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FM 5-13

DEPARTMENT OF THE ARMY FIELD MANUAL

ENGINEER SOLDIER'S HANDBOOK

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HEADQUARTERS, DEPARTMENT OF THE ARMY

DECEMBER 1969



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FIELD MANUAL)
 No. 5-13)

HEADQUARTERS
 DEPARTMENT OF THE ARMY
 Washington, D. C., 22 December 1969

ENGINEER SOLDIER'S HANDBOOK

	<u>Pages</u>
PART I INTRODUCTION	2-3
II HANDTOOLS	4-32
III CARPENTRY	33-50
IV ENGINEER EQUIPMENT	51-57
V EXPEDIENT ROAD AND AIRLANDING FACILITIES	58-68
VI RIVER CROSSING EQUIPMENT	69-83
VII EXPLOSIVES AND DEMOLITIONS	84-105
VIII LANDMINE WARFARE	106-111
IX FIELD FORTIFICATIONS	112-128
X OBSTACLES	129-141
XI ROUTE AND ROAD RECONNAISSANCE	142-155
XII CAMOUFLAGE	156-164
XIII RIGGING	165-189
XIV SIGNAL COMMUNICATIONS	190-198
XV SURVIVAL	199-208
XVI WEAPONS	209-212
APPENDIX REFERENCES	213-214
INDEX	215-237

* This manual supersedes FM 5-13, 31 July 1964.

PART ONE

INTRODUCTION

1. PURPOSE AND SCOPE

a. The purpose of this manual is to help the basic engineer soldier increase his knowledge of engineering subjects and develop the professional competence that is a hallmark of the Corps of Engineers.

b. The manual provides information relating to the typical tasks that an engineer soldier may be required to complete during the performance of his duties while a member of the Corps of Engineers. This includes construction and the material required; combat engineering tasks; general engineer work; and combat as infantry.

c. Users of this manual are encouraged to submit recommended changes and comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commandant, U.S. Army Engineer School, Fort Belvoir, Virginia 22060.

2. THE TYPES OF ENGINEER UNITS AND HOW THEY FIT INTO THE U.S.ARMY

a. In overseas commands or in theaters of operation, the Corps of Engineers is charged with many tasks. Its basic mission is to increase the combat effectiveness of the field forces by helping the movement of friendly troops and stopping that of the enemy; to undertake and carry out combat missions when required; and to perform general engineer work in support of the combat effort in rear areas of the combat zone and in the communications zone.

b. The Corps has the responsibility to provide the means for forward movement of the field units from the beach, airhead, or line of departure through the line of contact. The engineers build or reconstruct ports or improve beach facilities so that the field and logistic support units can move through them. In order that troops and equipment can move against the enemy forces, the engineers construct and maintain roads, bridges, and railroads and remove obstacles. Finally, at contact points with the enemy, engineers blast the enemy fortifications, assist in breaching minefields, and plan for and provide the means for river crossings with boats, rafts, and bridges. At the same time, engineer operations are conducted to impede the enemy movement by construction of fortifications and obstacles, and employment of atomic demolition munitions (ADM).

c. Five principal types of engineer units may be found in a theater of operations: teams, separate companies, battalions, groups, and brigades. (There is a construction Command which is responsible for all construction in the Communications zone, which consists of construction brigades, which in turn consist of construction groups.) These units vary in size from the team, which may consist of as few as two or three individuals, to the engineer brigade which may consist of 15,000 to 20,000 troops or more.

d. These various sized units are uniquely organized and equipped to perform the specific missions which have been assigned to the Corps.

(1) There is an engineer battalion organic to each of the five types of divisions.

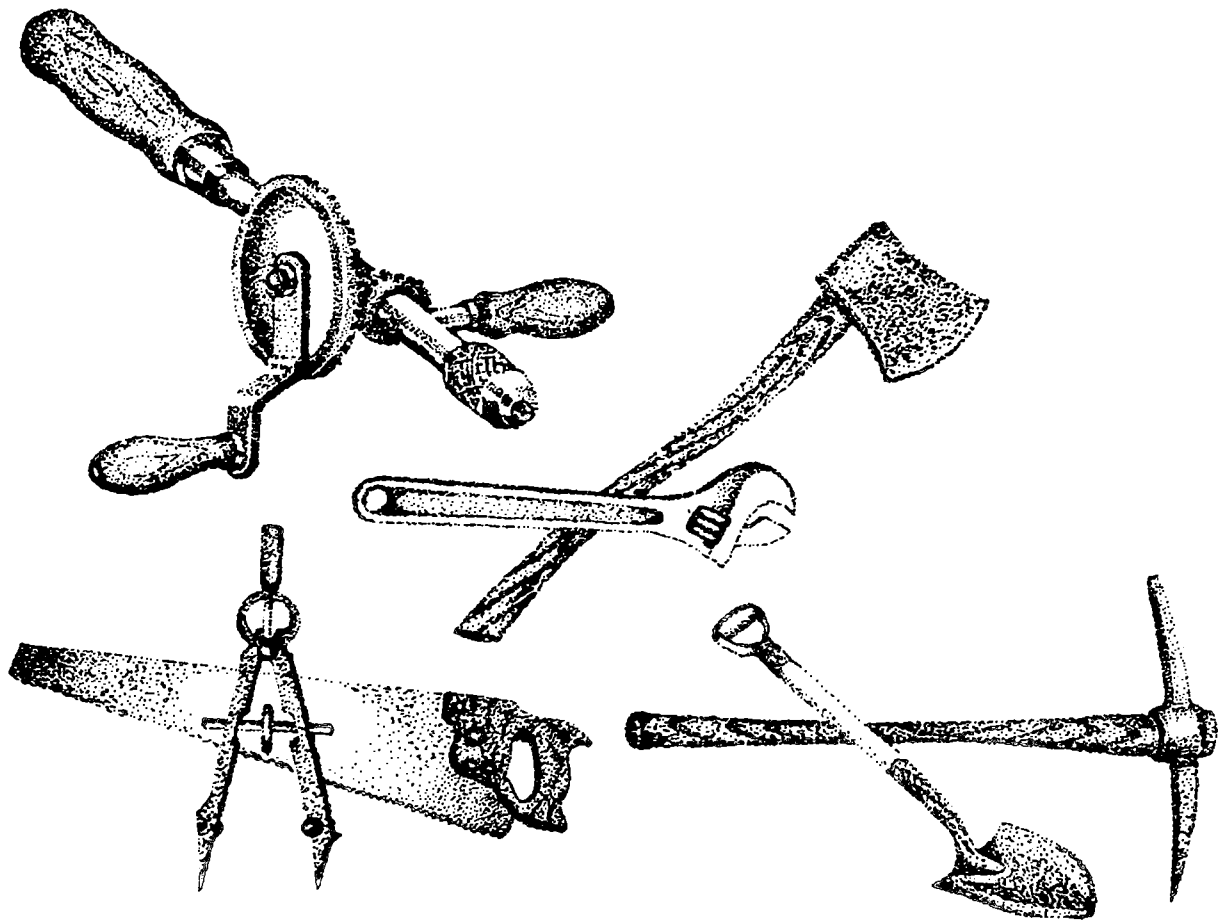
(2) To back up the divisional engineer units there are the nondivisional combat units consisting of: engineer combat battalions, army, float bridge companies, assault bridge companies, panel bridge companies, light equipment companies, dump truck companies, and assorted specialized teams.

(3) To perform the diversified construction, rehabilitation, and maintenance missions given to the Corps there are: construction battalions, construction support companies, port construction support companies, dump truck companies, and assorted construction-related teams.

(4) To perform the topographic and intelligence missions assigned to the Corps there are topographic battalions, army; topographic companies, Corps; base topographic battalions; and topographic and intelligence teams.

PART TWO

HANDTOOLS



MOST OF THE TOOLS YOU WILL BE USING ARE HANDTOOLS SINCE EACH ENGINEER ORGANIZATION IS EQUIPPED WITH THE HANDTOOLS NEEDED FOR ACCOMPLISHING THE MISSIONS ASSIGNED TO IT. FOR PURPOSES OF DISCUSSION THEY CAN BE DIVIDED INTO SEVEN GROUPS: CUTTING, DRIVING, DRILLING, MEASURING, DIGGING, CHOPPING, AND MISCELLANEOUS.

SAFETY PRECAUTIONS

Before using any handtool, inspect it. Repair or replace loose, splintered, or defective handles; damaged blades or parts; rough edges or burrs; and any other defects that lower the strength or make it unsafe for use.

Store handtools in a suitable storage space. Serious injuries can result from a cluttered toolroom.

Be sure handtools are not dirty, oily, or greasy. This could cause tools to slip out of the hand or off the working surface, resulting in injury.

Do not carry sharp-edged or pointed tools in pockets.

Do not use tools made of metal and power tools in locations where sources of ignition may cause a fire or explosion.

Wear safety goggles or other approved face and eye protectors when breaking rocks, grinding, striking metal with metal, drilling, driving wedges, chipping, or performing similar operations that might result in flying particles.

Do not toss tools from one location to another. Do not drop tools to another level or throw them to another worker.

Do not work on electrical circuits while the current is on.

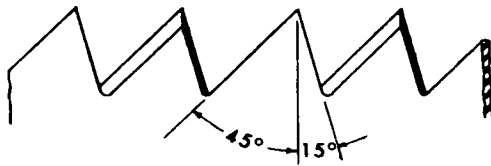
Do not wear loose or torn clothing that may become entangled with handtools, thereby causing injury.

Secure with clamps or vises any loose material to be cut, sheared, chiseled, or filed. This prevents the tool from slipping.

Do not swing a chopping or chipping tool until certain that no one in the area will be endangered by the backswing.

Do not allow pointed or edged tools to lie around on work surfaces.

SAWS

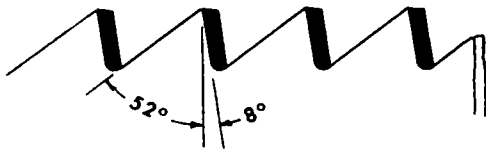


CROSSCUT SAW TEETH

KERF



TOP VIEW

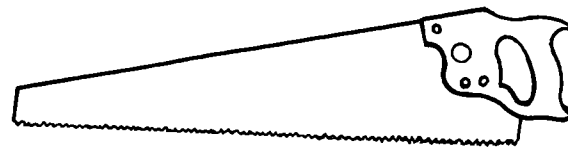


RIPSAW TEETH

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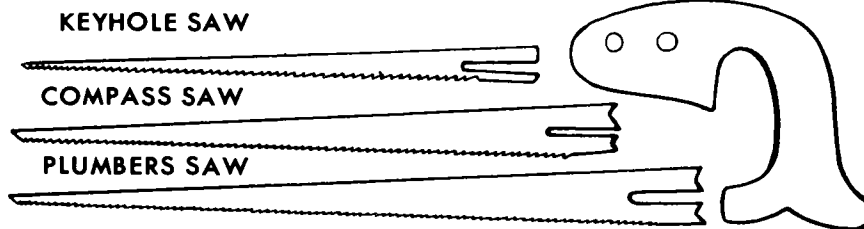


TOP VIEW



The **CROSSCUT HANDSAW** is used for cutting across the grain of wood. One with coarse teeth and a wide set is needed for cutting green, unseasoned wood. A fine toothed one is best for dry, seasoned wood since it cuts more accurately. On a crosscut saw each side of the tooth is filed to a cutting edge. The teeth are set to prevent the saw from binding and the teeth choking up with sawdust. The "face" of each crosscut tooth is slightly steeper than the back, making an angle with the line of the teeth of about 65°.

The **RIPSAW** resembles the crosscut excepting that it is designed for cutting with the grain of the wood. Each tooth is filed straight across to a sharp square edge like a little chisel and they are set in two parallel rows that overlap each other. At each stroke the sharp edge chisels off a little from the end of the wood fibers.



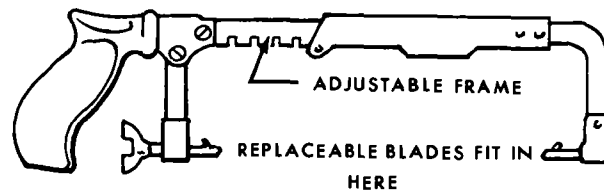
NESTED SAWS

Nested saws are used to cut along curved lines, start cuts for larger saws, and to make cuts inside a board when sawing must start from a drilled hole. They consist of one handle to which three different blades are attached.

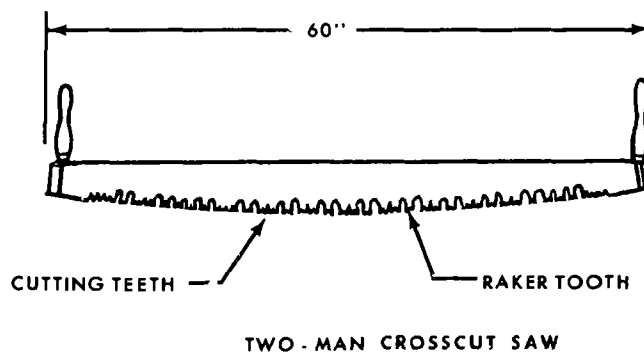
The **KEYHOLE** blade can enter a 1/4-inch hole and is used for close work such as cutting, shaping, or enlarging holes in a partition.

The **COMPASS** blade curves and is used for starting cuts to be completed by larger saws.

The **PLUMBERS** blade is heavy and slender with fine teeth. It cuts nails, screws, etc. The blade is thick enough to let a woodcutting saw pass through the cut it makes in a nail or screw.

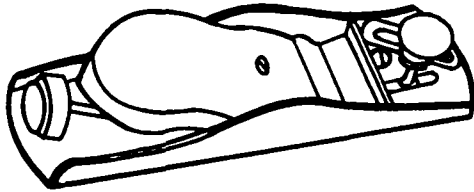


The **HACKSAW** cuts metal objects of almost any size or shape, blades are 8 to 12 inches long and are of two types – hard and flexible. The 18 point flexible blade, issued with the pioneer tool set, is considered best for general use.



The **LARGE TWO-MAN CROSSCUT SAW** is used for heavy work such as felling trees, cutting large trees into logs, and sawing heavy timbers. It must be operated by two men, since it is moved across the wood by pulling action only. One man pulls the blade as far as it will go, while the other man guides the blade. Then the procedure is reversed, with the first man doing the guiding and the second man doing the pulling.

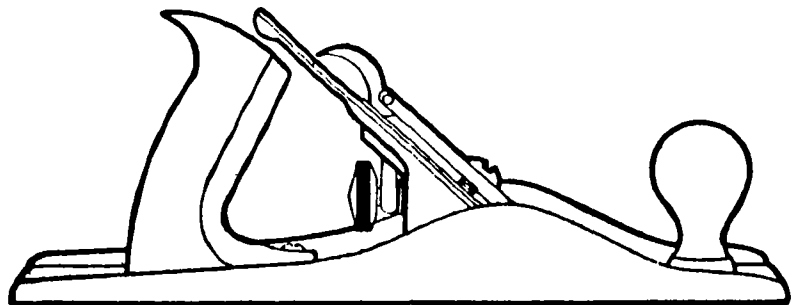
PLANES



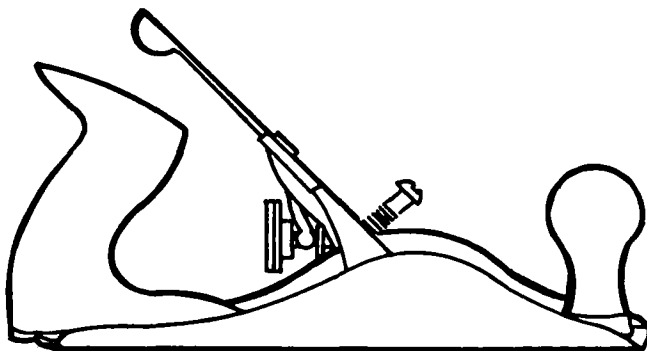
PLANES are smoothing tools used to true the edges or surfaces of wood, when finished surfaces or close-fitting joints are required. Planes, like saws, are made to do specific jobs and are found in many forms. However, the two most generally used are the block plane and a general purpose set of planes called bench planes.

BLOCK planes are the smallest, averaging 6 inches in length and are operated with one hand. They are used to make small cuts across the grain of the wood and to square edges.

BENCH planes cut with the grain. The most common types are the **SMOOTHING** plane for finishing and the **JACK** plane for all-purpose planing.



JACK PLANE (11 - 15 IN.)



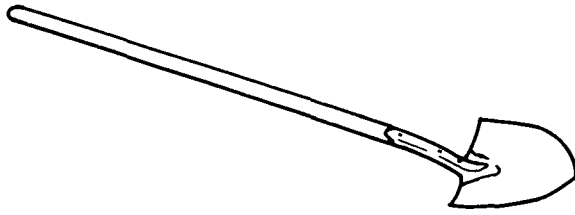
SMOOTHING PLANE (AVERAGE LENGTH 9-IN.)

CHISELS are steel blades, with or without handles, that are ground and sharpened to produce a keen cutting edge.

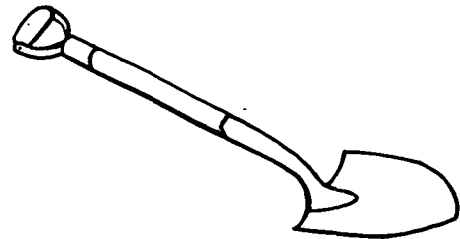
WOOD chisels are used to chip or to pare small quantities of wood, as in paring the edge or surface of a board, or in cutting a recess such as a socket in wood.

The **COLD** chisel is used to chip, pare, and cut cold metal or masonry.

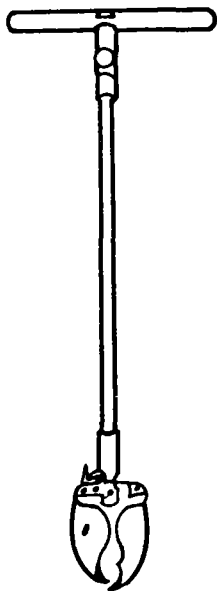
DIGGING TOOLS



The **LONG HANDLED SHOVEL** is designed for digging where continued swinging of the shovel is necessary to throw or move dirt a substantial distance.

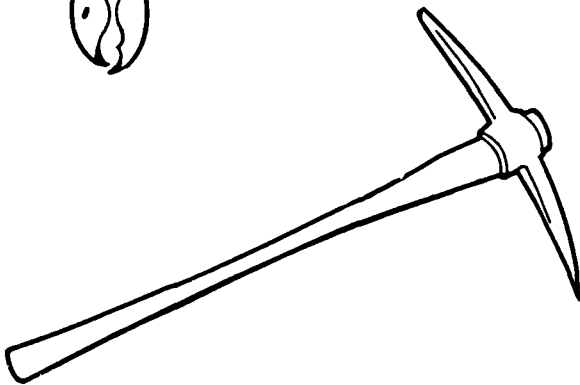


The **D-HANDLED SHOVEL** is designed for light work or for digging in cramped spaces.

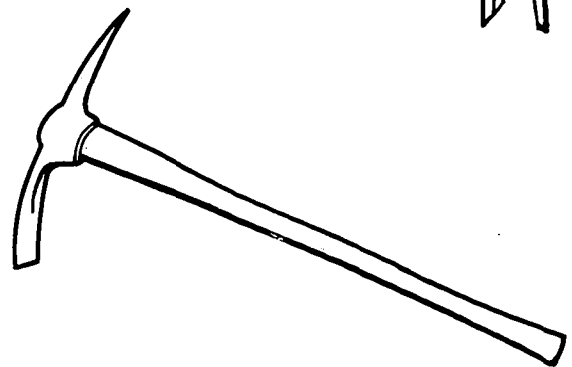


The **POSTHOLE AUGER** is used to bore holes in the ground for posts, poles, and explosive charges. It is an 8-foot, 3-inch long tool that has two shovel-like blades at one end, hinged to permit them to move enough to grasp the dirt and lift it from the hole.

The **POSTHOLE DIGGER** is used for the same purpose as the post-hole auger. Unlike the auger, it can be forced into the ground since the blades are harder and are angled to cut into hard earth.



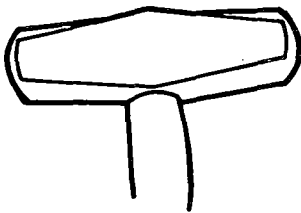
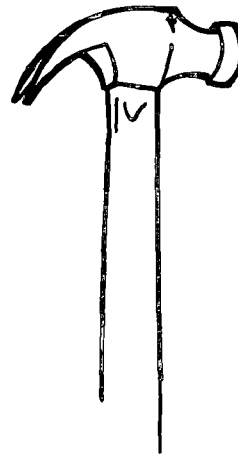
The **PICK** is used for breaking or loosening hard clay, rocky earth, and similar compacted material.



The **MATTOCK** is designed for digging in hard ground. Its pointed end is for breaking the surface and the wide blade for cutting roots and loosening clay and rocks.

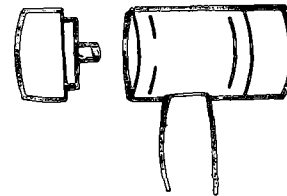
HAMMERS

The **CARPENTER'S CLAWHAMMER** is used for driving nails, wedges, and dowels. The claw is used to pull nails out of wood.

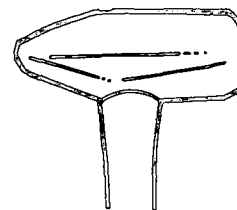


The **NAPPING HAMMER** is used in road construction or whenever there is a need to break a small amount of stones. It has a high carbon steel head with two narrow tapered faces and weighs approximately 2 pounds.

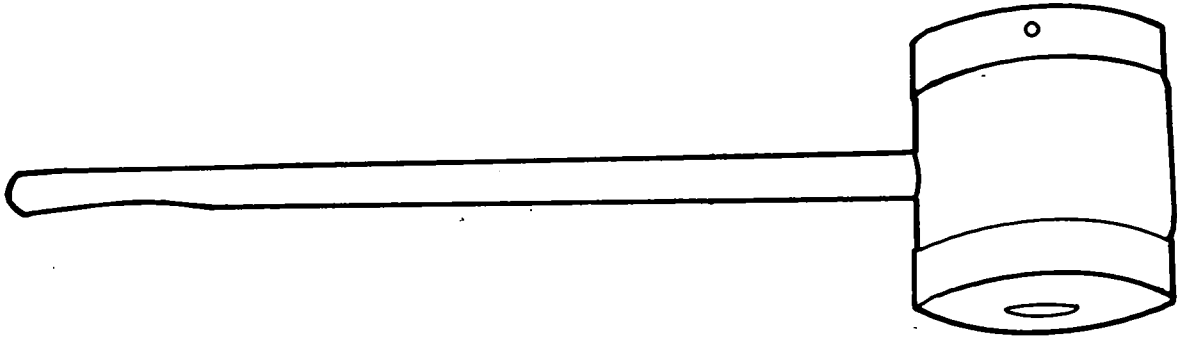
The **PLASTIC-FACED HAMMER** is used for striking wood or soft-metal surfaces that would be damaged by an all-steel hammer. It has a metal head with replaceable plastic faces screwed on to both sides of the metal section.



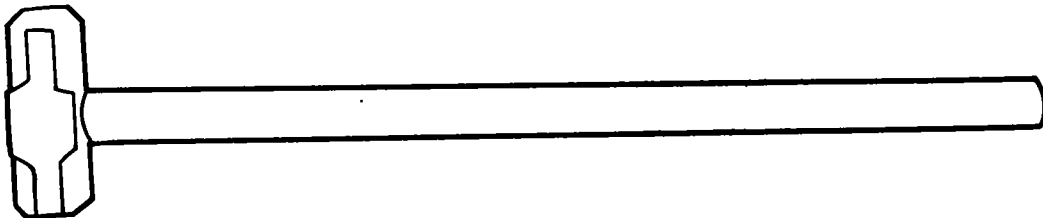
BLACKSMITH'S CROSS-PEEN HAMMER is used to beat out or spread metal, to spread heads of rivets, to drive metal chisels, and similar tasks.



MAULS AND SLEDGES



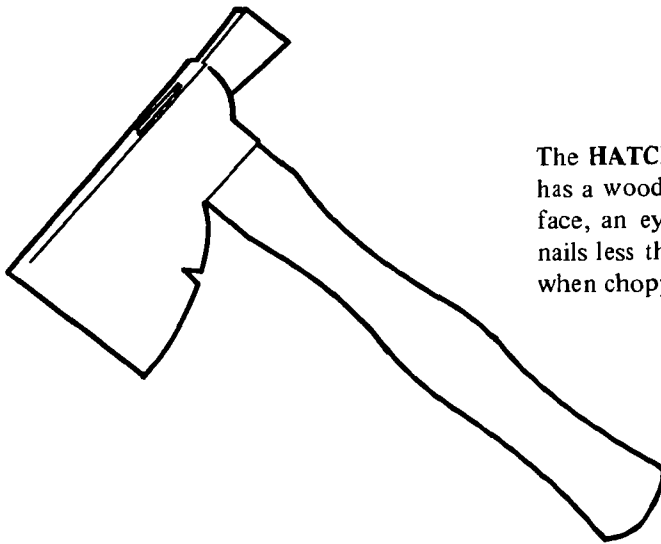
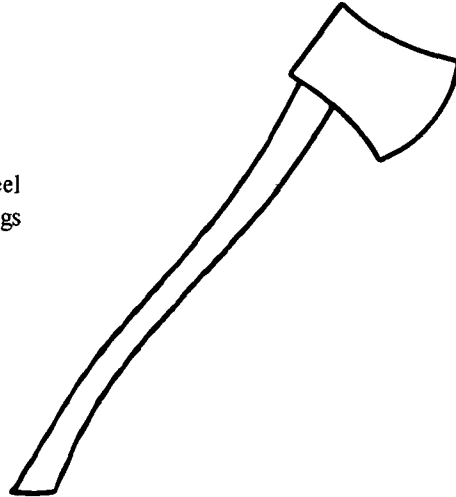
The **WOODEN MAUL** is used for driving small wooden pickets, posts, or stakes. The one in the pioneer set has a head about 10 inches long and 8 inches in diameter.



The **BLACKSMITH'S DOUBLE-FACED SLEDGE** is a general purpose tool for heavy pounding. It is used for such work as driving heavy spikes, drift pins, metal timber wedges, rock drills, and metal stakes. It may also be used for breaking rock. The pioneer set contains an 8- and 12-pound sledge.

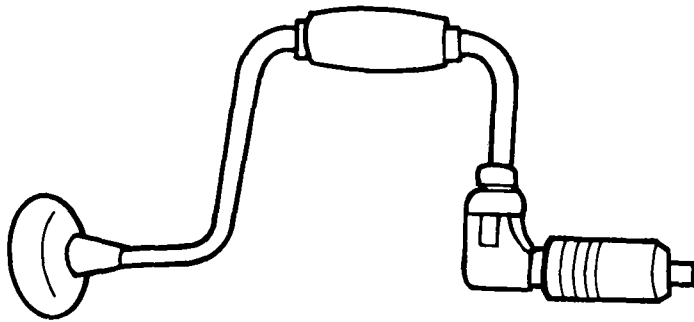
CHOPPING TOOLS

The **SINGLE BIT AX** is a chopping tool consisting of a steel head and wooden handle. The ax is used to fell trees, cut logs into convenient lengths, and to split and cut wood.



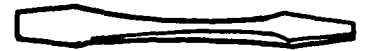
The **HATCHET** is a combination chopping and driving tool. It has a wooden handle and a steel head. The head has a hammer face, an eye, and a blade. The blade has a notch for pulling nails less than 8d in size. The hatchet is most effectively used when chopping with the grain of the wood.

DRILLING TOOLS



The **RATCHET BRACE** is used for drilling holes in wood only. It turns auger bits, expansive bits, countersink bits, or screwdriver bits.

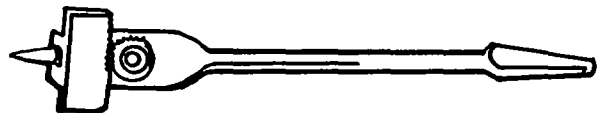
The **SCREWDRIVER BIT** consists of a blade with a square-shank tang instead of a handle. The tip resembles either the common or Phillips screwdriver tip.



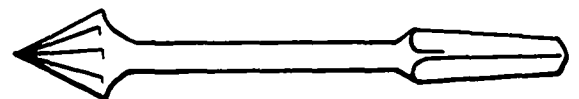
The **AUGER BIT** has a steel shaft varying from 7½ to 9 inches in length. It is not usually used for holes larger than 1 inch.

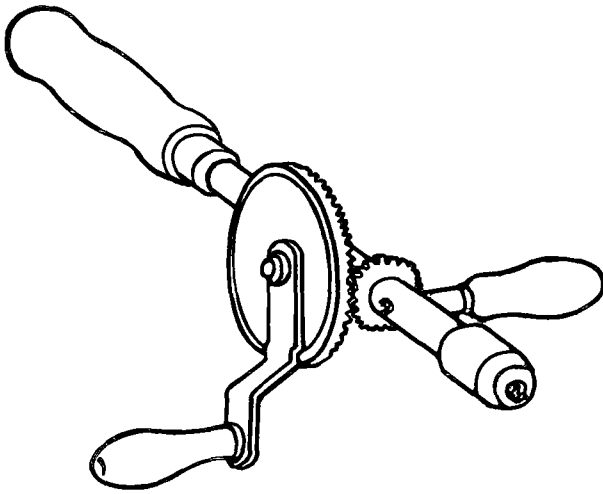


The **EXPANSIVE BIT** is used to bore holes from ½ to 3 inches in diameter.



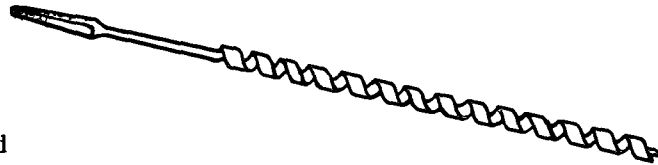
After a hole has been drilled, the **COUNTERSINK BIT** is used to shape the upper end of the hole so the head of a flatheaded screw can be driven flush with or slightly below the surface.



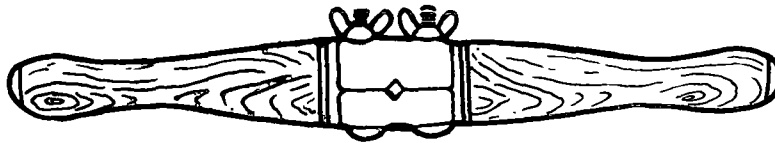


The ratchet type **HAND DRILL** is used to drill holes in soft metals or wood with the twist drill bit.

The **TWIST DRILL BIT** is cylinder shaped with spiral grooves, called flutes, around the body of the bit which do the cutting.



The **HOLLOW CENTER AUGER BIT** is used with a special handle to bore holes for holding driftpins and to drill other deep holes in heavy timber.



The **MASONRY DRILL** is used for drilling holes in concrete or stone. It is frequently called a star drill. The cutter edges are placed in position where the hole is to be drilled and the head of the drill is struck with a heavy hammer. The drill must be rotated after each blow to clear chips and to keep the drill from binding.

REPLACING WEDGED WOODEN HANDLES

The wooden handle of any tool that uses wedges to keep it fastened to the tool can be replaced by using the following procedures:

Remove the defective handle by pulling it out. If it is too tightly wedged to pull out, saw it off near the tool's head, then drive it out with a punch or chisel.

Shape the new handle with a wood rasp until it fits tightly in the tool's eye. Seat this handle on the head by holding the handle with the toolhead down, and striking the handle end with a wooden mallet. It can also be seated by striking the handle end sharply against a solid object several times.

Saw off the end of the handle if it projects from the eye, and work it down with a rasp. Drive wedge(s) into the eye at a slight angle to the handle notch. Grind off the excess portion of the wedge if it is metal. A wooden wedge should be smoothed down with a rasp. The toolhead can be soaked in water to give an extra tight fit. Be sure to wipe the tool dry and coat it with oil after soaking.

Remember that nails or screws should never be used as substitutes for wedges when replacing a handle. Screws and nails cannot make a tight fit and may permit the toolhead to fly off in use, injuring the user or others in the vicinity.

Never paint wooden handles since such treatment will cause the user to develop blisters.

SHARPENING

All edged tools should be kept sharp and in top condition. Methods for keeping tools sharp include whetting or honing, filing, and grinding.

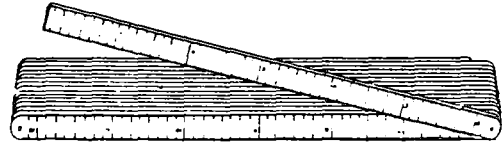
When an edged tool begins to show a slight dullness, whet its cutting edge with an oilstone or a combination Carborundum stone. These whetting or honing stones come in a variety of shapes and sizes to fit all types of tools. The honing stones with curved or rounded edges are called slipstones and are used to whet concave surfaces such as those found in the auger.

Where an oilstone cannot be used satisfactorily to whet a cutting edge, a touchup with the proper size and shape of file will help keep a keen cutting edge.

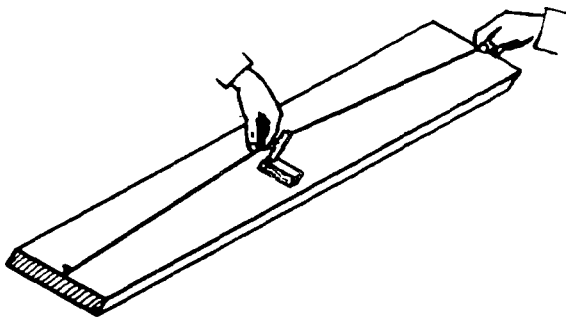
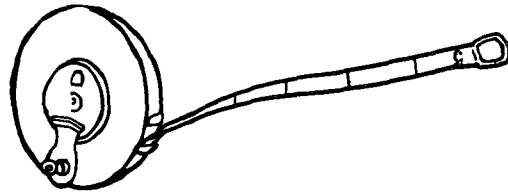
When a tool's keen cutting edge cannot be restored by whetting or filing, an abrasive stone in the form of a grinding wheel is used. Some grindstones are hand-operated and others are power driven.

RULES, TAPES AND MARKING TOOLS

The **MULTIPLE-FOLDING RULE** is used to make measurements up to 8 feet, where precision accuracy is not required.

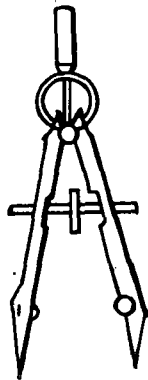


The **STEEL MEASURING TAPE** is used for measuring circumference and long distances where rules cannot be applied.



The **CHALKLINE** is used to lay out a straight line between two points that are too far apart to permit use of a square or straightedge for drawing a line. It can be used for such jobs as staking foundations, laying brick, aligning walls, forms, and posts and marking long boards for sawing.

Tie the chalkline to the object marking the spot, draw chalkline over the chalk, moving toward the other layout point. Grasp line midway between points and pull it away from the work surface at a *right angle* to the surface, release the line so it will snap straight downwards to deposit chalk in a straight line.



DIVIDERS are used for measuring, transferring, or comparing distances between two points when a precise measurement is required. They are also used to scribe an arc, radius, or circle, and to compare or transfer measurements directly from a rule.

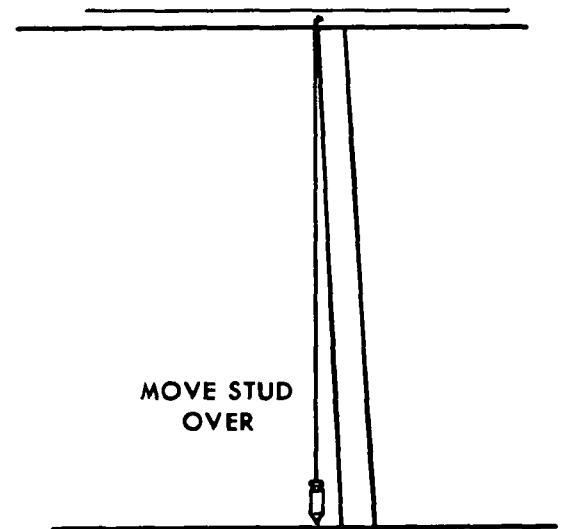
LEVELING TOOLS

The **CARPENTER'S LEVEL** is a 24-inch wood block with true surface edges. There are two bubble tubes in it — one to check for a level horizontal surface and one to check for a plumb vertical surface. (Plumb means vertical or at a right angle to level.)

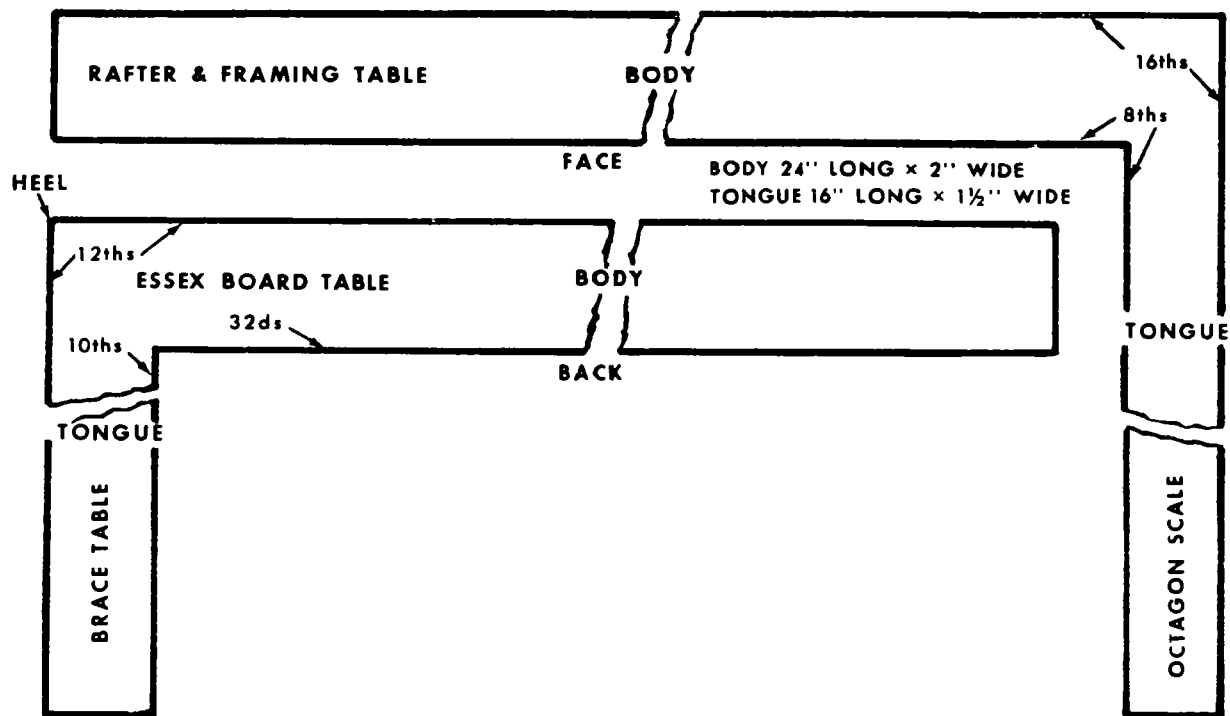


A **LINE LEVEL** is used to check the levelness of a line between two points, as in checking the floor of an excavation. It is used in conjunction with a stretched cord. It is usually made of aluminum, is 3 inches long, has a hook at each end for hanging it on a cord, and has just one bubble tube which operates in the same manner as those on the carpenter's level.

The **PLUMB BOB** is a metal weight with a pointed end. It has a device for attaching a string and is used to obtain a vertical line.



SQUARES



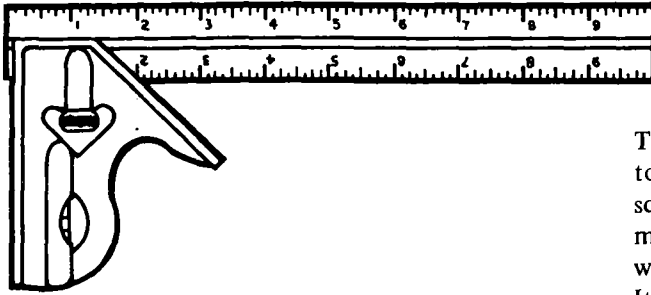
The **CARPENTER'S STEEL SQUARE** is used to measure and mark lumber, to test the squareness and flatness of wood, to make calculations with the aid of its gradations and tables, and for many other operations. The longer arm is called the body or blade and is 24 inches long. The shorter arm is called the tongue and is 16 inches long. The side showing the manufacturer's name is called the face, the reverse the back. The corner is called the heel.

The *Essex Board Measure Table* on the back is used to compute board feet in solid lumber that comes in standard sizes.

The *Rafter or Framing Table* on the face is used to determine rafter lengths, slope, and overhang.

The *Brace Table* on the back gives the lengths of commonly used braces.

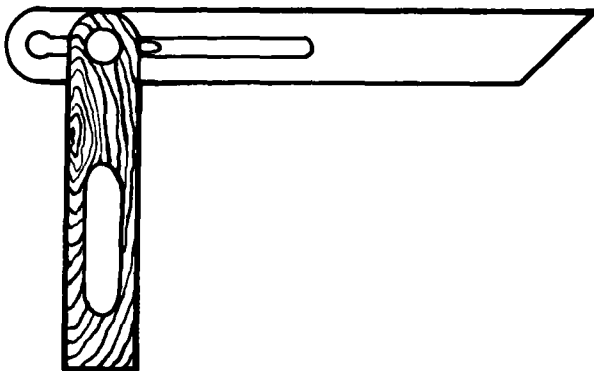
The *Octagon Scale* on the face is used to lay off lines when it is necessary to cut an octagon shape from a square piece of lumber, as for a pillar.



The **COMBINATION SQUARE** combines the uses of many tools such as the straight edge, plumb, level, outside try square, inside try square, marking gage, depth gage, and miter square. It is a foot-long steel blade with a metal head which can be moved and clamped to any desired position. It can be used to square lumber to a surface and at the same time determine whether the surfaces are level or plumb, by using the small level vial built into the head.



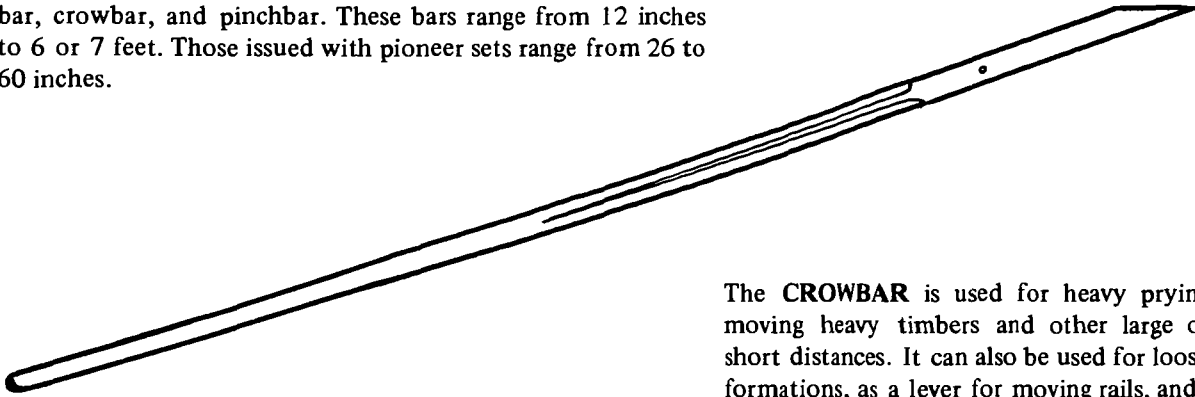
The **TRY SQUARE** has many uses — to serve as a guide for marking lines at right angles to an edge or surface; to test straightness and squareness of edges, faces, and ends of small boards; to check the edge or surface to determine if it is the same width or thickness throughout its length; to serve as a scale for laying out work on small pieces of lumber when cutting and framing; and to test inside or outside angles of 90°.



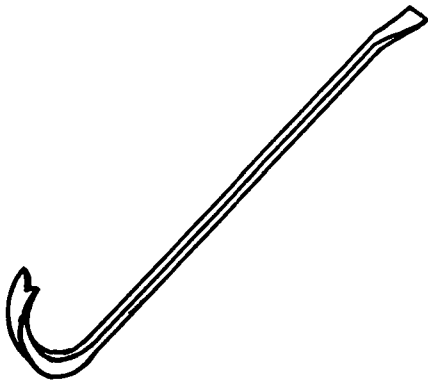
The **SLIDING-T BEVEL** is similar to the try square except that its blade is adjustable to any angle. It is used for laying out angles other than right angles, for testing bevels, and for repeating or transferring angles from one piece of lumber to another.

MISCELLANEOUS

BARS are heavy steel tools used to lift and move heavy objects and to pry where leverage is needed. They can also be used to remove nails and spikes and to loosen compacted soil for digging. The most commonly used types of bars are the wrecking bar, crowbar, and pinchbar. These bars range from 12 inches to 6 or 7 feet. Those issued with pioneer sets range from 26 to 60 inches.



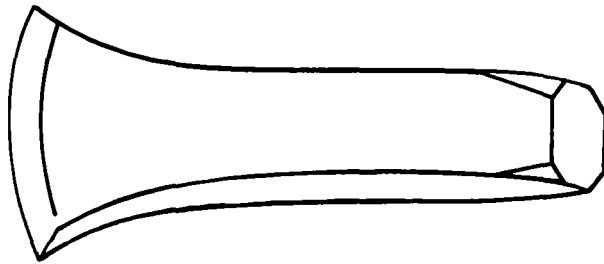
The **CROWBAR** is used for heavy prying and for moving heavy timbers and other large objects for short distances. It can also be used for loosening rock formations, as a lever for moving rails, and for breaking up hard earth when digging. The crowbar that is issued with pioneer tool sets is a steel bar, about 5 feet long, tapered to a rounded point at the end where it usually is held. There is a pinch point with a chisel-like, squared-off wedge at the other end. Some crowbars have the pinch point set at a slight angle.



The **WRECKING BAR** is used to pull large nails or spikes, to open heavy crates, and do demolition or wrecking work. The size of the wrecking bars found in the carpenter sets averages from 30 to 48 inches, with a diameter of $1/2$ to $1-1/8$ inches.



The **PINCHBAR** is used in light ripping and prying jobs. It is similar to the wrecking bar but it is lighter and used for lighter work. The pinchbar found in the pioneer sets is a steel bar, from 26 to 36 inches long, with a tapered point at one end and a chisel-like pinch point at the other. Some pinchbars have a short claw at the tapered end.

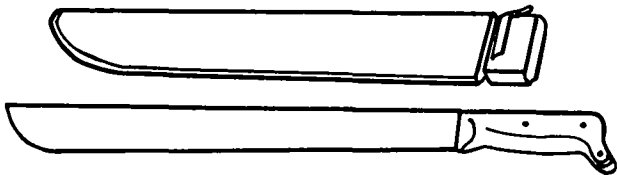
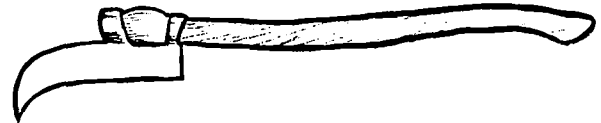


The **TIMBER WEDGE** is used with a sledge, primarily to split logs and timber. When sawing timber it may be used to spread the sawed cut so that the saw will not bind.



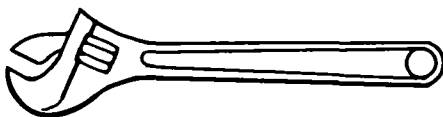
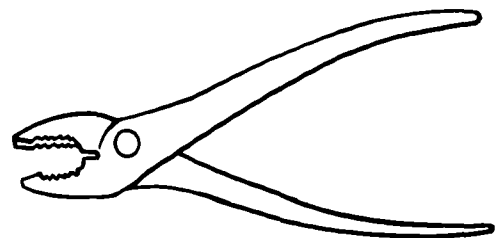
The **MINER'S SPOON** is used to lift material out of small, deep holes such as those made by the rock drill, to clear a hole for further drilling, to permit placing an explosive charge in the bottom, and other similar jobs. It is a slender metal rod with the ends forged into small bowl-shaped projections, sometimes called pan, at right angles to the rod. It ranges in length from 2 feet to 6 feet and the bowls are from 1 to 2 inches in diameter.

The **BRUSH HOOK** is a hook-shaped steel blade set onto a heavy duty handle by means of a strap and an eye. It is used where it is not practical to use the ax, for cutting underbrush, shrubs, and branches.



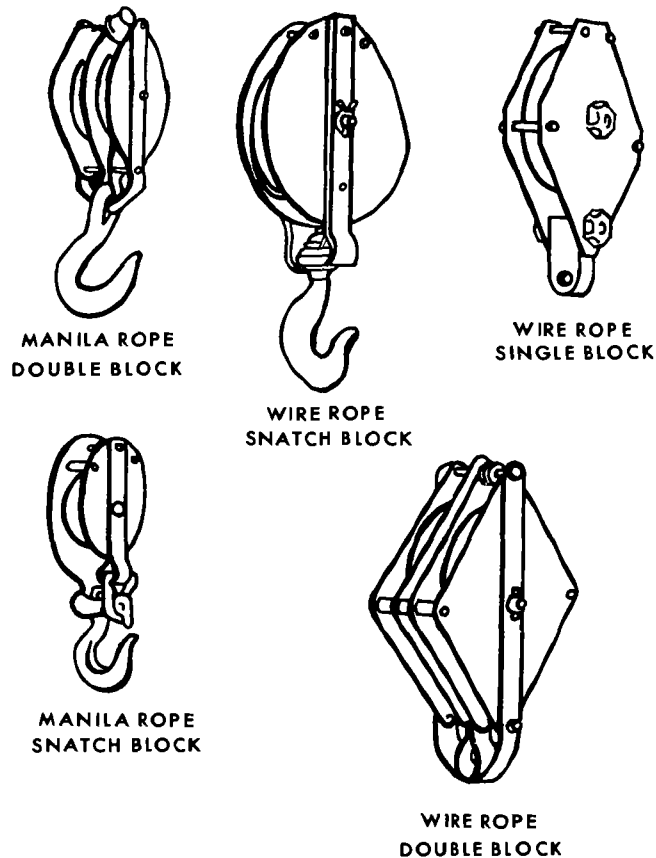
The **MACHETE** used in the military is an 18-inch knife. The blade is heaviest and widest at the point. It is used to cut tall grass, vines, and small brush with a chopping stroke.

SLIPJOINT COMBINATION PLIERS are used for such purposes as holding or bending wires and light bars or similar small items. Some slipjoint pliers have short cutting edges near the hinge for cutting light-weight, soft wire.



WRENCHES are available in a number of types, sizes, and designs. They are used to exert a twisting force on nuts, bolts, screws, and pipe plugs, with some of them made to grip special objects. The most common one is the open end adjustable wrench.

BLOCKS

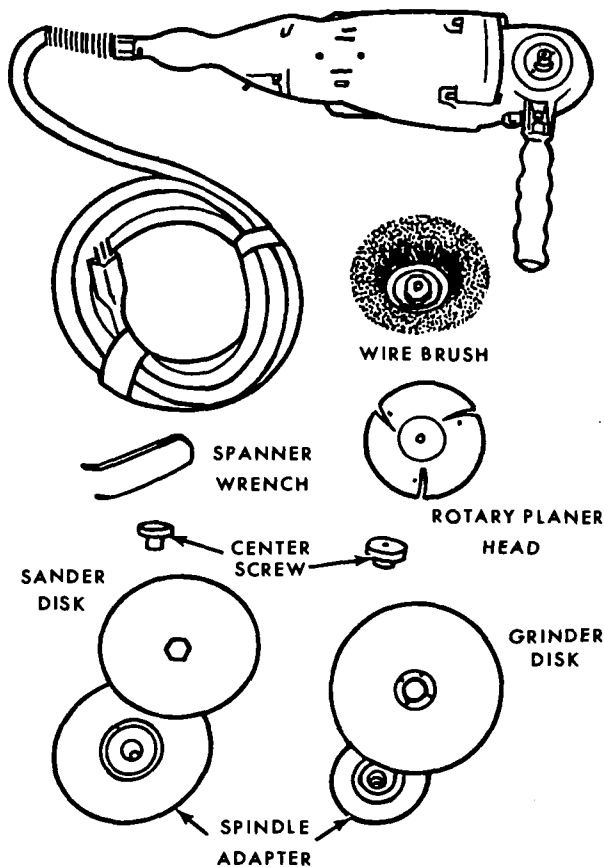


A block consists of a metal shell or frame which supports the ends of a pin and houses a grooved pulley or sheave that revolves on the pin. A hook, usually free to revolve, is attached to one end of the block, and sometimes an eye, or becket, is attached to the other end. Blocks are classified by the length of their frame in inches and by the number of sheaves or pulleys. A single block has one sheave; a double block has two sheaves. The recommended size rope to use on a block is one that fits the groove of the sheave and has clearance to slide or move easily. When a block is made so that its shell opens on one side to admit the rope without having to thread the rope over the sheave, it is called a snatch block.

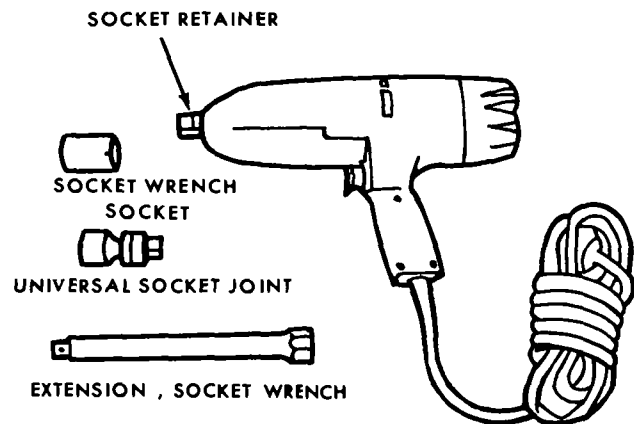
PIONEER PORTABLE ELECTRIC TOOLS

The **PORTABLE POWER** tools are designed for a wide variety of uses, such as construction, intrenching, timber cutting, bridging, and tree clearing. Their use increases production, lessens the requirement for labor and human strength, and cuts the time needed to perform a task. These tools are in the pioneer portable electric tool outfit.

An electric tool trailer carries the tools to the scene of the operation and stores them between jobs. The trailer is moved by a 3/4-ton cargo truck. There is a power generator that can be left in the trailer or handcarried to the place of use. It is a 3 kw, 60 cycle, 115 volt, AC generator and skid mounted in the trailer.

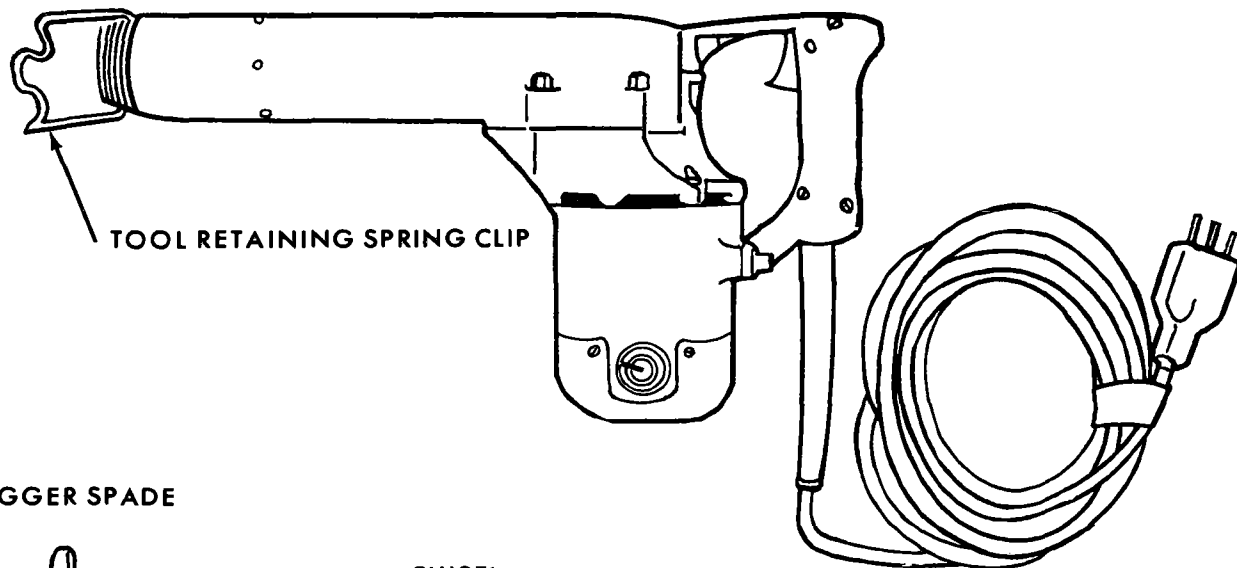


The **PORTABLE ELECTRIC DISK SANDER** is used for heavy duty sanding, grinding, wire brushing, and planing.



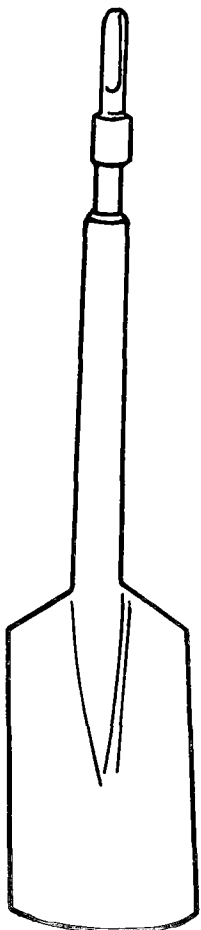
The **ELECTRIC IMPACT WRENCH** is used primarily for applying and removing nuts, bolts, and screws. It can also be used with proper accessories to drill and tap a variety of materials, to drive threaded studs, and to drive or remove socket-head or self-tapping screws.

The **PORTABLE ELECTRIC HAMMER** can be used for beveling, calking, and beading; for drilling in masonry, driving nails, digging in clay, breaking light concrete, and performing other similar jobs.



TOOL RETAINING SPRING CLIP

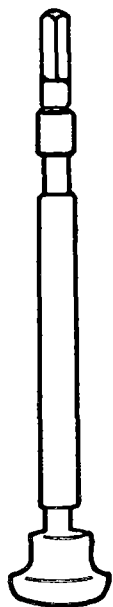
DIGGER SPADE



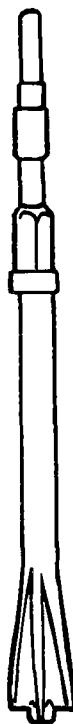
CHISEL



BACKFILL
TAMPER



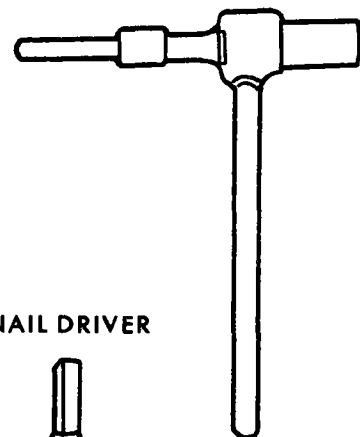
MASONRY (STAR)
DRILL BIT



MOIL
POINT



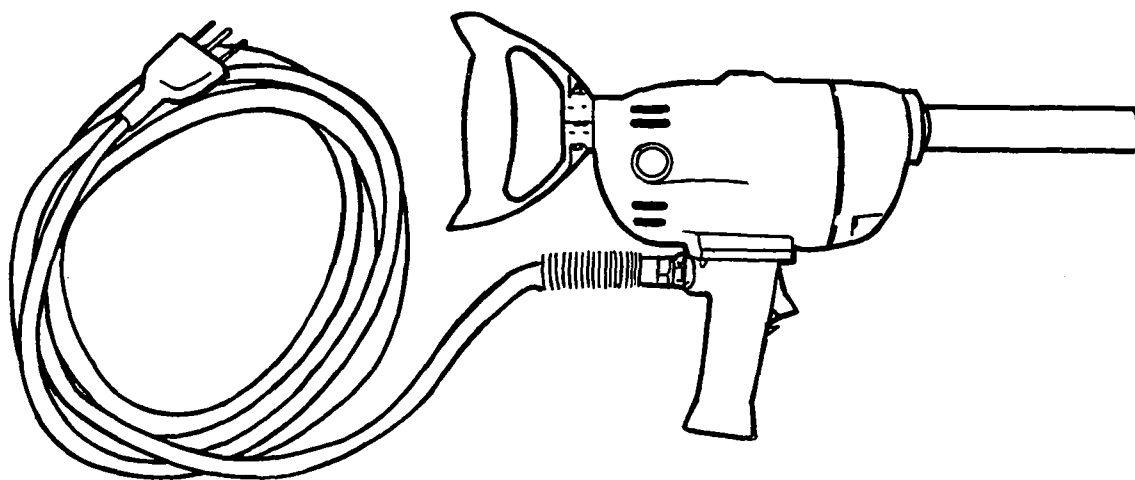
STAR DRILL CHUCK



NAIL DRIVER



The **PORTABLE ELECTRIC DRILL** can be used with a wide variety of bits and attachments for drilling holes, buffing, sawing, and driving screws.



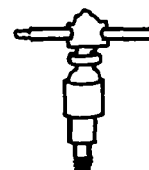
**MACHINE
REAMER**



**MORSE TAPER
SOCKET**



CENTER MARKER



**WOOD BIT
CHUCK**



TWIST DRILL BIT



CHUCK



CHUCK KEY

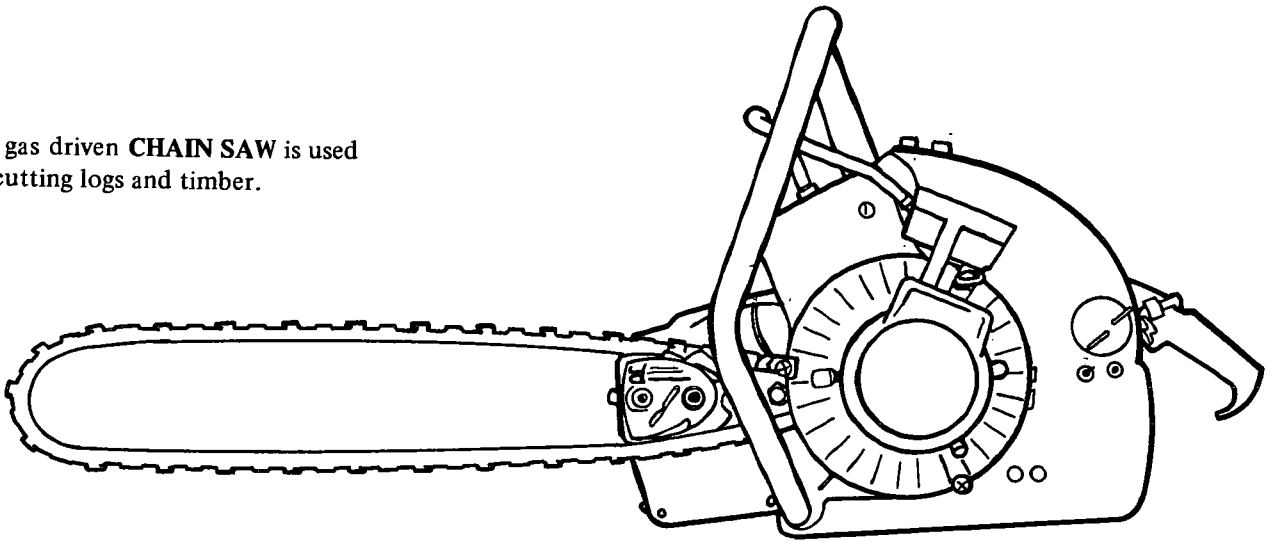
**TAPER SHANK
TOOL**



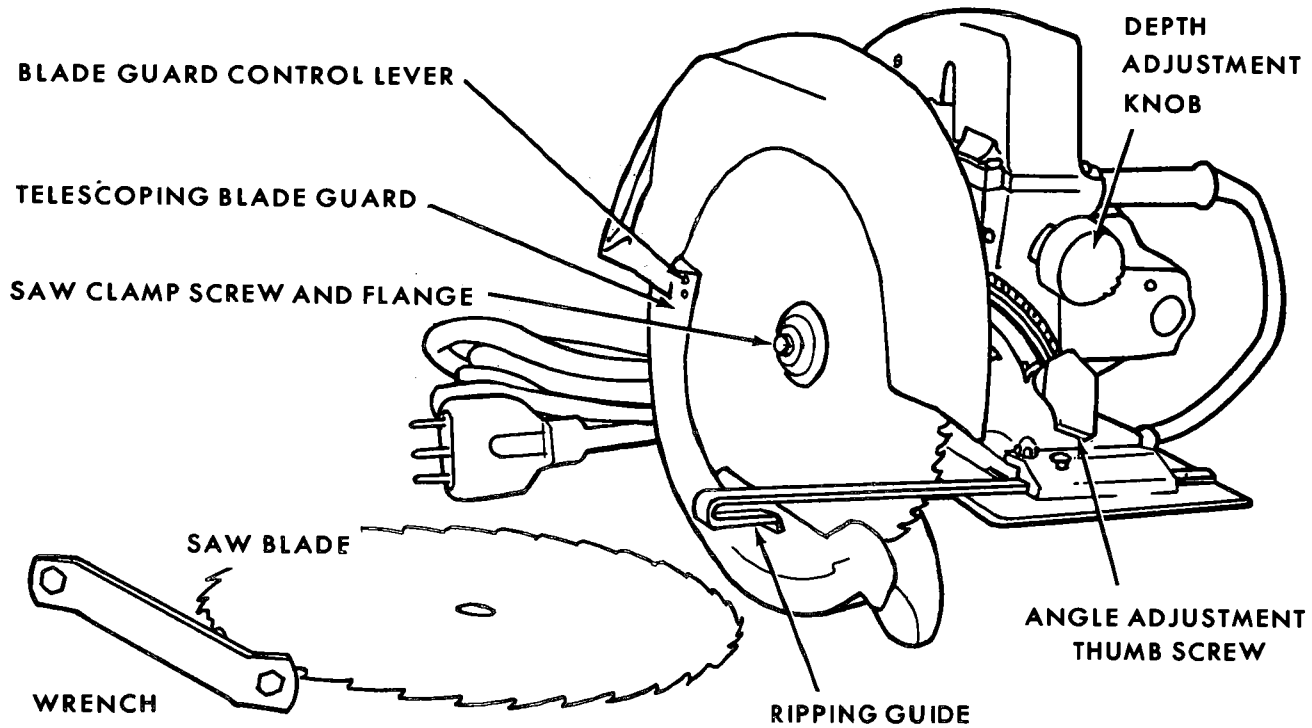
**AUXILIARY
HANDLE**



The gas driven **CHAIN SAW** is used for cutting logs and timber.



The **PORTABLE ELECTRIC CIRCULAR SAW** is used for cutting studding, cutting off the ends of subfloors or sheathing, ripping boards and planks, and preparing inside and outside trim.



CARE OF PORTABLE POWER TOOLS

Keep all power tools and accessories, especially the housing intake and exhaust holes clean and free of dust and dirt at all times. Wipe them with a soft cloth and use compressed air to blow particles from areas that cannot be reached with a cloth.

Examine cords for exposed or loose wires and damaged insulation. Wipe cords clean often to prevent deterioration from oils.

Check cord's ground wire connection and check plugs for loose prongs or cracked casings. Do not hold or drag electric tools by their cords at any time.

Store power tools in containers designated for this purpose or in the tool trailer, after coating any rustable metal with oil.

If attachments become dull or damaged, they should be sharpened or reground to their original shape and bevel.

SAFETY PRECAUTIONS

Before using a power tool, remove all loose accessories like special wrenches and chuck keys.

Make sure tool is grounded.

See that the switch operates freely and releases positively.

Check voltage specification to insure the power is correct.

Keep a firm grip on the tool while operating it.

Unplug tool when it is not being used.

Do not start a power tool in an unventilated area where combustible substances are present.

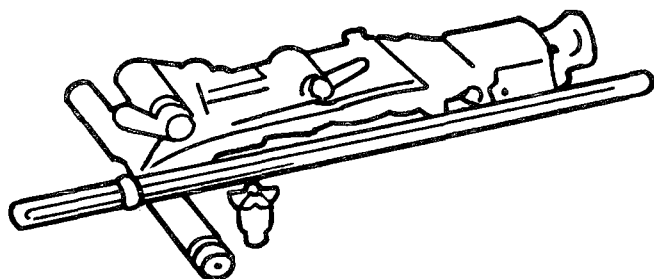
Do not operate power tools if they are damp.

When using the electric circular saw keep the hands, legs, and other parts of the body away from underneath the work surface.

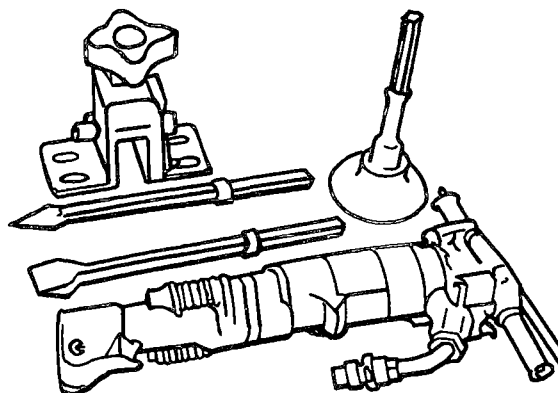
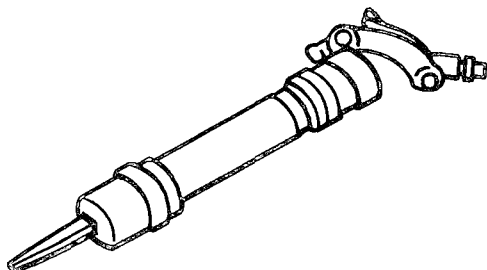
PNEUMATIC TOOLS

PNEUMATIC TOOLS are found in both combat and construction units. The power required to operate them is supplied by air compressors.

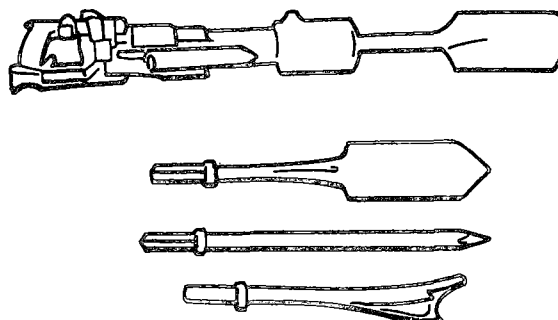
PAVING BREAKER is used to cut asphalt or concrete pavement and to demolish concrete foundations, retaining walls, culverts, and floors. It may be used also to drive sheet piling, by removing the front head unit and substituting the sheet pile driving attachment.



The **CLAY DIGGER** is used to dig stiff clay, hard sand, or gravel. It may also be used to cut up asphalt cement.



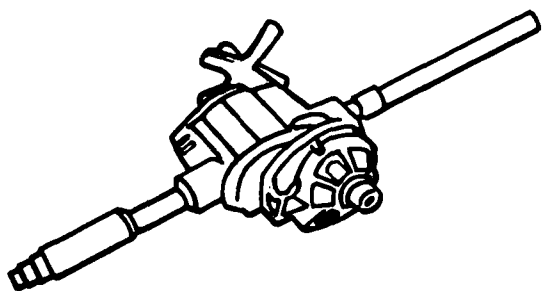
The **ROCK DRILL** is used in rock excavation and quarry work to drill holes for blasting charges.



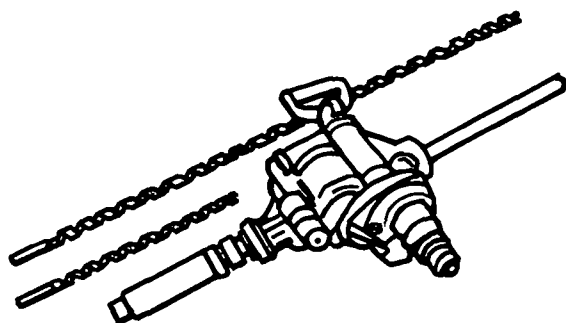
The **NAIL DRIVER** is used to drive large nails, spikes, and driftpins in the construction of bridges and buildings.



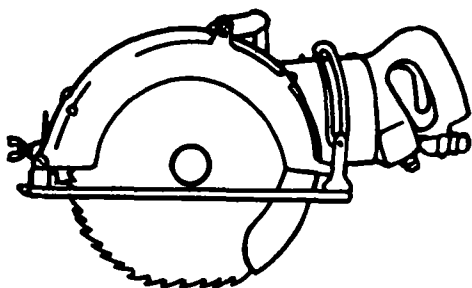
The **BACKFILL TAMPER** is used to compact earth backfill around culverts and fill material for crater repair and beneath road patches.



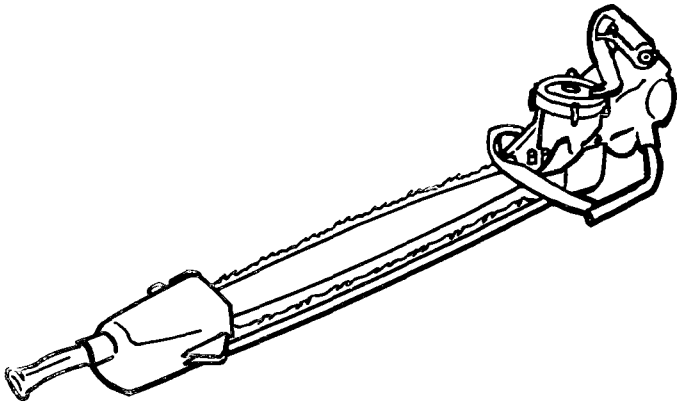
The **PORTABLE STEEL DRILL** is used to drill holes into steel for structural steel construction, equipment, and other items.



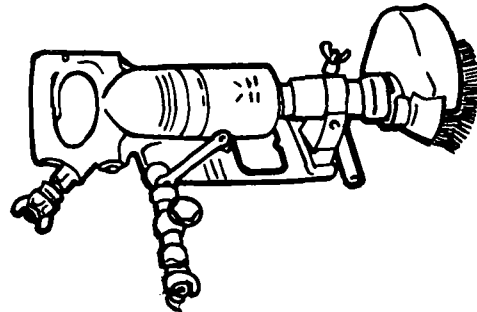
The **PORTABLE WOODBORING DRILL** is used to bore holes in wood for demolition charges and for construction of bridges and buildings.



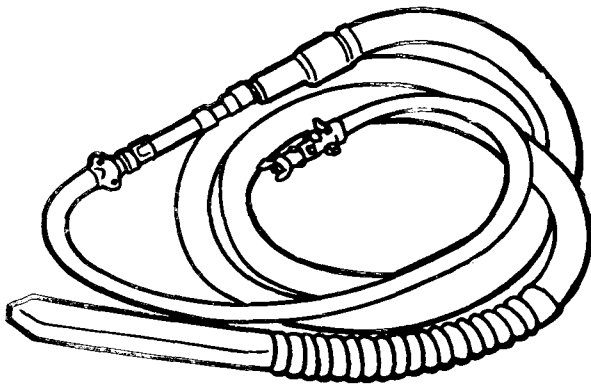
The **CIRCULAR WOODWORKING SAW** is used for cross-cutting or ripping lumber or planking for construction purposes.



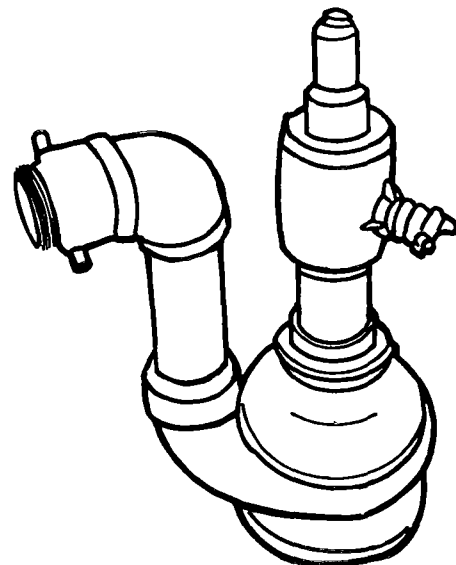
The **PORTABLE CHAIN SAW** is used in clearing timber and in support of construction tasks.



The **PNEUMATIC GRINDER** is used to sharpen and maintain tools, notch out structural steel, and rough polish surface irregularities.

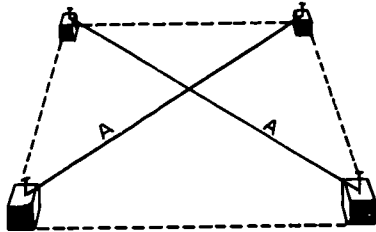


The **CONCRETE VIBRATOR** consolidates concrete by eliminating voids.

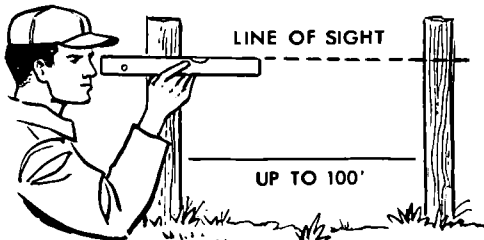


The **SUMP PUMP** is used to pump water out of excavations.

