CHAPTER 3

FIELD ENGINEERING HAND TOOLS

SECTION 1

GENERAL

INTRODUCTION

1. Field engineering tasks call for a wide variety of hand tools. These can generally be classified as digging, cutting or miscellaneous tools.

2. This chapter illustrates these tools and describes their uses. Section 2 covers digging tools; Section 3 deals with cutting tools and Section 4 contains notes on miscellaneous tools. Section 5 describes the care and sharpening of field engineering tools.

GENERAL SAFETY PRECAUTIONS

3. The majority of field engineer tools have sharp edges and some are used with a swinging motion. All of them can be dangerous if handled incorrectly.

4. Inspect hand tools before using them. 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.

5. Store hand tools in a suitable storage space. Serious injuries can result from a cluttered work site or tool room.

6. Be sure hand tools are clean and dry. Dirty, oily, or greasy. tools are unsafe.

7. Pointed or edged tools are dangerous, do not carry in pockets or leave lying around the worksite.

8. Carry sharp-edged or pointed tools so they face down or away from the body.

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

10. Dress properly. 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. Tuck in loose clothing.

11. Carry, do not toss, drop or throw tools from one location to another.

12. Turn off the electrical current before attempting any work on electrical circuits.

13. Steady with clamps or vises any loose material to be cut, sheared, chiselled, or filed. This prevents the material and the tool from slipping.

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

SECTION 2

DIGGING TOOLS

SERVICE SHOVELS

1. There are three types of service shovels. Only two of them are classified as digging tools. The third, the square mouth shovel, is classified as a miscellaneous tool. The two digging shovels are the shovels general service long and short. They are used to dig, carry and throw soil. Note that the shovel is the same, it is only the handles that are different to facilitate throwing of earth from various depths.

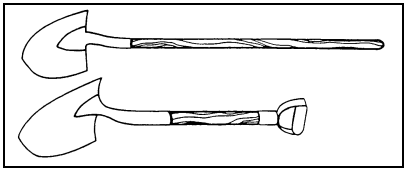

Fig 3-2-1 Long and Short Handle Shovels

2. The art in shovelling lies not so much in getting a full load on the shovel as depositing that load in the required place. With practice, personnel should be able to throw a shovelful of soil a distance of about 3 m with reasonable accuracy. The correct method of throwing soil is shown in Fig 3-2-2.

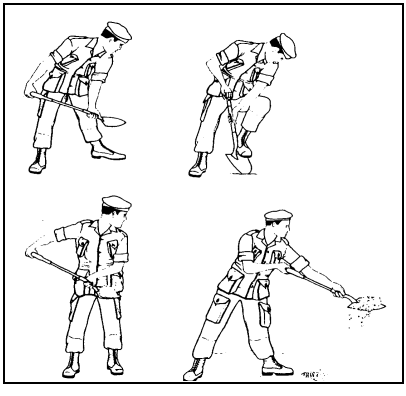

Fig 3-2-2 Correct Method of Holding and Loading a Shovel and Throwing Soil

ENTRENCHING TOOL

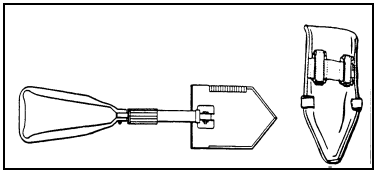

Fig 3-2-3 Entrenching Tool

3. The entrenching tool is the basic digging tool used by troops in the combat zone. It is designed to be carried by an individual in a pouch as part of the fighting order. It is used for digging-in under fire by soldiers kneeling or lying down. The earth is loosened with the chisel point and scraped aside with the shovel. Keep the shovel edge in good condition and the tightening screw well lubricated.

PICK AND MATTOCK

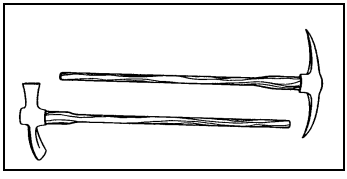

Fig 3-2-4 Pick (top) and Mattock

4. The pick is designed for breaking up hard soil or rock so that it can be moved with a shovel. It is also useful for spitlocking, that is, marking out the outline of an excavation on the ground. The pick can be taken apart for storage.

5. The mattock is a combined digging and cutting tool. It is a useful Tool when working in an excavation for loosening clay and chopping through roots. It is swung in the same manner as the pick, and can be taken apart for storage.

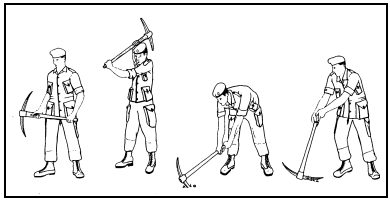

Fig 3-2-5 Correct Method of Holding and Using the Pick

6. The head of the pick, or the mattock, is not wedged on the handle (helve). When using the pick, or mattock, care shall be taken to ensure that the head is jammed tightly on the helve and does not loosen during use. Like the shovel, the pick can be used either left or right handed. This is advantageous when working in confined spaces such as weapon pits. The correct method of holding and using a pick is as shown. The strike of the pick is made so that the earth between the pick and the face will break away

when the handle is raised. The spoil can then be removed with the shovel. To aid shovelling, the base of the excavation is kept smooth and flat.

EARTH AUGER

7. The earth auger is designed for sinking holes in the ground, usually to a maximum depth of 2 m. The most common sizes are 150 mm to 225 mm in diameter. It is operated by screwing the tool into the ground in a clockwise direction causing the cutting edges to bite into the soil. The spoil collects in the bowl of the tool and when the bowl is full the tool is removed and the spoil emptied. The auger will not operate efficiently in stony or sandy ground. The handle can be removed for storage.

