heavy tape. Other materials such as galvanized steel, or wood bent in circular patterns, can be substituted.

Table 5.1. Fyke net hoop characteristics.

Hoop #	Diameter	Circumference	Hanging
#1	107 cm	336 cm	1 mesh per 2.5 cm
#2	91.4	287 cm	1 mesh per 2.2 cm
#3	76.2	239 cm	1 mesh per 1.8 cm
#4	76.2	239 cm	1 mesh per 1.8 cm

5.5.2 Funnels

Two funnels need to be constructed with the indicated measurements (Figure 5.3). These will be placed in hoops #1 and #3. The funnels are laced to the hoop with the same hanging ratio as the barrel.

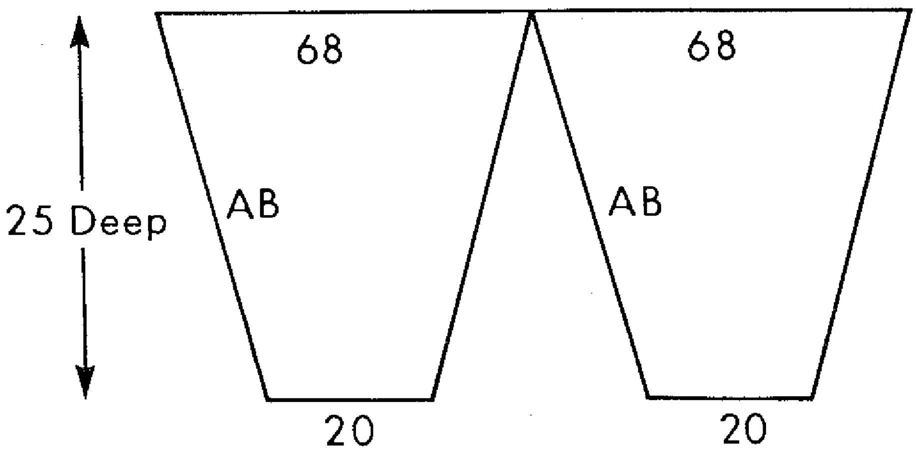

Figure 5.3. Funnel cutting plan.

Sew the two halves together at the all bars tapers to form the funnels, then sew onto the bare hoops.

5.5.3 Barrel

The fyke barrel is constructed entirely from a single piece of 50 cm mesh webbing that is rolled into a cylinder around hoops, and laced at the seam. There are 136 meshes along the mouth and 120 meshes in depth. Four all bars tapers are cut into the last section (25 meshes deep) to terminate in 20 meshes for each half of the cod-end (Figure 5.4).

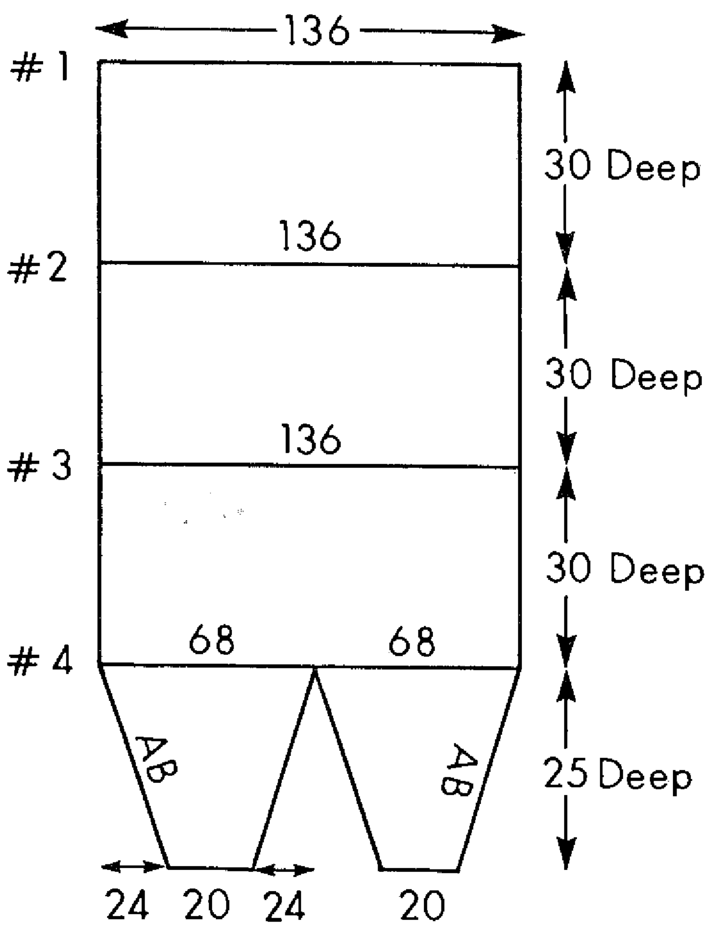

Figure 5.4. Cutting plan for barrel.

The fyke barrel is made by sewing the section to the fiberglass hoops. These hoops are placed every 30 meshes. The meshes are laced onto the hoops according to the hoop circumference. Once the barrel is attached to the hoops, the seam is sewn in the barrel section.

5.5.4 Leader

The leader is made from a single sheet of 5 cm webbing 240 meshes wide and 22 meshes deep.

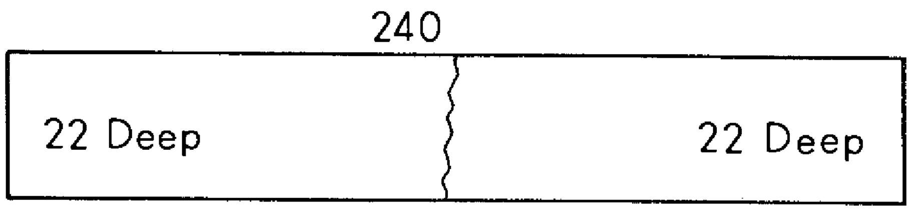

Figure 5.5. Cutting plan for the leader.

The leader is attached to a floatline of 1.0 cm braided polypropylene line with a hanging ratio of 0.5, meaning that the 240 mesh piece of webbing (12 m) will provide a 6 m leader. The leadline is similarly attached using a 1.0 cm braided polypropylene line with a 50 gram lead spaced every 30.0. The leader is then attached in the middle of the first hoop.

5.5.5 Wings

The wings are formed from a single sheet of 5 cm webbing measuring 240 meshes wide and 23 meshes deep.

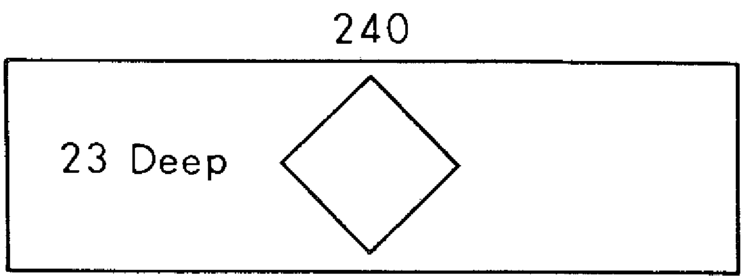

Figure 5.6. Cutting plan for the wings.

The wings will be secured to the first hoop by cutting a diamond shaped hole in the center of the webbing. Cut 19 bars down to a sider, then cut 19 bars to a pickup, and then cut 19 bars to the opposite sider and back 19 bars to the starting point (Figure 5.7).

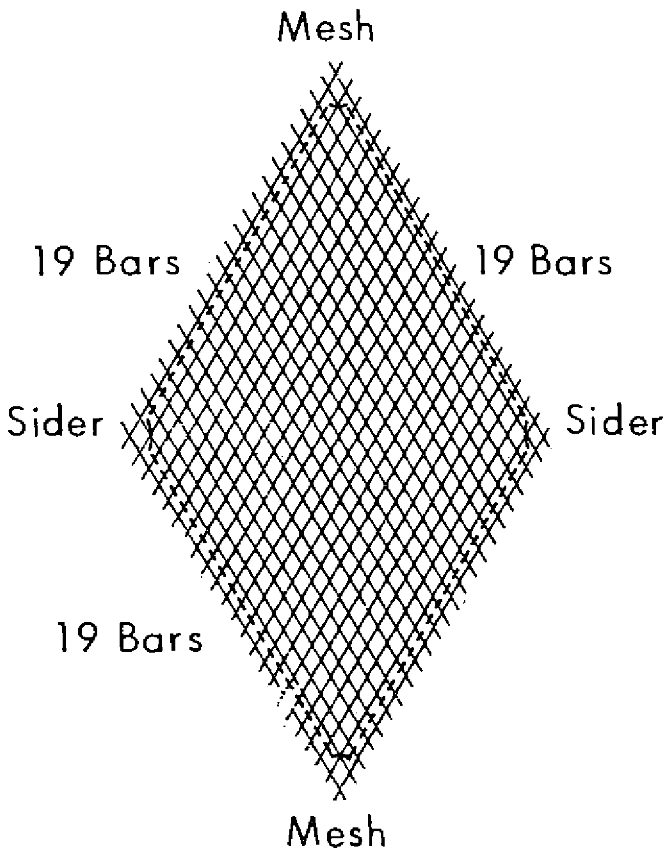

Figure 5.7. Detailed cutting plan for diamond shaped hole.

After attachment to the hoop, there will be a slight overhand along the top. This can be sewn into the hoop or left to form a canopy over the hoop to prevent escaping.

