

## CHAPTER 1

# COMMON MAINTENANCE TOOLS AND THEIR USES

Tools are designed to make a job easier and enable you to work more efficiently. If they are not properly used and cared for, their advantages are lost to you.

Regardless of the type of work to be done, you must have, choose, and use the correct tools in order to do your work quickly, accurately, and safely. Without the proper tools and the knowledge of how to use them, you waste time, reduce your efficiency, and may even injure yourself.

This chapter explains the specific purposes, correct use, and proper care of the more common tools you will encounter as an ABE. Also discussed briefly are other aids to maintenance, such as blueprints and schematics.

### TOOL WORK HABITS

**LEARNING OBJECTIVES:** Describe the Tool Control Program. List several good tool work habits.

"A place for everything and everything in its place" is just good common sense. You can't do an efficient repair job if you have to stop and look around for each tool you need. The following rules will make your job easier and safer.

**KEEP EACH TOOL IN ITS PROPER STOWAGE PLACE.** All V-2 divisions have incorporated a Tool Control Program as directed by the Aircraft Launch and Recovery Equipment Maintenance Program (ALREMP).

The Tool Control Program is based on the concept of a family of specialized toolboxes and pouches configured for instant inventory before and after each maintenance action. The content and configuration of each container is tailored to the task, work center, and equipment maintained. Work center containers are assigned to and maintained within a work center. Other boxes and specialized tools are checked out from the tool control center (tool room).

**KEEP YOUR TOOLS IN GOOD CONDITION.** Protect them from rust, nicks, burrs, and breakage.

**KEEP YOUR TOOL ALLOWANCE COMPLETE.** When you are issued a toolbox, each tool should be placed in it when not in use. When the

toolbox is not actually at the work site, it should be locked and stored in a designated area.

### NOTE

An inventory list is kept in every toolbox to be checked before and after each job or maintenance action, to ensure that all tools are available to do your work, and to ensure that they are accounted for after you have completed your work.

**USE EACH TOOL ONLY FOR THE JOB IT WAS DESIGNED TO DO.** Each particular type of tool has a specific purpose. If you use the wrong tool when performing maintenance or repairs, you may cause damage to the equipment you're working on or damage the tool itself. Remember, improper use of tools results in improper maintenance. Improper maintenance results in damage to equipment and possible injury or death to you or others.

**SAFE MAINTENANCE PRACTICES.** Always avoid placing tools on or above machinery or an electrical apparatus. Never leave tools unattended where machinery or aircraft engines are running.

**NEVER USE DAMAGED TOOLS.** A battered screwdriver may slip and spoil the screw slot, damage other parts, or cause painful injury. A gauge strained out of shape will result in inaccurate measurements.

Remember, the efficiency of craftsmen and the tools they use are determined to a great extent by the way they keep their tools. Likewise, they are frequently judged by the manner in which they handle and care for them. Anyone watching skilled craftsmen at work notices the care and precision with which they use the tools of their trade.

The care of hand tools should follow the same pattern as for personal articles; that is, always keep hand tools clean and free from dirt, grease, and foreign matter. After use, return tools promptly to their proper place in the toolbox. Improve your own efficiency by organizing your tools so that those used most frequently can be reached easily without digging through the entire contents of the box. Avoid accumulating unnecessary junk.

## REVIEW QUESTIONS

- Q1. *Describe the Tool Control Program.*
- Q2. *List several good tool work habits.*
- Q3. *What are inspection mirrors used for?*

## CARE OF HAND TOOLS

**LEARNING OBJECTIVES:** List several principles that apply to the care of hand tools.

Tools are expensive; tools are vital equipment. When the need for their use arises, common sense plus a little preventive maintenance prolongs their usefulness. The following precautions for the care of tools should be observed:

- Clean tools after each use. Oily, dirty, and greasy tools are slippery and dangerous to use.
- NEVER hammer with a wrench.
- NEVER leave tools scattered about. When they are not in use, stow them neatly on racks or in toolboxes.
- Apply a light film of oil after cleaning to prevent rust on tools.
- INVENTORY tools after use to prevent loss.

## REVIEW QUESTION

- Q4. *List several principles that apply to the care of hand tools.*

## PERSONAL SAFETY EQUIPMENT

**LEARNING OBJECTIVES:** Identify the types of personal safety equipment.

To protect you from danger, protective equipment such as safety shoes, goggles, hard hats, and gloves are issued. The use of this equipment is mandatory on certain jobs. Their use is a **MUST**, and there is no question about that. Be sure to **USE THEM** on any job **WHERE** they are **REQUIRED**. They can protect you from a lot of harm.

### SAFETY SHOES

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there.

Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

### GOGGLES

Proper eye protection is of the utmost importance for all personnel. Eye protection is necessary because of hazards posed by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood. These hazards are ever-present during welding, cutting, soldering, chipping, grinding, and a variety of other operations. It is **IMPERATIVE** for you to use eye protection devices, such as helmets, face shields, and goggles (fig. 1-1), during eye-hazard operations.

Appropriate use of goggles will limit eye hazards. Some goggles have plastic lenses that resist shattering upon impact. Others are designed to limit harmful infrared and ultraviolet radiation from arcs or flames by use of appropriate filter lenses.

Remember, eye damage can be excruciatingly painful. **PROTECT YOUR EYES.**

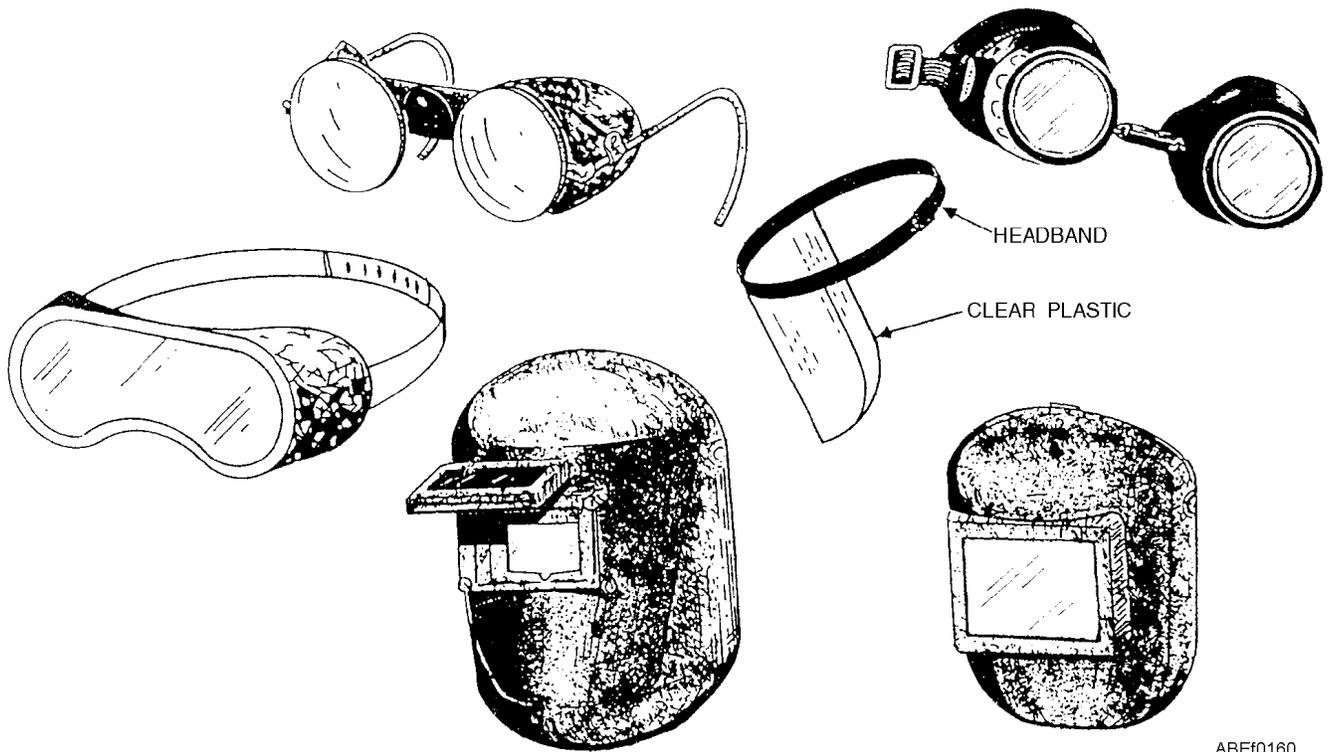
### GLOVES

Use gloves whenever you are required to handle rough, scaly, or splintery objects. Special flameproof gloves are designed for gas and electric-arc welding to limit danger and damage from sparks and other hot flying objects (fig. 1-2). Personnel in the electrical fields are usually required to wear insulating rubber gloves.

Be sure to follow all regulations prescribed for the use of gloves. Gloves must not be worn around rotating machinery unless sharp or rough material is being handled. If such is the case, **EXTREME CARE SHOULD BE EXERCISED** to prevent the gloves from being caught in the machinery.

### SAFETY BELTS AND STRAPS

The safety strap and body belt shown in figure 1-3 are what might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring (called a D-ring because of its



ABEF0160

Figure 1-1.—Eye-protection devices.

shape) on the body belt. When you are at working position, you unsnap one end of the safety strap, pass it around the supporting structure so there is no danger of its slipping (at least 18 inches from the top of the part on which it is fastened), and hook it to the right D-ring on the body belt.

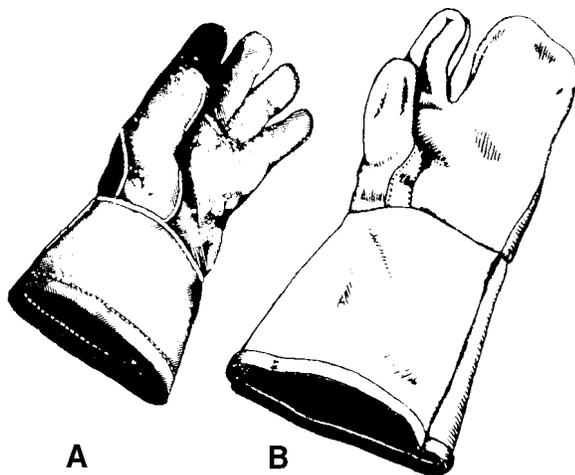
The safety strap must be placed around a part of the structure that is of sufficient strength to sustain an ABs weight and his or her equipment, and must rest flat against the surface without twists or turns. It must not

be placed around any part of a structure that is being removed.

Before placing your weight on the strap, determine VISUALLY that the snap and D-ring are properly engaged. Do not rely on the click of the snap-tongue as an indication that the fastening is secure.

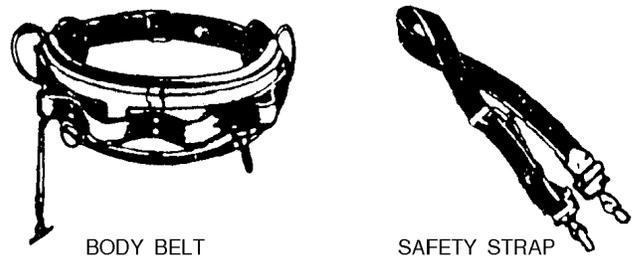
The body belt and safety strap require inspection before use. Look for loose or broken rivets; cracks, cuts, nicks, tears or wear in leather; broken or otherwise defective buckles, such as enlarged tongue-holes, defects in safety-belt snap hooks and body belt D-rings. If you discover any of these or other defects, turn in your equipment and replace it.

Perform maintenance periodically according to applicable procedures. Remember that leather and nylon belts are treated in different manners.



ABEF0161

Figure 1-2.—Gas and electric-arc welding gloves.



BODY BELT

SAFETY STRAP

ABEF0162

Figure 1-3.—Safety equipment.

## REVIEW QUESTION

- Q5. *Identify the different types of personal safety equipment.*

## MAINTENANCE AIDS

**LEARNING OBJECTIVES:** Read and interpret blueprints, drawings, diagrams, and other maintenance aids.

As an ABE you will be required to read blueprints and drawings during the performance of many maintenance actions required to maintain the operational readiness of the catapults and the arresting gear engines. As you advance in rating you may also be required to make sketches and drawings, which will assist you in the training of less-experienced maintenance personnel by making it possible for them to visualize the system or object you are explaining.

## BLUEPRINTS AND DRAWINGS

Blueprints are exact copies of mechanical or other types of drawings and employ a language of their own. It is a form of sign language or shorthand that uses lines, graphic symbols, dimensions, and notations to accurately describe the form size, kind of material, finish, and construction of an object. It can be said that blueprint reading is largely a matter of translating these lines and symbols into terms of procedure, materials, and other details needed to repair, maintain, or fabricate the object described on the print.

Usually you can look at a blueprint and recognize the object if you are familiar with the actual part. But when you are required to make or check on a certain part, the applicable blueprint must be referred to in order to get dimensions and other pertinent information. The important thing is to know what the different symbols stand for and where to look for the important information on a blueprint. Some of the important facts listed on all blueprints are discussed in the following paragraphs.

### Title Block

The title block is located in the lower right corner of all blueprints and drawings prepared according to military standards. The block contains the drawing number, the name of the part or assembly that the blueprint represents, and all information required to identify the part or assembly.

The title block also includes the name and address of the Government agency or organization preparing the drawing, the scale, drafting record, authentication, and the date (fig. 1-4).

A space within the title block with a diagonal or slant line drawn across it indicates that the information usually placed in it is not required or is given elsewhere on the drawing.

### Revision Block

The revision block (not shown) is usually located in the upper right corner of the blueprint and is used for the recording of changes (revisions) to the print. All revisions are noted in this block and are dated and identified by a letter and a brief description of the revision. A revised drawing is shown by the addition of a letter to the original number in the title block, as shown in figure 1-4, view A. If the print shown in figure 1-4, view A, was again revised, the letter in the revision block of the title block would be replaced by the letter *B*.

### Drawing Number

All blueprints are identified by a drawing number (NAVSHIP Systems Command No. in view A of fig. 1-4, and FEC Drawing No. in view B), which appears in a block in the lower right corner of the title block. It may be shown in other places also; for example, near the top border line in an upper corner, or on the reverse side at both ends so that it will be visible when a drawing is rolled up. If a blueprint has more than one sheet, this information is included in the block indicating the sheet number and the number of sheets in the series. For example, note that in the title blocks shown in figure 1-4 the blueprint is sheet 1 of 1.