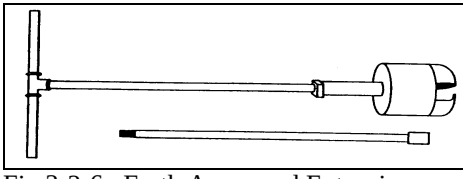

Fig 3-2-6 Earth Auger and Extension

HAND ICE AUGER

8. The hand ice auger is designed to cut holes 100 mm to 150 mm in diameter through ice to a depth of 4 m when using the extension. It is operated by screwing the tool into the ice in a clockwise direction causing the cutting edges to bite into the ice. The auger has to be withdrawn from the hole regularly to remove ice chips from the hole. Additional extensions may be used but drilling holes deeper than 4 m is very difficult.

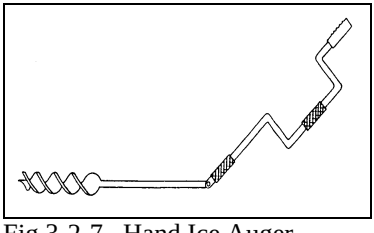

Fig 3-2-7 Hand Ice Auger

SECTION 3

CUTTING TOOLS

AXES

1. There are two types of axes in service use: the felling axe and the hand axe. The felling axe is the larger of the two and is used for felling trees and cutting large timber. The length of the handle is about 750 mm. This is a useful measure when cutting timber to length. The hand axe is used for cutting saplings and branches, trimming timber or sharpening.

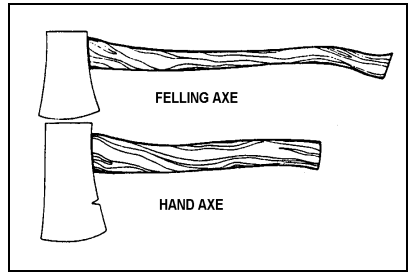

Fig 3-3-1 Axes

2. The axe may be used either left or right handed. The action of swinging an axe is like that of swinging the pick. Smaller timber (less than 75 mm in diameter) can be cut straight through in one or two strokes. For ease, the cut at an angle to the grain rather than at right angles to it.

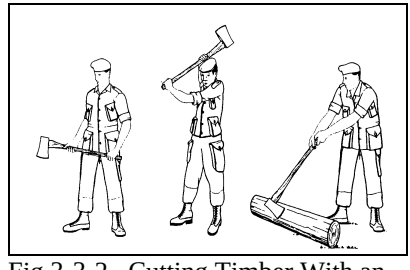
Fig 3-3-2 Cutting Timber With an Axe

3. For timber greater than 250 mm in diameter, cutting a notch from one side only becomes awkward and wastes timber. If the timber can be rolled over easily and safely it is better to make two cuts from opposite sides to meet in the centre. This enables the width of the notch to be reduced, sometimes by as much as half. If, however, the timber cannot be rolled over, it may be possible to produce two opposing cuts by chopping from a position standing on top of the timber.

MACHETE

4. The machete is used for cutting saplings or clearing vines, brushwood and similar materials. The machete comes in a case which can be attached to a soldier's fighting order.

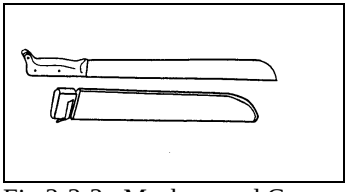

Fig 3-3-3 Machete and Case

CHISELS

5. Chisels are used to cut wood, metal, rock, concrete and masonry. They come in various widths and different types of points and are often used in conjunction with a hammer, mallet or sledgehammer.

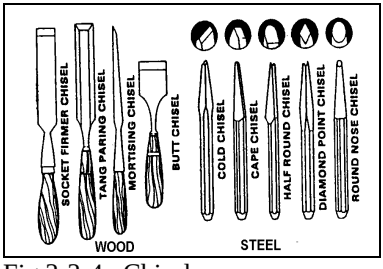

Fig 3-3-4 Chisels

SAWS

6. **Crosscut Saw.** The crosscut saw is a double-handled, two-man saw used for heavy work, such as felling trees, cutting large trees into logs, or sawing heavy bridge timbers. This saw is made of high-grade steel, with an arched blade 1.5 m to 1.8 m in length, approximately 20 cm wide at the middle and tapering to about 8 cm at each end. The cutting teeth are usually grouped four teeth to a section with raker teeth between each section to chisel out and remove the chips. It has largely been replaced by the power chainsaw.

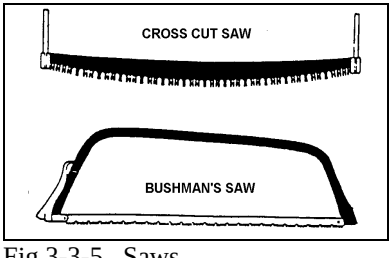

Fig 3-3-5 Saws

7. **Bushman's Saw.** This versatile tool can be used by one man in the field. It is particularly effective for felling trees up to 150 mm in diameter and can be used for basic carpentry. It has a replaceable blade.

ADZE

8. The adze is designed for shaping and squaring round timber. Considerable skill is required to obtain good results.

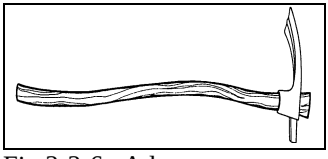

Fig 3-3-6 Adze

9. When working with an adze, the user stands astride the work, and the adze is swung with a chopping motion towards the body. The blade should bite into the timber slightly forward of the toes. A firm stance with the feet spread is important to avoid an accident should the blade miss its mark.

Fig 3-3-7 Correct Method of Using an Adze

SHEARS

10. Shears are used for cutting sheet metal and steel of various thicknesses and shapes. Hand shears are made with straight or curved cutting blades. Straight blades are used for cutting straight lines and also to cut curves in easily accessible locations. Curved blades, such as the hawk bill and the curved blade shears are made especially for cutting short straight lines or curves and for cutting out small intricate designs where the handle operating hand has to be kept away from the metal stock.