5.6 References

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CHAPTER 6

NET MENDING, PATCHING AND SPECIALIZED TRAWL REPAIR TECHNIQUES

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NET MENDING, PATCHING AND SPECIALIZED TRAWL REPAIR TECHNIQUES

6.1 Net Mending

6.1.1 Mending simple tears and holes

The simplest mending operation is the repair of tears where successive horizontal or vertical bars are cut.

In a piece of webbing, each knot always has four bars leading to it, never three or two unless it is on the edge of the webbing, and never five under any circumstances. When mending, a starting knot is tied to an existing knot and the twine on the needle must be used to form the fourth bar to that knot. To begin mending, therefore, the starting knot must be made over a knot which already has three bars leading to it. Similarly, the finishing knot must also be made over a knot which has three bars leading to it. Such existing knots in a piece of webbing which is damaged are called "three-leggers".

The simplest tear is shown in Figure 6.1a. Here the two three-leggers are at the same height in the webbing and the starting knot may be made at either (1) or (2). To start at (1), a double sheet bend or starting pickup knot is made around the three-legger. This tear may be mended working from left to right in a similar fashion to sewing two pieces of webbing together. First a pickup knot is made on the nearest mesh (the lower half mesh) at (a) in the usual manner with the length of the bar being adjusted by eye. This is followed by a pickup knot on the next mesh (the upper half mesh) at (b) in the usual manner, the length of the bar being adjusted by eye. This procedure is now continued until the final pickup knot on the mesh at (g) has been formed. The repair is completed by forming a double sheet bend at the three-legger (2) as a finishing knot. Note that in this case where the starting and ending three-leggers are at the same height, the mending could have been started at (2) and, working from right to left, finished at (1). In the Figure 6.1b, where the three-leggers are at different heights, a start is made on the upper three-legger at (1). Working from right to left, successive pickup knots are formed at (a), (b), (c), (d), (e), and (f), followed by the finishing knot around the three-legger at (2).

A simple vertical tear which has three-leggers at (1) and (2) is shown in Figure 6.2. The repair is started by forming a double sheet bend at the three-legger (1); this is followed by making a right sider knot at (a), a left sider knot at (b), and so on until the final right sider knot is completed at (e). The repair is completed by a

(a) The three leggers at 1 and 2 are at the same height

(b) The three leggers at 1 and 2 are at different heights

Figure 6.1. Simple horizontal tears.

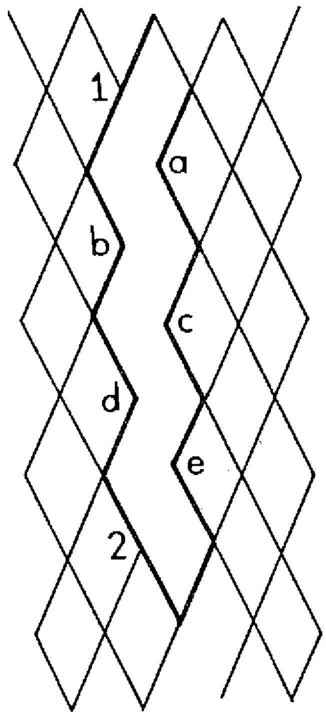

Figure 6.2. Simple vertical tear. The starting three-legger is at 1. The finishing three-legger is at 2.

double sheet bend around the three-legger (2). The missing bars have now been replaced and the vertical tear is mended.

A rectangular hole having a depth and width equal to two whole meshes plus a half mesh is shown in Figure 6.3a. The hole therefore, has two sides made of meshes (pickups), two sides of points (siders) and two diagonally opposite three-leggers at (1) and (2). The procedure for mending this hole is shown in Figure 6.3b, and is described as follows. A double sheet bend or starting pickup knot is tied onto the starting three-legger (1), then a single sheet bend or pickup knot on the upper meshes (a), to a left sider knot (b), a right sider knot (c), a single sheet bend or pickup knot to the lower meshes (d), and finally a double sheet bend or finishing pickup knot is tied on to the finishing three-legger (2).

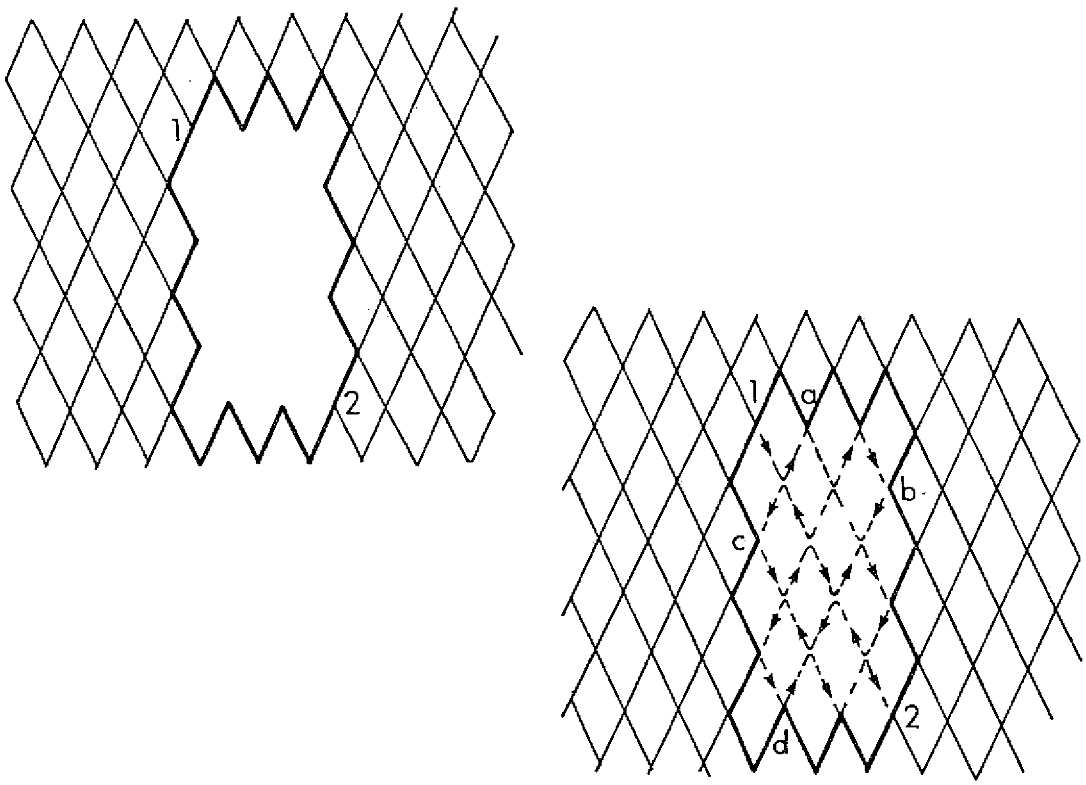

Figure 6.3. **(a) The repair on a simple rectangular hole is started at the three-legger 1 and finished at the three-legger 2. (b) The procedure for mending a simple rectangular hole.**

6.1.2 Trimming and mending of holes and tears

In the previous cases, it has been assumed that the tear or hole has already been prepared for mending, so that the twineperson has only to knit in the required meshes. In practice, this is seldom the case, and it is necessary to trim a hole before beginning to work with the needle.

The process of trimming a hole requires the cutting out of unwanted free ends of bars and some existing bars in order to provide starting and finishing three-leggers, and a logical mending sequence in between.

Two initial rules are important:

1. Knots in pickups or meshes should be removed entirely.

2. The knots in a sider cannot be cut out; if they are, the webbing will separate. The ends of sider knots should be left at least 1 cm long so that they do not become untied.

To begin trimming a hole, the webbing should be laid out and the run of the twine identified. Trimming should be started at the very top of the hole and proceed down one side of the hole. A three-legger must be left to start the mending. All the remaining three-leggers must be cut out by cutting around the edge of the hole. In places where three-leggers come together, a cut is made between them and both are eliminated. This is continued until the bottom of the hole is reached. Cutting is then begun next to the top three-legger and down the other side of the hole until the bottom is reached again. This will leave a three-legger in the bottom of the hole on which to finish.

To recognize a three-legger, the knot should be picked up on one finger and the parts of the twine that connect directly to the knot should be counted. Only the parts that connect with other knots should be counted; an end which is hanging free is not counted as a bar. Existing pickups and siders at the edges of the hole should be left as they are, since they will fit naturally into the mending pattern.

To do a proper job of trimming and mending, the following rules must be known and followed:

1. Make sure the three-legger is left in a position that will allow you to get to a sider on the opposite side of the hole.

2. The only time you can go to a sider is when a square mesh is formed by making a single bar.

3. Every time a sider is reached you then look for a pickup. If the pickup is there it must be taken; you will then find that another pickup will be directly opposite the one you have just taken. This is your next move. However, if after you make the sider a pickup is not there, you must turn and go back across the hole until you reach a sider. This procedure is followed until the hole is finished.

4. You cannot go from one sider to another sider on the same side of the hole, but you can go from sider to sider providing they are opposite each other.

5. You cannot make a pickup on a sider.

6. When starting to mend a hole on the left hand side, the needle is passed up through the mesh and the knot is tied. Whereas, moving from right to left, the needle is passed down through the mesh. This must be done in order to keep the meshes from becoming twisted. This applies only to a right-handed person. A left-handed person would do the opposite.