### Reference Numbers

Reference numbers that appear in the title block refer to numbers of other blueprints. When more than one detail is shown on a drawing, a dash and a number are frequently used. For example, if two parts are shown in one detail drawing, both prints would have the same drawing number, plus a dash and an individual number, such as 8117041-1 and 8117041-2.

In addition to appearing in the title block, the dash and number may appear on the face of the drawings, near the parts they identify. Some commercial prints show the drawing and dash number, and point with a leader line to the part; others use a circle, 3/8 inch in

NN DWG NO. <b>0101 46</b>		<b>NEWPORT NEWS SHIPBUILDING &amp; DRY DOCK CO.</b> NEWPORT NEWS, VIRGINIA FSCM NO. 43689 <b>HULL DESIGN DIV STRUCTURAL DEPT</b>			
DRAWN <i>J.A. Doe</i> CHECKED <i>J.R. Frost</i> SUPVR <i>W.J. Doe</i> DATE <i>6/11/95</i>		TITLE <b>AIRCRAFT CARRIER CVAN 68          DOUBLE BOTTOM          AFT OF FRAME 180          COMPARTMENT &amp; ACCESS.</b>			
EXAMINED <i>John Boat</i> DATE COMPLETED <i>5/17/95</i>		APPROVED <i>Ch. B. Seaman</i> DATE <b>JUL 17 1995</b> <small>FOR SUPERVISOR OF SHIPBUILDING USN</small>			
AUTHORIZED		TYPE OF DWG <b>WORKING DRAWING</b>		SIZE <b>H</b>	CODE IDENT NO <b>80064</b>
		NAVSHIP SYSTEM COMMAND NO. <b>800</b>	2647537	REV. <b>A</b>	
		SCALE $\frac{1}{8} = 1\text{FT.}$		SHEET <b>1</b> OF <b>1</b>	

**A**

DES. <i>Mary (M) Christmas</i> DRWN. <i>Mary (M) Christmas</i> CHK. <i>Ch. B. Seaman</i> SUPV. <i>Paul T. Brute</i> IN CHARGE <i>Yany C. Pistol</i>		DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND <b>U. S. NAVAL STATION, WASHINGTON, D.C.</b> <i>INSTALLATION OF NEW LIGHTING          BLDG. 220-3 &amp; 4          WASHINGTON NAVY YARD</i>			
SATISFACTORY TO <i>Flas A. Brute</i>		CODE IDENT. NO. <b>80091</b>	SIZE <b>F</b>	FEC DRAWING NO. <b>1167420</b>	
APPROVED <i>John Boat</i> DATE <i>5/17/95</i> OFFICER IN CHARGE		SCALE $\frac{1}{8} = 1'$		SPEC. <b>82805/91</b> NBy <b>82805</b>	SHEET <b>1</b> OF <b>1</b>
APPROVED <i>J.R. Frost</i> DATE <i>5/12/95</i> PUBLIC WORKS OFFICER					

**B**

ABE0172

Figure 1-4.—Blueprint title blocks. (A) Naval Ship's Systems Command; (B) Naval Facilities Engineering Command.

diameter, around the dash number, and carry a leader line to the part.

A dash and number are used to identify modified or improved parts, and also to identify right-hand and left-hand parts. Many aircraft parts on the left-hand side of an aircraft are exactly like the corresponding parts on the right-hand side but in reverse. The left-hand parts are usually shown in the drawing.

Above the title block on some prints you may see a notation such as "159674 LH shown; 159674-1 RH opposite." Both parts carry the same number. But the part called for is distinguished by a dash and number. (LH means left-hand, and RH means right-hand.) Some companies use odd numbers for right-hand parts and even numbers for left-hand parts.

## Drawing Lines

The lines used in working drawings are more than a means of showing a picture of an object for the purpose of building or repairing. The way a line is drawn has a definite meaning.

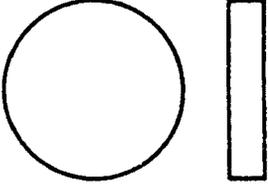
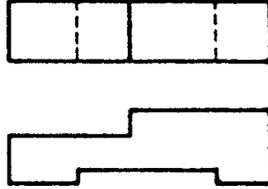
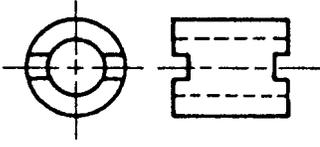
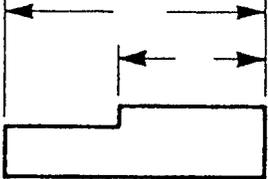
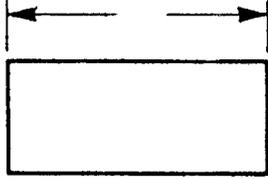
Thick lines are used for the visible outline of the object being drawn. Medium lines are used for the dotted lines representing hidden features and for cutting-plane, short-break, adjacent-part, and alternate-position lines. Center lines, dimension lines, long-break lines, ditto lines, extension lines, and section lines are represented by thin lines.

To understand blueprint reading, you must know the different types of lines used in general drawing practice and the information conveyed by each. Some of the lines of major importance are illustrated in

figures 1-5-A and 1-5-B. The correct uses are illustrated in figure 1-6.

Blueprints make it possible to understand, in a comparatively small space, what is to be made or repaired. Of the many types of blueprints you will use aboard ship, the simplest one is the plan view. This type

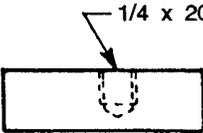
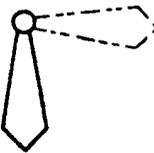
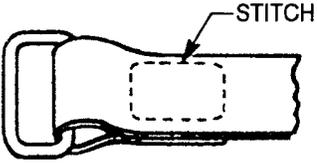
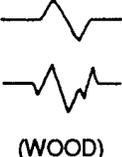
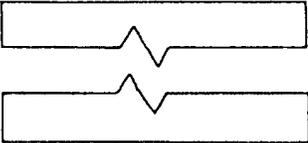
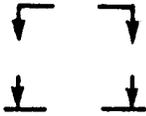
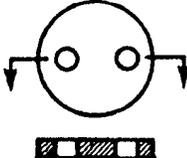
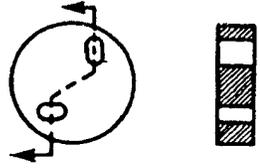
of blueprint shows the position, location, and use of the various parts of the ship; for example, to find the battlestations sickbay, barbershop, or other parts of the ship. In addition to plan views, other blueprints, called assembly prints, unit or subassembly prints, and detail prints, show various kinds of machinery and mechanical equipment.

LINE STANDARDS			
NAME	CONVENTION	DESCRIPTION AND APPLICATION	EXAMPLE
VISIBLE LINES		HEAVY UNBROKEN LINES USED TO INDICATE VISIBLE EDGES OF AN OBJECT	
HIDDEN LINES		MEDIUM LINES WITH SHORT EVENLY SPACED DASHES USED TO INDICATE CONCEALED EDGES	
CENTER-LINES		THIN LINES MADE UP OF LONG AND SHORT DASHES ALTERNATELY SPACED AND CONSISTENT IN LENGTH USED TO INDICATE SYMMETRY ABOUT AN AXIS AND LOCATION OF CENTERS	
DIMENSION LINES		THIN LINES TERMINATED WITH ARROWHEADS AT EACH END USED TO INDICATE DISTANCE MEASURED	
EXTENSION LINES		THIN UNBROKEN LINES USED TO INDICATE EXTENT OF DIMENSIONS	

ABEF0173

(A)

Figure 1-5-A.—Standard lines.

NAME	CONVENTION	DESCRIPTION AND APPLICATION	EXAMPLE
LEADER		THIN LINE TERMINATED WITH ARROW-HEAD OR DOT AT ONE END  USED TO INDICATE A PART, DIMENSION OR OTHER REFERENCE	
PHANTOM OR DATUM LINE		MEDIUM SERIES OF ONE LONG DASH AND TWO SHORT DASHES EVENLY SPACED ENDING WITH LONG DASH  USED TO INDICATE ALTERNATE POSITION OF PARTS, REPEATED DETAIL OR TO INDICATE A DATUM PLANE	
STITCH LINE		MEDIUM LINE OF SHORT DASHES EVENLY SPACED AND LABELED  USED TO INDICATE STITCHING OR SEWING	
BREAK (LONG)		THIN SOLID RULED LINES WITH FREEHAND ZIG-ZAGS  USED TO REDUCE SIZE OF DRAWING REQUIRED TO DELINEATE OBJECT AND REDUCE DETAIL	
BREAK (SHORT)		THICK SOLID FREE HAND LINES  USED TO INDICATE A SHORT BREAK	
CUTTING OR VIEWING PLANE VIEWING PLANE OPTIONAL		THICK SOLID LINES WITH ARROWHEAD TO INDICATE DIRECTION IN WHICH SECTION OR PLANE IS VIEWED OR TAKEN	
CUTTING PLANE FOR COMPLEX OR OFFSET VIEWS		THICK SHORT DASHES  USED TO SHOW OFFSET WITH ARROWHEADS TO SHOW DIRECTION VIEWED	

ABEF0174

(B)

Figure 1-5-B.—Standard lines—continued.

Assembly prints show the various parts of the mechanism, how the parts fit together, and their relation to each other. Subassembly prints show the location, shape, size, and relationships of the parts of the subassembly or unit. Detail prints show a single part

with its dimensions and all the information needed to make a new part as a replacement. Assembly and subassembly prints may be used to learn operation and maintenance of machines, systems, and equipment.

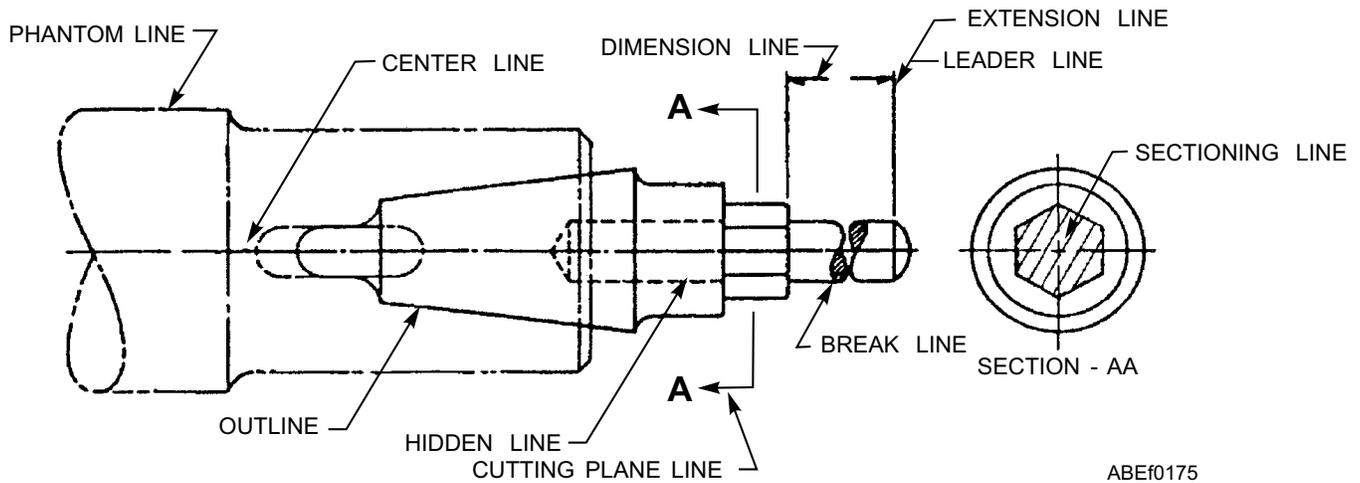


Figure 1-6.—Use of standard lines.

### MICROFILM/APERTURE CARDS

Many prints and drawings are procured in the form of 16- and 35-mm microfilm. Microfilm prints and drawings are available mounted on aperture (viewer) cards, as well as in roll form. A reader or some type of projector is required to enlarge the microfilm for reading. Activities are provided with a microfilm reader-printer, which as its name implies, enlarges the microfilm for reading and also has the capability of printing a working copy in a matter of a few seconds.

Microfilm greatly reduces the size of otherwise bulky files, which is very important aboard ship.

### SCHEMATIC DIAGRAMS

Schematic diagrams show by means of single lines and symbols how the parts of a system are connected for the operation of the system.

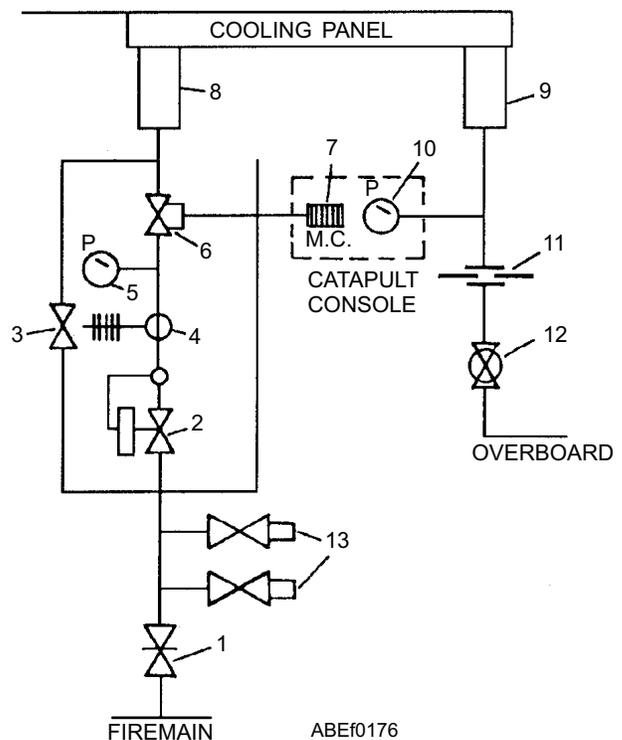
### Piping

Piping diagrams are normally used to trace piping systems and their functions without actually describing the shape, size, or location of the components or parts. Each component is represented by a symbol; and once these symbols are learned, the piping schematic diagram is easy to read.

Figure 1-7 is a good example of a piping diagram. As may be seen from this example, diagrams do not indicate the location of individual components within the station, but do locate the components with respect to each other within the system.