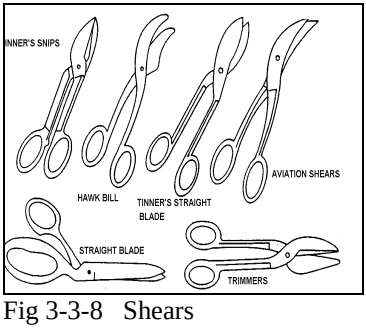

Fig 3-3-8 Shears

BOLT AND CABLE CUTTERS

11. Bolt cutters are available in various sizes with different cutting edges designed for specific applications and are replaceable. The centre cut cutters are used for all general purpose cutting with the cutting edges in the centre with equal bevels. The clipper cut cutters are almost entirely on one side which permits very close cutting of projecting ends. The shear cut cutters are used to cut steel cable, strip or flat bar stock. The cutting edges of the jaws pass each other in the manner of scissors. The side nut splitter cutters are used to split nuts off of bolts "head on" to the bolt's axis without damaging the bolt (when adjusted properly).

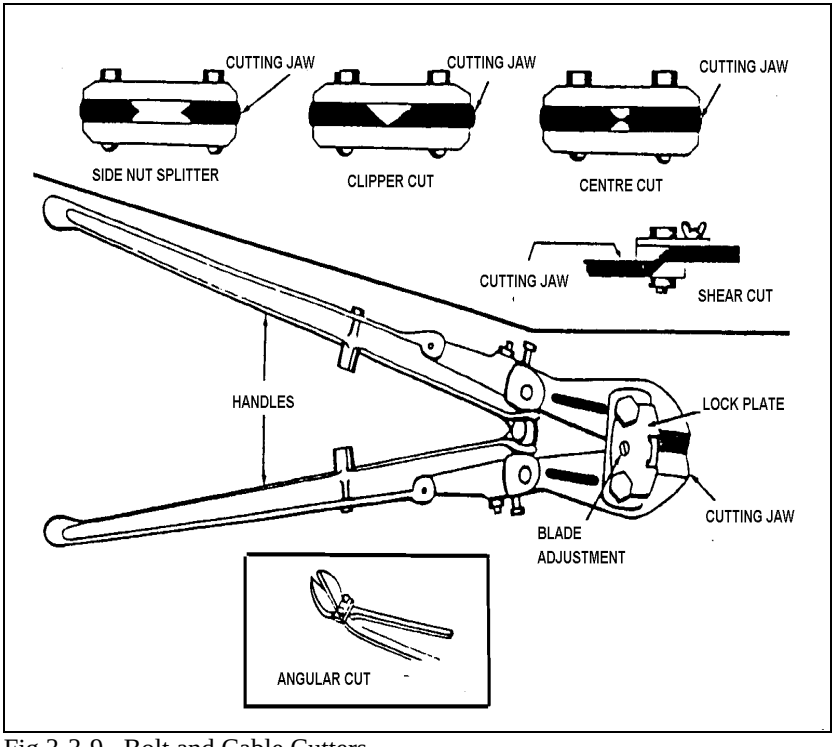

Fig 3-3-9 Bolt and Cable Cutters

WIRE CUTTERS AND PLIERS

12. Wire cutters are used to cut thin gauge metal and wire up to 5 mm in diameter. They come complete with a case which can be fitted to the soldier's fighting order.

13. Pliers are made in many different styles and sizes and are used to perform many operations. They are not a substitute for a wrench. Pliers are used for holding and gripping small articles where it may be inconvenient or impossible to use hands. Most commonly used pliers by the field engineer are the side cutters (lineman's) and the slip joint pliers. Other types of pliers that may be used for a specific purpose are locking jaw pliers (channel lock) and needle nose pliers.

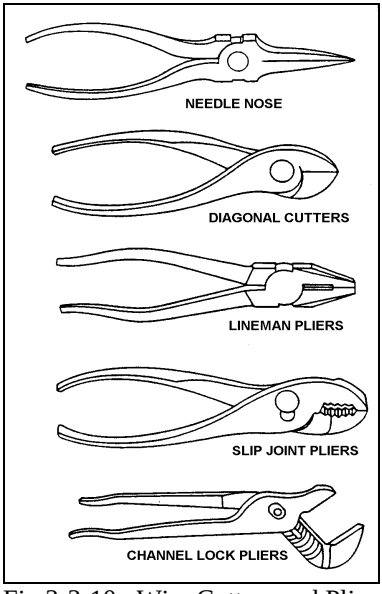

Fig 3-3-10 Wire Cutters and Pliers

14. Needle nose pliers were designed to assist electricians in making loops or eyes in wire in order to make proper connections, and can also be used to reach into hard to get at locations. The side and diagonal cutters are used to strip and cut wire. Slip joint pliers are designed to open in two positions. The channel lock pliers can open to seven different positions. They were originally designed for tightening or removing water pump packing nuts.

SECTION 4

MISCELLANEOUS TOOLS

SLEDGEHAMMERS AND MAULS

1. Sledge hammers come in two sizes: 1.8 kg and 3.6 kg. The 1.8 kg has a double face, but the 3.6 kg can be double-faced or straight-peen. The double-faced sledge hammer has two flat faces and is used for driving metal pickets and wedges. The straight-peen sledge hammer has one flat face, and a chiselled edge designed for breaking rock.

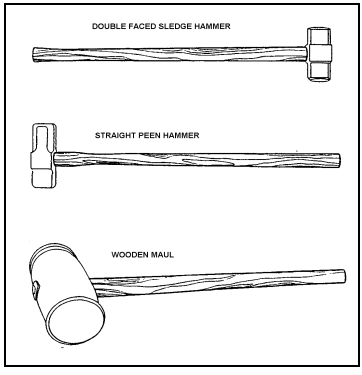

Fig 3-4-1 Sledgehammers and Mauls

2. The maul is a large, or small, hammer with a wooden head designed for driving wooden stakes or pickets. It is not used to hit metal objects.

HAMMERS

3. Claw and ball peen hammers are used to hammer nails and metal objects. The claw hammer is fitted with a claw to extract nails, while the ball peen hammer is fitted with a ball-shaped head at one end to shape metal.