The process of trimming a simple tear, based on the above procedures, is illustrated in Figure 6.4a. The broken lines indicate bars of meshes removed during trimming. The crosses (X) indicate cuts made during trimming operation. When mending the hole (Figure 6.4b), a start is made at (1) and the first row of meshes worked from right to left until the sider at (a) is taken. The next step is to the pickup at (b), following which a row of meshes is knitted from left to right until the opposite sider at (c) is taken. Here, the bottom pickup (d) is available and must be taken, followed by another row from right to left until the opposite sider at (e) is taken. Now the bottom pickup (f) is available and sewing proceeds from left to right until the finishing three-legger (2) is reached.

The procedure for trimming and mending a simple diagonal tear is illustrated in Figure 6.5a. Start at the top of the tear; a starting three-legger is available at (1). Working down the left side of the hole, remove all the

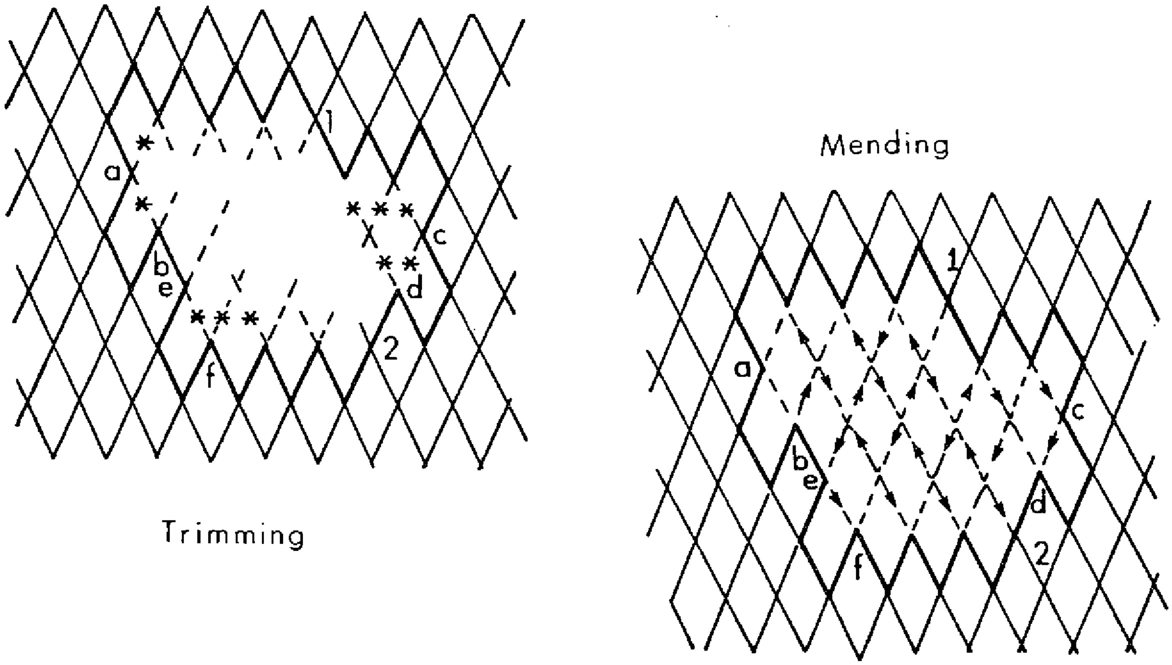

Figure 6.4. (a) Trimming and (b) mending a hole.

three-leggers by cutting at (b) and (c). Now work down the right side of the hole and remove the three-leggers by cutting at (d) and (e). This will leave a finishing three-legger at (2). The hole, when trimmed, will appear as in Figure 6.5b. The mending of this trimmed diagonal tear is straight forward. A start is made at the three-legger (1), followed by a natural progression to the sider (a), lower pickup (b), upper pickup (c), sider (d), opposite sider (e), lower pickup (f), upper pickup (g), sider (h), to the finishing three-legger (2).

The trimming and mending of a more complicated diagonal tear is illustrated in Figure 6.6a. In this case, a number of meshes of twine are missing entirely. The missing bars are shown by the blank spaces, and the final trimmed hole by the heavy lines. To trim the hole, a start is made at the top, a starting three-legger is available at (1). Working down the left side of the hole, bars are cut at (b), (c), and (d) to eliminate three-leggers. On the right side of the hole, three-leggers are eliminated by cutting bars at (e), (f), (g), and (h) until the finishing three-legger remains at (2).

The mending of the properly trimmed hole is slightly more difficult than the previous example. The final hole is shown in heavy lines (Figure 6.6b). Starting at the

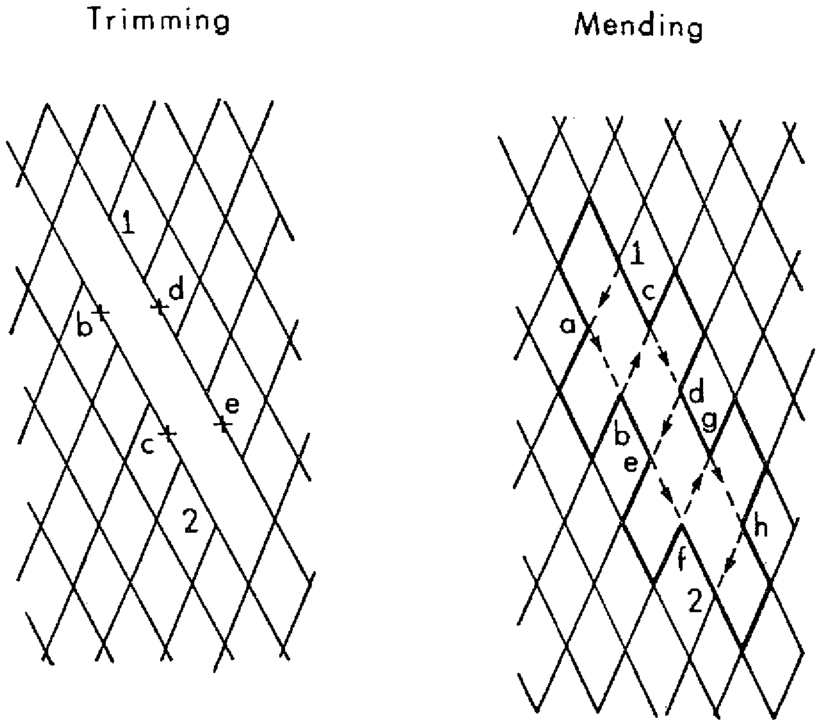

Figure 6.5. (a) Trimming a diagonal tear and (b) mending a diagonal tear.

three-legger (1), the procedure is to sider (a), to lower pickup (b), to upper pickup (c), to sider (d) to sider (e), knit half mesh to upper pickup (f), to sider (g), knit left to sider (h), knit right to upper pickup (j), half mesh to pickup (k), to sider (l), knit left to sider (m), to lower pickup (n), sew right to lower pickups (o), (p), knit right to upper pickup (q), to sider (r), knit left to sider (s), to lower pickup (t), and sew right to finishing three-legger (2).

Often a hole will appear in a V-shape. In this case, it is usually necessary to mend the hole in two stages, starting at the top of each leg of the V in turn. First the smaller of the tears is trimmed and mended as far as possible. Then the remaining hole is trimmed and mended in the usual fashion. Note that when trimming the remaining hole, it may be necessary to cut bars attached to the new twine knitted in when mending the first tear. This procedure