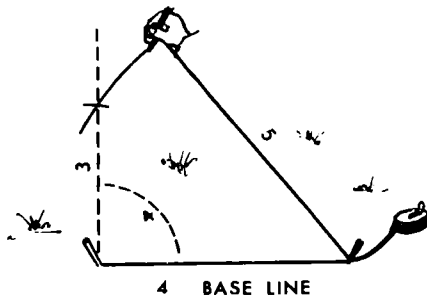
HELPFUL HINTS



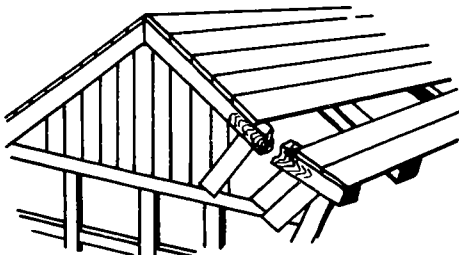
CHECKING FOR SQUARE, LAYOUT IS SQUARE WHEN DIAGONALS (A) ARE EQUAL



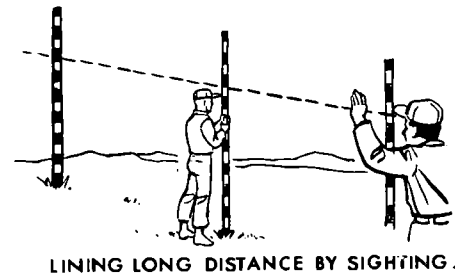
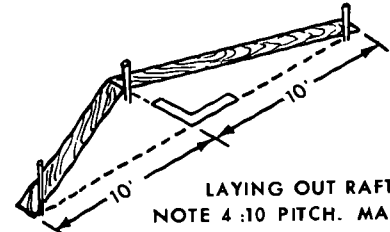
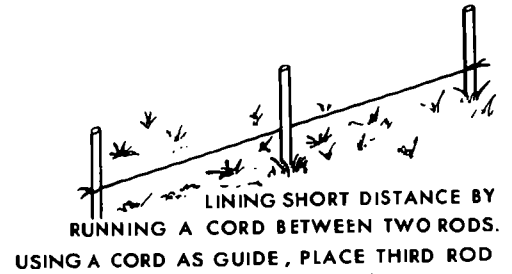
LEVELING BY SIGHTING OVER CARPENTERS LEVEL, FOR LONG DISTANCES.



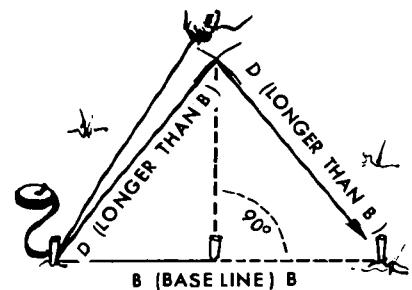
LAYING RIGHT ANGLE 3, 4, 5, TRIANGLE METHOD.



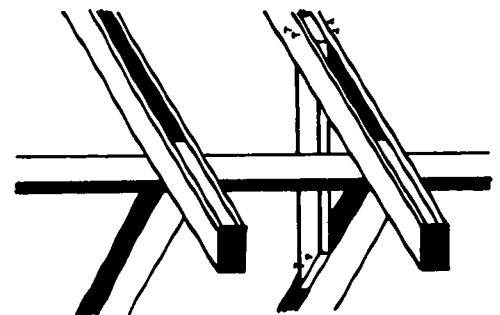
A KNOT IN THE WRONG PLACE DID THIS!



LINING LONG DISTANCE BY SIGHTING.

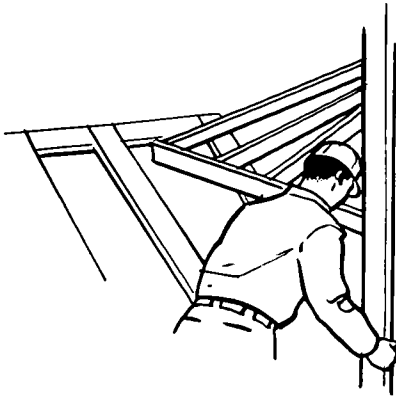


LAYING OUT RIGHT ANGLE, INTERSECTING ARC METHOD.

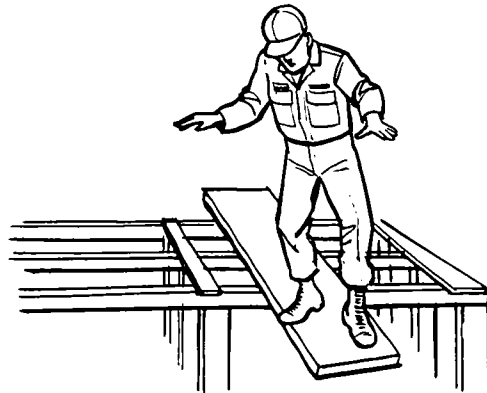


BE SURE BRACING IS THOROUGHLY NAILED

PRECAUTIONS



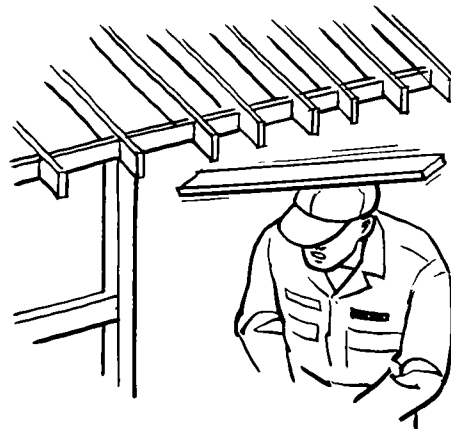
DON'T FORGET TO SHORE PROPERLY



DON'T WALK ON UNSUPPORTED PLANKING



DON'T HOLD STAKE WITH HANDS



DON'T PLACE LOOSE LUMBER ON ROOF



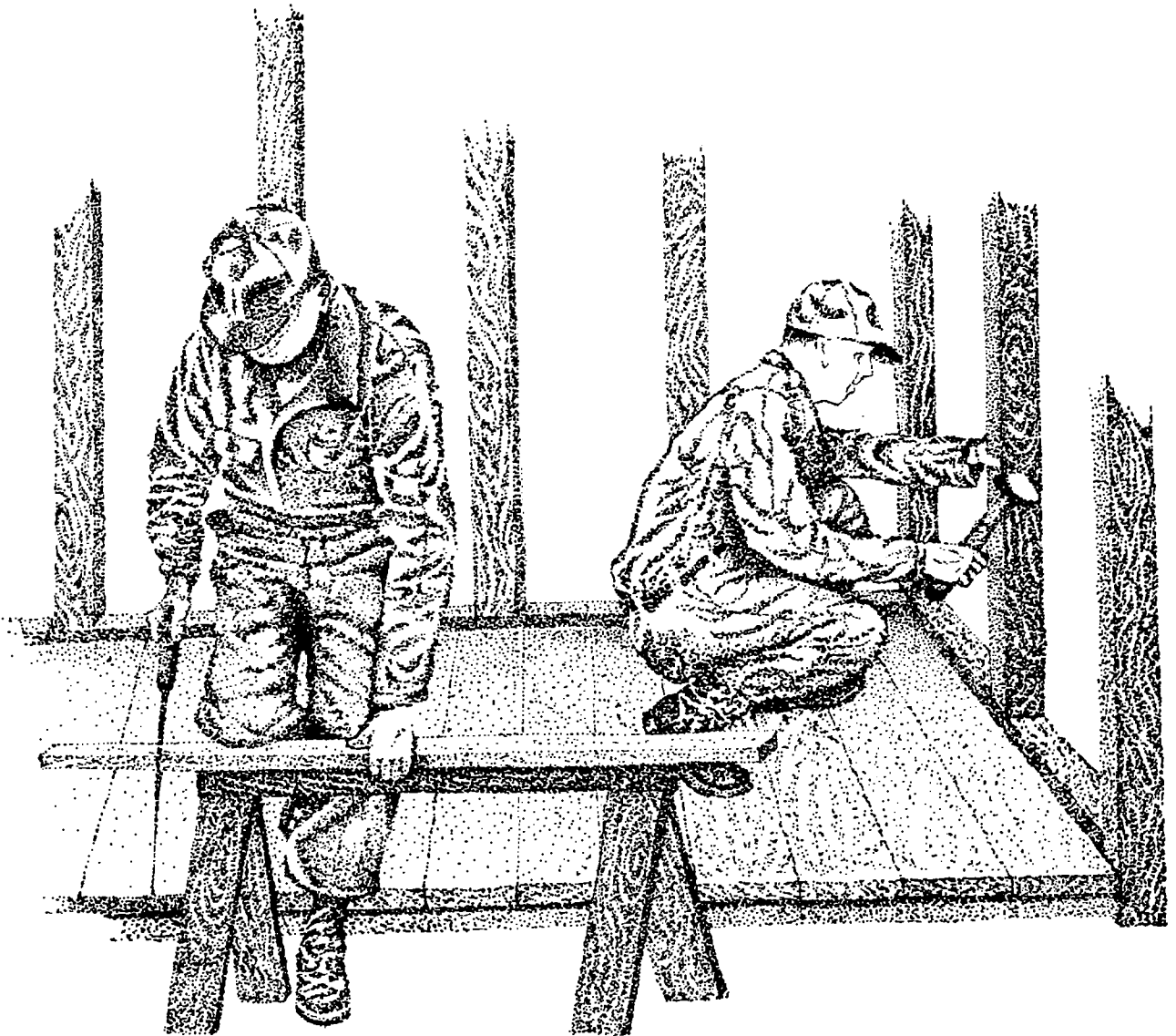
DON'T CARRY SAW LIKE THIS



DON'T REGRET YOU DIDN'T LOOK BEFORE STEPPING

PART THREE

CARPENTRY



An engineer soldier may often be called upon to construct, maintain, or repair theater of operations type buildings. To do this he must have an elementary knowledge of carpentry.

LUMBER

The basic construction material in carpentry is lumber. To allow uniformity in planning structures and in ordering materials, lumber is sawed, milled, and finished into standard sizes, lengths, widths, and thicknesses. The table below lists the common widths and thicknesses of wood in nominal and in dressed dimensions in the United States. The nominal sizes refer to dimensions prior to surfacing. It is important that these dimensional differences be taken into consideration when planning a structure.

		Dressed	
Nominal size (in.)		American standard (in.)	
1 x 3	.....	25/32 x 2-5/8	
1 x 4	.....	25/32 x 3-5/8	
1 x 6	.....	25/32 x 5-5/8	
1 x 8	.....	25/32 x 7-1/2	
1 x 10	.....	25/32 x 9-1/2	
1 x 12	.....	25/32 x 11-1/2	
2 x 4	.....	1-5/8 x 3-5/8	
2 x 6	.....	1-5/8 x 5-5/8	
2 x 8	.....	1-5/8 x 7-1/2	
2 x 10	.....	1-5/8 x 9-1/2	
2 x 12	.....	1-5/8 x 11-1/2	
3 x 8	.....	2-5/8 x 7-1/2	
3 x 10	.....	2-5/8 x 9-1/2	
3 x 12	.....	2-5/8 x 11-1/2	
4 x 12	.....	3-5/8 x 11-1/2	
4 x 16	.....	3-5/8 x 15-1/2	
6 x 12	.....	5-1/2 x 11-1/2	
6 x 16	.....	5-1/2 x 15-1/2	
6 x 18	.....	5-1/2 x 17-1/2	
8 x 16	.....	7-1/2 x 15-1/2	
8 x 20	.....	7-1/2 x 19-1/2	
8 x 24	.....	7-1/2 x 23-1/2	

GRADES OF LUMBER

Lumber as it comes from the sawmill is divided into three main classes: **YARD LUMBER**, **STRUCTURAL MATERIAL**, and **SHOP LUMBER**. In keeping with the purpose of this manual, only **YARD LUMBER** will be considered.

Yard lumber is manufactured and classified on a quality basis, into those sizes and shapes, and qualities required for ordinary construction and general building purposes. Yard lumber is divided into two classifications — select lumber and common lumber.

Select lumber is of good appearance and finishing. Common lumber is suitable for general construction and utility purposes.

The frame of a building consists of the wooden form constructed to support the finished members of the structure. It includes such items as posts, girders, joists, subfloor, sole plates, girts, knee braces, and rafters. Soft woods are usually used for light wood framing and all other aspects of construction carpentry that we are considering here. One of the classifications of soft wood lumber cut to standard sizes is called yard lumber and is manufactured for general building purposes. It is cut into those standard sizes required for light framing, including 2 by 4's, 2 by 6's, 2 by 8's, 2 by 10's, 2 by 12's and all other sizes required for framework, with the exception of those sizes classed as structural lumber.

Sizes of soft wood or building construction lumber have been standardized for convenience in ordering and handling. Building materials sizes run 8, 10, 12, 14, 16, 18, and 20 feet in length, 2, 4, 6, 8, 10, and 12 inches in width, and 1, 2, and 4 inches in thickness. Hard woods, which have no standard lengths or widths, run 1/4, 1/2, 1-1/4, 1-1/2, 2, 2-1/2, 3, and 4 inches in thickness. Plywoods run from 4 feet in width to 8 feet in length, and vary in thickness from 1/8 to 1 inch.

The amount of lumber required is measured in board feet. A board foot is a unit of measure representing a piece of lumber having a flat surface area of 1 square foot and a thickness of 1 inch actual or nominal size. A rapid estimation of board feet can be made by using this table.

Width	Thickness	Board feet
3"	1" or less	1/4 of the length
4"	1" or less	1/3 of the length
6"	1" or less	1/2 of the length
9"	1" or less	3/4 of the length
12"	1" or less	Same as the length
15"	1" or less	1-1/4 of the length

FASTENERS

The fasteners used in the theater of operations are made of metal, and classed as nails, screws, bolts, and driftpins.

NAILS come in many sizes and shapes. The standard nail used by the Army is the wire nail. All normal requirements of construction and framing are filled by the four illustrated below.

COMMON WIRE NAILS are used for housing-construction framing.



SCAFFOLD OR FORM NAILS are made with 2 heads. The lower head or shoulder, allows the nail to be driven securely while the upper head projects above to make the nail's withdrawal simple. They are used for temporary structures, such as scaffolding.

FINISHING NAILS are made from finer wire than is the common nail and they have smaller heads which allows them to set below the surface of the wood, leaving only a small hole easily puttied. These are used for finishing work, carpentry, and cabinet making.



ROOFING NAILS are round-shafted, diamond-pointed, galvanized nails of relatively short length and comparatively large heads. They are designed for fastening flexible roofing materials and for resisting continuous exposure to weather.

The **CUT NAIL** is an old type of nail no longer used except in special cases. The square point permits it to penetrate with less splitting than wire nails. Tapered shank permits drawing of floor joints much tighter than with wire nails.



GENERAL RULES TO BE FOLLOWED IN THE USE OF NAILS

A nail should be at least three times as long as the thickness of the wood it is to hold.

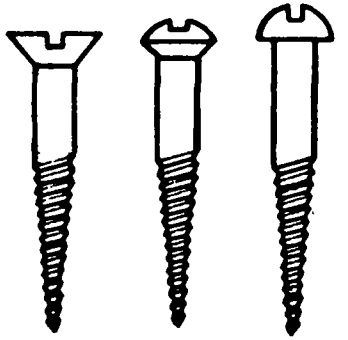
Two-thirds of the length of the nail is driven into the second piece of wood for anchorage and one-third provides the anchorage of the piece being fastened.

Nails are driven at an angle slightly toward each other.

Nails driven with the grain do not hold as well as nails driven across the grain.

A few nails, properly placed and driven hold better than a great many driven close together.

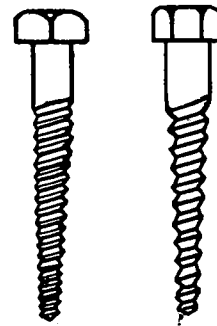
SCREWS provide more holding power than do nails, can be tightened to draw items being fastened securely together, are neater looking if driven correctly, and may be withdrawn without damaging the material.



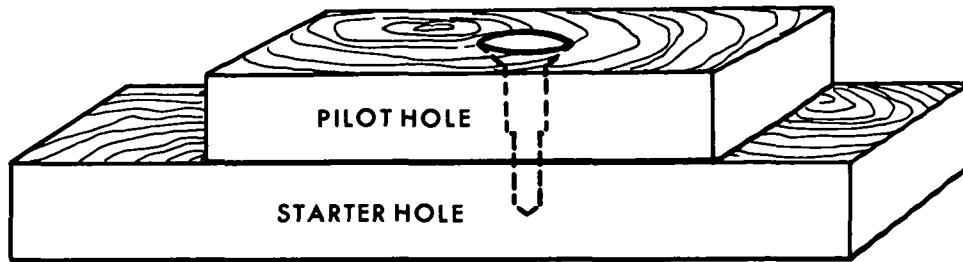
FLAT OVAL ROUND

WOOD SCREWS are classified according to head style.

LAG SCREWS are longer and much heavier than the common wood screw. They are used when ordinary screws would be too short or too light and spikes would not be strong enough. They are usually driven with a wrench.

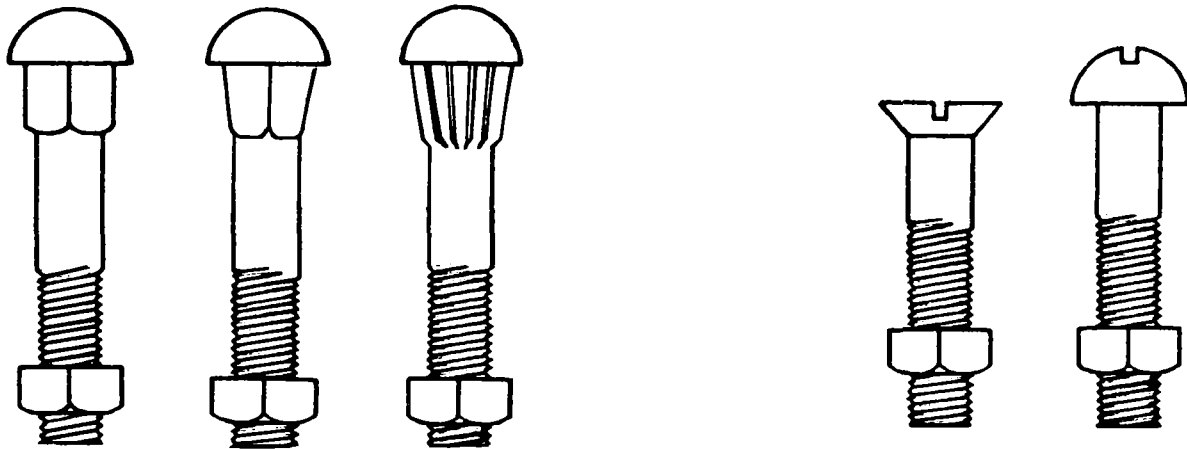


PROPERLY SET SLOTTED AND PHILLIPS flathead and oval head screws are countersunk to permit a covering material to cover the head. Slotted roundhead and phillips roundhead screws are not countersunk, but driven so that the head is firmly flush with the surface. The slot of the roundhead screw is left parallel to the grain of the wood.



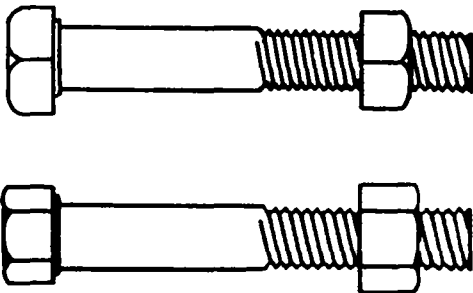
TO PREPARE WOOD for taking a screw, a hole the diameter of the screw is bored in the wood to be fastened. A smaller, starter hole is then bored in the anchor wood with a diameter less than that of the screw threads and about 1/2 the length of the threads to be anchored.

BOLTS are used when great strength is required or when the work under construction must be frequently disassembled.

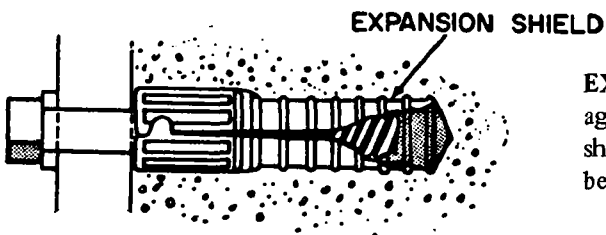


CARRIAGE BOLTS have round heads and are used chiefly for wood to wood. A common flat washer should be used with these bolts between the nut and the wood surface. The predrilled hole should provide a tight fit.

STOVE BOLTS, made with either flat or round heads, are generally used with square nuts and can be used for metal to metal, wood to wood, or wood to metal.



MACHINE BOLTS may have square, hexagon, double hexagon, rounded, or flat countersink heads. They are used chiefly for metal to metal. The predrilled hole should have the same diameter as the bolt.

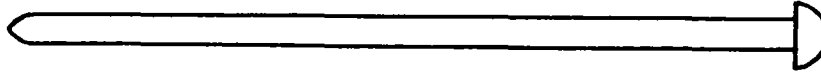


EXPANSION BOLTS have an expansion shield to provide anchorage in material in which a threaded fastener alone is useless. The shield expands when the bolt is driven in a predrilled hole and becomes wedged firmly.



The **TOGGLE BOLT** is a bolt that has a nut with pivoted flanged wings that close against a spring when passed through a constricted passage and open after emerging. It is used to fasten objects to a thin or hollow wall.

DRIFTPINS are long, heavy, threadless bolts used to hold heavy pieces of timber together. Their diameter varies from 1/2 to 1 inch, and their length from 18 to 26 inches. A pre-drilled hole, slightly smaller than the diameter of the pin, is made in the timber and the pin is driven with a sledge hammer. The compression action of the wood holds the pin in place.



The **CORRUGATED FASTENER** is used for joints and splices in very small lumber. It is seen most often in small miter joints, such as found in window screen frames.

A **STAPLE** is a U-shaped metal loop both ends of which are driven into a surface to hold a hook, hasp, or bolt of a lock, secure a rope, or fix a wire in place.

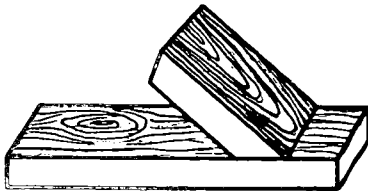
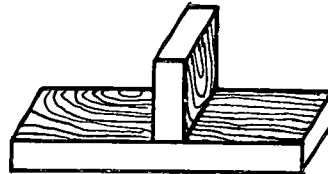
When using **GLUE** as a fastener, it is important to remember that most of the materials you will be gluing together are porous and will absorb a large portion of the first coat. Because of this, one coating should be applied to the two surfaces and allowed to dry thoroughly. Then a second coating should be applied to both surfaces and allowed to become tacky before placing together and clamping. Excess glue should be wiped off before it dries.

JOINTS

The two most commonly used joints are the **BUTT JOINTS** and the **LAP JOINTS**

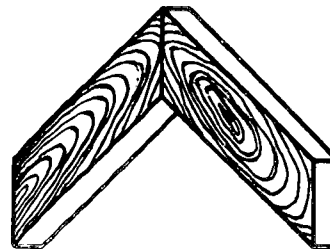
A structure is no stronger than its weakest point and these points often occur where there are connections. These connections are simple and if made properly, are strong. Connections are called either joints or splices. Joints are connections between two pieces of lumber which come together at an angle. Splices are connections between two pieces that extend in the same line.

The **STRAIGHT BUTT JOINT** is formed by bringing the square cut end of one board against the square face of another. Nails or screws are used to hold the pieces together. This is the weakest type of joint.

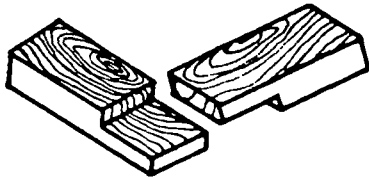
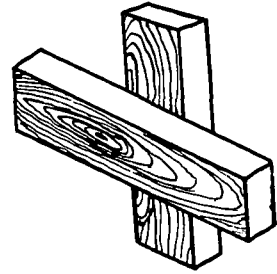


The **OBLIQUE BUTT JOINT** is formed by bringing the end of one board, cut on the oblique to form the desired angle against the face of another board. It is commonly used for bracing, and should not be used where great strength is required.

The **MITER JOINT** is used extensively in framing but is a very weak joint. To form a right-angle miter joint (the most commonly used) each piece is cut at a 45 degree angle to form a 90 degree angle when joined.

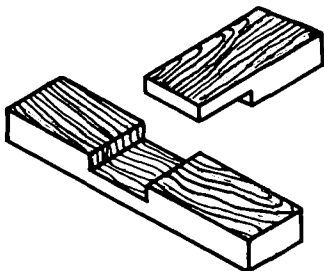


The **PLAIN LAP JOINT** is formed by laying one board over another and securing by screws or nails. It is most often used in framing and construction and is as strong as the fasteners and material used.

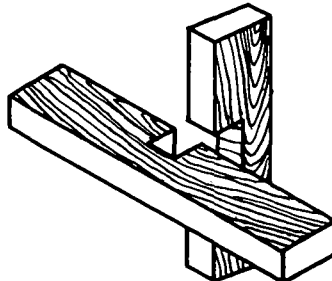


The **HALF-LAP SPLICE JOINT** is formed by cutting away portions (usually half) in equal lengths from the thickness of two boards and joining them in such a manner that the cut-away portions overlap in a complementary manner to form the joint. It is an easily made joint and relatively strong.

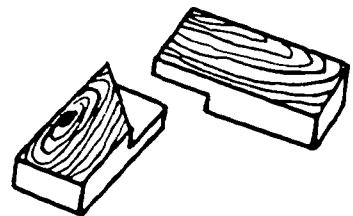
VARIATIONS OF THE HALF-LAP JOINT



MIDDLE LAP



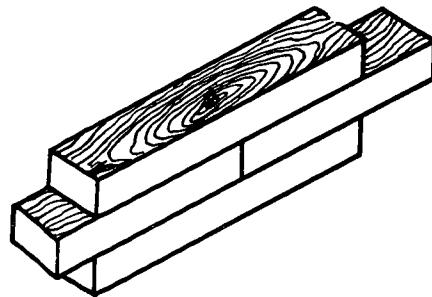
CROSS LAP



MITERED HALF-LAP

SPLICES

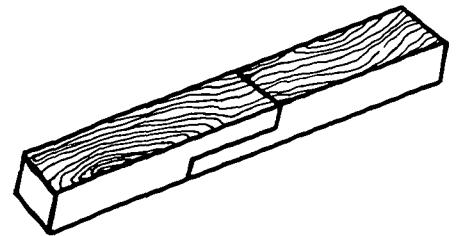
The **BUTT SPLICE** is formed by butting the squared ends of two pieces of lumber together and securing them in this position with two wood or metal pieces fastened on opposite sides of the lumber. Metal plates are called fishplates and are fastened with bolts or screws. Wood plates are called scabs and are secured with bolts, nails, or corrugated fasteners.



The **BEND RESISTANT SPLICE** is formed by cutting oblique complementary laps in the ends of 2 pieces of timber. The upper tongue is squared to butt against the square of the complementary lap and the lower tongue is beveled. A scab or fishplate may be fastened along the bottom.



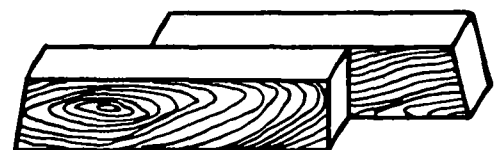
The **HALVED SPLICE** is formed by cutting away half the thickness of equal lengths from the ends of 2 pieces of timber and fitting the complementary tongues together. Nails or bolts are used to fasten them. Fishplates or scabs may also be used.



A **SQUARE SPLICE** is a modification of the halved splice. Complementary notches are cut in the tongues to provide an additional locking shoulder. It may be fastened with nails or bolts or for more strength fastened with fishplates or scabs.



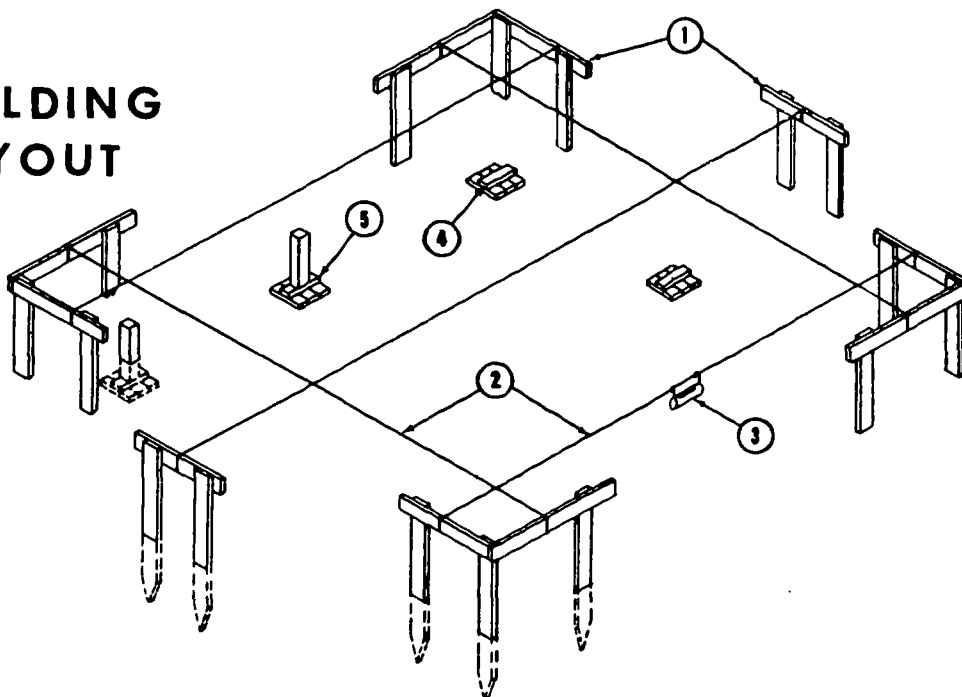
The **LONG PLAIN SPLICE** is a hasty substitute for the square splice. A long overlap of the 2 pieces is desirable to provide adequate bearing surface and enough room for fasteners.



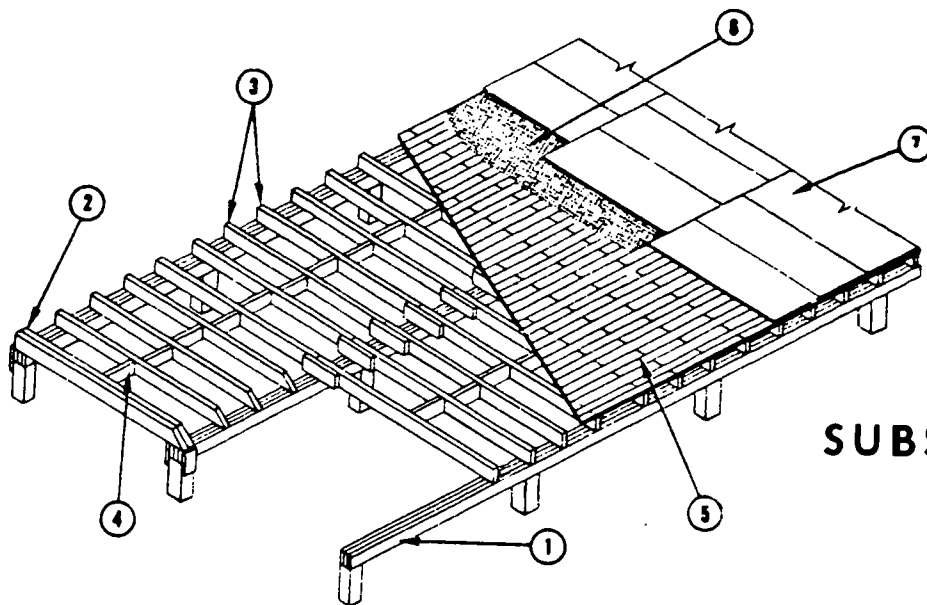
NOMENCLATURE AND CONSTRUCTION STEPS

This is typical of the frame buildings that would be found in a Theater of Operations. You can see here its construction from the layout stage through to the completed exterior.

BUILDING LAYOUT

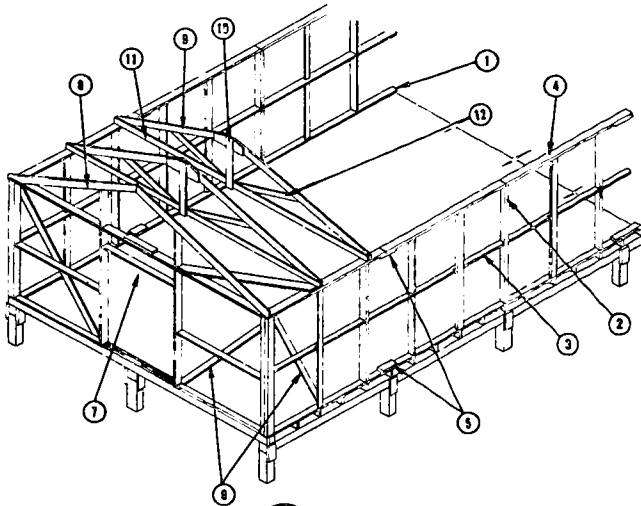


- ① **BATTER BOARDS**—installed at each corner of building, including offsets.
- ② **STRINGLINE**—forms the exact outline of building. Serves as finished floor reference line. Keeps substructure square and level during construction.
- ③ **LINE LEVEL**—used to check level of stringline.
- ④ **SPREADERS AND FOOTERS**—distribute the load of the building over a large area. Always buried a minimum of 1 foot or below the frostline.
- ⑤ **FOUNDATION PORT**—6 x 6 inch material. When the floor is more than 3 feet above ground, diagonal bracing is required. (Concrete piers sometimes used in place of wood posts.)



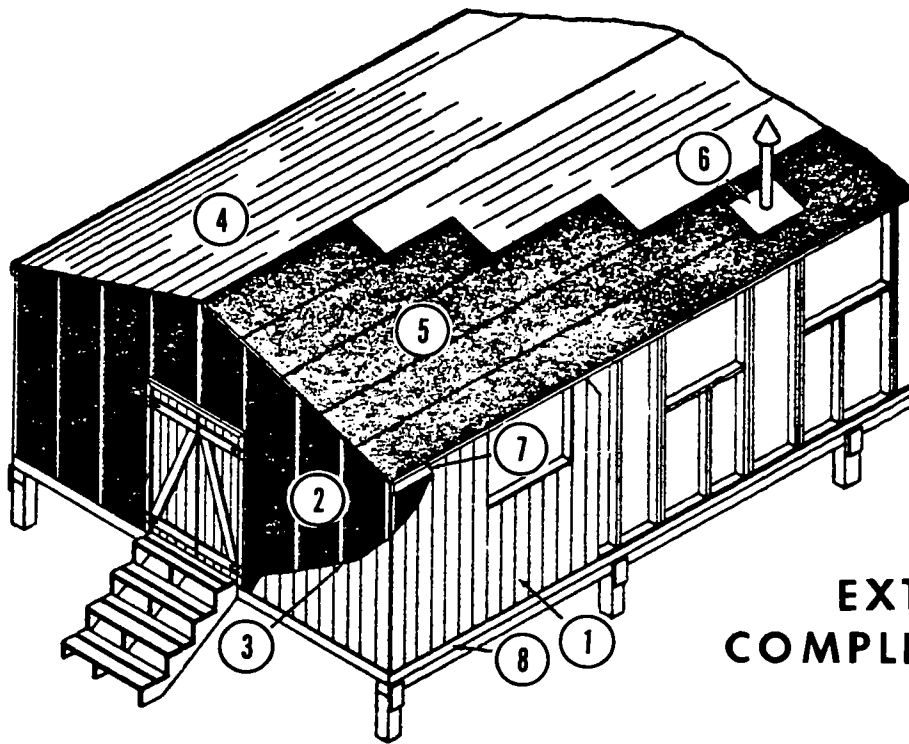
SUBSTRUCTURE

- ① **GIRDER**—three pieces of 2 x 6 inch lumber. Span post to post and are connected to the post by scabs.
- ② **REINFORCED JOISTS**—two pieces of 2 x 6 inch lumber. Reinforced because of extra weight of end panels.
- ③ **FLOOR JOISTS**—single 2 x 6 inch lumber. Span from girder to girder and spliced over center girder.
- ④ **BRIDGING**—used whenever joists are over 8 feet long. Distributes load to floor joists and stiffens the floor frame.
- ⑤ **SUBFLOOR**—laid perpendicular to joists in frigid climates and diagonal in temperate and tropical climates. Usually 1 inch lumber.
- ⑥ **ROOFING FELT**—asphalt impregnated felt. Used in frigid climates as a lightweight air and moisture seal.
- ⑦ **FINISHED FLOOR**—either 1 inch lumber or 5/8 to 3/4 inch plywood.



WALL PANELS AND TRUSSED RAFTERS

- ① **SOLE PLATE**—nailed directly to subfloor. Distributes the load of the wall panels to the substructure.
- ② **STUD**—primary structural members of the wall panels. Nailed to the sole plates.
- ③ **GIRT**—horizontal bracing members between studs.
- ④ **TOP PLATE**—tie in the studs at the top and serve as a nailing surface for sheathing.
- ⑤ **SCAB**—short pieces of lumber reinforcing top and sole plates where they are spliced.
- ⑥ **DIAGONAL BRACING**—located at the corners to prevent swaying motion.
- ⑦ **HEADER**—used to frame the doorways and acts as a nailing surface for the sheathing above it.
- ⑧ **RAKE RAFTER**—the rafters on both ends of the building.
- ⑨ **UPPER CHORD**—often referred to as rafter. Carries the roof load to the studs.
- ⑩ **HANGER**—ties the peak of the rafters to the center of the bottom chord.
- ⑪ **BOTTOM CHORD**—spans the lower ends of the two upper chords. Often referred to as ceiling joists.
- ⑫ **WEB**—diagonal bracing which ties in the centers of the bottom chord with the centers of the upper chord.



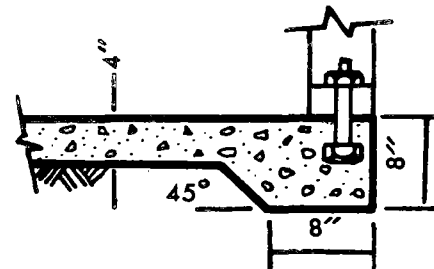
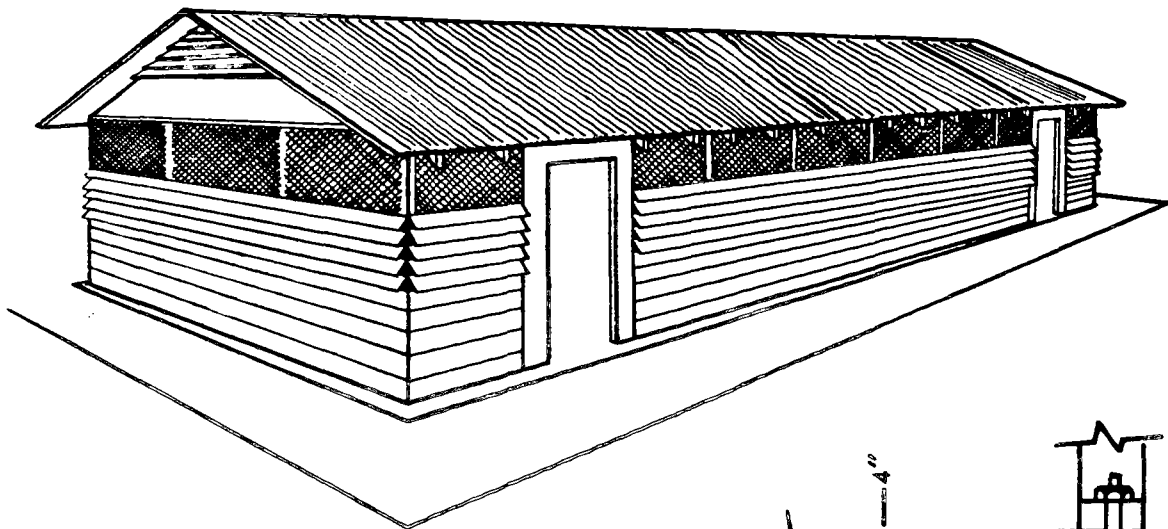
EXTERIOR OF COMPLETED BUILDING

- ① **SIDE SHEATHING**—1 inch lumber applied to the sides solidly.
- ② **ROOFING FELT**—applied horizontally over the sheathing with a side lap of 4 inch lap on ends.
- ③ **BATTENS**—1 x 2 inch lumber nailed vertically to building 2 feet on center. Used to hold roofing felt in place.
- ④ **ROOF SHEATHING**—1 inch lumber nailed horizontally to the rafters. Strengthens the roof and acts as a nailing surface for roofing felt.
- ⑤ **ROOF FELT**—applied horizontally over roof sheathing. Must have minimum 4 inch side lap and 8 inch end lap.
- ⑥ **ROOF JACK**—a piece of sheet metal through which the stove pipe passes. Fire protection measure.
- ⑦ **FACIA BOARD**—attached to the ends of the rafters to prevent decay.
- ⑧ **CLOSER SKIRT**—protects floor joists and girders from decay.

CONCRETE FLOORS may be constructed where earthen or wooden floors are not suitable or when other materials are not available. They are made by placing concrete on the ground after the earth has been graded, tamped, and moistened. Drainage is provided both for the floor area and for the area near the floor, to prevent flooding after heavy rains. The floor should be reinforced with steel or wire mesh. Where concrete floors are to be placed, a foundation wall may be placed first and the floor placed after the building is completed. This gives protection to the concrete floor while it sets and eliminates the waiting period before construction of the building.

The exterior surfaces of a building usually consist of **SHEATHING, SHEET METAL, OR CORRUGATED ROOFING**. However, the materials prescribed by typical plans are not always available and substitutes or improvised materials must be found. Concrete block, brick, rubble stone, metal, or earth may be substituted for wood in treeless regions. In the tropics, improvised siding and roofs can be made from bamboo and grasses. Roofing felt, sandwiched between two layers of light wire mesh may serve for wall and roof materials where climate is suitable.

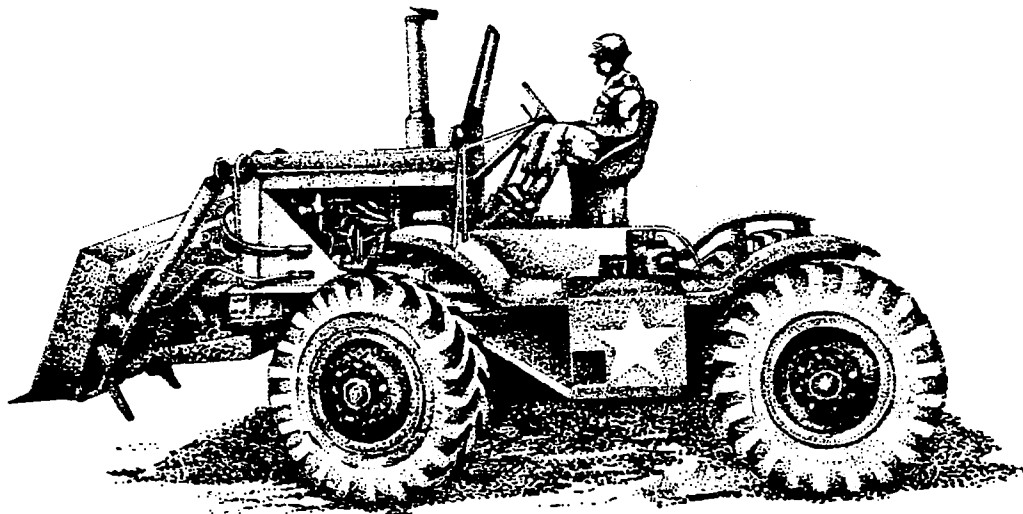
This is typical of the construction being done in South Vietnam.



DETAIL OF FLOOR AND FOOTER
(CROSS SECTION)

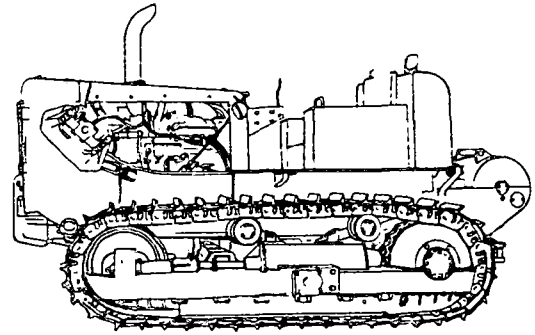
PART FOUR

ENGINEER EQUIPMENT

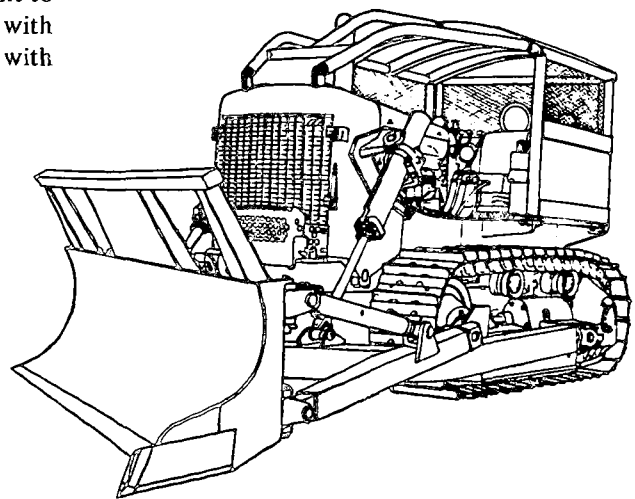


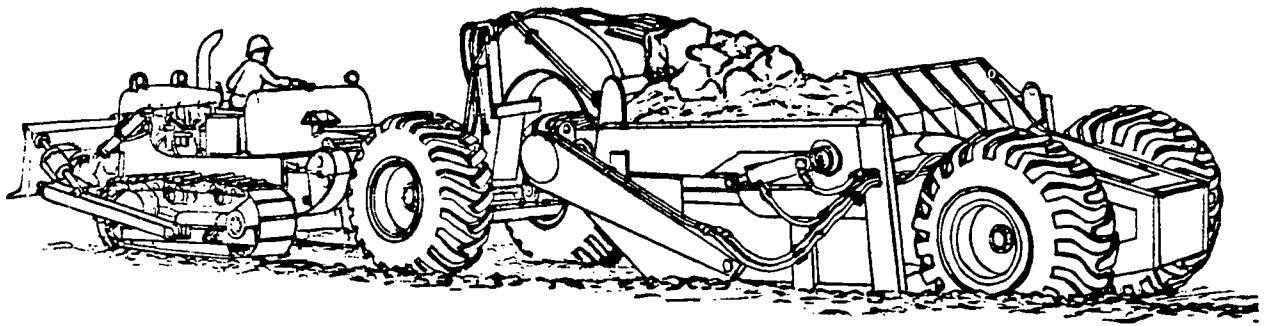
There are many types of engineer equipment which have been developed to support the engineer combat and construction missions. A few of the common standard items and their typical employment appear in the following pages as well as several pieces of equipment recently introduced into the system.

The **DOZER** is usually the first piece of equipment to arrive on a construction project and the last to leave. It is practical for many jobs at the construction site, such as removing brush and trees, and rocks; stripping; ditching and diking; backfilling; and excavation and embankment digging and moving.

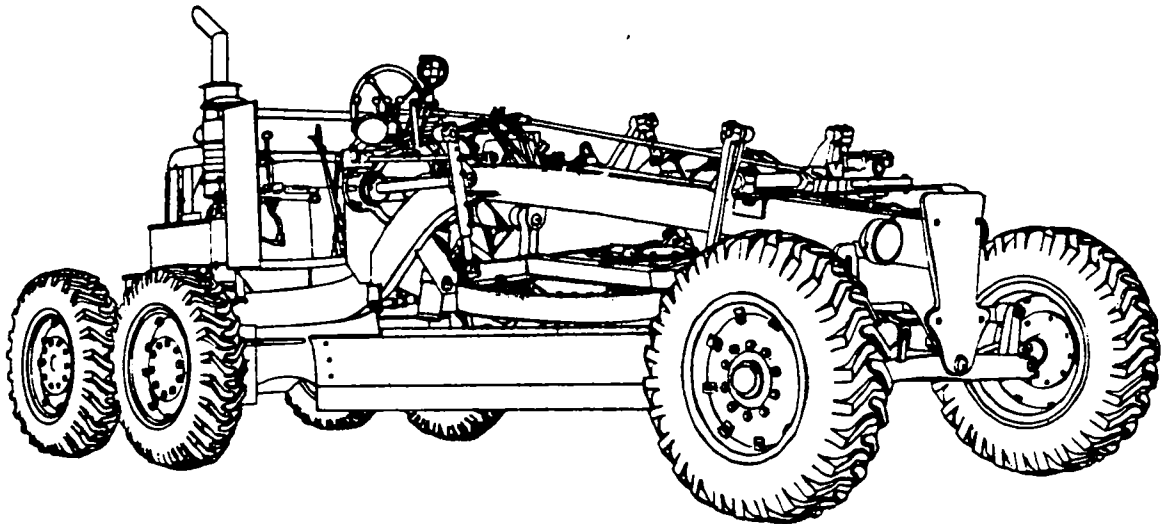


A **DOZER**, as commonly defined, is a tractor on which a dozer blade has been mounted. Dozer blades are of two general types: bulldozer (straight dozer) and angle-dozer. A new blade, however, commercially known as the Rome K/G blade and in the military as the tree-dozer, tractor mounted, has been added. It clears light to dense vegetation by shearing trees at ground level with little disturbance to the soil. One tractor equipped with this blade is able to cut from 1 to 2 acres an hour.

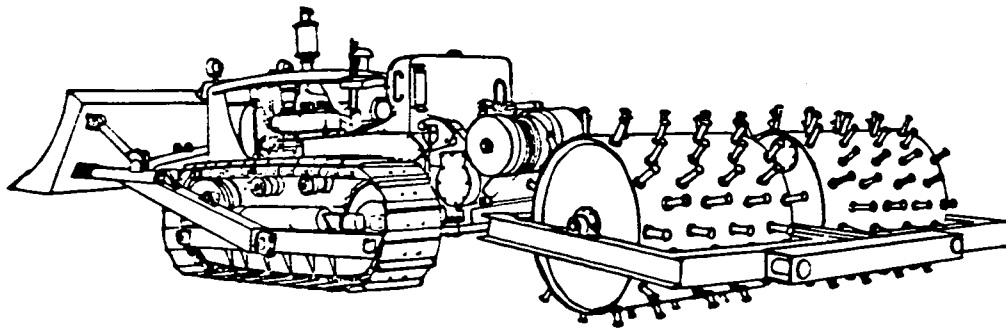




SCRAPERS are large earthmoving machines capable of digging, loading, hauling, dumping, and spreading material. They are particularly useful on large earthmoving jobs, such as airfield construction, and road projects built in rolling terrain involving many cuts and fills. Most scrapers are built with open tops which make them suitable for loading by crane, shovel, or chute.

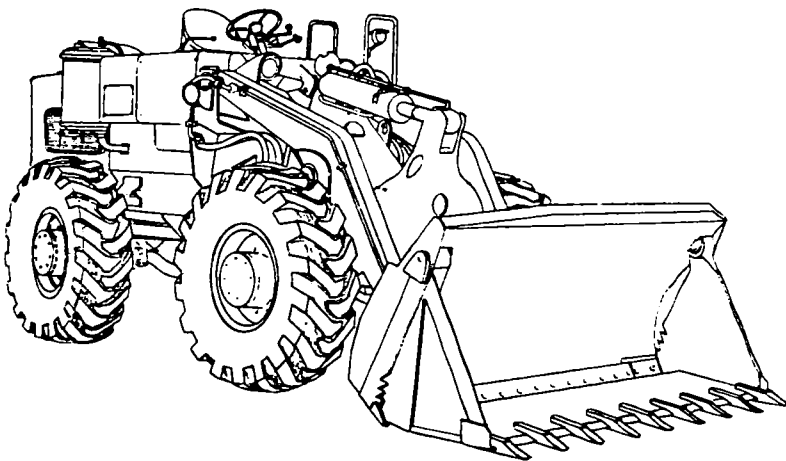


GRADERS are multi-purpose machines used for leveling and crowning, mixing and spreading, ditching and bank sloping, and side casting material. They may also be used for light stripping operations but they are not intended for heavy excavation.

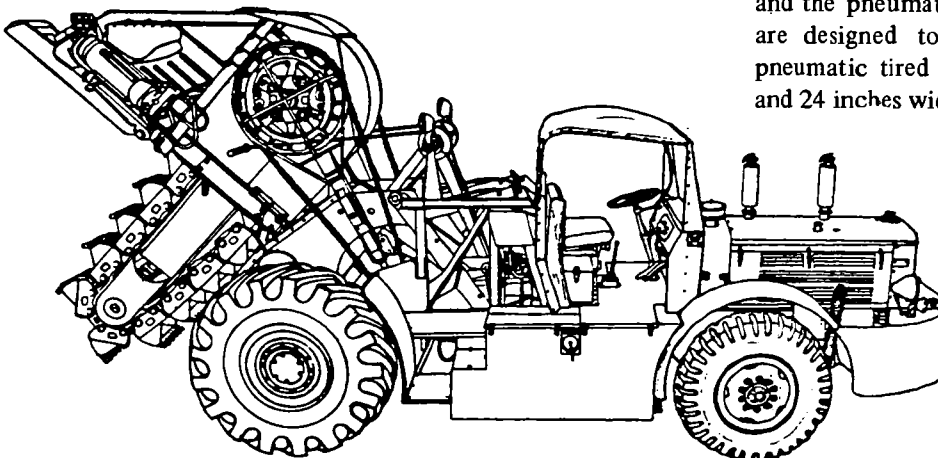


ROLLERS are used for compaction of different types of materials. Each roller compacts different soils at different depths, at different speeds, and at different bearing pressures. The

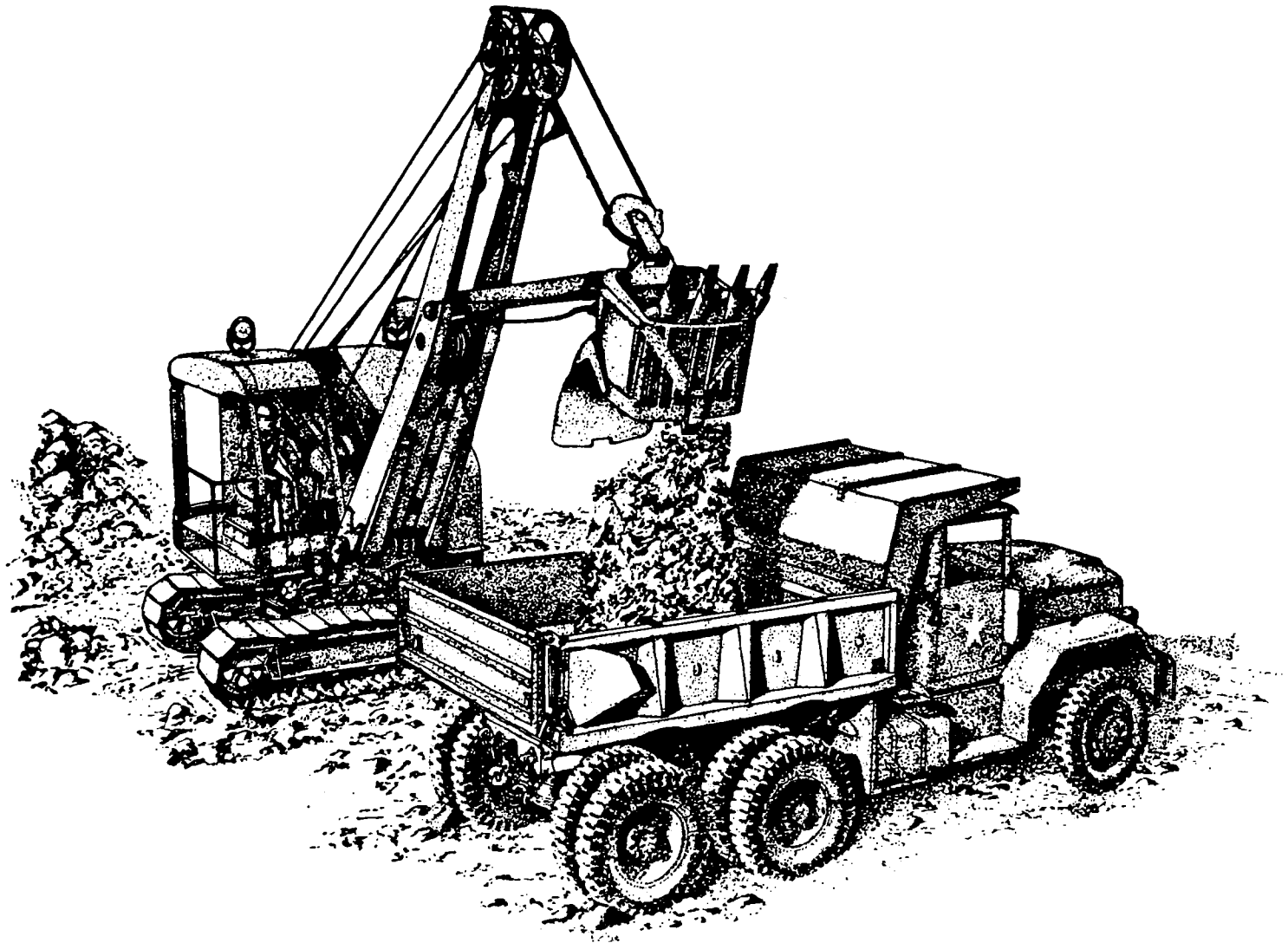
SHEEPSFOOT ROLLER, unlike pneumatic tired rollers, tamps a loose lift starting from the bottom of the lift and working upward until the roller "walks out" of the lift.



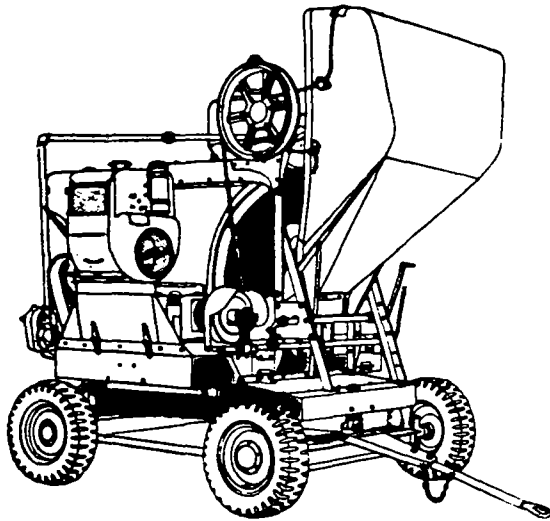
SCOOP LOADERS are capable of handling material from easy-to-load stockpiles to tough digging in bank-run gravel and some rock excavation. The scoop loader is a very versatile piece of equipment and is a great asset on small construction projects.



The two types of **DITCHING MACHINES** found in engineer units are the crawler mounted ditcher and the pneumatic tired ditcher shown here. They are designed to rapidly excavate ditches. The pneumatic tired ditcher can excavate 6 feet deep and 24 inches wide.

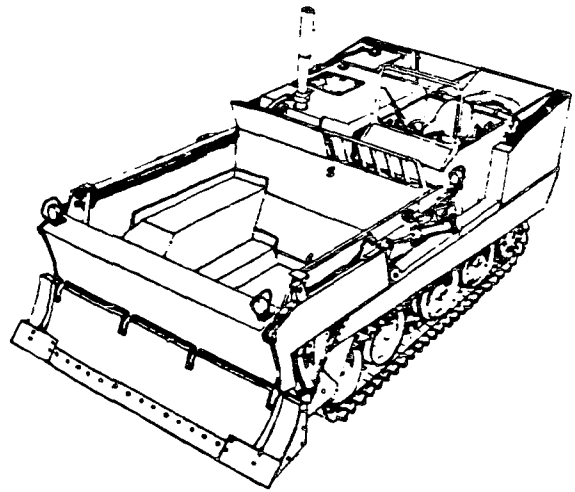


The **CRANE SHOVEL** with its variety of front end attachments is the most versatile type of lifting and loading equipment available to construction units. The basic crane shovel unit consists of a lower travel assembly and an upper revolving frame. On this basic unit may be mounted any one of the attachments depending upon the work to be performed.

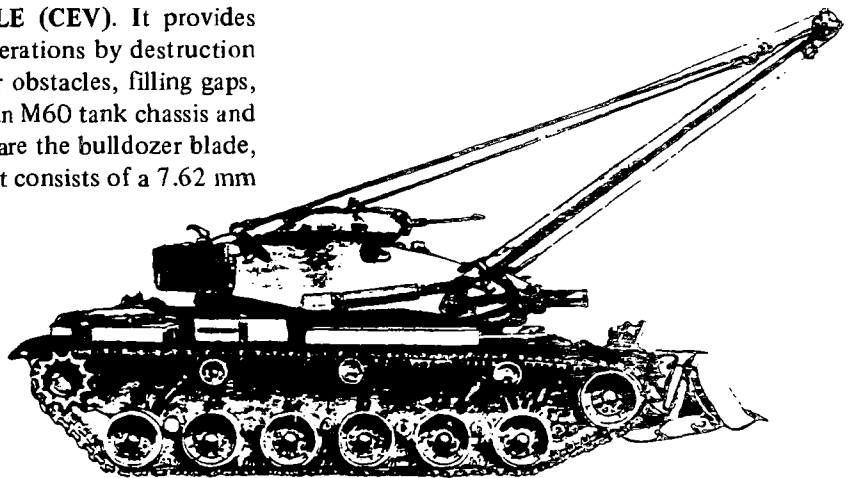


Many construction projects involve concrete operations. There is a wide variety of concrete equipment; however, one of the most common items is the 16-CUBIC FOOT CONCRETE MIXER.

The **UNIVERSAL ENGINEER TRACTOR (UET)** is an all-purpose earthmover that performs the operations of a bulldozer, grader, scraper, dump truck, prime mover, and cargo and troop carrier. It is air-droppable and can travel cross-country at up to 30 miles an hour. It is planned that it will be the basic vehicle of the combat engineer squad of the future.



A relatively new piece of equipment for use by engineer units is the **COMBAT ENGINEER VEHICLE (CEV)**. It provides engineer combat support to ground operations by destruction and removal of road blocks and other obstacles, filling gaps, ditches, and craters. It is mounted on an M60 tank chassis and its hydraulically operated attachments are the bulldozer blade, ^{and} a 165 mm demolition gun. Its armament consists of a 7.62 mm machinegun and a .50 cal machinegun.



SAFETY PRECAUTIONS

All equipment must be shut down or positive means taken to prevent accidents while repairs, adjustments, or manual lubrications are being made.

Dozer and scraper blades should be lowered to rest on the ground or on suitable blocking when not in use.

Machinery and mechanized equipment must be operated only by qualified and authorized personnel.

All motorized vehicles and mechanized equipment using gasoline shall be shut down with ignition off prior to and during refueling operations.

Excavations, if over 4 feet in depth, unless in solid rock, hard shale, hardpan, cemented sand and gravel, or other similar materials, shall be either shored, sheeted and braced, or sloped to the angle of repose.

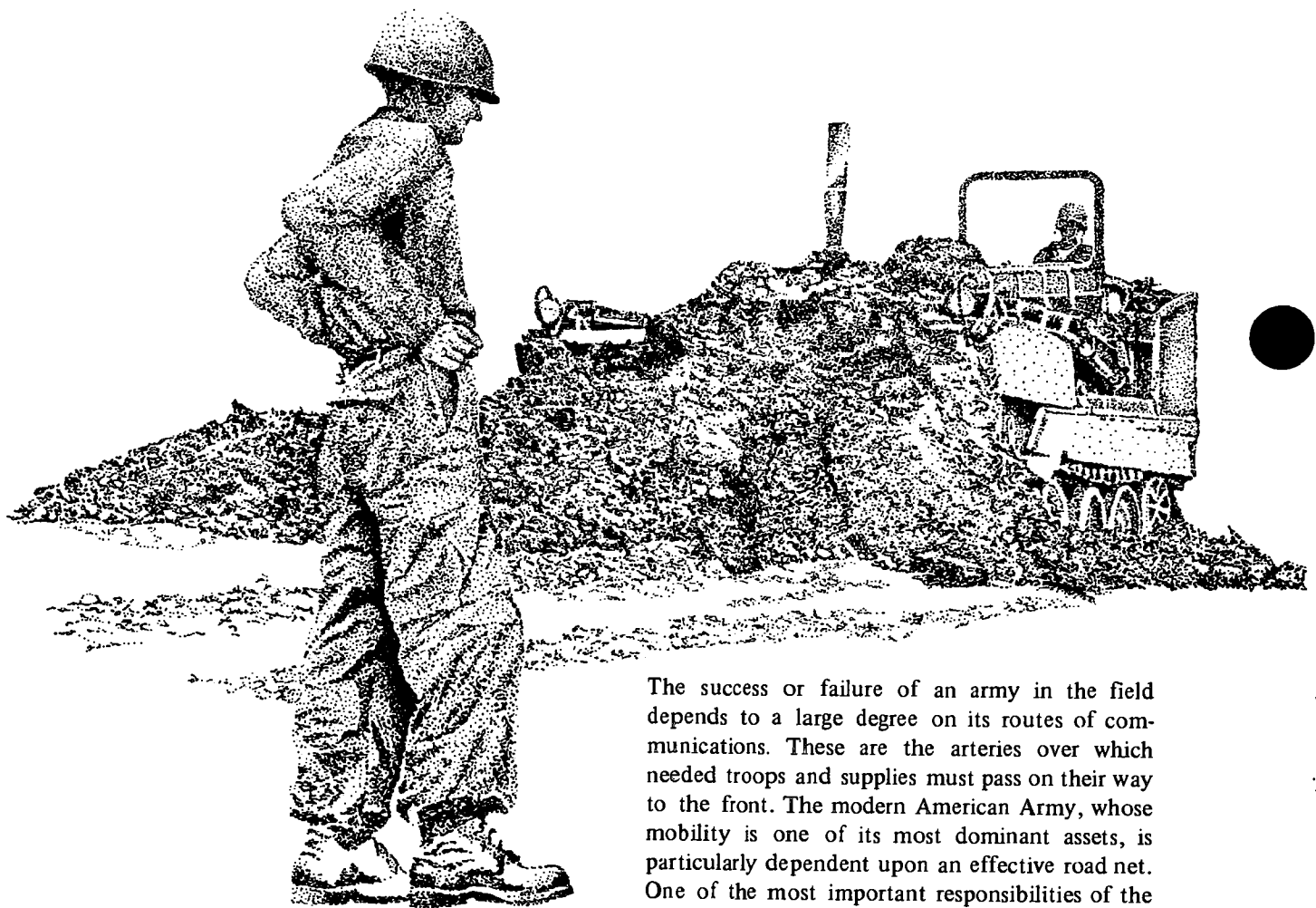
Loads should not extend beyond the sides of the vehicle except under emergency circumstances, and then precautions taken to prevent endangering passing traffic.

Equipment requiring an operator will not be permitted to run unattended.

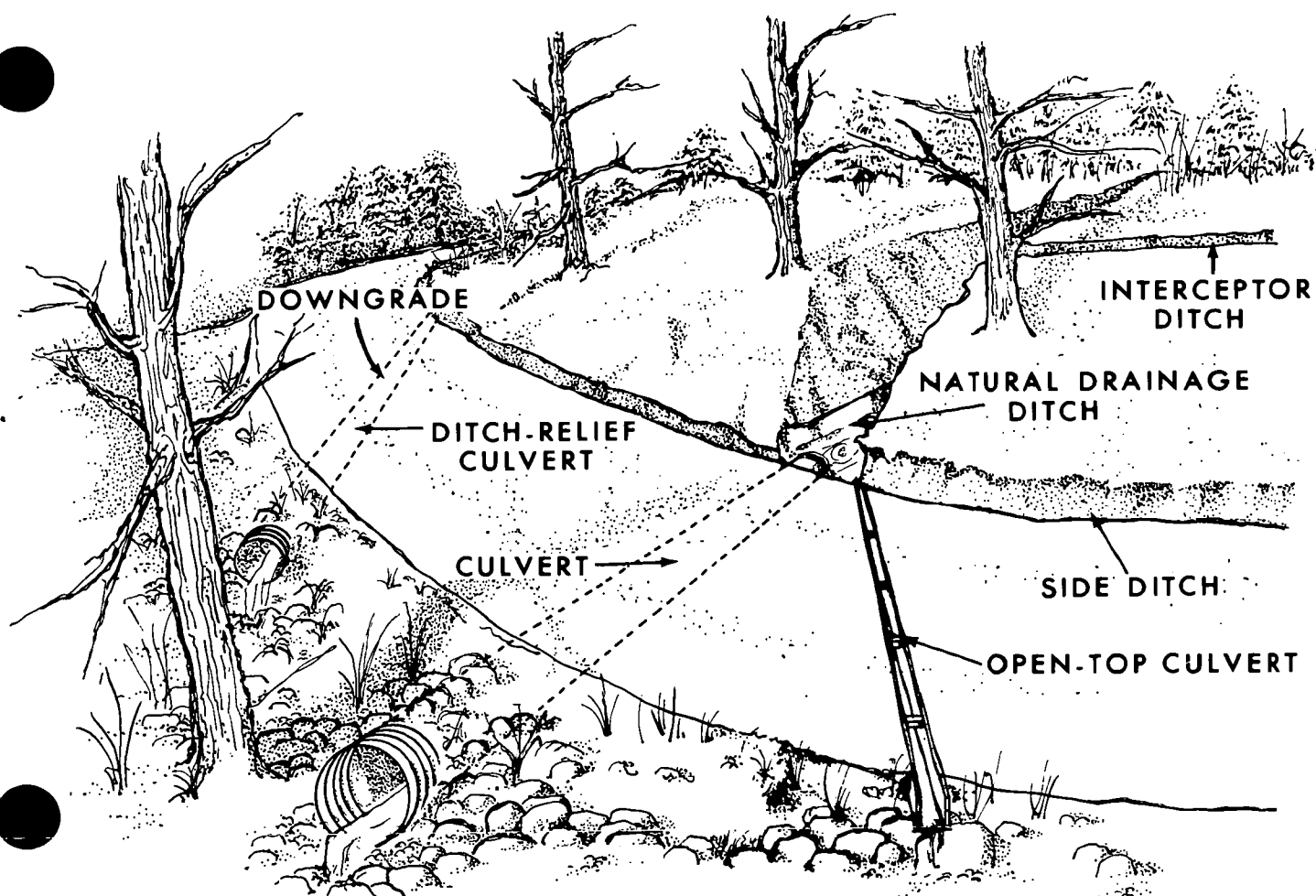
Cranes will not be operated where contact with overhead power or electrical lines is possible.

PART FIVE

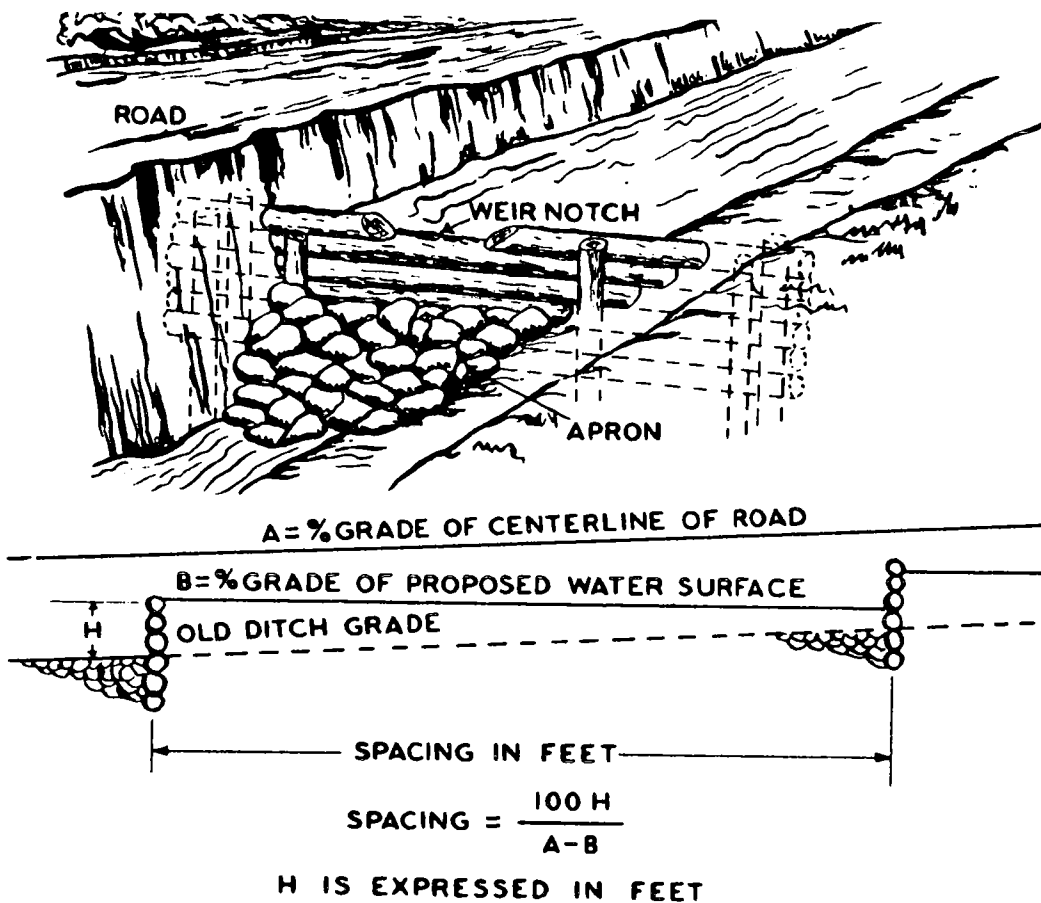
EXPEDIENT ROAD AND AIRLANDING FACILITIES



The success or failure of an army in the field depends to a large degree on its routes of communications. These are the arteries over which needed troops and supplies must pass on their way to the front. The modern American Army, whose mobility is one of its most dominant assets, is particularly dependent upon an effective road net. One of the most important responsibilities of the military engineer is to construct, repair, rehabilitate, and maintain this road net. In fact, between 25 and 50 percent of all engineer effort is expended on this one responsibility in a theater of operations.



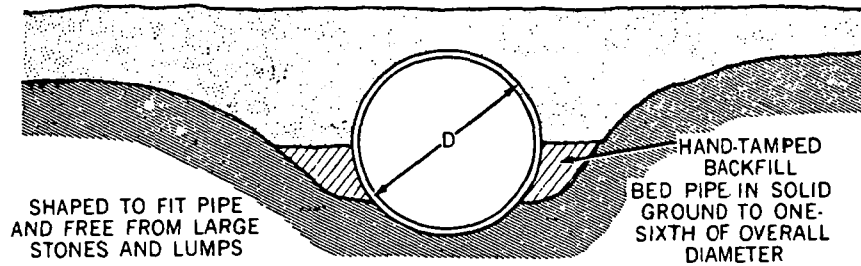
The importance of **DRAINAGE** in the construction of roads and airlanding facilities can never be overemphasized. The first work completed on any such project should provide drainage for the work to follow. In addition, the entire serviceability of the facility depends on the adequacy of the drainage system. In a theater of operations surface ditching is used almost exclusively because of the logistical limitations on pipe and the absence of storm-sewer systems into which the collected runoff may be discharged. Also, the comparative ease of repair and cleaning makes them preferable to pipe for subsurface drainage. Some of the structures used in surface drainage are shown above.



CHECK DAMS are used on side-hill cuts and steep grades. They are placed in side ditches to slow the water flow and prevent runoff from washing out the road. Check dams are used when the ditch-line grade is one to five percent and erosion occurs. Also, when the ditch-line exceeds five percent, line ditches with stable material such as logs, rocks, concrete, and asphalt. Check dams are composed of timber, sandbags, concrete, rock or similar materials.

CULVERTS

CULVERTS are used to provide cross drainage at low points in a fill section, to provide ditch relief, and to continue side ditches at intersections. They should be used where bedding conditions are favorable, cover is adequate, and jamming by debris and ice is not likely. Pipe culverts, in the form of nestable corrugated steel pipe, are standard items of engineer supply, and there are 2 types: notched—having a notched edge and plain edges; and flanged—having flanges with slotted holes. The 2 types are not interchangeable.



The length of a culvert is determined by the width of the embankment at the location where the culvert is to be installed.

Grades of 1/2 inch to 1 foot drop for placement of culverts are desirable. Water velocities should not be over 8 feet per second nor less than 2-1/2 feet per second.