### Electrical

Schematic diagrams are also used to depict electrical systems. They are basically the same as the



- |                      |                     |                    |
|----------------------|---------------------|--------------------|
| 1. Cutout valve.     | 6. Hytrol valve.    | 11. Orifice.       |
| 2. Reducing valve    | 7. Pilot valve.     | 12. Scupper valve. |
| 3. Throttling valve. | 8. Inlet lines.     | 13. Hose valves.   |
| 4. Relief valve.     | 9. Discharge lines. |                    |
| 5. Test gauge.       | 10. Pressure gage.  |                    |

Figure 1-7.—Typical piping schematic for saltwater cooling.

piping diagrams except they use electrical symbols instead of piping symbols. Figure 1-8 is an example of an electrical system schematic.

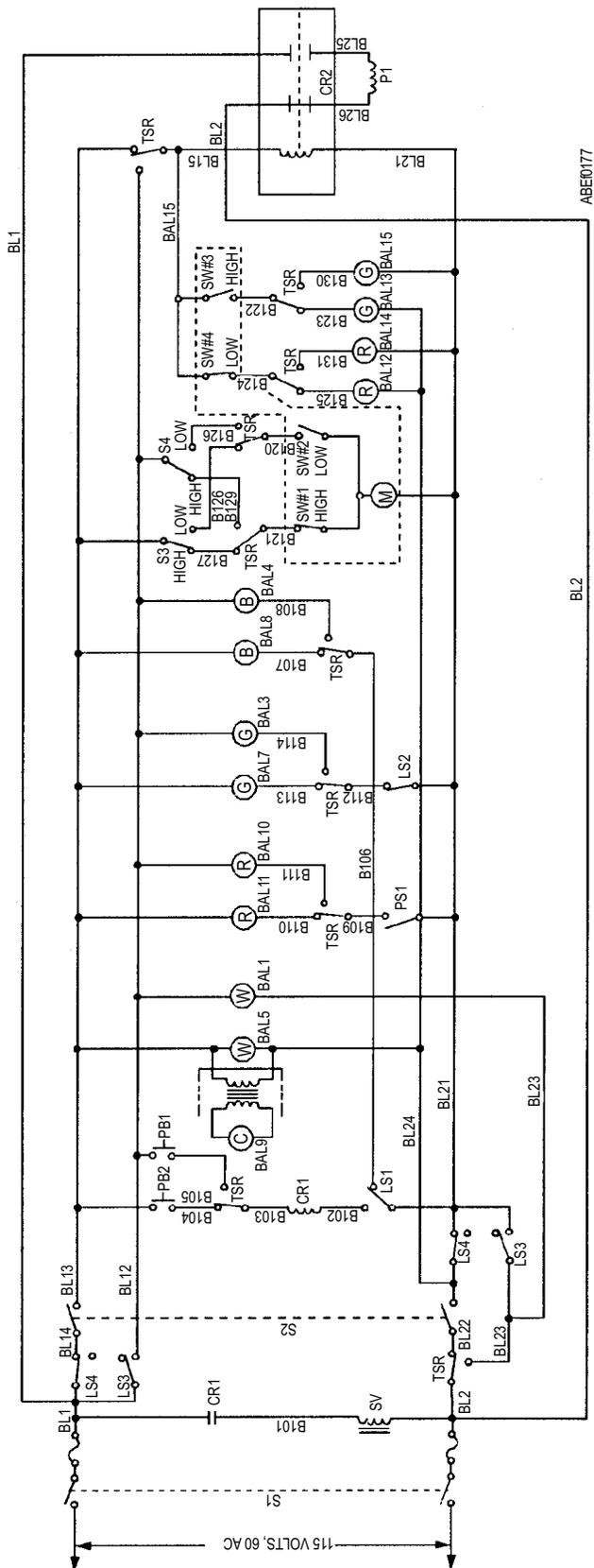


Figure 1-8.—Electrical system schematic.

Schematic diagrams are especially helpful when you are learning a hydraulic system or pinpointing a malfunction in an electrical system. For more information on diagrams, drawings, and blueprints, and their interpretation, study *Blueprint Reading and Sketching*, NAVEDTRA 12014.

### REVIEW QUESTION

Q6. Where is the title block located on all blueprints and drawings prepared to military standards?

### METAL-CUTTING TOOLS

**LEARNING OBJECTIVES:** Identify the different types of metal-cutting tools. Describe the uses of different types of cutting tools.

Many types of metal-cutting tools are used by skilled mechanics of all ratings. As you become better acquainted with the ABE rating, you will probably discover many tools that you use for cutting metal that are not described in this text. In this text, only the basic hand metal-cutting tools will be considered.

### SNIPS AND SHEARS

Snips and shears are used for cutting sheet metal and steel of various thickness and shapes. Normally, the heavier or thicker materials are cut by shears.

One of the handiest tools for cutting light (up to 1/16-inch thick) sheet metal is the hand snip (tip snips). The STRAIGHT HAND SNIPS, shown in figure 1-9,

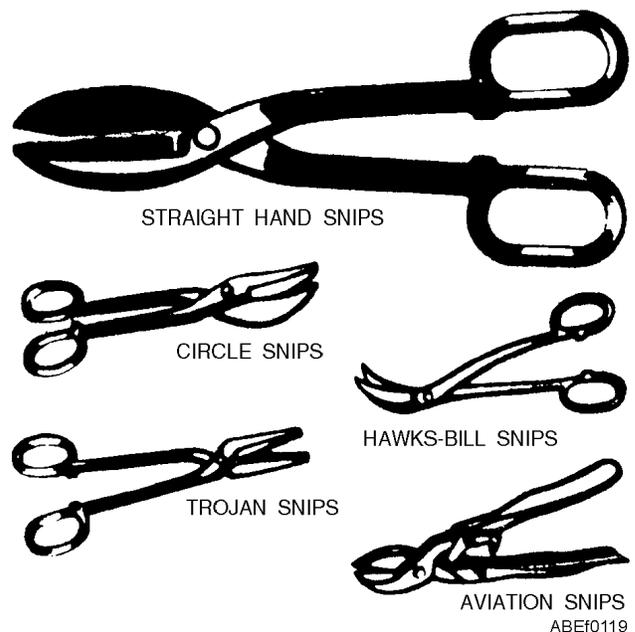


Figure 1-9.—Metal snips.

have blades that are straight and cutting edges that are sharpened to an 85-degree angle. Snips like this can be obtained in different sizes, ranging from the small, 6-inch, to the large, 14-inch, snip. Tin snips will also work on slightly heavier gauges of soft metals, such as aluminum alloys.

Snips will not remove any metal when a cut is made. There is danger, though, of causing minute metal fractures along the edges of the metal during the shearing process. For this reason, it is better to cut just outside the layout line. This procedure will allow you to dress the cutting edge while keeping the material within required dimensions.

Cutting extremely heavy gauge metal always presents the possibility of springing the blades. Once the blades are sprung, hand snips are useless. When cutting heavy material, use the rear portion of the blades. This procedure not only avoids the possibility of springing the blades but also gives you greater cutting leverage.

Many snips have small serrations (notches) on the cutting edges of the blades. These serrations tend to prevent the snips from slipping backwards when a cut is being made. Although this feature does make the actual cutting easier, it mars the edges of the metal slightly. You can remove these small cutting marks if you allow proper clearance for dressing the metal to size. There are many other types of hand snips used for special jobs, but the snips discussed here can be used for almost any common type of work.

### Cutting Sheet Metal with Snips

It is hard to cut circles or small arcs with straight snips. There are snips especially designed for circular cutting. They are called **CIRCLE SNIPS**, **HAWKS-BILL SNIPS**, **TROJAN SNIPS**, and **AVIATION SNIPS** (fig. 1-9).

To cut large holes in the lighter gauges of sheet metal, start the cut by punching or otherwise making a hole in the center of the area to be cut out. With an aviation snips, or some other narrow-bladed snips, make a spiral cut from the starting hole out toward the scribed circle, as shown in figure 1-10, and continue cutting until the scrap falls away.

To cut a disk in the lighter gauges of sheet metal, use a combination snips or a straight-blade snips, as shown in figure 1-11. First, cut away any surplus material outside the scribed circle, leaving only a narrow piece to be removed by the final cut. Make the

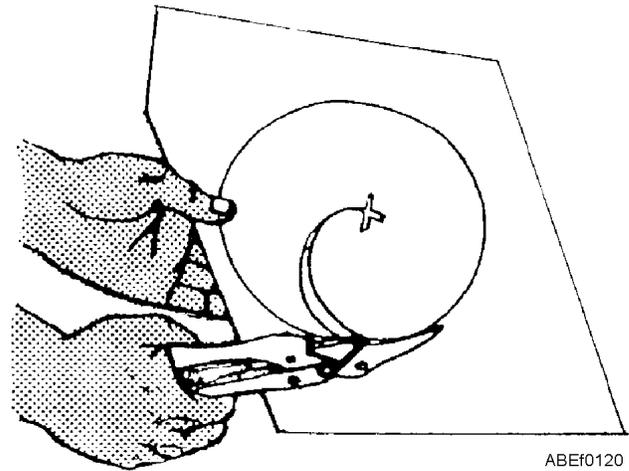


Figure 1-10.—Cutting an inside hole with snips.

final cut just outside the layout line. This will permit you to see the scribed line while you are cutting and will cause the scrap to curl up below the blade of the snips, where it will be out of the way while the complete cut is being made.

To make straight cuts, place the sheet metal on a bench with the marked guideline over the edge of the bench and hold the sheet down with one hand. With the other hand, hold the snips so that the flat sides of the blades are at right angles to the surface of the work. If the blades are not at right angles to the surface of the work, the edges of the cut will be slightly bent and burred. The bench edge will also act as a guide when you are cutting with the snips. The snips will force the scrap metal down so that it does not interfere with cutting. Any of the hand snips may be used for straight cuts. When notches are too narrow to be cut out with a pair of snips, make the side cuts with the snips and cut the base of the notch with a cold chisel.

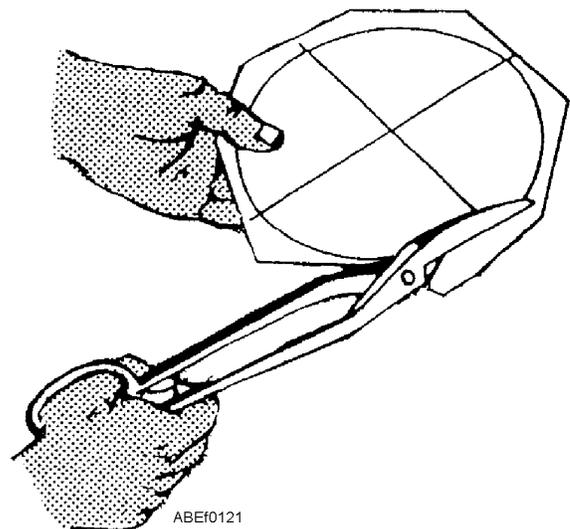


Figure 1-11.—Cutting a disk out of sheet metal.

## Safety and Care

Learn to use snips properly. They should always be oiled and adjusted to permit ease of cutting and to produce a surface that is free from burrs. If the blades bind or if they are too far apart, the snips should be adjusted. Remember the following safety tips:

- Never use snips as screwdrivers, hammers, or pry bars. They break easily.
- Do not attempt to cut heavier materials than the snips are designed for. Never use tin snips to cut hardened steel wire or other similar objects. Such use will dent or nick the cutting edges of the blades.
- Never toss snips in a toolbox where the cutting edges can come into contact with other tools. This dulls the cutting edges and may even break the blades.
- When snips are not in use, hang them on hooks or lay them on an uncrowded shelf or bench.

## HACKSAWS

Hacksaws are used to cut metal that is too heavy for snips or bolt cutters. Thus, metal bar stock can be cut readily with hacksaws.

There are two parts to a hacksaw: the frame and the blade. Common hacksaws have either an adjustable or a solid frame (fig. 1-12). Most hacksaws found in the Navy are of the adjustable-frame type. Adjustable frames can be made to hold blades from 8 to 16 inches long, while those with solid frames take only the length blade for which they are made. This length is the

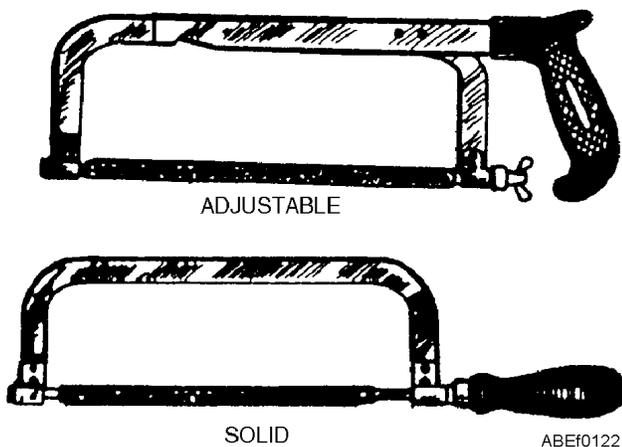


Figure 1-12.—Hacksaws.

distance between the two pins that hold the blade in place.

Hacksaw blades are made of high-grade tool steel, hardened and tempered. There are two types, the all-hard and the flexible. All-hard blades are hardened throughout, whereas only the teeth of the flexible blades are hardened. Hacksaw blades are about 1/2-inch wide, have from 14 to 32 teeth per inch, and are from 8 to 16 inches long. The blades have a hole at each end, which hooks to a pin in the frame. All hacksaw frames, which hold the blades either parallel or at right angles to the frame, are provided with a wingnut or screw to permit tightening or removing the blade.

The SET in a saw refers to how much the teeth are pushed out in opposite directions from the sides of the blade. The four different kinds of set are the ALTERNATE set, DOUBLE ALTERNATE set, RAKER set, and WAVE set. Three of these are shown in figure 1-13.

The teeth in the alternate set are staggered, one to the left and one to the right throughout the length of the blade. On the double alternate set blade, two adjoining teeth are staggered to the right, two to the left, and so on. On the raker set blade, every third tooth remains straight and the other two are set alternately. On the wave (undulated) set blade, short sections of teeth are bent in opposite directions.

## Using Hacksaws

The hacksaw is often used improperly. Although it can be used with limited success by an inexperienced person, a little thought and study given to its proper use will result in faster and better work and in less dulling and breaking of blades.