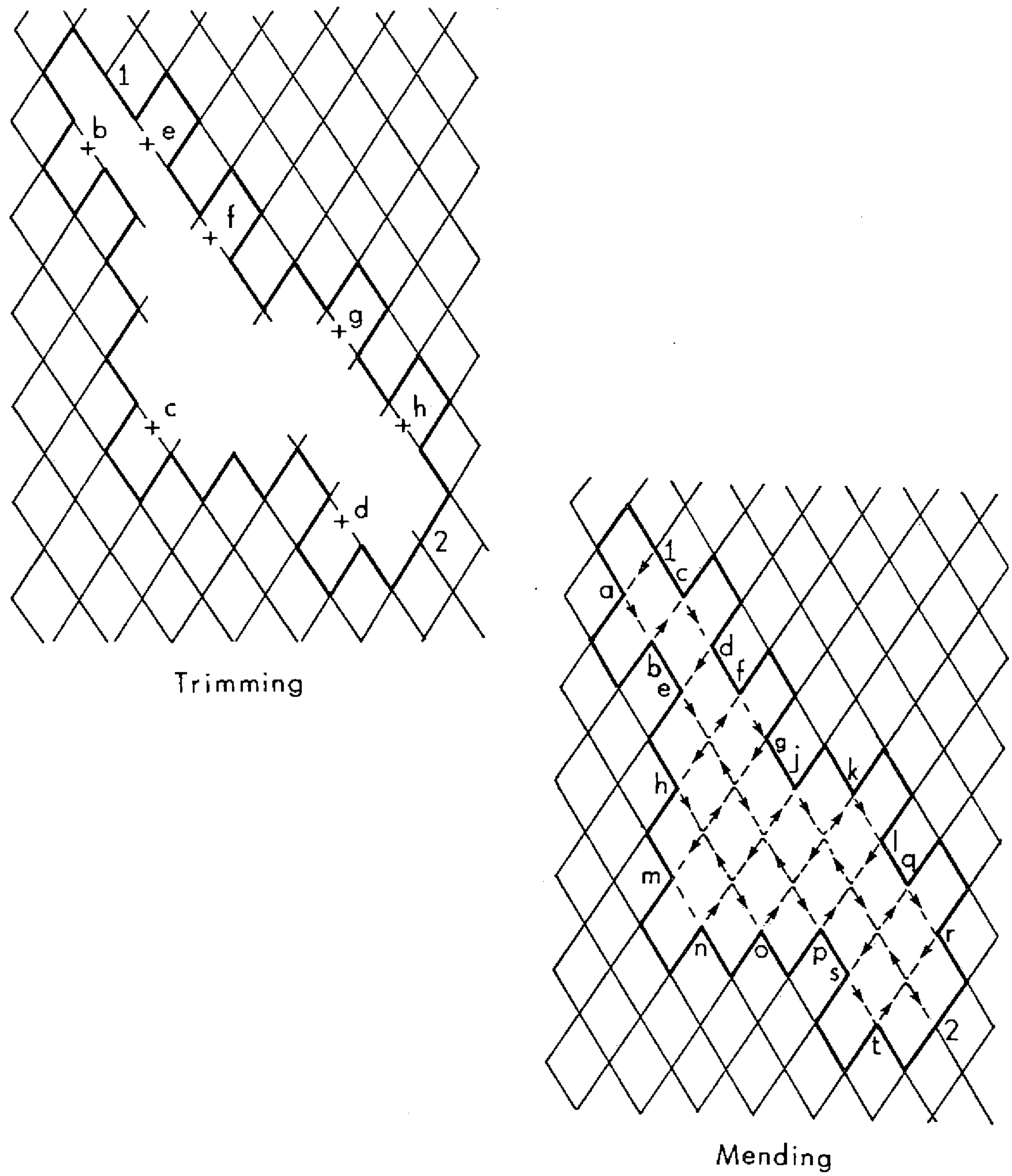

Figure 6.6. (a) Trimming and (b) mending a more complicated diagonal tear.

avoids the cutting away and replacement by mending of a large part of the V-shaped flap of webbing which would be necessary if the hole were trimmed for mending in one operation. Often, when holes of this type are large and spread in several directions, mending may be done simultaneously by two or more twinepersons working down towards one another.

The tear in the shape of a V is shown in Figure 6.7a. The small tear on the left is mended first. The starting three-legger is at (1) and the left side of the tear is trimmed by cutting, as shown, to remove the three-leggers. Starting at the three-legger (1), mending proceeds to the right sider (a), to the left sider (b), to the lower pickup (c), to the upper pickup (d), to the right sider (e), to the left sider (f), and to the upper pickup (g) (Figure 6.7b). At this point there is no pickup or sider available to be taken, and the mending stops. The shape of the remaining hole is now as shown in Figure 6.7c. The remaining hole is now trimmed as shown, to permit a new start to mending at the three-legger (2), with the finishing three-legger at (3). The shape of the final trimmed hole is as shown in Figure 6.7d. Starting at the three-legger (2), mending proceeds to the pickup (h), to the right sider (j), knit left to the left sider (k), then knit right to the right sider (e), knit left to the upper pickups (m) and (n), and to the left sider (g), knit right to the right sider (p), take the lower pickups (q) and (r), to the upper pickup (s), to the left sider (t), to the right sider (u), and finally to the three-legger (3).

6.2 Net Patching

When a hole is so large that an excessive amount of mending would be needed for repair, it is preferable to replace the damaged portion with a patch of webbing having the same mesh size. In order to avoid complicating the work, the prepared hole and the patch should be square or rectangular in shape, having dimensions in length and depth equal to a whole number of meshes. This avoids the leaving of three-leggers in the hole (and in the patch) and enables the work to be done by straight sewing and sidering.

6.2.1 A simple patch in a rectangular hole

The damaged section of webbing is removed by cutting horizontally below a row of pickups at the top and above a row of pickups at the bottom, being sure that a whole number of meshes are removed. This is illustrated in Figure 6.8a, where a length of three meshes has been cut

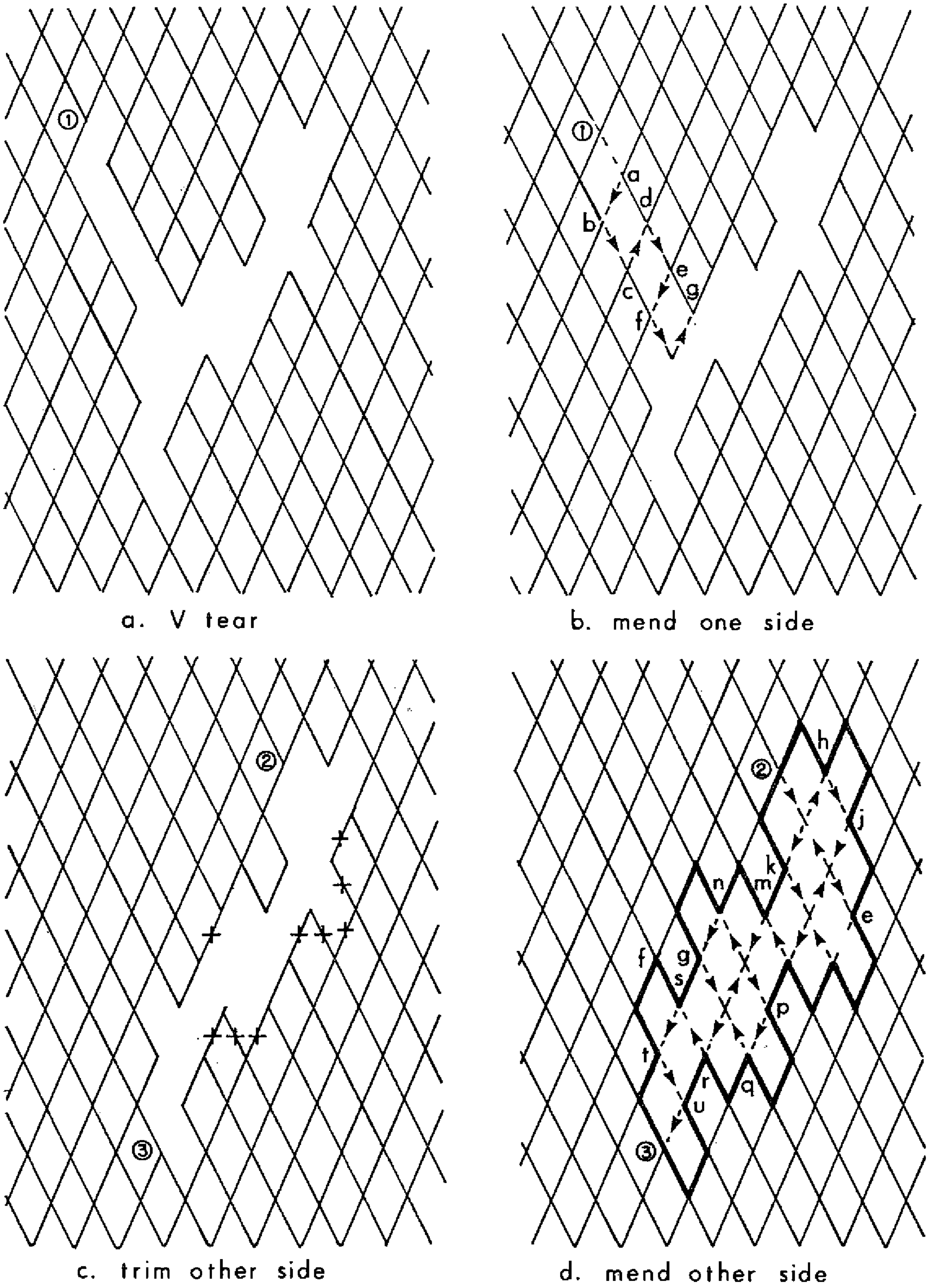

Figure 6.7. Trimming and mending a v-tear in two steps.

out (the existing pickup knots are then removed). This is followed by a vertical cut on the left hand edge to the right of a line of points (siders) and a vertical cut on the right, to the left of a series of points (siders), again ensuring that a whole number of meshes has been removed in this manner (the siders are, of course, left "as is").

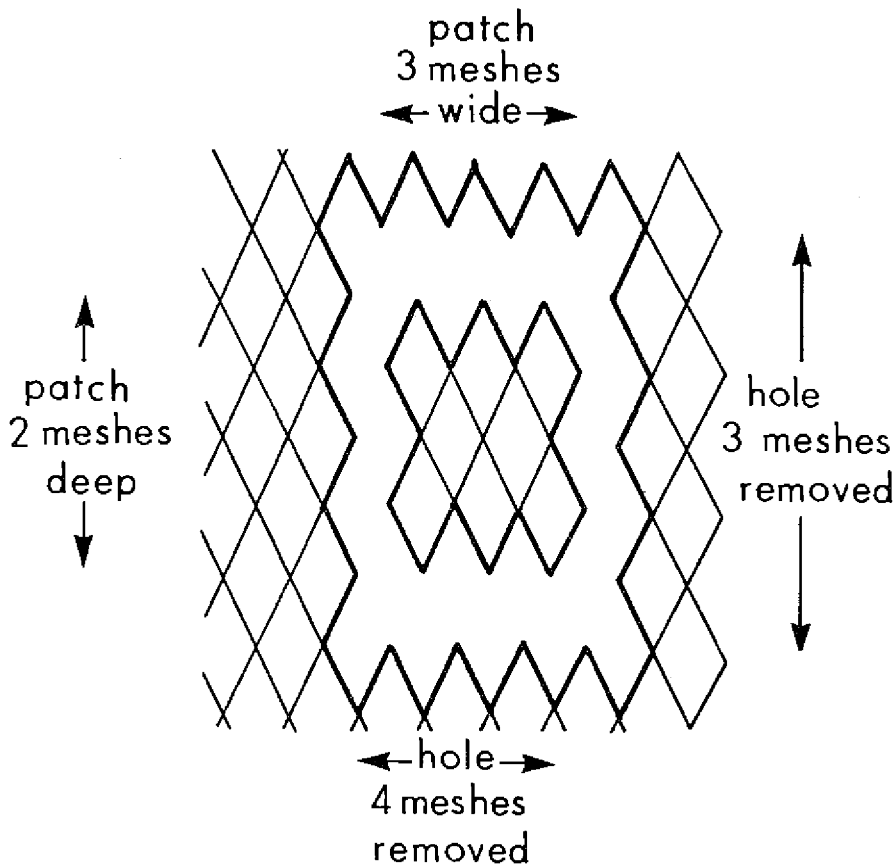

Figure 6.8. (a) Trimming for a patch.