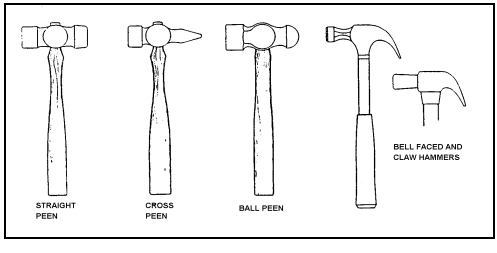

Fig 3-4-2 Claw and Ball Peen Hammers.

WOOD AUGER

4. The wood auger is used for boring holes in timber. The sizes available

are 12, 25, 37, 50 and 60 mm diameters. The wood handle can be detached, or come as a brace with bits.

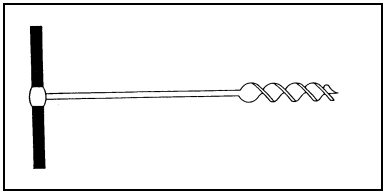

Fig 3-4-3 Wood Auger

WEDGES

5. Wedges can be made of wood or steel and when used to split timber, are usually driven with a wooden mallet or a sledge hammer. They are also used when sawing timber to hold the saw-cut open and prevent binding.

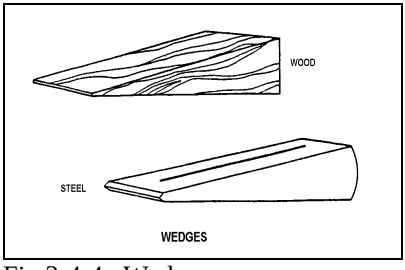

Fig 3-4-4 Wedges

PEAVEY AND TIMBER CARRIERS

6. Peavey and timber carriers are used to manoeuvre or carry logs or large square timber. The peavey carrier is used by one man and the timber carrier by two men.

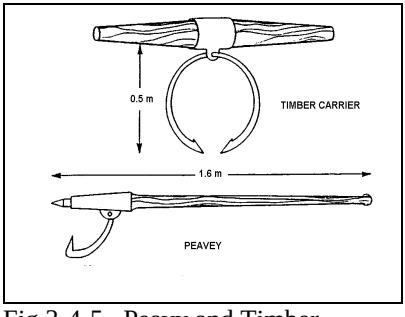

Fig 3-4-5 Peavy and Timber Carriers

PINCH AND CROW BARS

7. Pinch and crow bars are used to loosen timber, remove nails, loosen hard ground or break up masonry. They can also be used as a lever for moving heavy weights. The cutting edge is chisel shaped.

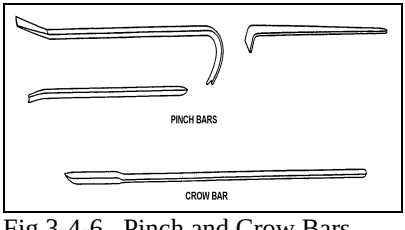

Fig 3-4-6 Pinch and Crow Bars

FILES AND RASPS

8. Files and rasps are used to shape wood or metal, and come in various sizes and lengths. A file may have teeth classified as: rough, coarse, bastard (medium coarse), second cut, smooth cut, and dead smooth grade. For fast removal of metal for rough work, the rough, coarse, and bastard files are used. For finishing, the second cut (small teeth), smooth cut (very small teeth), and the dead smooth (very fine teeth) are used.

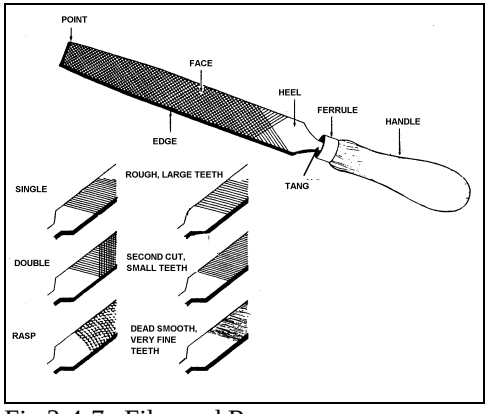

Fig 3-4-7 Files and Rasps

THUMPER

9. The thumper is a useful tool for driving steel pickets, pipes, rods and fence pickets. It is part of the demolition camouflet set.

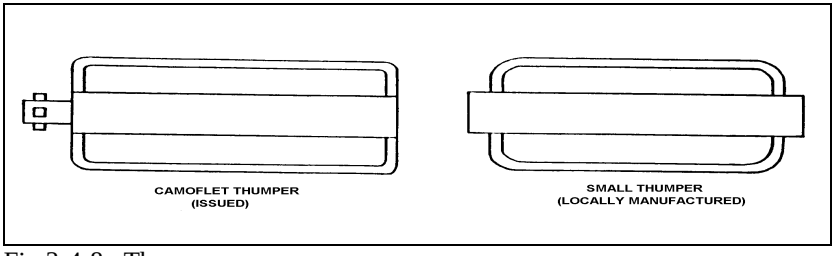

Fig 3-4-8 Thumpers

A locally produced model for driving steel pickets and smaller items can be made using a 1 m long piece of 10 cm galvanized pipe, one end capped with 1.2

cm steel and with two handles of 19 mm smooth round bar approximately 80 cm long.

RATCHET BRACE AND BITS

10. The ratchet brace is used **only** for drilling holes in wood. It turns auger bits, expansive bits, coun- tersink bits or screwdriver bits

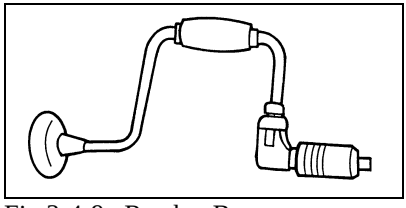

Fig 3-4-9 Ratchet Brace

11. The auger bit has a steel shaft which varies in length from 190.5 mm to 228.6 mm. It is not usually used for holes larger than 25.4 mm in diameter.