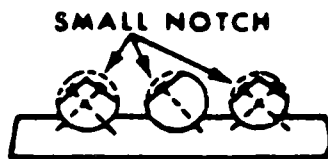
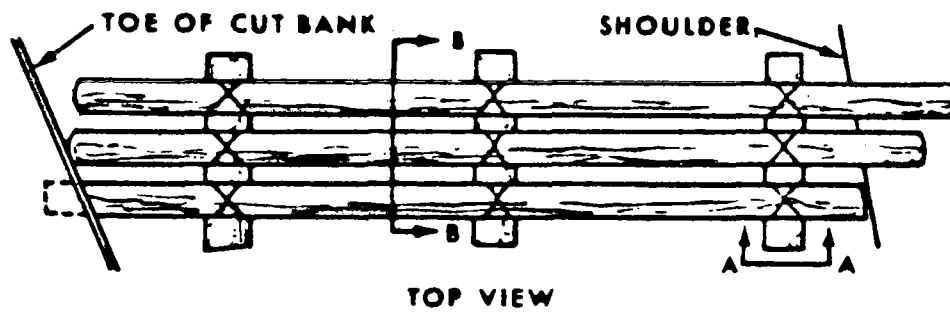
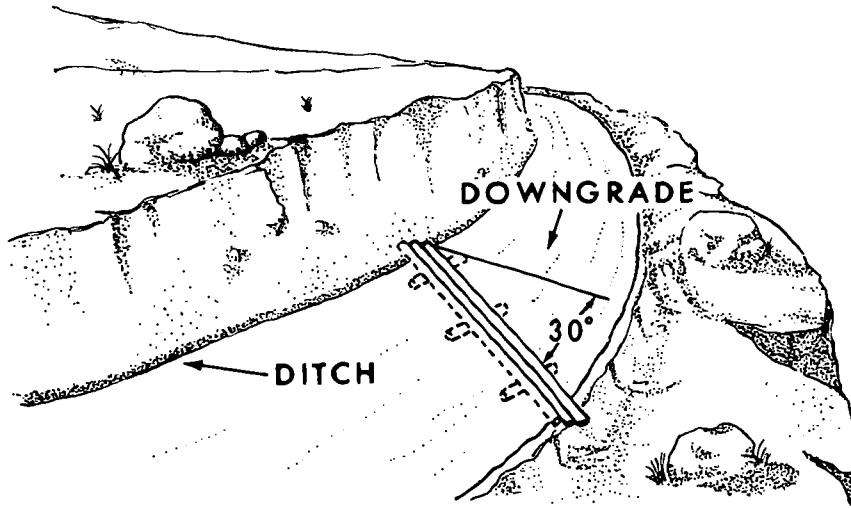
The culvert must be strong enough to carry the weight of the fill above it plus the weight of live loads that pass over the road.

The bottom of the culvert at the inlet is placed on or below the stream-bed. At the outlet end, the bottom of the culvert should be at the elevation of the surface of the stream.

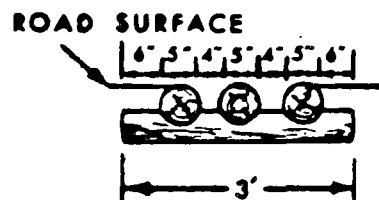
Dirt is backfilled and tamped to one-half the culvert depth to hold culvert in place. Backfill is completed and tamping continues to at least 12 inches above the culvert.

The cover is the depth of compacted earth from the top of the culvert to the final grade of overlying materials. A general rule for the minimum cover for road culverts is one-half the pipe diameter, or 12 inches, whichever is greater.

OPEN TOP CULVERTS of sawed timbers or rocks may be used on steep grades where heavy flow is expected down the road surface.



SPIKING PLAN

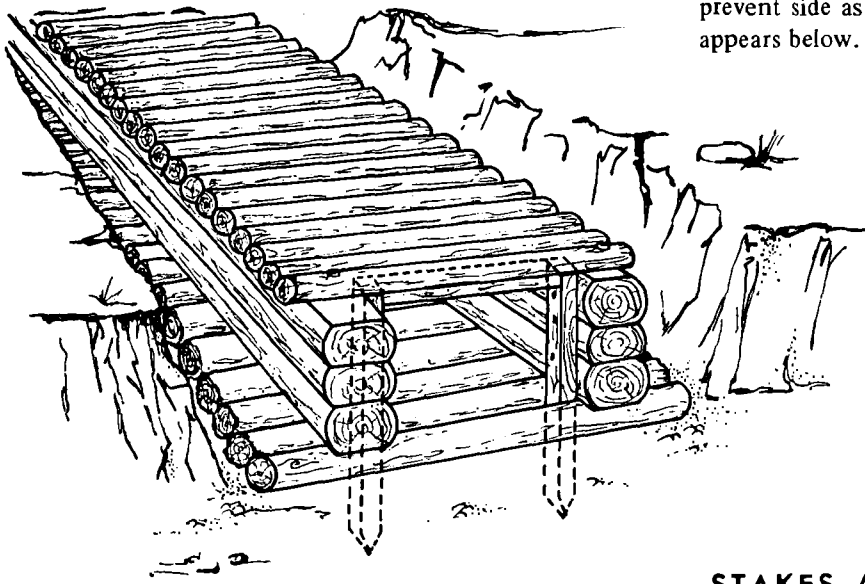


SECTION B-B

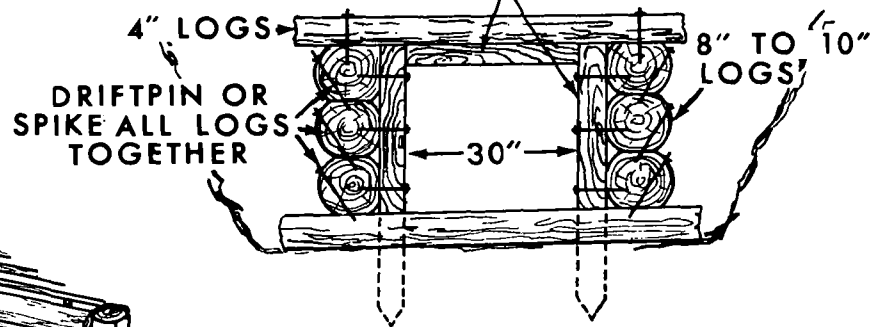


SECTION A-A

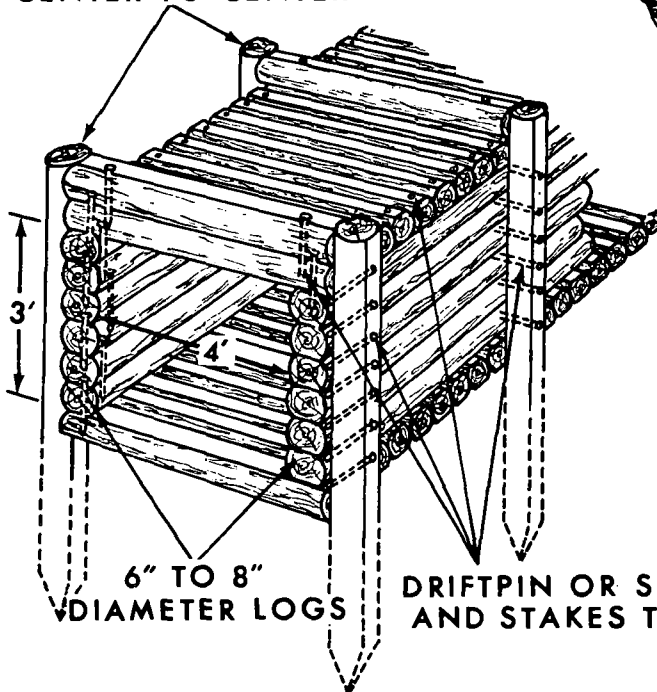
LOG BOX CULVERTS are constructed with a square or rectangular cross section and must be designed to prevent side as well as roof collapse. A typical design appears below.



**STAKES AND SPREADERS
SPACED 8' C TO C**

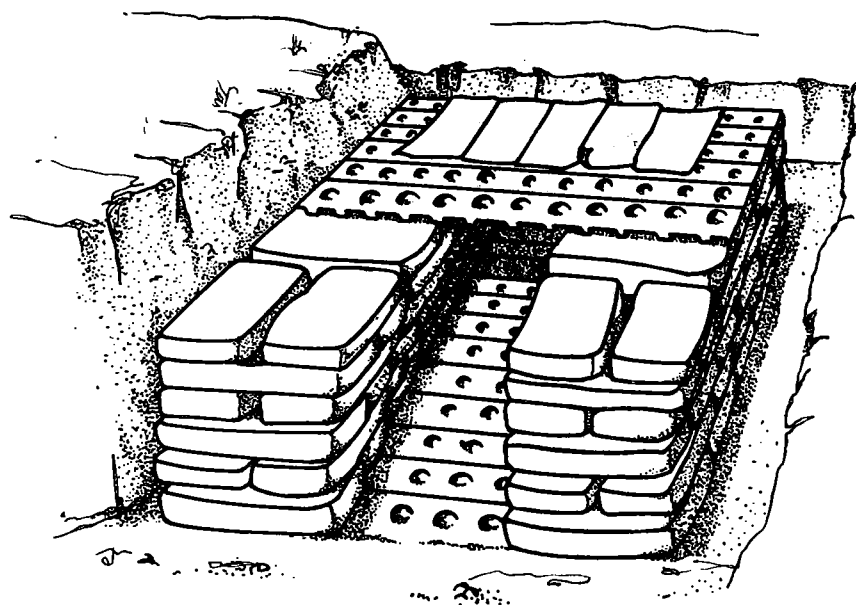
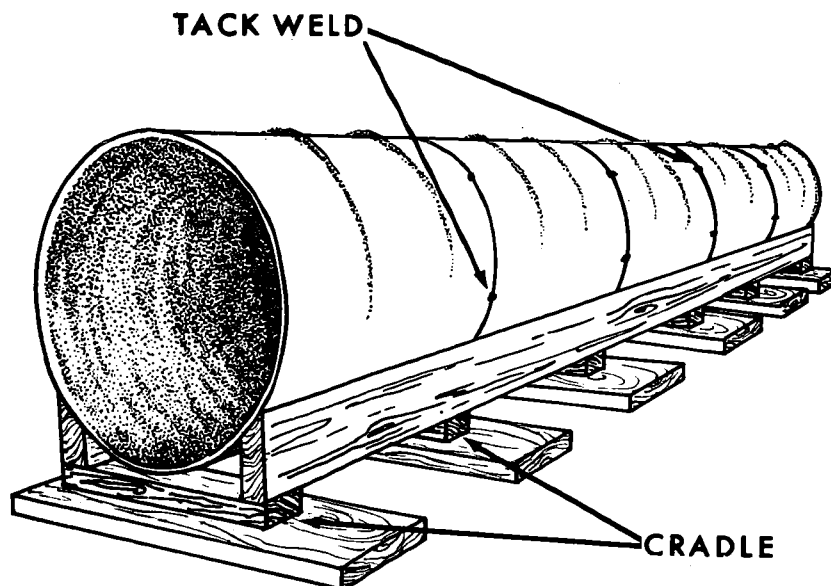


**STAKES 6'
CENTER-TO-CENTER**



This may be modified by placing the stakes on the outside of the culvert and extending them flush with the top logs, with the top logs then acting as spreaders.

EXPEDIENTS for forming drainage structures are empty oil, gasoline, or asphalt drums. (Culverts other than pipe should have a minimum of 12 (preferably 18) inches of cover. Where heavy equipment is used in construction, adequate cover must be provided to protect culvert structures from damage.)



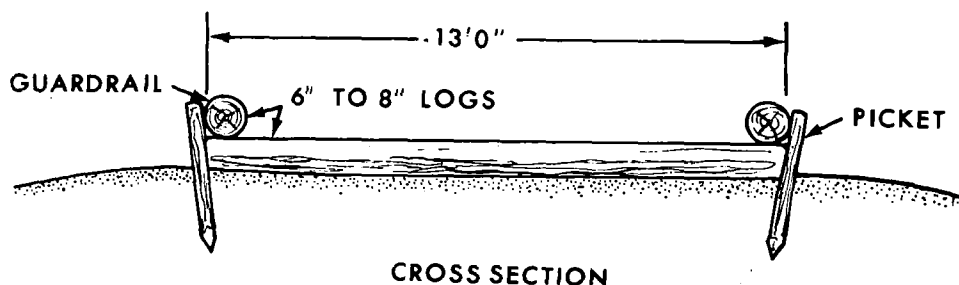
Also, box-like culverts can be built from pierced steel plank and sandbags.

EXPEDIENT SURFACES

A military road can be anything from a superhighway to a path through the jungle. Any route that is used by the military for transportation of any type can be so classified. Specifically what is required and to what standard the construction must be carried is dependent largely upon the mission of the units that use the road. In the forward combat areas where the engineer effort consists almost entirely of combat battalions with somewhat limited construction means, the requirement for roads is purely to support tactical operations. Anything that will get the job done, with no attempt at permanency, is the rule.

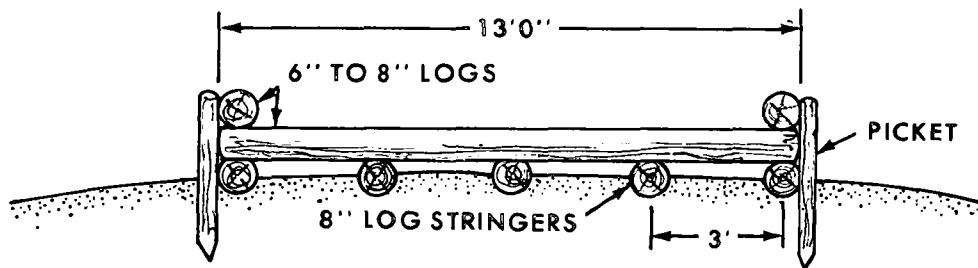
There are several types of materials used for expedient roads such as corduroy, chespalang, metal landing mats, Army track, tread roads, plank roads, wire mesh, snow and ice, and prefabricated bituminous surfacing.

CORDUROY construction is an old standby used in every theater of operations where a heavy expedient road is needed over muddy terrain and sufficient natural material exists. There are three types of corduroy construction: standard, corduroy with stringers, and heavy corduroy.



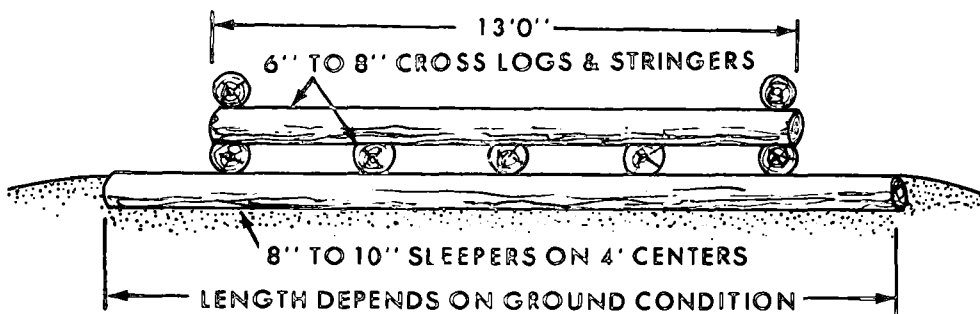
The most frequently constructed is the **STANDARD**. This involves placing 6- to 8-inch diameter logs about 13 feet long next to each other (butt to tip) and 6-inch diameter logs along the edges as curbs which are drift-pinned in place. Four-foot pickets are driven into the ground at regular intervals along the outside edge of the road to hold it in place. For greater surface smoothness the chinks between the logs are filled with brush, rubble, twigs, etc., and the whole surface is covered with a layer of gravel or dirt. Side ditches and culverts are just as important in this type of construction as for a standard road.

A more substantial corduroy road can be made by placing log stringers parallel to the centerline on about three-foot centers and then laying the corduroy over them. The decking is securely pinned to the stringers and then the surface is treated as for the standard corduroy road.



CROSS SECTION

HEAVY CORDUROY involves the use of sleepers—heavy logs, 10 to 12 inches in diameter and long enough to carry the entire road—placed at right angles to the centerline on 4-foot centers. On top of these, corduroy with stringers is constructed.

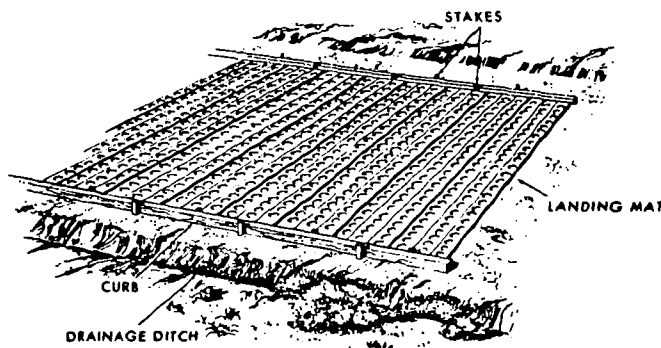


CROSS SECTION

MATS

The urgent demand for speedily constructed airfields in World War II led to the development of a variety of **PORTABLE METAL LANDING MATS** for aircraft. At the same time, engineers in all theaters were continually facing the problems of amphibious operations where roads that were the life lines of the invading forces started at the water's edge and crossed stretches of sandy beaches that almost defied passage. When the metal landing mats became standard items of supply, they were quickly put to use on the beaches as well as on the airfields and they still are the foremost expedient for crossing sandy terrain. When used on sand the metal mats can be placed directly on the sand to the width and length desired, though burlap or straw underneath the planking greatly improves the job.

One difficulty encountered in using these metal landing mats is their tendency to curl up at the edges. This is solved by making an excavation at the edges of the road about 1 foot deep with a 3:1 slope on the side of the excavation nearest the road. The mats are bent to fit the trench, placed in position and the excavation is backfilled over them. Another method, shown here, is to use a timber curb on the outside edge of the road and either wiring it tightly to buried logs laid parallel to the road or staking it down.



The limited standard M6, M8, M8A1, and M9 mats may still be encountered in the field because of past inventories or limited new procurement. Although these mats do not meet current performance or weight requirements, they will find wide application on roads, taxiways, and runways, until replaced by the new series of aluminum mats now under development. Currently in the advance testing stage are the MX18B, MX18C, and MX19 aluminum mats.

Several new materials and techniques are currently being studied for possible application as expedient surfacings. **PLASTIC TRACKWAY** consists of continuous fiberglass panels and weighs 1 pound per square foot. The trackway rolls are 11 feet wide, 300 feet long, and weigh less than two tons. They can be transported in a helicopter. The durability of this matting is excellent.

A **REINFORCED TRACKWAY** is being developed also, which consists of a polyester resin reinforced with chopped fiberglass. The mat is sprayed on the sand using modified commercial application equipment. The material cures within 30 minutes.

WOVEN WIRE BEACH MATTING is a portable assault type roadway for crossing areas with a low load bearing capacity, for example, loose sand, mud flats, rice paddies, fords, etc. The suitability of this type of matting is marginal due to its tendency to drift and ruck, its limited durability, the requirement for a special item of equipment for transporting and dispensing, and its limited capability when laid on a low load bearing soil that has a high moisture content.

CHICKEN WIRE, EXPANDED METAL LATH AND CHAIN-LINK WIRE MESH may be used as road expedients in sand. They should not be used on muddy roads since they prevent grading and reshaping of the surface when ruts appear. The effectiveness of any type of wire mesh expedient depends on its being kept taut. To this end, the edges of the wire mesh road must be picketed at 3 to 4 foot intervals. Diagonal wires, crossing the centerline at a 45 degree angle and attached securely to buried pickets, fortify the lighter meshes.

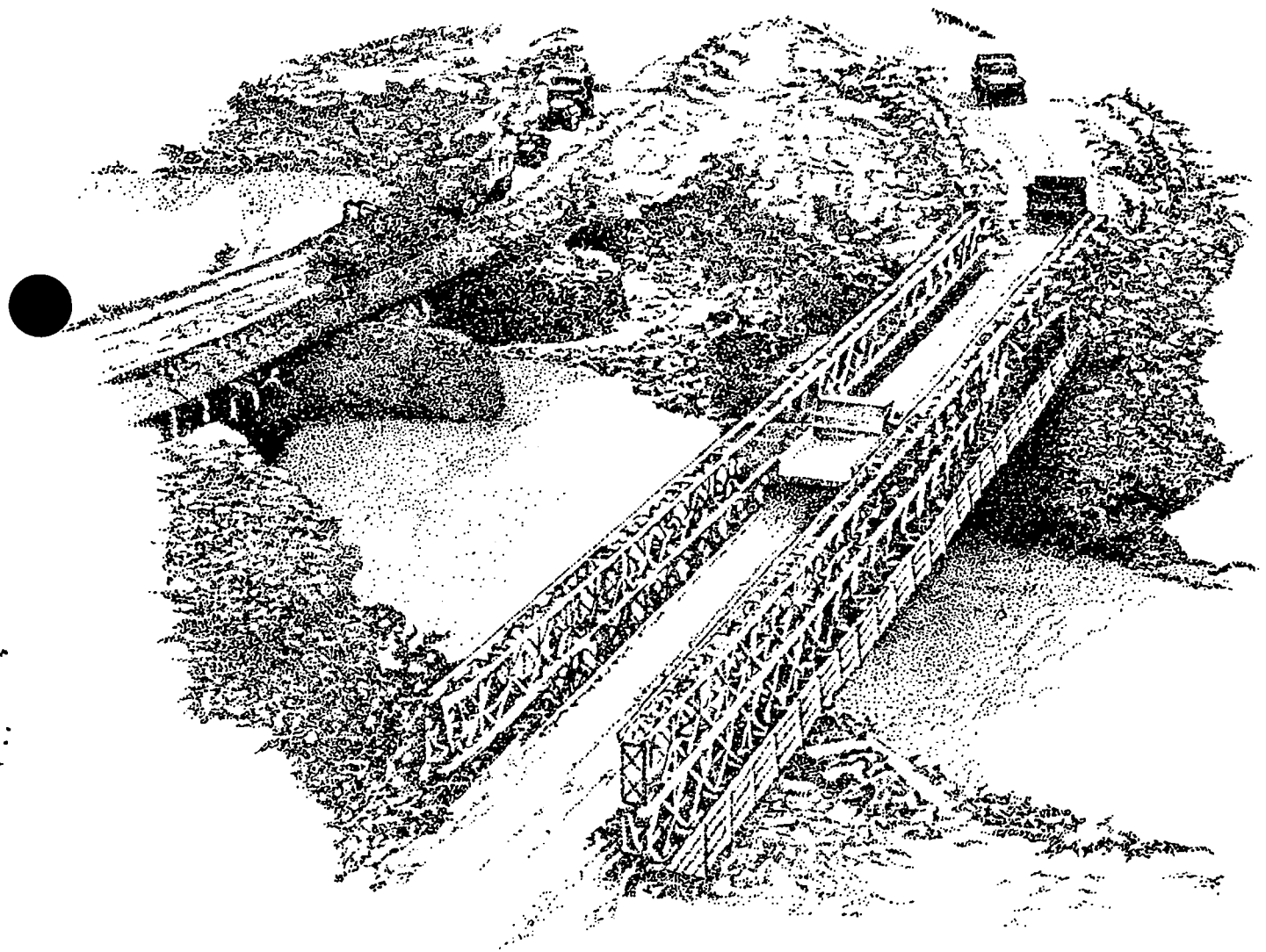
MEMBRANE SURFACING

To date, the most successful **MEMBRANE SURFACING** has been the T-17 membrane which is a neoprene-coated, 2-ply, nylon fabric designed to provide a dustproof and waterproof wearing surface for soil subgrades used as landing areas and roadways. The membrane surfacing consists of 54-inch wide runs of the fabric joined with a series of 2½- to 3-inch wide vulcanized, single lap joints. It is durable and resistant to wear caused by aircraft operations and wheeled vehicle traffic. Its life is limited usually by inadequate subgrade strengths and by excessive lock-wheel braking action. The size of the membrane surfacing can be varied to fit a particular area.

When constructing **EXPEDIENT HELIPADS**, any of the procedures and methods already discussed can be easily adapted. In dry and dusty areas, a dust palliative is necessary for helicopter operations of any duration. Tarpaulins, truck canvas, or plastic membrane material will serve this purpose. Extreme care must be taken, however, to secure the material to prevent it from rising in the rotor wash.

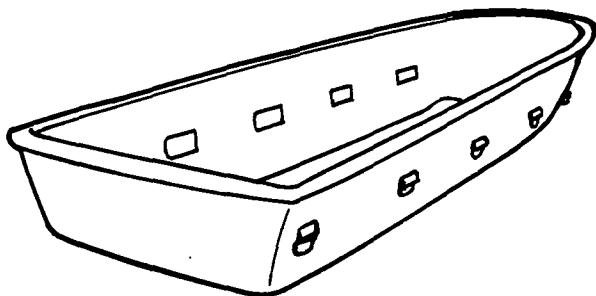
PART SIX

RIVER CROSSING EQUIPMENT



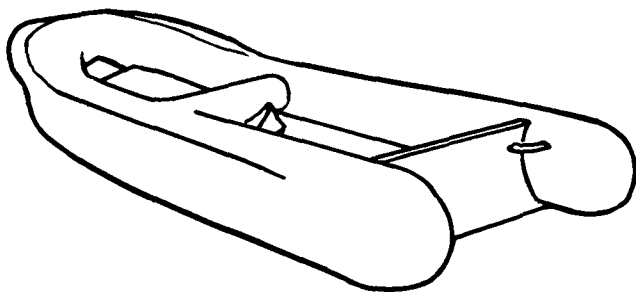
ASSAULT BOATS

The 16-foot **PLASTIC ASSAULT BOAT** is a light craft designed to carry the leading elements in a forced stream crossing. This boat can carry a three-man engineer crew and 12 infantrymen with individual weapons and equipment in currents up to 5 feet per second.



The engineer soldier in charge is seated in the stern and his duty is to steer. The other two engineers are seated in the bow, one on either side. They paddle and set the cadence. Four infantry soldiers kneel on one knee along each side of the boat and assist paddling. When the far shore is reached and the infantrymen are discharged, the engineers return the boat to the near shore for the next load.

When an outboard motor is used, two engineer soldiers form the crew, with one operating the motor and directing distribution of the load and the other in the bow assisting in launching and beaching.



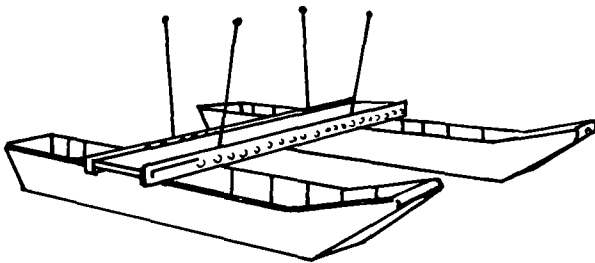
The **PNEUMATIC ASSAULT BOAT** is made from neoprene-coated nylon fabric. It is divided into 10 separate air compartments, 5 of which can be punctured without endangering the load. It can carry 15 men with their equipment. This is paddled or can be propelled by an outboard motor.

CAUTION NOTE: When using a standard military motor accelerate cautiously. Apply power gradually—never start out at full power under load. The transom may be damaged by excessive initial thrust.

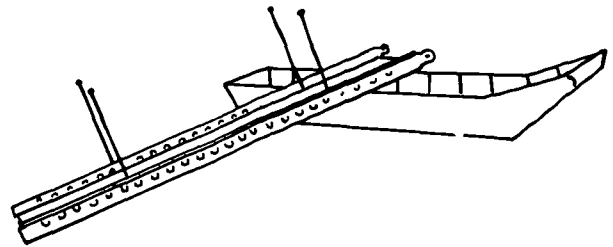
The **ALUMINUM FLOATING FOOTBRIDGE** is the standard means of crossing foot troops. This set furnishes 472 feet 6 inches of bridge and can be used in currents up to 11 feet per second.

One bay of this bridge consists of one pontoon, one treadway, and four handrail posts. The bridge is erected by successively connecting individual bays to the near shore end and pushing the entire bridge toward the far shore.

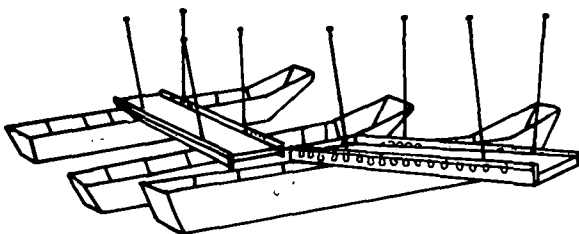
STEP 1



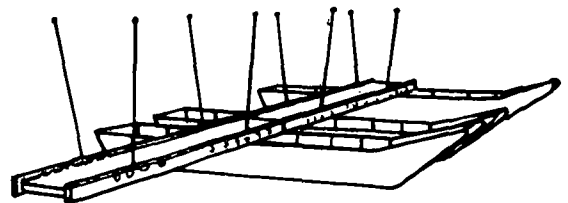
STEP 2



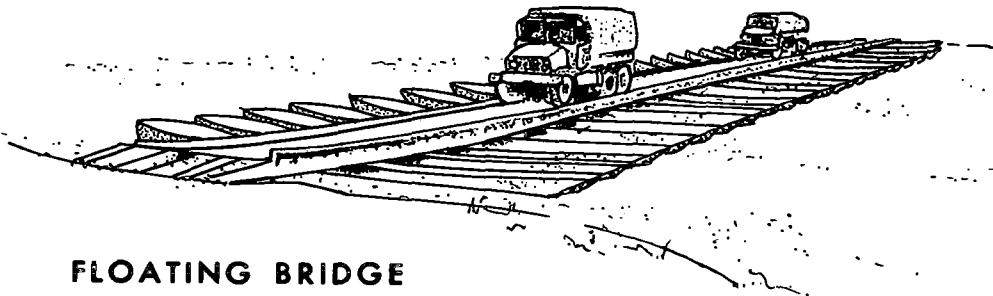
STEP 3



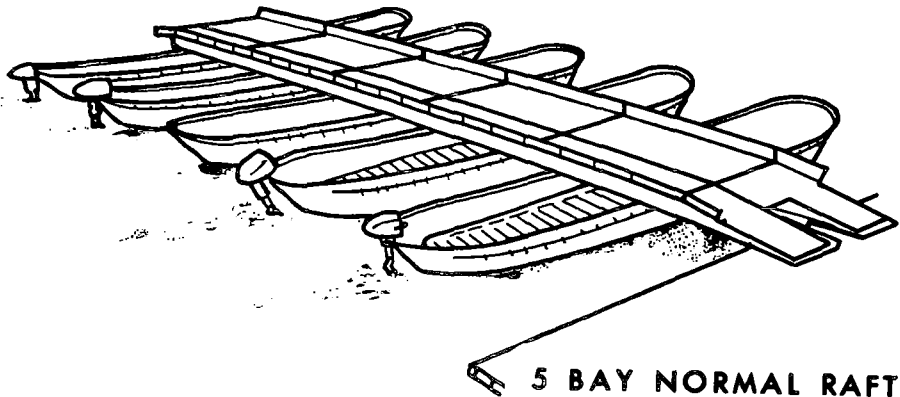
STEP 4



The **LIGHT TACTICAL RAFT EQUIPMENT** can be used to assemble either rafts or floating bridges. Both the raft and the bridges consist of a deck built of aluminum sections supported on aluminum pontoons. The most commonly used raft is a four-ponton reinforced raft with three bays of decking and ramps on each end.

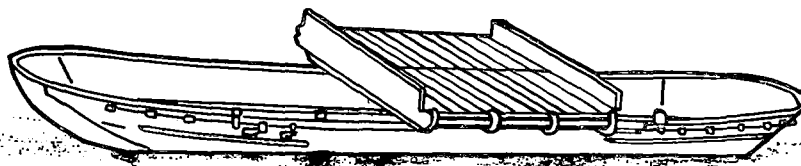


FLOATING BRIDGE



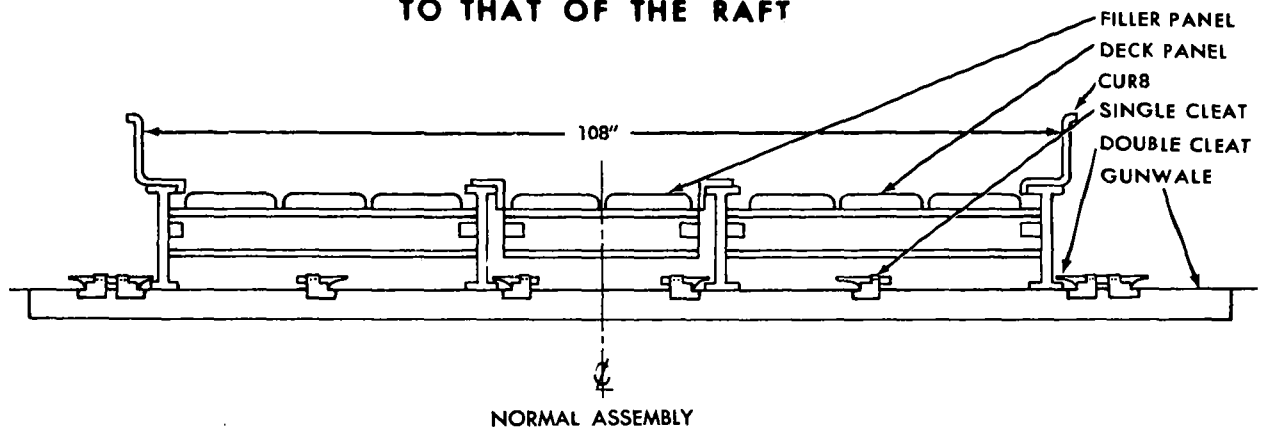
5 BAY NORMAL RAFT

Normal rafts such as the four-ponton, four-bay or five-ponton, five-bay, are assembled by placing one set of deck panels on one ponton. The completed bay is pushed out from the shore, then another ponton is pulled in next to the shore and deck panels are placed on it and the two completed bays are joined. Additional bays are added until there are four or five pontoons and an equivalent number of deck panel sets.

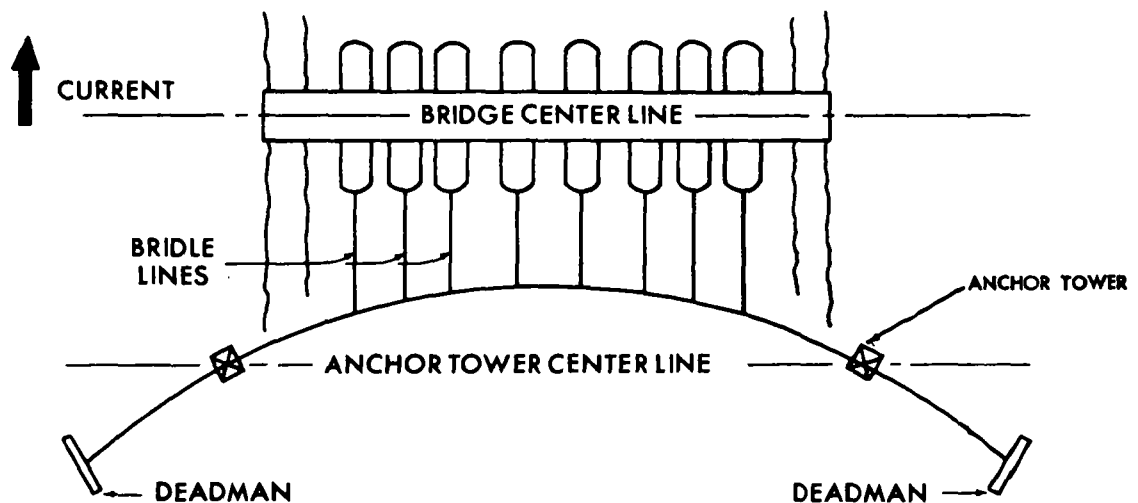


ONE ASSEMBLED BAY OF LIGHT TACTICAL RAFT

**ASSEMBLY OF THE NORMAL LIGHT TACTICAL BRIDGE IS SIMILAR
TO THAT OF THE RAFT**



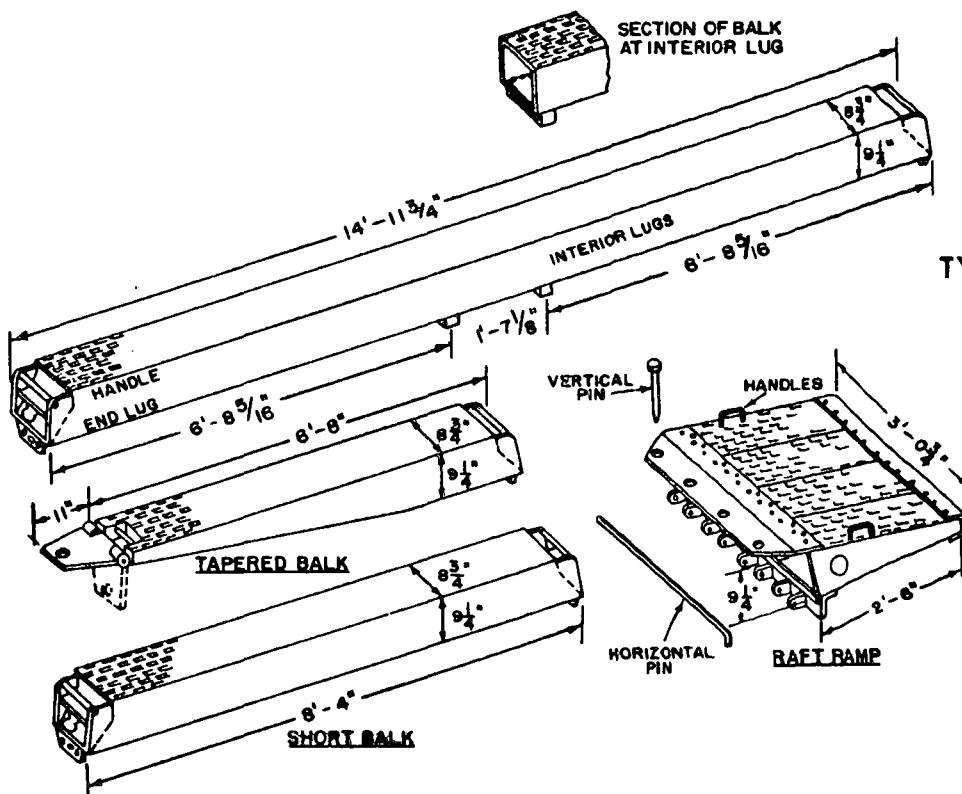
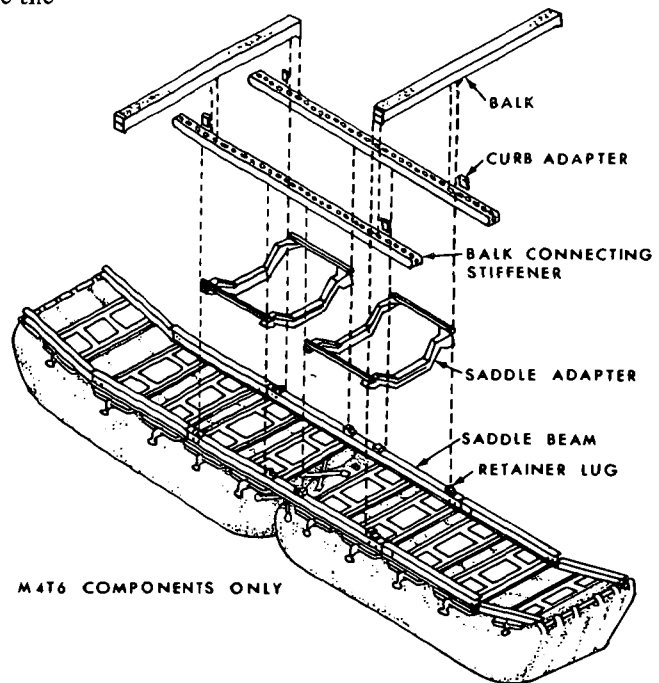
ANCHORAGES must be provided to secure floating bridges between the abutments and to insure continued alignment. The basic anchorage systems used are: overhead cable bridle line systems, shore guys, kedge anchors, and a combination of kedge anchors and shore guys. The most satisfactory method of anchoring a floating bridge is the overhead cable bridle line system supplemented by shore guys. A typical layout for this system is shown here.



The two major heavy tactical floating bridges are the M4T6 and the CLASS 60.

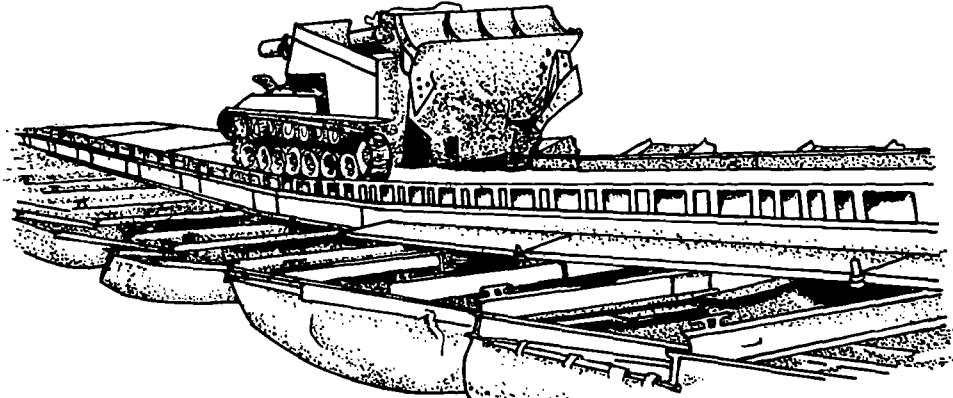
The heavy pneumatic float assemblies on these two bridges are interchangeable.

24-ton float and saddle system

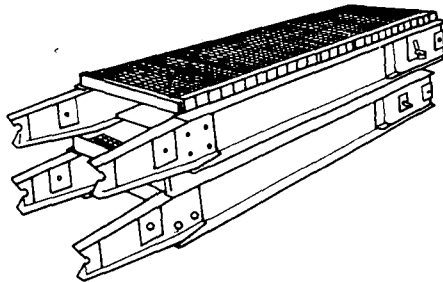


TYPES OF DECK BALK
(M4T6)

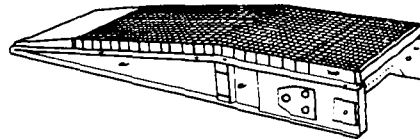
The **CLASS 60 FLOATING BRIDGE** has a deck of flush-surfaced steel grid panels 162 inches wide between curbs, supported by the same 24-ton pneumatic floats in the M4T6 bridge, spaced 15 feet center-to-center. The deck panels are pinned together end-to-end to provide rigid connections. The bridge requires cranes and an air compressor for assembly.



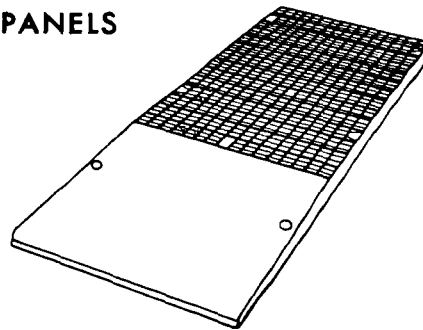
BRIDGE COMPONENTS



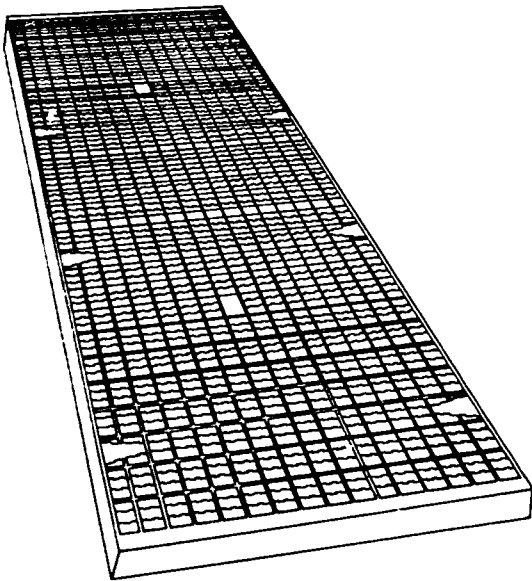
DECK TREAD PANELS



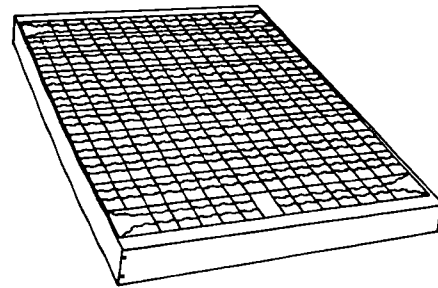
RAMP TREAD PANELS



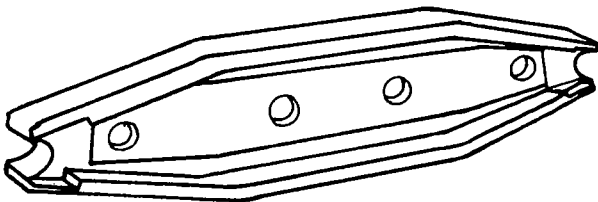
RAMP FILLER PANELS



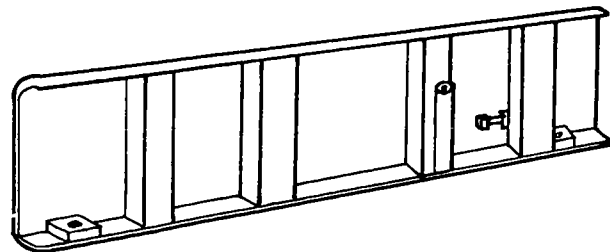
DECK FILLER PANEL



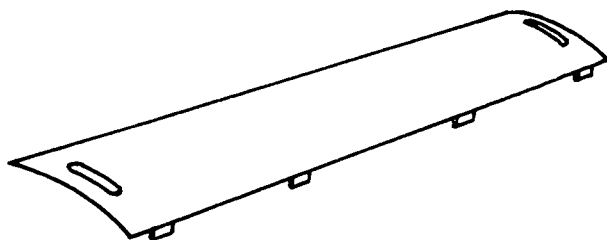
SHORT DECK FILLER PANEL



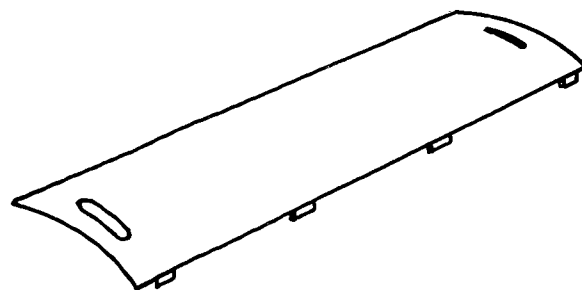
CONNECTOR BEAM



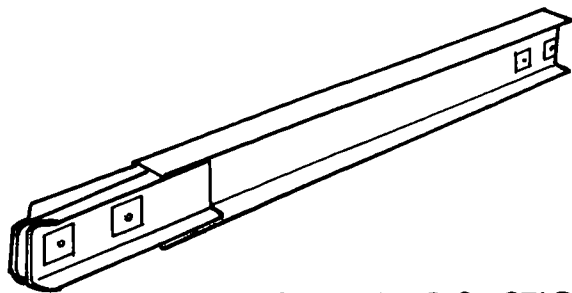
SHORT DECK CURB



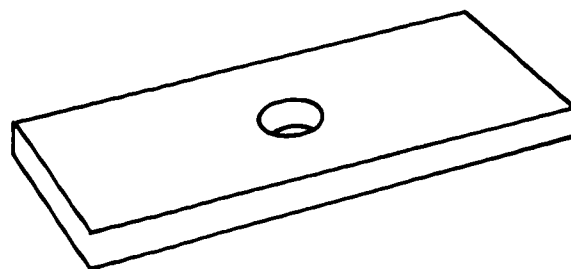
COVER PLATE TREAD



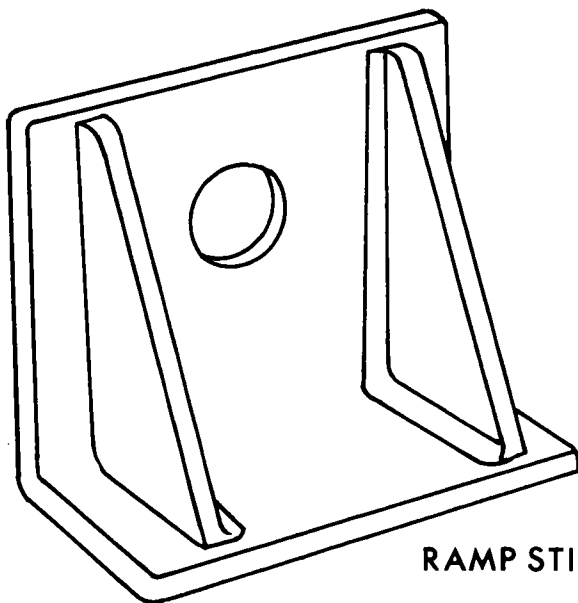
COVER PLATE FILLER



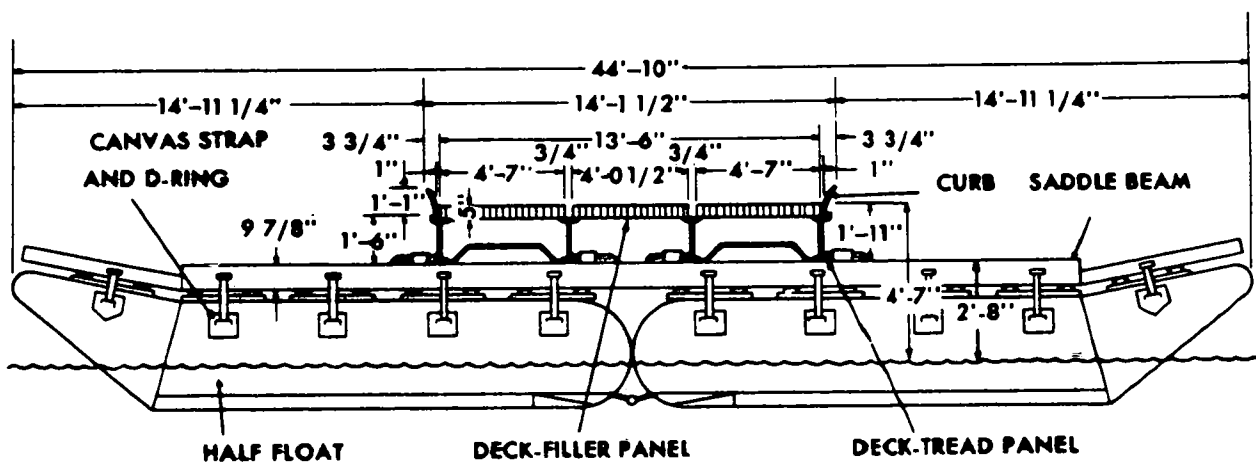
RAMP STIFFENER SECTION



RAMP STIFFENER STOP BAR

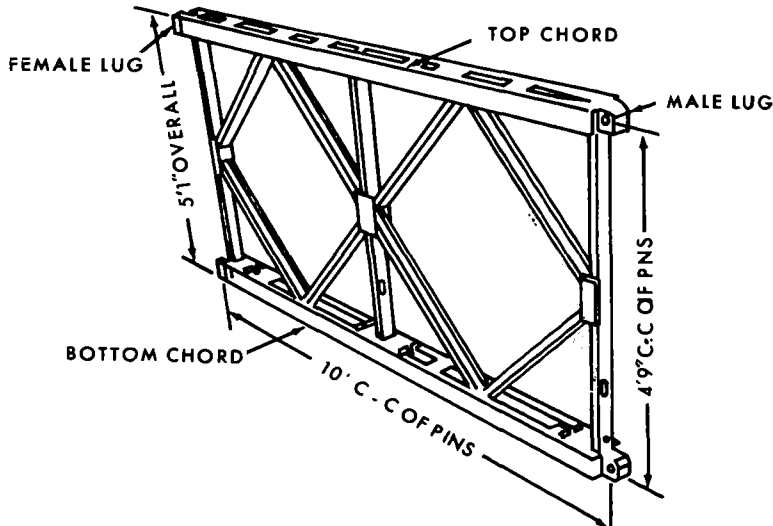


RAMP STIFFENER STOP BRACKET

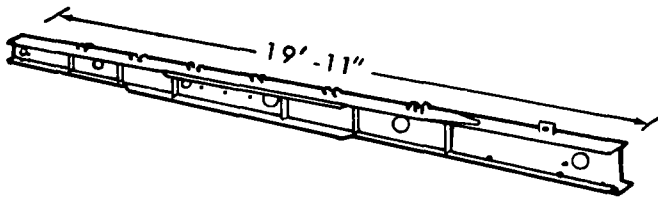


CROSS SECTIONAL VIEW OF BRIDGE SUPERSTRUCTURE

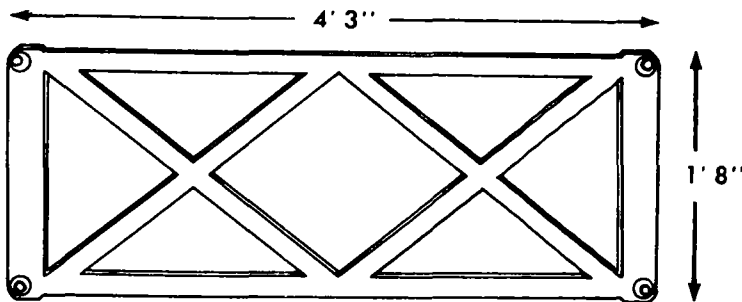
The **M2 PANEL BRIDGE, BAILEY TYPE**, provides a rapid means of bridging streams and ravines for all military loads. It can be assembled by hand in different ways for various spans and classes. It consists of numerous standardized parts, shown here.



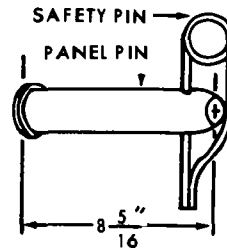
The **PANEL** is the basic member of the bridge. It weighs 577 pounds and can be carried by six men using carrying bars.



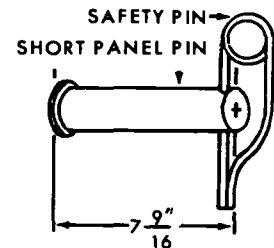
The **TRANSOM** supports the floor system of the bridge. It weighs 618 pounds and is carried by eight men using carrying tongs.



The **BRACING FRAME** is used to brace the inner two trusses on each side of the double and triple truss bridge.

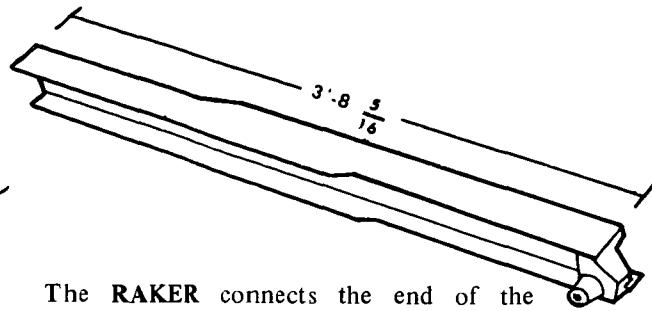


A.

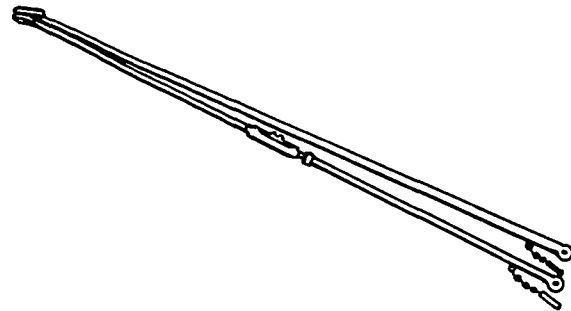


B.

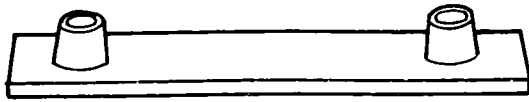
Pin A is used to connect several panels together to form a truss. Pin B is used to pin the end posts of the outer truss in a triple-truss bridge.



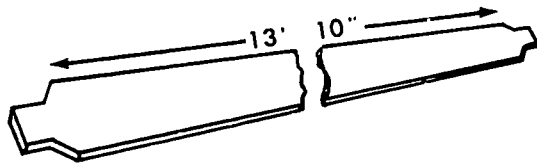
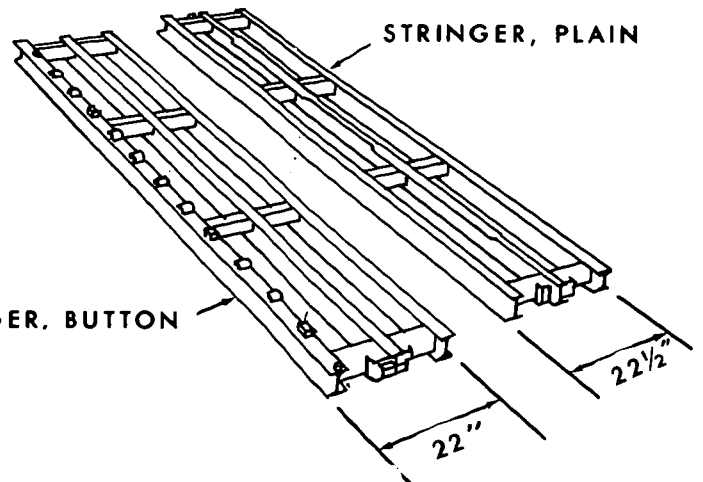
The **RAKER** connects the end of the transom to the top of the panels of the inner truss and prevents the panels from over-turning.



The **SWAY BRACE** is hinged at the center and is adjusted by a turnbuckle. Two sway braces are required in the lower chord of each bay to increase stability.

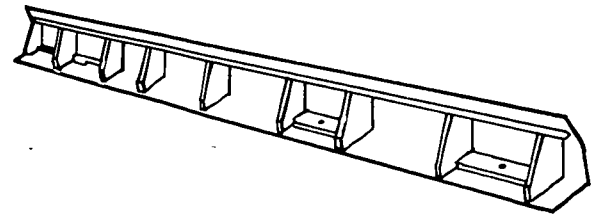


The **TIE PLATE** is used only in triple-truss bridges. It secures the second truss to the third truss.

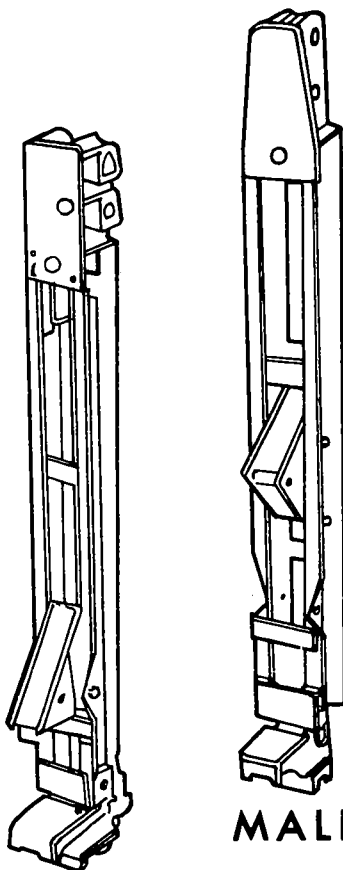


STRINGERS carry the roadway of the bridge. Each bay of the bridge has six—four plain stringers in the middle and a button stringer on each side.

CHESSE form the road surface. Each bay of the bridge contains 13 chess, which lie across the stringers and are held in place by the buttons on the stringers. Chess are held down by ribands.



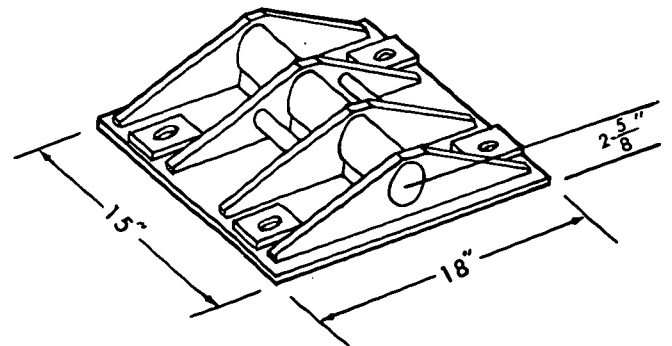
A **RIBAND** is a metal curb 8 inches high and 10 feet long. It is fastened to the button stringers by four bolts.



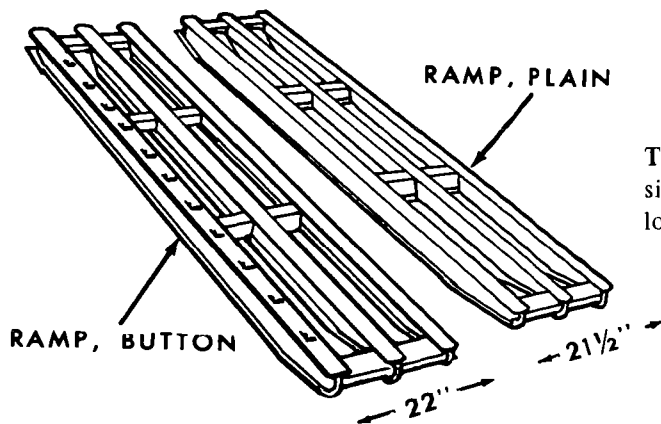
FEMALE

MALE

END POSTS are used on both ends of each truss of the bridge to take the vertical shear.

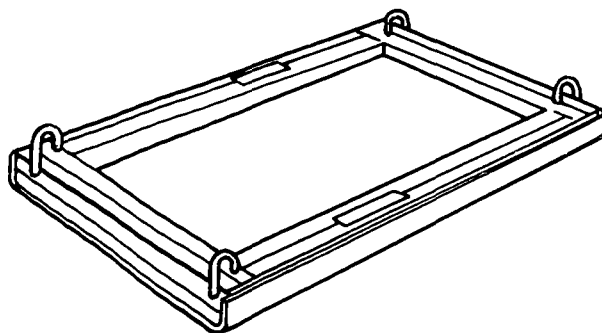


The **BEARING** is connected to the bottom of the end posts and spreads the load of the bridge to the base plate.

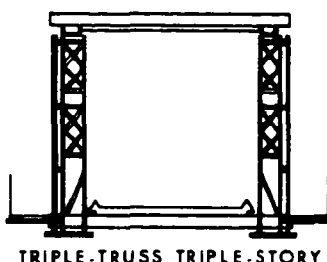
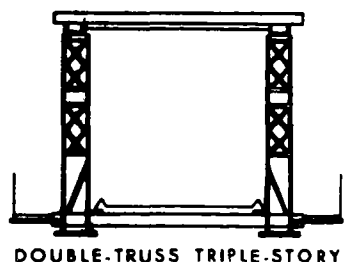
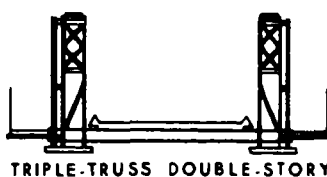
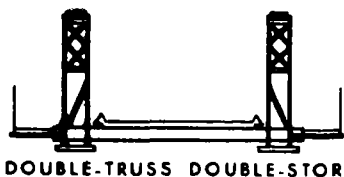


The **RAMPS** are similar to stringers, except that they consist of three 5-inch, instead of 4-inch, steel I-beams. The lower surface of the ramp tapers upward near the ends.

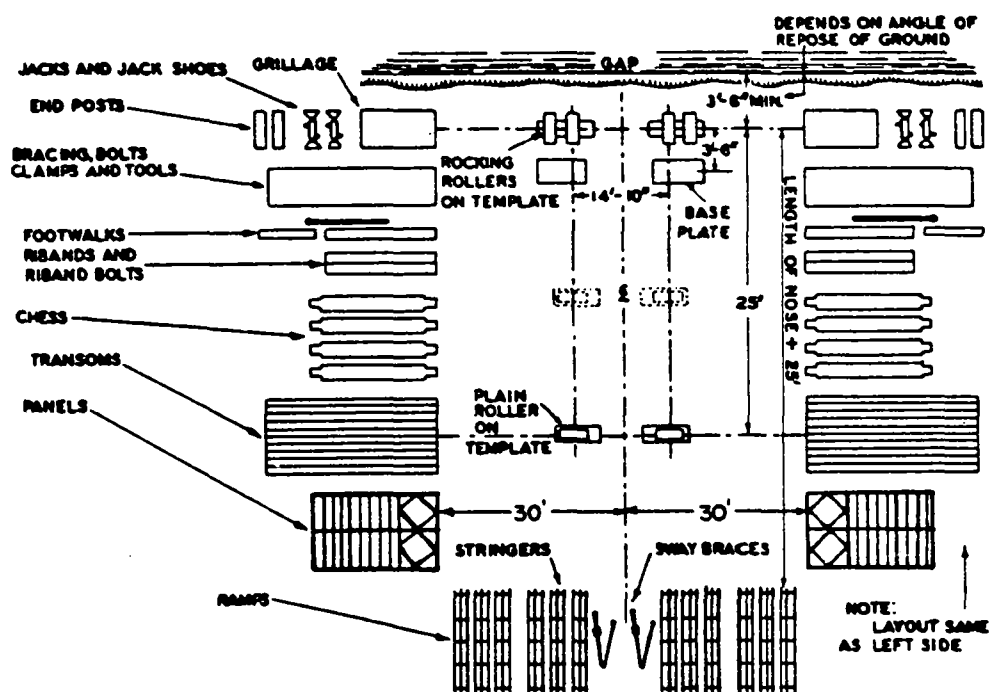
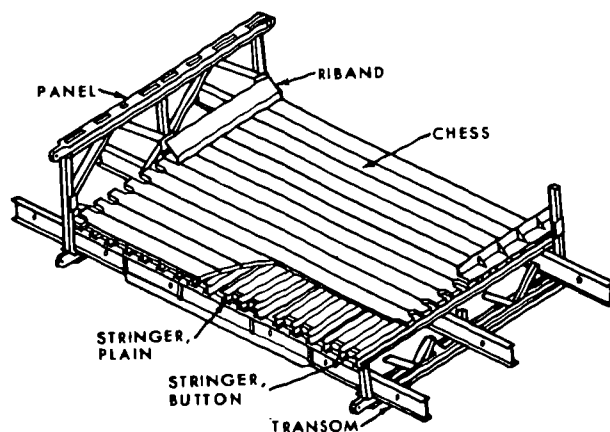
The **BASE PLATE** is used under the bearings to spread the load from the bearings over the ground or grillage.



HERE ARE THE STANDARD TYPES OF TRUSS ASSEMBLIES

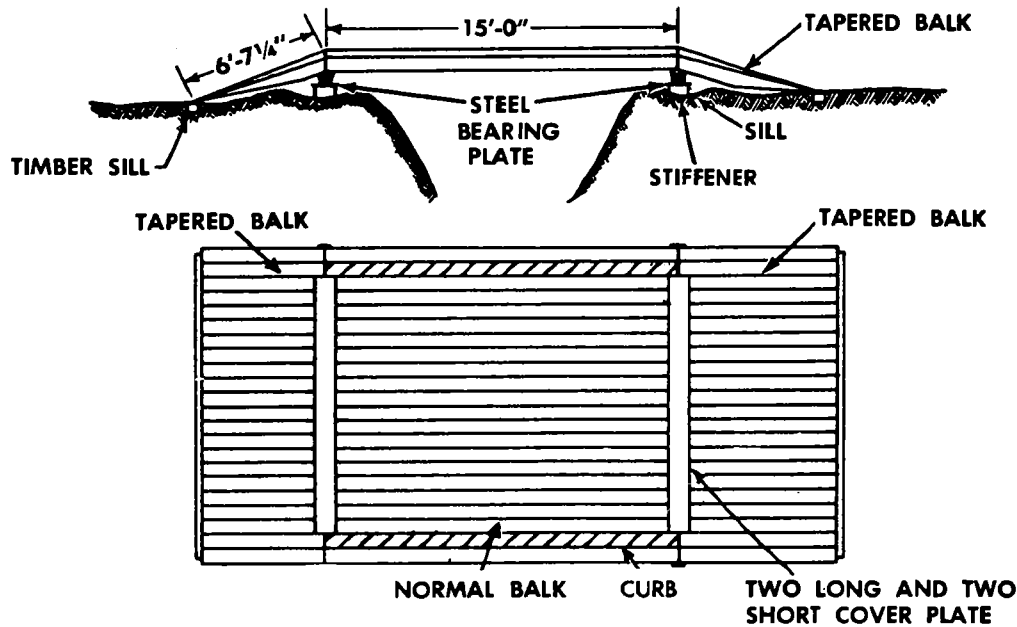


The single truss single story is launched by the cantilever method which involves assembling the bridge on rollers on one bank and pushing it across the gap, keeping enough weight behind the rollers on the near bank to balance the bridge. These are the components in one bay of a single story bridge.

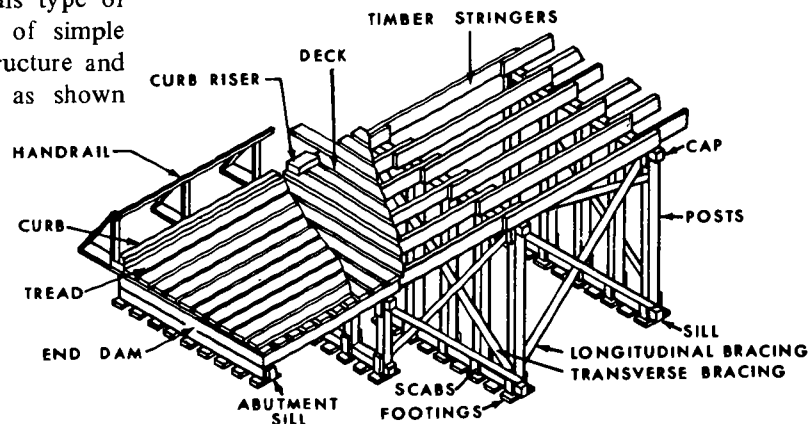


**SUGGESTED LAYOUT OF ASSEMBLY AREA
FOR THE M2 PANEL BRIDGE, BAILEY TYPE**

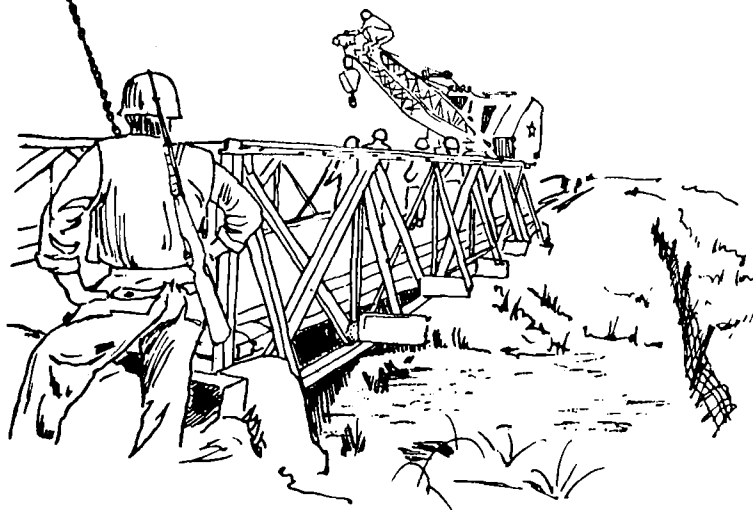
SHORT FIXED SPANS provide a rapid means of crossing narrow streams or dry gaps with heavy vehicles and equipment. Aluminum deck balk fixed spans from 15 feet (shown here) to 45 feet long may be assembled without intermediate supports from the components of an M4T6 floating bridge set. Fixed spans over 45 feet long can be assembled using trestles or piers as intermediate supports. Short balk are used at both ends of the 23-foot 4-inch and 38-foot 4-inch spans to fill the gaps between normal balk, while 30 and 45 foot spans require short balk at one end and tapered balk at the other. These spans are anchored at both ends using either picket holdfasts or deadmen. The roadway is usually 18 balk wide.



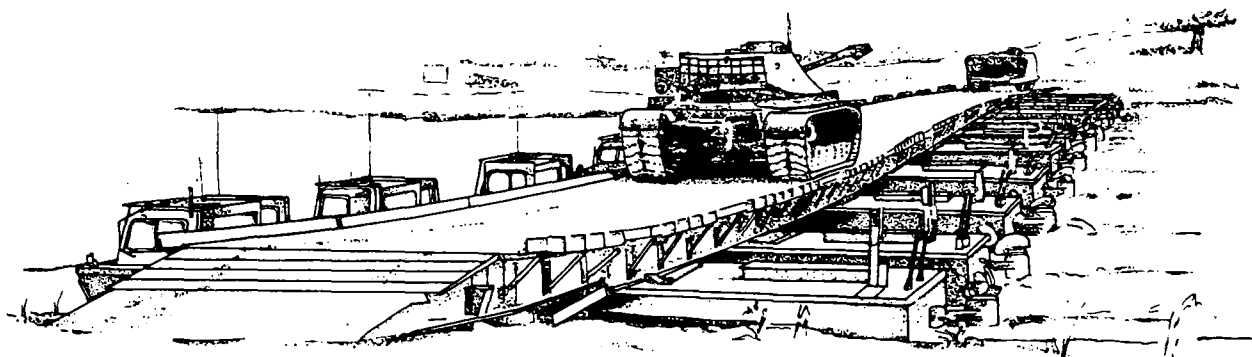
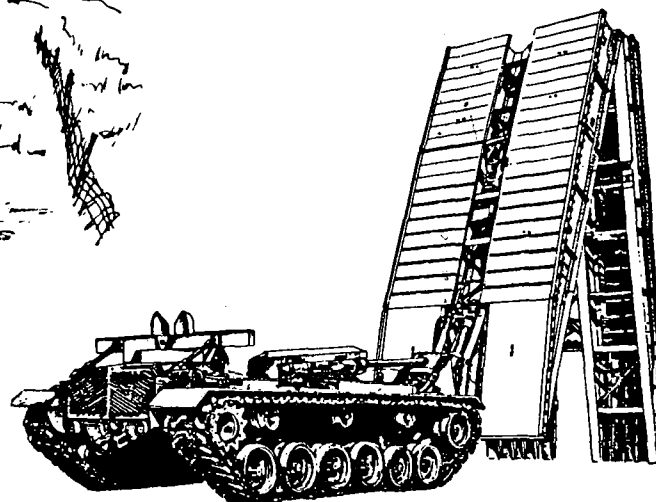
The most commonly used nonstandard bridge is the simple span **TIMBER TRESTLE BRIDGE** on timber footings. In many cases, logs or railroad rails may be used as expedients in this type of construction. The bridge is of simple design and consists of substructure and superstructure components as shown here.



The French **IEFFEL BRIDGE** is found on many routes in South Vietnam. They often cause delay in the movement of the engineer equipment on lines of communication because of their low classification. Caution or risk crossings should not be made on the older models because of their design and low grade steel.



The **ARMORED VEHICLE LAUNCHED BRIDGE (AVLB)** is a folding bridge designed to be transported, launched, and retrieved by a modified turretless tank. It will support the heaviest division load and will span gaps up to 60 feet.



Amphibious river crossing equipment, commonly referred to as the **MOBILE ASSAULT BRIDGE**, consists of three major components—the transporter, the interior bay (bridge) superstructure, and the end bay (ramp) superstructure. Due to its mobility and rapid rate of assembly, it is expected to replace conventional floating bridge equipment in the assault elements. Here is a MAB assembled with ten interior bay and two end bay units.

PART SEVEN

EXPLOSIVES AND DEMOLITIONS



EXPLOSIVES

The items described here are the **EXPLOSIVES** used in military demolition operations which include both military explosives and commercial dynamites. In addition to being used as the principal component of demolition charges, military explosives are also used in the initiating and priming components described a little further on.