A suitable patch for the repair is then cut out of a square piece of webbing. This patch must again have length and depth equal to a whole number of meshes, but be one mesh less in each dimension. The patch is put in by sewing and sidering along each edge in turn as shown by Figure 6.8b in one continuous operation, two twinepersons may work together. One twineperson should start on the top left as shown in Figure 6.8b, and sew along the top and sider along the right side to end at (d). The other twineperson would also start at (1) (or alternatively at (d)) and work along the left and bottom sides of the patch. A start may be made at any corner. Here, the starting point is on the pickup (1) at the top left corner. The twineperson starts with a double sheet bend at (1) and then sews to the right until the pickup at (a) is taken; then proceeds to the right sider (b) and siders down the right side until the final sider at (c) is taken; then to the lower pickup at (d), sewing to the left until (e) is reached, then to the first left sider at (f), and siders up to (g). The patch is completed by a finishing knot at (1), the starting point. (Note that (1) becomes a three-legger once the starting knot has been made.)

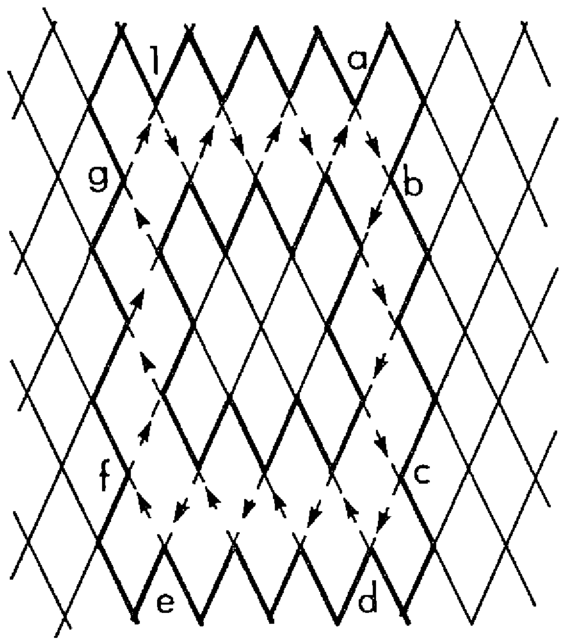

Figure 6.8. (b) Sewing and sidering for a patch.

6.2.2 Patching a non-rectangular hole

It is not essential that all holes and patches are rectangular, although the operation should always involve horizontal (all meshes) and vertical (all points) cuts for both the hole and the patch. Commonly, part of a large hole may be cut out and joining in the patch commenced. When the operation has proceeded as far as practicable, then a further section of hole and patch can be cut to fit. The patch can be any shape so long as each corner turned during cutting out the hole and patch is a right angle.

Figure 6.9 shows a typical non-rectangular patch fitted to an appropriate hole; dimensions equal to a whole number of meshes for each length and depth are illustrated, and joining up the patch can be accomplished by either one continuous operation or by several twinepersons working together if a very large patch is involved.

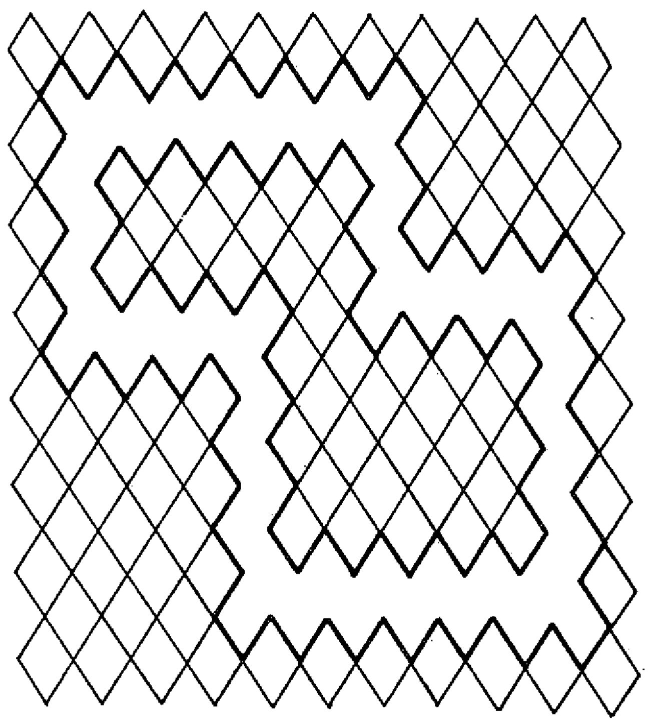

Figure 6.9. Fitting a non-rectangular patch.

6.2.3 Using a patch of different mesh size

Although normally the webbing used for patching should be of the same mesh size as the damaged web, sometimes the only material available will be of a different mesh size.

In such a case, it is still possible to put in a patch in order to effect a temporary repair. However, on the first possible occasion, such a patch should be removed and replaced by a patch of the correct mesh size. This is termed a "soft patch."

In such a case, measurement of the length and depth is made by using the stretched mesh length of each side of the hole against the stretched mesh length of the corresponding side of the web being used as the patch. Obviously, the meshes of the patch cannot be lined up with those of the hole.

Knots are tied only in the side of the join that has the larger mesh size. The twine is simply passed behind the knots along the edge of the webbing having the smaller mesh, as shown in Figure 6.10.

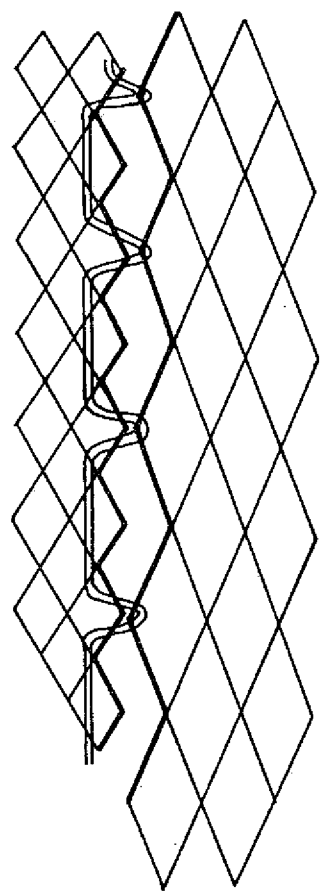

Figure 6.10. Patching with webbing of a smaller size.

6.2.4 Lacing for temporary repair

Lacing is used to make a temporary repair when it is necessary to make a net available for use as quickly as possible. It is usually pulled out as soon as an opportunity is available, and a proper repair made. When lacing, the twine is passed behind the knots on each side of the tear and fastened with a double hitch on one side of the tear only, about 15.2 cm to 30.5 cm apart. It is most important, when lacing, to leave sufficient slack in the mending twine so that some natural adjustment can take place when strain is placed on the laced-up section of the web.

6.3 Specialized Trawl Net Mending Techniques

The repair of interior tears and holes in the webbing of trawl net sections is accomplished according to the procedures outlined in the previous sections. Trawl net wings are often torn off the straight bar of the inside edge along the mouth frame. In many cases, the wings are reinforced with dog ears or straight bars plus a full mesh. If wings become damaged so that it is necessary to repair them, this may be done by mending or by joining in a new section of wing. Because straight bars and dog ears are involved, such mending requires procedures beyond those normally used for the usual mending and patching.

6.3.1 Mending wings reinforced with dog ears

This is necessary when the dog ears which are knitted directly on to the straight bars with double twine are damaged. Two cases arise.

The first occurs when a length of the wing which does not involve the wide end is damaged at the edge. Here it is possible to trim the hole and mend from the wide end toward the narrow end, as a starting point is available on a remaining three-legger. The procedure is shown in Figure 6.11. The steps are as follows, using a needle filled with single twine: starting at the three-legger (a), half meshes are knitted downward to (b), then to sider (c), and then half meshes are knitted back upward to the pickup (d). From (d), a four bar length look of twine is made back to a second pickup knot at (d), then a three bar loop of twine to the pickup (e) completes the doubled dog ear. Meshes are then knitted downward to the sider (f) and back upward to the pickup (g), where a four bar look is formed back to the same knot at (g) followed by a three bar loop to (h) to complete the second doubled dog ear. Knitting is continued to (j) and back to (k) where again a four bar loop and a three bar loop are formed to end the third dog ear at (1). Mending is completed by the straight bar to the three-legger at (m).