Good work with a hacksaw depends not only upon the proper use of the saw but also upon the proper

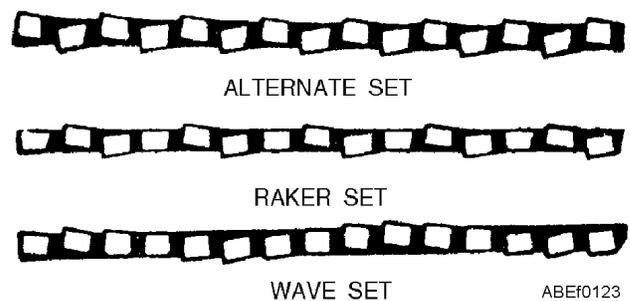


Figure 1-13.—"Set" of hacksaw-blade teeth.

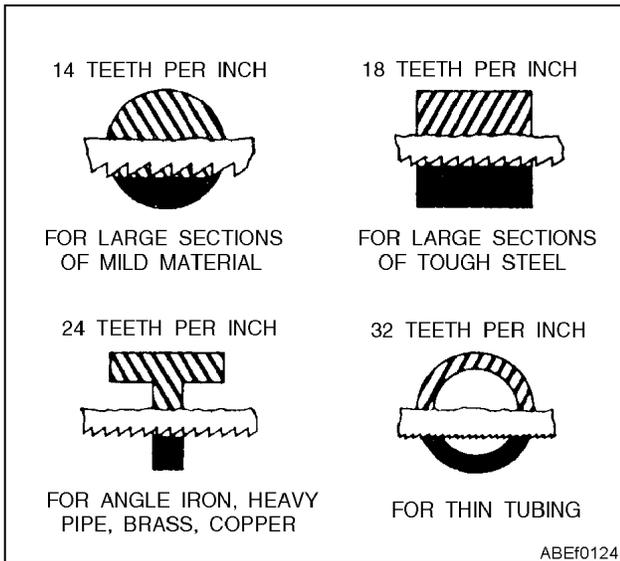


Figure 1-14.—Selecting the proper hacksaw blade.

selection of the blades for the work to be done. Figure 1-14 will help you select the proper blade to use when sawing metal with a hacksaw. Coarse blades, with fewer teeth per inch, cut faster and are less likely to choke up with chips. However, finer blades, with more teeth per inch, are necessary when thin sections are being cut. The selection should be made so that, as each tooth starts its cut, the tooth ahead of it will still be cutting.

To make the cut, first install the blade in the hacksaw frame (fig. 1-15) so the teeth point away from the handle of the hacksaw. (Hand hacksaws cut on the push stroke.) Tighten the wingnut until the blade is definitely under tension. This helps make straight cuts.

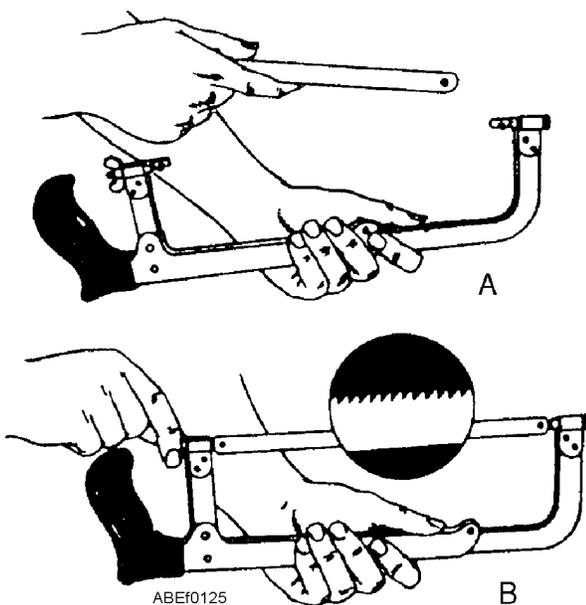


Figure 1-15.—Installing a hacksaw blade.

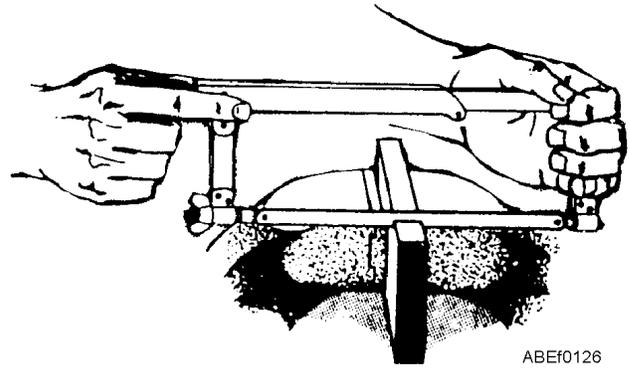


Figure 1-16.—Proper way to hold a hacksaw.

Place the material to be cut in a vise. A minimum of overhang will reduce vibration, give a better cut, and lengthen the life of the blade. Have the layout line outside of the vise jaw so that the line is visible while you work.

The proper method of holding the hacksaw is depicted in figure 1-16. See how the index finger of the right hand, pointed forward, aids in guiding the frame.

When cutting, let your body sway ahead and back with each stroke. Apply pressure on the forward stroke, which is the cutting stroke, but not on the return stroke. From 40 to 50 strokes per minute is the usual speed. Long, slow, steady strokes are preferred.

For long cuts, rotate the blade in the frame so that the length of the cut is not limited by the depth of the frame. Hold the work with the layout line close to the vise jaws, raising the work in the vise as the sawing proceeds.

To remove a frozen nut with a hacksaw, saw into the nut, as shown in figure 1-17, starting the blade close to the threads on the bolt or stud and parallel to one face of the nut, as shown in view A. Saw parallel to the bolt until the teeth of the blade almost reach the lockwasher. Lockwashers are hard and will ruin hacksaw blades, so do not try to saw them. View B shows when to stop sawing. Then, with a cold chisel and hammer, remove this one side of the nut completely by opening the saw

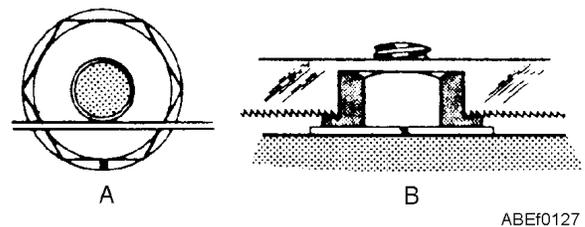


Figure 1-17.—Removing a frozen nut with a hacksaw.

kerf. Put an adjustable wrench across this new flat and the one opposite, and again try to remove the frozen nut. Since very little original metal remains on this one side of the nut, the nut will either give or break away entirely and permit its removal.

To saw a wide kerf in the head of a cap screw or machine bolt, fit the hand hacksaw frame with two blades side by side, and with teeth lined up in the same direction. With slow, steady strokes, saw the slot approximately one-third the thickness of the head of the cap screw, as shown in figure 1-18. Such a slot will permit subsequent holding or turning with a screwdriver when it is impossible, due to close quarters, to use a wrench.

### Hacksaw Safety

The main danger in using hacksaws is injury to your hand if the blade breaks. The blade will break if too much pressure is applied, when the saw is twisted, when the cutting speed is too fast, or when the blade becomes loose in the frame. Additionally, if the work is not tight in the vise, it will sometimes slip, twisting the blade enough to break it.

### CHISELS

Chisels are tools that can be used for chipping or cutting metal. They are made from a good grade of tool steel and have a hardened cutting edge and beveled head. Chisels are classified according to the shape of their points, and the width of the cutting edge denotes their size. The most common shapes of chisels are the flat (cold chisel), cape, round nose, and diamond point (fig. 1-19).

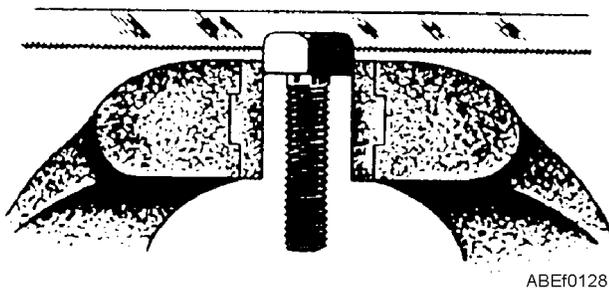


Figure 1-18.—Cutting a wide kerf in the head of a cap screw or bolt.

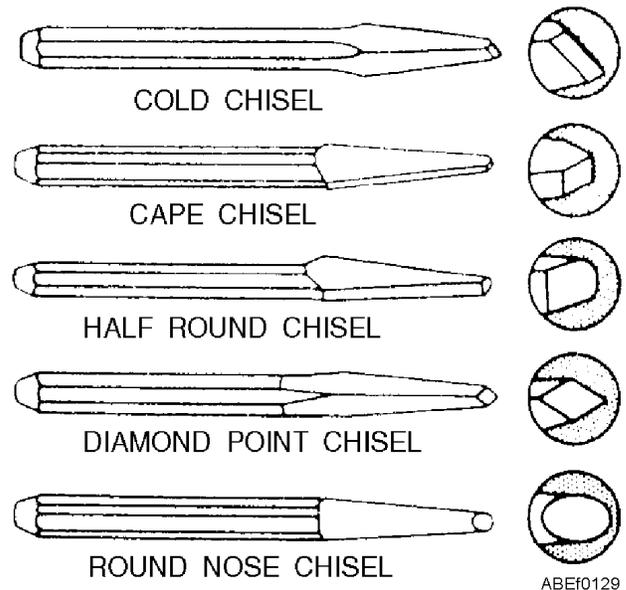


Figure 1-19.—Types of points on metal-cutting chisels.

The type of chisel most commonly used is the flat cold chisel, which serves to cut rivets, split nuts, chip castings, and cut thin metal sheets. The cape chisel is used for special jobs like cutting keyways, narrow grooves, and square corners. Round-nose chisels make circular grooves and chip inside corners. Finally, the diamond-point is used for cutting V-grooves and sharp corners.

As with other tools, there is a correct technique for using a chisel. Select a chisel that is large enough for the job. Be sure to use a hammer that matches the chisel; that is, the larger the chisel, the heavier the hammer. A heavy chisel will absorb the blows of a light hammer and will do virtually no cutting.

When using a chisel for chipping, always wear goggles to protect your eyes. If others are working close by, see that they are protected from flying chips by erecting a screen or shield to contain the chips. Remember that the time to take these precautions is before you start the job.

### FILES

There are a number of different types of files in common use, and each type may range in length from 3 to 18 inches.

## Grades

Files are graded according to the degree of fineness and whether they have single- or double-cut teeth. The difference is apparent when you compare the files in figure 1-20, view A.

Single-cut files have rows of teeth cut parallel to each other. These teeth are set at an angle of about 65 degrees with the centerline. You will use single-cut files for sharpening tools, finish filing, and drawfiling. They are also the best tools for smoothing the edges of sheet metal.

Files with crisscrossed rows of teeth are double-cut files. The double cut forms teeth that are diamond-shaped and fast cutting. You will use double-cut files for quick removal of metal and for rough work.

Files are also graded according to the spacing and size of their teeth, or their coarseness and fineness. Some of these grades are pictured in view B. In addition to the three grades shown, you may use some DEAD SMOOTH files, which have very fine teeth, and some ROUGH files, with very coarse teeth. The fineness or coarseness of file teeth is also influenced by the length of the file. (The length of a file is the distance from the tip to the heel, and does not include the tang view C.) When you have a chance, compare the actual size of the teeth of a 6-inch, single-cut smooth file and a 12-inch, single-cut smooth file; you will notice the 6-inch file has more teeth per inch than the 12-inch file.

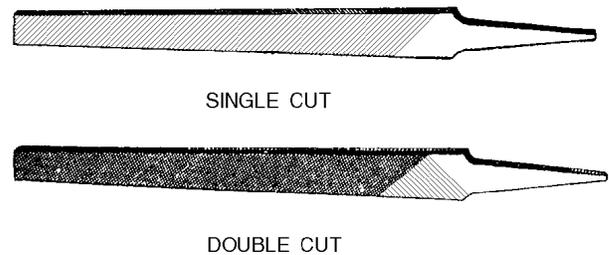
## Shapes

Files come in different shapes. Therefore, in selecting a file for a job, consider the shape of the finished work. Some of the cross-sectional shapes are shown in figure 1-20, view D.

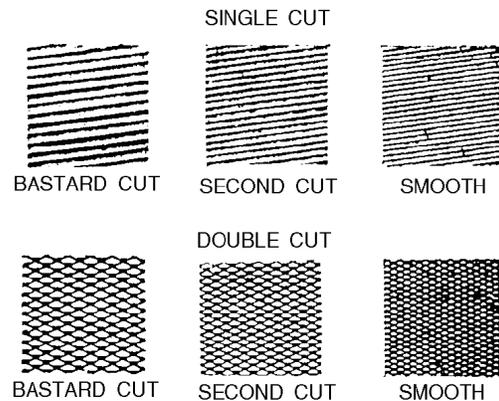
TRIANGULAR files are tapered on all three sides. They are used to file acute internal angles and to clear out square corners. Special triangular files are used to file saw teeth.

MILL files are tapered in both width and thickness. One edge has no teeth and is known as a SAFE EDGE. Mill files are used for smoothing lathe work, drawfiling, and other fine, precision work. Mill files are always single-cut.

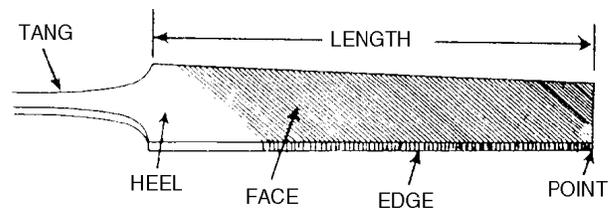
FLAT files are general-purpose files and may be either single- or double-cut. They are tapered in width and thickness. HARD files, not shown, are somewhat



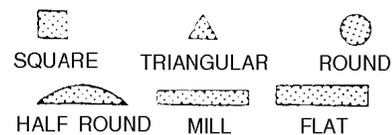
A. SINGLE AND DOUBLE-CUT FILES



B. DESIGN AND SPACING OF FILE TEETH



C. FILE NOMENCLATURE



ABEf0130

Figure 1-20.—File information.

thicker than flat files. They taper slightly in thickness, but their edges are parallel.