Name	Principal use	Smallest cap * required for detonation	Approx. velocity of detonation (meter/sec) (feet/sec)	Relative effectiveness as external charge (TNT: 1.00)	Intensity of poisonous fumes	* Water resistance
TNT	Main charge, booster charge, cutting and breaching charge, general and military use in forward areas	Special blasting cap	6,900 mps 23,000 fps	1.00	Dangerous	Excellent
Tetrytol			7,000 mps 23,000 fpa	1.20	Dangerous	Excellent
Composition C 3			7,625 mpa 25,018 fps	1.34	Dangerous	Good
Composition C 4			8,040 mps 26,379 fpa	1.84	Slight	Excellent
Ammonium Nitrate	Cratering and ditching	No. 6 commercial cap	3,400 mpa 11,000 fpa	0.42	Dangerous	Poor
Military Dynamite M1	Quarry and rock cuts		6,100 mps 20,000 fps	0.92	Dangerous	Good
Straight Dynamite (commercial)	Land clearing, cratering quarrying, and general use in rear areas	No. 6 commercial cap	4,600 mpa 15,000 fps	0.65	Dangerous	Good (if fired within 24 hours)
			5,500 mps 18,000 fpa	0.79		
			5,800 mpa 19,000 fpa	0.83		
Ammonia Dynamite (commercial)	Land clearing, cratering quarrying, and general use in rear areas	No. 6 commercial cap	2,700 mps 8,900 fpa	0.41	Dangerous	Poor
			3,400 mpa 11,000 fpa	0.46		
			3,700 mps 12,000 fpa	0.58		
Gelatin Dynamite (commercial)	Land clearing, cratering quarrying, and general use in rear areas	No. 6 commercial cap	2,400 mps 7,900 fpa	0.42	Slight	Good
			2,700 mpa 8,900 fpa	0.47		
			4,900 mpa 16,000 fpa	0.76		
Ammonia Gelatin Dynamite (commercial)	Land clearing, cratering quarrying, and general use in rear areas	No. 6 commercial cap	4,900 mps 16,000 fps		Slight	Excellent
			5,700 mps 18,700 fps			
PETN	Detonating cord	Special blasting cap	7,300 mps 24,000 fps	1.66	Slight	Good
	Blasting caps	N/A				
TETRYL	Booster charge	Special blasting cap	7,100 mps 23,300 fps	1.25	Dangerous	Excellent
RDX	Base charge in blasting caps		8,350 mps 27,440 fps	1.50		
Composition B	Shaped charges	Special blasting cap	7,800 mps 25,600 fps	1.35	Dangerous	Excellent
Amatol 80/20	Bangalore torpedo	Special blasting cap	4,900 mps 16,000 fps	1.17	Dangerous	Poor
Black Powder	Time blasting fuze	N/A	400 mps 1,312 fps	0.55	Dangerous	Poor

* Electric or nonelectric

Abbreviations: fps - feet per second
mps - meters per second
N/A - not applicable

No. - number
sec. - second(s)

DEMOLITIONS

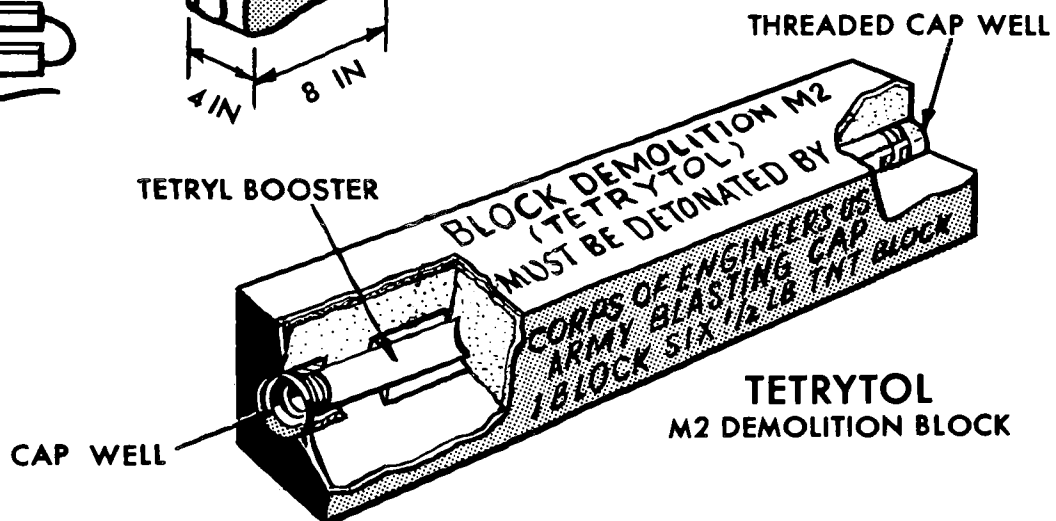
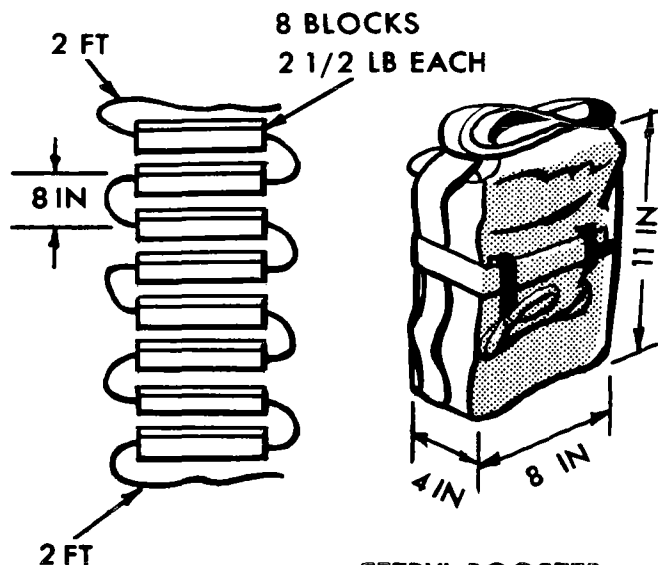
BLOCK DEMOLITION CHARGES are used in general demolition operations such as cutting, breaching, and cratering. They are composed of the high velocity explosives amatol, composition B, composition C series, tetrytol, TNT, and the low velocity explosive ammonium nitrate. With the exception of the 40-pound ammonium nitrate block demolition charge and the 1/4-pound TNT block demolition charge (training), which are made in cylindrical form, block charges are made in the form of rectangular blocks.

NOMENCLATURE

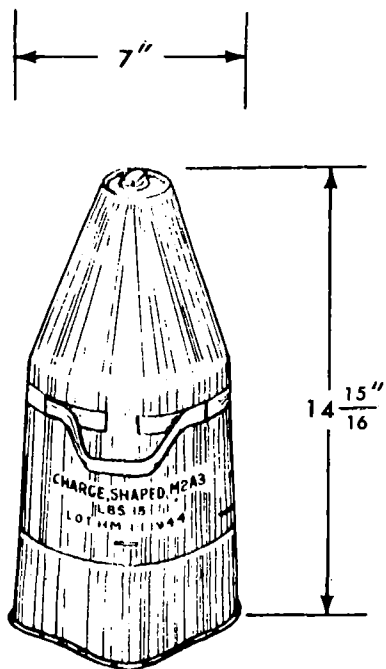
USES

CHARGE, DEMOLITION: chain M1, (2 1/2-lb, tetrytol).	General demoli- tions, cutting & breaching.
CHARGE, DEMOLITION: block M2 (2 1/2-lb, 75-25 tetrytol).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block M3 (2 1/4-lb, comp C-2).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block M3 (2 1/4-lb, comp C-3).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block M5 (2 1/2-lb, comp C-3).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block M5A1 (2 1/2 lb, comp C-4).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block M112 (1 1/4-lb, comp C-4).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block (1/2-lb, TNT).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block (1-lb, TNT).	General demolitions cutting, breaching.
CHARGE, DEMOLITION: block ammonium ni- trate, 40-lb (cratering).	Ditching and cra- tering.

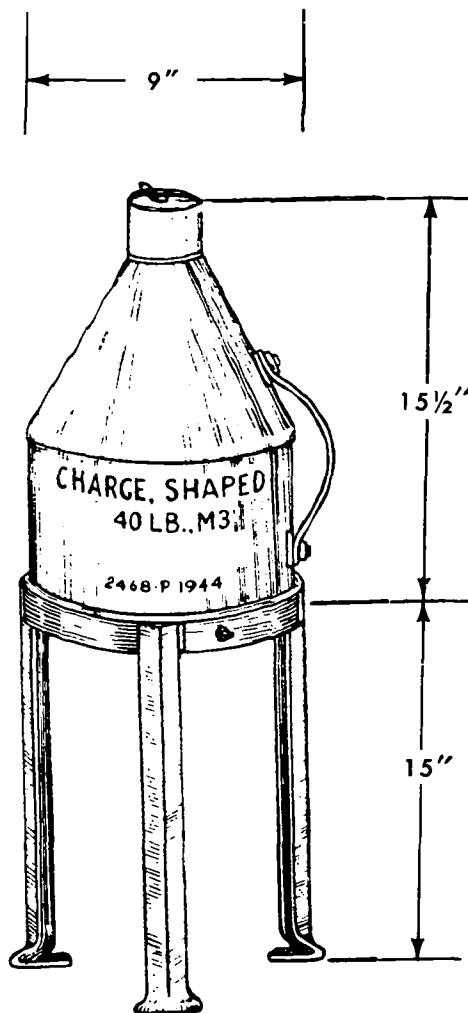
MI CHAIN DEMOLITION BLOCK



SHAPED DEMOLITION CHARGES used in military demolition operations consist of cylindrical blocks of high explosive and have a conical or hemispherical metal-lined cavity in one end and a conical shape with blasting cap well at the other end. They penetrate steel plate, concrete, masonry, pavement, and ice.

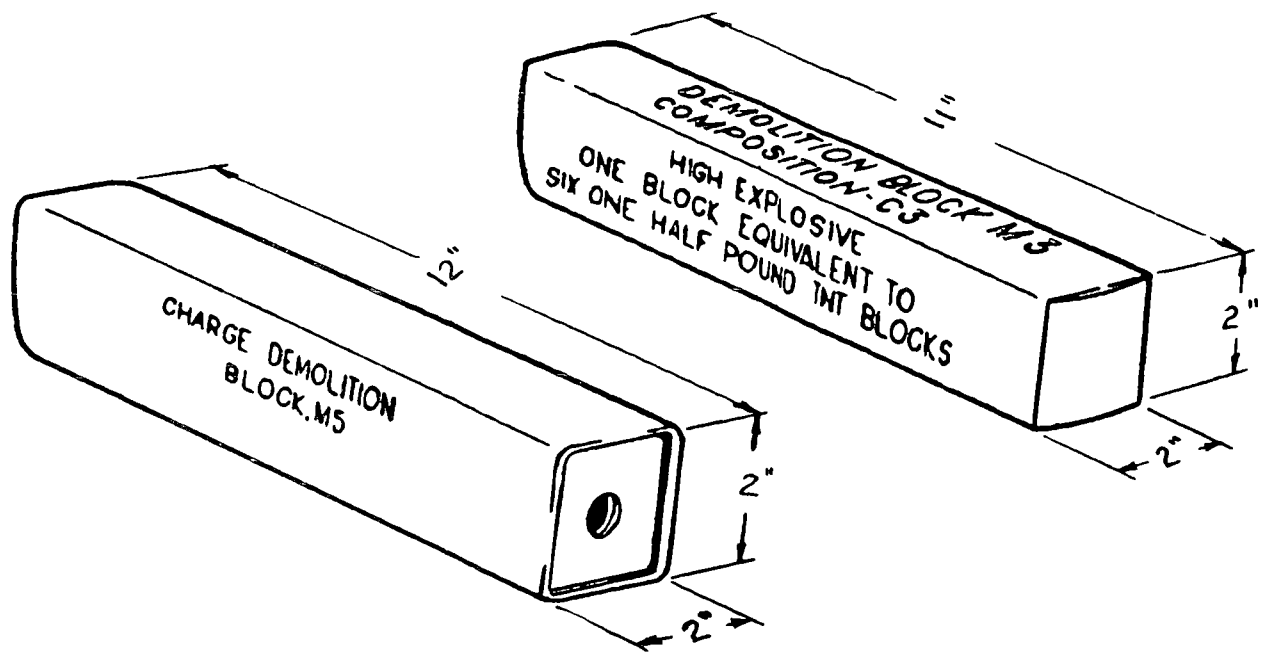


15-LB. SHAPED
CHARGE
M2A3

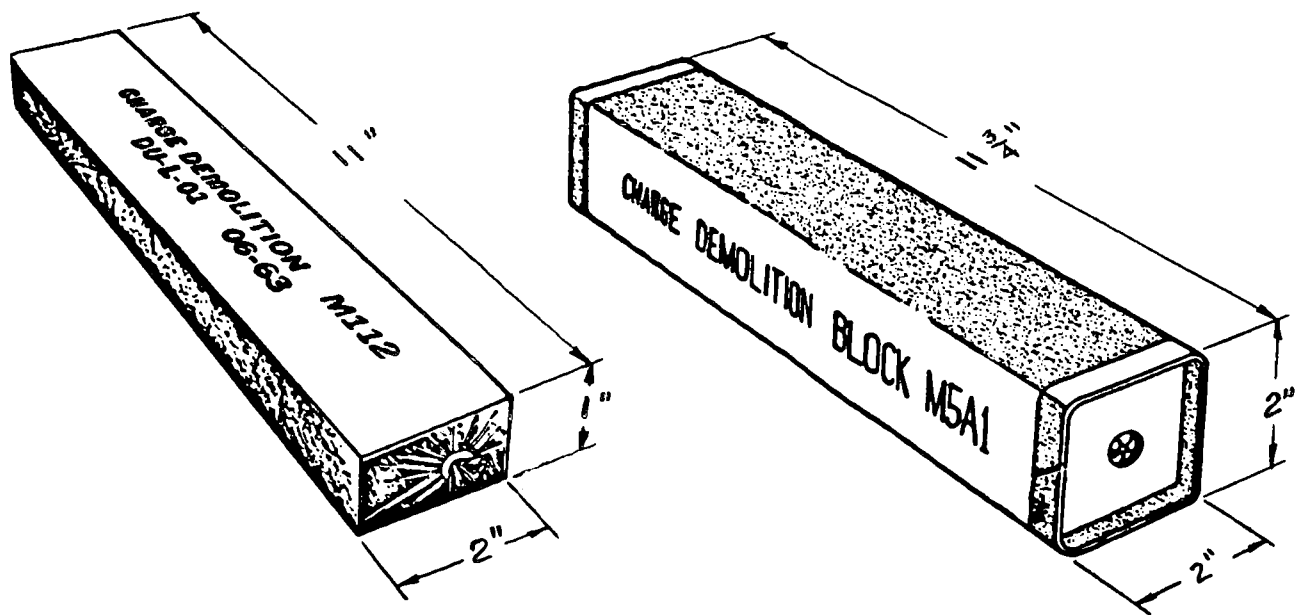


40-LB. SHAPED
CHARGE

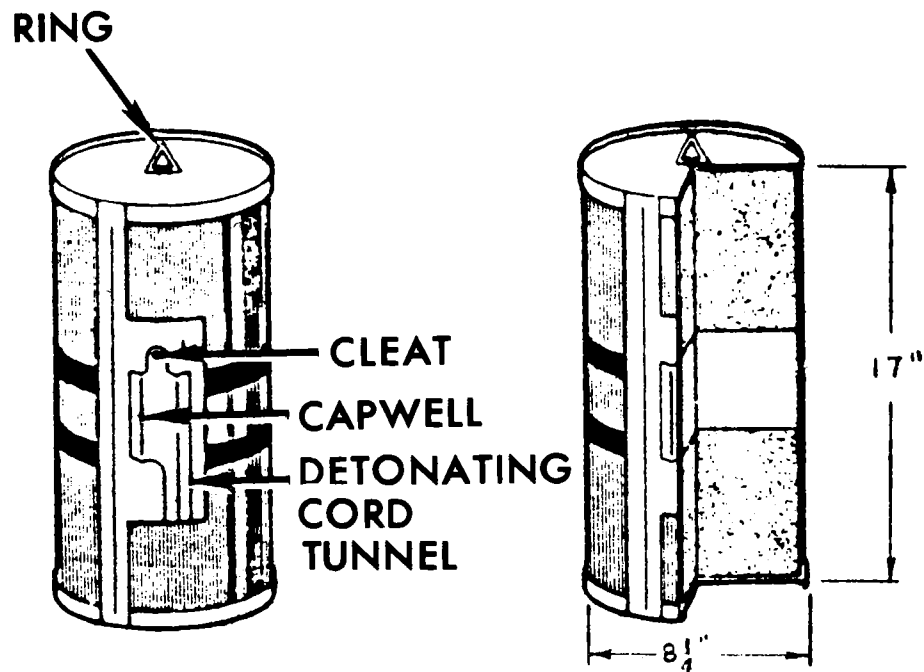
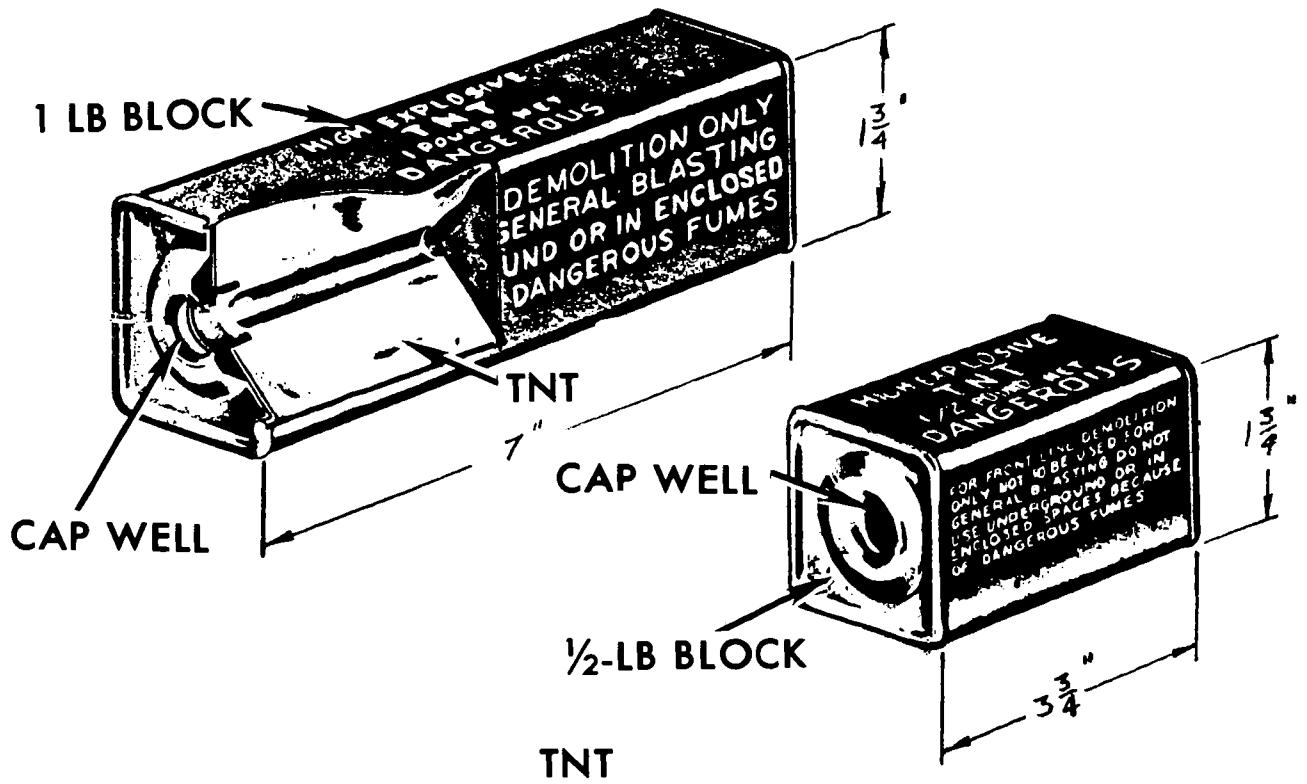
M3



COMPOSITION C3

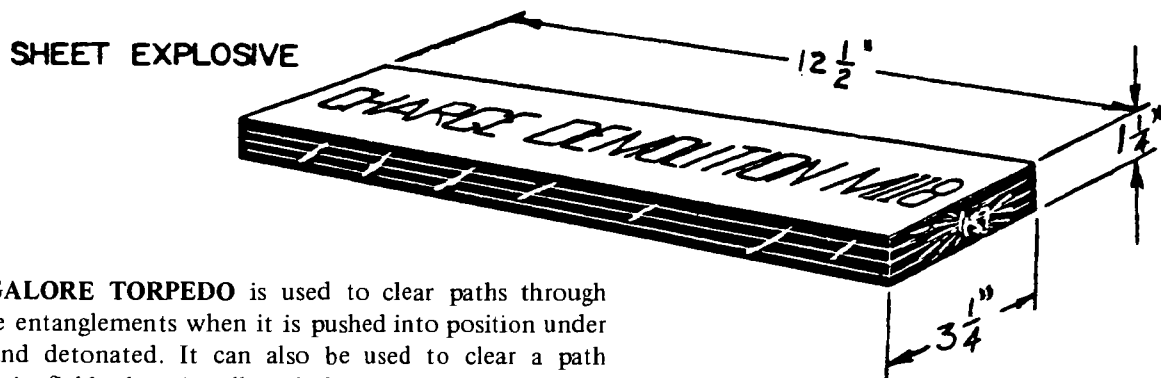


COMPOSITION C4

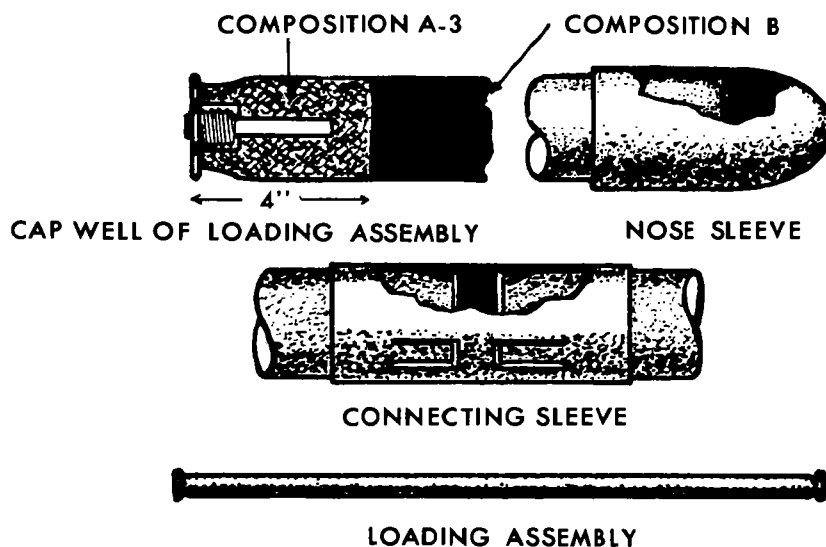


AMMONIUM NITRATE

A **DEMOLITION CHARGE** has been developed (M118) which after the protective cover-strip is pulled off may be quickly pressed against any dry surface at a temperature higher than 32 degrees F. This is particularly suitable for cutting steel and breaching. This sheet may be detonated by a military electric or nonelectric blasting cap.

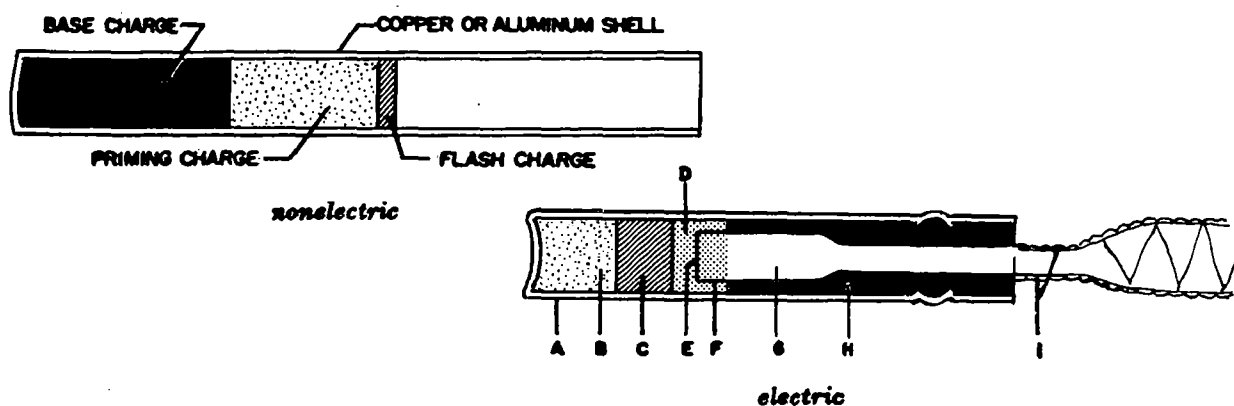


The **BANGALORE TORPEDO** is used to clear paths through barbed wire entanglements when it is pushed into position under the wire and detonated. It can also be used to clear a path through a minefield where it will explode antipersonnel and most antitank mines. (Mines not detonated will be sensitive and care should be taken to walk on path where bangalore torpedo exploded.) It consists of a series of assemblies, connected with a connecting sleeve. A nose sleeve is used on the front end to make pushing it through entanglements and across the ground easier. Recommended firing methods for the bangalore torpedo are done either by means of priming adapter and a military electric or nonelectric blasting cap and time fuse or by detonating cord with six turns around the 4-inch booster portion of the torpedo.



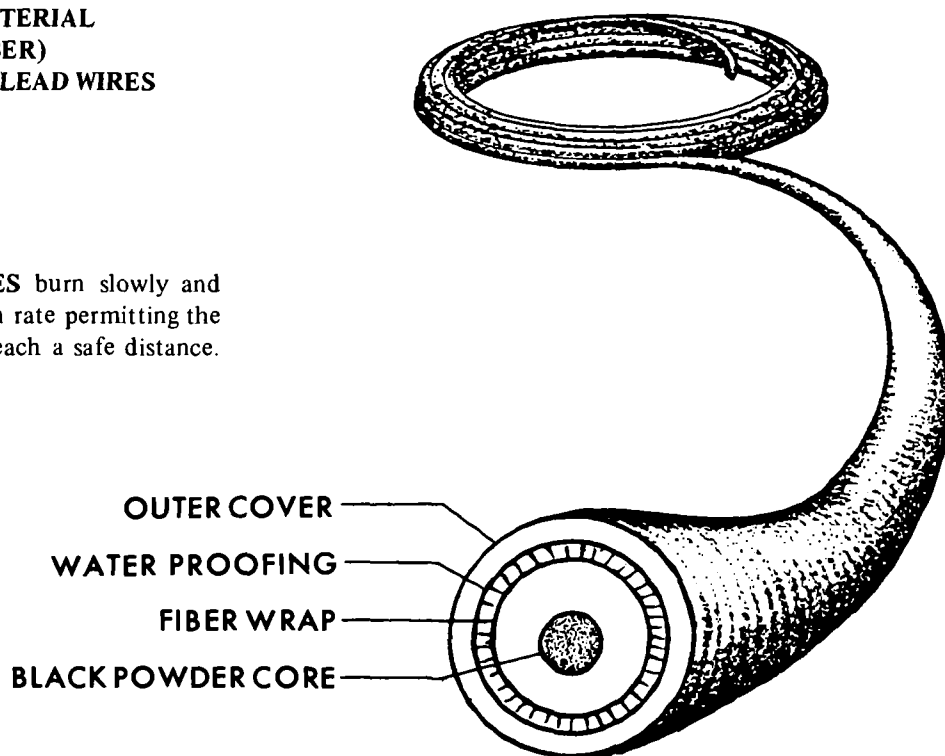
PRIMING AND DETONATING EQUIPMENT

There are two types of **BLASTING CAPS**—electric and nonelectric—used to initiate detonation of the explosive.

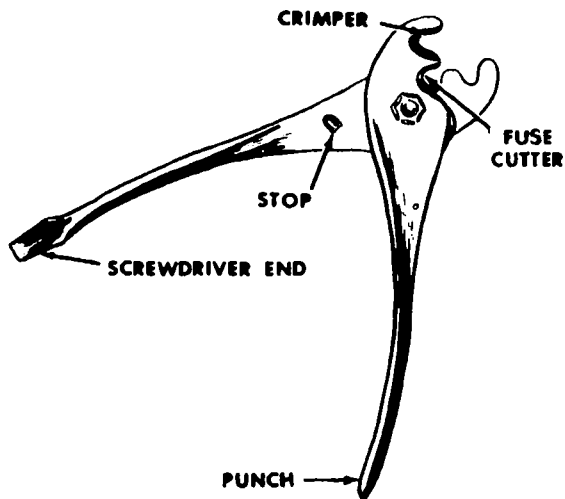
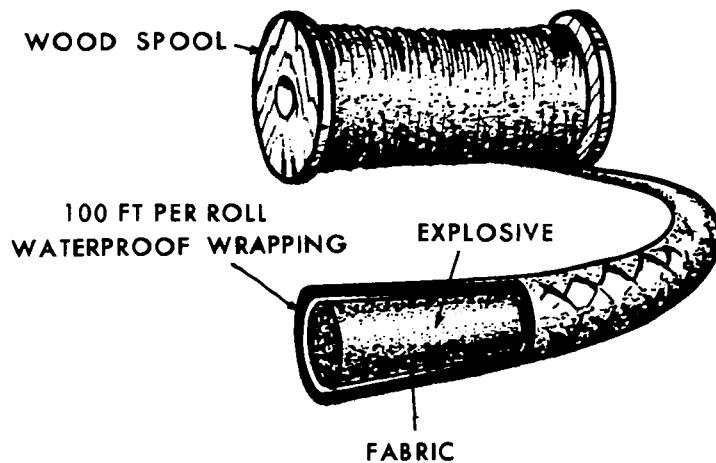


- A. METAL SHELL
- B. BASE CHARGE
- C. INTERMEDIATE CHARGE
- D. IGNITION CHARGE
- E. PLATINUM WIRE OR BRIDGE
HEATED BY THE ELECTRIC CURRENT
- F. ENDS OF LEAD WIRES SET IN
IGNITION CHARGE
- G. FILLING MATERIAL
- H. PLUG (RUBBER)
- I. INSULATED LEAD WIRES

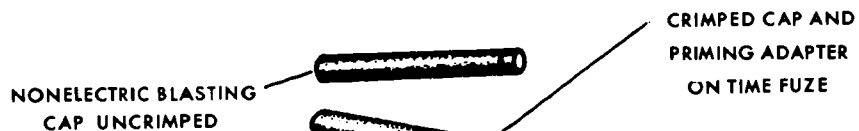
TIME FUSES burn slowly and at a uniform rate permitting the blaster to reach a safe distance.



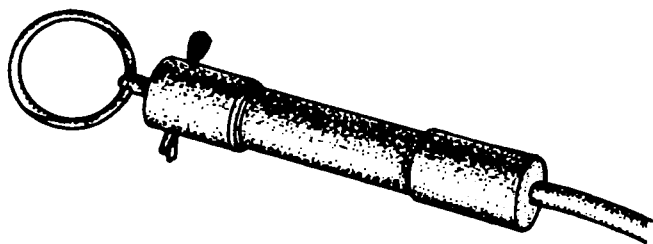
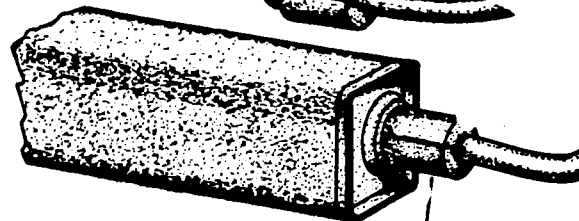
DETONATING CORD is used to prime charges and explode a number of charges simultaneously. It is important that the time fuse and the detonating cord not be mistaken for each other.



CAP CRIMPERS squeeze the shell of the nonelectric blasting cap around the time fuse or the detonating cord to prevent separation, and cut time fuses and detonating cord.



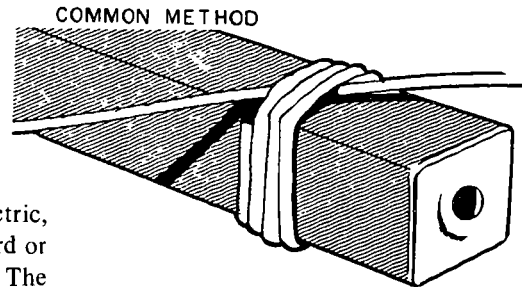
A **PRIMING ADAPTER** is used to secure the blasting cap attached to the time fuse or detonating cord inside the threaded cap wells.



The **FUSE LIGHTER** will light fuses under all weather conditions and under water, if waterproofed.

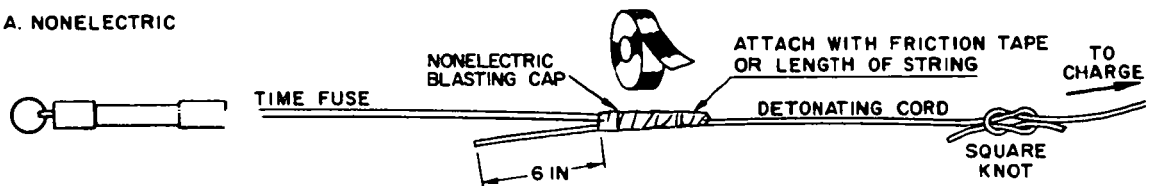
DETONATING CORD

DETONATING CORD may be used to detonate any number of high explosive charges, provided a single electric or nonelectric blasting cap is properly attached to the cord. To prime TNT with detonating cord, the cord is tied securely around the charge by a clove hitch with an extra turn as shown here. At least four complete turns are required to insure proper detonation. The cord must fit snugly against the block and the loops must be pushed together.

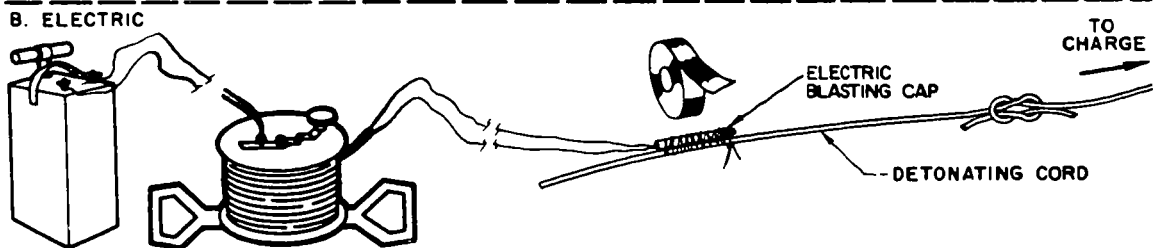


To attach the blasting cap, electric or nonelectric, tape or tie the cap securely to the detonating cord or it can be fastened to the cord with a cord clip. The cap must be placed with the closed end toward the charge.

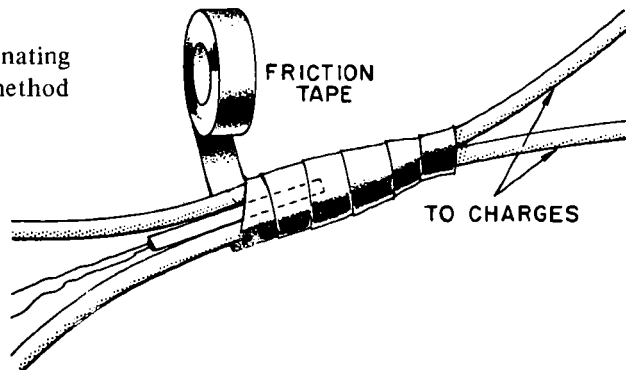
A. NONELECTRIC



B. ELECTRIC



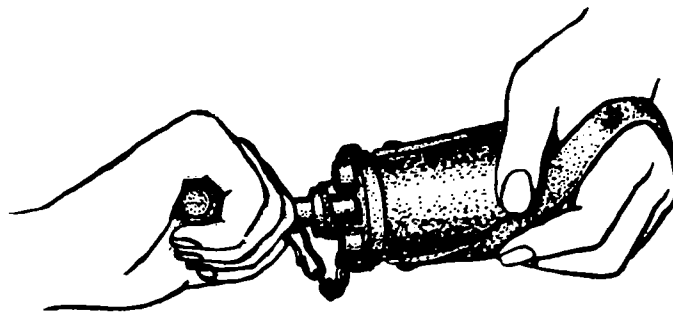
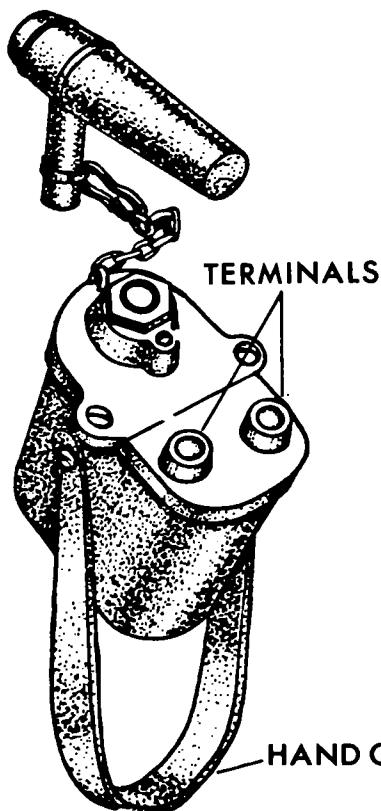
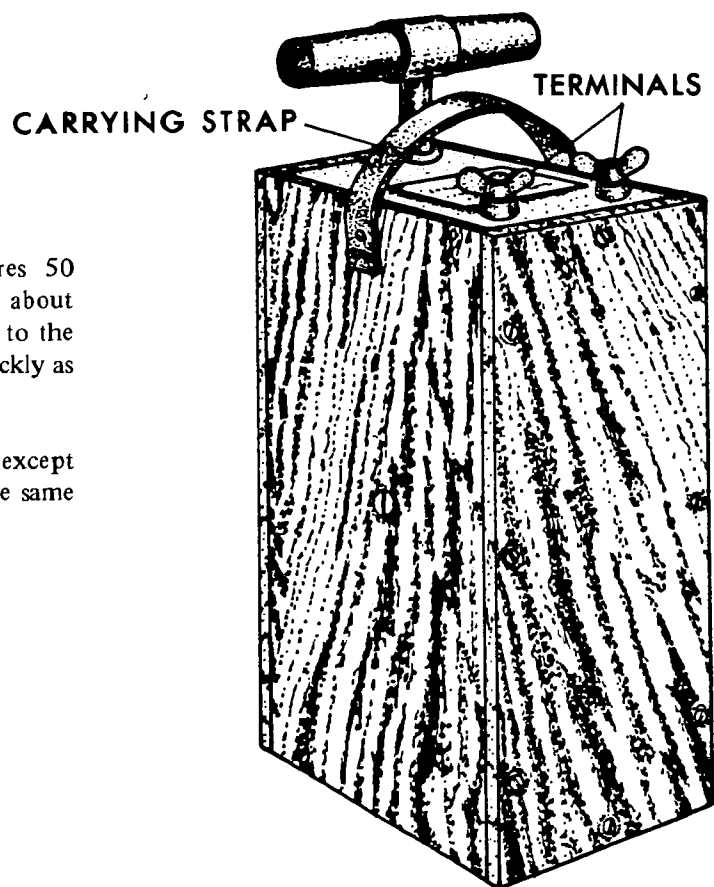
A single cap properly fastened to two detonating cords will detonate both. Here is the correct method for doing this.



BLASTING MACHINES

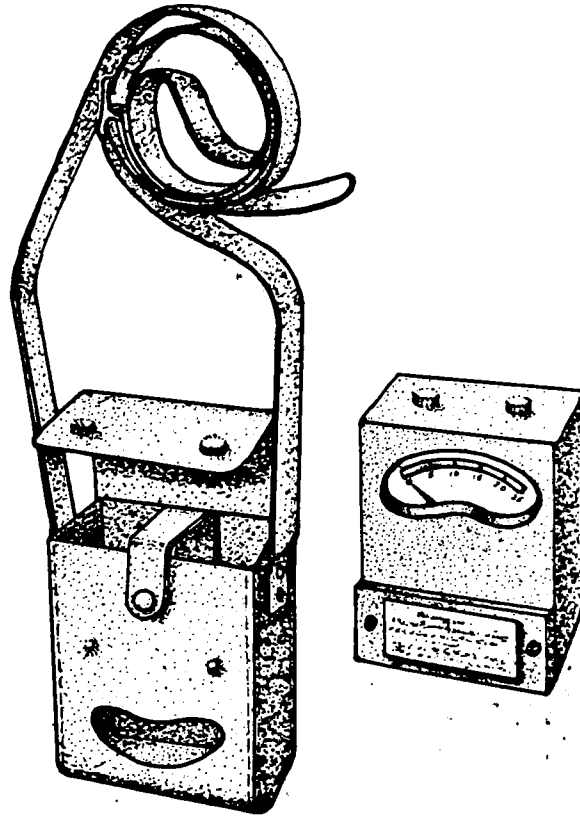
The **50-CAP BLASTING MACHINE** fires 50 electric caps connected in series. It weighs about 20 pounds. To operate the handle is raised to the top of its stroke and then pushed down quickly as far as it will go.

The 100-cap machine is similar to this one except for size and weight and it is operated in the same manner.



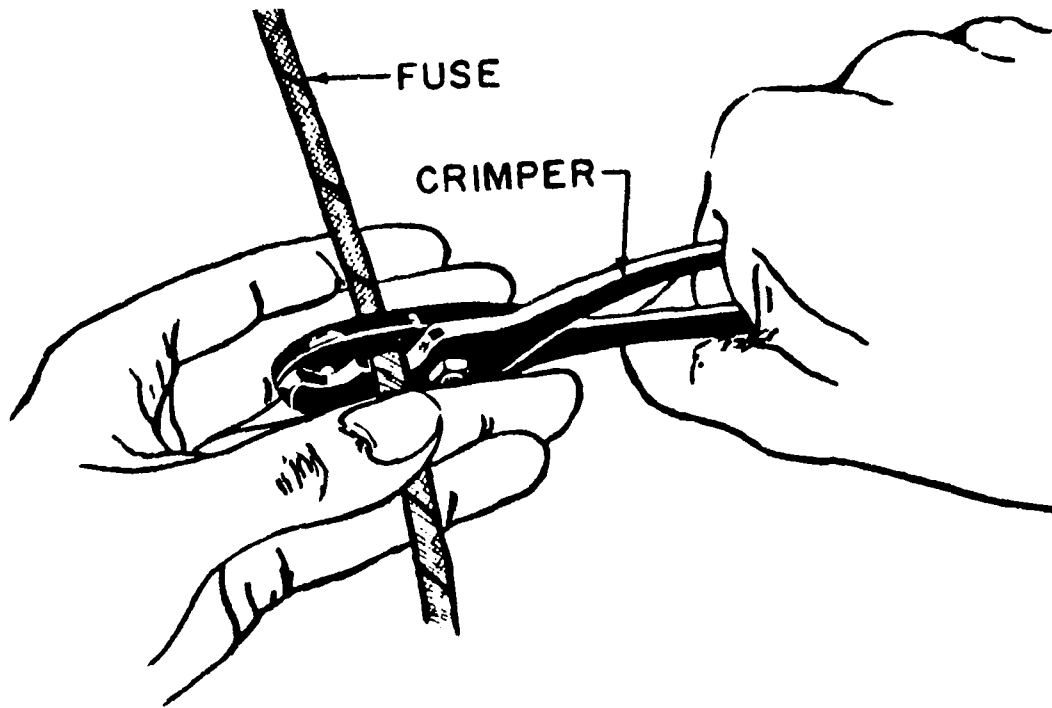
The **10-CAP BLASTING MACHINE** is a small electric impulse-type generator that produces adequate current to initiate 10 electric caps connected in series if the handle is rotated to the end of its travel. It weighs about 5 pounds.

The **GALVANOMETER** is an instrument used in testing the electric firing system to check the continuity of the circuit, in order to reduce the possibility of misfires. Only the special dry cell battery BA 245/U, which produces 0.9 volts is to be used in this instrument as other batteries may produce sufficient voltage to detonate electric blasting caps.



There are two systems for firing explosives—nonelectrically and electrically. The **NON-ELECTRIC SYSTEM** calls for a nonelectric blasting cap to provide the shock to initiate the explosion and the time fuse which transmits the flame that fires the blasting cap. To assemble this system:

NONELECTRIC SYSTEM



Cut and discard a 6-inch length from the free end of the time fuse. (This is to insure no chance of misfire from a damp powder train.) Then cut off a minimum of 1 foot of time fuse to check the burning rate.

A more exact method is to cut off a 3-foot length, timing the entire length, and taking the average.

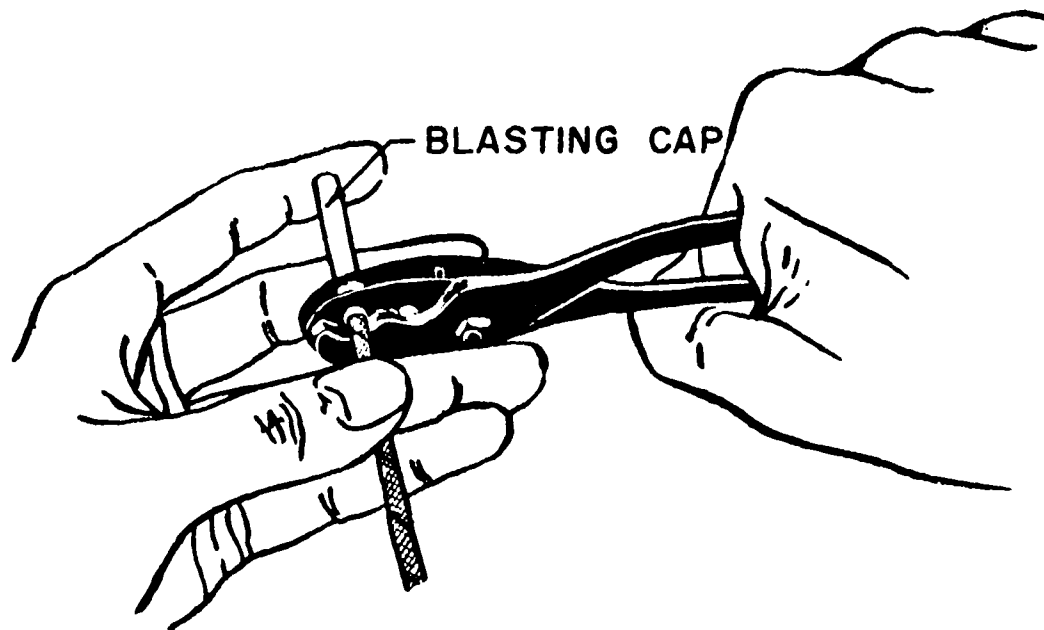
Cut the time fuse long enough to permit the person detonating the charge to reach a safe distance by walking at a normal pace before the explosion. This cut should be made squarely across the time fuse.

Take one blasting cap from the cap box, inspect it, hold it with the open end down and shake gently to remove any dirt or foreign matter. **NEVER TAP THE CAP WITH A HARD OBJECT OR AGAINST A HARD OBJECT. NEVER BLOW INTO THE CAP. DO NOT INSERT ANYTHING INTO THE CAP TO REMOVE ANY DIRT OR FOREIGN MATERIAL.**

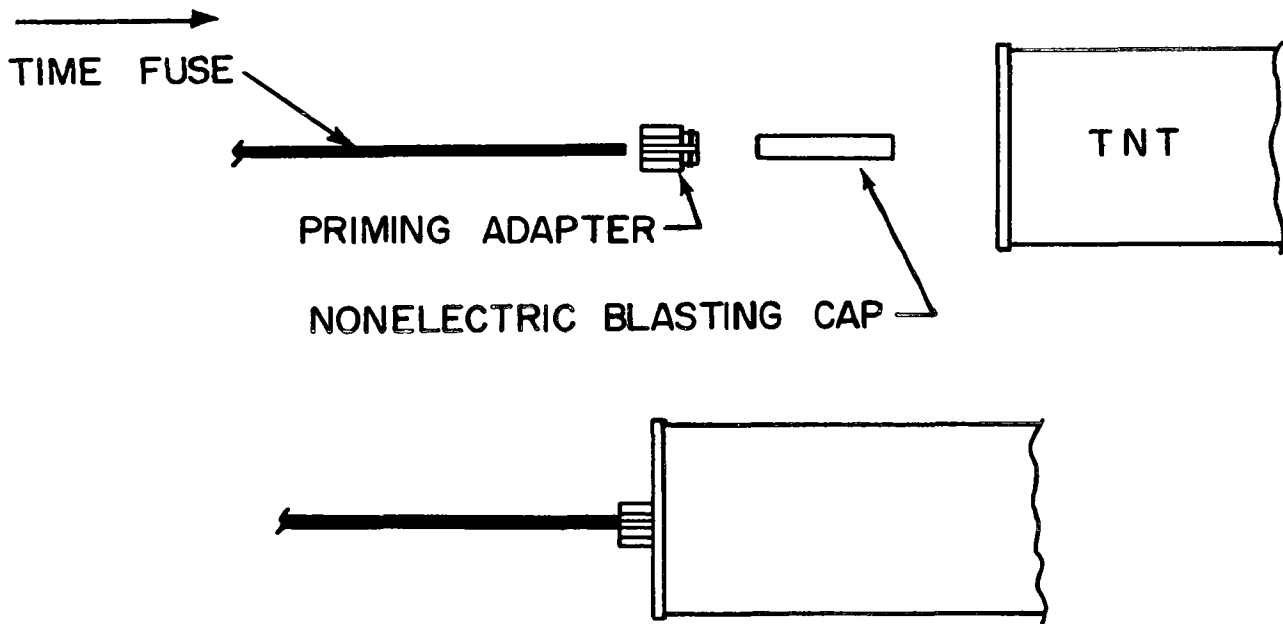
Hold the time fuse vertically with the square cut end up and slip the blasting cap gently down over it so that the flash charge in the cap is in contact with the end of the time fuse; if not, it may misfire. Never force the time fuse into the blasting cap by twisting or any other method.

After the blasting cap has been seated, grasp the time fuse between the thumb and third finger of the left hand and extend the forefinger over the end of the cap to hold it firmly against the end of the time fuse. Keep a slight pressure on the closed end of the cap with the forefinger.

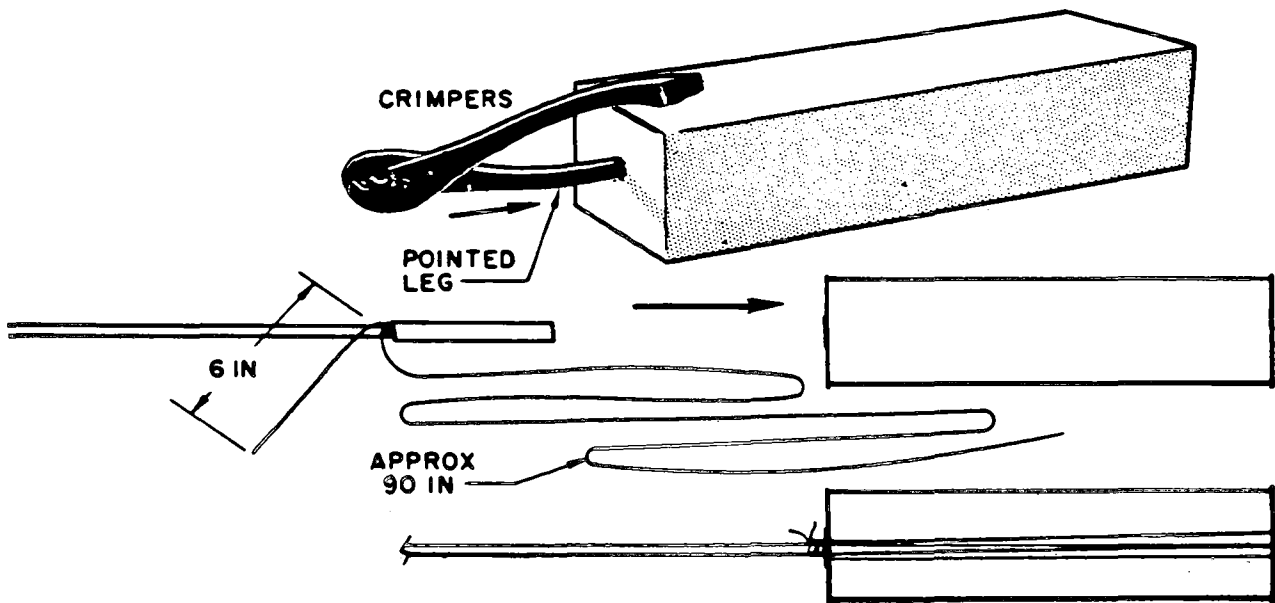
Slide the second finger down the outer edge of the blasting cap to guide the crimpers and obtain accurate crimping, even in darkness.



Crimp the cap at a point $\frac{1}{8}$ to $\frac{1}{4}$ inch from the open end. A crimp too near the explosive in the cap may cause detonation. **POINT THE CAP OUT AND AWAY FROM THE BODY DURING CRIMPING.**



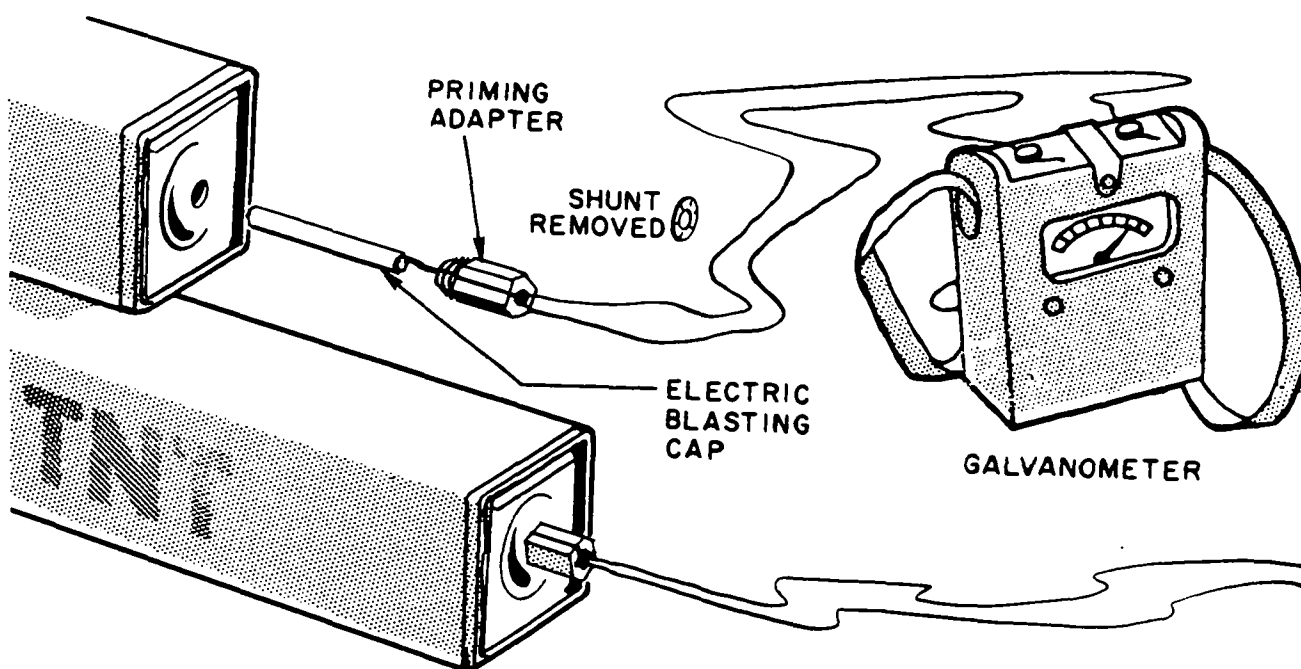
Pass the end of the time fuse through the priming adapter. Pull the cap into the adapter until it stops, insert into the cap well of the explosive, and screw the adapter into place.



If a priming adapter is not available, insert the electric cap (after testing with galvanometer) into the cap well and tie the lead wires around the block by two half hitches or a girth hitch as shown here.

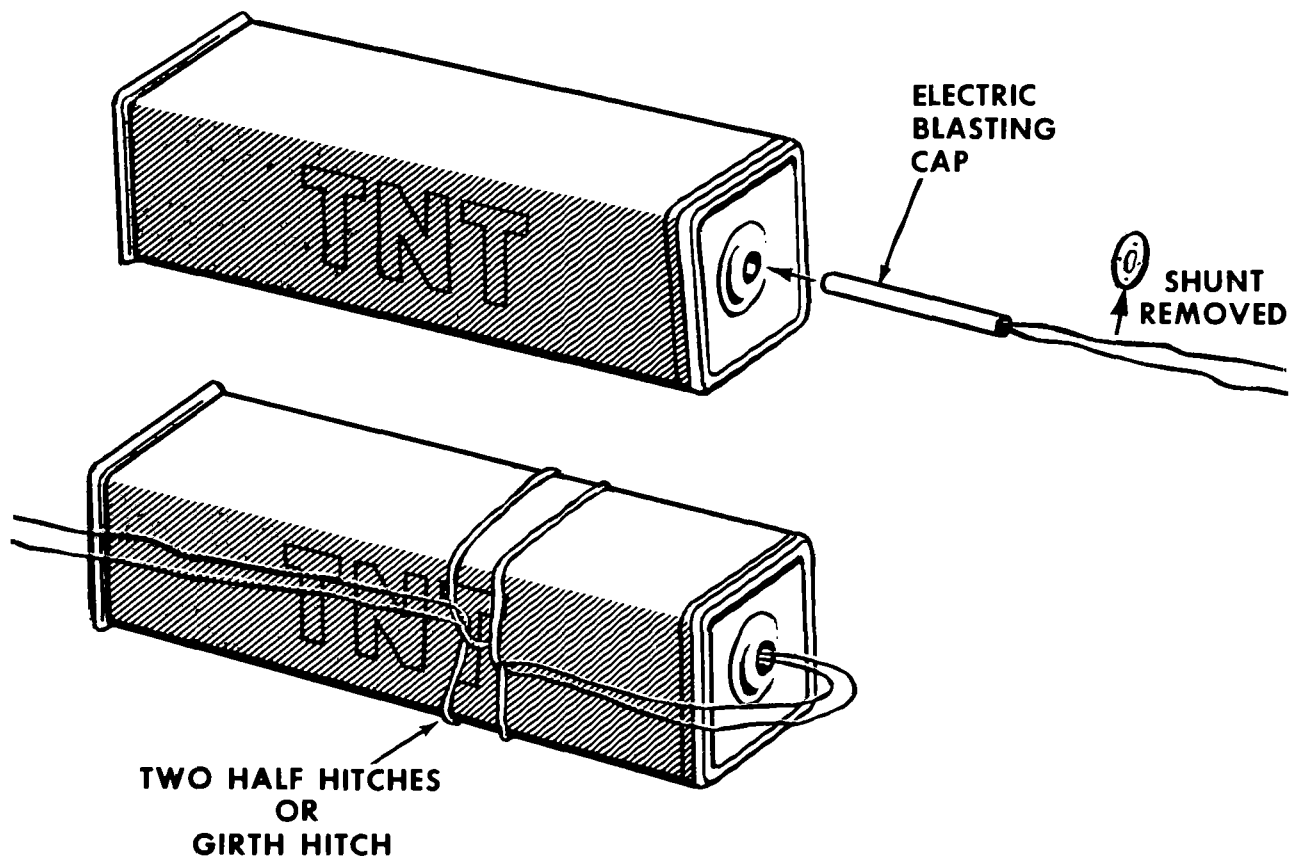
ELECTRICAL SYSTEM

The **ELECTRIC FIRING SYSTEM** provides the electric spark or impulse to initiate detonation. The electric impulse travels from the power source through the lead wires to fire the cap. The chief components of the system are the blasting cap, firing wire, reel, and the blasting machine. Shown here is the assembly of the electric primer, with adapter.



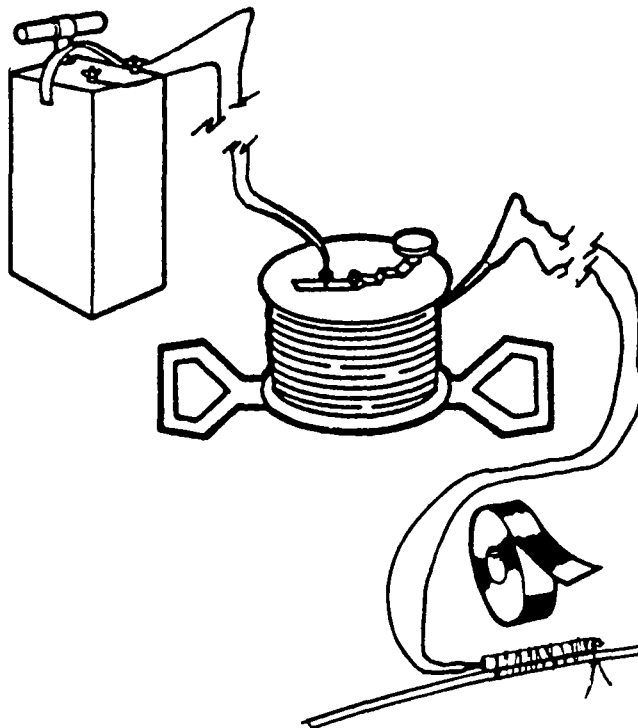
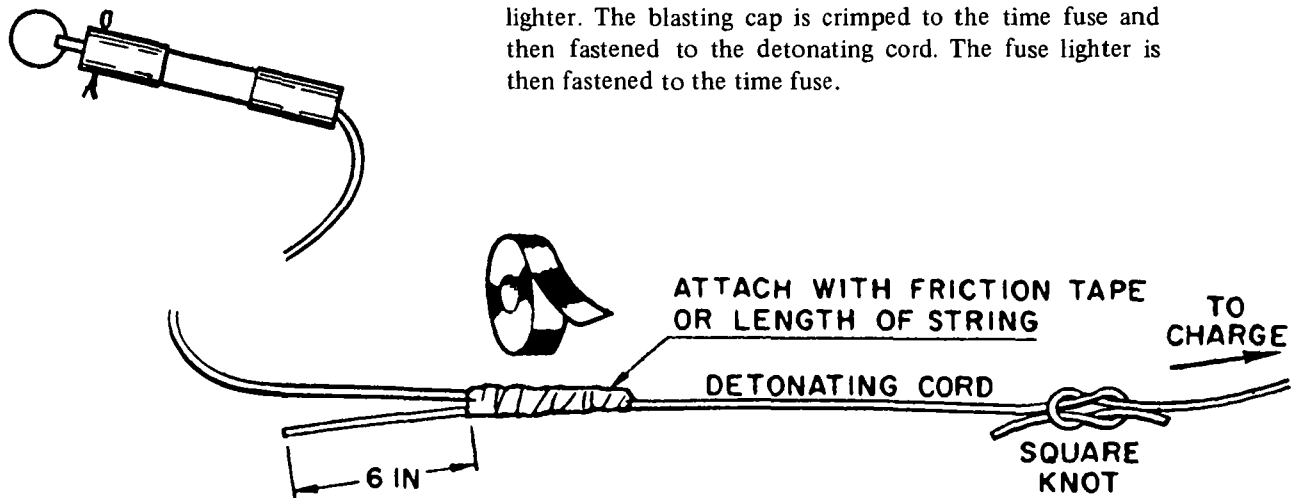
The galvanometer should be tested before using by holding a piece of metal across its two terminals. If this does not cause a wide deflection of the needle (23-25 units) the battery is weak and should be replaced. Remove the short circuit shunt from the lead wires of the electric blasting cap and touch one cap lead wire to one galvanometer post and the other cap lead wire to the other. If the instrument registers a flowing current (20-25 units), the blasting cap is all right; if not, the cap is defective and should not be used. **DURING THIS TEST ALWAYS POINT THE EXPLOSIVE END OF THE BLASTING CAP AWAY FROM THE BODY.**

If a priming adapter is not available, insert the electric cap (after testing with galvanometer) into the cap well and tie the lead wires around the block by two half hitches or a girth hitch as shown here.



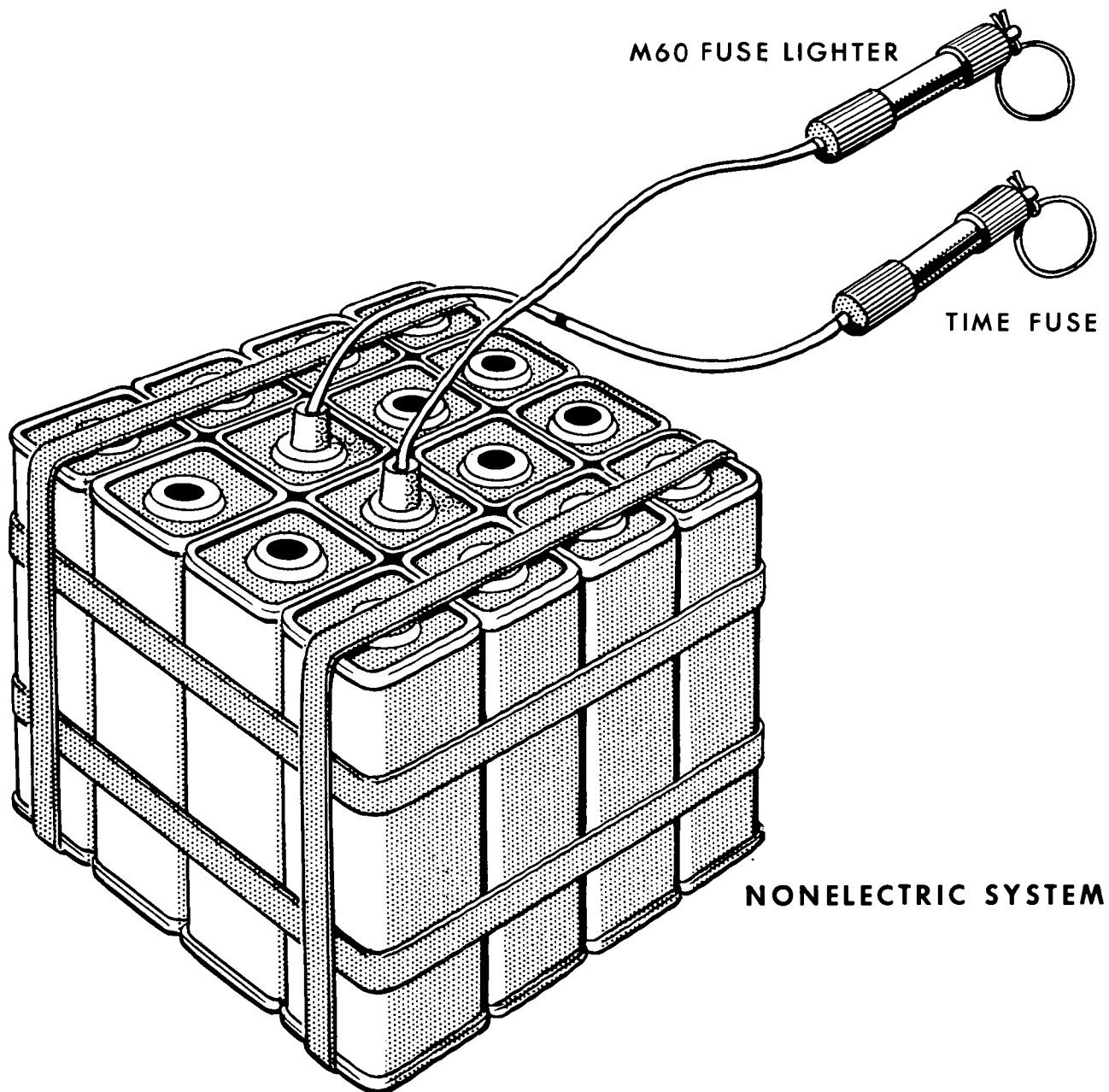
DETONATING ASSEMBLIES

A **NONELECTRIC DETONATING ASSEMBLY** consists of approximately 2 feet of detonating cord, a nonelectric blasting cap, the desired length of time fuse, and a fuse lighter. The blasting cap is crimped to the time fuse and then fastened to the detonating cord. The fuse lighter is then fastened to the time fuse.



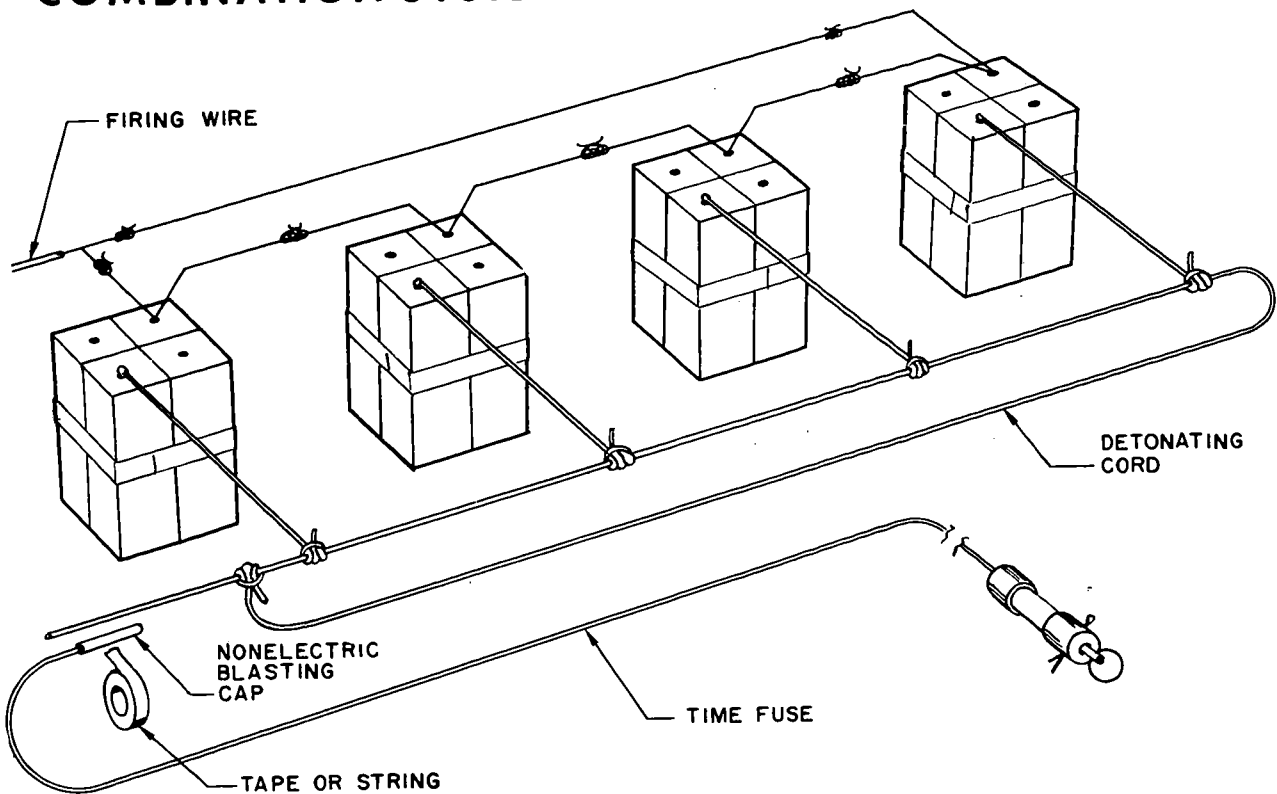
The **ELECTRIC DETONATING ASSEMBLY** is approximately 2 feet of detonating cord with an electric blasting cap attached. The free end of the detonating cord is fastened to the main line by a clip, or as shown here by a square knot.

DUAL FIRING SYSTEMS

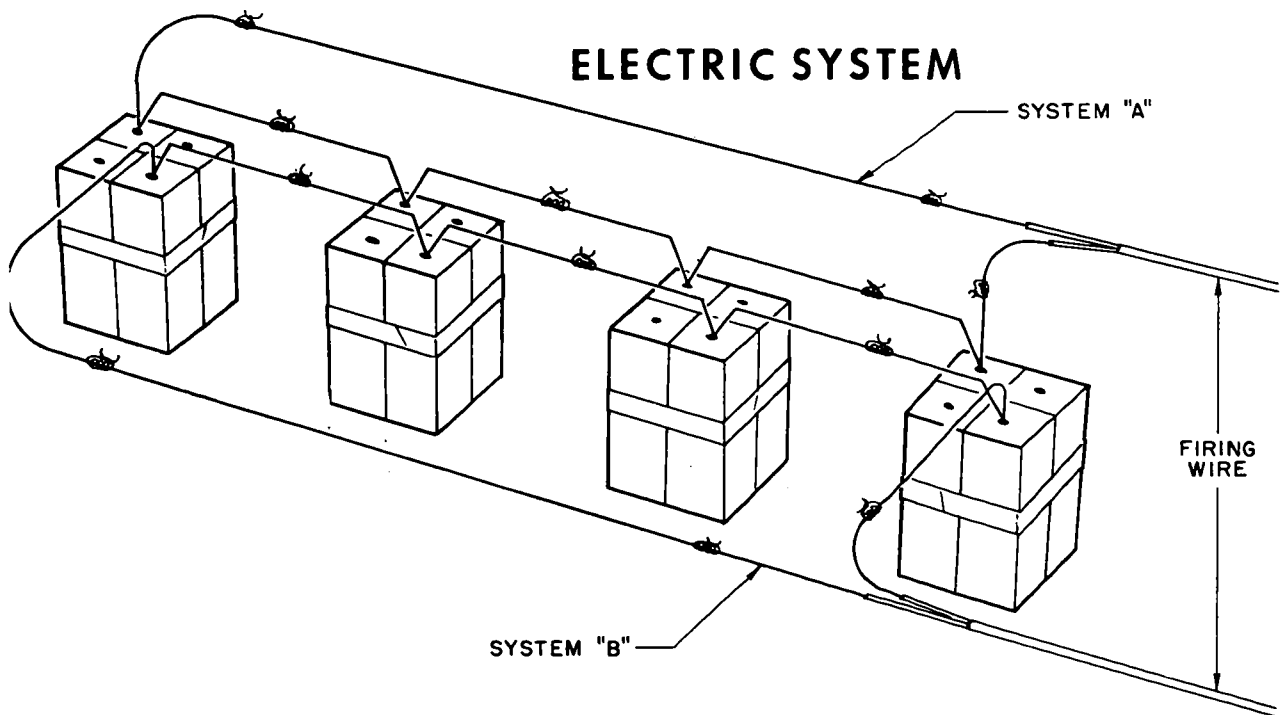


A **DUAL FIRING SYSTEM** increases the probability of successful firing, and should be used whenever time and materials are available. It may consist of two electric systems, two nonelectric systems, or one of each. The systems must be independent of each other and capable of firing the same charge.

COMBINATION SYSTEM

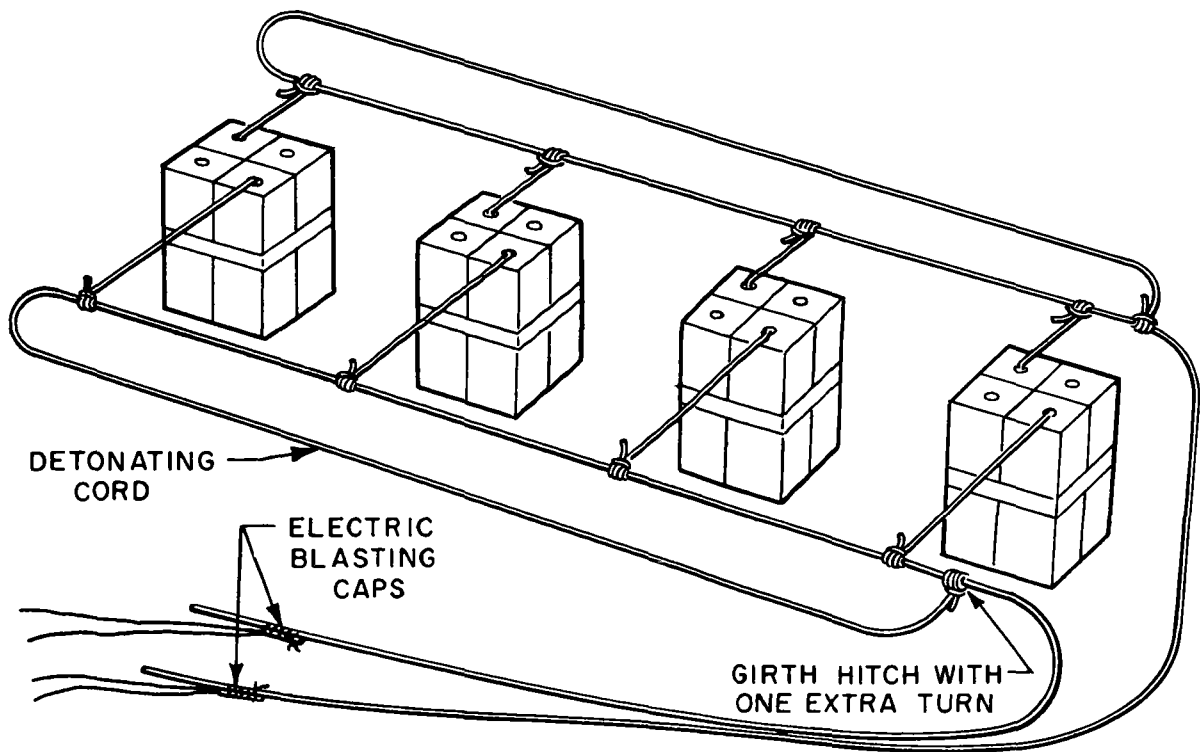


ELECTRIC SYSTEM



RING MAIN CONNECTION

A **RING MAIN CONNECTION** is made by bringing the main line back in the form of a loop and attaching it to itself with a girth hitch and one extra turn. If of sufficient length, this will detonate an almost unlimited number of charges. The ring main makes the detonation of all charges more positive because the detonating wave approaches the branch lines from both directions and the charges will be detonated even when there is one break in the ring main.



Branch lines coming from a ring main should be at a 90-degree angle. Kinks in lines should be avoided, and curves and angles should be gentle. A branch line is never connected at a point where the main line is spliced. When making branch line connections avoid crossing lines or be sure that the cords are at least a foot apart in places where they cross or they will cut each other and possibly destroy the firing system.