If the damage extends into the wide end so that no dog ears remain, then it is necessary to build up the missing twine by working from the narrow end toward the wide end. This is known as "backscuttling" and the procedure is shown in Figure 6.12. This method, as shown in the sketch, is used in particular when the bunt end (wide end) is torn out, so that it is necessary to work from the narrow end toward the wide end. Some twinepersons prefer to use the method when mending dog ears are at the center of the wing. The steps are as follows, using a needle filled with single twine: a starting knot is made at (a), the three-legger which includes one bar of the doubled dog ear. A one bar length of twine is adjusted, followed by a four bar loop, which is the full round of a single part of twine for the first dog ear; the four bar round is ended with a pickup knot at (b).

A second round of single twine is then made with a second pickup knot at (b) to complete the first dog ear of doubled twine. From (b) the twineperson proceeds to (c), with a sider, and then up to a pickup knot at (d) on the doubled mesh (dog ear) formed previously. From (d), the single bar and the two rounds to form the second dog ear are made, with pickup knots at (e). From (e), continuing as before brings us back to the pickup knot at (g) on the second dog ear formed. From (g), the procedure is repeated once more to form the third doubled dog ear, ending at the pickup (h). From (h), normal knitting takes us to the sider (j) at the wide end of the wing. From (j), the twineperson knits the end row of the wing up to the pickup (k). The repair is completed by finishing on the three-legger at (1).

6.3.2 Mending wings reinforced with dog ears and a full mesh of double twine

If the wing is reinforced with a full mesh of doubled twine to which dog ears are added, then the procedures involved are more complicated and involve the use of two needles, one filled with doubled twine, the other with a single part. The same two cases arise as before.

When the wide end of the wing is not damaged, then it is possible to work toward the narrow end; this procedure is shown in Figure 6.13. It involves the use of two needles, one filled with single twine (shown by single lines) the

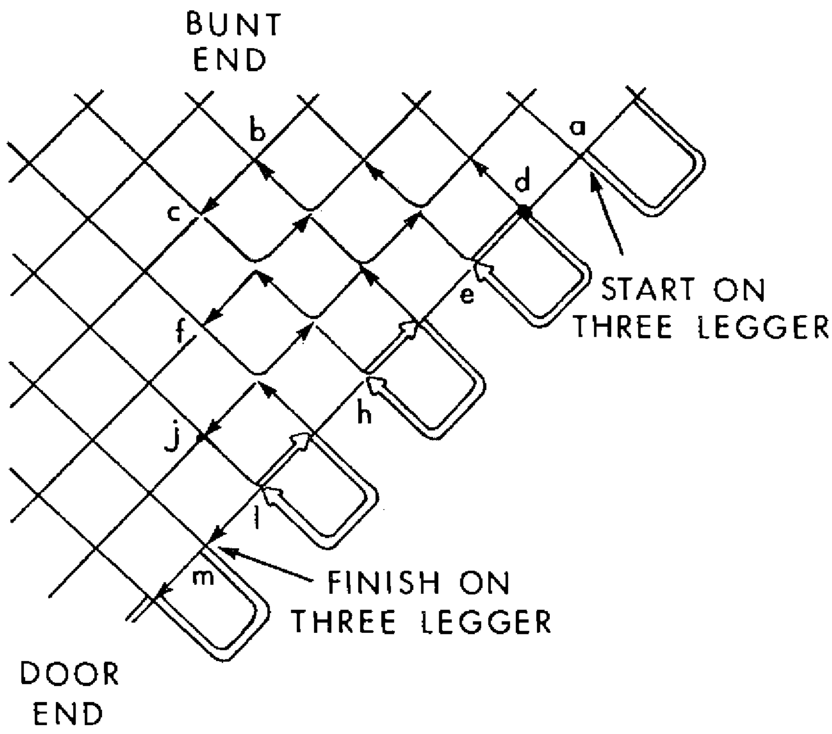

Figure 6.11. Mending wings reinforced with dog ears.

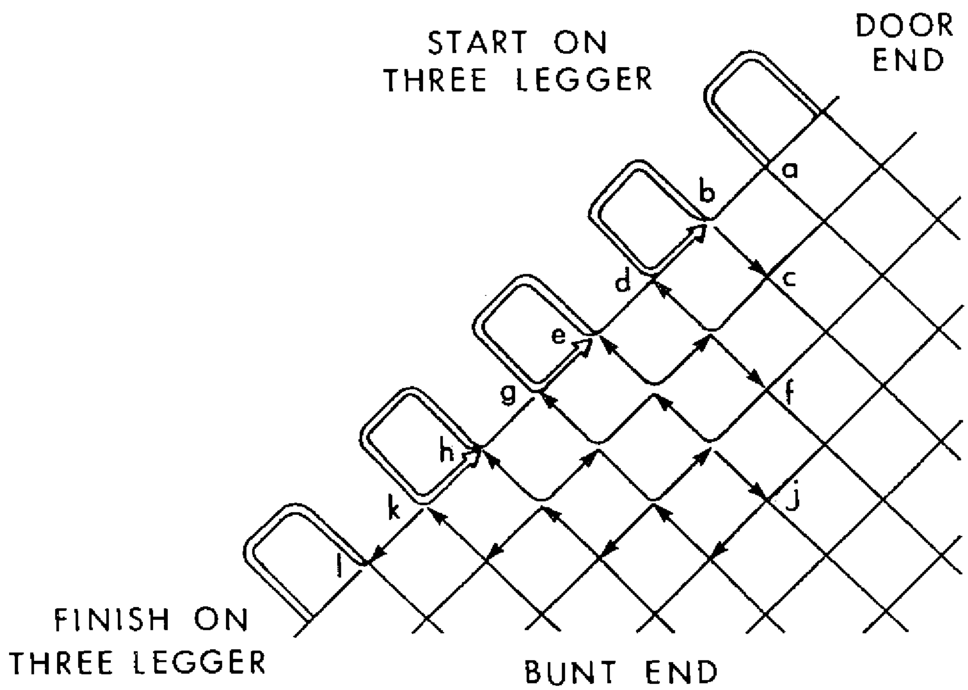

Figure 6.12. Backscuttling.

other filled with doubled twine (shown by two lines). Start at the three-legger (a) using the needle filled with single twine. The twineperson knits across to (b) at which point a three bar length of twine is made which includes an overhand knot (c) which acts as a dummy sider for later mending with the doubled twine, when it serves to anchor the knot. The twineperson then proceeds across to the sider (d) and back to (e). Here, another three bar loop is made, including the dummy overhand knot at (f). The procedure is continued, losing one mesh for each complete mesh knitted on until the final double bar is made, including a dummy sider (p) to end at the three-legger (q). Mending of the single twine is now complete. Using the needle filled with double twine, the twineperson now begins at the three-legger (A) and knits on the double mesh plus the dog ear, as has been explained previously in the chapter on trawl construction.

For simplicity of explanation, the above technique involved completing mending with single twine before beginning with the double twine. In practice, the twineperson will usually find it more convenient, especially if the damage is considerable, to mend with single twine to form the doubled mesh and dog ears on the partially completed repair. By alternating single and double twine, the twineperson can then move along the edge of the twine, completing the mending as he/she progresses.

If the wide end of the wing is missing at the edge, then it is necessary to begin work on the remaining twine of the narrow end and work toward the wide end. This is shown in Figure 6.14. It involves the use of two needles used alternately, one filled with single twine, the other with double twine. The steps for mending twine are as follows:

Single Twine: start at three-legger (a) and knit to sider (b) including an overhand knot as a dummy sider (to anchor double twine later); drop the needle.

Double Twine: start at three-legger (A) and form a five bar loop back to one bar with a pickup knot as shown, then to dummy sider in the single twine, then to (B); drop the needle.

Single Twine: from (b) go to (c) on the double twine formed in previous step. Then form three bar loop which includes the dummy sider as shown, and across to (d); drop the needle.