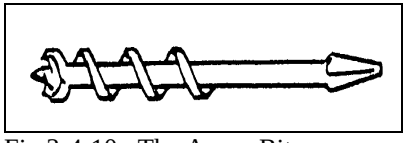

Fig 3-4-10 The Auger Bit

12. The expansive bit is used to bore holes from 12.7 mm to 76.2 mm in diameter.

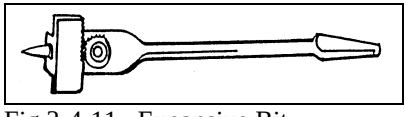

Fig 3-4-11 Expansive Bit

BREAST DRILL

13. The breast drill is used for drilling holes in metal or wood. Start holes in metal with a centre punch to help centre the twist drill. Place the drill bit at the point. Place the breast plate against the chest or shoulder; loosen the adjustment screw in the side of the plate and move the plate into a position which is comfortable, and tighten the ad just- ment screw. Set the speed shifter lever to desired speed: high or low. Hold the drill by the side handle with one hand, and apply a steady, even pressure on the breastplate. Turn the handle with the other hand.

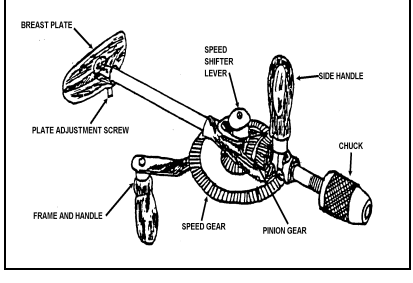

Fig 3-4-12 Breast Drill

HACKSAW

14. The hacksaw cuts metal objects of almost any size or shape, blades are 203.2 mm to 304.8 mm long, and are of two types, hard and flexible. The 18 point flexible blade, issued with the engineer tool set, is considered best for general use.

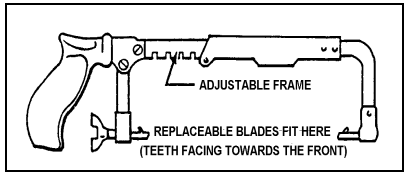

Fig 3-4-13 Hacksaw

MASONRY DRILL

15. 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 to keep the drill from binding.

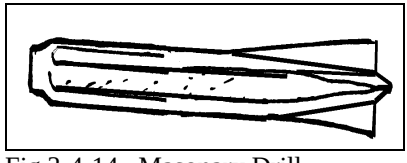
Fig 3-4-14 Masonary Drill

MEASURING INSTRUMENTS

16. 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 side is called the back. The corner is called the heel.

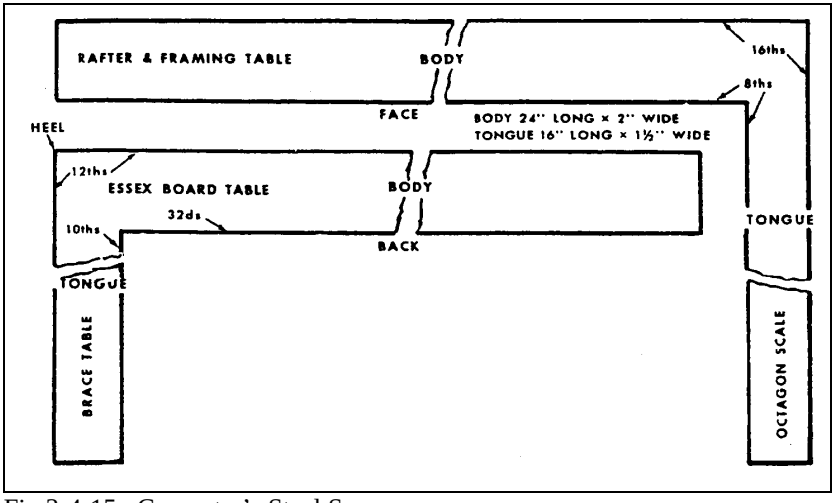

Fig 3-4-15 Carpenter's Steel Square

17. The Carpenter's level is a 24-inch wood or metal block with true surface edges. There are three bubble tubes in it, one to check for a level horizontal surface, one to check for a plumb vertical surface and the third to check a 45^{O} angle from horizontal. (Plumb means vertical or at a right angle to level.)

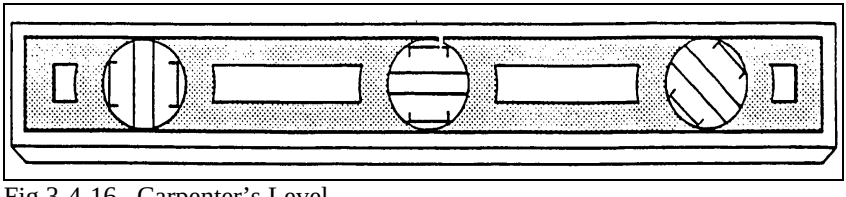

Fig 3-4-16 Carpenter's Level

18. 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

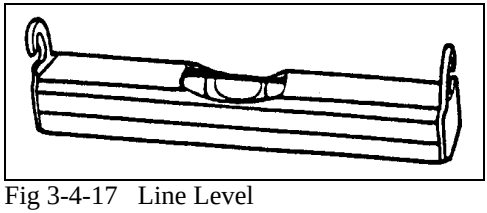

Fig 3-4-17 Line Level

Aluminum, is 76.2 mm 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.

19. The Plumb Bob is a metal weight with a pointed end. It has a device for attaching string and is used to obtain a vertical line.