SAFETY PRECAUTIONS

- Do not smoke while handling explosives, nor handle explosives near open lights, fires, or stoves.
- Do not handle or keep explosives in or near places where there are large groups of people.
- Do not leave explosives in the open where they may be stolen, tripped over, or where animals can get to them.
- Do not leave explosives in wet or damp places; keep them locked in a dry place.
- Do not keep or transport caps near explosives.
- Do not carry caps in your pockets; keep them in their box until time to use.
- Do not pull on wires of an electric cap.
- Do not crimp caps with anything except issue cap crimpers.
- Do not tamp with iron or steel bars or tools; use only a blunt wooden tamping stick.
- Do not force primer into drilled hole; make hole big enough.
- Do not cut fuse too short; explosion may occur before safe distance can be reached. Test the burning rate of time fuse before using.
- Do not risk a misfire by using wrong size cap; use proper cap for explosive being used.
- Do not connect firing wires to blasting machine until ready to fire charge.
- Do not use old, leaking, or frozen dynamite.
- Do not leave explosives or caps exposed to direct sunlight.
- Do not prime or connect charges for electric firing during thunderstorm.
- Do not use an electric firing system within range of power transmitter.
- Do not use any battery except BA 245/V in the galvanometer.
- Do not make sharp bends or twist time fuse and detonating cord.
- Do not fire a charge until everyone is out of danger.
- Do not investigate a nonelectric misfire until 30 minutes past the expected time of detonation.
- DO NOT FORGET THAT EXPLOSIVES ARE ALWAYS DANGEROUS.**

PART EIGHT

LAND MINE WARFARE

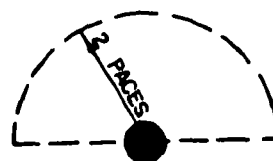


A **MINE** is an explosive or other material normally encased, designed to destroy or damage vehicles, boats, or aircraft, or to wound, kill, or otherwise incapacitate personnel. It may be detonated by the action of its victim, by a time fuse, or by controlled actions. There are two general types—antipersonnel and antitank.

A mine cluster is the unit of mine laying

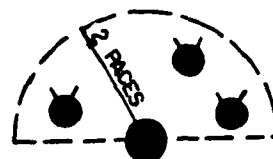
**A CLUSTER MAY CONSIST OF
ONE ANTITANK MINE**

OR



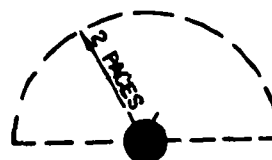
**ONE ANTITANK MINE AND NOT
MORE THAN FOUR ANTIPER-
SONNEL MINES WITHIN A
2-PACE SEMICIRCLE FROM THE
ANTITANK MINE**

OR

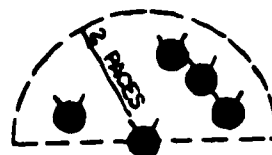


**ONE READILY DETECTABLE
ANTIPERSONNEL MINE**

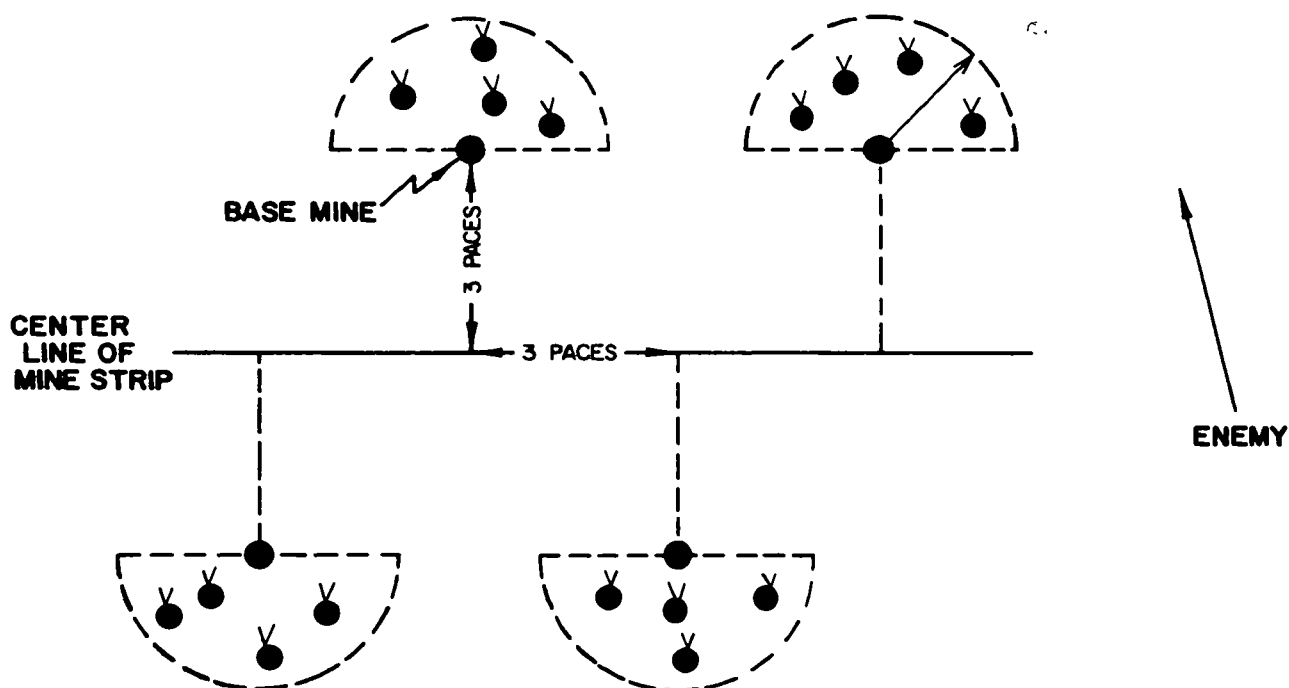
OR



**NOT MORE THAN FOUR ANTI-
PERSONNEL MINES WITHIN A
2-PACE SEMICIRCLE OF THE
BASE ANTIPERSONNEL MINE**

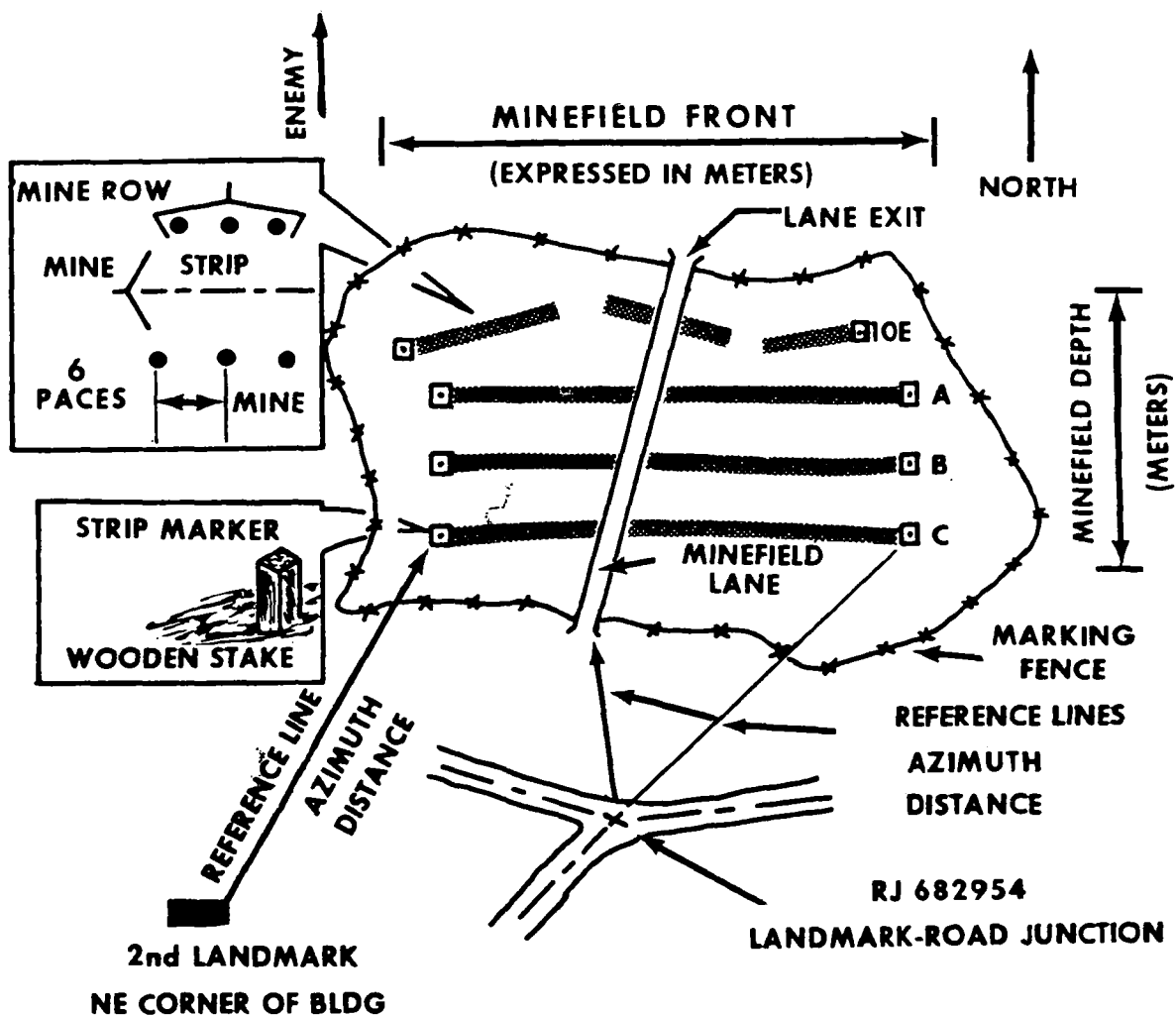


A mine row is a single row of clusters laid in a generally straight line.

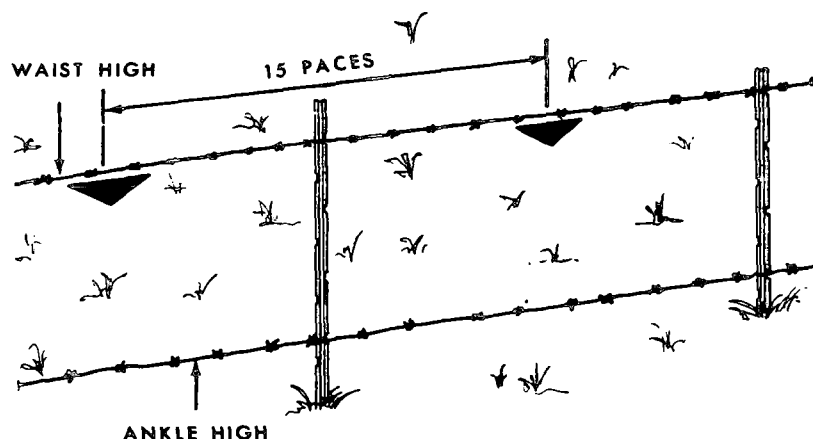


A mine strip is two parallel mine rows laid six paces, or meters, apart. The clusters in opposing rows are staggered evenly, as shown here.

A minefield is an area of ground containing mines laid in a standard pattern as shown here or in a scattered fashion in which no organized system of placement is recognized. The standard pattern consists of an irregular outer edge and a minimum of three complete mine strips.



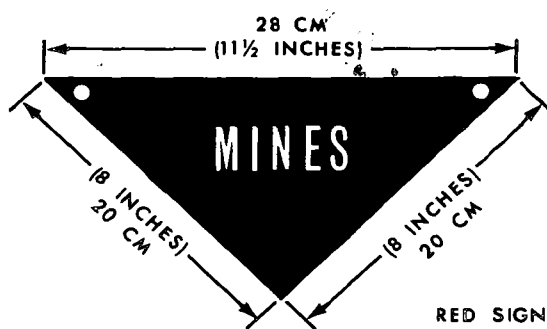
FENCING AND MARKING



A rear-area minefield must be completely fenced with two strands of barbed wire at the time of laying. The fence does not follow the exact boundary of the field, but is placed so as to avoid indicating the exact boundary. In no case should it be placed less than 20 paces from the nearest mine.

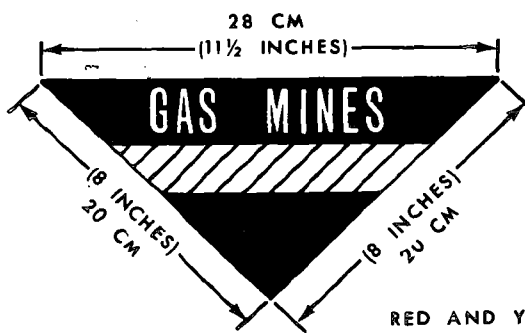
Sometimes, forward area minefields are fenced only on the friendly (rear) side or on the friendly side and flanks if necessary to protect friendly troops. Forward area minefields laid out of contact with the enemy may be completely inclosed, but part of the fencing is to be removed before the enemy approaches them.

Standard marking signs are hung on the upper strand so that the word "mines" faces away from the field. For minefields containing chemical mines, standard chemical mine marking signs are used. When chemical mines are mixed with other type mines in a field, both signs, "mines" and "gas mines" are hung closely together.



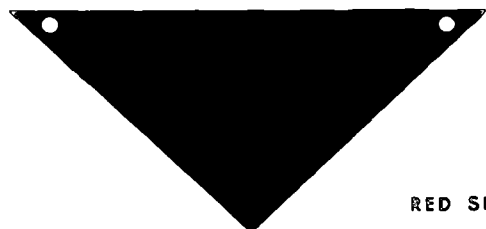
RED SIGN WITH
WHITE LETTERS

FRONT



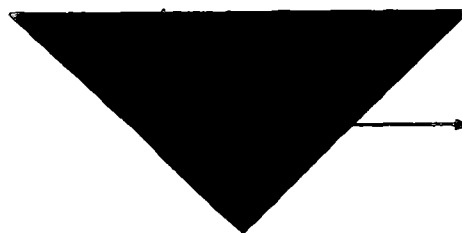
RED AND YELLOW SIGN
WITH YELLOW LETTERS

FRONT



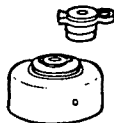

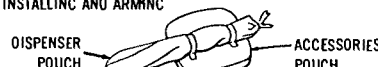
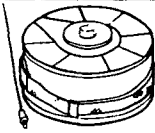
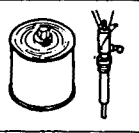


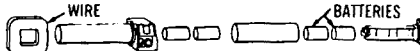
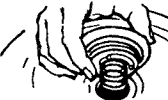
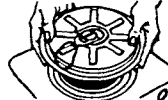





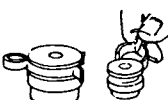
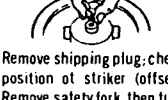
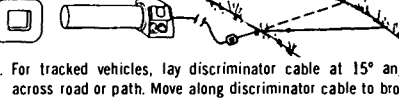
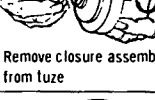


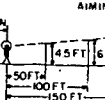
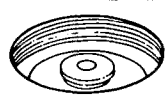

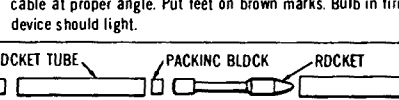
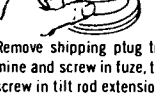
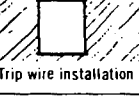




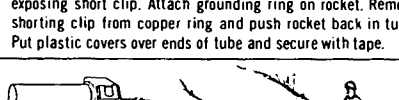

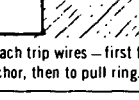
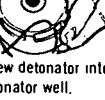
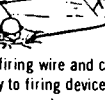

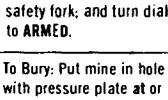
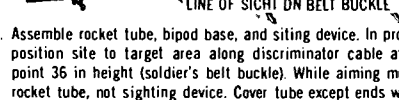
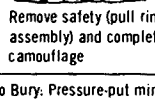
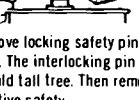
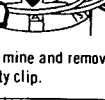
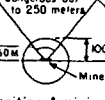
RED SIGN

REAR



DATE
AGENT

REAR

METALLIC M15 HEAVY ANTITANK MINE		M19 PLASTIC HEAVY ANTITANK MINE		GTA 5-10-10 MINE CARD (Supersedes GTA-10-10, July, 1965)		M21 METALLIC (KILLER) ANTITANK MINE		M16 SERIES BOUNDING ANTIPERSONNEL MINES		M14 BLAST ANTIPERSONNEL MINE		M18A1 FRAGMENTATION ANTIPERSONNEL MINE	
				M24 OFF-ROUTE ANTITANK MINE INSTALLING AND ARMING 									
M15 Wt. 30 lb. Expl. 22 lb. Fuze M603 Secondary fuze wells .. 2 Functioning .. 300 to 400 lb. press.		Wt. 28 lb. Explosive 21 lb. Fuze M606 integral with pressure plate Secondary fuze wells .. 2 Functioning .. 350 to 500 lb. press.		 1. Remove discriminator cable, firing device, and batteries from dispenser pouch. Unscrew tube from firing device, insert batteries, and replace tube.		Wt. 18 lb. Explosive 10.5 lb. Functioning .. 290 lb. pressure on pressure ring or 20° deflection of tilt rod		Wt. 8.25 lb. Projectiles Steel Fuze M605 Combination Functioning: Pressure 8 to 20 lb. Pull 3 to 10 lb.		Wt. 3 1/4 oz. Explosive 1 oz. TETRYL Fuze 1 integral with Belleville Spring Functioning .. 20 to 35 lb.		Wt. 3.5 lb. Explosive 1.5 lb. C4 Projectiles 700 steel balls Equipment: One electric cap with 100 ft firing wires per mine. One circuit tester per 6 mines. One electric firing device per mine.	
				 2. For wheeled and tracked vehicles unreel discriminator cable, laying it across road or path perpendicular to edge. Connect firing device, field wire, and discriminator cable. Move along discriminator cable to brown marks (9 ft from reel) and put feet on brown marks. Bulb in firing device should light.									
				 3. For tracked vehicles, lay discriminator cable at 15° angle across road or path. Move along discriminator cable to brown marks (9 ft from reel) and align perpendicular to edge. Midway between marks count off 2 1/2 steps, heel to toe perpendicular to discriminator cable. Position discriminator cable at proper angle. Put feet on brown marks. Bulb in firing device should light.									
				 4. Remove rocket tube from dispenser pouch. Take wooden packing blocks from ends of tube. Push rocket through tube, exposing safety band. Remove safety band and push rocket back, exposing short clip. Attach grounding ring on rocket. Remove shorting clip from copper ring and push rocket back in tube. Put plastic covers over ends of tube and secure with tape.									
				 5. Assemble rocket tube, bipod base, and sighting device. In prone position site to target area along discriminator cable at a point 36 in height (soldier's belt buckle). While aiming move rocket tube, not sighting device. Cover tube except ends with dirt or other material and pack firmly in position. Sight again to be sure that rocket tube is properly aligned.									
				 6. Attach rocket cable to rocket and firing device. Arming switch should be in SAFE position. Turn switch to ARMED position.									
To Bury: Put mine in hole with pressure plate at or slightly above ground level.		Complete camouflage		Tilt Rod-mines should be seated firmly in snug-fitting hole. Effective in tall brush or grass.		To Bury: Pressure-put mine in hole with fuze cap flush with ground surface.		Mine bounds into air and explodes at height of 0.6 meters to 1.2 meters. Mine has a 10.6 meter casualty radius.		To Bury: Pressure plate should be slightly above ground level.		Firing position: A minimum of 16 meters from rear of mine to fox hole. Friendly troops at side and rear should be under cover at a minimum of 100 meters.	
To Disarm: Reverse arming procedure.		To Disarm: Reverse arming procedure.		To Disarm: Reverse arming procedure.		To Disarm: Reverse arming procedure.		To Disarm: Reverse arming procedure.		To Disarm: Insert safety clip and remove detonator. Caution: Do not turn pressure plate back to SAFE position as it causes excess wear.		To Fire: Disengage safety bail and depress handle. To Disarm: Reverse arming procedure.	

This card is a handy reference for the small unit commander while laying friendly mine fields or handling enemy or friendly mines.

PART NINE

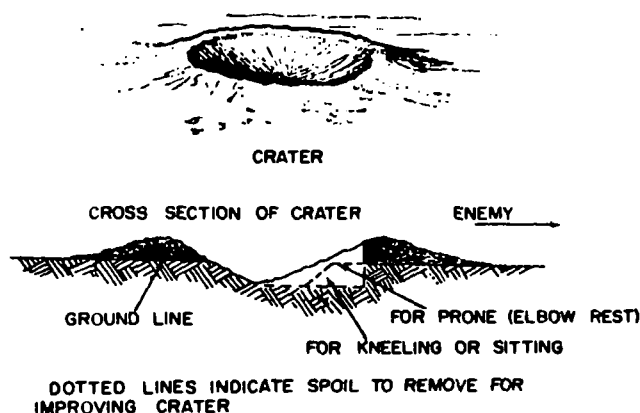
FIELD FORTIFICATIONS



Field fortifications are constructed by personnel of all arms and services. Hasty shelters and emplacements are normally constructed by the combat units occupying the position. Some engineer equipment and supervisory assistance is frequently required, however, to assist the combat units. Fortifications of a more complex character, such as trenches and field-works, may require construction by engineer troops.

HASTY EMPLACEMENTS

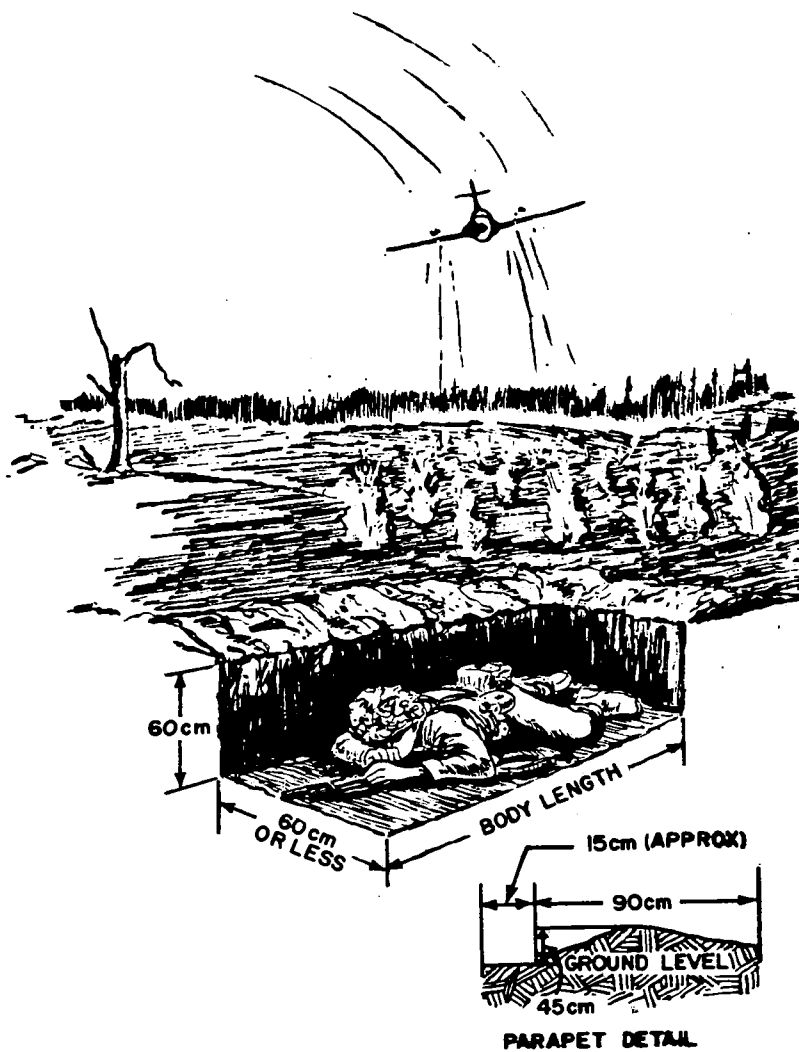
are dug by troops in contact with the enemy when time and materials are limited. They are good for a short time because they give some protection from direct fire. However, they must be developed into well prepared positions if the unit remains in the area and the situation permits.



A BOMB OR SHELL CRATER, 2 to 3 feet wide, offers immediate cover and concealment and can be made into a hasty position. By digging the crater to a steep face on the side toward the enemy, you can create a firing position. A small crater can be developed into a foxhole.

THE SKIRMISHER'S TRENCH is a shallow emplacement which provides a temporary, open, prone firing position. If immediate shelter from a heavy enemy fire is required and defiladed firing positions are not available, each soldier lies prone or on his side, scrapes the soil with his entrenching tool, and piles it in a low parapet between himself and the enemy. This way a shallow body-length pit can be dug quickly in all but the hardest ground. You will present a low silhouette in this emplacement and be protected to a limited extent from small arms fire. This can be developed into a foxhole or a prone emplacement.



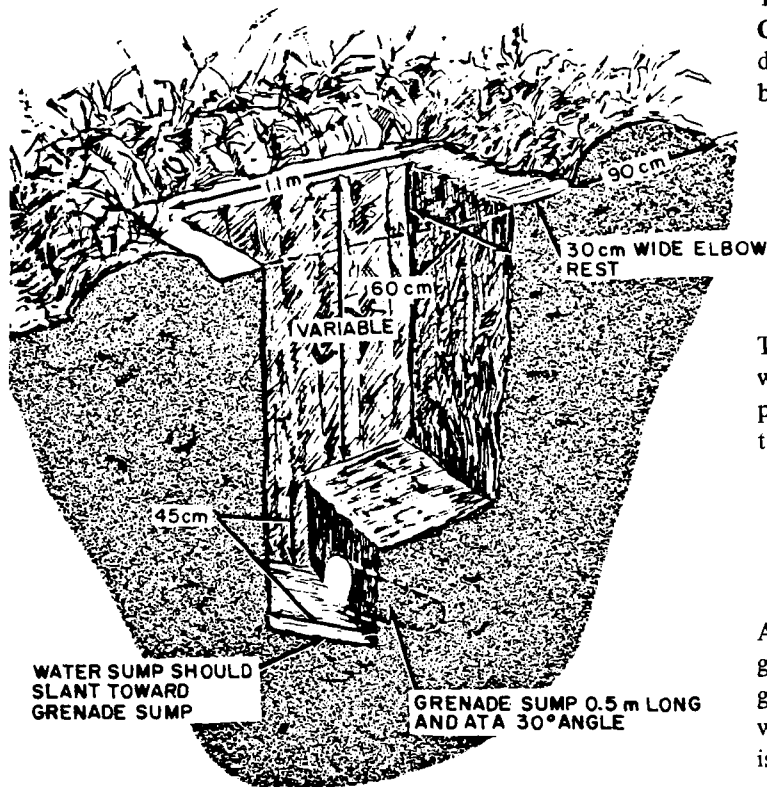


THE PRONE EMPLACEMENT serves as a good firing position for a rifleman and provides better protection against small arms or direct fire weapons than the improved crater or skirmisher's trench.

Limited protection can be provided by piling up rocks, chunks of ice, or packing snow. Icecrete, formed by mixing dirt and water, is very effective as an arctic building material. A minimum of 30 cm of this material will resist penetration of small arms fire.

FOX HOLES

are the individual rifleman's basic defensive position. They afford good protection against enemy small arms fire and can be developed from well chosen crater, skirmishers' trenches, or prone emplacements. They should be improved, when possible, by revetting the sides, adding expedient cover, providing drainage, and excavating a grenade sump to dispose of hand grenades tossed into the opening.

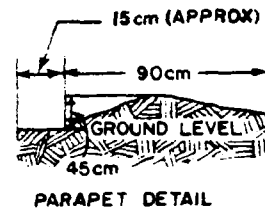


The overall dimensions and layout of the **ONE-MAN FOXHOLE** are shown here. The depth to the fire step depends on your height, but the average is 105 to 150 cm.

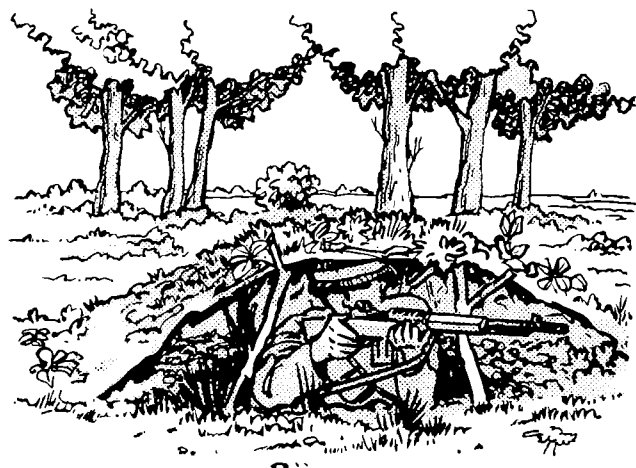
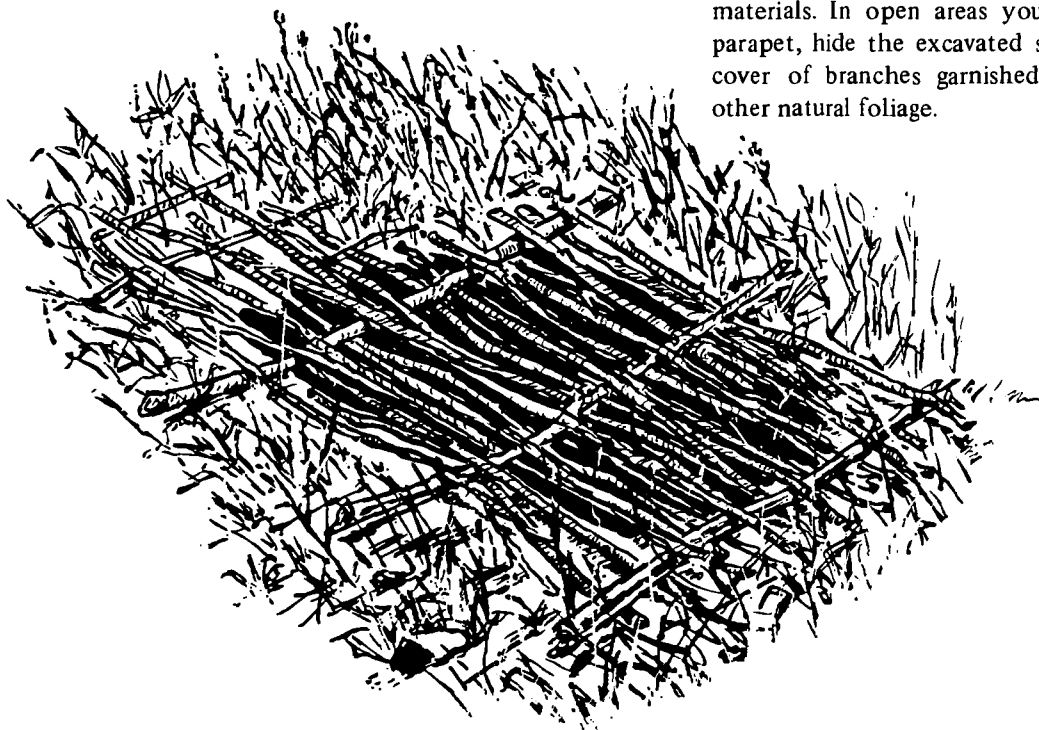
The water sump is dug at the rear end to collect water. One or two layers of large stones are placed at the bottom with smaller stones on top.

A grenade sump is excavated as illustrated. For good drainage and to assist in disposing of grenades, the fire step is sloped toward the water sump and the bottom of the water sump is funneled downward to the grenade sump.

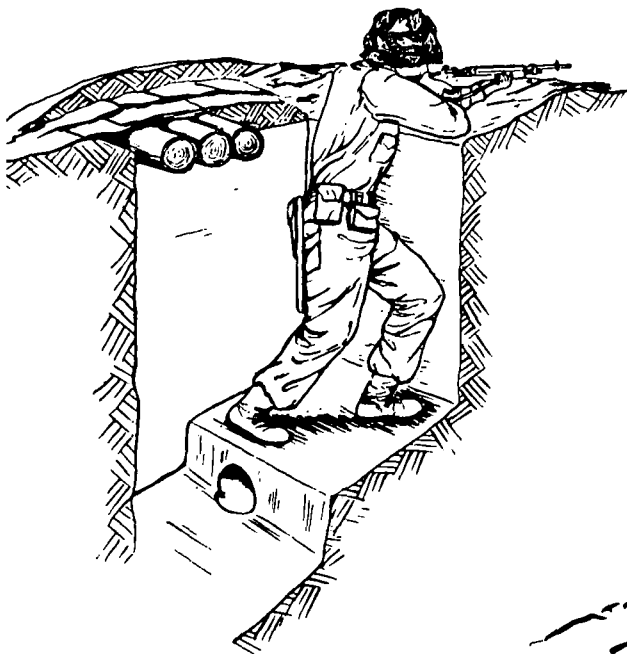
If excavated spoil is used as a parapet it should be placed all around the foxhole, leaving an elbow rest (berm) of original earth surface about 30 cm wide next to the hole. If sod or top soil is to be used for camouflage it should be set aside until the parapet is complete and then put back on top in a natural manner.



A foxhole can be camouflaged with natural materials. In open areas you might omit the parapet, hide the excavated spoil, and make a cover of branches garnished with grasses or other natural foliage.

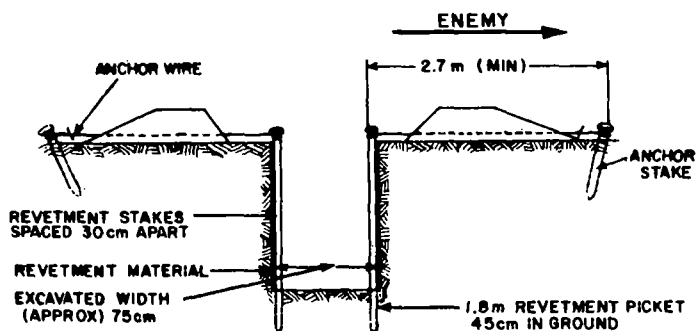
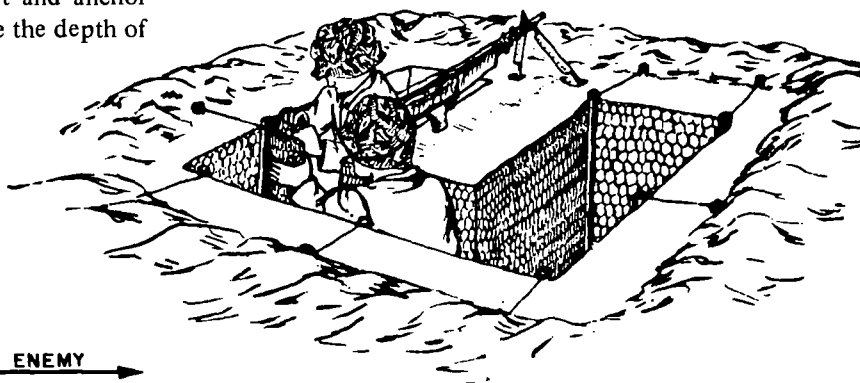


Or, the foxhole can be covered with a shelter-half, poncho, etc., and then covered with some natural material. You would, of course, raise one side to observe or fire.



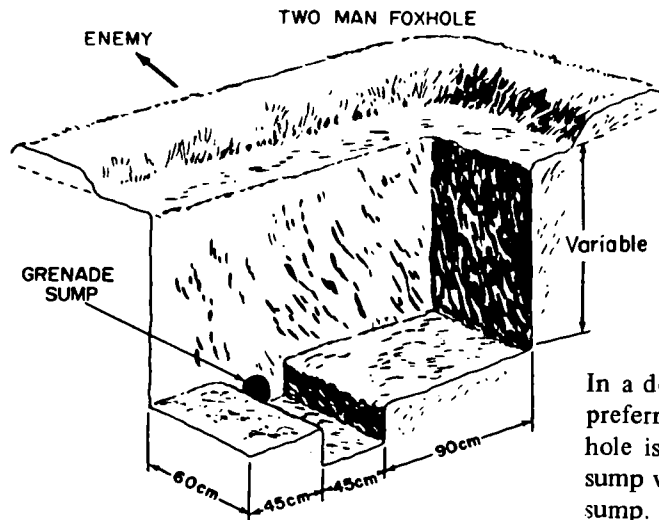
A half cover over a one-man foxhole protects and permits full use of weapons. Logs 10 to 15 cm in diameter about 1.2 meters long, support the earth cover. Dirt is removed on each side of the hole to make logs even with the ground surface. If the earth is soft, timbers are used for cover supports. This cover will support 30 to 45 cm of earth cover. Under the cover the walls of the hole should be strengthened with some revetment material to prevent a cave-in.

Metal or wood revetment stakes, 1.8 meters long, are spaced about 60 cm apart and driven into the ground 30 to 45 cm. They are held in place by anchor wire of barbed or 14 gauge wire attached to the anchor stakes. Five or six strands of it are stretched between the revetment and anchor stakes at ground level and tightened by twisting. The distance between the revetment and anchor stakes should be approximately twice the depth of the foxhole.



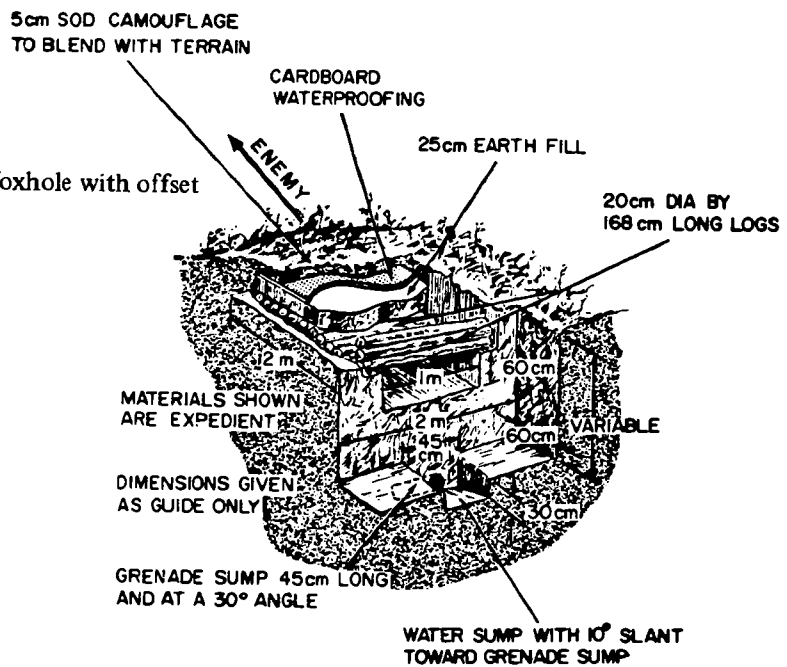
CHICKEN WIRE AND BURLAP

Whatever revetment material is used, it must be thin and tough enough to support the sides of the emplacement when staked.



In a defensive position the **TWO-MAN FOXHOLE** is preferred. It is built the same way the one-man foxhole is built except for the location of the grenade sump which is placed on the enemy side of the water sump.

This is one way to construct a two-man foxhole with offset on the enemy side.



SHELTERS

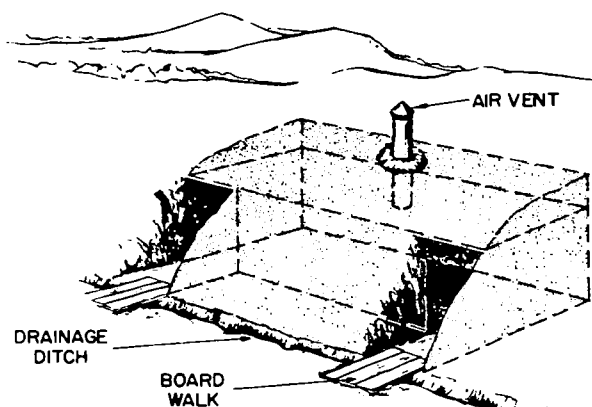
SHELTERS protect soldiers, equipment, and supplies. They differ from emplacements in that there are no provisions for firing weapons from them. However, they are constructed near or supplement the fighting positions.



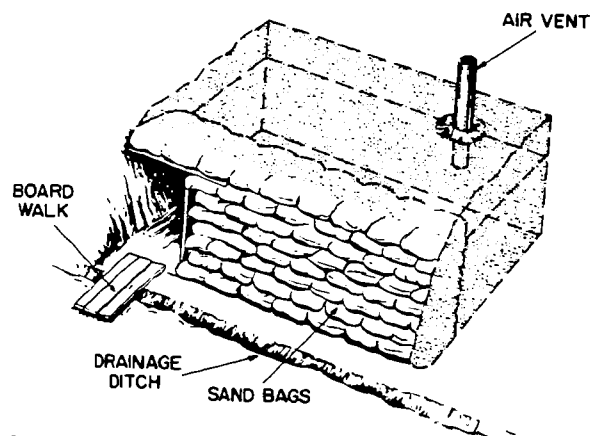
The **WIGWAM** is easy to build. Three men can use this and still have room for cooking. Lean about 25 evergreen saplings with their limbs left on against a small tree with their butt ends about 2 meters from the base of the tree. Trim the branches off inside the wigwam and bend them down on the outside. If you wrap shelter halves around the outside you will make it almost windproof.

The **TWO-MAN MOUNTAIN SHELTER** is good in wintry conditions. It is a hole 2 meters long, 1 meter wide, and 1 meter deep. Cover the hole with logs, then evergreen branches, a shelter half, and local topsoil or leaves, twigs, or snow. Entrances can be made at both ends if desired and you can dig a fire pit at one end.



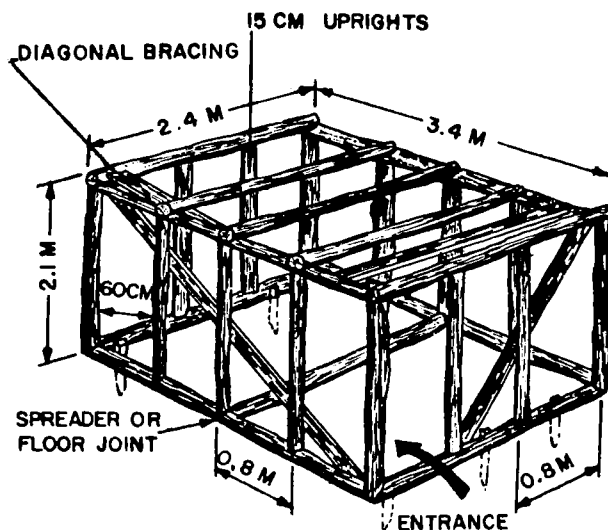


CUT-AND-COVER SHELTER IN A HILLSIDE (BAFFLE WALL OF ENTRANCE CAMOUFLAGE OMITTED) SHADED AREA AND BROKEN LINES SHOW CUT-AND-FILL SECTION.



CUT-AND-COVER SHELTER IN A CUT BANK SHOWING SAND-BAGGED OUTER WALL. SHADED AREA AND BROKEN LINES SHOW AREA OF CUT-AND-FILL.

The best location for this **CUT AND COVER SHELTER** is on the reverse slope of a hill, mountain, ridge, or steep bank.



Size of timber (diameter)		Maximum span when used to support 45 cm of earth
10 cm (4 in.)	.....	1.2 m (4 feet)
12.5 cm (5 in.)	.....	2.0 m (5 feet)
15 cm (6 in.)	.....	2.1 m (7 feet)
17.5 cm (7 in.)	.....	2.7 m (9 feet)
20.0 cm (8 in.)	.....	3.3 m (11 feet)
22.5 cm (9 in.)	.....	3.9 m (13 feet)

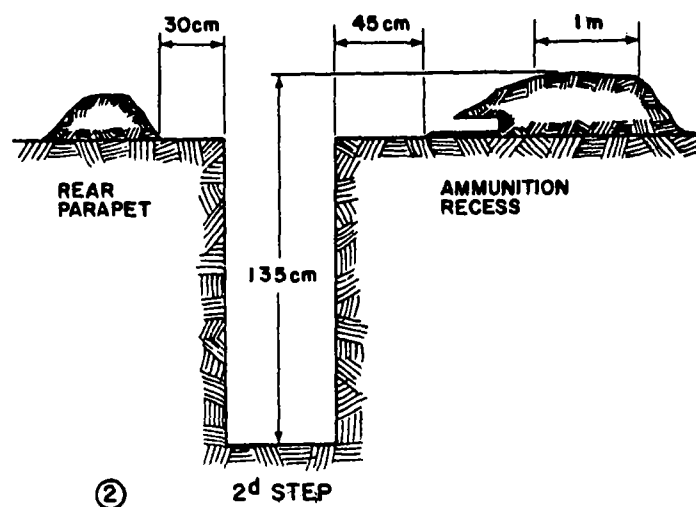
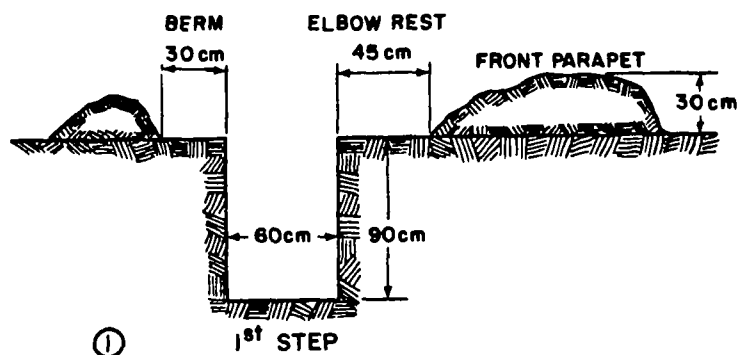
Build this shelter frame inside the excavation. Then lay a roof of planks, sheet metal, or other material over the roof supports and perpendicular to them to hold the spoil that is backfilled around and over the frame to ground level, or somewhat above, and camouflaged. The table shows the size of the roof supports required to hold a minimum of 45 cm of earth.

TRENCHES

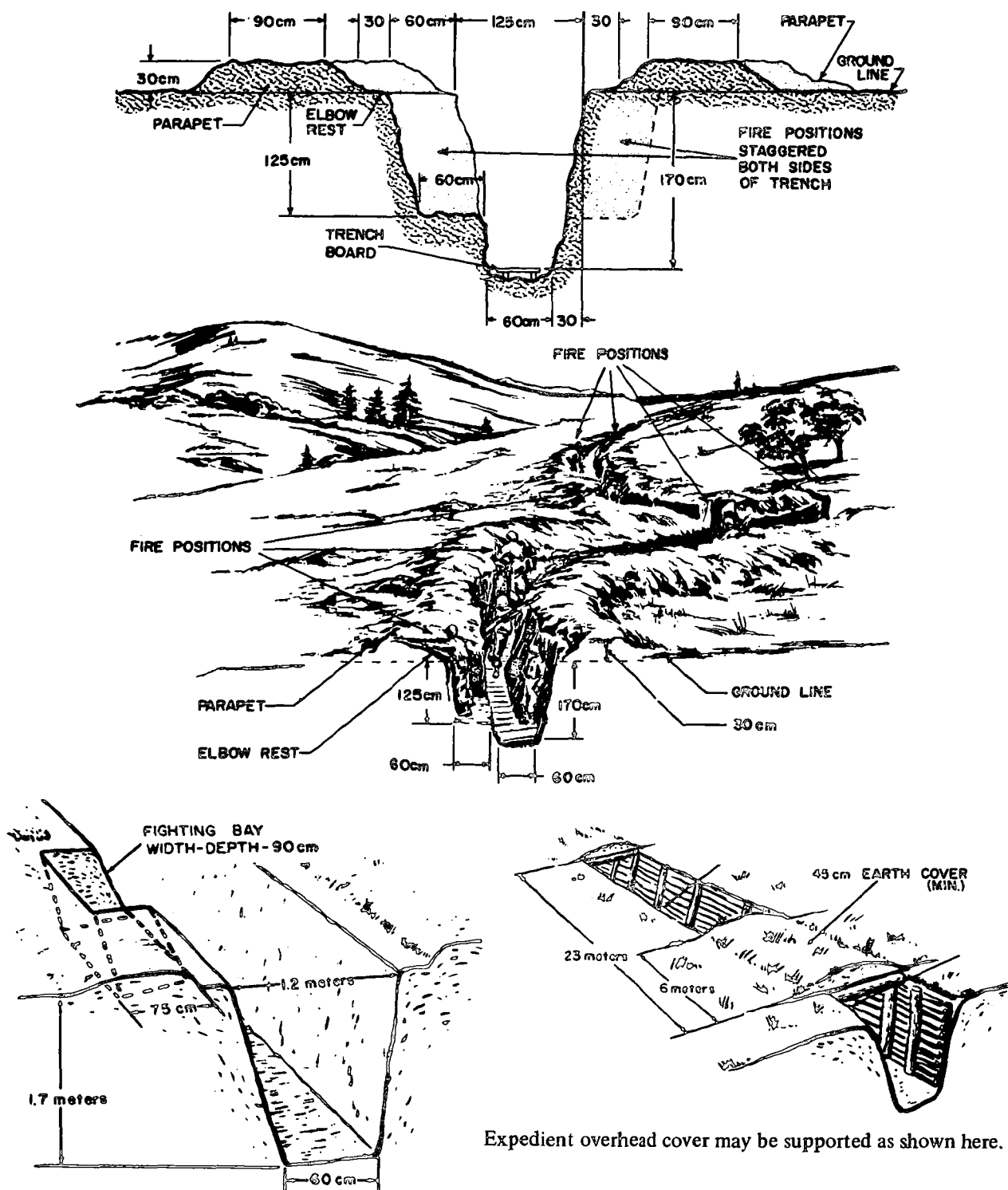
TRENCHES are excavated to connect individual foxholes, weapons emplacements, and shelters in the progressive development of a defensive area.

CRAWL TRENCHES are used to conceal movement into or within a position and to provide a minimum of protection. They should be 60 to 75 cm deep and about 60 cm wide and zigzagged or winding. The spoil can be thrown up into parapets on each side, however, if the trench runs across a forward slope, it is better to throw all the spoil on the enemy side.

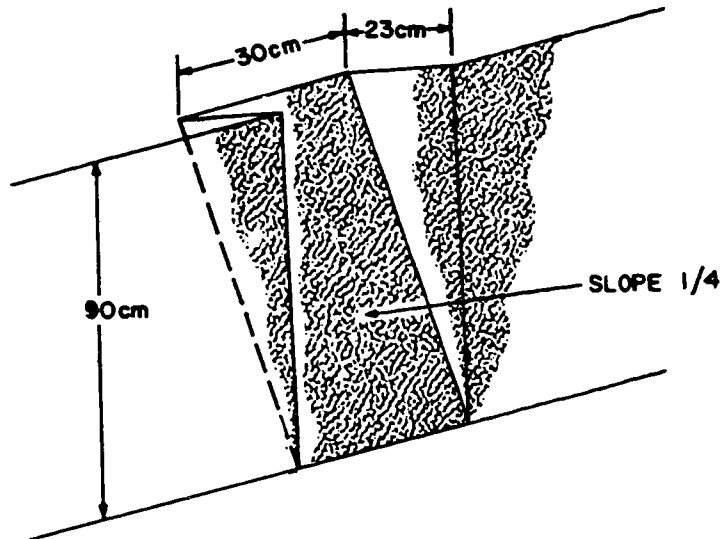
When developing a **FIGHTING TRENCH SYSTEM** the outline of the trench is marked on the ground if time permits. If the digging is to be done at night the outline can be taped. Each 2 meter segment of trench is dug by 2 men working in the same direction.



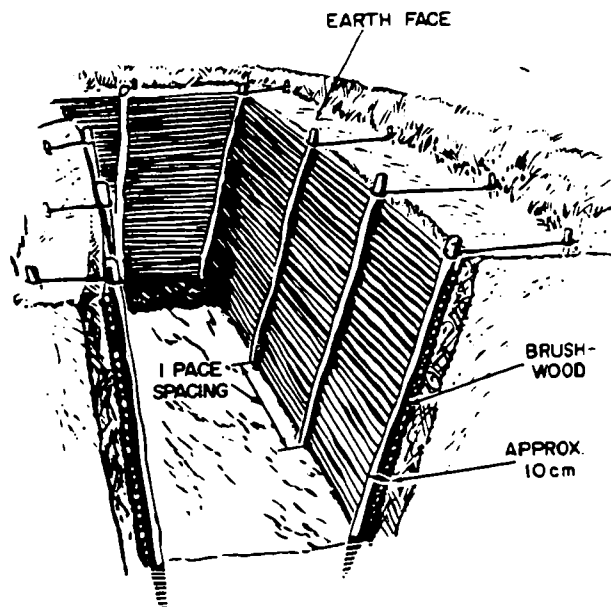
The **STANDARD TRENCH** is developed from the fighting trench by lowering it to a depth of 1.7 meters. It may be constructed with fighting bays or with a fighting step. This trench provides more protection than the fighting trench because of its depth.



Expedient overhead cover may be supported as shown here.

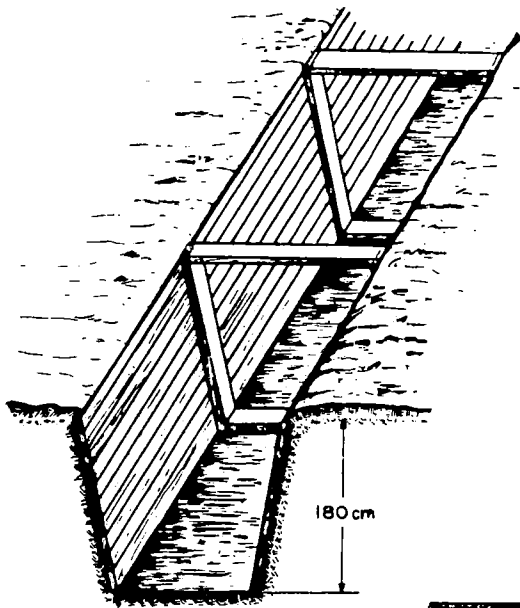


The necessity for revetment may be avoided sometimes by sloping the walls 1:3 or 1:4 in most soils.

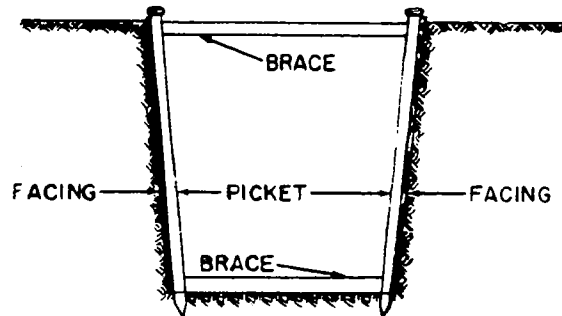


If a revetment is needed, a facing type may be constructed of brushwood hurdles, continuous brush, pole and dimensioned timbers, corrugated metal, or burlap and chicken wire. Here is a continuous brush revetment.

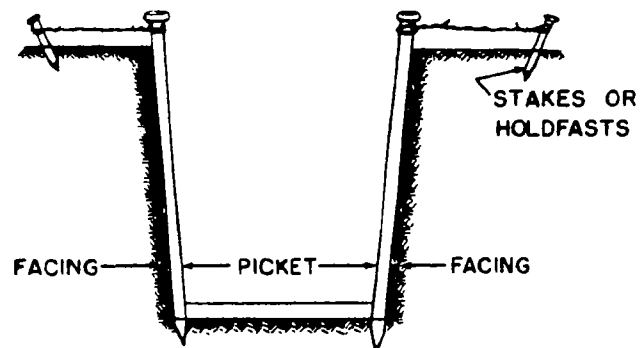
These revetments can be supported by ...

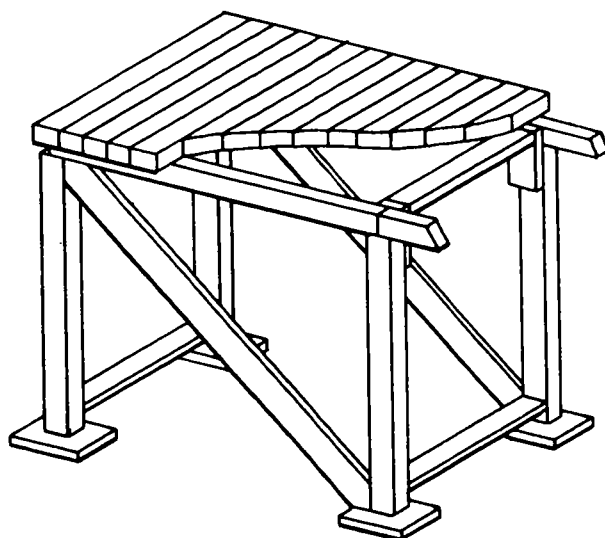
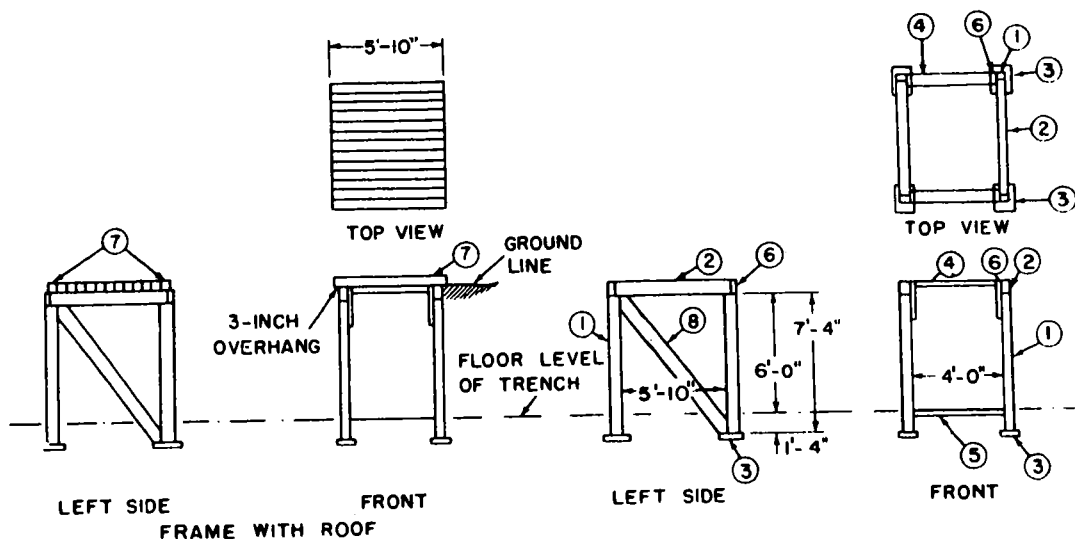


FRAMES

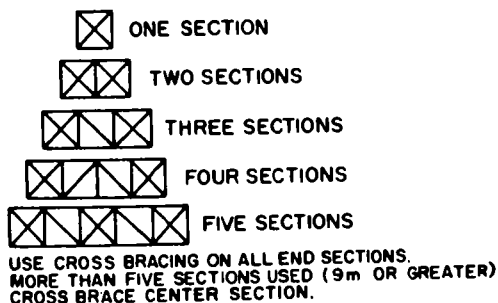


OR PICKETS





TYPICAL TRENCH COVER SECTION



FRAMING DETAILS

No.	Nomenclature	Size	Basic section as shown	Additional sections when used in series
1	Post	8" x 8" x 7' - 4"	4	2
2	Cap	8" x 10" x 6' - 2"	2	2
3	Footing	2" x 8" x 1' - 4"	16	8
4	Top spreader	3" x 8" x 3' - 6"	2	1
5	Bottom spreader	3" x 8" x 4' - 0"	2	1
6	Scab	3" x 8" x 2' - 0"	4	2
7	Stringer*	6" x 8" x 5' - 10"	13	13
8	Bracing	3" x 8" x 9' - 6"	2**	2**
9	Driftpin	3/4" x 16"	8	4
10	Driftpin	1/2" x 12"	26	24
11	Nails	60d	20 lb	15 lb

* Laminated wood roof, designed in accordance with table VI may be substituted if desired.

** Change to 4 when cross bracing is required. See bracing details.

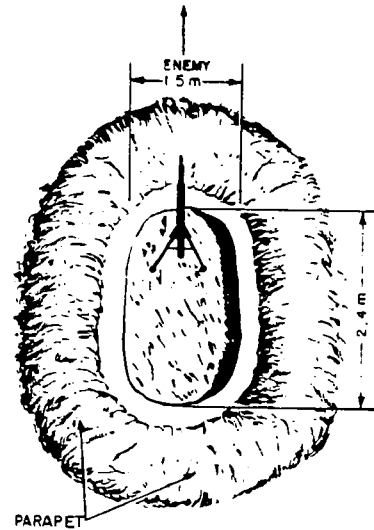
Suggested Construction Procedure

1. Dig holes for footers.
2. Place footers in holes making them as level as possible.
3. Nail posts to footers.
4. Place caps on top of posts and secure with driftpins (bore 1/2 inch holes for pins).
5. Nail scabs in place.
6. Nail top and bottom spreaders in place.
7. Nail side braces in place.
8. Put stringers on top of caps and secure with 1/2 inch driftpins.

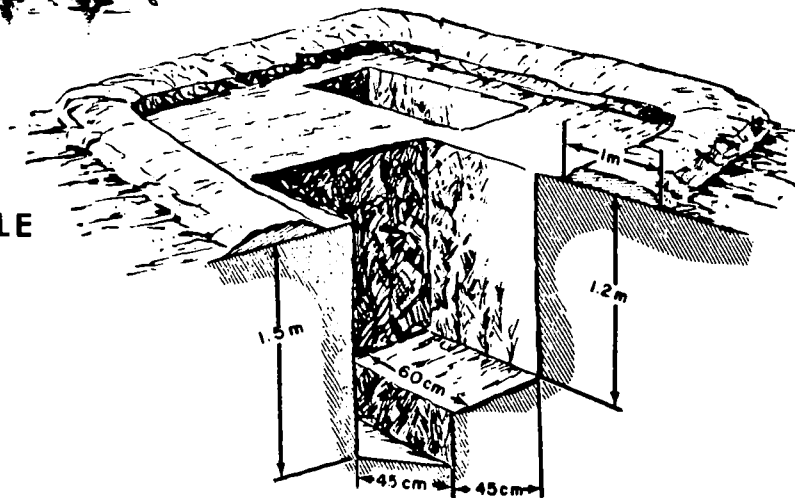
If heavy overhead cover is used it is installed in 6-12 meter sections. Support for such cover is provided by post, cap, and stringer construction dimensioned timber. Bill of materials is shown above.

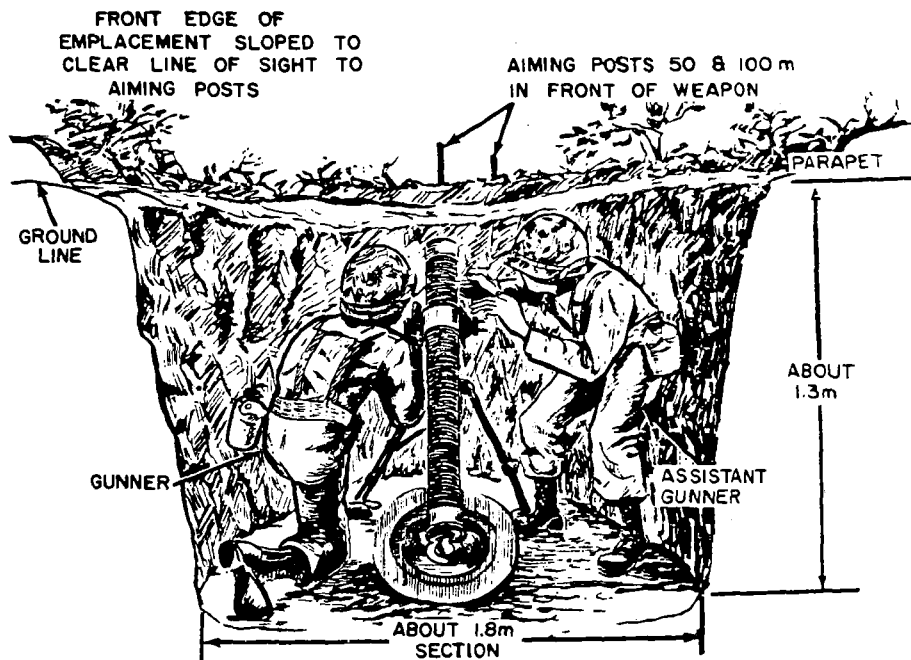
CREW SERVED WEAPONS EMPLACEMENTS

PLAN VIEW OF A MACHINE-GUN
EMPLACEMENT (PIT TYPE)



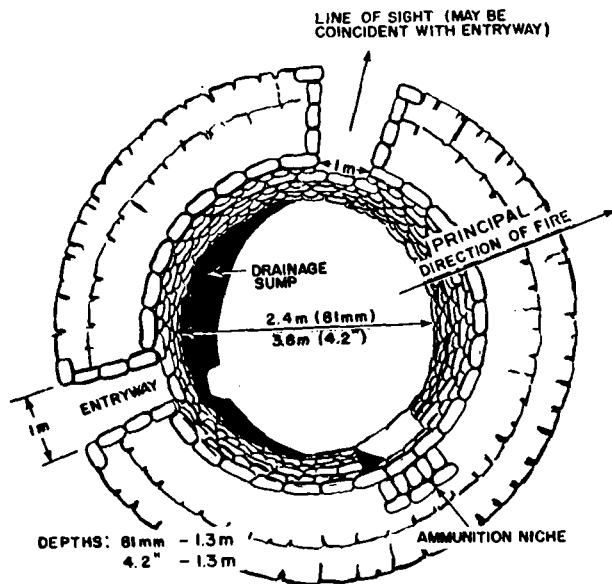
TWO ONE-MAN FOXHOLE
TYPE MACHINE GUN
EMPLACEMENT



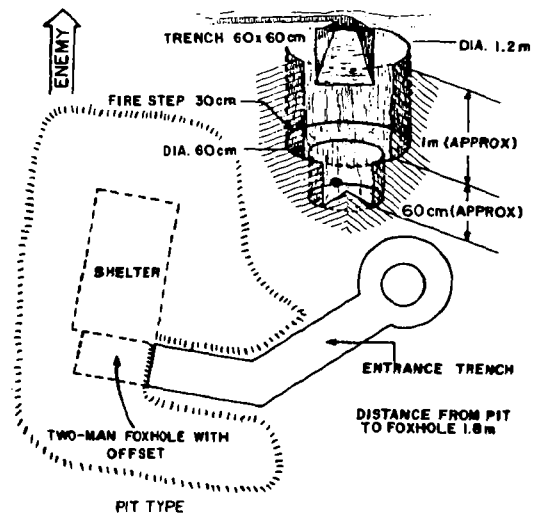


PIT TYPE

MORTAR EMPLACEMENTS



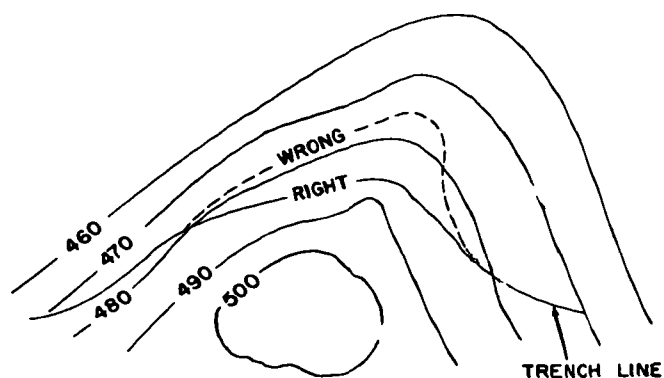
CIRCULAR



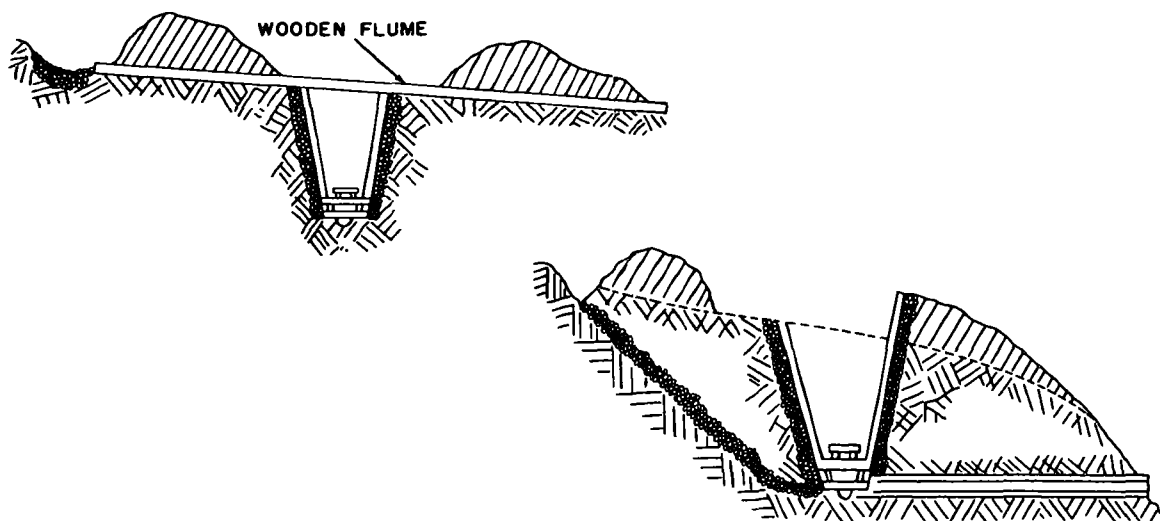
PIT TYPE EMPLACEMENT FOR
90 MM RECOILLESS RIFLE

DRAINAGE

Siting of emplacements, shelters, and trenches should take advantage of the natural drainage pattern of the ground.



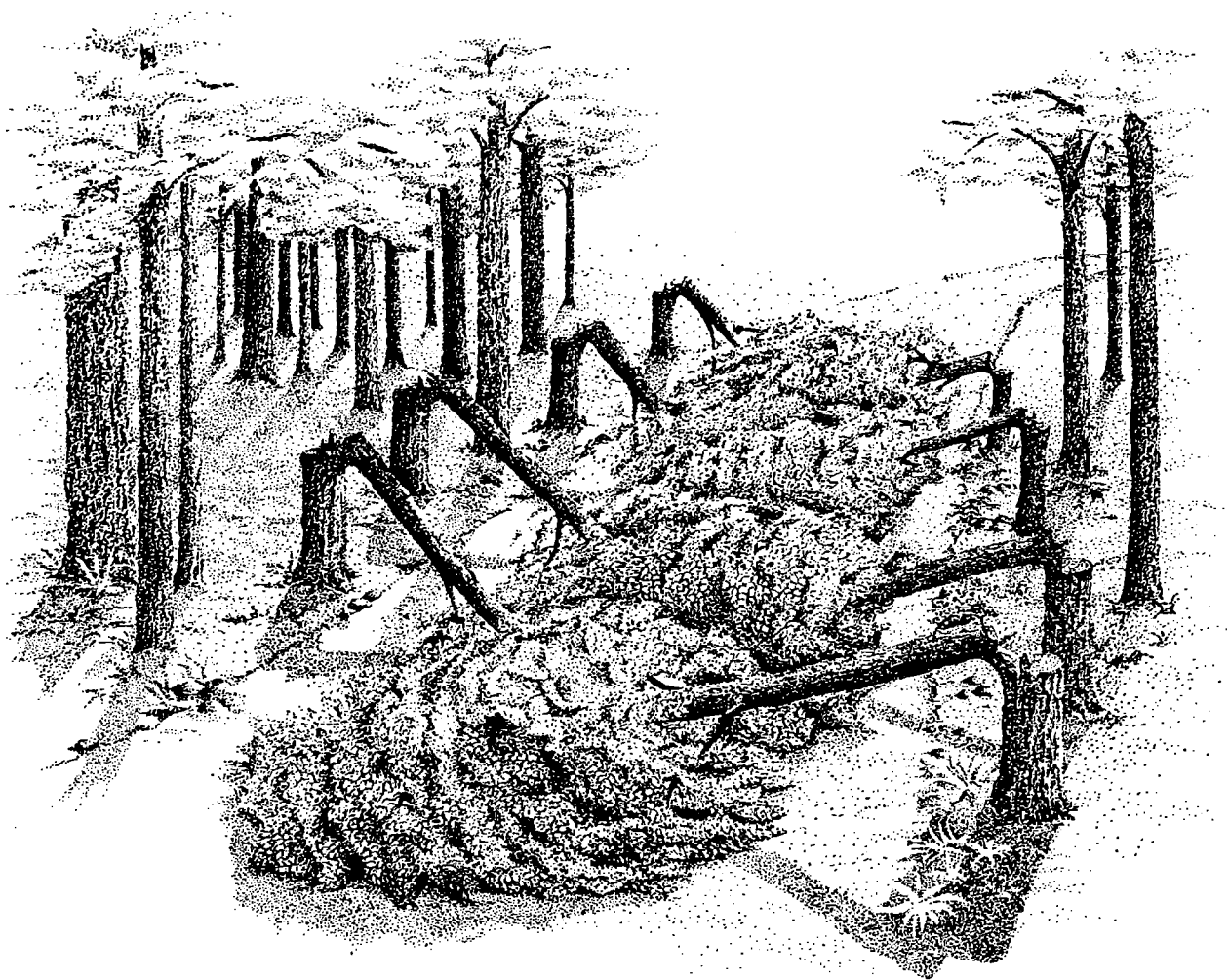
This siting will lessen the problem of excessive runoff.



If it is not possible to direct water to natural drainage lines the water can be carried across the trench through open flumes or under the trench through a combination of trench drains and culverts.

PART TEN

OBSTACLES



ARTIFICIAL OBSTACLES are used together with natural obstacles and usually in combinations of two or more types of artificial obstacles. Obstacles can be used to provide security, to delay the enemy, and to break up an enemy attack formation to canalize it into areas where it is blocked.

FIELDS OF FIRE

When a unit is in contact with the enemy there is very little opportunity to clear fields of fire. Riflemen and weapons crews select at such a time the best natural positions available. However, when preparing defensive positions for expected contact with the enemy, fields of fire can be cleared in front of each position. There are several rules to follow.

Excess or careless clearing will disclose the firing positions.

In areas organized for close defense, clearing should start near the position and work forward at least 100 meters or to the greatest effective range of the weapon, if time permits.

A thin natural screen of vegetation should be left to hide the defensive positions.

Remove the lower branches of large scattered trees in sparsely wooded areas.

In heavy woods, fields of fire may be neither possible nor desirable. Restrict work to thinning the undergrowth and removing the low branches from large trees.

Clear narrow lanes of fire for automatic weapons.

Thin or remove dense brush since it never acts as a suitable obstacle and obstructs the field of fire.

Cut weeds when they obstruct the view from the firing position.

Remove brush, weeds, and limbs that have been cut to other areas where they cannot be used to conceal enemy movements or disclose the position.



ORIGINAL GROWTH



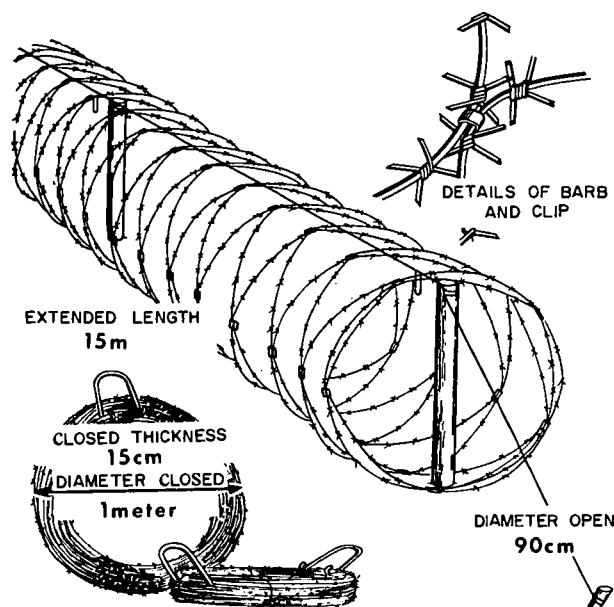
IMPROPER CLEARING



PROPER CLEARING

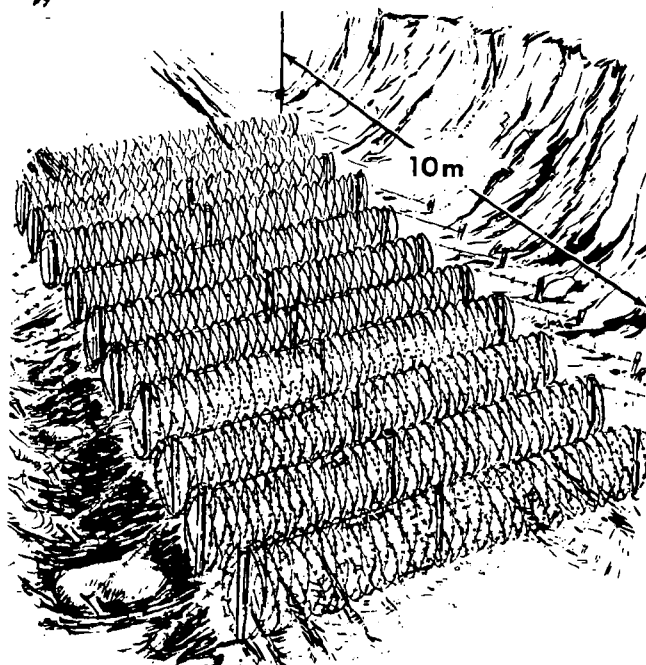
BARBED WIRE ENTANGLEMENTS

are designed to impede foot troops and in some cases tracked and wheeled vehicles.