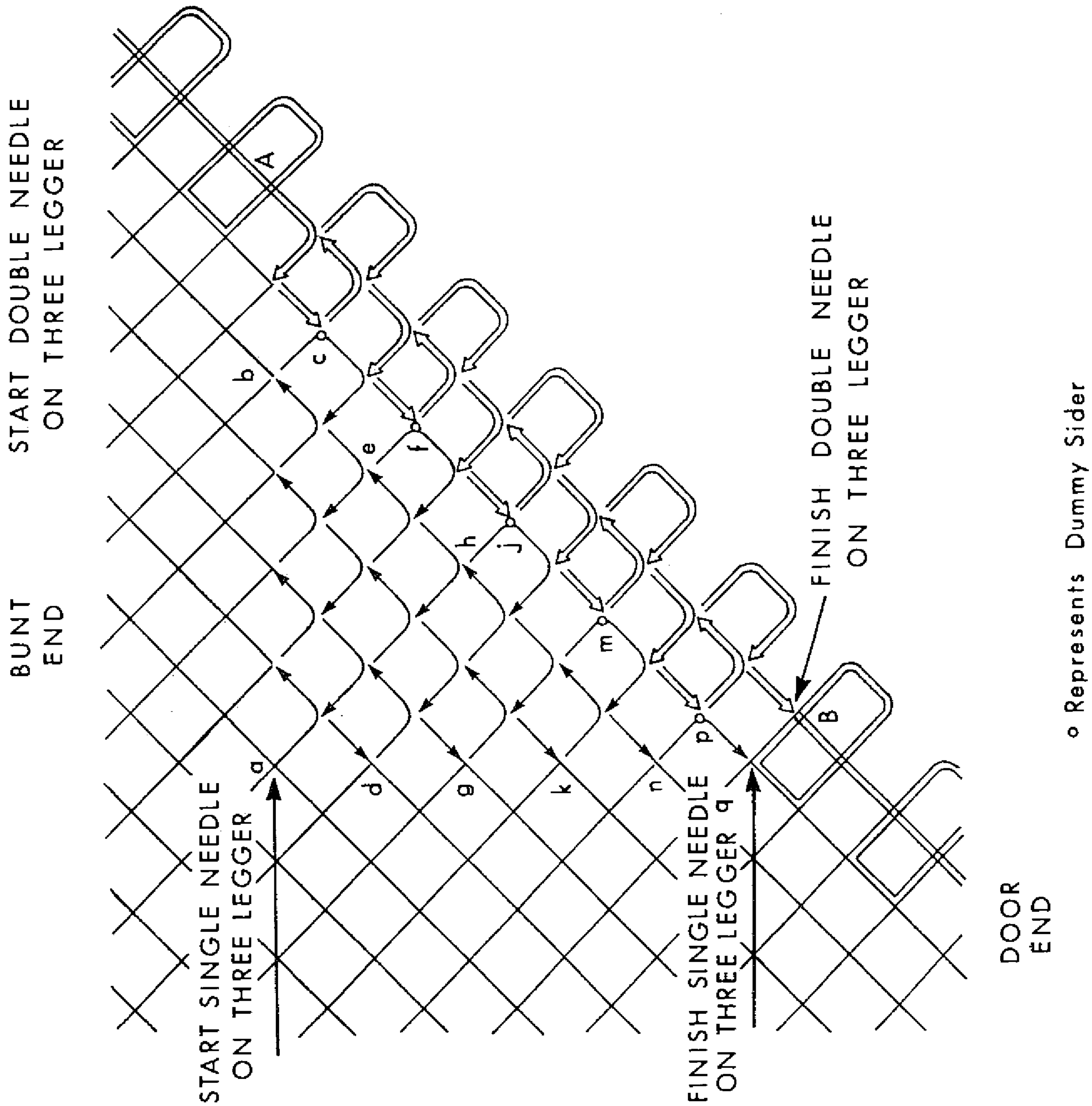

Figure 6.13. Mending wings with two needles (straight dog ears).

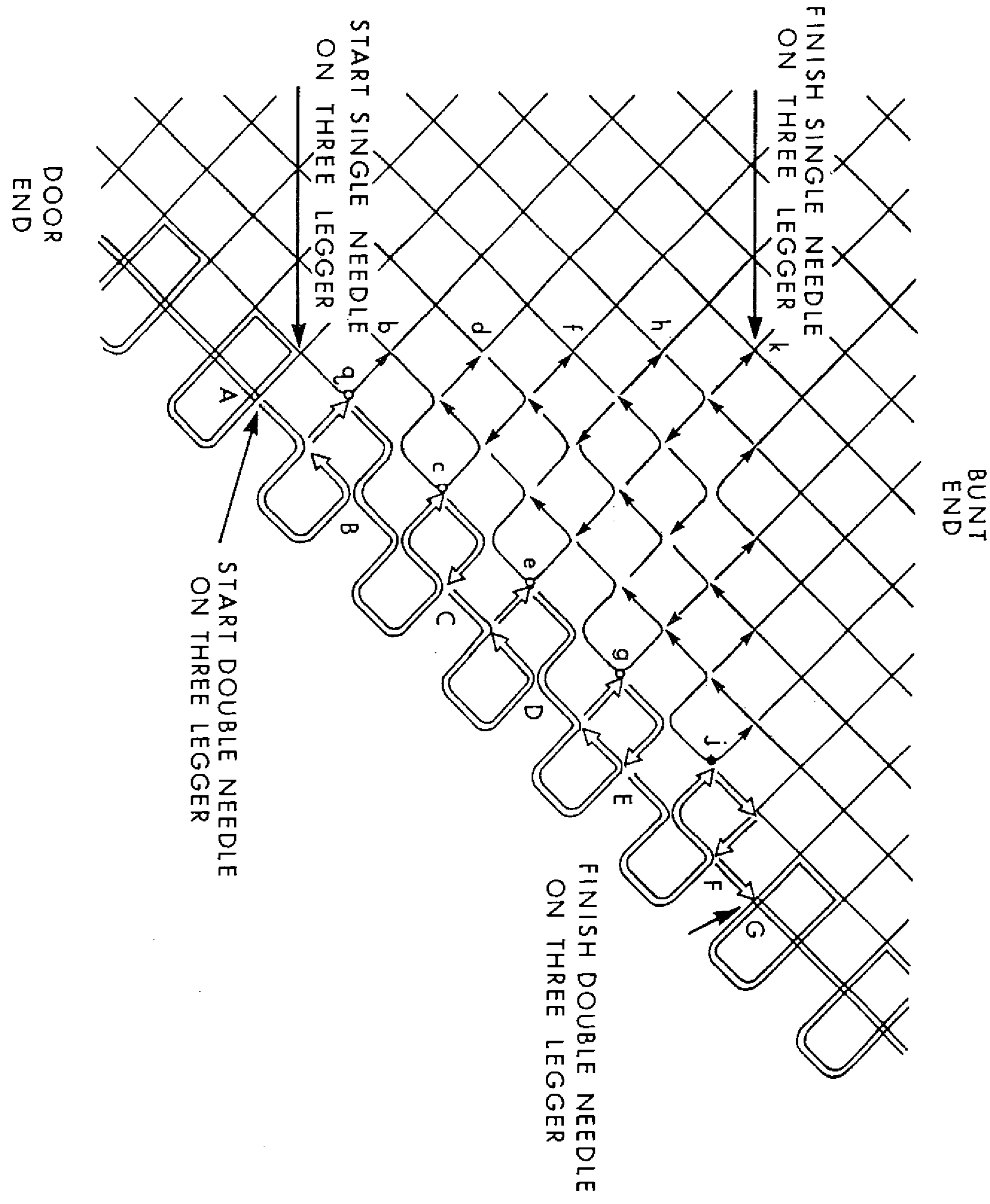

Figure 6.14. Mending wings with two needles (backscuttled dog ears).

Double Twine: from (B) form a five bar loop to the one bar with a pickup knot as shown, then to the dummy sider on the single twine and back to (C); drop the needle.

Single Twine: from (d) knit to (e) then form three bars including the dummy sider, and go back to (f); drop the needle.

Double Twine: from (C) form the five bar loop to the one bar with a pickup knot as shown, then to the single twine dummy sider, and back to (D); drop the needle.

Single Twine: from (f) knit to (g), make the three bar loop including dummy sider and back to (h); drop the needle.

Double Twine: from (D) form five bar loop then to single twine dummy sider and back to (E); drop the needle.

Single Twine: from (h) knit to (j), form three bar loop including overhand knot and knit back to end on the three-legger (k). These actions form the single twine part of the wide end of the wing.

Double Twine: from (E) make the five bar loop, then to the single twine dummy sider and back to (F), then finish on the three-legger of double twine at its correct position on the wing.

6.3.3 Mending wings reinforced with straight bars

Depending on the way a hole is running, it may be mended by working from the narrow end (door end) of the wing toward the wide end, or from the wide end toward the narrow end.

The procedure when working from the wide end toward the narrow end, which is possible if the wide end is not damaged is shown in Figure 6.15. In this case, batings are involved because a mesh is lost in length with each two straight bars. The hole resulting from the damage is trimmed to give the shape shown. Run of twine is from top to bottom. Mending is begun with a starting knot at (a) and half meshes are knitted down to (b), and then to the sider (c). From (c), half meshes are knitted across to (d); at (d) a loop equal to three bar lengths is made as shown, ending in a pickup knot at (e) formed around the three parts of twine (a selvedge mesh). From (e), meshes are knitted across to (f), then to the sider (g) and finally to the knot at (h). In forming the pickup knot at (h), both mesh and loop are taken up in the needle and the knot tied around the four parts of twine (forming a bating). From (h), another loop equal to three bar lengths is made and the pickup knot tied around the three parts of twine, as before, at (j). A mesh is knitted to (k) and then to the sider (l) and across to (m) where the four parts of twine are again included in the knot. A further three bar length loop is formed with the pickup knot at (n) made around the three parts. Mending is completed by forming the bar from (n) to (o); at (o) the final knot is tied around the four parts of twine.