The flat or hard files most often used are the double-cut for rough work and the single-cut smooth file for finish work.

SQUARE files are tapered on all four sides and are used to enlarge rectangular-shaped holes and slots. ROUND files serve the same purpose for round openings. Small round files are often called "rattail" files.

The HALF ROUND file is a general-purpose tool. The rounded side is used for curved surfaces, and the flat face on flat surfaces. When you file an inside curve, use a round or half-round file whose curve most nearly matches the curve of the work.

Kits of small files, often called "swiss pattern" or "jewelers" files, are used to fit parts of delicate mechanisms and for filing work on instruments. Handle these small files carefully because they break easily.

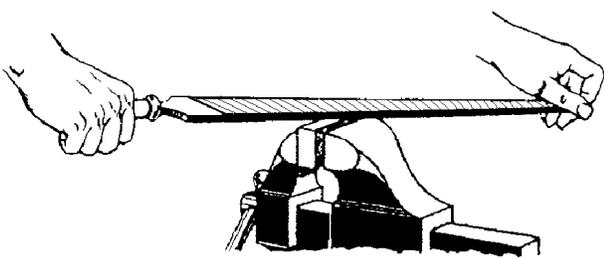
### Filing Operations

Using a file is an operation that is nearly indispensable when working with metal. You may be crossfiling, drawfiling, using a file card, or even polishing metal. Let's examine these operations.

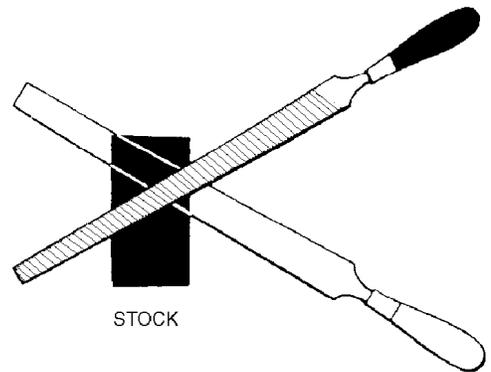
When you have finished using a file, it may be necessary to use an abrasive cloth or paper to finish the product. Whether this is necessary depends on how fine a finish you want on the work.

**CROSSFILING.**—Figure 1-21, view A, shows a piece of mild steel being crossfiled. This means that the file is being moved across the surface of the work in approximately a crosswise direction. For best results, keep your feet spread apart to steady yourself as you file with slow, full-length, steady strokes. The file cuts as you push it—ease up on the return stroke to keep from dulling the teeth. Keep your file clean.

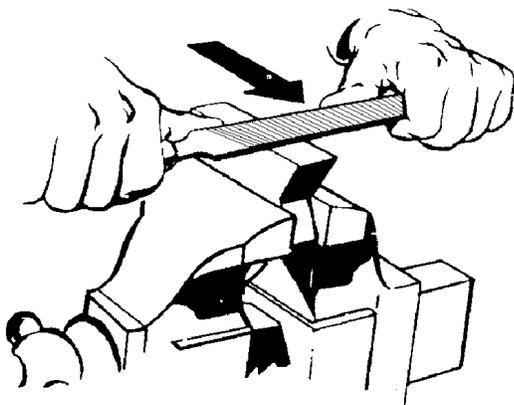
View B shows the alternate positions of the file when an exceptionally flat surface is required. Using either position first, file across the entire length of the stock. Then, using the other position, file across the entire length of the stock again. Because the teeth of the file pass over the surface of the stock from two directions, the high spots and low spots will readily be visible after filing in both positions. Continue filing first in one position or direction and then the other until



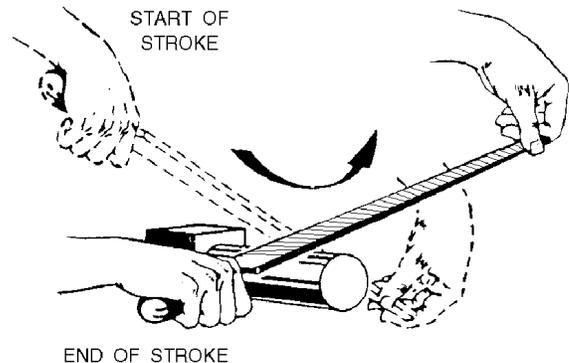
A. CROSSFILING A PIECE OF MILD STEEL



B. ALTERNATING POSITIONS WHEN FILING



C. DRAWFILING A SMALL PART



D. FILING ROUND METAL STOCK

ABEF0131

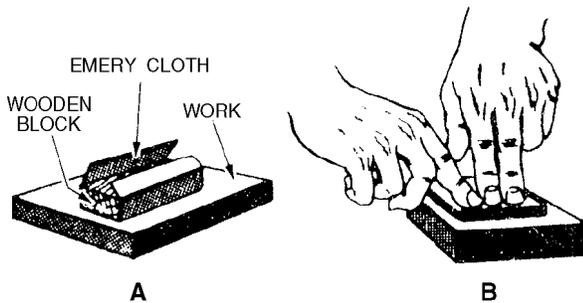
Figure 1-21.—Filing operations.

the surface has been filed flat. Test the flatness with a straightedge or with prussian blue and a surface plate.

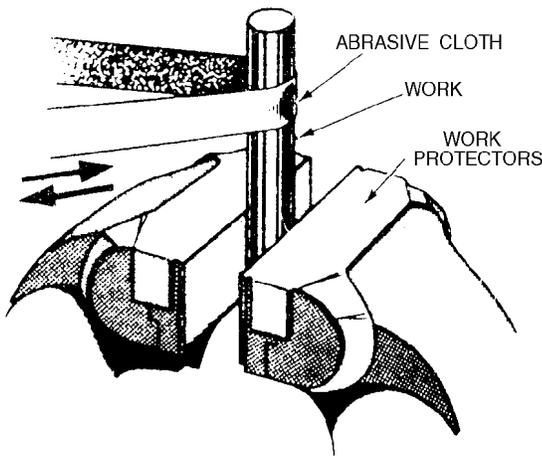
**DRAWFILING.**—Drawfiling produces a finer surface finish and usually a flatter surface than crossfiling. Small parts, as shown in view C, are best held in a vise. Hold the file as shown in the figure; notice that the arrow indicates that the cutting stroke is away from you when the handle of the file is held in the right hand. If the handle is held in the left hand, the



**A. POLISHING METAL WITH ABRASIVE CLOTH WRAPPED AROUND A FILE**



**B. ALTERNATE METHODS FOR POLISHING METAL SURFACE**



**C. POLISHING ROUND METAL STOCK**

ABEF0132

**Figure 1-22.—Polishing operations.**

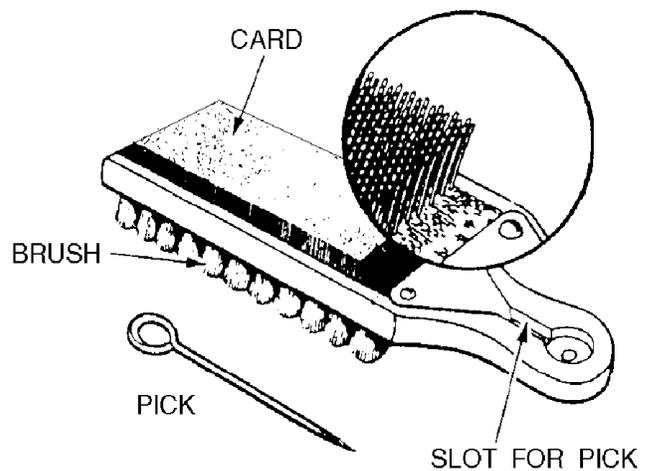
cutting stroke will be toward you. Lift the file away from the surface of the work on the return stroke. When drawfiling will no longer improve the surface texture, wrap a piece of abrasive cloth around the file and polish the surface as shown in figure 1-22, view A.

**USE OF FILE CARD.**—As you file, the teeth of the file may "clog up" with some of the metal filings and scratch your work. This condition is known as PINNING. You can prevent pinning by keeping the file teeth clean. Rubbing chalk between the teeth will help prevent pinning, too, but the best method is to clean the file frequently with a FILE CARD or brush. A file card (fig. 1-23) has fine wire bristles. Brush with a pulling motion, holding the card parallel to the rows of teeth.

Always keep the file clean, whether you're filing mild steel or other metals. Use chalk liberally when filing nonferrous metals.

**FILING ROUND-METAL STOCK.**—Figure 1-21, view D, shows that as a file is passed over the surface of round work, its angle with the work is changed. This results in a rocking motion of the file as it passes over the work. This rocking motion permits all the teeth on the file to make contact and cut as they pass over the work's surface, thus tending to keep the file much cleaner and thereby doing better work.

**POLISHING A FLAT-METAL SURFACE.**—When polishing a flat metal surface, first draw file the surface as shown in figure 1-21, view C. Then, when the best possible drawfiled surface has been obtained, proceed with abrasive cloth, often called emery cloth. Select a grade of cloth suited to the drawfiling. If the drawfiling was well done, only a fine cloth will be needed to do the polishing.



ABEF0133

**Figure 1-23.—File card/brush cleaner.**

If your cloth is in a roll and if the job you are polishing is the size that would be held in a vise, tear off a 6- or 8-inch length of the 1- or 2-inch width. If you are using sheets of abrasive cloth, tear off a strip from the long edge of the 8- by 11-inch sheet.

Wrap the cloth around the file (fig. 1-22, view A) and hold the file as you would for drawfiling. Hold the end of the cloth in place with your thumb. In polishing, apply a thin film of lubricating oil on the surface being polished and use a double stroke with pressure on both the forward and the backward strokes. Note that this is different from the drawfiling stroke in which you cut with the file in only one direction.

When further polishing does not appear to improve the surface, you are ready to use the next finer grade of cloth. Before changing to the finer grade, however, reverse the cloth so that its back is toward the surface being polished.

Work the reversed cloth back and forth in the abrasive-laden oil as an intermediate step between grades of abrasive cloth. Then, with the solvent available in your ship, clean the job thoroughly before proceeding with the next finer grade of cloth. Careful cleaning between grades helps to ensure freedom from scratches.

For the final polish, use a strip of crocus cloth—first the face and then the back—with plenty of oil. When polishing is complete, again carefully clean the job with a solvent and protect it with oil or other means, from rusting.

In figure 1-22, A of view B shows another way to polish, in which the abrasive cloth is wrapped around a block of wood. In B of view B, the cloth has simply been folded to form a pad, from which a worn, dull surface can be removed by simply tearing it off to expose a new surface.

**POLISHING ROUND-METAL STOCK.**—In figure 1-22, view C, a piece of round stock is being polished with a strip of abrasive cloth, which is "seesawed" back and forth as it is guided over the surface being polished.

Remember that the selection of grades of abrasive cloth, the application of oil, and the cleaning between grades applies to polishing, regardless of how the cloth is held or used.

## Care of Files

A new file should be broken in carefully by using it first on brass, bronze, or smooth cast iron. Just a few of the teeth will cut at first, so use a light pressure to prevent tooth breakage. Do not break in a new file by using it first on a narrow surface.

Protect the file teeth by hanging your files in a rack when they are not in use or by placing them in drawers with wooden partitions. Your files should not be allowed to rust—keep them away from water and moisture. Avoid getting the files oily. Oil causes a file to slide across the work and prevents fast, clean cutting. Files that you keep in your toolbox should be wrapped in paper or cloth to protect their teeth and prevent damage to other tools.

Never use a file for prying or pounding. The tang is soft and bends easily. The body is hard and extremely brittle. Even a slight bend or a fall to the deck may cause a file to snap in two. Do not strike a file against the bench or vise to clean it—use a file card.

## Safety

Never use a file unless it is equipped with a tight-fitting handle. If you use a file without the handle and it bumps something or jams to a sudden stop, the tang may be driven into your hand. To put a handle on a file tang, drill a hole in the handle, slightly smaller than the tang. Insert the tang end, and then tap the end of the handle to seat it firmly. Make sure you get the handle on straight.

## TWIST DRILLS

Making a hole in a piece of metal is generally a simple operation, but in most cases an important, precise job. A large number of different tools and machines have been designed so that holes may be made speedily, economically, and accurately in all kinds of material.

To be able to use these tools efficiently, it is important that you become acquainted with them. The most common tool for making holes in metal is the twist drill. It consists of a cylindrical piece of steel with spiral grooves. One end of the cylinder is pointed, while the other end is shaped so that it may be attached to a drilling machine. The grooves, usually called FLUTES, may be cut into the steel cylinder, or the flutes may be formed by twisting a flat piece of steel into a cylindrical shape.

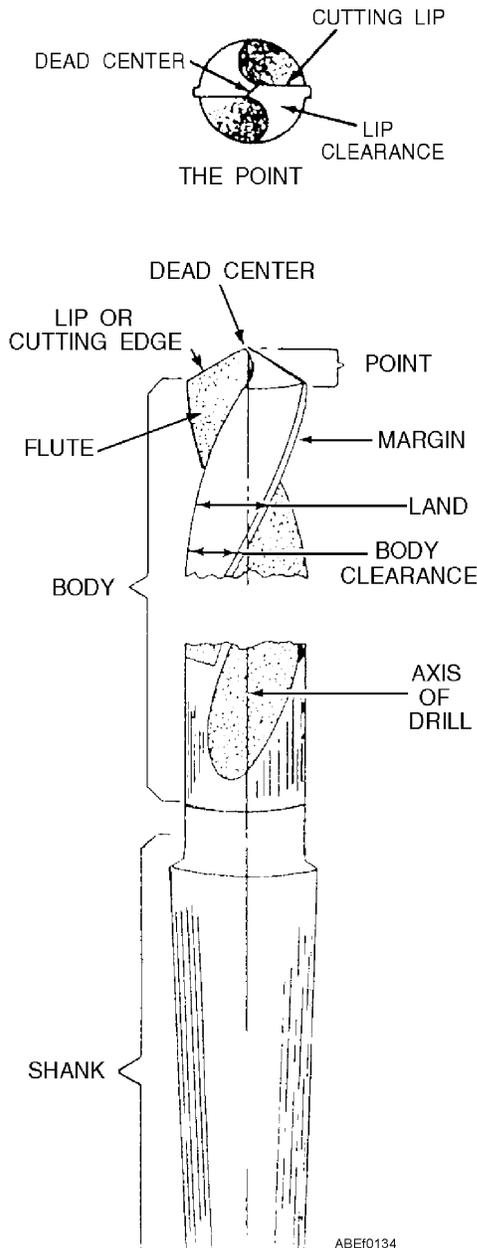


Figure 1-24.—Twist drill nomenclature.