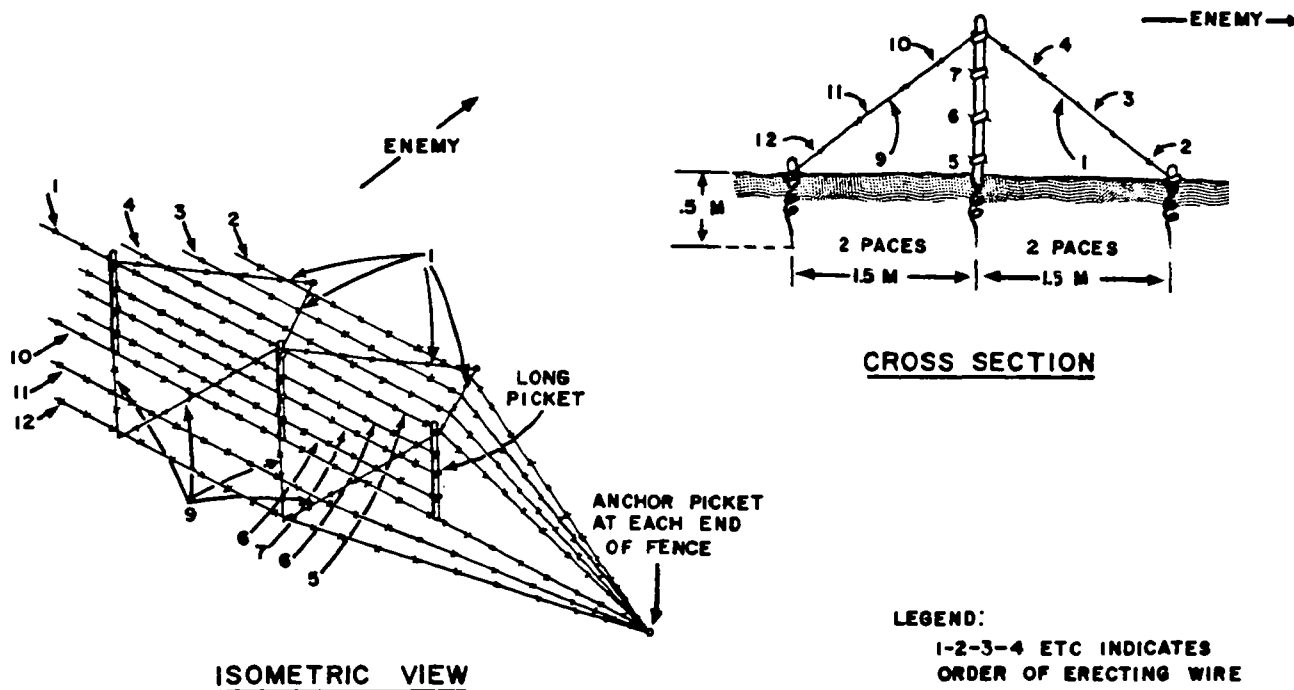
The **STANDARD BARBED WIRE CONCERTINA** is a roll of single strand wire with 4-point barbs at every 5 cm. When opening the concertina the wire bindings are removed and twisted around the carrying handle so that they can be reused. Four men open a concertina to its 15 meter length, one at each end and the other two along the length to see that it opens evenly. Two men can do it by bouncing it on the ground to prevent snagging.

When used as a roadblock, a series of these rolls are placed in a 10-meter depth. The ends of adjacent coils are wired together and the obstacle is lightly anchored at the sides of the road. This should be sited to achieve surprise and have no bypass. This will stop wheeled vehicles.



DOUBLE APRON FENCE

There are two types of **DOUBLE APRON FENCE**, the 4- and 2-pace and the 6- and 3-pace. The 4- and 2-pace is the better obstacle and more often used. In this fence the center pickets are 4 paces apart and the anchor pickets are 2 paces from the line of the center pickets and opposite the midpoint of the space between center pickets.



There are two operations in building a double apron fence—laying out and installing pickets and installing the wire. A platoon is normally assigned to build a 300-meter section.

One squad lays out the long pickets on the centerline at 4-pace intervals, at the spot where they are to be installed and with their points toward the enemy. Another squad lays out the anchor pickets with points toward the enemy and positioned 2 paces each way from the centerline and midway between the long pickets.

The third squad installs all the pickets with the help of the other two squads as they finish laying out the pickets. The lower notch, or bottom eye, of the long pickets should be approximately 10 cm off the ground to make passage difficult either over or under.

As the groups complete this first task, they return to the head of the fence and begin installing the wire.

No. 1 wire is the diagonal wire on the enemy side and is secured with top-eye tie to all pickets. It is important to keep this wire as tight as possible.

No. 2 wire is the trip wire on the enemy side and is secured to both diagonals just above the anchor picket with the apron tie. This wire must be tight enough and close enough to the ground to make passage over or under difficult.

No. 3 wire is an apron wire on the enemy side. It is secured to the first diagonal wire, then to each alternate diagonal, and then to the last diagonal wire.

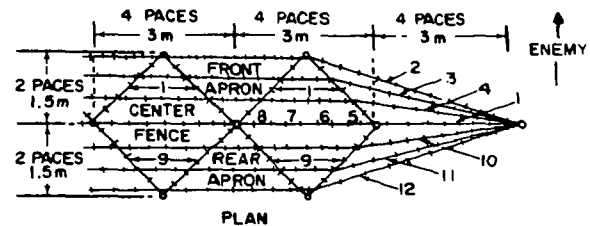
No. 4 wire is also an apron wire on the enemy side. It is secured to No. 1 wire, then to the diagonal wires which are not tied to the No. 3 wire, and then to the last diagonal wire. Apron wires Nos. 3 and 4 are equally spaced along the diagonal wire.

No. 5 wire is the first one which is not started from the end anchor pickets. It is started at the first long picket and ended at the last long picket. It is secured with the intermediate-eye tie and is stretched tightly to prevent passage over or under.

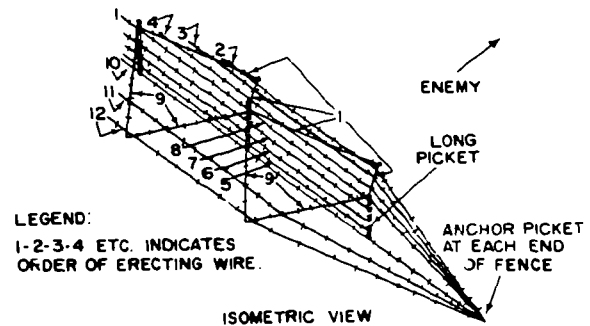
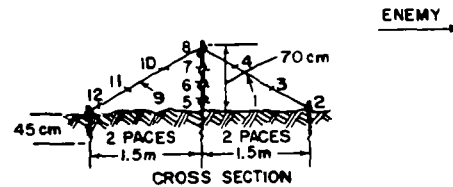
Wires Nos. 6, 7, and 8 complete the center portion of the fence and are secured to the long pickets, Nos. 6 and 7 with the intermediate eye tie. They also start at the first and end at the last long picket. No. 8 is secured with the top eye ties. These wires should be taut enough to prevent them from being easily depressed by boards, mats, or similar objects thrown across them. If wires are stretched too tightly they are more easily cut by fragments.

No. 9 wire is the diagonal apron wire on the friendly side and is secured with the top-eye to all pickets except the end anchor pickets. Nos. 10 and 11 are apron wires and No. 12 is the trip wire on the friendly side. Wire No. 12 is installed in the same manner as No. 2.

If the fence is not tight when installed, the wires are tightened by racking.

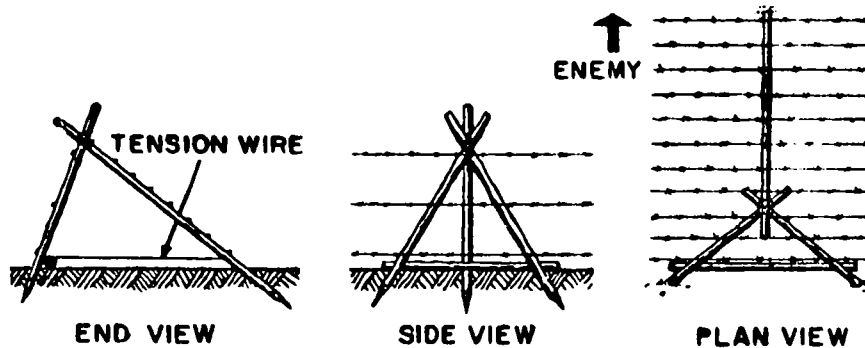
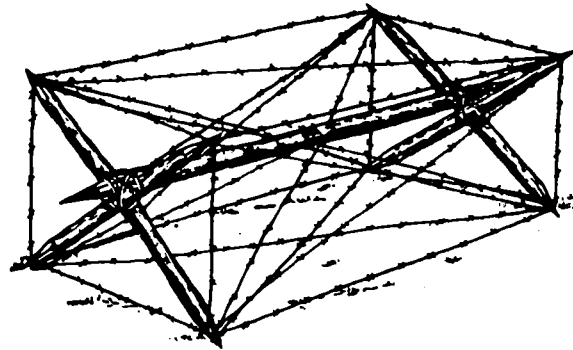


NOTE:
EYES OF ALL PICKETS POINT
IN DIRECTION FROM WHICH
FENCE IS BEING ERRECTED.



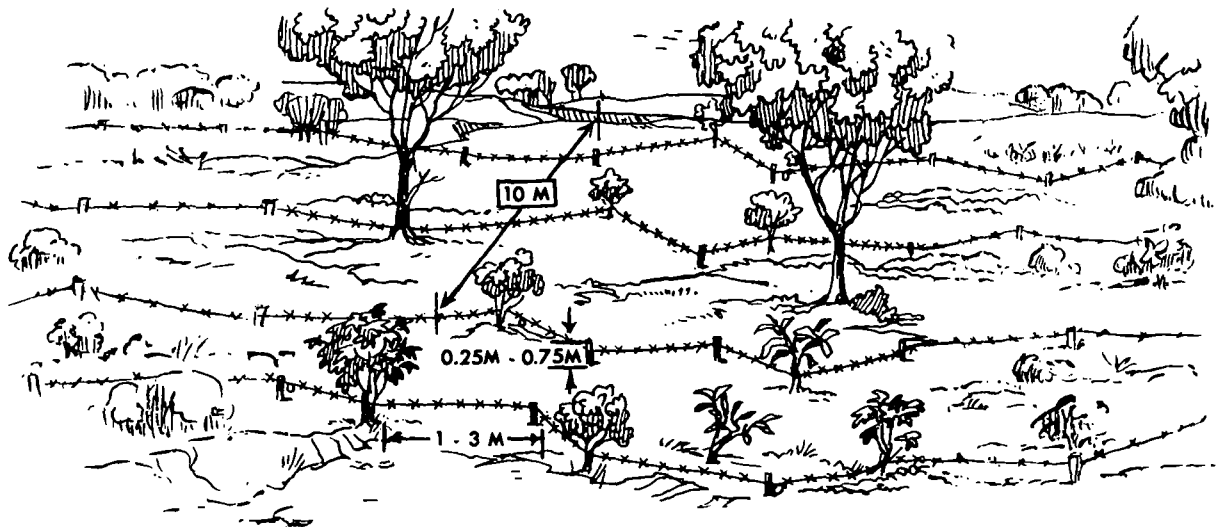
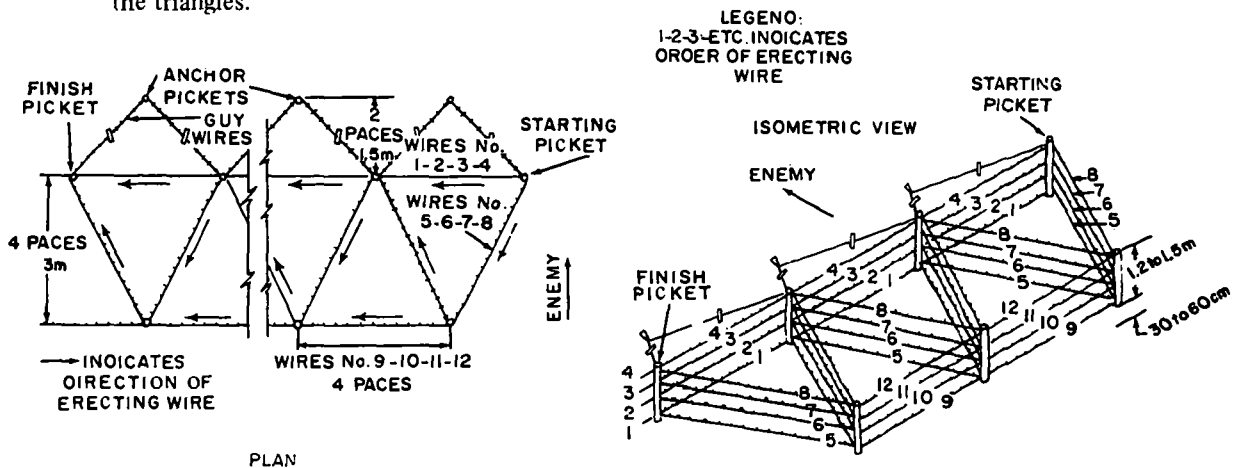
LEGEND:
1-2-3-4 ETC. INDICATES
ORDER OF ERRECTING WIRE.

The **KNIFE REST** is used whenever a readily removable barrier is needed such as at lanes in wire obstacles or at a road block. With a metal frame it can be used as an effective underwater obstacle. It is constructed with 3 to 5 meters between cross members and is approximately 1.2 meters high. The cross members are firmly lashed to the horizontal member with plain wire. When used as a fixed obstacle the knife rest is secured to the ground.



The **TRESTLE APRON FENCE** has inclined crosspieces spaced at 5 to 6-meter intervals to carry longitudinal wires on the enemy side. The rear ends of the crosspieces are carried on triangular timber frames which are kept from spreading by tension wires on the friendly side. The crosspieces may be laid flat on the ground for tying the longitudinal wires in place and then raised into position. The frames are tied securely in place and held by tension wires. The fence is sited in such a way that it can be guyed longitudinally to natural anchorages.

The **HIGH WIRE ENTANGLEMENT** consists of two parallel 4-strand fences with a third 4-strand fence zigzagged between them to form triangular cells. To add to the obstacle effect, front and rear aprons may be installed and spirals of loose wire may be placed in the triangles.

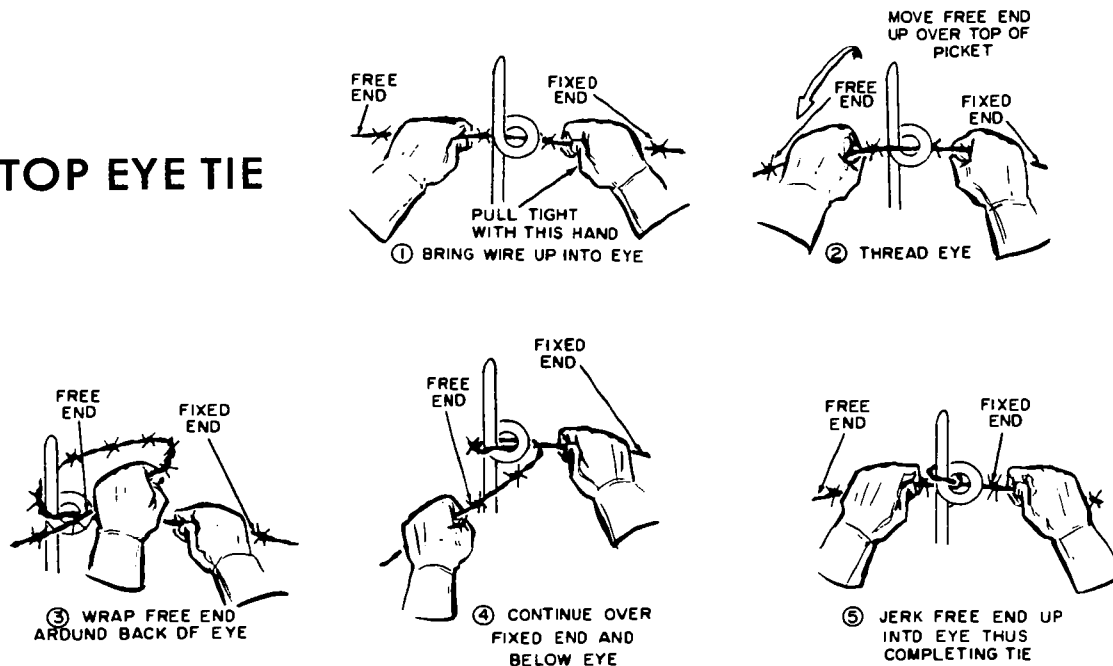


The **TANGLEFOOT** is used when concealment is necessary. It should have a minimum depth of 10 meters. The pickets are spaced at irregular intervals of from 1 to 3 meters, and the height of the wire varies from .25 meters to .75 meters. It is sited in scrub, if possible, using bushes as supports for part of the wire. In open ground, short pickets are used.

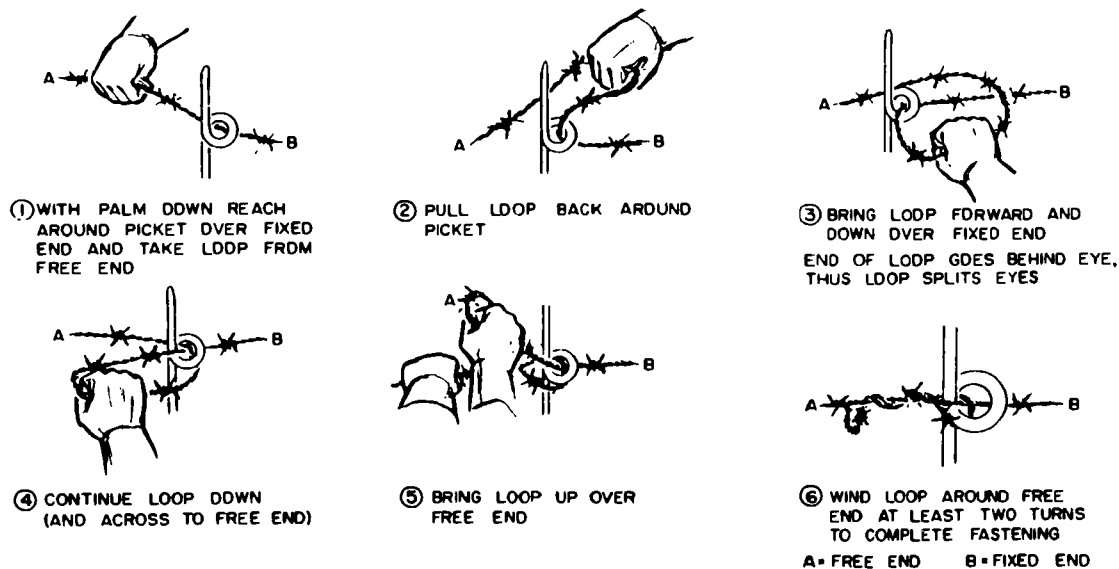
WIRE TIES

Wires are tied to pickets by men working from the friendly side of the wire and picket, stretching the wire with the right hand as the tie is started. There are four ties used in erecting wire entanglements.

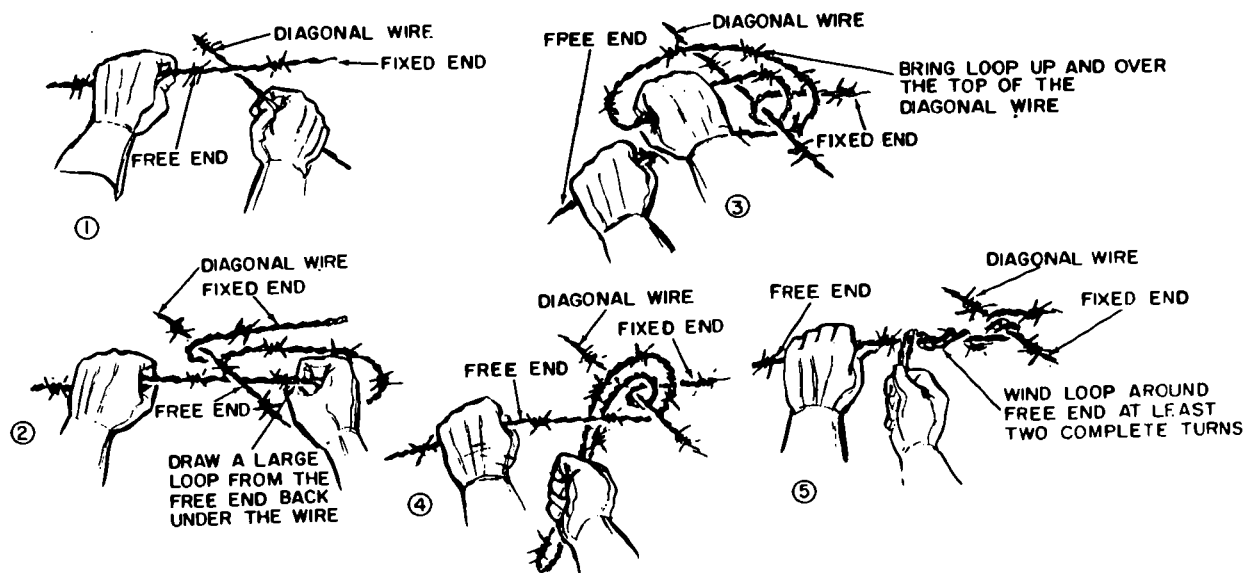
TOP EYE TIE



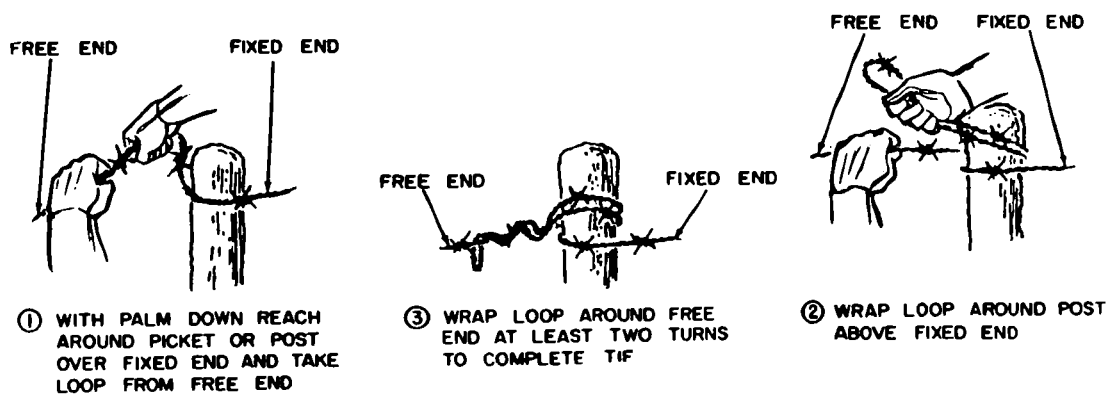
INTERMEDIATE EYE TIE



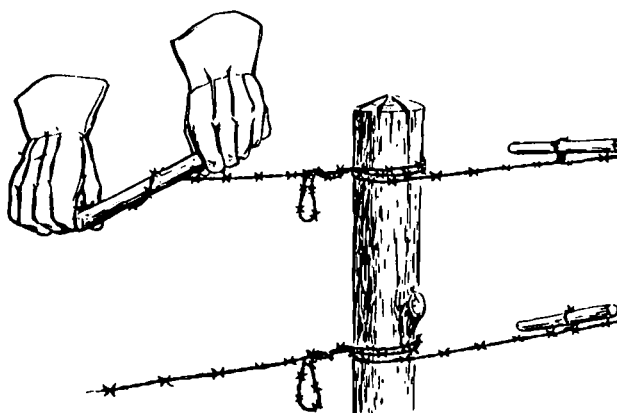
APRON TIE



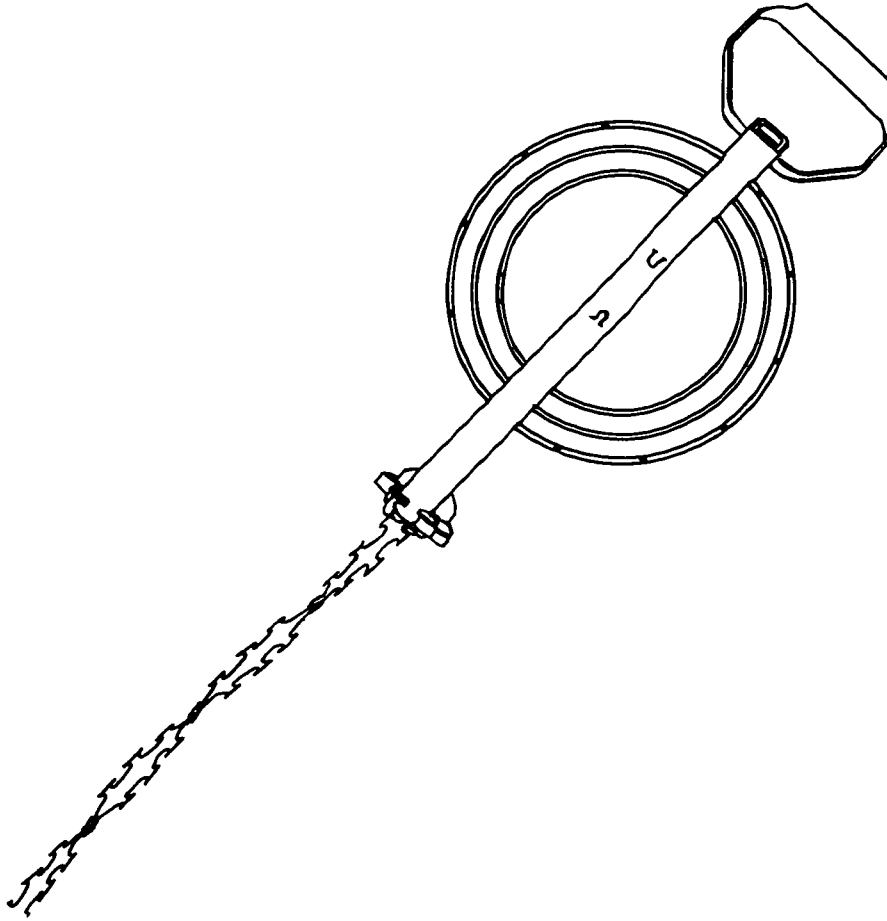
POST TIE



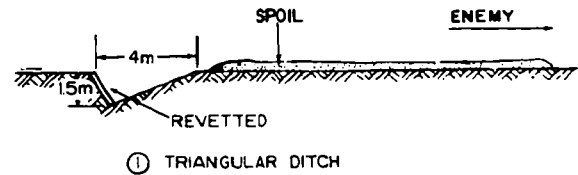
TIGHTENING WIRE BY RACKING



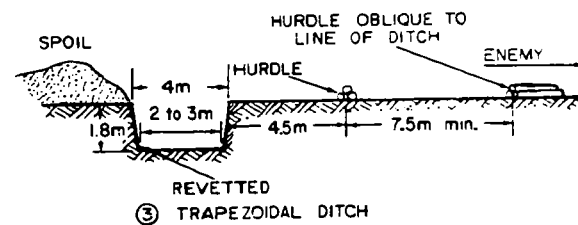
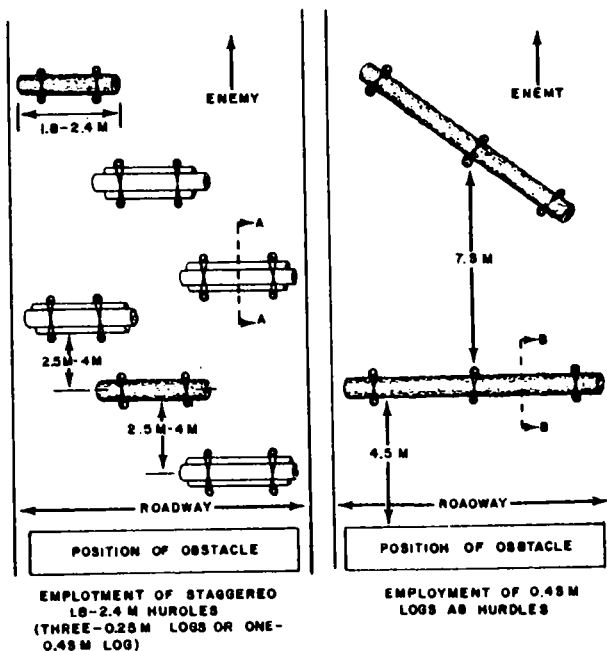
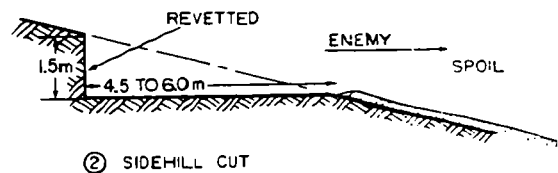
BARBED TAPE, a relatively new development, is easier to use than the standard barbed wire because of its lighter weight. (400 meters of barbed wire weighs 104.5 pounds while the same length of barbed tape weighs only 35.5 pounds.) Barbed tape is used in the same manner as barbed wire.



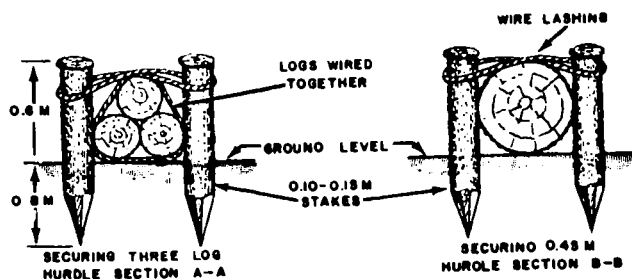
ANTIVEHICULAR OBSTACLES

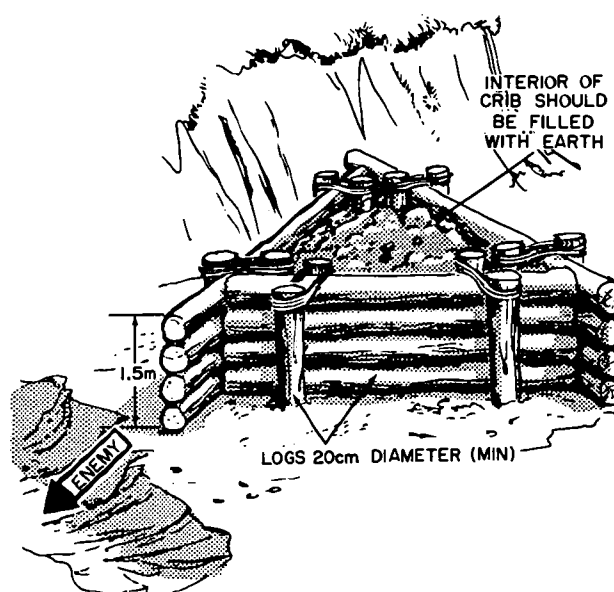
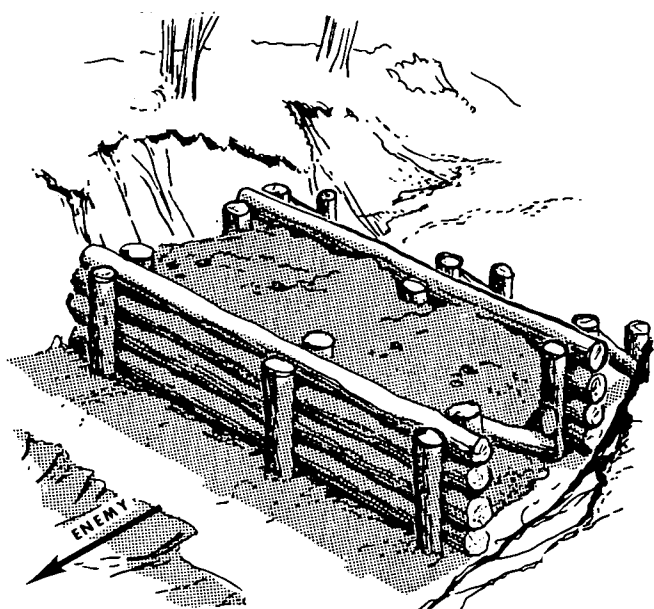


ANTITANK DITCHES are excavated by earthmoving equipment, explosives, or handtools.

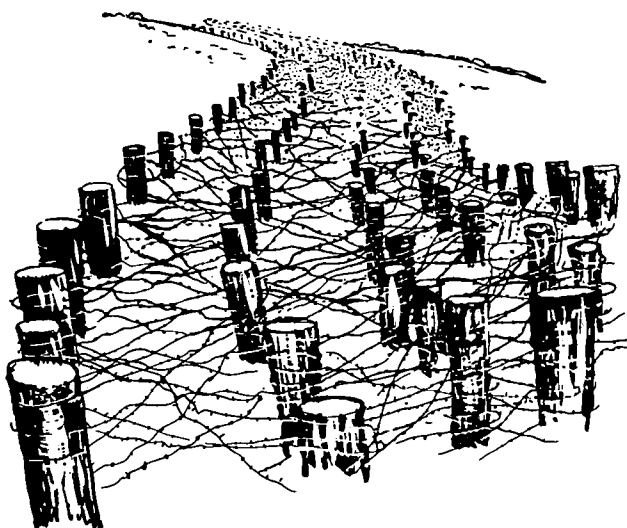


LOG HURDLES of .25 m to .45 m long may be used to add to the obstacle effect of a crater or any other type of roadblock. A hurdle of this type stops or damages most wheeled vehicles. Tanks can cross them at reduced speed on reasonably level ground but are stopped by hurdles on uphill grades which approximate the critical grade of the vehicle. The hurdle is sited on the steepest part of the slope and mined.



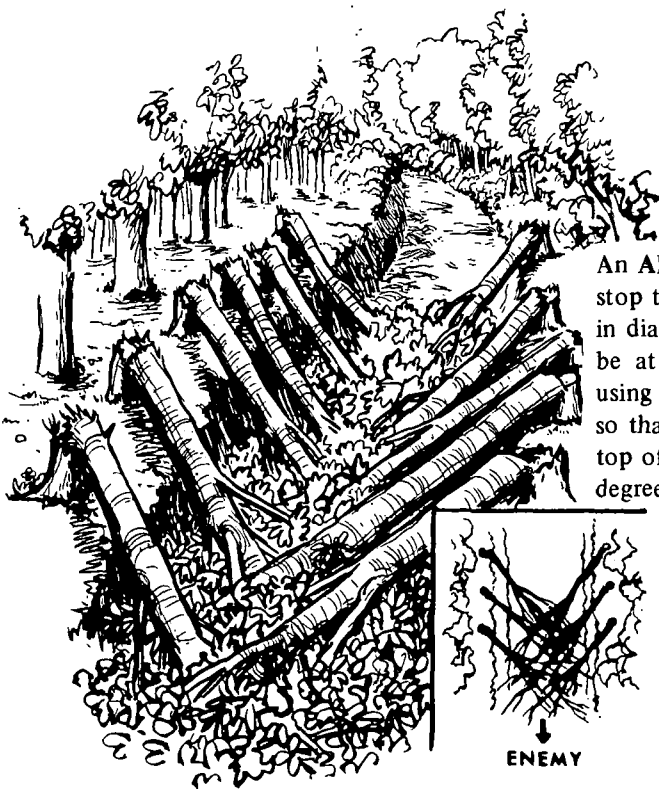


Rectangular or triangular **LOG CRIBS** are effective roadblocks. They are strengthened by filling them with earth obtained from a shallow ditch dug on the enemy side of the crib.



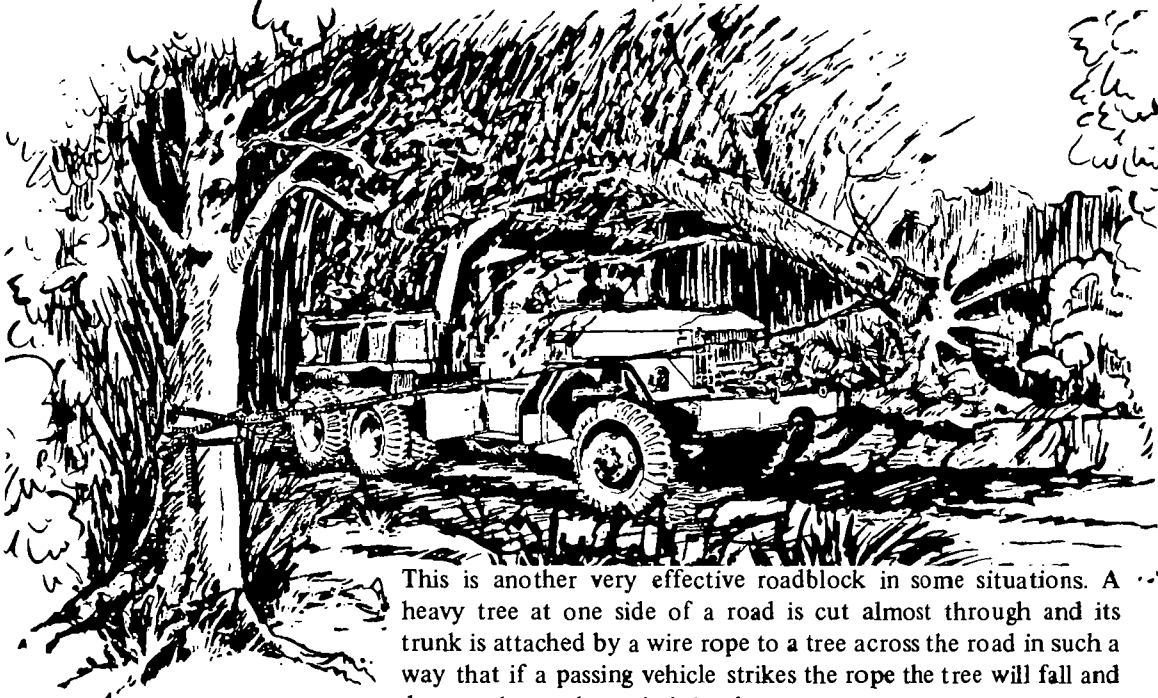
POST OBSTACLE BELTS may be constructed using either steel, log, or concrete posts or a combination. The effect of this obstacle may be improved by weaving spirals of barbed wire among the posts as shown here.

CRATERS are used for blocking roads, trails, or defiles, at points where the terrain prevents bypassing. They are improved whenever possible by steepening the sides, flooding, or mining.



An **ABATIS** is formed by felling trees as shown here. To stop tracked vehicles the trees should be at least 60 cm in diameter and 6 meters tall. The entire obstacle should be at least 75 meters deep. Abatis are constructed by using handtools or explosives. The trees must be felled so that the trunk remains attached to the stump and the top of the trees face toward the enemy at an angle of 45 degrees.

ROADBLOCKS may be improvised from farm carts, automobiles, and trucks, which are loaded with rock, concrete, or any other heavy material. When placed in position the wheels should be damaged or removed and the vehicles should be firmly anchored.



This is another very effective roadblock in some situations. A heavy tree at one side of a road is cut almost through and its trunk is attached by a wire rope to a tree across the road in such a way that if a passing vehicle strikes the rope the tree will fall and damage the truck or pin it in place.

PART ELEVEN

ROUTE AND ROAD RECONNAISSANCE



A route describes an area of ground defined by specific limits over which movement is anticipated. It consists of roads, tracks, bridges, tunnels, fords, ferries, and any other terrain feature that could affect the flow of traffic.

The purpose of route reconnaissance is to collect, evaluate, and report information which will aid in the selection of a particular route for the movement of troops, equipment, and supplies in a military operation.

To insure that important information is not overlooked during route reconnaissance and to also aid in the preparation of the reconnaissance report, a checklist based on the characteristics of the area of operations is recommended. General items for consideration are:

Identification and location of the reconnoitered route.

Distances between easily recognized points both on the ground and map.

The percent of slope and length of grades which are 7 percent or greater.

Sharp curves whose radii of curvature are 30 meters or less.

Bridge military load classifications and limiting dimensions to include suitable bypasses.

Locations and limiting data of fords and ferries.

Route constrictions, such as underpasses, which are below minimum standard and, if appropriate, the distances such restrictions extend.

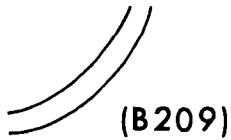
Locations and limiting dimensions of tunnels to include suitable bypasses.

Suitable areas for short halts and bivouacs which offer drive-off facilities, adequate dispersion, cover, and concealment.

Areas of rock falls and slides which may present a traffic hazard.

ROUTE RECONNAISSANCE SYMBOLS

MEANING



Civil or military route; designation written in parentheses along route.



Critical point to be numbered and described in legend. Used to point out features not covered by reconnaissance symbols.



Limits of reconnoitered sector.

10.5mX120
6mZ(OB)
9mY20(OB)W

Route classification formula expressed in order of: width, type, military load classification, obstructions if present, and regular flooding or snow blockage.

X — all weather route
Y — all weather route (limited traffic)
Z — fair weather route
T — regular snow blockage
W — regular flooding

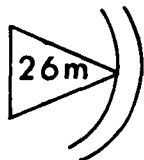
→ 5-7%

→ 7-10%

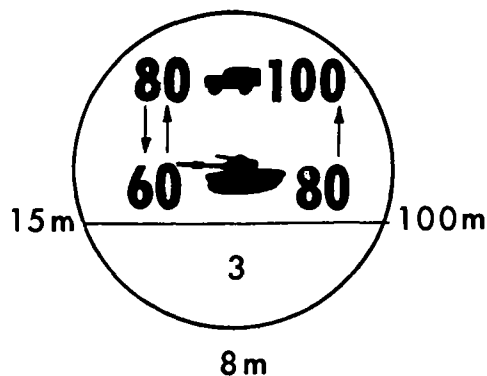
→ 10-14%

→ OVER 14%

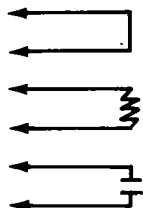
Grades. Arrows point uphill. Right of symbol is shown the actual percent of slope; length of arrow represents length of grade if map scale permits.



Sharp curves. Vertex of triangle points to map location of curve. Radius is written within symbol.



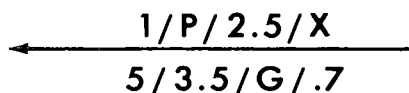
Full bridge symbol. Arrow extends to map location of bridge; minimum width placed below, overhead clearance to left, and overall length to right of basic symbol. Lower portion indicates bridge serial number; upper portion indicates military load classification data. Underlined values are those below minimum standard.



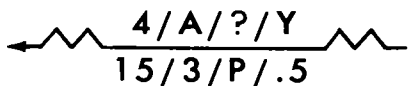
Bypass easy. Used with bridge and tunnel reconnaissance symbols.

Bypass difficult.

Bypass impossible.



Ford. Arrow extends to ford location. Data above line expressed in order of serial number, ford type, stream velocity, and seasonal limitations. Data below the line expressed in order of length, width, bottom type, and depth. Question marks indicate unknown information. Difficult approaches represented by zigzag lines corresponding in position to shore where approach is located.



Ford Type

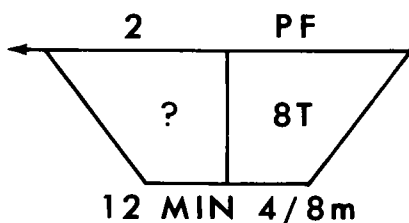
A – vehicular
P – foot
D – deepwater, tank
S – swimming vehicle

Seasonal Variations

X – none
Y – significant

Bottom Type

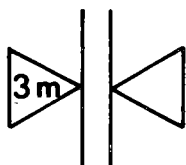
M – mud
C – clay
S – sand
G – gravel
R – rock
P – artificial paving



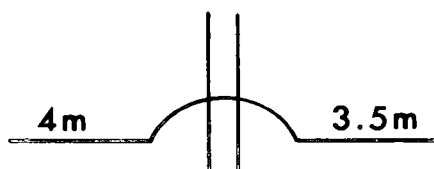
Ferry. Arrow extends to map location. Data above symbol expressed in order of ferry serial number and ferry type. Data inside symbol expressed in order of military load classification and dead weight capacity; data below symbol expressed in order of turnaround time and width and length of cargo space.

Ferry Type

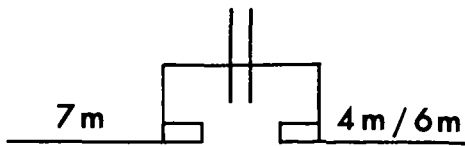
AF – vehicular
PF – foot
MF – military



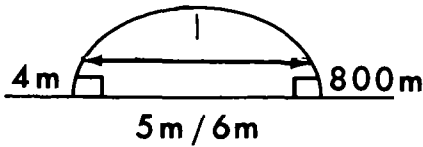
Width constriction. Route constriction in width of usable traveled way in triangle corresponding to the side of the traveled way in which the constriction occurs.



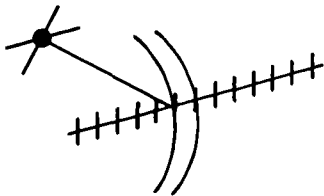
Arch constriction. Width expressed to right of symbol, overhead clearance to left.



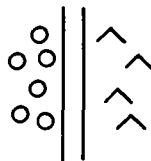
Rectangular constriction with sidewalks. Width of traveled way followed by total width including sidewalk to right of symbol, overhead clearance to left.



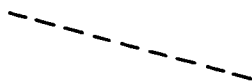
Tunnel with sidewalks. Arrow extends to map location. Serial number placed inside the symbol. The width of the traveled way followed by total width including sidewalks placed below the symbol. Underlined widths indicate reduction of widths below that of the outside route. Overhead clearance placed to the left of the symbol and total tunnel length to the right.



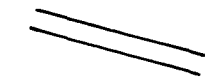
RR grade crossing. Level crossing; passing trains will interrupt traffic flow.



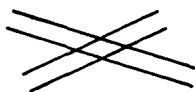
Concealment. Route lined with trees; deciduous (left); coniferous (right).



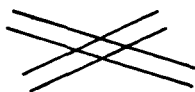
Roadblock, craters, and blown bridges. Center of symbol indicates position of block.



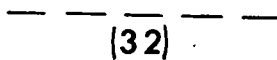
proposed



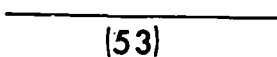
prepared but passable



completed



Lateral route. Broken lines and identified by even number.



Axial route. Solid line and identified by odd number.

?

Unknown or doubtful information.

ROAD RECONNAISSANCE REPORT (FD 1248)				DATE 21 February 1964																												
TO (Headquarters receiving reconnaissance) 5-2 185 H ECB		FROM (Name, grade and unit of officer or PCO making reconnaissance) 2nd Lt. John B. Broad, 185th ECB																														
1. MIPE Virginia, Allandale	2. COUNTRY 150000	3. SCALE US Sheet 3561 15 W AMS 1934	4. DATE/TIME GROUP 271530Z																													
SECTION I - GENERAL ROAD INFORMATION																																
A. ROAD GRID REFERENCE 305024-294100 305000-294100		B. ROAD NAME FAIRFAX 644																														
C. ROAD NUMBER (Post or other number) 14-20 feet		D. ROAD NUMBER (Post or other number) 6.7 Miles																														
E. ROAD TYPE 27 February 1964 0800-1200		F. ROAD TYPE Cold, dry, 31° F, Last rain 25 February 1964																														
SECTION II - DETAILED ROAD INFORMATION (When circumstances permit more detailed information will be shown in an itinerary or on the mileage chart on the reverse side of this form. Standard symbols will be used.)																																
<table border="0"> <tr> <td>(I) FLAT GRADIENTS AND SHARP CURVES</td> <td>(II) DEBRIS (Check one ONLY)</td> </tr> <tr> <td>(II) STEEP GRADIENTS (Steeper than 1 in 100)</td> <td>(I) SOLOUTE OF CHES. CRACKS/CANALS WITH SOLOUTE</td> </tr> <tr> <td>(III) SHARP CURVES (Radius less than 100 ft)</td> <td>(II) CULVERTS IN GOOD CONDITION</td> </tr> <tr> <td>(IV) SHARP CURVES (Radius more than 100 ft)</td> <td>(III) CULVERTS ON DITCHES ARE SELECTED OR OTHER</td> </tr> <tr> <td>(V) SHARP CURVES AND SHARP CURVES</td> <td>(IV) CULVERTS ON DITCHES ARE SELECTED OR OTHER</td> </tr> <tr> <td>(VI) STABILIZED COMPACT MATERIAL OF GOOD QUALITY</td> <td>(V) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(VII) SURFACE DESCRIPTION (Complete Name (See 15-15))</td> <td>(VI) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(VIII) FREE OF POTHOLES, RUMPT, OR RUTS LIKELY TO</td> <td>(VII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(IX) CONCRETE</td> <td>(VIII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(X) BITUMINOUS (Specify type other than)</td> <td>(IX) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(XI) BRICK (Paved)</td> <td>(X) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(XII) STONE (Paved)</td> <td>(XI) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(XIII) COARSE ROCK OR CORAL</td> <td>(XII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> <tr> <td>(XIV) OTHER (Describe)</td> <td>(XIII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY</td> </tr> </table>					(I) FLAT GRADIENTS AND SHARP CURVES	(II) DEBRIS (Check one ONLY)	(II) STEEP GRADIENTS (Steeper than 1 in 100)	(I) SOLOUTE OF CHES. CRACKS/CANALS WITH SOLOUTE	(III) SHARP CURVES (Radius less than 100 ft)	(II) CULVERTS IN GOOD CONDITION	(IV) SHARP CURVES (Radius more than 100 ft)	(III) CULVERTS ON DITCHES ARE SELECTED OR OTHER	(V) SHARP CURVES AND SHARP CURVES	(IV) CULVERTS ON DITCHES ARE SELECTED OR OTHER	(VI) STABILIZED COMPACT MATERIAL OF GOOD QUALITY	(V) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(VII) SURFACE DESCRIPTION (Complete Name (See 15-15))	(VI) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(VIII) FREE OF POTHOLES, RUMPT, OR RUTS LIKELY TO	(VII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(IX) CONCRETE	(VIII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(X) BITUMINOUS (Specify type other than)	(IX) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(XI) BRICK (Paved)	(X) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(XII) STONE (Paved)	(XI) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(XIII) COARSE ROCK OR CORAL	(XII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY	(XIV) OTHER (Describe)	(XIII) RUMPT, RUTTED OR POTHOLED TO A EXTENT LIKELY
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SECTION III - OBSTRUCTIONS (List in the columns below particular of the following characteristics which affect the traffic capacity of a road. If information of any feature cannot be ascertained, use "NOT KNOWN".)																																
(a) Obstruction to traffic, less than 10 feet or 6.75 meters, such as fence, bridge, overhead wire and surrounding building.																																
(b) Obstruction to road width, which limit the traffic capacity, such as culvert, narrow bridge, underpass, and building.																																
(c) Obstruction to road width (Above 1 in 100)																																
(d) Curve less than 100 feet (30 meters) in radius																																
(e) Other																																
SERIAL NUMBER	PARTICULARS	GRID REFERENCE	REMARKS																													
1	Steep grade - 8% uphill going east, 0.2 miles long	305024-294100																														
2	Series of sharp curves	305024-294100																														
3	Steep grade - 2% downhill going east	305024-294100																														

DA FORM 1248

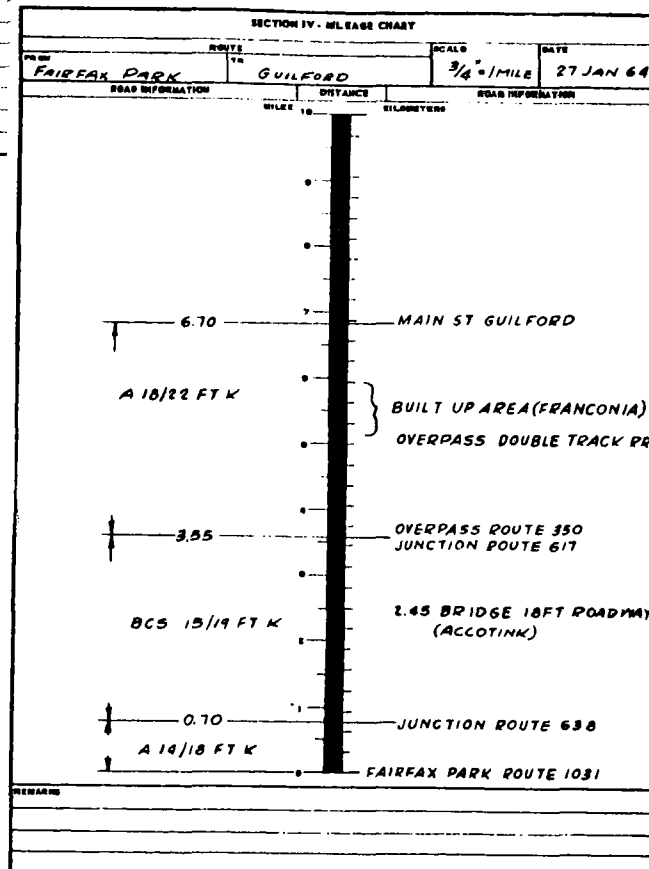
PREVIOUS EDITION OF THIS FORM IS OBSOLETE.

FRONT

Road reconnaissance is conducted to determine the traffic capabilities of a particular road and to provide more detailed information than that required by the route classification formula. Road classification is based upon limiting characteristics, obstructions, snow blockage, flooding, civil and military road designation, turnouts, and available cover and concealment.

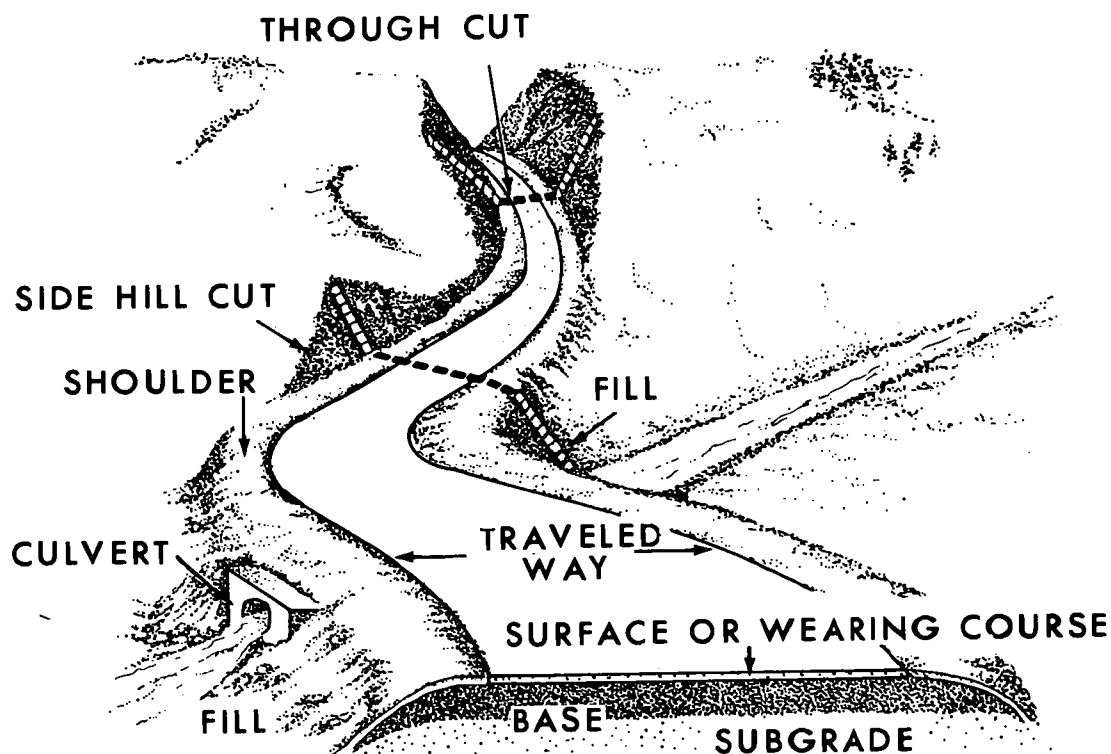
ROAD RECONNAISSANCE REPORT

The route reconnaissance report is accompanied by a ROAD RECONNAISSANCE REPORT (DA Form 1248), a sample of which is shown here.



BACK

ROAD NOMENCLATURE



INFORMATION REQUIRED FOR A ROAD RECONNAISSANCE REPORT

Local name of the road

Local road designation and number

Location of road by map grid reference

Length of road between specified and readily identifiable points

Normal width of road between fences, drainage ditches, and edge of the traveled way

Alignment of road

Drainage, including culverts

Foundation

Surface

Obstructions, including kinds and locations

Reductions in width

Excessive gradients; locations and grades of all gradients steeper than 6 percent

Sharp curves (radius shorter than 100 feet)

Bridge locations

Underpass locations, showing length, width, and height

Tunnel locations showing length, width, and height

Ford and ferry locations

The **ROAD CLASSIFICATION FORMULA** is expressed in the following order:

Limiting characteristics, width, road surface material, length, and obstructions if present

The formula is prefixed by the symbol A if there are no limiting characteristics.

Or B if there is one or more.

If a limiting factor is unknown, it is expressed as (?).

Here are the criteria for determining a **LIMITING FACTOR** and its symbol.

Sharp curves	Sharp curves with radii less than 30 meters are also reported as obstructions	c
Steep gradients	Steep gradients, 5 percent or steeper. Such gradients are also reported as obstructions	g
Poor drainage	Inadequate ditches, crown or camber, or culverts; culverts and ditches blocked or otherwise in poor condition	d
Weak foundation	Unstable, loose, or easily displaced material	f
Rough surface	Bumpy, rutted, or potholed to an extent likely to reduce convoy speeds	s
Excessive camber or superelevation	Falling away so sharply as to cause heavy vehicles to skid or drag toward the shoulders	j

The **MINIMUM WIDTH** of the traveled way is followed by a slash and the combined width of the traveled way and the shoulders.

The **ROAD SURFACE MATERIAL** is expressed by these symbols.

k	Concrete	(X)
kb	Bituminous concrete	(X)
p	Paving brick or stone	(X)
rb	Bitumen penetrated macadam, waterbound macadam with superficial asphalt or tar cover	(X) or (Y) (X) or (Y)
r	Waterbound macadam, crushed rock or coral	(Y)
l	Gravel or lightly metalled surface	(Y)
nb	Bituminous surface treatment on natural earth, stabilized soil, sand clay or other material	(Y) or (Z)
b	Used when type of bituminous construction cannot be deter- mined	(Y) or (Z)
n	Natural earth stabilized soil, sandy clay, shell, cinders, dis- integrated granite, or other material	(Z)
v	Various other types not men- tioned above*	

*indicate length when this
symbol is used.

The **LENGTH** of the road may be shown in brackets following the surface material notation.

The existence of **OBSTRUCTIONS** along a road is expressed by placing (OB) at the end of the formula. Details of the obstruction are not shown in the formula, but appear in the route reconnaissance report.

If serious **SNOW BLOCKAGE** or **FLOODING** occurs the symbol (T) for snow and (W) for flooding follow the formula.

The **CIVIL AND MILITARY DESIGNATION** of the road, **COVER** and **CONCEALMENT**, possibilities of **MOVEMENT OFF THE ROAD**, and similar information appear on the route reconnaissance report overlay.

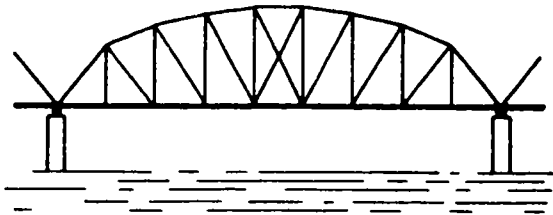
EXAMPLES OF ROAD CLASSIFICATION FORMULA

A 5.0/6.2m k. This formula describes a road with no limiting characteristics or obstructions, a minimum traveled way of 5.0 meters, a combined width of traveled way and shoulders of 6.2 meters, and a concrete surface.

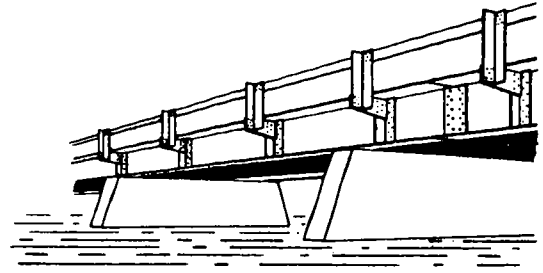
B g s 14/16 ft. 1 (OB). This formula describes a road with limiting characteristics of steep gradients and a rough surface; a minimum traveled way of 14 feet and a combined width of 16 feet; gravel or lightly metalled surface; and obstructions.

B c (f?) 3.2/4.8m p (4.3 km) (OB) (T). This formula describes a road with limiting characteristics of sharp curves and unknown foundation; a minimum traveled way of 3.2 meters and a combined width of 4.8 meters; paving brick or stone surface; 4.3 kilometers long; with obstructions; and subject to snow blockage.

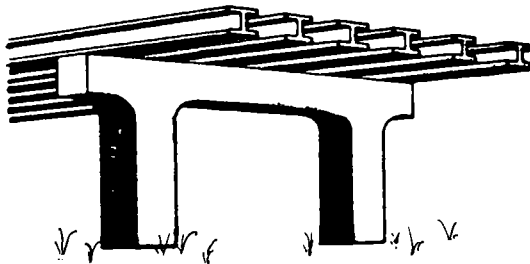
TYPICAL BRIDGE SPANS



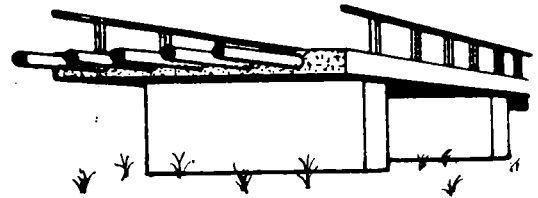
TRUSS



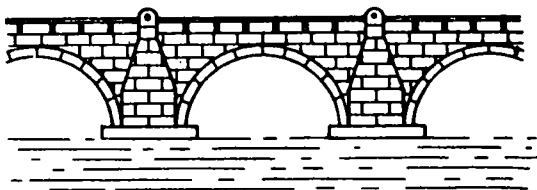
GIRDER



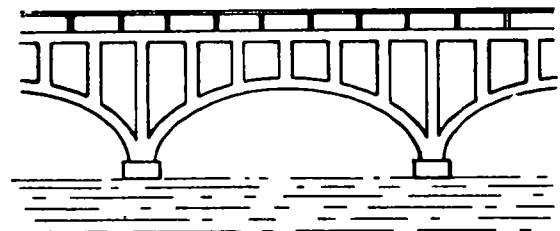
BEAM



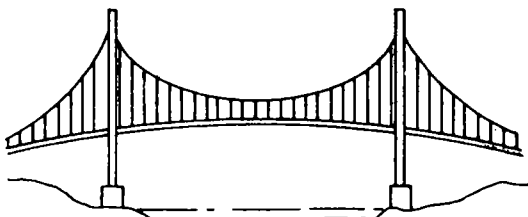
SLAB



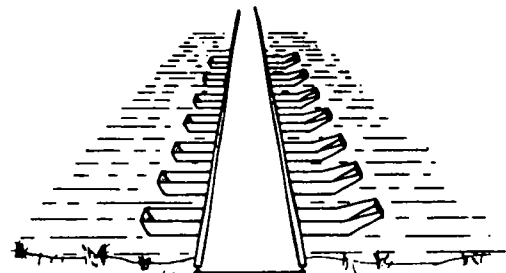
ARCH (closed spandrel)



ARCH (open spandrel)

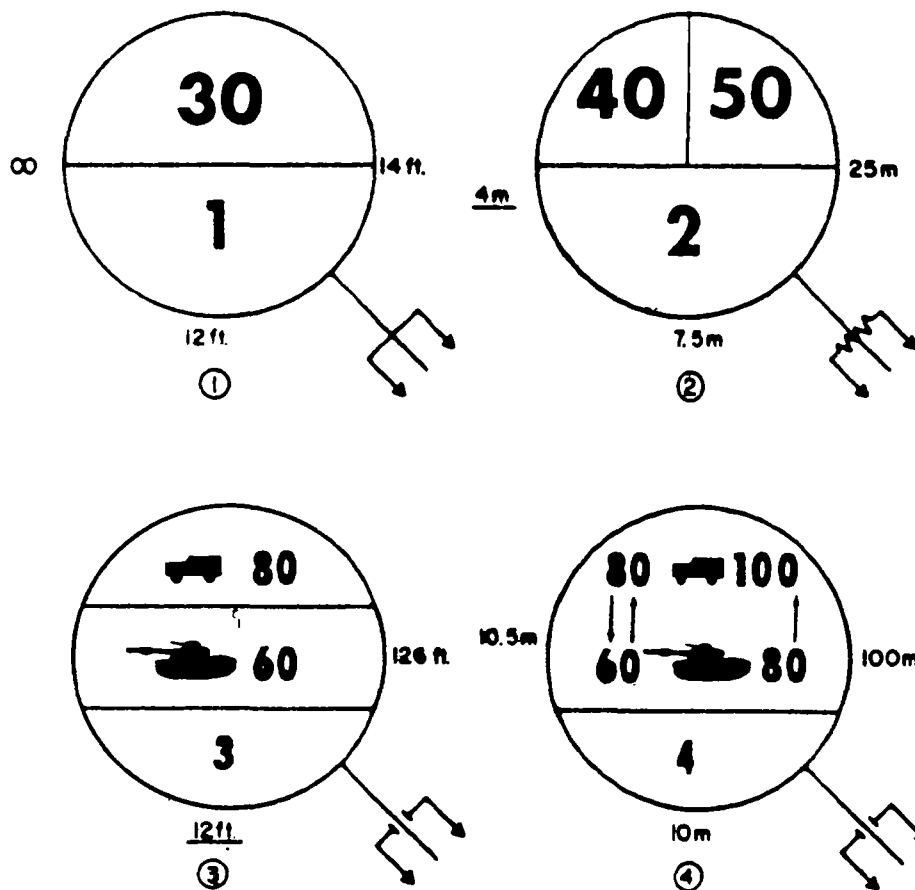


SUSPENSION BRIDGE



FLOATING BRIDGE

EXAMPLES OF THE FULL BRIDGE SYMBOL



1. This symbol represents a single flow bridge, classification 30, assigned the arbitrary serial number 1, with an overall length of 14 feet, traveled way width of 12 feet, unlimited overhead clearance, and easy bypass conditions.

2. This symbol represents a classification 40 double flow and classification 50 single flow bridge assigned the arbitrary serial number 2 with an overall length of 25 meters, traveled way width of 7.5 meters, overhead clearance 4 meters, and difficult bypass conditions. The overhead clearance of 4 meters is less than 4.25m specified by STANAG 2021, and the dimension is, therefore, underlined.

3. This symbol represents a single flow bridge assigned the arbitrary serial number 3 which is classification 80 for wheeled vehicles and classification 60 for tracked vehicles with overall length of 126 feet, traveled way width of 12 feet, overhead clearance unknown, and impossible bypass conditions. The traveled way width is less than specified by STANAG 2021, and the dimension is, therefore, underlined.

4. This symbol represents a double flow bridge assigned the arbitrary serial number 4, which is classification 80 double flow and classification 100 single flow for wheeled vehicles; classification 60 double flow and classification 80 single flow for tracked vehicles with overall length 100 meters, traveled way width of 10 meters, overhead clearance 10.5 meters, and impossible bypass conditions.

ENGINEER INTELLIGENCE

Engineer intelligence is needed by everyone and it is every engineer's responsibility to supply information to be developed into engineer intelligence. Every engineer soldier must know the importance of intelligence and be trained in collecting whatever information he can and placing it into the appropriate intelligence channels.

Although much specific and precise information is obtained by trained observers and intelligence personnel, engineers not specifically trained or assigned to intelligence activities are a potential source of engineer intelligence.

For example, troops on a combat mission can observe and report the distance between large trees in an area and how effective the vegetation is for concealment and cover. They can report the effect streams have on movement, the existence of tracks and trails that do not show on maps or are shown incorrectly, the presence of caves and tunnels, the existence of footbridges and fords, patches of cultivated ground in seemingly uninhabited areas, possible landing zones, and unusual structures.

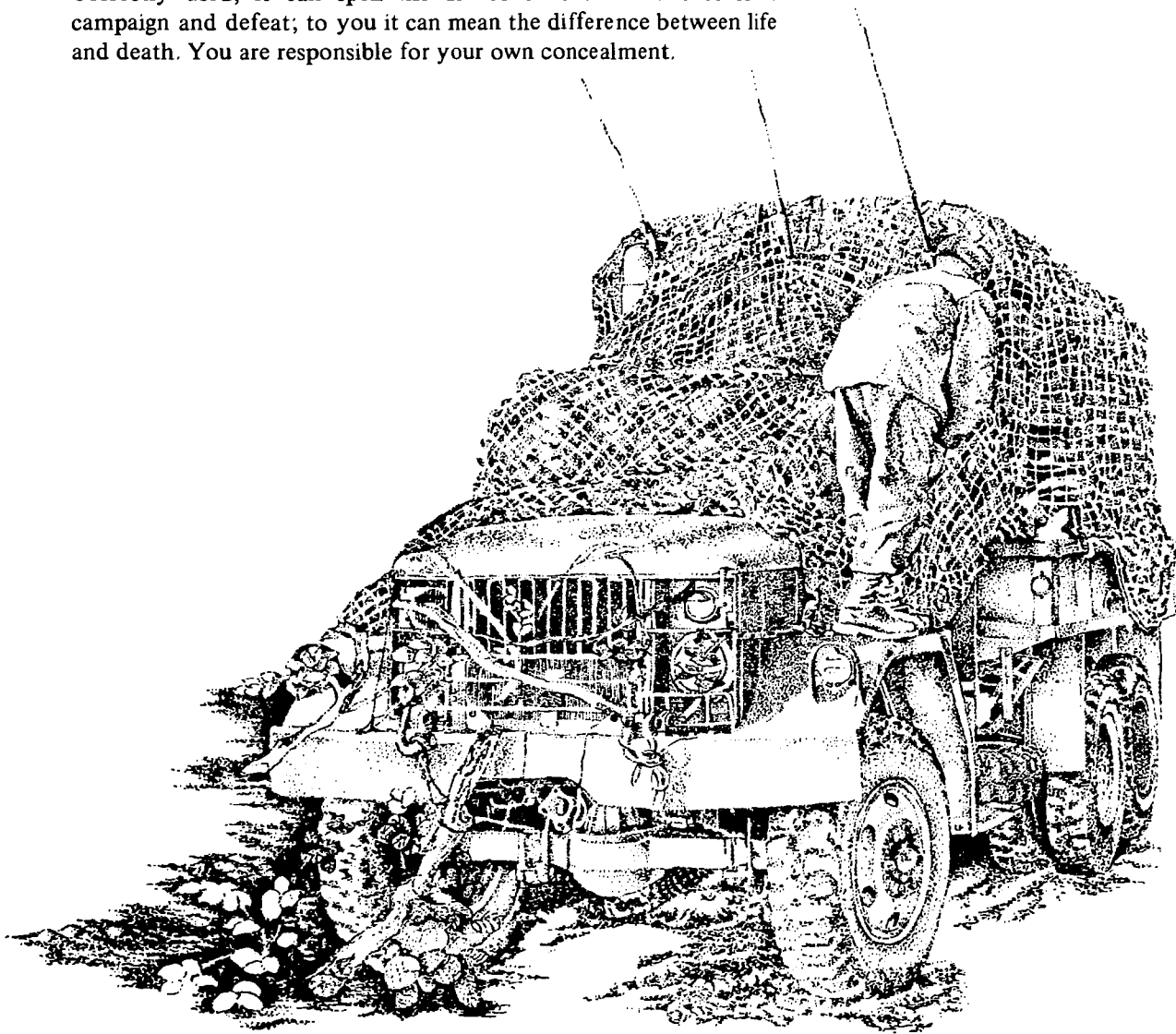
They can also report new equipment and whether engineer material such as lumber, gravel, or building stone or quarry sites are in the area. No special training is required for personnel to make these and many other observations.

Each individual contributes to the collection of engineer intelligence and thereby strengthens his unit and the Army as a whole. The importance of the individual to intelligence cannot be overemphasized.

PART TWELVE

CAMOUFLAGE

CAMOUFLAGE IS ONE OF THE BASIC WEAPONS OF WAR. Correctly used, it can spell the difference between a successful campaign and defeat; to you it can mean the difference between life and death. You are responsible for your own concealment.



CONCEALMENT DEPENDS ON —

BLENDING WITH YOUR BACKGROUND

BACKGROUND IS YOUR SURROUNDINGS SEEN FROM THE GROUND AND FROM THE AIR. THIS MAY BE ANYWHERE—A PORTION OF A JUNGLE, AN AREA IN A BARREN, ROCKY DESERT, A FARMYARD, OR A CITY STREET.

EFFECTIVE CONCEALMENT OF THE INDIVIDUAL DEPENDS PRIMARILY ON BACKGROUND—YOUR CHOICE OF IT, AND YOUR KNOWLEDGE OF HOW TO EMPLOY IT TO YOUR ADVANTAGE.

BACKGROUND IS THE CONTROLLING ELEMENT IN INDIVIDUAL CONCEALMENT. IT GOVERNS EVERY CAMOUFLAGE MEASURE YOU WILL TAKE. YOU WEAR CLOTHES WHICH BLEND WITH THE PREDOMINANT COLOR OF THE BACKGROUND AND TONE DOWN THE COLOR OF YOUR SKIN AND YOUR EQUIPMENT FOR THE SAME PURPOSE.

YOU PRACTICE BLENDING WITH YOUR BACKGROUND BY HIDING IN SHADOW AND BY AVOIDING CONTRAST BETWEEN YOUR SILHOUETTE AND THE BACKGROUND. YOU AVOID MOVEMENT WHICH THE STILLNESS OF THE BACKGROUND WILL EMPHASIZE.

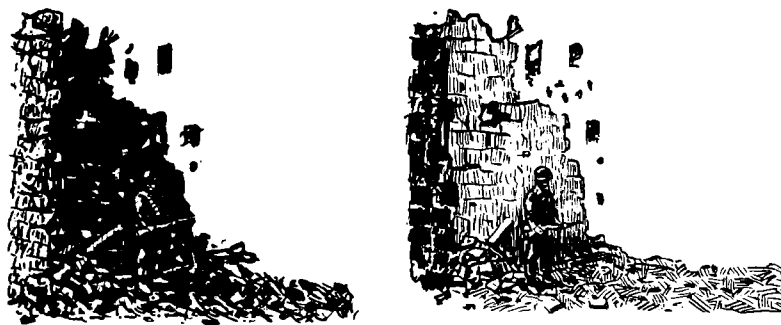
TO KEEP THE APPEARANCE OF THE BACKGROUND FREE OF SIGNS WHICH POINT TO THE PRESENCE OF MILITARY PERSONNEL, YOU FOLLOW CONCEALED ROUTES AND YOU CONCEAL SPOIL, TRACKS, EQUIPMENT, AND INSTALLATIONS.

SHADOWS

Shadows are part of every background. You can make them work for you if you know how to use them. They will work against you if you are thoughtless or careless. When you observe from within buildings, stand well back from the opening. Stay in the shadow. Your field of vision is more limited, but you will remain unseen.

When you observe, take care not to break the regular angle of a wall of a building. Stay close to it and observe from near the junction of wall and wall, or wall and ground. Shadows of cuts and ditches offer concealment during movement. Heavy shadows offer the best concealment when moving.

Where there are clear expanses of unbroken ground, shadows are definite and revealing signs. Standing erect casts a large and conspicuous shadow. Hugging the ground keeps the shadow as small as possible.



Shadows move. They change direction at noon. The shadow around noon is deep and offers good concealment. The longer shadows cast when the sun is low are much fainter. Thus a position which was well concealed at 1230 hours may be in plain sight of the enemy later in the afternoon.

SILHOUETTE

Avoid bright backgrounds of all kinds, especially when such backgrounds are unbroken by shadows and dark objects. In the same way, when you are in a light colored uniform, avoid contrast with dark, shadowed objects. If you must be revealed against a contrasting background, be aware of it and be there for the shortest possible time. Select your next point of concealment in advance and get there as quickly as you can.



You must watch your background for lights and shadows. You can be outlined against a contrasting background as plainly as against the sky. This soldier, standing in the shade, is plainly outlined by the brightly lighted background.



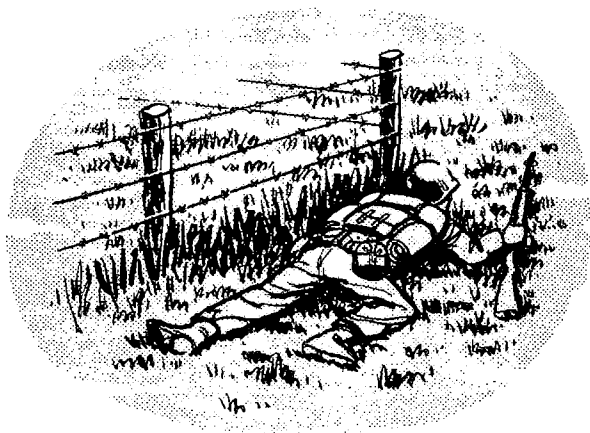
On the other hand, this soldier, bathed in sunlight, stands out against the shady background. Two steps backward and the shadows would fall over his figure, blending it with the speckled light and shade pattern of the jungle.