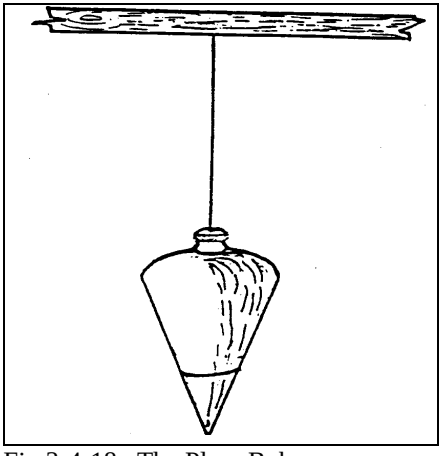

Fig 3-4-18 The Plum Bob

20. The chalk line 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 making long boards for sawing. To use:

a. tie the chalk line at the first point, pull the chalkline over the chalk, and secure the chalked line at the second point; and

b. grasp the line midway between the points and pull away at a right angle to the surface, release the line so it will snap straight downwards and deposit chalk in a straight line.

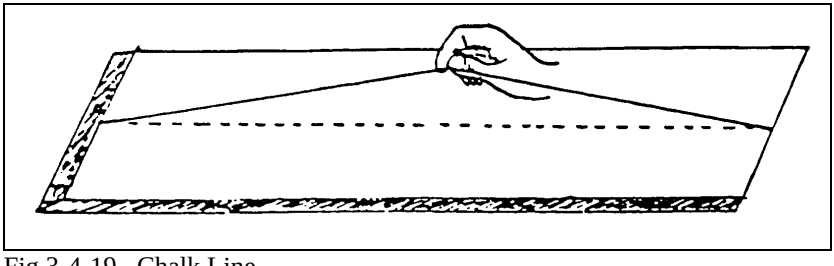

Fig 3-4-19 Chalk Line

21. The steel measuring tape is used for measuring circumference and long distances where rulers cannot be used.

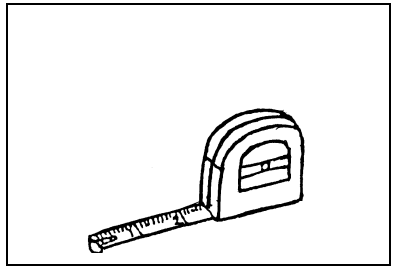

Fig 2-4-20 Steel Measuring Tape

22. The multiple folding rule is used to make measurements up to 8 feet, where precise measurement is not re- quired.

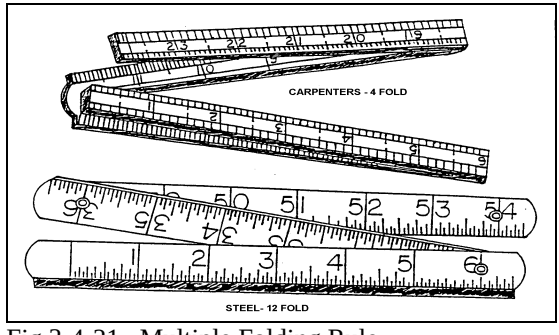

Fig 3-4-21 Multiple Folding Rule

LADDERS

23. A ladder is a piece of equipment which is used only where a more suitable means of access is impractical. The preferred ascent angle is 4 in 1 or 75 degrees to the horizontal. When using ladders, the following points shall be observed:

a. a safety person shall securet the bottom of the ladder when in use. In periods of prolonged use, the ladder will be secured top and bottom;

b. the ladder shall be placed on a firm base;

c. the ladder shall extend 1.05 m above the land-ing place unless an equi-valent handhold is provided; and of more than nine metres.

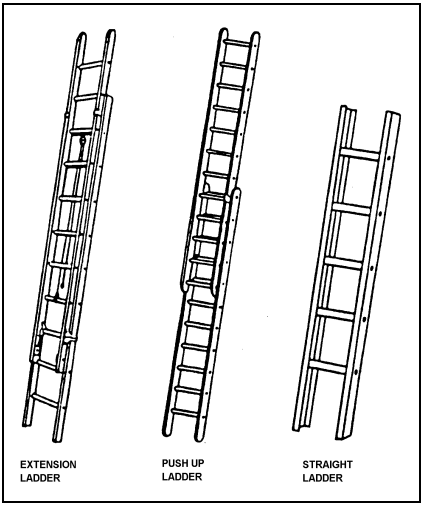

Fig 3-4-22 Ladders

TIMBER FASTENERS

24. **General.** The following fastenings for timber structures are generally available. They fall into two broad categories:

a. **Nails, Screws, Threaded Bolts and Coach Screws** are suitable for all types of light work; and

b. **Dogs, Spikes and Drift Pins** are used to connect heavy baulks of rough timber in constructions such as bridges or piers.

25. **Nails.** Nails range in size from 25 mm to 150 mm and come in a variety of types. Where possible, a nail should pass through the thinner timber into the thicker, and should be approximately three times longer than the thickness of the timber to be held in place. When nailing hardwood, the timber should be re-bored with a hole four-fifths of the nail diameter, and three-quarters of its length, and the nail should be lightly greased.

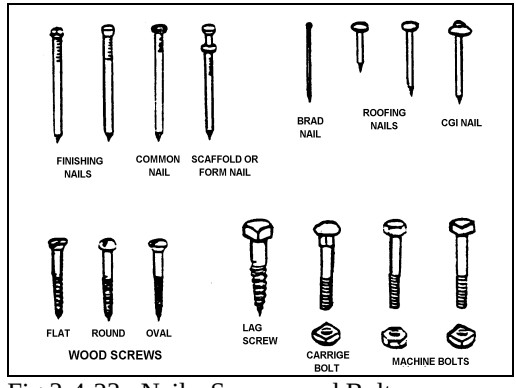

Fig 3-4-23 Nails, Screws, and Bolts

26. **Screws.** Where possible screws should pass through the thinner timber into the thicker. Holes should be bored four-fifths of the screw diameter and the screw length before insertion.

27. **Bolts.** When bolts are used to fasten timber, washers must always be used under the nut to prevent the wood being crushed and thus loosening the connection.

28. **Coach Screws.** Coach screws are used when it is impractical to use bolts and nuts. When using a coach screw, bore a hole four-fifths of the diameter of the shank for the full length of the screw, hammer it half way home and then screw tight.