The principal parts of a twist drill are the body, the shank, and the point (fig. 1-24). The dead center of a drill is the sharp edge at the extreme tip end of the drill. It is formed by the intersection of the cone-shaped surfaces of the point and should always be the exact center of the axis of the drill. The point of the drill should not be confused with the dead center. The point is the entire cone-shaped surface at the end of the drill.

The lip or cutting edge of a drill is that part of the point that actually cuts away the metal when drilling a hole. It is ordinarily as sharp as the edge of a knife. There is a cutting edge for each flute of the drill.

The shank is the part of the drill that fits into the socket, spindle, or chuck of the drill press. Several types exist (fig. 1-25).

The maintenance of twist drills and more about how to use them on specific jobs are discussed later.

## REVIEW QUESTIONS

- Q7. Identify the different types of metal-cutting tools.
- Q8. What are hawks-bill snips used for?
- Q9. What are hacksaws used for?
- Q10. What are taps and dies used for?

## WRENCHES

**LEARNING OBJECTIVES:** Identify the different types of wrenches. Describe the uses of different types of wrenches. List the safety precautions that apply to wrenches.

A wrench is a basic tool that is used to exert a twisting force on bolt heads, nuts, studs, and pipes. The special wrenches designed to do certain jobs are, in most cases, variations of the basic wrenches that are described in this section.

The best wrenches are made of chrome vanadium steel. Wrenches made of this material are lightweight and almost unbreakable. This is an expensive material, however, so the most common wrenches found in the Navy are made of forged carbon steel or molybdenum steel. These latter materials make good wrenches, but they are generally built a little heavier and bulkier to achieve the same degree of strength as chrome vanadium steel.

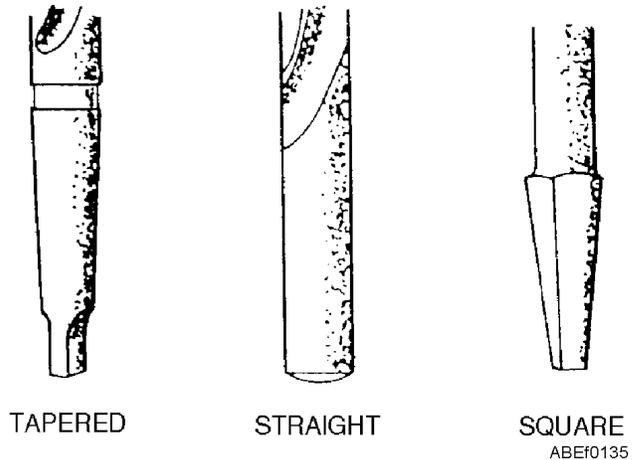


Figure 1-25.—Representative shanks.

The size of any wrench used on bolt heads or nuts is determined by the size of the opening between the jaws of the wrench. The opening of a wrench is manufactured slightly larger than the bolt head or nut that it is designed to fit. Hex-nuts (six-sided) and other types of nut or bolt heads are measured across opposite flats (fig. 1-26). A wrench that is designed to fit a 3/8-inch nut or bolt usually has a clearance of from 5 to 8 thousandths of an inch. This clearance allows the wrench to slide on and off the nut or bolt with a minimum of "play." If the wrench is too large, the points of the nut or bolt head will be rounded and destroyed.

There are many types of wrenches. Each type is designed for a specific use. Let's discuss some of them.

### OPEN-END WRENCHES

Solid, nonadjustable wrenches with openings in one or both ends are called open-end wrenches. (See fig. 1-26.) Usually they come in sets of from 6 to 10 wrenches, with sizes ranging from 5/16 to 1 inch. Wrenches with small openings are usually shorter than wrenches with large openings. This proportions the lever advantage of the wrench to the bolt or stud and helps prevent wrench breakage or damage to the bolt or stud. One exception exists.

Hydraulic piping installations for catapult and arresting gear are often in close spaces. During certain

phases of hydraulic maintenance it may be impossible to swing an ordinary wrench because of its length. Ordinary wrenches that are normally available increase in length as their size increases. Thus, when a large-size wrench is needed, the length of the wrench sometimes prevents its use, due to the space available to swing the wrench. The Bonney wrench, shown in figure 1-27, is an open-end wrench that may be used to great advantage because of its thickness and short length. This wrench is normally procured in the larger sizes, although it is available in a range of sizes to fit most hydraulic fittings.

Open-end wrenches may have their jaws parallel to the handle or at angles anywhere up to 90 degrees. The average angle is 15 degrees (fig. 1-26). This angular displacement variation permits selection of a wrench suited for places where there is room to make only a part of a complete turn of a nut or bolt. If the wrench is turned over after the first swing, it will fit on the same flats and turn the nut farther. After two swings on the wrench, the nut is turned far enough so that a new set of flats are in position for the wrench, as shown in figure 1-28.

Handles are usually straight, but may be curved. Those with curved handles are called S-wrenches. Other open-end wrenches may have offset handles. This allows the head to reach nut or bolt heads that are sunk below the surface.

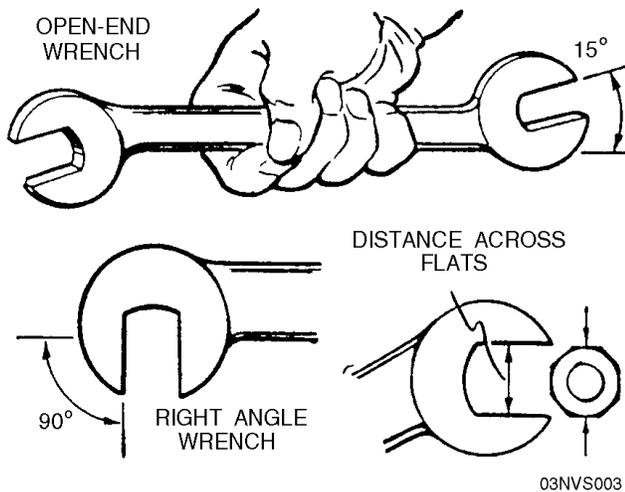


Figure 1-26.—Open-end wrenches.

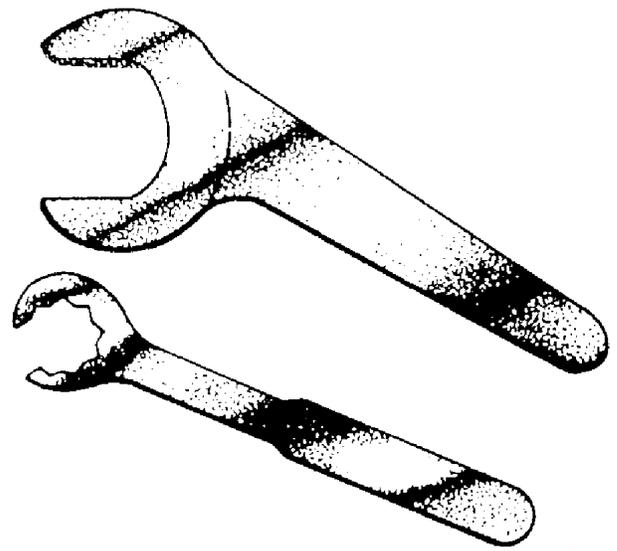
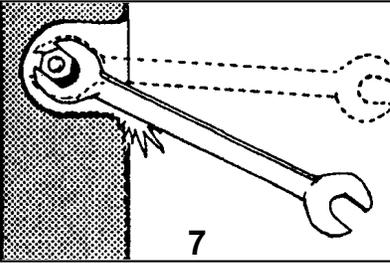
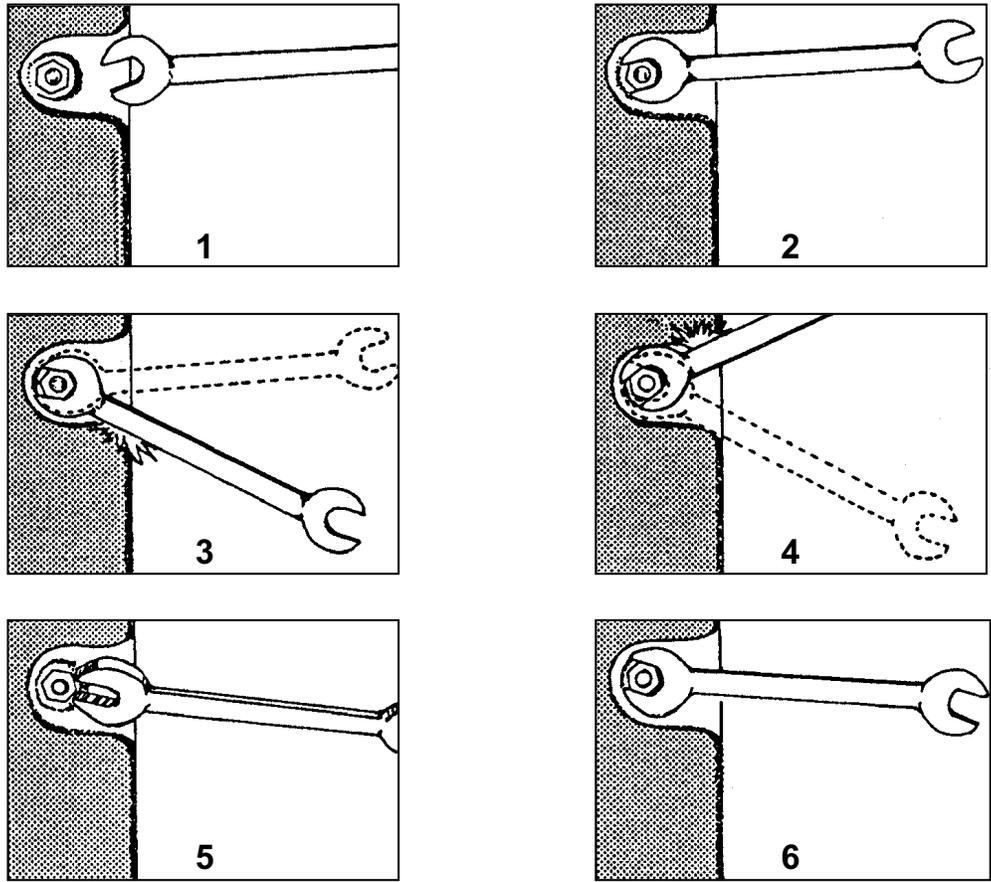


Figure 1-27.—Bonney wrenches.



1. WRENCH, WITH OPENING SLOPING TO THE LEFT, ABOUT TO BE PLACED ON NUT.
2. WRENCH POSITIONED AND READY TO TIGHTEN NUT. NOTE THAT SPACE FOR SWINGING THE WRENCH IS LIMITED.
3. WRENCH HAS BEEN MOVED CLOCKWISE TO TIGHTEN THE NUT AND NOW STRIKES THE CASTING, WHICH PREVENTS FURTHER MOVEMENT.
4. WRENCH IS REMOVED FROM NUT AND TURNED COUNTER CLOCKWISE TO BE PLACED ON THE NEXT SET OF FLATS ON NUT. BUT CORNER OF CASTING PREVENTS WRENCH FROM FITTING ONTO THE NUT.
5. WRENCH IS BEING TURNED OVER SO THAT WRENCH OPENING WILL SLOPE TO THE RIGHT.
6. IN THIS POSITION, THE WRENCH WILL FIT THE NEXT TWO FLATS ON THE NUT.
7. WRENCH NOW IS PULLED CLOCKWISE TO FURTHER TIGHTEN NUT UNTIL WRENCH AGAIN STRIKES CASTING. BY REPEATING THE PROCEDURE, THE NUT CAN BE TURNED UNTIL IT IS TIGHT.

Figure 1-28.—Use of open-end wrench.

ABEf0105

The non-adjustable union nut wrench (fig. 1-29) is used to assemble and disassemble launch valve piping union nuts. These special open-end wrenches are designed to pass over the piping and then slide onto the union nut to fully engage five of the six flats, thus reducing the probability of damaging the nuts.

**NOTE**

These non-adjustable union nut wrenches are the preferred type for launch valve piping. Under **no** circumstances should any other type of adjustable or open-end wrench be used on launch valve piping fittings.

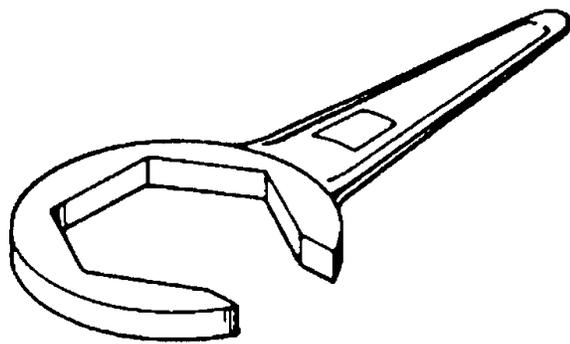
**BOX WRENCHES**

Box wrenches (fig. 1-30) are safer than open-end wrenches since there is less likelihood they will slip off the work. They completely surround, or box, a nut or bolt head.

The most frequently used box wrench has 12 points or notches arranged in a circle in the head and can be used with a minimum swing angle of 30 degrees. Six- and eight-point wrenches are used for heavy duty; twelve-point for medium, and sixteen for light-duty only.

One advantage of the 12-point construction is the thin wall. It is more suitable for turning nuts that are hard to get at with an open-end wrench. Another advantage is that the wrench will operate between obstructions where the space for handle swing is limited. A very short swing of the handle will turn the nut far enough to allow the wrench to be lifted and the next set of points fitted to the corners of the nut.

One disadvantage of the box-end wrench is the time loss that occurs whenever a craftsman has to lift the wrench off and place it back on the nut in another



ABEf0106

Figure 1-29.—Nonadjustable union nut wrench.



ABEf0107

Figure 1-30.—12-point box-end wrench.

position when there is insufficient clearance to spin the wrench in a full circle.

**COMBINATION WRENCH**

After a tight nut is broken loose, it can be unscrewed much more quickly with an open-end wrench than with a box-wrench. A combination box-open end wrench (fig. 1-31) comes in handy in a situation of the type. You can use the box-end for breaking nuts loose or for snuggling them down, and the open-end for faster turning.