Beware of hills. Even though you may be below the crest, you may appear to be on the skyline to an enemy observer at the base of the hill. The skyline varies according to the angle from which the hillside is viewed.

MOVEMENT

Choose your route carefully by day and night. Make all possible use of screens, background and shadow. Under favorable circumstances the enemy can see as much as 100 yards into an open wood. In such cases, travel farther back from the edge. Woods with medium undergrowth also furnish numerous good observation points and cover. Heavy undergrowth is an obstacle to movement and where rapid movement is more important than full concealment, movement by bounds along the outside edge and in the shadow of the woods may be possible. Where only a hedge or fence is available, and you can do so, move in the shadow.



Creep along fence lines and low vegetation—move slowly, silently. Always choose the next point before crossing open areas.



Then sprint for it, keeping body low and following a zig-zag course.

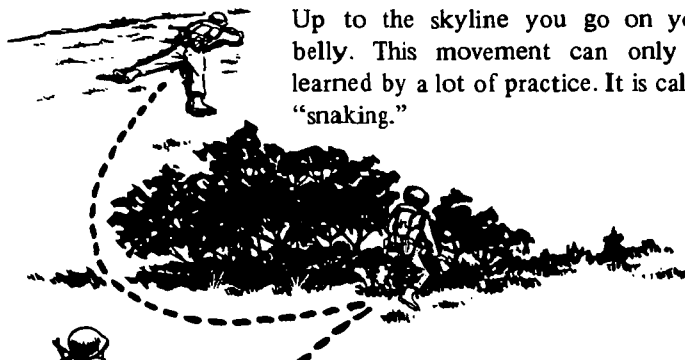


Observe from bushes large enough to prevent you from becoming an obvious target—observe through or under low branches—make movements slowly. Be sure that no part of your silhouette stands out against the background.

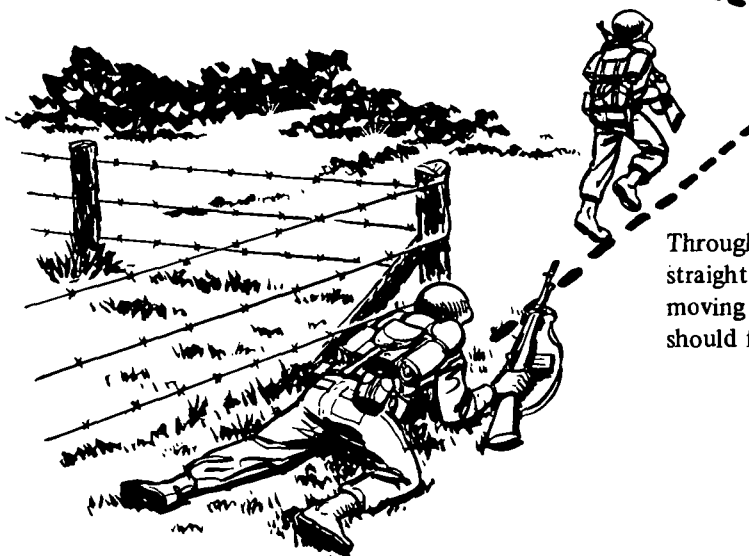


If skyline cannot be avoided, crawl to it—approach crest slowly, using whatever concealment there may be. How you cross depends on whether you are alone or with others, on how irregular the line is, and on how much you have been able to learn about the enemy. It is almost always possible to cross a skyline without being seen by losing your silhouette in the silhouette of rocks, bushes, ditches, etc., which cause irregularities in the line. You should sprint across a skyline only when concealment is impossible.

It pays to study the movements of a cat stalking a bird. He wears no camouflage and he uses no tricks. He depends upon stealth alone. In moving through dangerous areas, you should imitate him.



Up to the skyline you go on your belly. This movement can only be learned by a lot of practice. It is called "snaking."



You picked this clump of brush before you left your last concealment. It is large enough to offer alternate positions in case an enemy sniper has spotted you.

Through the open, you should sprint in a straight line to your next concealment. If moving directly toward the enemy you should follow a zig-zag course.

Along the fence line or in low concealment, you should creep on your knees and elbows. Still imitating the cat, keep your tail down.



If tall weeds obstruct your vision on the skyline, part them with a slow, even motion. If, for any reason, you think this movement may have been seen, freeze, remaining motionless until you feel that the enemy's interest has passed.

When you hit the ground after a dash through the open, it is often a good precaution to roll. A hostile observer may have spotted you while you were exposed. If he has, bullets will soon hum through your concealment at the point where you disappeared.

NIGHT

The night is not a protective blanket. You can see at night. Take it for granted that the enemy can too. Within half an hour in the dark the eye adjusts itself fully for night vision.



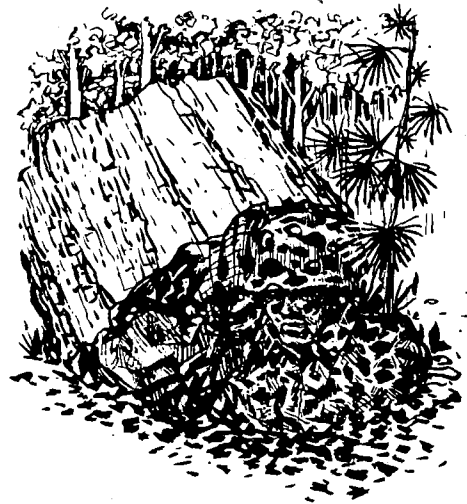
As in the daytime, silhouette and background are still the vital elements of concealment. A silhouette is always black against a night sky. Be just as careful at night as in the daytime about keeping off the skyline. If you are framed against a light road at night you will make a sharp silhouette. On moonlight nights, take the same precautions as in daylight.

When a flare goes up, you must react instantly. Don't look at the flare, it will blind you temporarily, but hit the ground and remain motionless. As the light fades, move quickly, remembering that the enemy has also been temporarily blinded by the glare.

At night, sound is an important, revealing signal. Move carefully and quietly and stay close to the ground.

CLOTHING

Individual concealment is mostly a matter of using your head and the materials at hand. This applies to camouflage clothing as well. When issue camouflage clothing, including helmet covers, are unavailable you make your own, suiting its form and color to the terrain.



The usual order of importance, as far as camouflage of your body is concerned, is from the top of the head down. From the most frequently exposed parts to the least frequently exposed parts. This makes the job of concealing yourself easier and the enemy's job of finding you harder, and it is worth every bit of the time you devote to it. Remember though that camouflage clothing and equipment alone won't conceal you. They must be used intelligently in accordance with the principles of scouting and patrolling.

DISCIPLINE

Always remember that you are a member of a team. Camouflage discipline is the most important part of individual camouflage because not only you but all your buddies in the unit will have to suffer for the mistake of one member. Concealing and maintaining the concealment of your unit is a cooperative responsibility shared by you and by every other individual in the unit.

From the air such an innocent action as crossing an open field is easily observed. Your individual footprints show up as a light line across such a field. Keep to existing paths in a bivouac area or position of any kind. Stay on the terrain lines—fences, ditches, hedgerows, roads, and paths already there. Be sure you understand the details of the camouflage scheme for your unit and do your part in maintaining it.

CAMOUFLAGE CHECKLIST

PREPARE YOUR INDIVIDUAL EQUIPMENT IN THE FOLLOWING ORDER:

- Helmet (break form, color, shine; keep garnishing short)
- Face and hands (darken, disrupt)
- Weapons (disrupt)
- Shine (darken, conceal, remove)
- Canvas equipment (darken)
- Camouflage clothes, body nets where necessary (especially patrols, observers, covering parties)

CHOOSE POSITION CAREFULLY FOR:

- Fire mission (field of fire, observation, communication)
- Concealment, cover, obstacles

CONSIDER ENEMY VIEWPOINT (GROUND AND AIR, ENEMY IS ALERT)

USE NATURAL CONCEALMENT (TERRAIN FEATURES, DARKNESS, MIST, SHADOWS)

BLEND WITH BACKGROUND

- Silhouette (avoid becoming one)
- Shadows (use them, do not make them)

AVOID CARELESS MOVEMENT

- Move by bounds between good concealed fire positions
- Move swiftly or crawl very slowly (when forced to)
- Select time and place of movement that enemy will least notice
- Use concealed routes, buildings of all kinds, burned-out places, gorges, defiles, cliffs, embankments, caves, hollows, ditches, hedges, edges of woods with undergrowth, fence lines, terrain irregularities which contain usable shadows. Keep off roads and paths.
- Avoid landmarks, lone trees and rocks, fence corners, light ground, edges of woods with no undergrowth, all targets in silhouette.

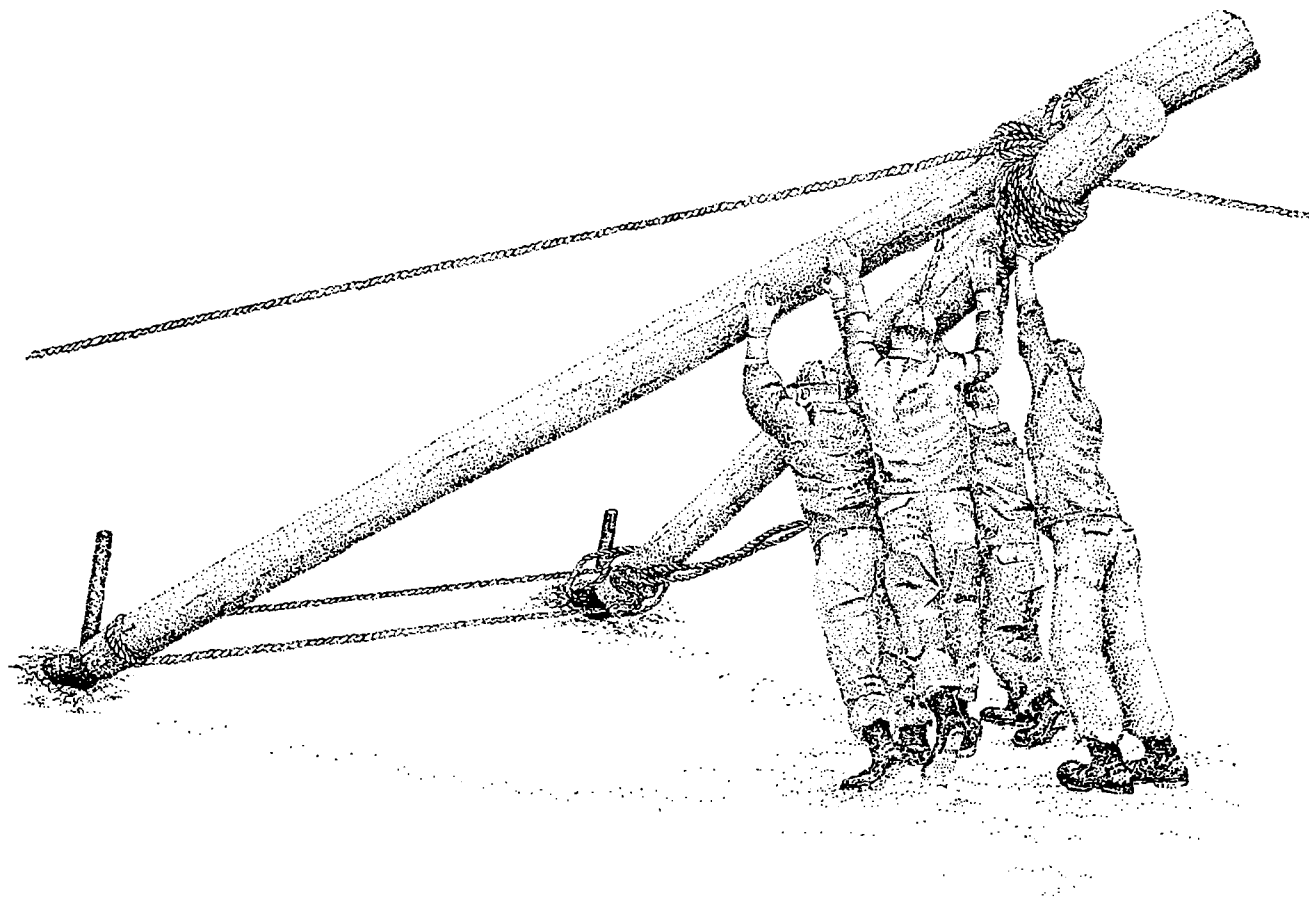
CAMOUFLAGE DISCIPLINE

- Maintain camouflage
- Carelessness may reveal the team (move quietly, avoid banging equipment)
- Do not look up at planes
- Do not walk or drive in open, make no unnecessary tracks
- Disperse on march and in bivouac
- At halts, during a march, disperse and take cover
- Do not throw trash, boxes, ration tins, or cans in the open
- Do not use open flashlights or matches in a combat area at night
- In sudden enemy light, stop moving, or drop

PART THIRTEEN

RIGGING

RIGGING, in the military sense, is the use of fiber rope, wire rope, or chain to secure a load or to reeve to gain a mechanical advantage for lifting or moving heavy objects.



CARE OF FIBER ROPE

It should be dry when stored.

It should be stored in a cool and dry area.

It should be coiled on a spool or hung from pegs in a way to allow circulation of air.

It should not be dragged through sand and dirt or over sharp edges.

Taut rope should be loosened before being exposed to rain or dampness.

A frozen rope should not be disturbed until it has thawed.

It should not be exposed to excessive heat.

HANDLING OF NEW FIBER ROPE

New rope is coiled, bound, and wrapped in burlap. The protective covering should not be removed until the rope is to be used.

To open, strip off the burlap wrapping and look inside the coil for the end of the rope. This should be at the bottom of the coil. If it is not, turn the coil over so that the end is at the bottom.

Pull the end of the rope up through the center of the coil. As the rope comes up it will unwind in a counterclockwise direction.

If loops form remove them carefully or they will develop into kinks which if pulled out will severely damage the rope.

Before going into the elementary aspects of rigging it is necessary to know the terminology of the parts of a rope.

A **BIGHT** is a bend or U-shaped curve in a rope.

The **RUNNING END** is the free or working end of a rope.

An **OVERHAND LOOP** is made when the running end passes over the standing part.

An **UNDERHAND LOOP** is made when the running end passes under the standing part.

A **ROUND TURN** is the same as a turn with the running end leaving the encircled object in the same general direction as the standing part.

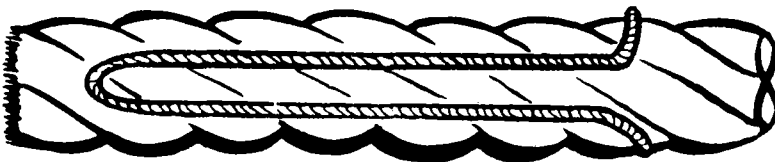
A **TURN** is the same as a loop, but it is placed around an object, such as a post with the running end continuing in the direction opposite to the standing part.

The **STANDING PART** is all of the rope excluding the running end.

The raw, cut end of a rope has a tendency to untwist and should be knotted or fastened in some manner to prevent this.

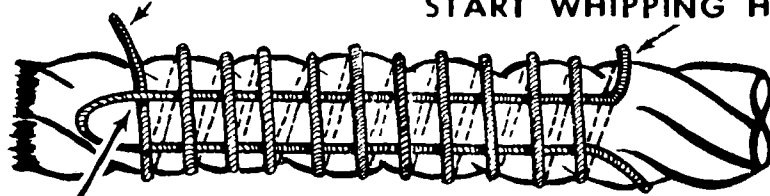
WHIPPING is one method of fastening the end of a rope. This is done by wrapping the end tightly with a small cord. Before cutting a rope place two whippings on the rope 1 or 2 inches apart and make the cut between the whippings.

LAY BIGHT ALONG ROPE



END

START WHIPPING HERE



LAST ROUND THRU LOOP

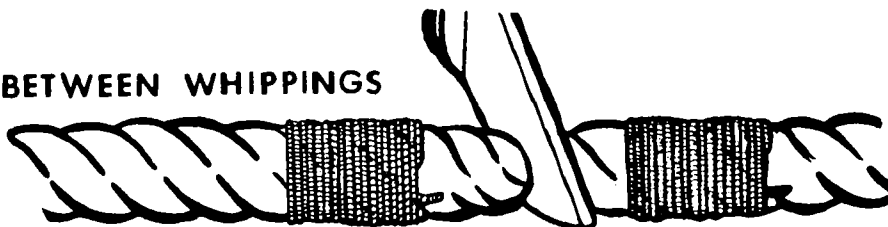
ROUNDS OPENED TO CLARIFY



PULL LOOP TO CENTER

CUT HERE

CUT BETWEEN WHIPPINGS

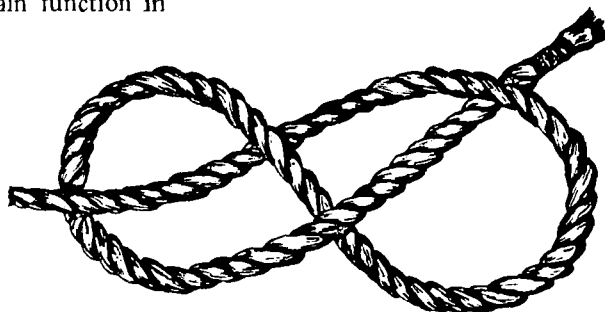


KNOTS

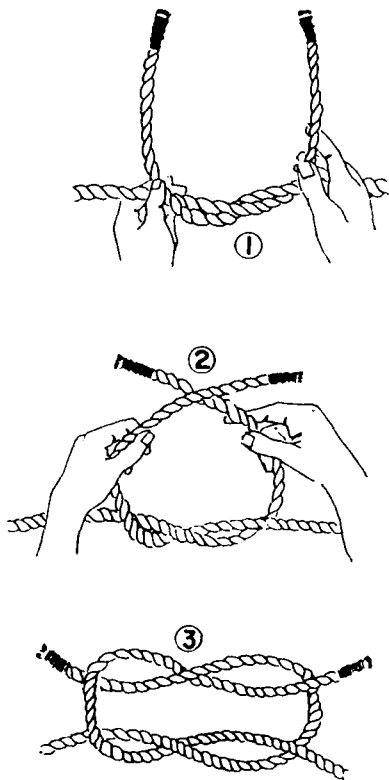
There are many different types of knots and each performs a certain function in rigging.



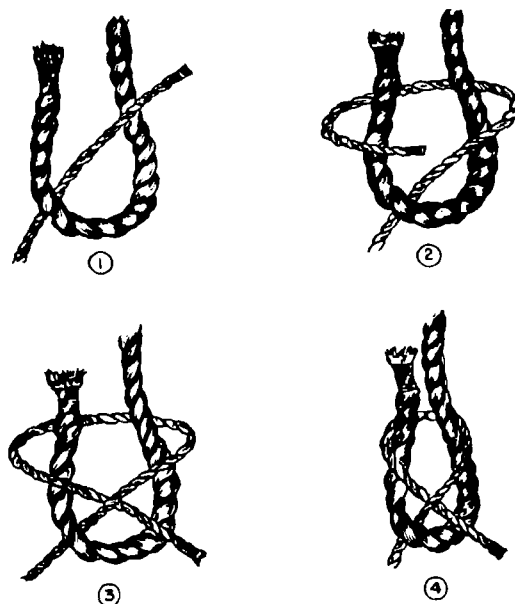
An **OVERHAND KNOT** may be used to prevent the end of a rope from untwisting.



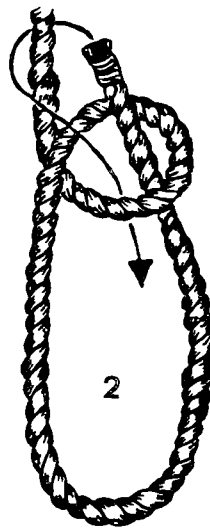
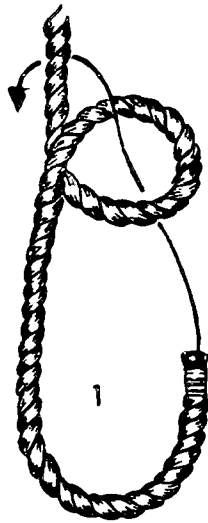
The **FIGURE EIGHT KNOT** is a larger knot than the overhand and is used in the end of a rope to prevent the end from slipping through a fastening or loop in another rope.



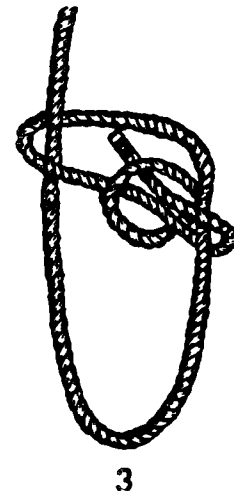
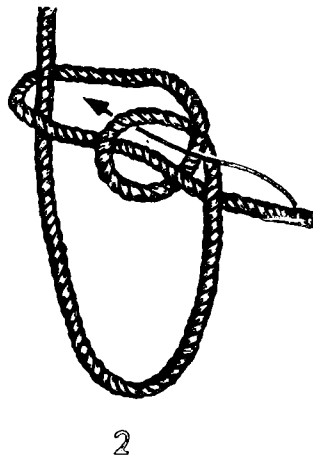
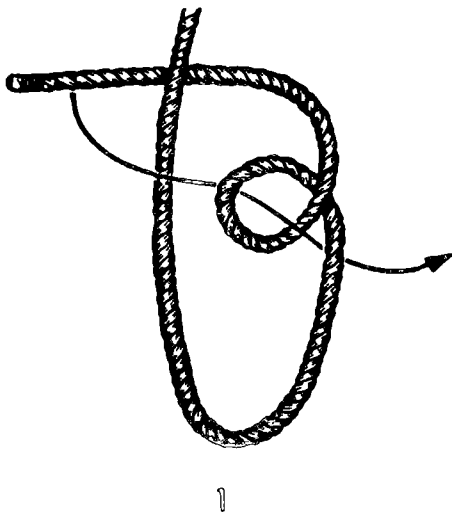
A **SQUARE KNOT** is used to tie together two ropes of the same size. It draws tighter under strain and unties easily when the two bights are grasped and pulled apart.



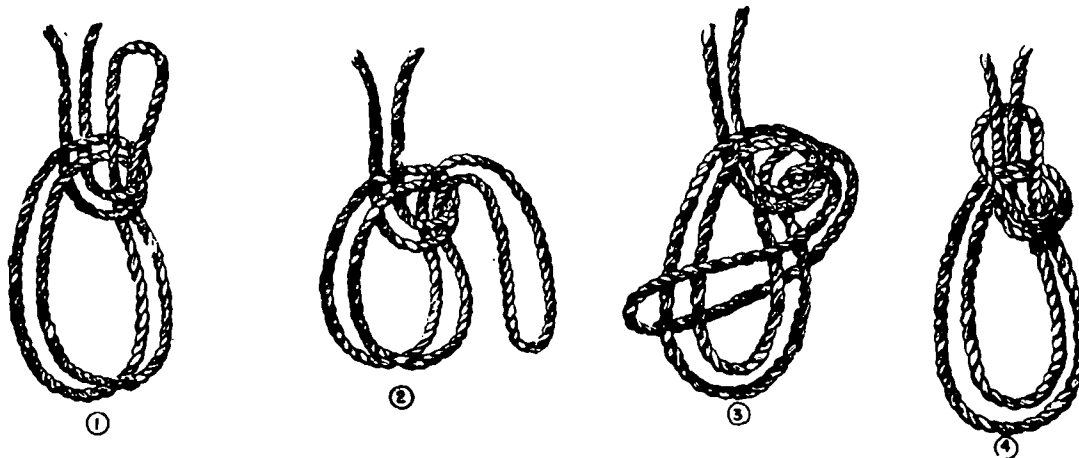
The **SINGLE SHEET BEND** (sometimes called a weaver's knot) is used to tie together two ropes of unequal size and to tie a rope to an eye. This knot will draw tight but will loosen or slip when the lines are slackened. This knot is stronger and more easily untied than the square knot.



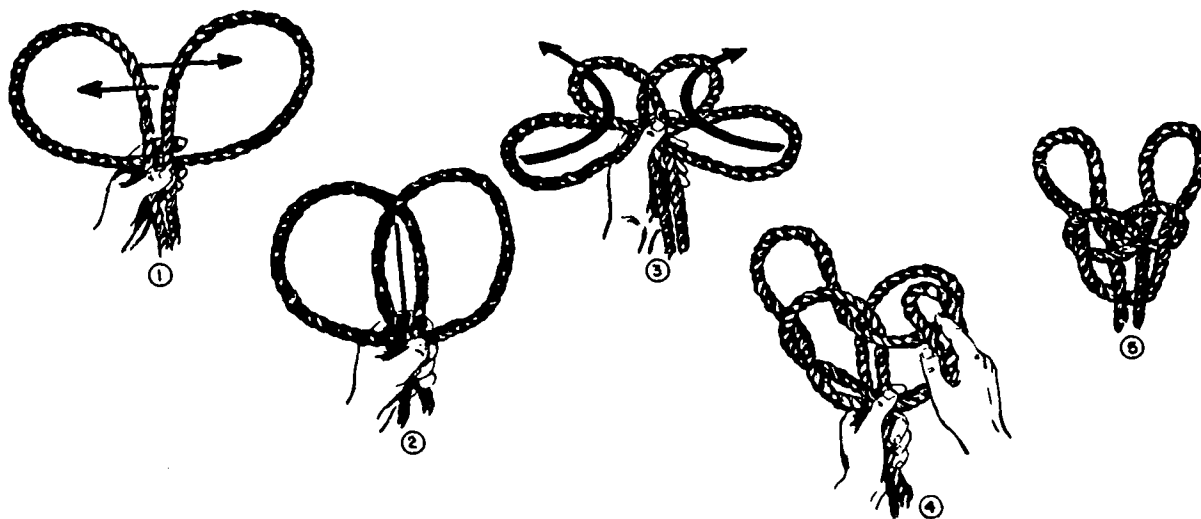
The **BOWLINE** is the best knot for forming a single loop that will not tighten or slip under strain and may be easily untied. The bowline is one of the most common and useful knots. It forms a loop which may be of any length. It can be used for lowering men or material.



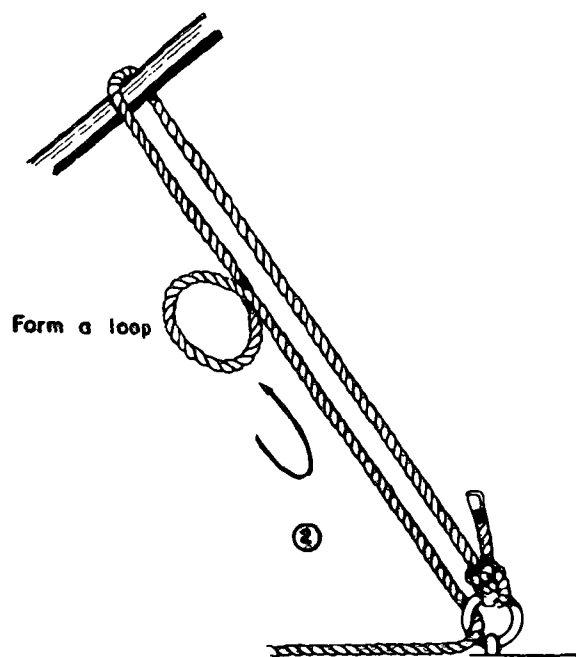
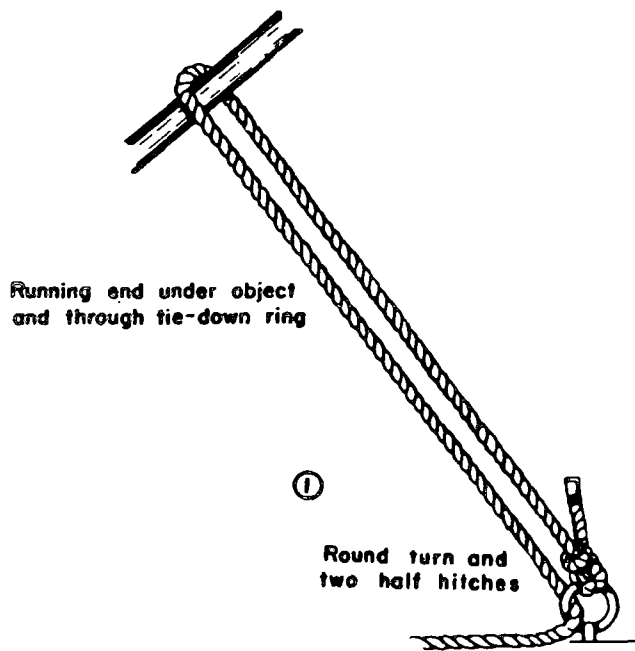
The **RUNNING BOWLINE** is a multi-purpose knot. It provides a sling of the choker type at the end of a single line and is used generally in rigging for this purpose.



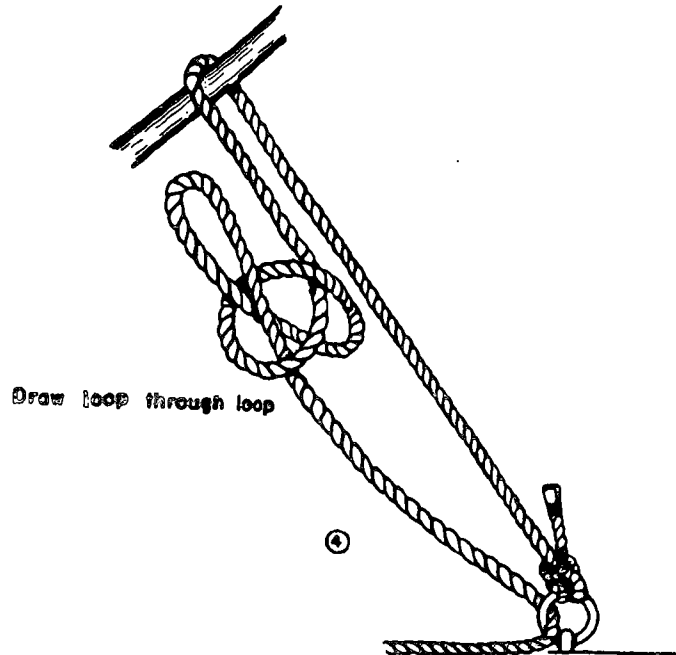
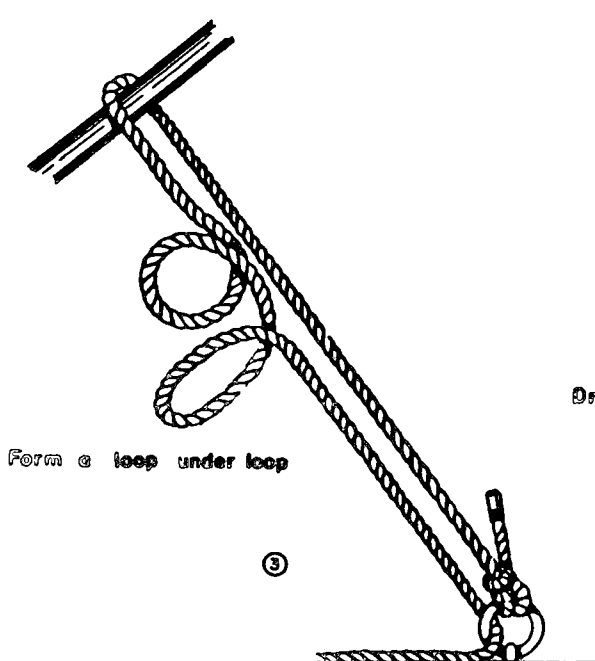
The **BOWLINE ON A BIGHT** is used to form a loop in a rope other than at the end. This knot is easily untied and will not slip.



The **SPANISH BOWLINE** can be tied at any point in a rope. This knot is used generally in rescue operations or to give a two-fold grip on a round object.

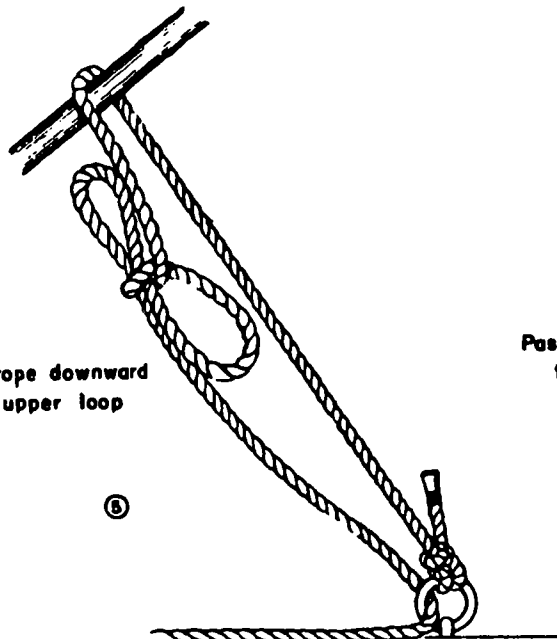


The **BAKER BOWLINE** is easy to tie, can be adjusted without losing control, and quick to release. It can be used for the same purpose as the butterfly knot and for lashing cargo. To release the rope, simply pull on the running end.



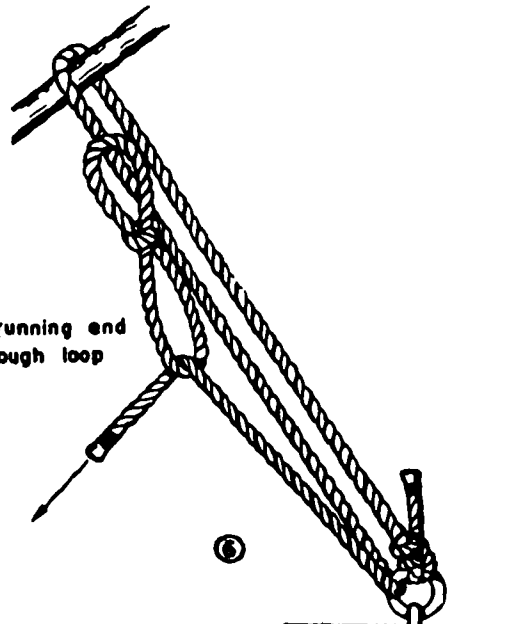
Rotate top rope downward
binding upper loop

⑤



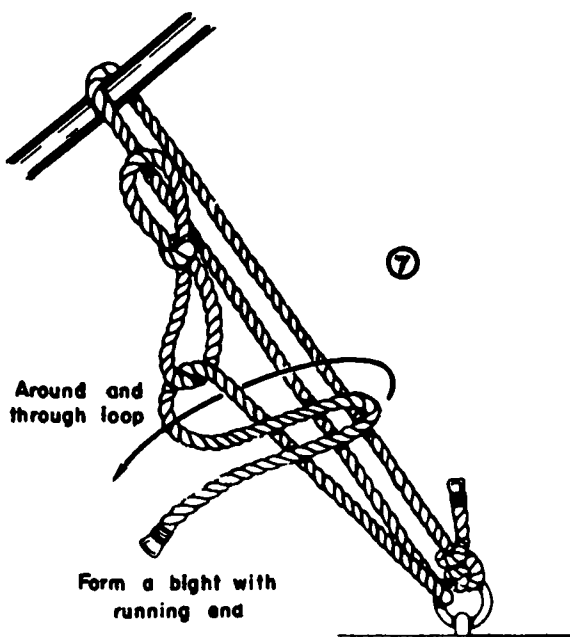
Pass running end
through loop

⑥



Around and
through loop

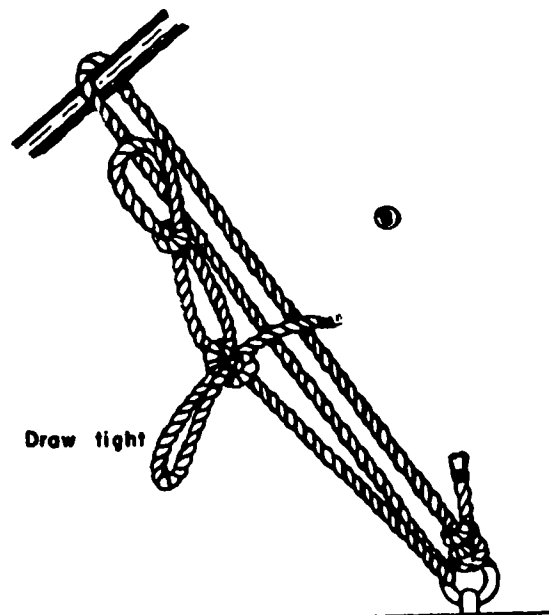
⑦

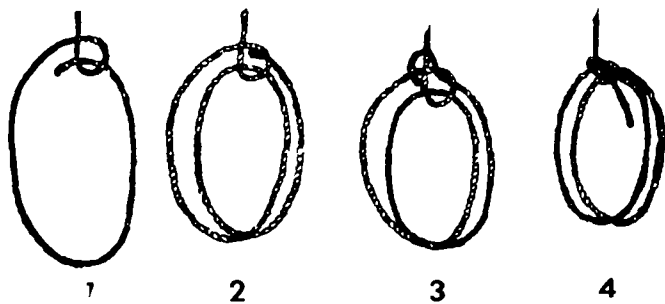


Form a bight with
running end

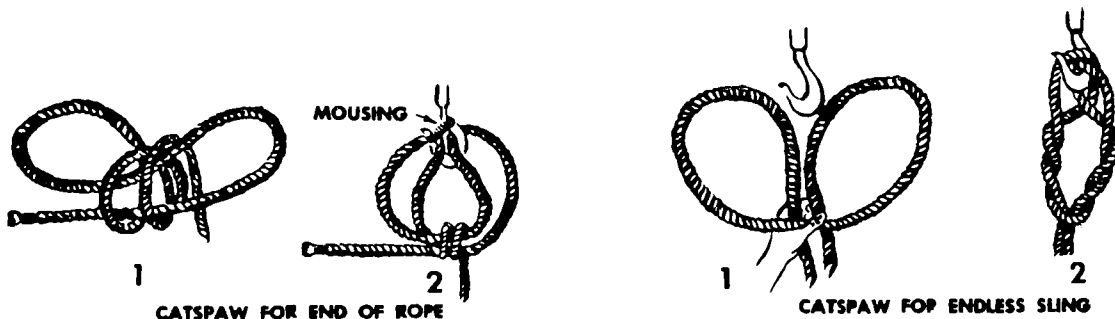
Draw tight

⑧

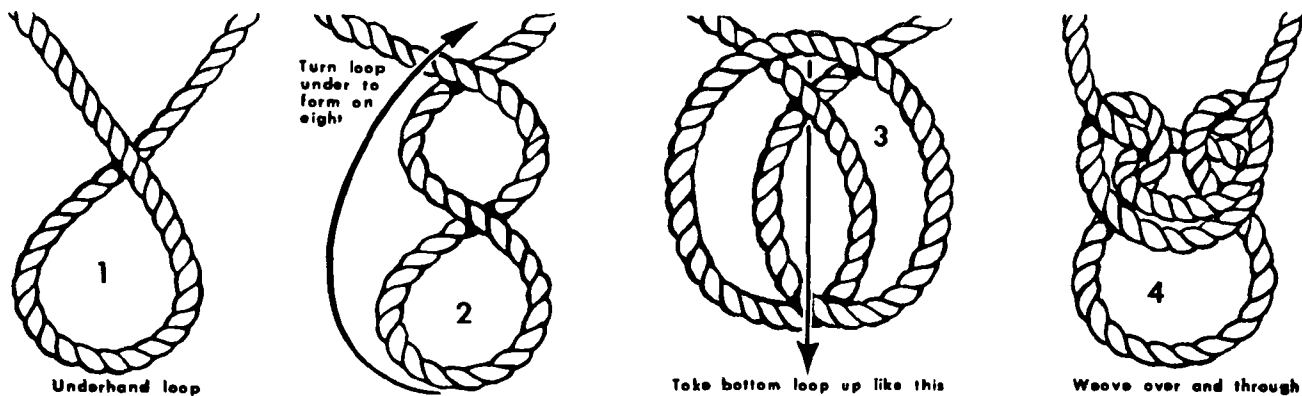




The **FRENCH BOWLINE** is often used as a sling to transport personnel. When used in this manner, one loop is the seat and the other is placed around the body or under the arms.

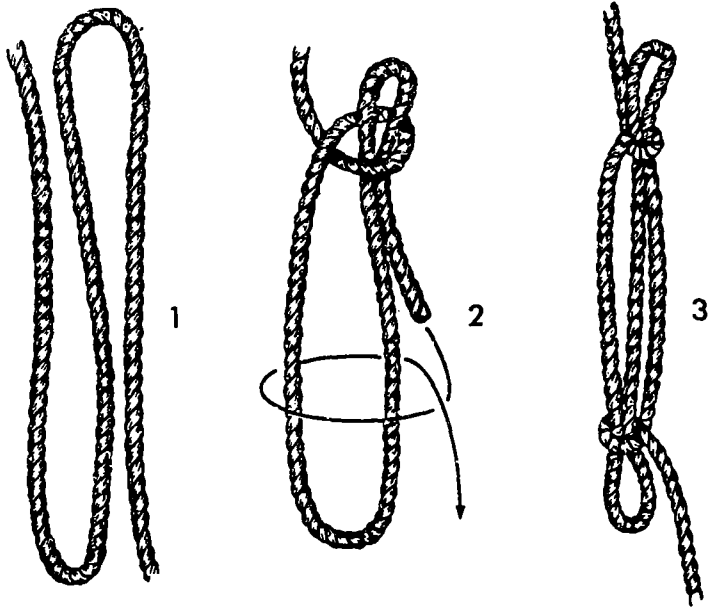


A **CATSPAWE** can be used for fastening an endless sling to a hook or it can be made at the end of a rope for fastening the rope to a hook. It is easily tied and untied. It will not slip off and needs no constant strain upon it to make it hold.



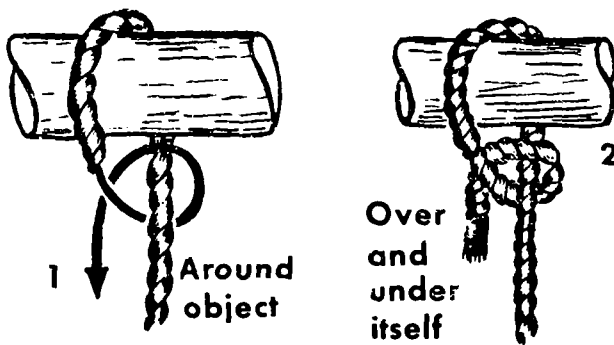
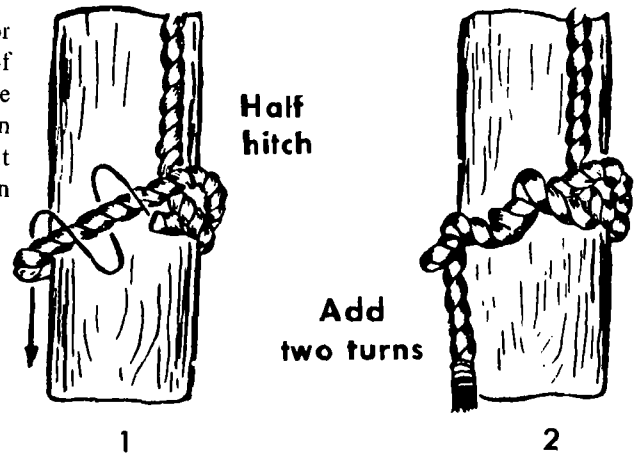
A **BUTTERFLY KNOT** is used to pull taut a high line, handline, tread rope for foot bridges, or similar installations. Using this knot allows tightening a fixed rope when mechanical means are not available. This knot will not jam if a stick is placed between the two upper loops.

HITCHES

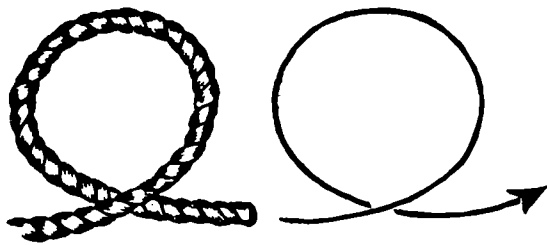


A **SHEEPSHANK** is a method of shortening a rope, but it also may be used to take the load off a weak spot in the rope. It is never made at the end of a rope. It is only a temporary knot unless the eyes are seized to the standing part of each end.

The **TIMBER HITCH** is used for moving heavy timbers or poles. It is an excellent and ready way of securing a piece of lumber or anything similar. The pressure of the coils, one over the other, holds the timber securely, the more tension applied, the tighter the hitch becomes about the timber. It will not slip under load, but will readily loosen when strain is relieved.

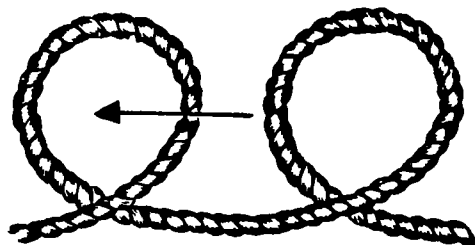


The **HALF HITCH** is an important aid and the foundation of many knots. A half hitch is the start of a timber hitch and a part of the fisherman's bend, and makes the rolling hitch more secure. It is used to tie a rope to a timber or to a larger rope. By itself, it will hold against a steady pull on the standing part, but it is not a very secure hitch and is mainly used for temporarily securing the free end of a rope.



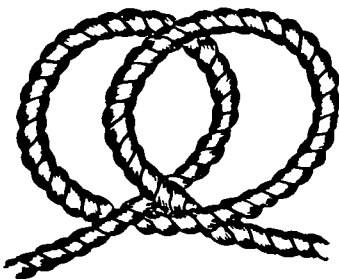
1

Underhand loop



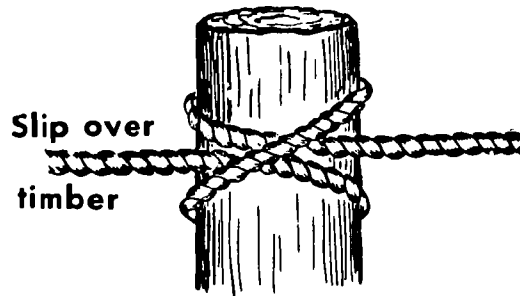
2

Add second loop



3

Lay one
loop over
the other



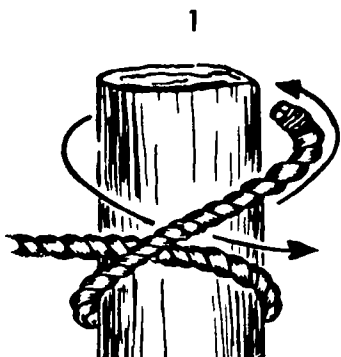
4

Slip over
timber

AT CENTER OF ROPE

The **CLOVE HITCH** is one of the most widely used. Passing around an object in one continuous direction, it puts very little strain on the fibers. It is used to fasten a rope to a timber, pipe, or post. It can be tied at any point in a rope, and is used where there is continuous tension on the line.

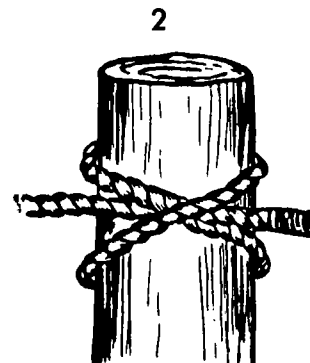
AT END OF ROPE



1

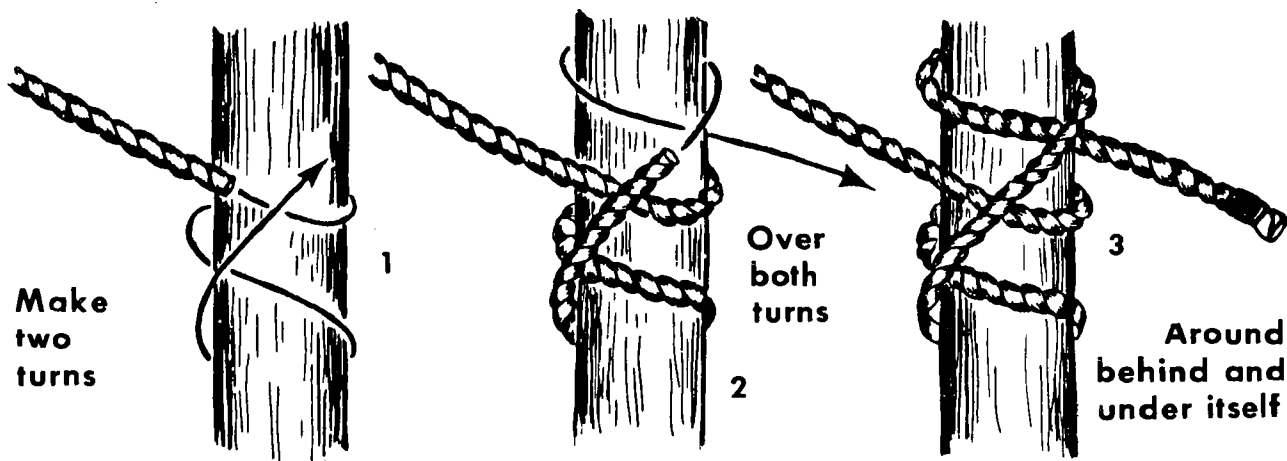
Around once

Over and
around again

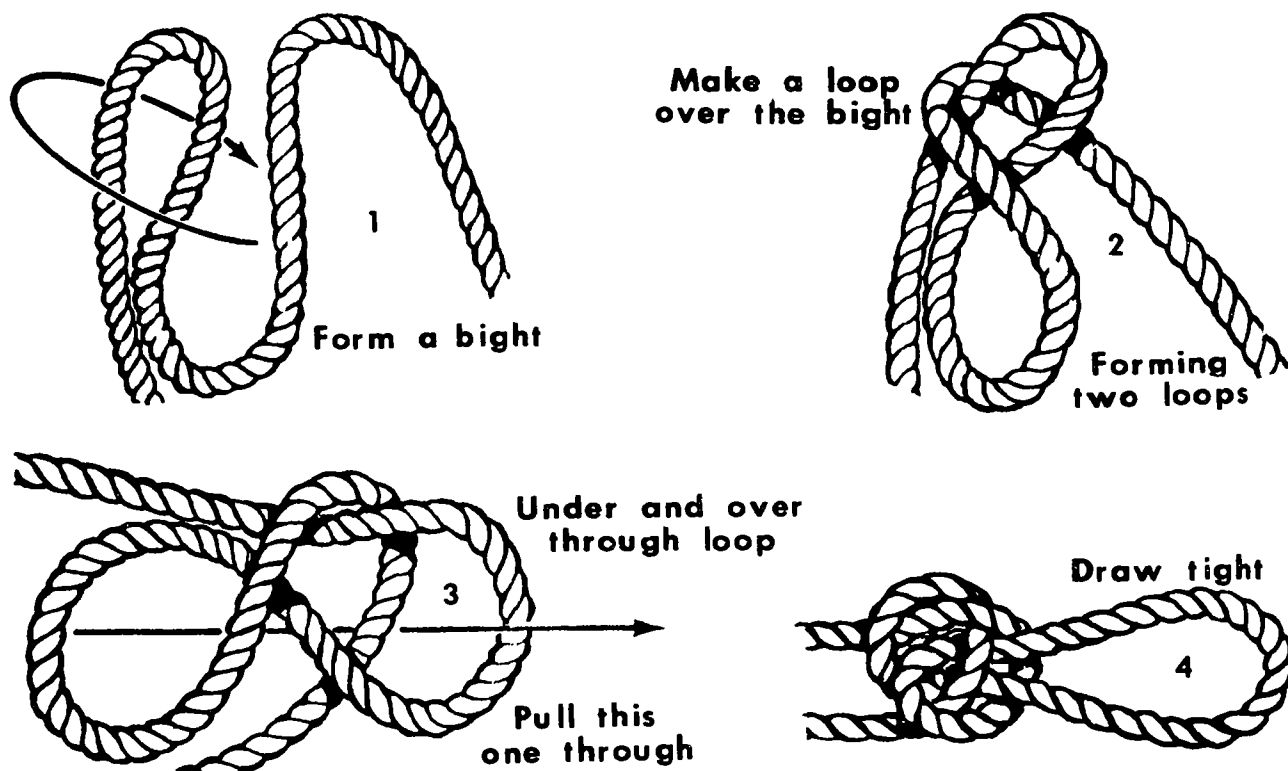


2

Under itself



The **MOORING HITCH**, also called the **ROLLING** or **MAGNUS HITCH**, grips tightly and is easily removed. The mooring hitch is used to make a rope fast around a mooring post or to attach a rope at a right angle to a post.



The **HARNESS HITCH** forms a nonslipping loop in a rope. When only one end of the rope is subject to pull, this hitch will slip. When manpower is being used for hauling, it is generally employed by putting the arm through the loop, placing the loop on the shoulder and then applying force. It is tied only in the middle of the rope.

SLINGS

SLINGS may be made of fiber rope, wire rope, or chain. The sling for lifting a given load may be an endless sling, a single sling, or several single slings used together to form a combination sling. Fiber rope makes good sling material because of its flexibility, but is more easily damaged by sharp edges on the material hoisted than wire rope or chain.

The **ENDLESS SLING** is the simplest type. It is made up by splicing the ends of a piece of wire rope or fiber rope together, or by inserting a cold shut link in a chain. These slings are easy to handle and may be used in several different ways.

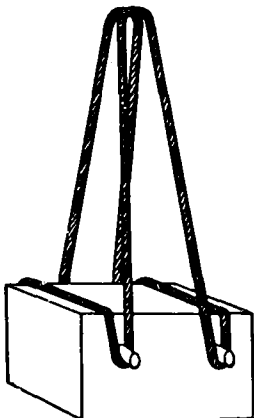
A common method is to cast the sling under the load to be lifted and insert one loop through the other and over the hoisting hook. This is a **CHOKER** or **ANCHOR** hitch.



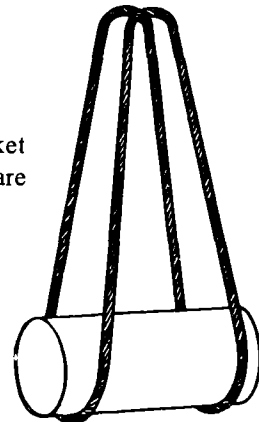
If the endless sling is passed around the object to be lifted and both remaining loops are slipped over the hook, it is called a **BASKET HITCH**.



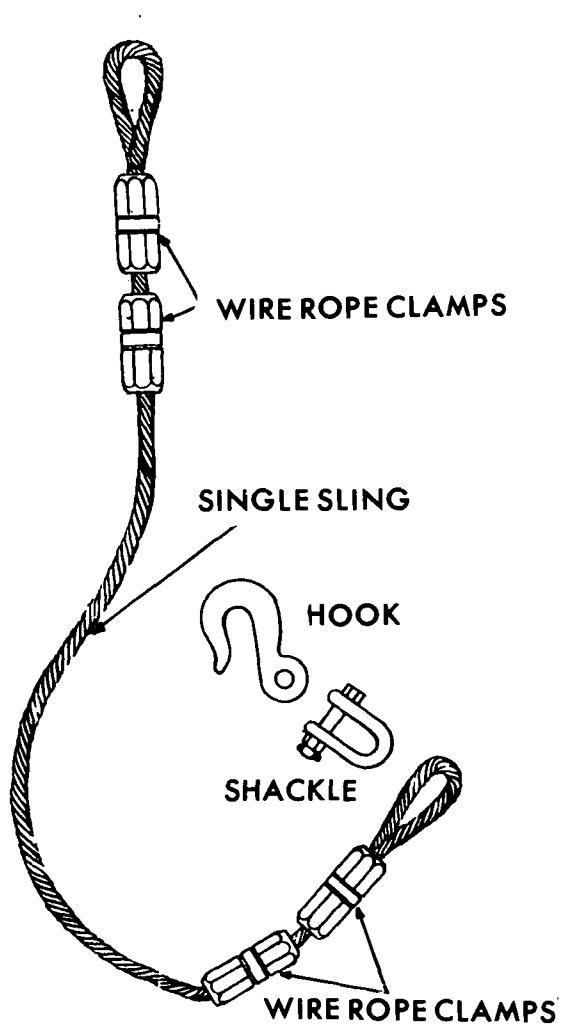
The **INVERTED BASKET HITCH** is very much like the simple basket hitch except that the two parts of the sling going under the load are spread wide apart.



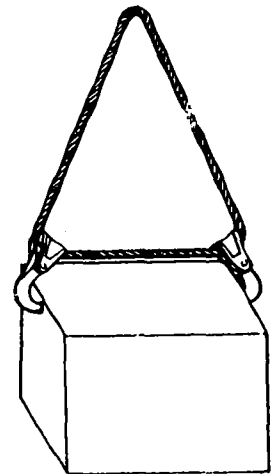
A **TOGGLE HITCH** is a modification of the inverted basket hitch except that the line passes around toggles fastened to the load rather than going around the load itself.



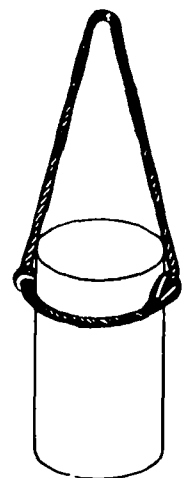
A **SINGLE SLING** may be made of wire rope, fiber rope, or chain. Each end of the sling is made up into an eye, or has a hook attached.



Another application of a single sling is the **DOUBLE ANCHOR HITCH** which is used for hoisting drums or other cylindrical objects where it is necessary for the sling to tighten itself under strain and lift by friction against the sides of the cylinder.

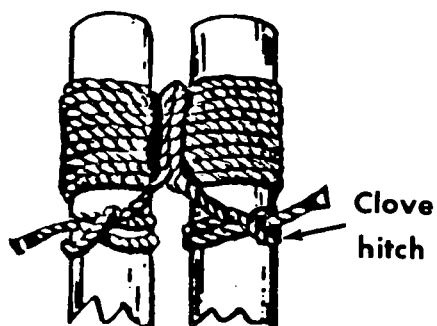
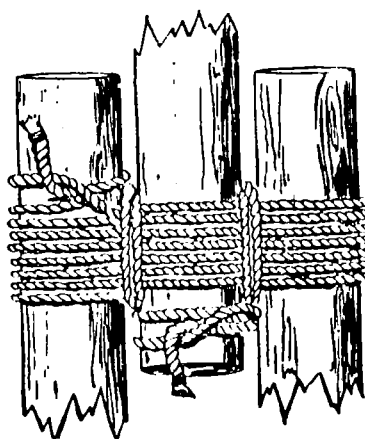
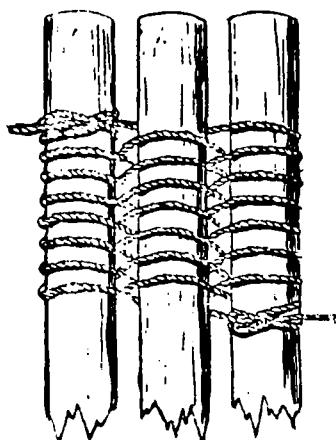


They can be used like the endless sling in a choker hitch or a basket hitch. In addition, single slings with two hooks are used sometimes for lifting stone and are known as **STONE BOG HITCHES**.

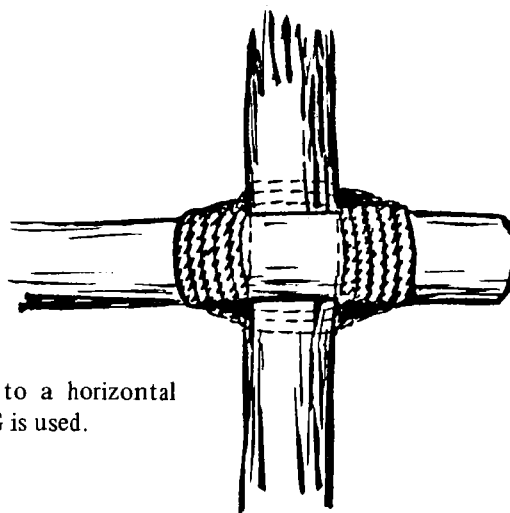


LASHING

LASHING is the wrapping of rope around two or more pieces of timber, usually referred to as spars or legs, to fasten them together. Shown here are two ways of lashing three spars to form a tripod.



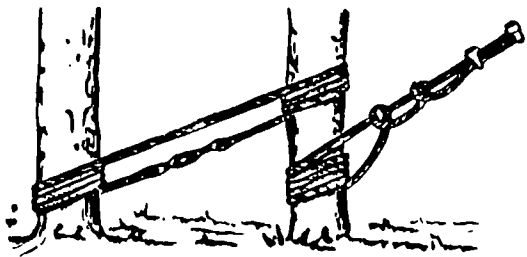
Detail for
shear lashing



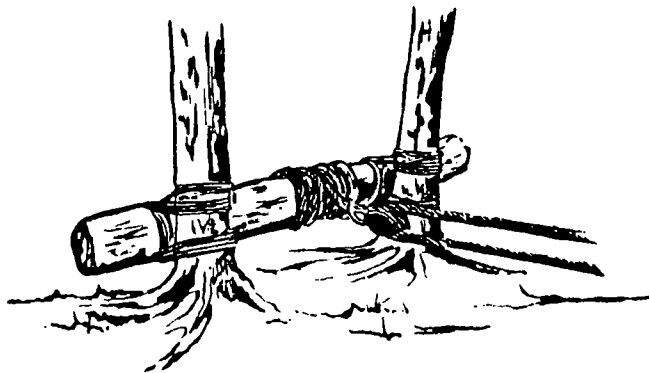
To fasten a vertical member to a horizontal member, a **SQUARE LASHING** is used.

ANCHORAGES

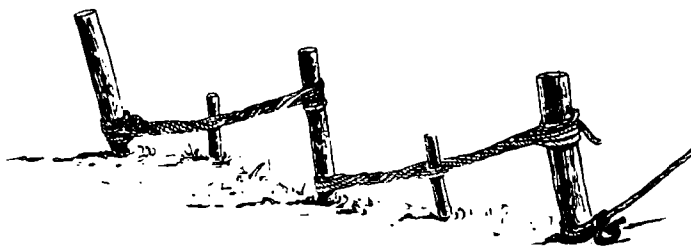
When heavy loads are handled with tackle, it is necessary to have some means of anchorage. Natural, temporary, or permanent anchorages may be used for rigging to support guylines. Wherever possible, natural anchorages should be used for speed and economy. Temporary anchorages include pickets, rock anchors, holdfasts, and deadmen. Permanent anchorages may be made up of steel anchors set in concrete or fastened to permanent structures. Guylines should always be fastened to anchorages at a point as near to the ground as possible and the guyline should leave the anchorage as nearly parallel to the ground as possible.



NATURAL
ANCHORAGES

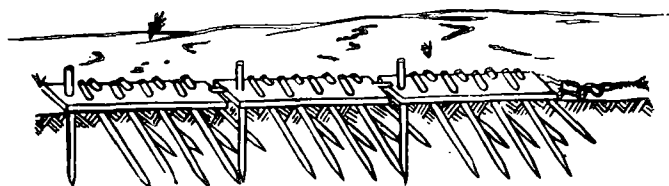
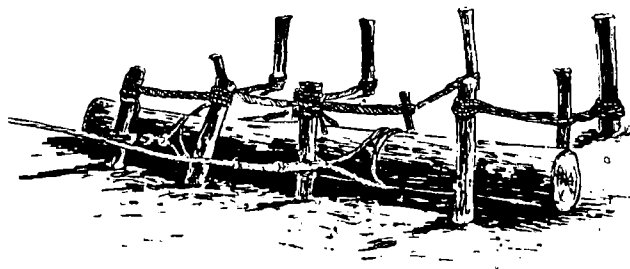


PICKET HOLDFASTS



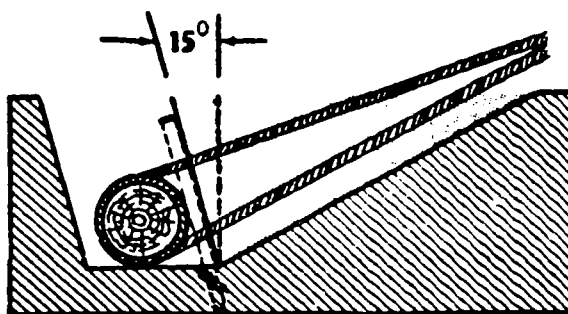
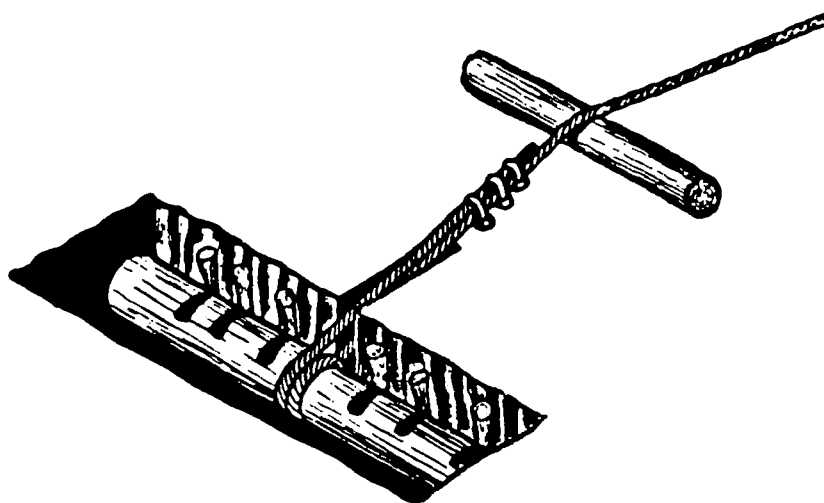
To make a **MULTIPLE HOLDFAST**, pickets at least 3 inches in diameter and 5 feet long are driven into the ground 3 feet and spaced 3 to 6 feet apart, being careful to keep them in line with the guyrope.

For heavy loading it is desirable to spread the load over the largest possible area of ground. This is accomplished by increasing the number of pickets used. Four or five multiple holdfasts can be made up parallel to each other with a heavy log resting against the front pickets to form a **COMBINATION LOG PICKET HOLDFAST**. The guyline or anchor is fastened to the log which bears evenly against the pickets.



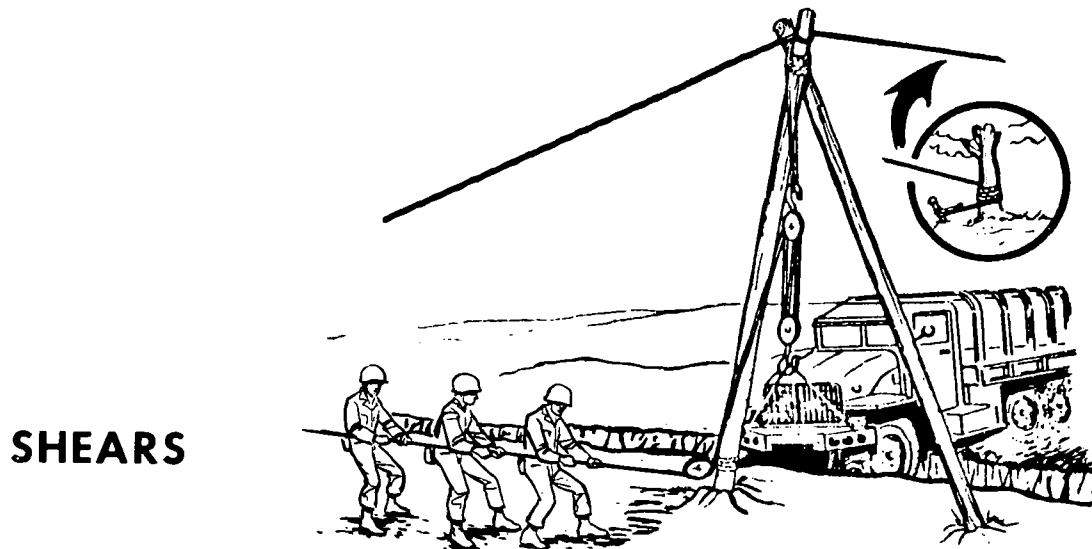
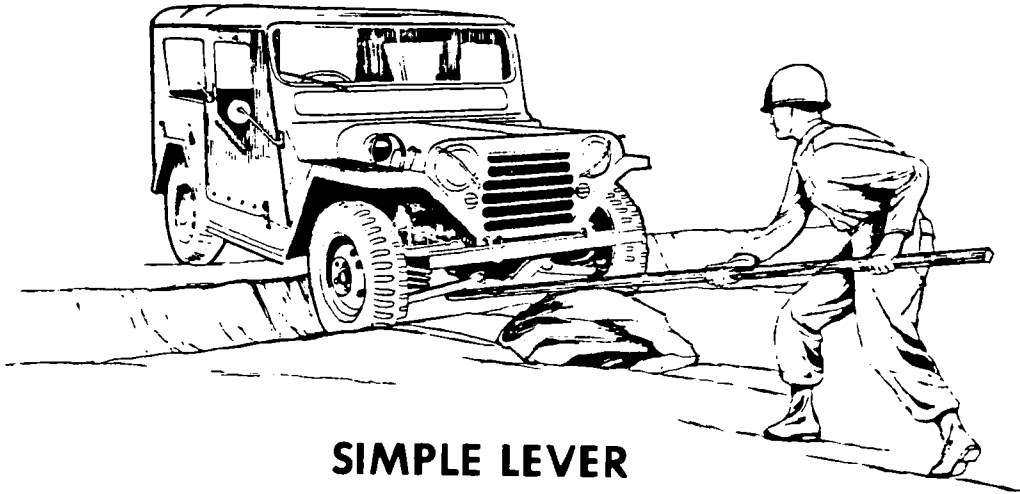
A **STANDARD STEEL PICKET HOLDFAST** is available on issue or can be easily fabricated. It consists of a steel plate with nine holes drilled through it and a steel eye welded on the end for attaching the guyline. The steel pickets are driven through the holes in a manner that clinches the pickets in the ground. This holdfast is especially adapted for anchoring horizontal lines, such as the anchor cable on a ponton bridge.

The **DEADMAN** consists of a log, timber, steel beam, or similar object buried in the ground with the guyline connected in the center. For heavy loads the deadman is the best form of anchorage because of the large surface area presented against undisturbed soil. When constructing a deadman, place it where the direction of pull is as nearly horizontal as possible. To strengthen the anchor, drive stakes into the bank at several points over the deadman.

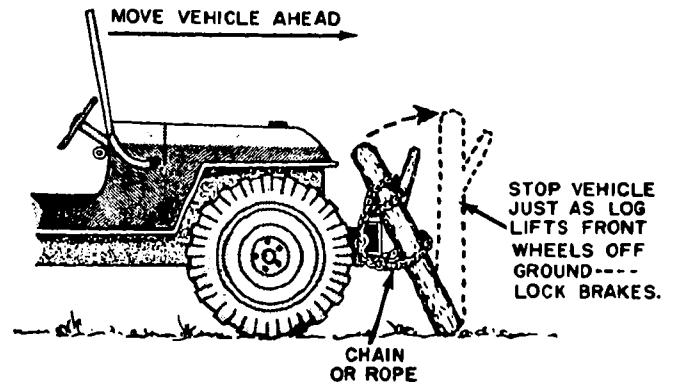
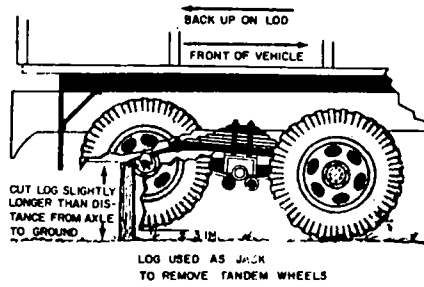


EXPEDIENT VEHICLE RECOVERY

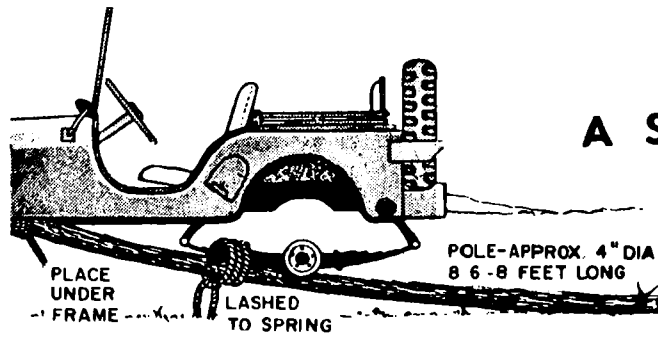
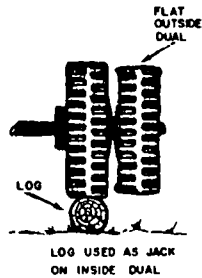
The possibility of vehicles becoming stuck or disabled when assistance from experienced recovery teams is not available should never be discounted. Expedient vehicle recovery techniques, based on elementary rigging principles may often prove your only salvation.



JACK SUBSTITUTES

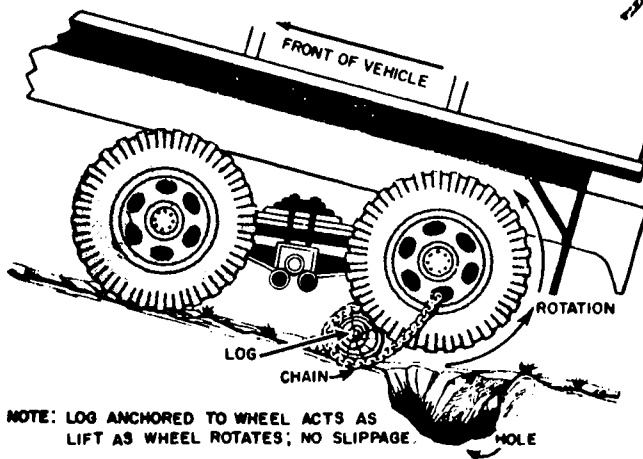
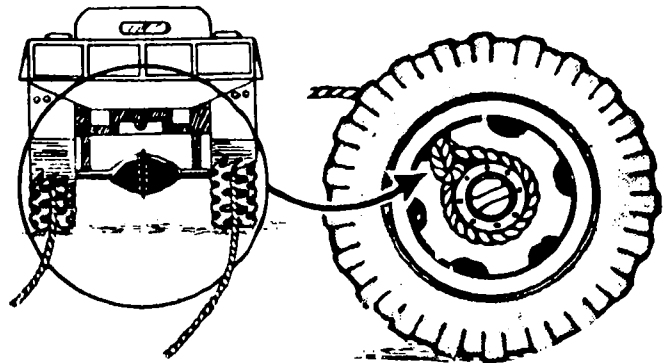


LOG LASHED TO BUMPER TO REMOVE FRONT WHEELS.



A SKID

USING WHEEL FOR WINCH

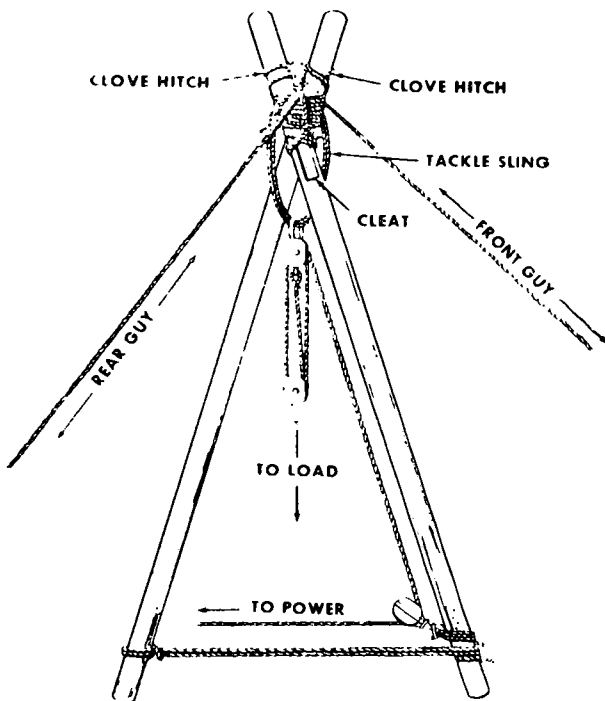


NOTE: LOG ANCHORED TO WHEEL ACTS AS LIFT AS WHEEL ROTATES; NO SLIPPAGE.