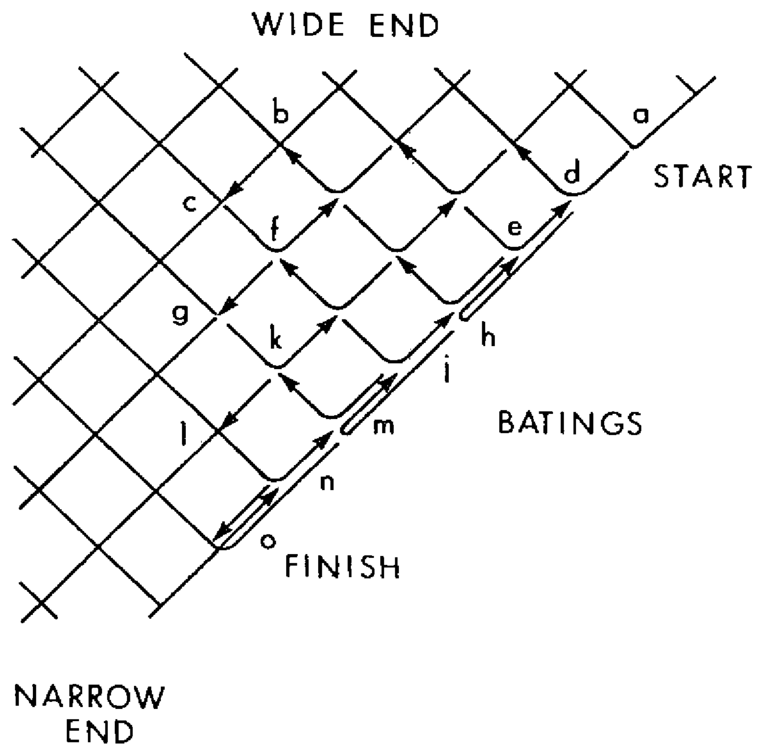

Figure 6.15. Mending the straight bar toward the narrow end.

The procedure when working from the narrow end toward the wide end, as when the wide end is damaged, is shown in Figure 6.16. Herein, creasings are involved as an extra mesh must be created in the length for each two straight bars.

The hole is trimmed in exactly the same manner as before. The mending procedure involves creating meshes as necessary to gain the length of web in steps. The first procedure is to create a mesh from the beginning point (a). A sheet bend with a long tail is made at (a) and the mesh created by using the "around the thumb" knot to form a sheet bend at (b). From (b) a loop of twine equal to two bar lengths is made with a pickup knot formed around the "thumb" knot at (b), forming a creasing; the twineperson then proceeds to the sider (c). From (c) a half mesh is knitted to (d), where a pickup knot is made, taking in the loop formed previously. From (d), another loop of two bar lengths, a creasing, is made and a pickup knot formed at (d); the twineperson then makes a loop equal to three bar lengths to a knot formed around the three parts of twine at (e), forming a selvedge mesh. From (e), a half mesh is knitted to the sider (f), and half meshes knitted to (g), the loop

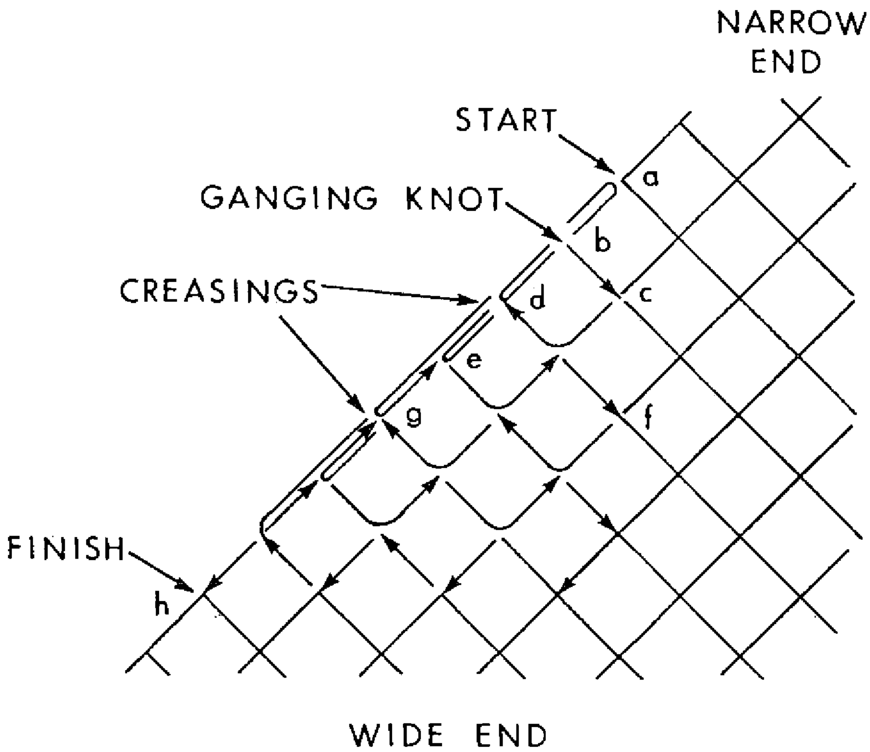

Figure 6.16. Mending the straight bar toward the wide end.

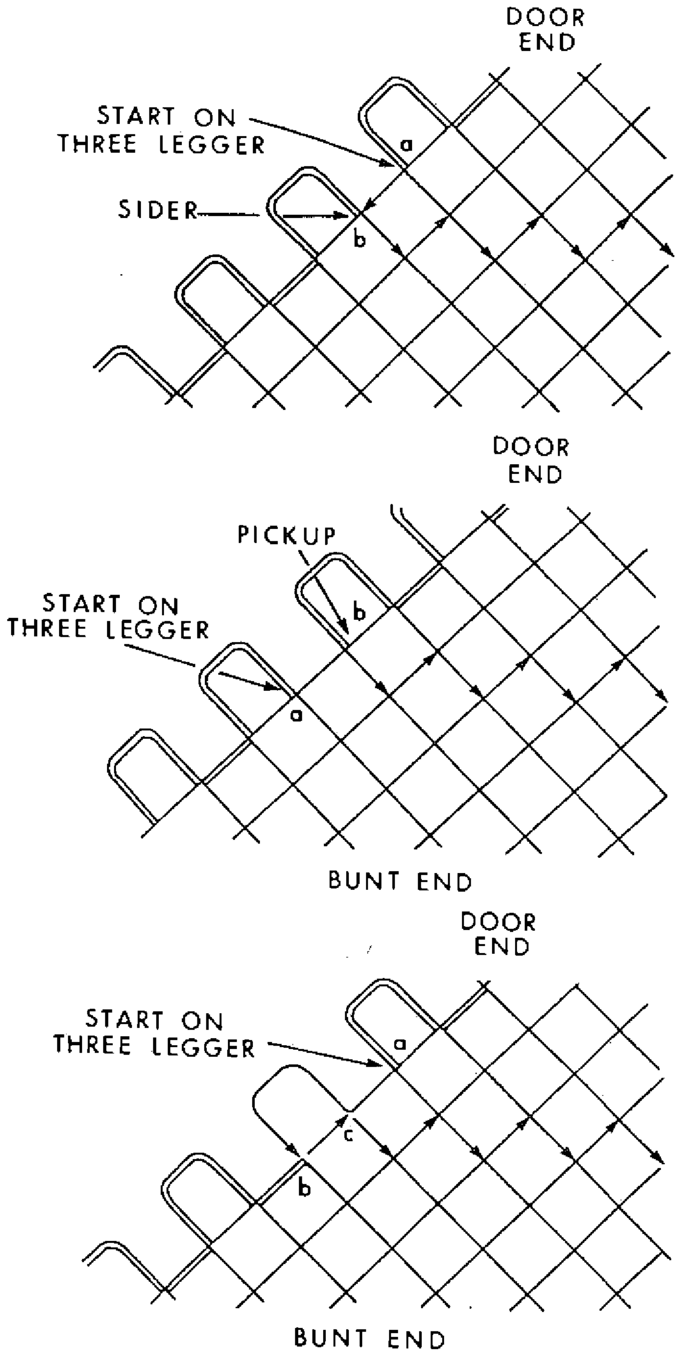

Figure 6.17. Joining wing sections.

formed previously. The mending is completed by repeating the procedure from (g) a loop of two bars is made back to (g), a creasing, followed by a three bar loop ending with the knot at (h), a selvedge, then continuing as before and finally to the finishing knot at (h).

6.3.4 Joining wing sections

If the wing is badly damaged so that normal mending is too great a task, it is usual to cut away the affected section and join in a new section of the required size.

If the narrow end is damaged, then the procedures are straightforward as shown in Figure 6.17. In this case the remaining wide end of the wing and the section of the narrow end to be joined may be trimmed in either of the ways shown in (a) and (b) in order to prepare for sewing together. Either of the techniques shown may be used, depending on the way in which the wing is damaged, and the preference of the twineperson. In Figure 6.17a, a straight mesh is cut between dog ears with a three-legger (half mesh) left on the wide end. The twineperson starts at the three-legger (a), proceeds to (b) and forms a sider knot; he/she then sews the two parts together in the usual manner. In Figure 6.17b, a mesh is cut between dog ears, with a three-legger (half mesh) on the narrow end. The twineperson starts at the three-legger (a), proceeds to (b) and forms a pickup knot, he/she then sews the two parts together in the usual manner. If the wide end is missing, then it is necessary to work from the narrow end in joining the sections, as shown by Figure 6.17c. In this case, the section toward the narrow end which is to be replaced is trimmed, so that it has a three-legger on its upper edge in the same manner as a wing is prepared for joining the belly or square. The wide end will then often be trimmed as shown on a straight mesh cut, so that it is necessary to replace a dog ear during the joining operation. The twineperson starts at the three-legger (a) on the narrow end and forms a four bar length loop to the pickup (b); from here, he/she proceeds to make a pickup knot at (c) and then sews the two parts together in the usual manner.

6.4 References

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