29. **Timber Dogs.** Timber dogs are normally made from 10 mm square bar. They are used with heavy timber and are set so that the points are at least 75 mm from the edge or 100 mm from the end of the timber. A sledge hammer is used for driving. If the joint requires dogs on both sides, lay the frame flat on the ground, drive the dogs on the upper side halfway home, turn the frame over, and drive the dogs on the other

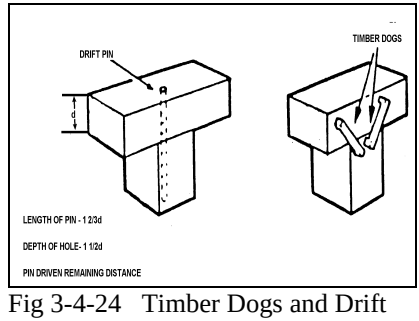

Fig 3-4-24 Timber Dogs and Drift Pins

side right home. Turn the frame over, and complete the driving.

30. **Spikes.** Spikes are large nails. They are 150 mm to 230 mm long and have a square cross-section of about 10 mm. The point is wedge-shaped and are driven with a sledge hammer across the grain to lessen the chance of splitting the timber.

31. **Drift Pins.** Drift pins are short lengths of round or square iron bar, without a head. They are driven using a sledge hammer into holes previously bored in the timber. The diameter of the hole should be about four-fifths of the bolt. The length of the pin and the depth of the bored hole depends on the thickness of the **front** piece of timber.

SECTION 5

CARE AND SHARPENING OF FIELD ENGINEERING TOOLS

GENERAL

1. All field engineering tools must be properly maintained if they are to give effective service. In most cases, this maintenance is straight forward. The basic principles are:

a. clean and lightly oil the metal parts of tools before returning them to stores;

b. keep cutting edges sharp at all times;

c. maintain wooden handles and replace them when damaged;

d. store cutting and digging tools in racks to protect their edges; and

e. report all damages to the storeman when returning tools.

TOOL SHARPENING

2. A tool's cutting edge is wedge shaped, and for maximum efficiency it must be maintained at the correct angle. The correct cutting angle for some commonly used tools is shown in Fig 3-6-1. Cutting edges are specially hardened by a heat process called tempering. Most tools can be sharpened by grinding or filing but care shall be taken, when doing this, not to reheat them to the stage where they lose their temper.

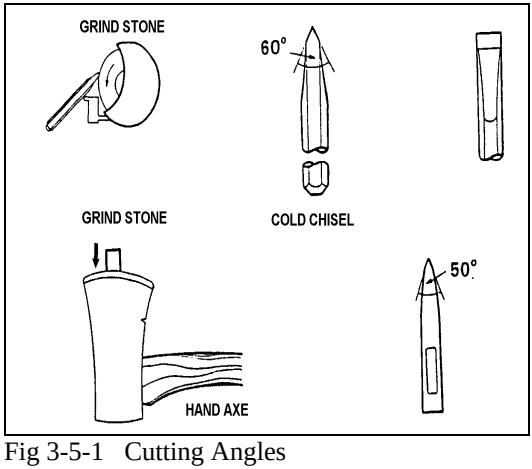

Fig 3-5-1 Cutting Angles

3. The four common types of sharpening equipment are: grindstone, power grinder, file and oilstone.

4. **Grindstone.** Although the hand-operated wet grindstone is somewhat obsolescent it is still a useful tool for cutting back large surface areas. Because the stone turns slowly in a bath of water, there is no danger of the tool edge becoming overheated.

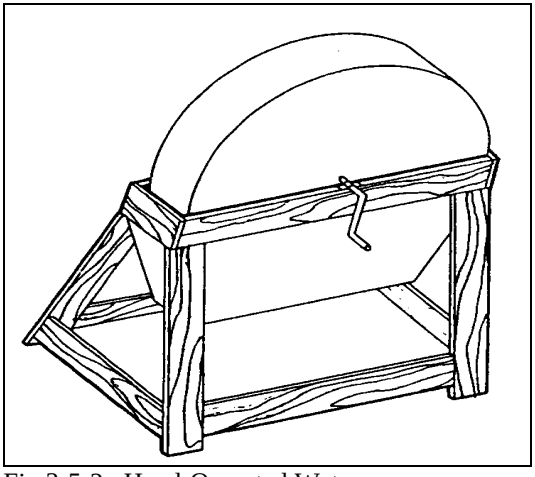

Fig 3-5-2 Hand-Operated Wet Grindstone

5. **Power Grinder.** The power grinder is a high speed grinding wheel that can be used to sharpen most tools. Use with caution; the heat generated by the speed of rotation will remove a tool's temper. Pass the edge of the blade along the grindstone and dip it in water to cool it. Eye protection shall be worn when using a power grinder. Ensure the tool rest and safety guards are properly adjusted before using.

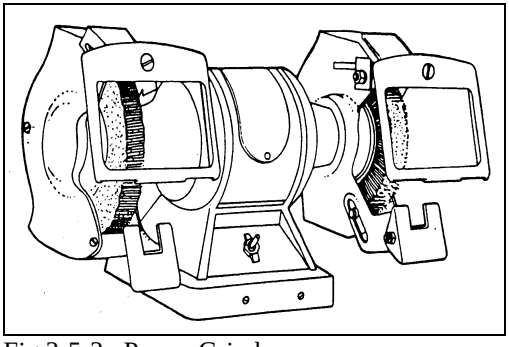

Fig 3-5-3 Power Grinder

6. **File.** Metal files are available in various sizes, shapes and grades. The file should be fitted with a handle before use, and the tool being

sharpened should have the edge cleaned and be free of oil. The sharpening stroke should be made with a combined forward and sideways motion, with the file at the right angle. As the file becomes clogged with filings, it should be cleaned with a wire brush.