ANCHORING A WHEEL

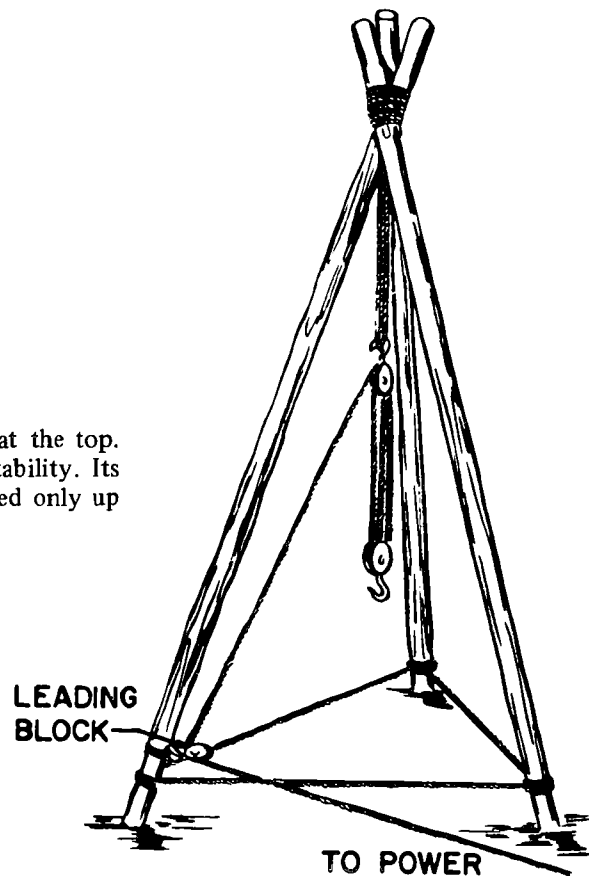
LIFTING AND MOVING LOADS

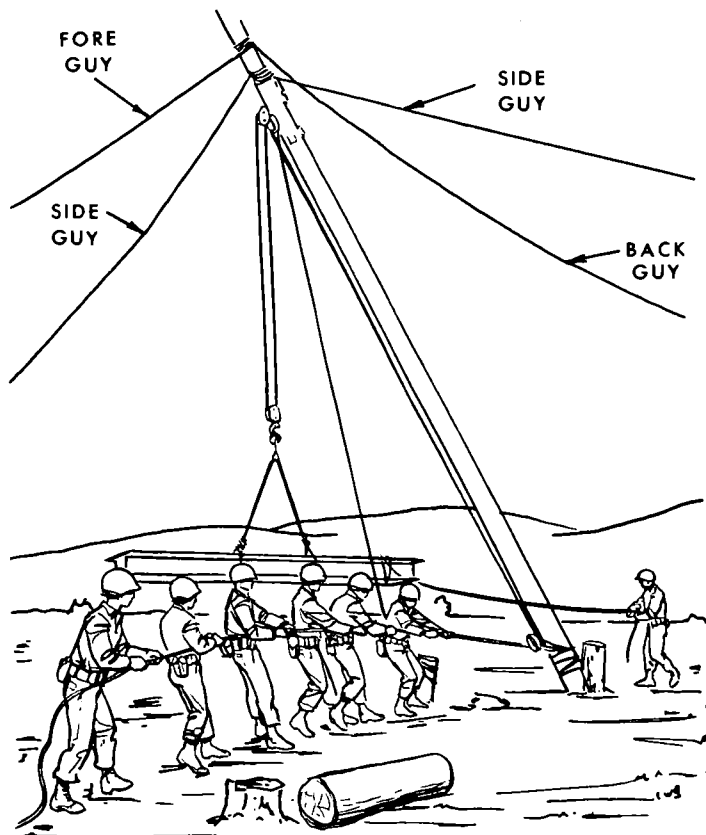
With an elementary knowledge of rigging, rope, tackle, and timber, devices can be made in the field to assist greatly in lifting or moving heavy loads. These devices are called gin poles, tripods, shears, and boom derricks.



SHEARS are easily assembled and require only two guys, and are adaptable to working at an inclination from the vertical. In addition to their hoisting and lifting capabilities, shears are used extensively as towers for cableways and in floating bridge operations.

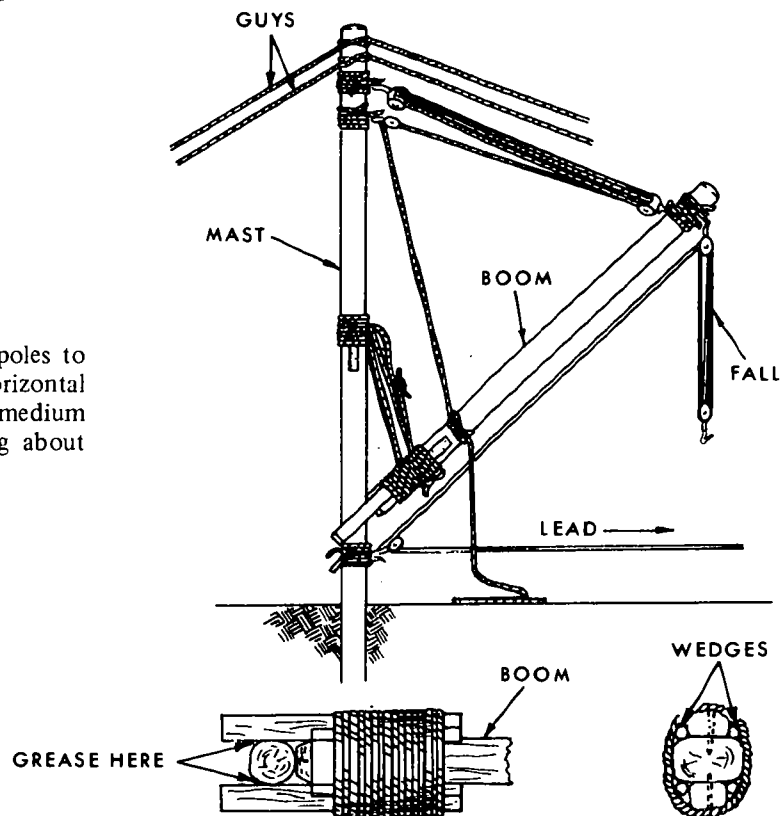
A **TRIPOD** consists of three legs lashed at the top. Its advantage over other devices is its stability. Its disadvantage is that the load can be moved only up and down.





A **GIN POLE** consists of an upright spar which is guyed at the top to maintain it in vertical or nearly vertical position, equipped with suitable hoisting tackle. The load may be hoisted by hand tackle or by use of hand or engine driven hoists. The gin pole is used widely in erection work because of the ease with which it can be rigged, moved, and operated.

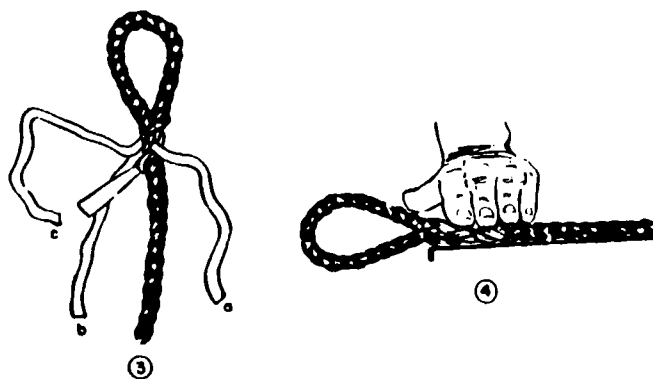
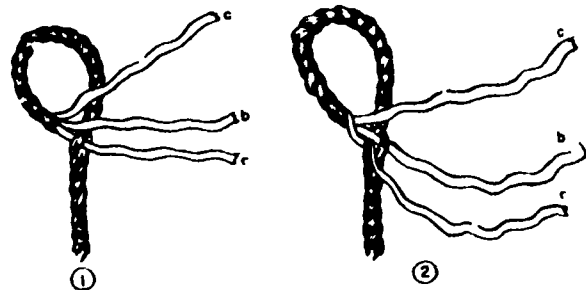
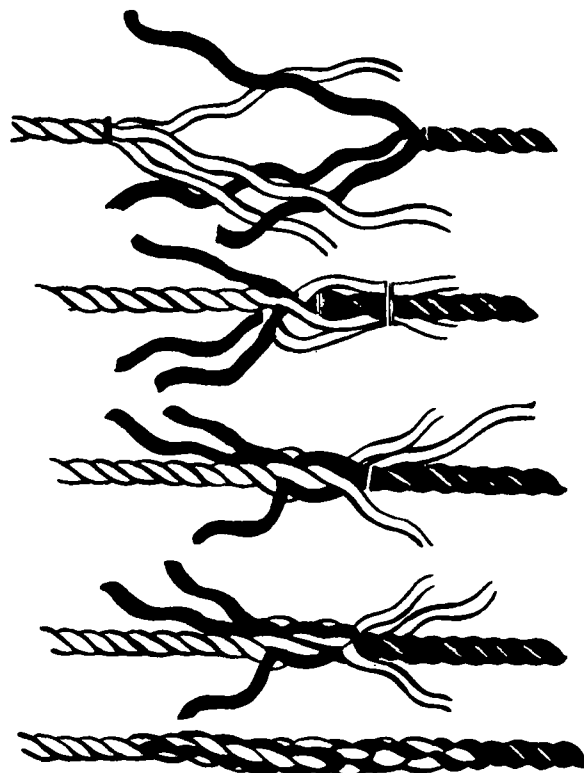
BOOMS are used on gin poles to lift loads where a long horizontal reach is required. For medium loads, the boom can swing about the gin pole.



SPLICES

SPLICES are used to join fiber rope or wire rope. The splices are as strong as the rope itself. There are four general types of splices in fiber rope—long, back, short, and eye splices. All are similar, and if one is mastered all can be made easily. No special tools are necessary but it will be helpful if you have a marline-spike available. All splices consist of three principal steps; unlaying the strands of the rope, placing rope ends together, and interweaving the strands and tucking them into the rope.

The **SHORT SPLICE** causes an increase in the diameter of the rope for a short distance and can be used only when this increase will not affect the operation of the rope.



The **EYE SPLICE** is used for making a permanent loop in the end of a rope.

CARE AND USE OF WIRE ROPE

Reels of wire rope should not be dropped. Weight of rope may break reel, permitting rope to become kinked.

Prying with bars should be done on flanges of reel, not on the rope.

Wire rope should be stored in a dry place and away from corrosive fumes. Outside layer of reel or coil should be protected by a layer of lubricant. Wire in use should be well lubricated.

Newly installed wire rope should be worked for a while without load to enable the rope to adjust itself to the working conditions.

To avoid sharp kinks, all loops in slack rope should be straightened before load is applied. To remove a kink, wire rope must be bent back and reversed to direction in which kink was formed. A kink cannot be straightened by pulling the rope taut. This merely unlays the rope.

Loads must not be applied suddenly. This puts excessive strain on the rope.

Avoid using wire rope on sheaves or drums which are too small and avoid reverse bends or sudden changes in direction or pull. Either of these conditions causes severe strain and broken wire in strands which weakens rope.

To avoid accidents stand clear of any wire rope under tension.

Work gloves should be worn at all times when handling wire rope.

WIRE ROPE ATTACHMENTS

Attachments for wire rope are designed to take the place of knots.

Most of the attachments used with wire rope provide an eye on the end of the rope by which maximum strength can be obtained when the rope is connected with another rope, hook, or ring. Any two of the ends can be joined either directly or by the aid of a shackle or end fitting.

PART FOURTEEN

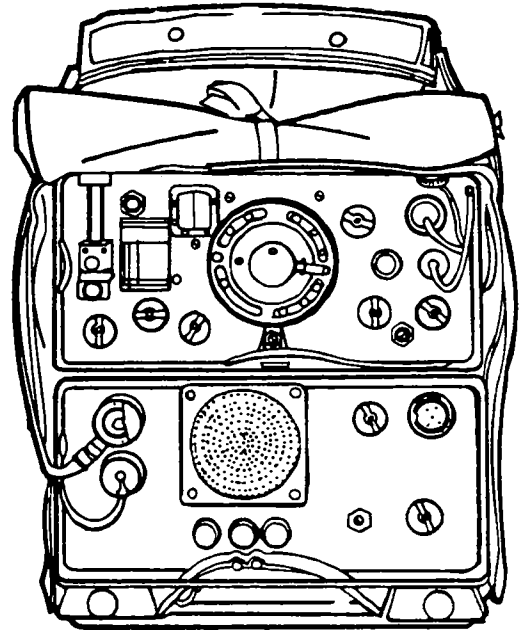
SIGNAL COMMUNICATIONS



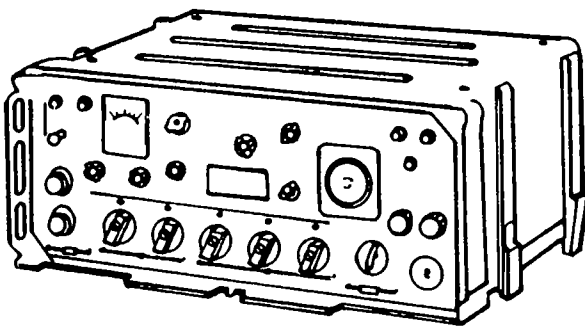
You very likely will be exposed to the following items of communications equipment regardless of the type of engineer unit to which you are assigned.

RADIO

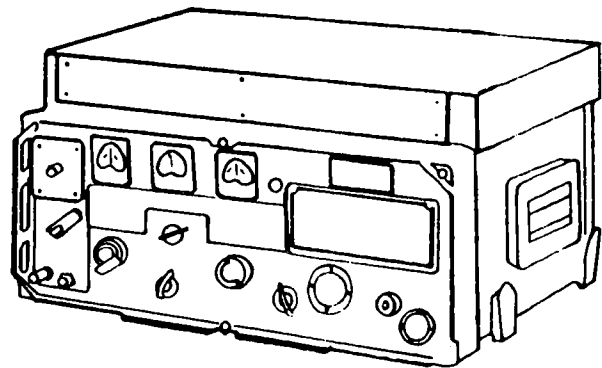
RADIO AN/GRR-5 is a receiver intended for use either in a field station or for mobile operation. It is used to monitor the division warning net.



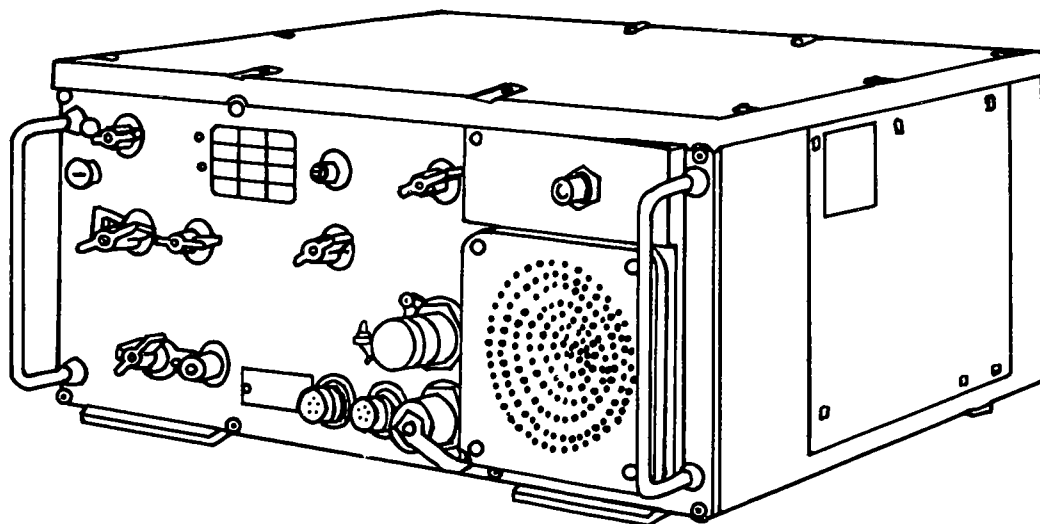
RADIO SET AN/GRC-106(AM) is employed primarily in forward area tactical command and administrative nets where range or terrain precludes use of FM equipment. It is found in the engineer combat company headquarters. It may be installed in a 1/4-ton utility truck or any other vehicle that has a 24-volt ignition system. Here are the components of the AN/GRC-106.



**RECEIVER-TRANSMITTER,
RADIO RT-662/GRC**



**AMPLIFIER , RADIO
FREQUENCY AM 3349/GRC 106**



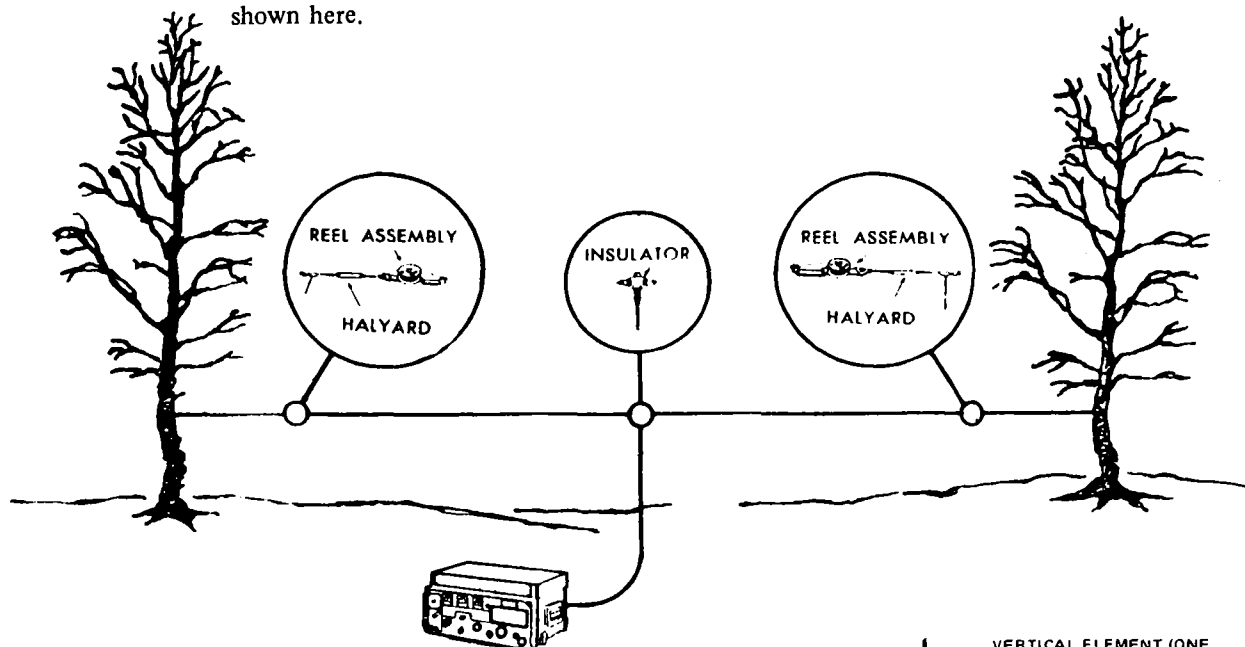
RADIO SET AN/VRC-46 is a configuration of the AN/VRC-12 family using manual tuning. It is designed for use in vehicles in which the operator has ready access to all controls and has a requirement to monitor and transmit on one frequency. Its basic component is the receiver RT-524/VRC shown here. In engineer units, the AN/VRC-46 is the primary means of communications for the platoon leader.

RADIO SET AN/VRC-47 is also a manually tuned configuration of the AN/VRC-12 family which is used when a requirement exists to monitor two channels simultaneously and to transmit on one channel at a time. It is similar to the AN/VRC-46 with the addition of an auxiliary receiver which gives the operator the capability of monitoring an additional channel while operating. In engineer units it is the primary means of communications for the company commander.

The RADIO SET AN/GRC-125 is the vehicular version of the man-pack AN/PRC-25 which is shown here. It is commonly called the ON-OFF vehicle set. There are 14 of these radio sets in the engineer combat company.

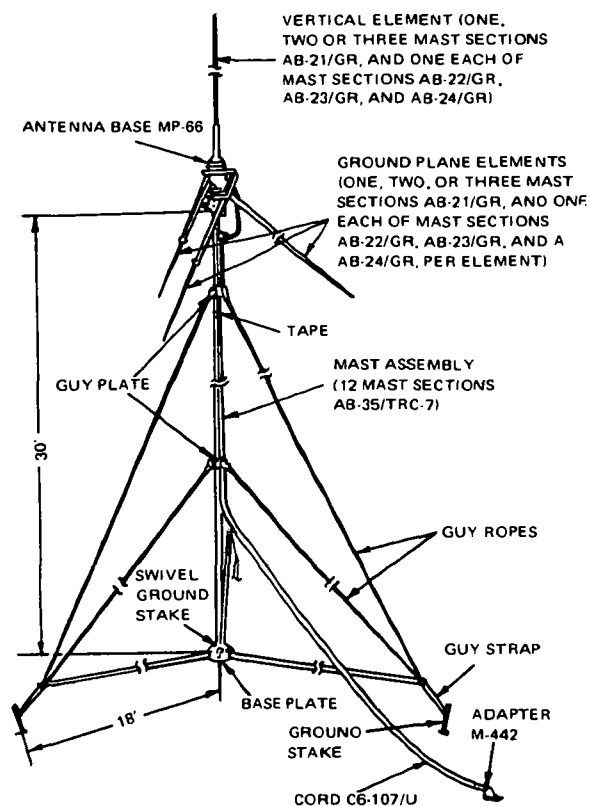


The ANTENNA is a part of the electrical circuit of a transmitter or a receiver and either radiates energy into space or receives energy from space. The same antenna that radiates energy, in most cases, is used to receive energy, however, an antenna used for this purpose cannot radiate and receive at the same time. The Army uses many types of antennas for vehicular, portable, or field use. Two items of antenna equipment are shown here.



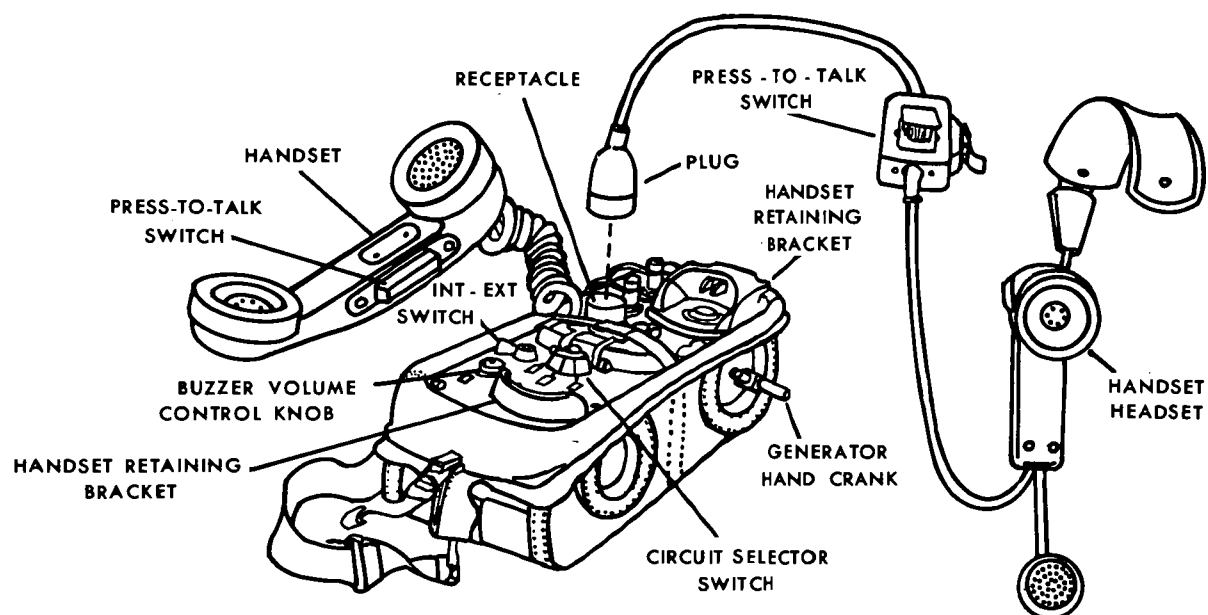
The antenna group AN/GRA-50 is a portable half-wave antenna assembly designed to increase the range of AM radio sets. It is directional and radiates and receives its strongest signal broadside to its length.

Antenna Group RC-292 is an elevated wide-band modified ground plane antenna designed to operate with and increase the distance range of FM radio sets.

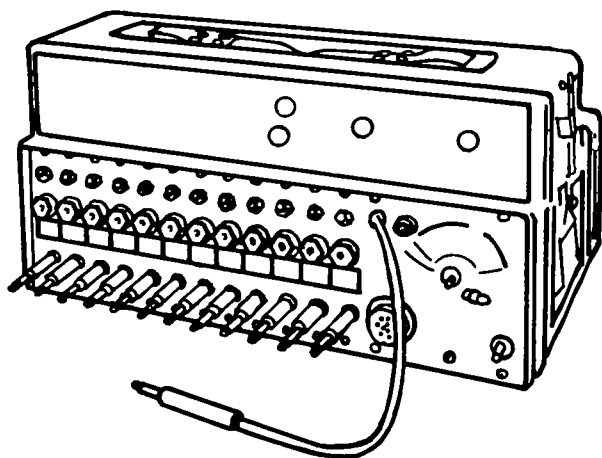


WIRE

The TELEPHONE SET TA-1/PT is a complete sound-powered telephone in handset form designed for talking and signaling without having to use batteries.



The TELEPHONE SET TA-312/PT is a field telephone set having the receiver end of the handset designed to fit under your steel helmet. Its power is supplied by two batteries.



The SWITCHBOARD TELEPHONE SB-22/PT is found in company headquarters in engineer units. Under normal operation it handles 12 field wire lines.

INTERNATIONAL MORSE CODE

A . —

B — ...

C — . — .

D — ..

E .

F .. — .

G — — .

H

I ..

J . — — —

K — . —

L . — ..

M — —

N — .

O — — —

P . — — .

Q — — . —

R . — .

S ...

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8 — — — ..





































9 — — — — .

0 — — — — —

MILITARY LETTERING AND PHONETIC ALPHABET

Legibility is important in making hand printed entries in logs, registers, number sheets, etc. Entries should be typed or legibly hand printed. Most letters are formed with a straight line as the foundation stroke. The letter Z has a line through the center to distinguish it from the number 2. The numeral 1 has a line under it to distinguish it from the letter I. A zero has a line diagonally through it to distinguish it from the letter o.

Certain letters of the alphabet have similar sounds and often are confused in telephone conversations. The phonetic alphabet shown here indicates the words to be used in voice communications to represent letters of the alphabet and numbers.

					
ALFA (AL FAH)	BRAVO (BRAH VOH)	CHARLIE (CHAR LEE)	DELTA (DELL TAH)	ECHO (ECK OH)	FOXTROT (FOKS TROT)
					
GOLF (GOLF)	HOTEL (HOH TELL)	INDIA (IN DEE AH)	JULIETT (JEW LEE ETT)	KILO (KEY LOH)	LIMA (LEE MAH)
					
MIKE (MIKE)	NOVEMBER (NO VEM BER)	OSCAR (OSS CAH)	PAPA (PAH PAH)	QUEBEC (KEH BECK)	ROMEO (ROW ME OH)
					
SIERRA (SEE AIR RAH)	TANGO (TANG GO)	UNIFORM (YOU NEE FORM)	VICTOR (VIK TAH)	WHISKEY (WISS KEY)	XRAY (ECKS RAY)
					
YANKEE (YANG KEE)	ZULU (ZOO LOO)	WUN	TOO	THUH-REE	FO-WER
					
FI-YIV	SIX	SEVEN	ATE	NINER	ZERO

WORLD TIME ZONES AND TIME CONVERSION TABLE

The date and time in messages are expressed as six digits followed by a zone suffix. The first pair of digits denotes the date, the second pair the hour (24-hour clock), the third pair the minutes past the hour. An example of a date-time group with a zone suffix is 201132Z.

Greenwich Civil Time is accepted as the basis for measuring the time throughout the world. Time groups expressing GCT are designated by the letter suffix Z immediately following the last digit of the group. Any other suffix used after a 4 digit time group indicates the zone in which the local civil time is expressed. It does not designate location on the earth's surface. The proper suffix can be determined from the time zone map and the time conversion table which appear on the following pages.

[illegible]

The **TIME CONVERSION TABLE** converts time in one zone to time in any other zone. Vertical columns indicate time zones. Zone Z is Greenwich Civil Time. Time in each successive zone to the right of zone Z is 1 hour later, to the left of zone Z is 1 hour earlier. Time in each successive shaded area to the right is one day (24 hours) later, to the left is one day earlier. To determine the time in zone Z when it is 0500 hours in zone 1 find 0500 in column 1 and locate figure 2000 in the corresponding line in column Z. Since 2000 is not in a shaded area, the time is 2000 hours yesterday.

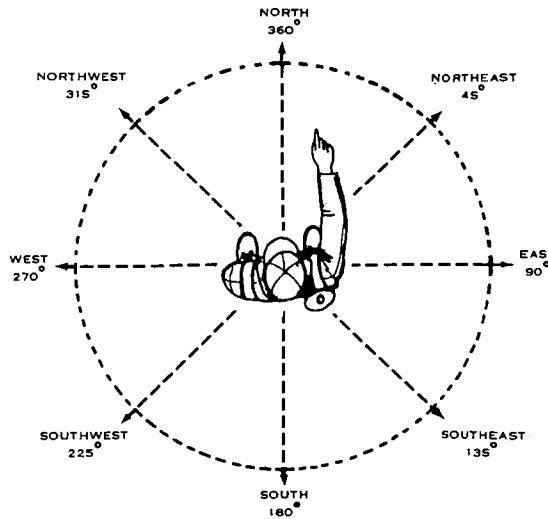
Numerals in the zones indicate the number of hours that local time differs from GCT. Time zones extend east and west from Greenwich to the 180th meridian. If a given zone lies east of the prime meridian, the appropriate number is added to convert it to local time. In transposing local time to GCT, the appropriate number is subtracted. For zones west of the prime meridian, the process is reversed. Deviation in time shown here occurs because of local policies or conditions.

PART FIFTEEN

SURVIVAL



SIZE UP THE SITUATION
UNDUE HASTE MAKES WASTE
REMEMBER WHERE YOU ARE
VANQUISH FEAR AND PANIC
IMPROVISE
VALUE LIVING
ACT LIKE THE NATIVES
LEARN BASIC SKILLS



Face north and recall these directions.

The ability to evade the enemy and to escape if captured are basic requirements of the soldier's Code of Conduct and demand every survival skill you can master. Always expect the unexpected—to be placed in a survival situation at any time and be ready to meet survival problems in any environment in which you may be stranded.

The shock of finding yourself isolated behind enemy lines, in a desolate area, or in enemy hands can be reduced or even avoided if you remember these points.

Recognize your limitations and abilities and formulate a plan.

Don't be too eager, impatient, or lose your temper. Think before acting.

Do not wander aimlessly about the countryside. Take time to discover your location and the general direction you want to travel.

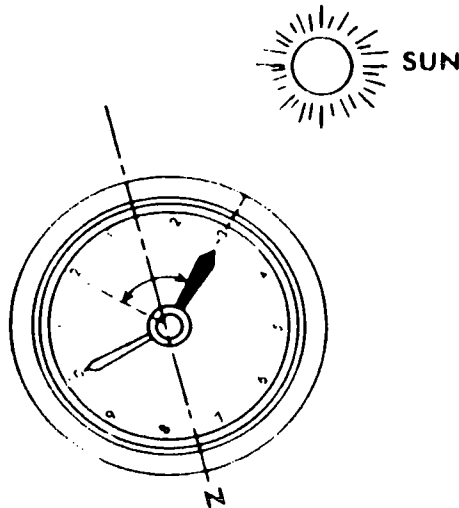
Improvise. Remember, no matter how bad things are, you can do something to improve the situation. Figure out what you need. Take stock of what you have. Then improvise.

Observing local inhabitant's behavior and copy their way of living. "Go native" and avoid attracting attention to yourself.

Learn the skills of firemaking, food and water identification, shelter construction, and navigation so thoroughly that they become automatic.

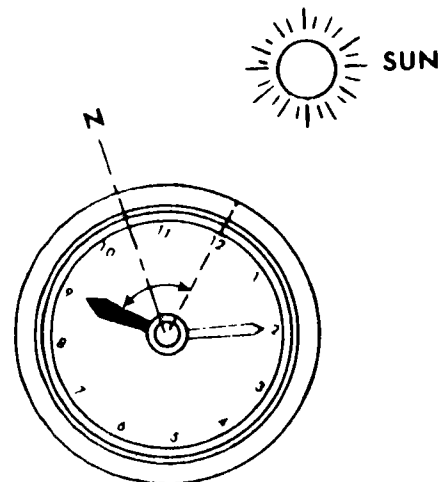
Chances are that the first problem you must solve is to determine where you are, where you must go, and how to get there. Should you be cut off from your unit as a result of enemy action, try to remember the location of friendly forces. Then travel in that direction, using the sun and stars as directional guides.

An ordinary watch can be used to determine the approximate true north. In the North Temperate Zone only, the hour hand is pointed toward the sun. A north-south line can be found midway between the hour hand and 1200 hours. This applies to standard time.



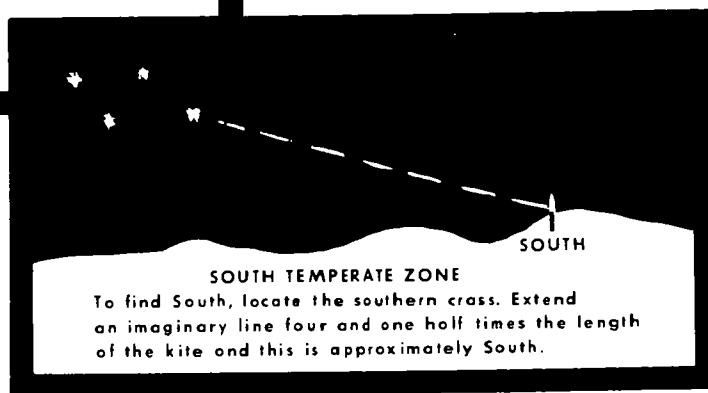
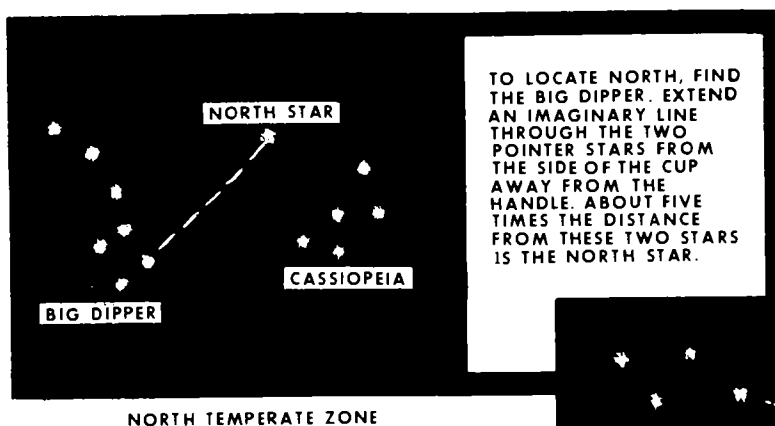
NORTH TEMPERATE ZONE

The watch may also be used to determine direction in the South Temperate Zone. However, it is used a bit differently. 1200 hours is pointed toward the sun, and halfway between 1200 hours and the hour hand will be a north-south line. If on daylight saving time, the north-south line lies midway between the hour hand and 1300 hours.



SOUTH TEMPERATE ZONE

On cloudy days, place a stick at the center of the watch and hold it so that the shadow of the stick falls along the hour hand. One half the distance between the shadow and 1200 hours is north.



If you are fortunate enough to have a map you can determine your location, a possible route to safety, and any natural obstacles you might encounter. Your map will have to be oriented by inspection or with a compass.

By climbing a tree or nearby hill, you can often match your map to the surrounding countryside. Turn the map until the roads, rivers, hills, or woods around you look as if they are in the same place on your map as they are on the ground. When your map lines look much the same as the land lines, your map is turned in the right direction—that is the north side of the map is toward north, and the east side is on the east.

If you are even more fortunate and have a compass, lay the map flat on the ground or other smooth and level surface. Place the compass on the map and turn the map until the north-south grid lines are parallel to the compass needle and north coincides with compass north. Turn the map again until the needle on the compass indicates the amount of magnetic declination for the area. The magnetic declination diagram usually appears in the marginal information.

DRINKING WATER

There are three ways in which you can make water safe for you to drink.

Add **CALCIUM HYPOCHLORITE** to produce residual chlorine of 1 part per million (ppm) after a 10 minute contact time, and wait an additional 20 minutes before drinking. For a 36 gallon lyster bag, 1 calcium hypochlorite capsule is usually enough. For individual use, prepare a disinfecting solution by placing 1 calcium hypochlorite capsule in a canteen of water. Add 1 canteen-capful of this solution to each canteen of water, shake, and allow it to set for 30 minutes before drinking.

If you are using **IODINE TABLETS**, use one per canteen of water for clear water and two per canteen of cloudy water. Allow the water to stand for 5 minutes, shake it vigorously, and allow it to stand another 20 minutes before drinking. (Don't forget color change).

Or you can bring your water to a vigorous boil and keep it boiling for 15 seconds.

If **AMOEBC DYSENTERY CYSTS** are suspected, all water must be treated by coagulation and sedimentation, followed by sand filtration at reduced rates or by diatomite filtration. Water treated in this way is safe to drink if it has a residual chlorine content of 1 ppm after a 10 minute contact time. In emergencies, disinfect water in individual canteen by following the directions on the bottle of individual water purification tablets, unless an increase is directed by a medical officer. Small units may boil their own drinking water; this is a sure method. If the lyster bag is used, the following steps must be taken.

Break 1 ampule and pour into filled bag; stir with a clean paddle.

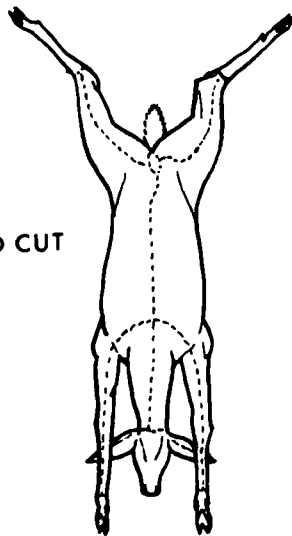
Disinfect faucets by flushing 1/2 cup water through each faucet.

After 10 minutes, residual should exceed 1 ppm. Then add another ampule. Keep bag covered.

Water is potable 30 minutes after adding last ampule.

KNOW HOW TO PREPARE FOOD

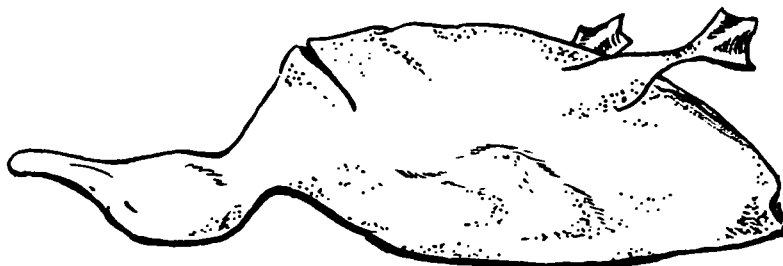
SKIN AND CUT



DRESSING A CARCASS

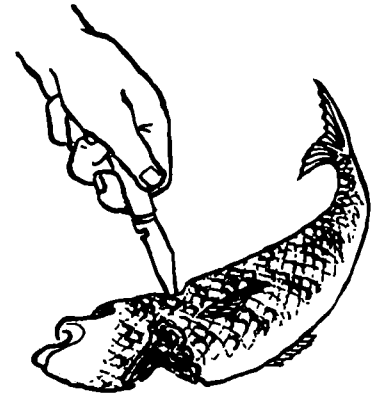


FEATHERING



CUTTING AND GUTTING

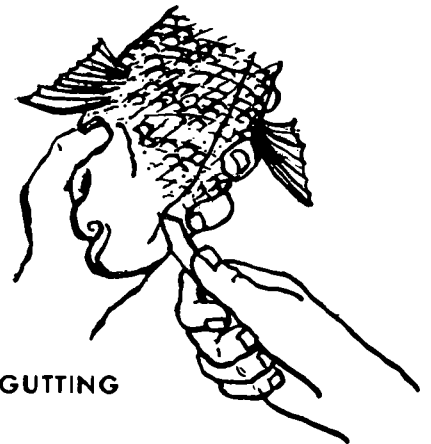
BLEEDING



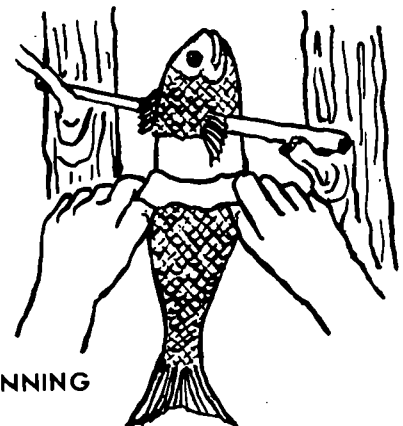
SCALING



GUTTING

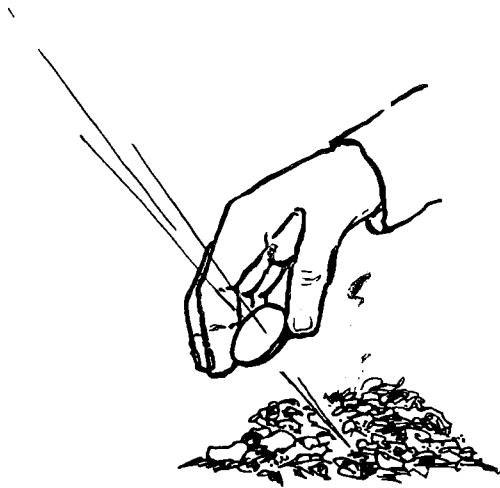


SKINNING

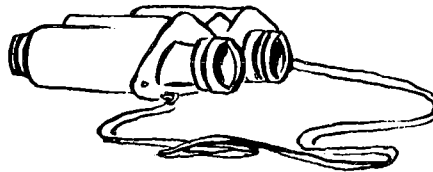


KNOW HOW TO START A FIRE WITHOUT MATCHES

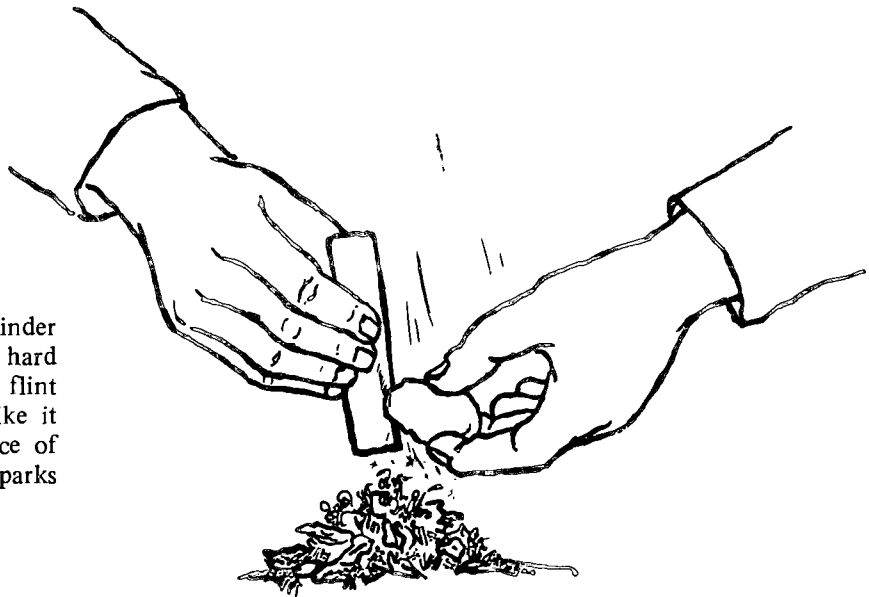
Prepare some extremely dry tinder before attempting to start a fire without matches. Once prepared, shelter your tinder from wind and dampness. Excellent tinders include punk, lint from cloth, rope, or twine; dead palm frond; finely shredded dry bark; dry powdered wood; bird nests, woody materials from plants; and wood dust produced by insects and often found under the bark of dead trees.



A camera lens, a convex lens from a binocular, or lens from a telescopic sight or flashlight may be used to concentrate the rays of the sun on your tinder.



This is the best method to start tinder burning if you don't have matches. A hard stone will substitute for a flint. Hold flint as near the tinder as possible and strike it with a knife blade or other small piece of steel. Strike downward so that the sparks will hit in the center of the tinder.

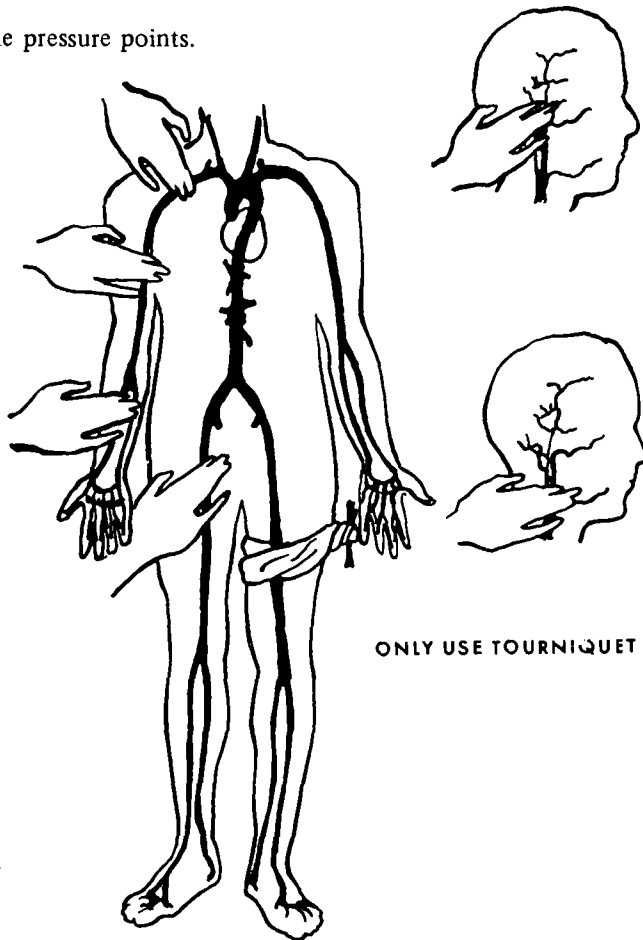


STAY HEALTHY

KEEP YOUR BODY CLEAN
KEEP YOUR CLOTHES CLEAN
KEEP EATING UTENSILS CLEAN
GUARD AGAINST OVEREXPOSURE
GUARD AGAINST INSECTS
TAKE EXTRA CARE OF YOUR FEET

KNOW HOW TO TREAT YOUR OWN INJURIES AND THOSE OF A BUDDY

Learn the pressure points.



ONLY USE TOURNIQUET IF ALL ELSE FAILS

BURNS; SCALDS

FIRST DEGREE (REDDENED SKIN)

USE OINTMENT.

SECOND DEGREE (BLISTERS)

USE DRY STERILE GAUZE,

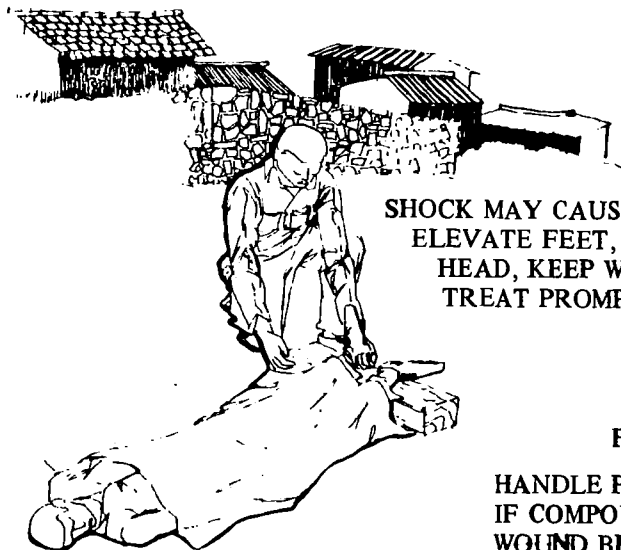
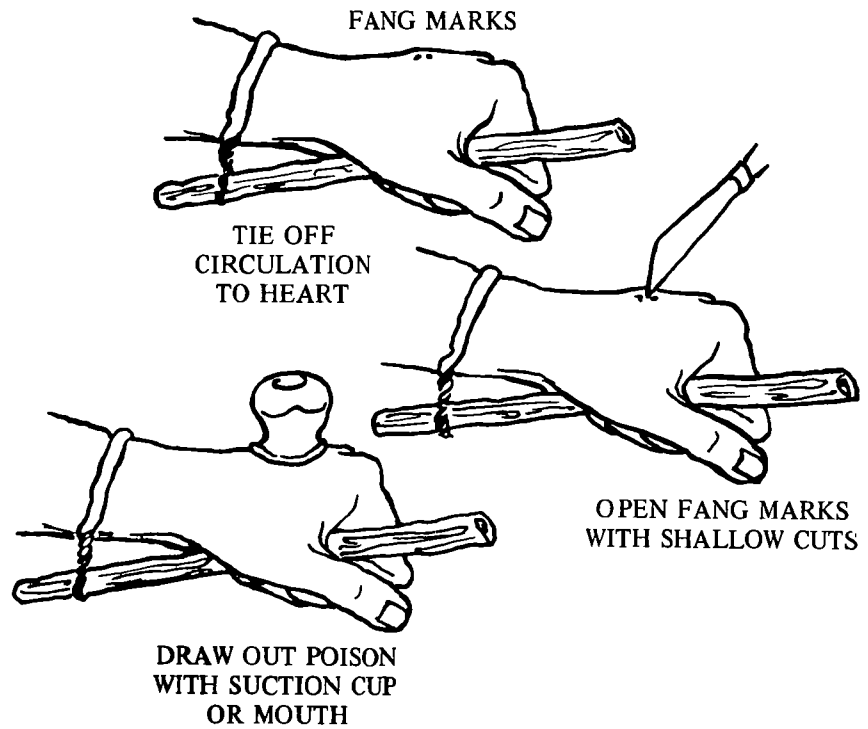
THIRD DEGREE (CHARRED SKIN)

COVER AREA LIGHTLY; DO NOT

REMOVE STUCK CLOTHING.



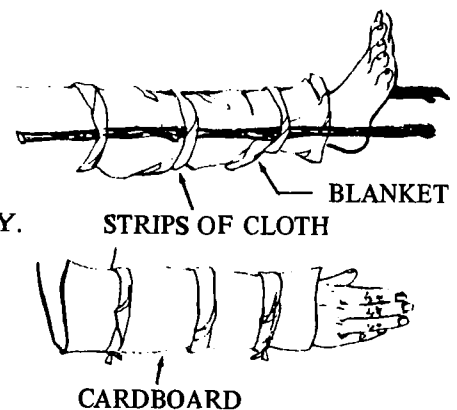
TREATMENT FOR POISONOUS SNAKE BITES



SHOCK MAY CAUSE DEATH.
ELEVATE FEET, LOWER
HEAD, KEEP WARM,
TREAT PROMPTLY.

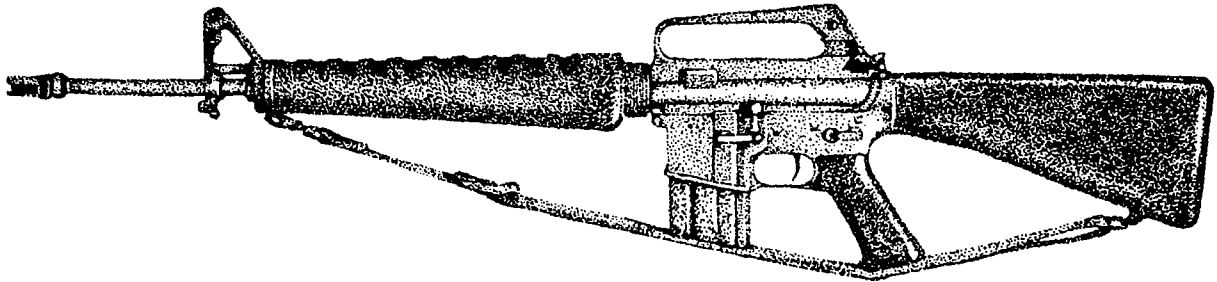
FRACTURES--

HANDLE PERSON CAREFULLY.
IF COMPOUNDED, TREAT
WOUND BEFORE SPLINTING.
SPLINT USING BRANCHES,
CARDBOARD, BLANKETS,
ETC



PART SIXTEEN

WEAPONS



An engineer soldier must know how to protect himself and his worksite. In addition, he must be able, when necessary, to reinforce the infantry. This means he must be thoroughly qualified with his weapon and know its limitations as well as its capabilities. It is mandatory that he maintain his weapon properly to insure its efficient operation at a moments notice.

CARE AND CLEANING OF WEAPONS

FROM STORAGE

Unpack all equipment and check for completeness immediately after receiving it from storage.

Remove rust preventive compound using a wiping cloth saturated with a drycleaning solvent.

Dry all parts and apply a light film of preservative lubricating oil on all unpainted metal parts of the weapon and organizational equipment. Use a cleaning staff to oil the bore. Oil all other unpainted surfaces clean and free from rust.

BEFORE AND DURING FIRING

Before firing, clean and lightly oil moving parts.

Clean as necessary.

Tighten all nuts, bolts, and screws.

AFTER FIRING

Immediately after firing, preferably while the barrel is still warm, and for three consecutive days thereafter, or as long as the barrel continues to sweat, swab the bore with rifle bore cleaner, until all fouling is removed. Apply a light coat of oil after each cleaning.

Clean.

Remove rust.

Coat all unpainted surfaces with a light coat of preservative lubricating oil.

WEAPONS RECORD DATA

Information regarding condition of the barrel, number of rounds fired, and assignment of the weapon is recorded on the Weapon Record Data Card. (To be used for rifled cannon and mortar tubes only.)

ADJUSTMENT OF HEADSPACE AND TIMING OF .50 CALIBER MACHINEGUN

If the headspace is not properly adjusted on the .50 caliber machinegun, injury or damage to the weapon or to the operating personnel will result.

When adjusting the headspace and timing certain precautions must be observed.

The machinegun must be cocked when using the headspace gauge, thus withdrawing the firing pin from the recess in the face of the bolt to prevent damage to the gauge and the firing pin.

The firing pin must not be released while the gauge is inserted in the "T" slot as the harder steel of the gauge will damage the firing pin.

The recoiling parts must be pulled to the rear until the lug on the barrel locking spring is in the recess in the right side of the receiver before the barrel can be screwed in or out.

The headspace on the machinegun must be adjusted before the timing can be adjusted.

CHARACTERISTICS OF INFANTRY WEAPONS

WEAPON	Unloaded Weight (Approximate in pounds)	Type of Feed	Method of Operation	*Cyclic (C) or *Maximum (M) Rate of Fire (Rds per Min)	*Sustained Rate of Fire (Rds per Min)	*Maximum Effective Rate of Fire (Rds per Min)	*Maximum Range (in meters)	*Maximum Effective Range (meters)	REMARKS
M40 GRENADES									
Fragmentation M26A2 Grenade	1		Electrical Impact fuse				40		The M26A1 and M24 may be fired as rifle grenades with projection M142 adapter. The M26A2 will not be used as a rifle grenade with the projection adapter. Approximate effective bursting radii in meters are: M26A1-15, M26A2-15, M24-25.
M26A1	1		4-5 second time delay fuse				40		
M7 Grenade M24	1 1/2						35		
MINE ANTI-PERSONNEL M16A1 CLAYMORE	3.5		Controlled Electric Detonation or Uncontrolled Trip Wire Operation	One Shot		One Shot	250	First Effective Range is 50 meters	Check FM 23-33 for backblast effects. When employed in unimproved role Claymore must be treated as a mine and its location concealed and reported. Electrical fragmentation -60° sector with radius of 50 meters.
PISTOL AUTOMATIC CAL. 45, M1911A1	2 1/2	7 Rd Magazine	Recoil Semiautomatic	35-42 (M)			1500	50	
SUBMACHINEGUN CAL. 45, M3A1	9	30 Rd Magazine	Blow Back Automatic	450 (C)	40-60	40-60	1550	100	Used as on-vehicle equipment. Replaced by M14 rifle and M16A1 rifles.
US CARBINE CAL. 30, M2	5 1/2	30 Rd Magazine	Gas Operated Semiautomatic and Automatic	750-775 (C)	40-60	40-60	2025	250	Replaced by M14 rifle. May be equipped with anti-air-scope infrared set (A. 1, 20, 600 Watts Lts.
US RIFLE 7.62mm, M14	9.84	20 Rd Magazine	Gas Operated Semiautomatic and Automatic	700-750 (C)	40 for First Two Minutes (Semiautomatic)	60 for First Minute (Automatic)	3725	460	Full automatic capability requires installation of selector. Sustained rate based on limited tests. Bipod is a major item and used in conjunction with rifle when used as an automatic rifle.
US RIFLE 7.62mm, M14A1	12.12	20 Rd Magazine	Same as for M-14 Rifle	700-750 (C)	Same as for M-14 Rifle	Same as for M-14 Rifle	3725	700 (Semi-automatic) 460 (Automatic)	Essentially same characteristics as M-14. Major difference lies in modified straight line stock with pistol grip.
RIFLE, 5.56mm, M16A1	6 1/2	20 Rd Magazine	Gas Operated Semiautomatic and Automatic	700-620	45-65 (Semi-automatic) 150-200 (Automatic)	20-40 (Semi-automatic) 40-60 (Automatic)	2653	460	Installed selector with choice of semiautomatic or automatic fire. Bipod issued with the rifle.
US RIFLE CAL. 30, M1	9 1/2	8 Rd Clip	Gas Operated Semiautomatic		8-10	16-24	3200	460	Replaced by M-14 rifle.
US RIFLE CAL. 30 M1 WITH RIFLE GRENADE LAUNCHER, M7A3, HEAT RIFLE GRENADE M31 AND SIGHT M15	10 1/2	Manual	Manual Single Shot	4 (M)	4	2	275	115	Complete round weighs approximately 1 1/2 pounds.
US RIFLE, 7.62mm, M14 WITH RIFLE GRENADE LAUNCHER M7A3, HEAT RIFLE GRENADE, M31 AND SIGHT M15	10 1/2	Manual	Manual Single Shot	4 (M)	4	2	275	115	Grenade launcher and M15 sight, weight approximately 1 lb. Complete round weighs approximately 1 1/2 lbs.
BROWNING AUTOMATIC RIFLE CAL. 30 M1918A2	15 1/2	20 Rd Magazine	Gas Operated Automatic	350 (C) Slow Rate 550 (C) Fast Rate 120-150 (M)	40-60	40-60 (3 Round Bursts) 120-150 (20 Round Bursts)	2750-200	460	Replaced by M14A1 or M16A1 rifles.
MACHINEGUN 7.62mm, M60	23	Belt Metallic Split Link	Gas Operated Automatic	550 (C)	100	200	3725	1100	Maximum effective range limited by gunner's ability to see and adjust on target.
MACHINEGUN, CAL. 50 M3, M2	KG Tripped Total -82 -44 -128	Belt Metallic Split Link	Recoil Semiautomatic and Automatic	450-500	40	100	6800	725 AA Target, Ground Target	
66mm HEAT ROCKET M72 (LWS)	4.7 (Rocket and Launcher Combined)			Single Shot Throaty			1000	200	Launcher is disposable after firing rocket and is bore-sighted during manufacture. Front sight graduated to 325 meters. The M72 is issued as a caution.
PORTABLE FLAME-THROWER, M2A1-7	42 1/2	Fuel Propelled by Gas Under Pressure	Manual	Continuous Discharge 6-9 seconds	Continuous Discharge 6-9 seconds	Continuous Discharge 6-9 seconds	20-30 Unthickened Fuel 40-50 Thickened Fuel	55	Contains 4 1/2 - 4 3/4 gallons of fuel weighing 25 to 29 pounds. To be replaced by M9-7 flamethrower.
PORTABLE FLAME-THROWER, ABC, M9-7	25	Fuel Propelled by Gas Under Pressure	Manual	Continuous Discharge 5-8 seconds	Continuous Discharge 5-8 seconds	Continuous Discharge 5-8 seconds	20-30 Unthickened Fuel 40-50 Thickened Fuel		Contains 4 gallons of fuel.
SELF-PROPELLED FLAMETHROWER M13A-1	Approx. 21700	Fuel Propelled by Gas Pressure	Electrical	Continuous Discharge 32 seconds	Continuous Discharge 32 seconds	Continuous Discharge 32 seconds	150-170	150-170	Contains 200 gallons of thickened fuel.
IRRITANT GAS DISPENSER, PORTABLE M-3	Approx. 40	Agent Propelled by Gas Pressure	Manual	Continuous Discharge 25 seconds	Continuous Discharge 25 seconds	Continuous Discharge 25 seconds	Up to several hundred feet	Up to several hundred feet	Contains about 20 pounds of CSI.
40mm GRENADE LAUNCHER M79	6	Percussion Type Single Shot						PT Tgts - 150 Area Tgts - 35	Minimum safe range: Combat: 31 meters Training: 60 meters Firing distance: 14-26m. Effective bursting radius: 5m
81mm MORTAR, M29 WITH MOUNT, M28A2	Barrel 28 Bipod 36 Sight 29 Baseplate 93	Muzzle Loading by Hand	Drop Fire	12 (M) for 2 Minutes With Any Charge	8 Indefinitely With Any Charge	12 (M) for First 2 Minutes With Charge Eight	4512	4512	Accumulation weights 7-12 pounds. (M) Effective Bursting Area: 25 x 20 meters
4.2 MORTAR, M30 WITH MOUNT, M28A1	640	Muzzle Loading by Hand	Drop Fire	18 (M) for 1 Minute For First 5 Minutes For Last 9 Minutes	3	20 (M) for First 2 Min. 6 for Last 20 Min. 2 Indefinitely	5650	5650	Accumulation weights 26-29 pounds. (M) Effective Bursting Area: 40 x 15 meters
SHOTGUN 12 GAUGE RIOT TYPE	7 1/2	5 Rd Tub	Manual (Pump Action) Air Cooled				Depends on type of shot	Depends on type of shot	

*Cyclic Rate of Fire (C) ----- Rate at which weapon fires automatically.

*Maximum Rate of Fire (M) ----- Greatest rate at which well-trained gunner can fire.

*Sustained Rate of Fire ----- Rate at which weapon can fire indefinitely without seriously overheating.

*Maximum Effective Rate ----- Rate at which gunner can fire and obtain reasonable number of hits (50%)

*Maximum ----- Greatest distance weapon will fire.

*Maximum Effective Range ----- Greatest distance at which gunner may be expected to fire accurately.

NOTE: (A) Depending upon type of Accumulation Used.

APPENDIX
REFERENCES

1. Army Regulations (AR)

AR 10-5	Department of the Army
AR 310-25	Dictionary of United States Army Terms
AR 310-50	Authorized Abbreviations and Brevity Codes
AR 385-10	Army Safety Program
AR 420-90	Fire Prevention and Protection

2. Field Manuals (FM)

FM 5-1	Engineer Troop Organizations and Operations
FM 5-15	Field Fortifications
FM 5-20	Camouflage
FM 5-25	Explosives and Demolitions
FM 5-36	Route Reconnaissance and Classification
FM 21-26	Map Reading
FM 21-41	Soldiers Handbook for Chemical and Biological Operations and Nuclear Warfare
FM 21-76	Survival, Evasion, and Escape

3. Technical Manuals (TM)

TM 5-200	Camouflage Materials
TM 5-210	Military Floating Bridge Equipment
TM 5-270	Cableways, Tramways, and Suspension Bridges
TM 5-277	Bailey Bridge
TM 5-280	Foreign Mine Warfare Equipment
TM 5-297	Well Drilling Operations
TM 5-312	Military Fixed Bridges
TM 5-315	Firefighting
TM 5-332	Pits and Quarries
TM 5-330	Planning and Design of Roads, Airbases, and Heliports in the Theater of Operations
TM 5-337	Paving and Surfacing Operations
TM 5-342	Logging and Sawmill Operation
TM 5-349	Arctic Construction

TM 5-460	Carpentry and Building Construction
TM 5-461	Engineer Handtools
TM 5-700	Field Water Supply
TM 5-725	Rigging
TM 5-742	Concrete and Masonry

4. Department of the Army Pamphlets (DA Pam)

DA Pam 310-1	Index of Administrative Publications
DA Pam 310-3	Index of Doctrinal, and Organizational Publications
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders
DA Pam 310-7	U.S. Army Equipment Index of Modification Work Orders

INDEX

	<u>Page</u>
Abatis	141
Adapter, priming	95
Aluminum floating footbridge	71
Ammonium nitrate	89
Anchor hitch	178
Anchorage	73, 181
Antennas	193
Antitank ditches	139
Antivehicular obstacles	139-141
Apron, double, fence	132
Apron, trestle, fence	134
Apron tie, wire	137
Armored vehicle launched bridge (AVLB)	83
Assault boats	70
Auger, posthole	9
Auger bit	13
Auger bit, hollow center	14
Ax	12
Backfill tamper, pneumatic	29
Background, blending with	157
Bailey bridge, M2 panel	78-81
Baker bowline	172, 173
Bangalore torpedo	90

	<u>Page</u>
Barbed tape	138
Barbed wire concertina	131
Barbed wire entanglements	131
Bars	20
Basket hitch	178
Battens	49
Batter boards	46
Beach matting, woven wire	68
Bench plane	8
Bend resistant splice	44
Bevel, sliding-T	19
Bight	167, 168
Bits	13, 14
Blacksmith's cross-peen hammer	10
Blacksmith's double-faced sledge	11
Blasting caps	91
Blasting machine	94
Block demolition charges	86
Block planes	8
Blocks	22
Blocks, road	141
Bolts	40
Booms	187
Bottom chord	48

	<u>Page</u>
Bowline	170
Bowline on a bight	171
Brace table	18
Bracing, diagonal	48
Bridge, foot, aluminum, floating	71
Bridge, light tactical	72, 73
Bridge symbols	154
Bridges, typical spans	153
Bridging, housing construction	47
Brush hook	21
Bulldozer	52
Butt joints	42
Butt splice	44
Butterfly knot	174
Camouflage check list	164
Cap crimpers	92
Carpenter's clawhammer	10
Carpenter's level	17
Carpenter's steel square	18
Carriage bolts	40
Catspaw	174
Chain saws	26
pneumatic	30
Chalkline	16

	<u>Page</u>
Check dams	60
Chemical mine signs	110
Chisels	8
Choker hitch	178
Chopping tools	12
Chords	48
Circular mortar emplacement	127
Circular saw:	
electric	26
woodworking, pneumatic	29
Class 60 floating bridge	74, 75
Classification formula, road	150-152
Clawhammer	10
Clay digger, pneumatic	28
Closer skirt	49
Clothing, camouflage	163
Clove hitch	176
Cold chisel	8
Combat engineer vehicle (CEV)	56
Combination firing system	103
Combination log picket holdfast	182
Combination square	19
Common wire nail	36
Compass saw	6

	<u>Page</u>
Composition C4	88
Composition C3	88
Concertina, barbed wire	131
Concrete floors	50
Concrete mixer	56
Concrete vibrator, pneumatic	30
Cord, detonating	92, 93
Corduroy road construction	65, 66
Corrugated fastener	41
Countersink bit	13
Covers:	
foxholes	115-118
trenches	121-125
Crane shovel	55
Craters, obstacle	140
Crawl trenches	121
Crew served weapons emplacements	126, 127
Cribs, log	140
Crimpers, cap	92
Cross lap joint	43
Cross-peen hammer	10
Crosscut hand saw	6
two-man	7
Crowbar	20

	<u>Page</u>
Culverts	61-64
Cut and cover shelter	120
Cut nails	36
Deadman	183
Detonating cord	92, 93
Detonating assemblies	101
D-handled shovel	9
Diagonal bracing	48
Digging tools	9
Directional guides	202, 203
Discipline, camouflage	163
Disk sander, electric	23
Ditches, antitank	139
Ditching machines	54
Dividers	16
Double anchor hitch	179
Double apron fence	132, 133
Double block	22
Double faced sledge	11
Dozer	52
Drainage	59, 64, 128
Drift pin	41
Drill:	
electric	25

	<u>Page</u>
steel, pneumatic	29
wood boring, pneumatic	29
Drilling tools	13, 14, 25, 29
Dual firing system	102
Eiffel bridge	83
Electric blasting caps	91, 100
Electric firing system	99, 100, 103
Electric tools, portable	23-26
Emplacements	113-128
Endless sling	178
Entanglements:	135
high wire	135
Essex board measure table	18
Expansion bolt	40
Expansive bit	13
Expedient road mattings	68
Explosives	85
Eye splice	188
Eye ties	136
Facia board	49
Fastener, corrugated	41
Felt, roofing	47, 49
Fence, double apron	132, 133
Fence, trestle apron	134

	<u>Page</u>
Fields of fire	130
Fighting trench system	121
Figure eight knot	169
Finished floor	47
Finishing nails	36
Fire lanes, clearing	130
Firing system:	
combination	103
dual	102
electric	99, 100
nonelectric	96-98
First aid	207, 208
Fixed spans, short	82
Flat wood screws	38
Floating aluminum footbridge	71
Floating bridges, heavy	74-77
Floors:	
joists	47
concrete	50
Folding rule, multiple	16
Food preparation	205
Footbridge, aluminum floating	71
Footers	46
Form nails	36

	<u>Page</u>
Foundation port	46
Foxhole covers	116, 117
Foxholes	115-118
Frame building	46-49
Framing table	18
French bowline	174
Fuse lighter	92
Galvanometer	95, 99
Gin pole	187
Girder, housing construction	47
Girt	48
Glue	41
Graders	53
Grinder, pneumatic	30
Hacksaws	7
Half-hitch	175
Half-lap splice joint	43
Halved splice	45
Hammer, electric	24
Hammers	10
Hand drill	14
Handles, wooden, replacement	15
Handsaws	6
Hanger	48

	<u>Page</u>
Harness hitch	177
Hasty emplacements	113
Hatchet	12
Header	48
Heavy tactical floating bridge	74-77
Helipads, surfacing	68
High wire entanglements	135
Hitches	175-177
Holdfasts, picket	182
Hollow center auger bit	14
Hook brush	21
Hurdles, log	139
Impact wrench, electric	23
Improved crater	113
Intermediate eye ties	136
Inverted basket hitch	178
Jack, roof	49
Jack plane	8
Jack substitutes	185
Joints	42, 43
Joists	47
Keyhole saw	6
Knife rest	134
Knots	169-177

	<u>Page</u>
Lag screws	38
Landing mats, metal	67
Lanes, fire, clearing	130
Lap joints	43
Lashings	180
Lettering, military	196
Leveling tools	17
Lever, simple	184
Lifting tools	20-22
Light tactical bridge, raft	72, 73
Lighter, fuse	92
Limiting factors	150
Line level	17, 46
Loaders, scoop	54
Log box culverts	63
Log cribs	140
Log hurdles	139
Long handled shovel	9
Long plain splice	45
Loops	167
Lumber; dimensions	34
grades	35
Machete	21
Machine bolts	40

	<u>Page</u>
Machinegun adjustment of headspace	211
Machinegun emplacements	126
Marking signs, minefields	110
Marking tools	16
Masonry drill	14
Mason's single faced hammer	10
Mats, landing, metal	67
Mattock	9
Mauls	11
Measuring tables	18
Measuring tapes	16
Membrane surfacing	68
Metal landing mats	67
M4T6 floating bridge	74-77
M5 demolition charge	88
M5A1 demolition charge	88
Middle lap joint	43
Military lettering	196
Mine card, GTA 5-10-10	111
Mine cluster	107
Mine row	108
Mine strip	108
Minefield	109
Miner's spoon	21

	<u>Page</u>
Miter joint	42
Mitered half-lap joint	43
Mixer, concrete	56
Mobile assault bridge (MAB)	83
M1 chain demolition charge	86
M112 demolition charge	86
M118 demolition charge	90
Mooring hitch	177
Morse code	195
Mortar emplacement	127
Mountain shelter, two-man	119
Movement	160, 161
M2 demolition block	86
M2 panel bridge, bailey type	78-82
M2A3 shaped charge	87
M3 demolition charge	86
M3 shaped charge	87
Multiple folding rule	16
Multiple holdfasts	182
Nail driver, pneumatic	28
Nails	36, 37
Napping hammer	10
Nested saws	6
Night movement	162

	<u>Page</u>
Nonelectric blasting caps	93
Nonelectric firing system	95-98
Oblique butt joint	42
Octagon scale	18
One-man foxhole	115
Open top culverts	62
Oval wood screws	38
Overhand knot	169
Overhand loop	167
Panels, wall	48
Patrolling	161
Paving breaker	28
Phillips screws	38
Phonetic alphabet	196
Pick	9
Picket holdfasts	182
Pin, drift	41
Pinchbar	20
Pipe culverts	61
Pit type emplacements	126, 127
Plain lap joints	43
Plain splice, long	45
Planes	8
Plastic assault boats	70

	<u>Page</u>
Plastic faced hammer	10
Plastic trackway	67
Pliers	21
Plumb bob	17
Plumbers saw	6
Pneumatic assault boats	70
Pneumatic tools	28-30
Portable power tools	23-26
Posthole auger	9
Posthole digger	9
Post obstacle belts	140
Post tie, wire	137
Power tools, portable	23-27
Pressure points, first aid	207
Priming adapter	92
Prone emplacement	114
Pump, sump, pneumatic	30
Racking wire	137
Radios	191-193
Raft, light tactical	72, 73
Rafter, rake	48
Rafter table	18
Rafters, trussed	48
Rake rafters	48

	<u>Page</u>
Ratchet brace	13
Rectangular log cribs	140
Reinforced joists	47
Reinforced trackway	67
Revetments for trenches	123, 124
Ring main connection	104
Ripsaw	6
Roadblocks	141
Road classification formula	150-152
Road culverts	61
Road reconnaissance report	148
Road surfaces, expedients	65-68
Roads, nomenclature	149
Rock drill, pneumatic	28
Rollers	54
Rome blade	52
Roof jack	49
Roof sheathing	49
Roofing felt	47, 49
Roofing nails	36
Rope, fiber, care of	166
Rope, wire, care of	189
Rope, terminology	167
Round turn	167

	<u>Page</u>
Round wood screws	38
Route reconnaissance report	144
Route reconnaissance symbols	145-147
Rules	16
Running bowline	170
Running end	167
Safety precautions:	
engineer equipment	57
explosives	105
handtools	5, 31,32
power tools	27
wire, rope	189
Saws:	
chain	29
hand	6
pneumatic	28-30
Scab	48
Scaffold nails	36
Scale, octagon	18
Scoop loaders	54
Scrapers	53
Screwdriver bit	13
Screws	38, 39
Shadows	158

	<u>Page</u>
Shaped demolition charges	87
Sharpening tools	15
Shear lashing	180
Shears	184, 186
Sheathing	49
Sheepsfoot roller	54
Sheepshank	175
Shelters	119
Short fixed spans	82
Short splice	188
Shovels, crane	55
Shovels, hand	9
Side sheathing	49
Signs, marking minefields	110
Silhouette	159
Simple lever	184
Single bit ax	12
Single block	22
Single sheet bend	169
Single sling	179
Skids	185
Skirmishers trench	113
Sledges	11
Sliding-T bevel	19

	<u>Page</u>
Slings	178, 179
Slip joint combination pliers	21
Slotted screws	38
Smoothing plane	8
Snatch block	22
Sole plate	48
Spanish bowline	171
Spans, short fixed	82
Splices	44, 45, 188
Spoon, miner's	21
Spreaders	46
Square knot	169
Square lashing	180
Square splice	45
Squares	18, 19
Standard barbed wire concertina	131
Standard steel picket holdfast	182
Standard trench	122
Standing part	167
Staples	41
Steel drill, pneumatic	29
Steel measuring tape	16
Steel square, carpenters	18
Stone bog hitches	179

	<u>Page</u>
Stove bolts	140
Straight butt joint	42
Stringline	46
Stud	48
Subfloor	47
Sump, pump, pneumatic	30
Surfaces, road, expédients	65
Surfacing, membrane	68
Survival techniques	200-208
Symbols:	
bridge	154
route reconnaissance	145-147
Tables, measuring	18
Tamper, backfill, pneumatic	29
Tanglefoot	135
Tape, barbed	138
Tapes	16
Telephones	194
Tetrytol	86
Timber hitch	175
Timber trestle bridge	82
Timber wedge	21
Time conversion table	197
Time fuses	91

	<u>Page</u>
Time zones, world	198
TNT	89
Toggle bolt	40
Toggle hitch	178
Top eye tie, wire	136
Top plate	48
Trackways	67
Tractor dozer	52
Treedozer	52
Trenches	121-125
Trestle apron fence	134
Tripod	186
Truss assemblies	80, 81
Trussed rafters	48
Try square	19
Turn	167
Twist drill bit	14, 25
Two-man crosscut saw	7
Two-man foxhole	118
Two-man mountain shelter	119
Two one-man foxhole machinegun emplacement	126
Underhand loop	167
Universal engineer tractor (UET)	56
Upper chord	48

	<u>Page</u>
Vehicle recovery, expedients	184, 185
Vibrator, concrete, pneumatic	30
Wall panels	48
Water, potable	204
Weapons, care of	210
Weapons, characteristics of infantry weapons	212
Weapons emplacements	126
Weaver's knot	169
Web	48
Wedge, timber	21
Whipping fiber rope	168
Wigwam shelter	119
Winch, expedient	185
Wire, barbed	131-135
Wire nails, common	36
Wire rope	189
Wire ties	136, 137
Wood boring drill pneumatic	29
Wood chisels	8
Wood screws	38
Wooden handles, replacement	15
Wooden maul	11
Woodworking saw, circular, pneumatic	29
World time zones	197, 198

	<u>Page</u>
Woven wire beach mattings	68
Wrecking bar	20
Wrench:	
hand	21
impact, electric	23



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