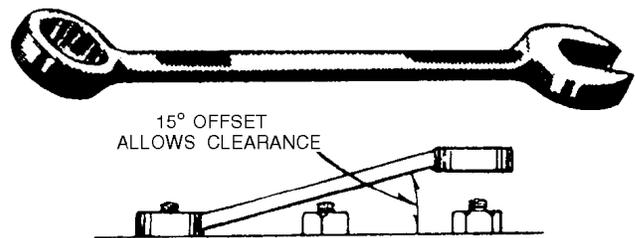
The box-end portion of the wrench can be designed with an offset in the handle. Notice in figure 1-31 how the 15-degree offset allows clearance over nearby parts.

The correct use of open-end and box-end wrenches can be summed up in a few simple rules, most important of which is to be sure that the wrench properly fits the nut or bolt head.

When you have to pull hard on the wrench, as in loosening a tight nut, make sure the wrench is seated squarely on the flats of the nut.

Pull on the wrench—**DO NOT PUSH**. Pushing a wrench is a good way to skin your knuckles if the wrench slips or the nut breaks loose unexpectedly. If it is impossible to pull the wrench and you must push, do it with the palm of your hand and hold your palm open.

Only actual practice will tell you if you are using the right amount of force on the wrench. The best way to tighten a nut is to turn it until the wrench has a firm, solid "feel." This will turn the nut to proper tightness without stripping the threads or twisting off the bolt. This "feel" is developed by experience alone. Practice until you have mastered the "feel."



ABEf0108

Figure 1-31.—Offset combination wrench.

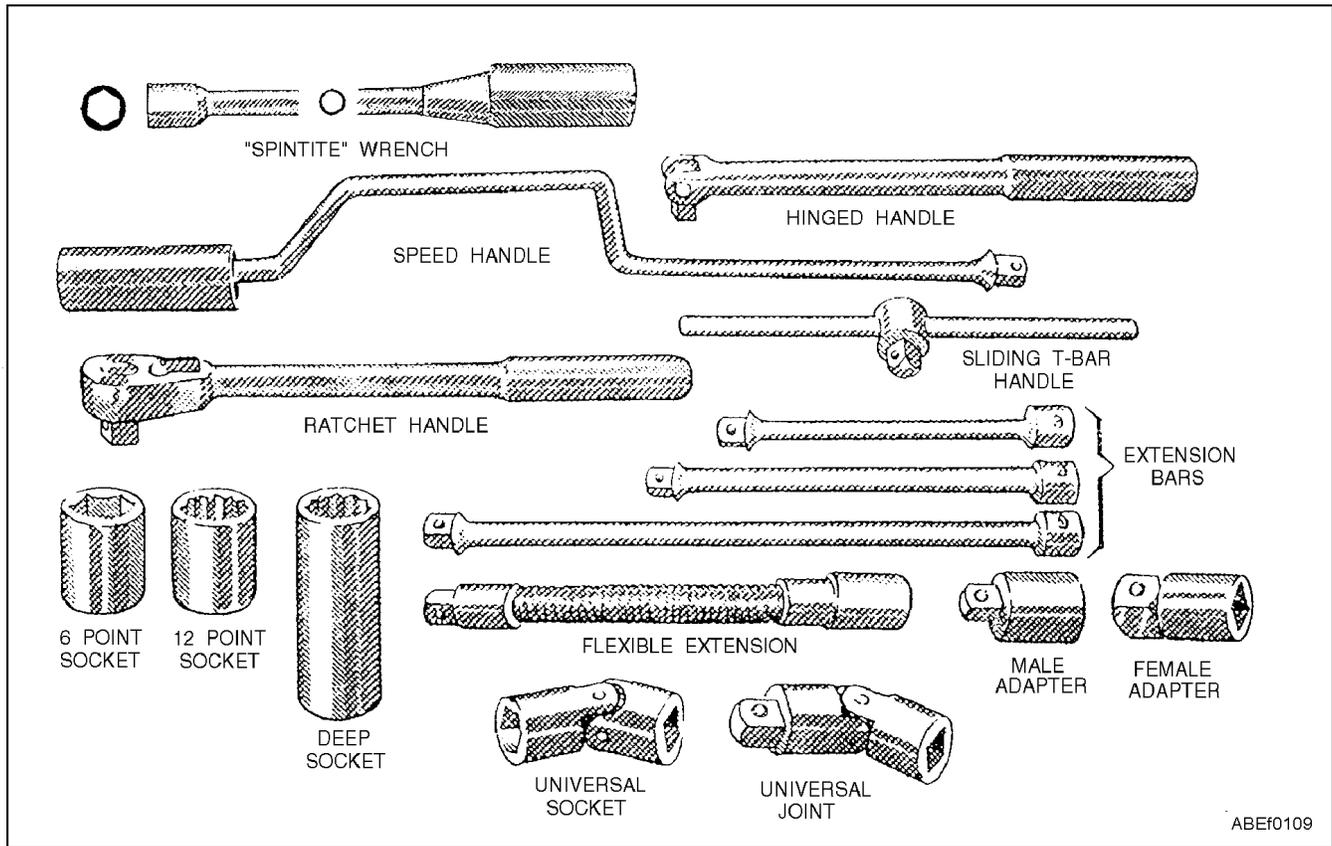


Figure 1-32.—Socket set components.

## SOCKET WRENCH

The socket wrench is one of the most versatile wrenches in the toolbox. Basically, it consists of a handle and a socket-type wrench that can be attached to the handle.

The "Spintite" wrench, shown in figure 1-32, is a special type of socket wrench. It has a hollow shaft to accommodate a bolt protruding through a nut, has a hexagonal head, and is used like a screwdriver. It is supplied in small sizes only and is useful for assembly

and electrical work. When used for the latter purpose, it must have an insulated handle.

A complete socket wrench set consists of several types of handles along with bar extensions, adapters, and a variety of sockets (fig. 1-32).

## Sockets

A socket (fig. 1-33) has a square opening cut in one end to fit a square drive lug on a detachable handle. In the other end of the socket is a 6-point or 12-point

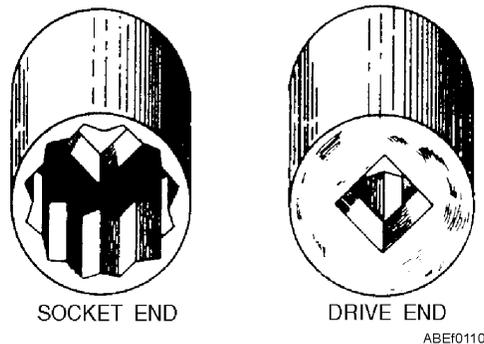


Figure 1-33.—12-point sockets.

opening, very much like the opening in the box-end wrench. The 12-point socket needs to be swung only half as far as the 6-point socket before it has to be lifted and fitted on the nut for a new grip. It can therefore be used in closer quarters where there is less room to move the handle. (A ratchet handle eliminates the necessity of lifting the socket and refitting it on the nut again and again.)

Sockets are classified by size according to two factors. One is the size of the square opening, which fits on the square drive lug of the handle. This size is known as the drive size. The other is the size of the opening in the opposite end, which fits the nut or bolt. The standard toolbox can be outfitted with sockets having 1/4-, 3/8-, and 1/2-inch-square drive lugs. Larger sets are usually available in the tool room for temporary checkout. The openings that fit onto the bolt or nut are usually graduated in 1/16-inch sizes. Sockets are also made in deep lengths to fit over spark plugs and long bolt ends.

### Socket Handles

There are four types of handles used with these sockets. (See fig. 1-32.) Each type has special advantages, and the experienced worker chooses the one best suited for the job at hand. The square driving lug on the socket wrench handles has a spring-loaded ball that fits into a recess in the socket receptacle. This mated ball-recess feature keeps the socket engaged with the drive lug during normal usage. A slight pull on the socket, however, disassembles the connection.

**RATCHET.**—The ratchet handle has a reversing lever that operates a pawl (or dog) inside the head of the tool. Pulling the handle in one direction causes the pawl to engage the ratchet teeth and turn the socket. Moving the handle in the opposite direction causes the pawl to slide over the teeth, permitting the handle to back up without moving the socket. This allows rapid turning of the nut or bolt after each partial turn of the handle. With the reversing lever in one position, the handle can be used for tightening. In the other position, it can be used for loosening.

**HINGED HANDLE.**—The hinged handle is also very convenient. To loosen tight nuts, swing the handle

at right angles to the socket. This gives the greatest possible leverage. After loosening the nut to the point where it turns easily, move the handle into the vertical position and then turn the handle with the fingers.

**SLIDING T-BAR HANDLE.**—When you are using the sliding bar or T-handle, the head can be positioned anywhere along the sliding bar. Select the position that is needed for the job at hand.

**SPEED HANDLE.**—The speed handle is worked like the woodworker's brace. After the nuts are first loosened with the sliding bar handle or the ratchet handle, the speed handle can be used to remove the nuts more quickly. In many instances the speed handle is not strong enough to be used for breaking loose or tightening the nut. The speed socket wrench should be used carefully to avoid damaging the nut threads.

### Accessories

Several accessory items complete the socket wrench set. Extension bars of different lengths are made to extend the distance from the socket to the handle. A universal joint allows the nut to be turned with the wrench handle at an angle. Universal sockets are also available. The use of universal joints, bar extensions, and universal sockets in combination with appropriate handles makes it possible to form a variety of tools that will reach otherwise inaccessible nuts and bolts.

Another accessory item is an adapter, which allows you to use a handle having one size of drive and a socket having a different size drive. For example, a 3/8- by 1/4-inch adapter makes it possible to turn all 1/4-inch-square drive sockets with any 3/8-inch-square drive handle.

### TORQUE WRENCHES

There are times when, for engineering reasons, a definite force must be applied to a nut or bolt head. In such cases a torque wrench must be used. For example, equal force must be applied to all the head bolts of an engine. Otherwise, one bolt may bear the brunt of the force of internal combustion and ultimately cause engine failure.

The three most commonly used torque wrenches are the deflecting beam, dial indicating, and micrometer setting types (fig. 1-34). When using the deflecting beam and the dial indicating torque wrenches, read the torque visually on a dial or scale mounted on the handle of the wrench.

To use the micrometer setting type, unlock the grip and adjust the handle to the desired setting on the micrometer-type scale, then relock the grip. Install the required socket or adapter to the square drive of the handle. Place the wrench assembly on the nut or bolt and pull in a clockwise direction with a smooth, steady motion. (A fast or jerky motion will result in an improperly torqued unit.) When the torque applied reaches the torque value, which is indicated on the handle setting, a signal mechanism will automatically issue an audible click, and the handle will release or "break," and move freely for a short distance. The release and free travel is easily felt, so there is no doubt about when the torquing process is complete.

Manufacturers' and technical manuals generally specify the amount of torque to be applied. To assure getting the correct amount of torque on the fasteners, it is important that the wrench be used properly according to manufacturer's instructions.

Use the torque wrench that will read about mid-range for the amount of torque to be applied. **BE SURE THE TORQUE WRENCH HAS BEEN CALIBRATED BEFORE YOU USE IT.** Remember, too, that the accuracy of torque-measuring depends a lot on how the threads are cut and the cleanliness of the threads. Make sure you inspect and clean the threads. If

the manufacturer specifies a thread lubricant, it must be used to obtain the most accurate torque reading. When using the deflecting beam or dial indicating wrenches, hold the torque at the desired value until the reading is steady.

Torque wrenches are delicate and expensive tools. The following precautions should be observed when using them:

1. When using the micrometer setting type, do not move the setting handle below the lowest torque setting. However, it should be placed at its lowest setting before it is returned to storage.
2. Do not use the torque wrench to apply greater amounts of torque than its rated capacity.
3. Do not use the torque wrench to loosen bolts that have been previously tightened.
4. Do not drop the wrench. If a torque wrench is dropped, its accuracy will be affected.
5. Do not apply a torque wrench to a nut that has been tightened. Back off the nut one turn with a nontorque wrench and retighten to the correct torque with the indicating torque wrench.
6. Calibration intervals have been established for all torque tools used in the Navy. When a tool is calibrated by a qualified calibration activity at a shipyard, tender, or repair ship, a label showing the next calibration due date is attached to the handle. This date should be checked before a torque tool is used to ensure that it is not overdue for calibration.

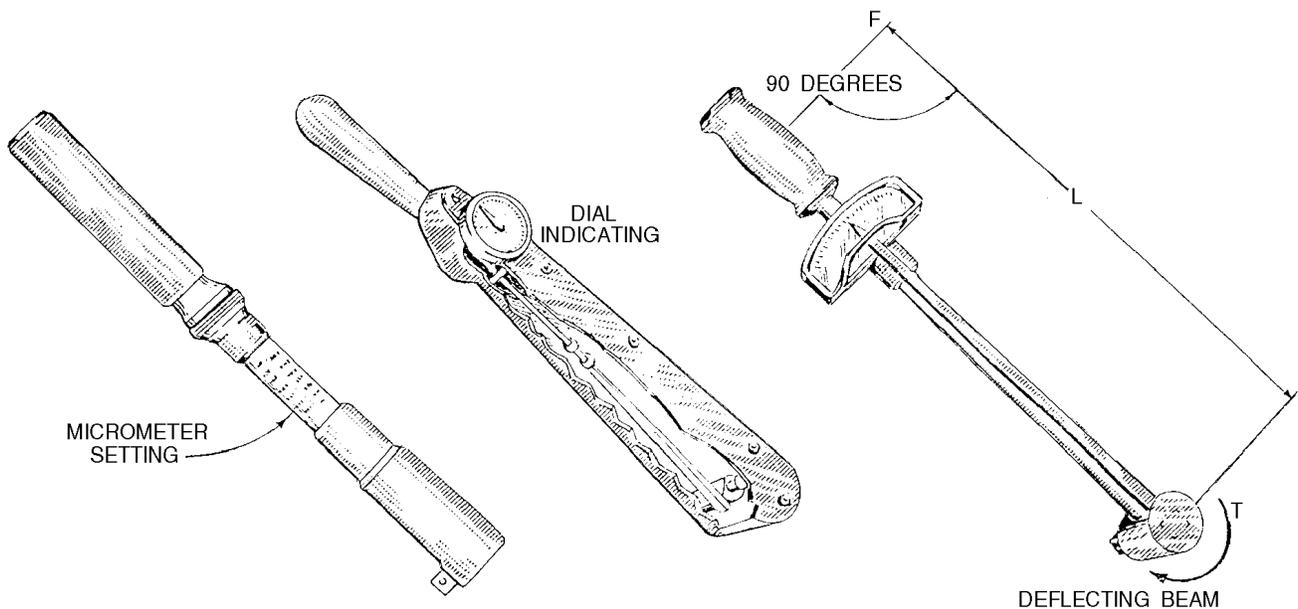


Figure 1-34.—Torque wrenches.