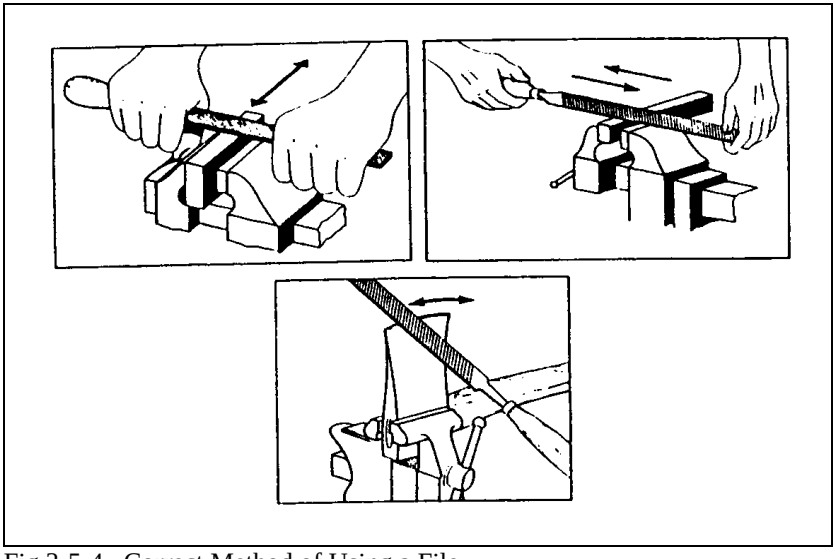

Fig 3-5-4 Correct Method of Using a File

7. **Oilstone.** The oilstone is used to put the fine edge on a cutting tool. It usually has both a fine and coarse side. The stone should be lightly oiled before use, and the whole surface should be used in the sharpening action to ensure even wear. After considerable use, the porous surface will become clogged with oil and metal particles, and its sharpening effect will be lessened. It can be reconditioned by being soaked for several hours in a solvent and then scrubbed with a stiff bristle brush.

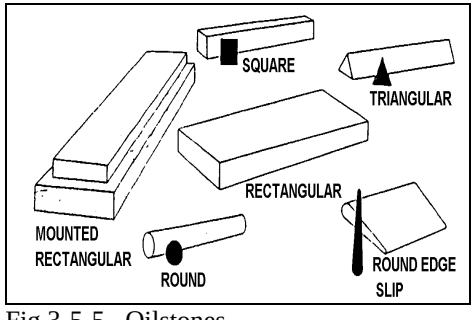

Fig 3-5-5 Oilstones

MAINTAINING AND REPLACING WOODEN HANDLES

8. The wooden handle of a field engineering tool can be a hazard if allowed to loosen or deteriorate. Replace them before this happens. Keep handles free of splinters by regularly rubbing with sandpaper, and do not paint them, as this causes blisters. Maul handles can be kept tight by soaking the head in a drum of water overnight. This causes the handle to expand and tighten in the head. For axes, hammers and sledges of all sizes, handles can be tightened by using wedges.

9. The following is the recommended method of replacing the wooden handle of a tool such as an axe:

a. remove the defective handle. This may require tapping the head away from the handle with a hammer. If it is tightly wedged the handle is sawed off near the head and then driven out using a punch, or drilled out;

b. shape the new handle using a wood rasp until it fits snugly in the tool's eye, then tap the handle with a wooden mallet to seat the head fully home;

c. saw off any of the handle projecting through the eye and finish it off flush, using a rasp; and

d. drive a new wedge (metal or wooden) into the handle and remove any of the wedge still projecting using a rasp or file as appropriate.

CARE OF THE HAND SAW

10. The two types of hand saws are the cross-cut and the rip saw. To function well, they must be kept sharpened and set periodically. The set is used to prevent the saw from binding and the angle of the set depends on the type of wood being cut.

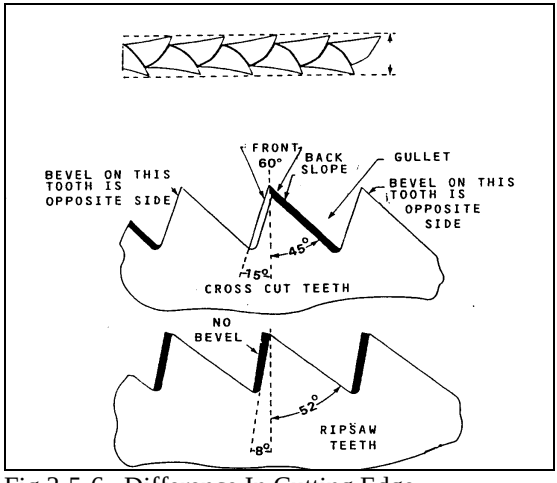

Fig 3-5-6 Difference In Cutting Edge.

11. Sharpen the saw by using a triangular file and ensure that the proper angle is kept (Fig 3-5-6). Once the saw is sharpened, the set is verified and if needed reset. This is done by using the setting tool resembling pliers (Fig 3-5-7). It has an adjustable tooth which can be adjusted to the proper angle. To set the saw teeth, start at the heel (handle end) and work towards the toe (tip), up one side, then change over and do the other side. Once the job is finished, make a test cut to ensure that it is cutting correctly.

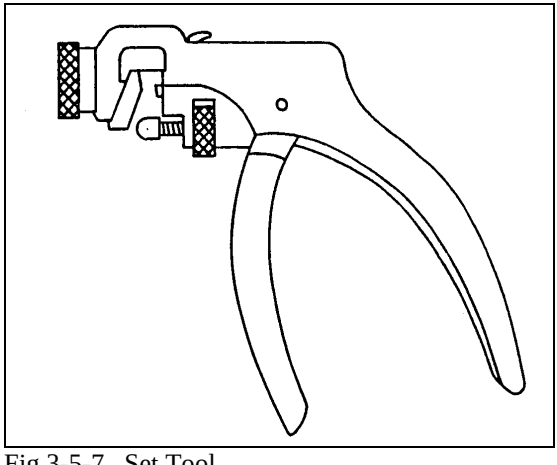

Fig 3-5-7 Set Tool