03NVS010

## ADJUSTABLE WRENCHES

A handy all-round wrench that is generally included in every toolbox is the adjustable open-end wrench. This wrench is not intended to take the place of the regular solid open-end wrench. Additionally, it is not built for use on extremely hard-to-turn items. Its usefulness is achieved by being capable of fitting odd-sized nuts. This flexibility is achieved although one jaw of the adjustable open-end wrench is fixed, because the other jaw is moved along a slide by a thumbscrew adjustment (fig. 1-35). By turning the thumbscrew, you can adjust the jaw opening to fit various sizes of nuts.

Adjustable wrenches are available in varying sizes, normally ranging from 4 to 24 inches in length. The size of the wrench selected for a particular job is dependent upon the size of the nut or bolt head to which the wrench is to be applied.

Adjustable wrenches are often called "knuckle busters," because mechanics frequently suffer these consequences as a result of improper usage of these tools. To avoid accidents, follow four simple steps. First, choose a wrench of the correct size; that is, do not pick a large 12-inch wrench and adjust the jaw for use on a 3/8-inch nut. This could result in a broken bolt and a bloody hand. Second, be sure the jaws of the correct-size wrench are adjusted to fit snugly on the nut. Third, position the wrench around the nut until the nut is all the way into the throat of the jaws. If the wrench is

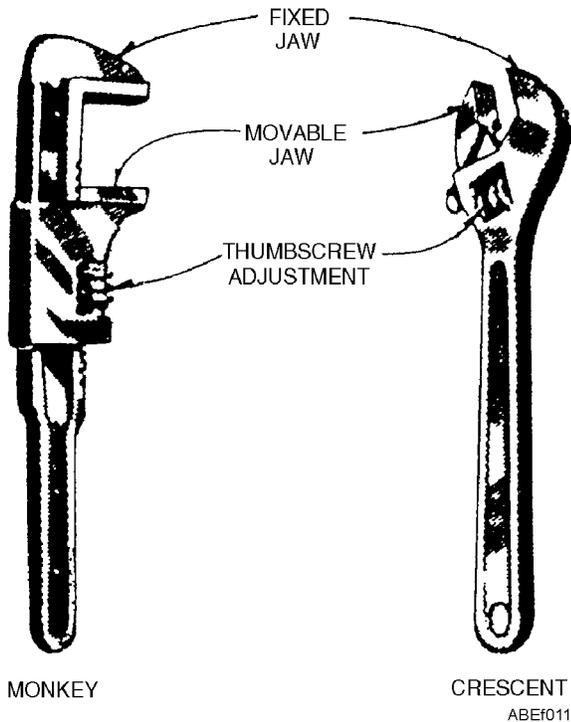


Figure 1-35.—Adjustable wrenches.

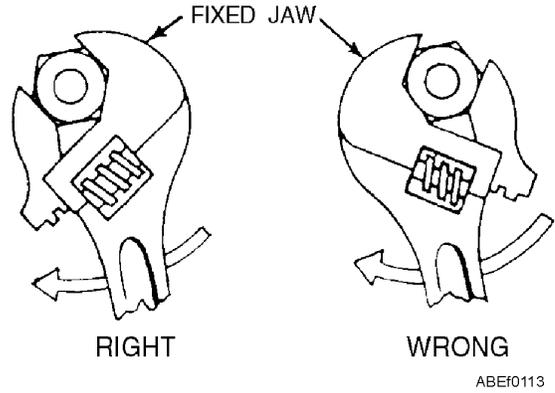


Figure 1-36.—Proper procedure for using adjustable wrenches.

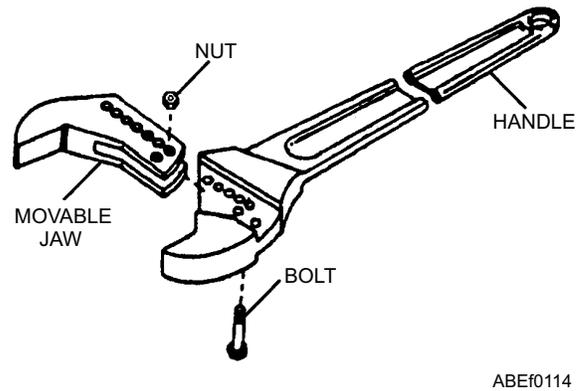


Figure 1-37.—Union nut wrench.

not used in this manner, the result is apt to be as bloody as before. Fourth, pull the handle toward the side having the adjustable jaw (fig. 1-36). This will prevent the adjustable jaw from springing open and slipping off the nut. If the location of the work will not allow for all four steps to be followed when using an adjustable wrench, then select another type of wrench for the job.

### Union Nut Wrench

The adjustable union nut wrench (fig. 1-37) is used to assemble and disassemble pipe union nuts. The adjustable jaws are held in place by removable nut and bolt and is adjusted to proper size before each use.

In rotating or holding round work, an adjustable pipe wrench (Stillson) may be used (fig. 1-38). The



Figure 1-38.—Adjustable pipe wrench.

movable jaw on a pipe wrench is pivoted to permit a gripping action on the work. This tool must be used with discretion, as the jaws are serrated and always make marks on the work unless adequate precautions are observed. The jaws should be adjusted so the bite on the work will be taken at about the center of the jaws.

### Strap Wrench

The strap wrench (fig. 1-39) is used for turning pipe or cylinders where you do not want to mar the surface of the work. To use this wrench, the webbed strap is placed around the pipe and passed through the slot in the metal body of the wrench. The strap is then pulled up tight; and as the mechanic turns the wrench in the desired direction, the webbed strap tightens further around the pipe. This gripping action causes the pipe to turn.

### SPANNER WRENCHES

Many special nuts are made with notches cut into their outer edge. For these nuts a hook spanner (fig. 1-40) is required. This wrench has a curved arm with a lug or hook on the end. This lug fits into one of the notches of the nut, and the handle is turned to loosen or tighten the nut. This spanner may be made for just one particular size of notched nut, or it may have a hinged arm to adjust it to a range of sizes.

Another type of spanner is the pin spanner. Pin spanners have a pin in place of a hook. This pin fits into a hole in the outer part of the nut.

Face pin spanners are designed so that the pins fit into holes in the face of the nut (fig. 1-40).

When you use a spanner wrench, you must make sure the pins, lugs, or hooks make firm contact with the nut while the turning force is transferred from the wrench to the nut. If this is not done, damage will result to tools or equipment or injury to personnel.

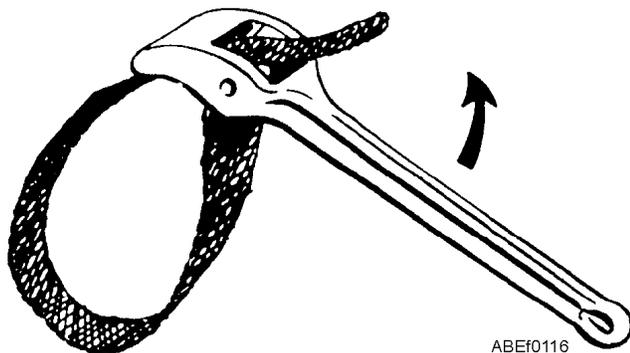
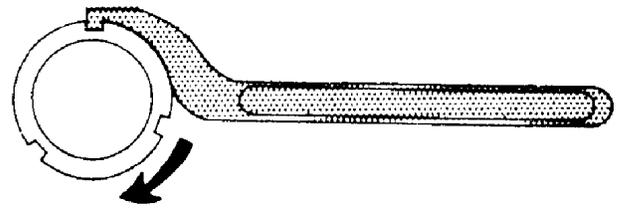


Figure 1-39.—Strap wrench.

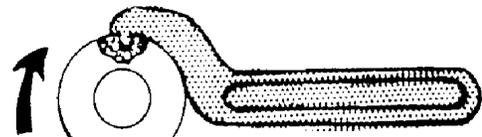
ABEF0116



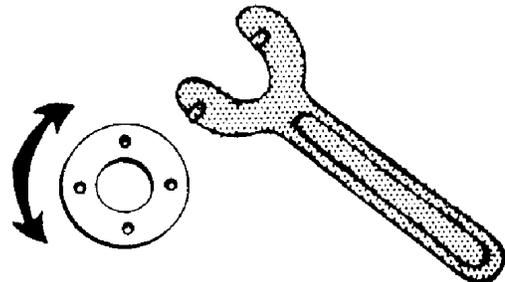
HOOK SPANNER



ADJUSTABLE HOOK SPANNER



PIN SPANNER



FACE PIN SPANNER

ABEF0117

Figure 1-40.—General-purpose spanner wrenches.

### SETSCREW WRENCHES (ALLEN AND BRISTOL)

In some places it is desirable to use recessed heads on setscrews and capscrews. One type of screw (Allen) is used extensively on office machines and in machine shops. The other type (Bristol) is used infrequently.

Recessed-head screws usually have a hex-shaped (six-sided) recess. To remove or tighten this type of screw requires a special wrench that will fit in the recess. This wrench is called an Allen-type wrench. Allen wrenches are made from hexagonal L-shaped

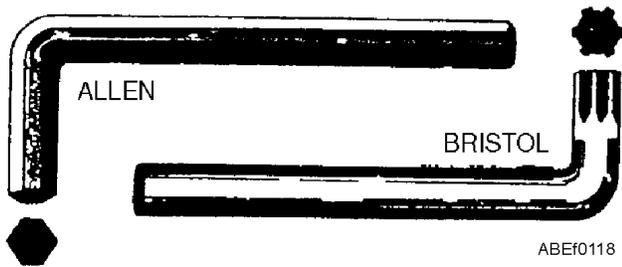


Figure 1-41.—Allen- and Bristol-type wrenches.

bars of tool steel (fig. 1-41). They generally range in size up to 3/4 inch. When using the Allen-type wrench, make sure you use the correct size to prevent rounding or spreading the head of the screw. A snug fit within the recessed head of the screw is an indication that you have the correct size.

The Bristol wrench is made from round stock. It is also L-shaped, but one end is fluted to fit the flutes or little splines in the Bristol setscrew (fig. 1-41).

### SAFETY RULES FOR WRENCHES

There are a few basic rules that you should keep in mind when using wrenches. They are as follows:

- Always use a wrench that fits the nut properly.
- Keep wrenches clean and free from oil. Otherwise they may slip, resulting in possible serious injury to you or damage to the work.
- Do not increase the leverage of a wrench by placing a pipe over the handle. Increased leverage may damage the wrench or the work.
- Provide some sort of kit or case for all wrenches. Return them to the case at the completion of each job. This saves time and trouble and aids selection of tools for the next job. Most

important, it eliminates the possibility of leaving them where they can cause injury to personnel or damage to equipment.

- Determine which way a nut should be turned before trying to loosen it. Most nuts are turned counterclockwise for removal. This may seem obvious, but even experienced people have been observed straining at the wrench in the tightening direction when they wanted to loosen the nut.
- Learn to select your wrenches to fit the type of work you are doing. If you are not familiar with these wrenches, make arrangements to visit a shop that has most of them, and get acquainted.

### REVIEW QUESTIONS

- Q11. Identify the different types of wrenches.
- Q12. Describe the uses of different types of wrenches.
- Q13. List the safety precautions that apply to wrenches.

### PLIERS

**LEARNING OBJECTIVES:** Identify the different types of pliers. Describe the uses of different types of pliers. Describe the proper care of pliers.

Pliers are made in many styles and sizes and are used to perform many different operations. Pliers are used for cutting purposes, as well as holding and gripping small articles in situations where it may be inconvenient or impossible to use hands. Figure 1-42 shows several different kinds.

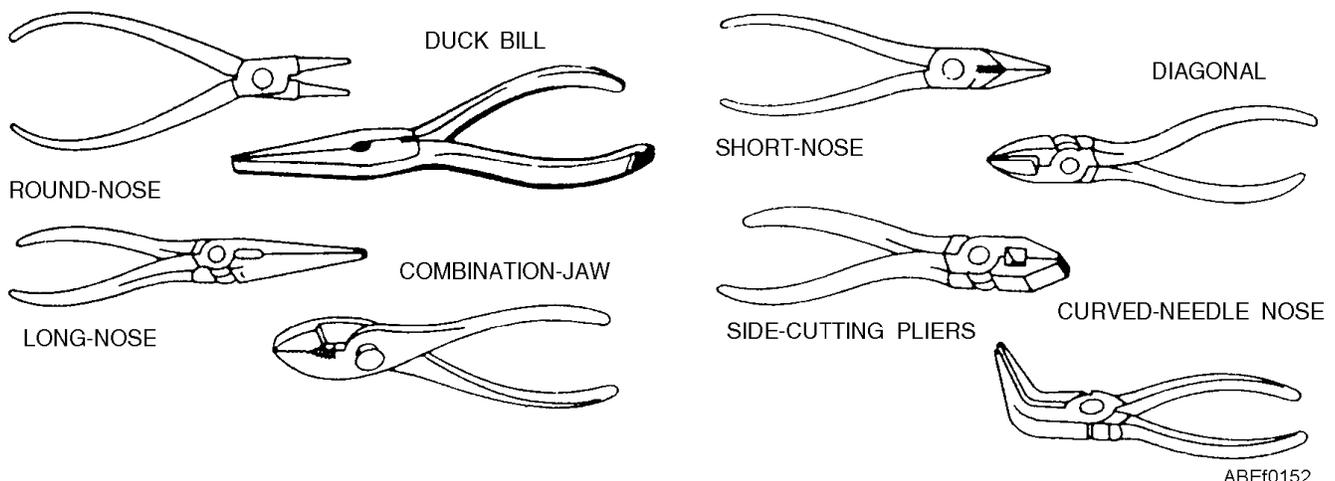


Figure 1-42.—Pliers.

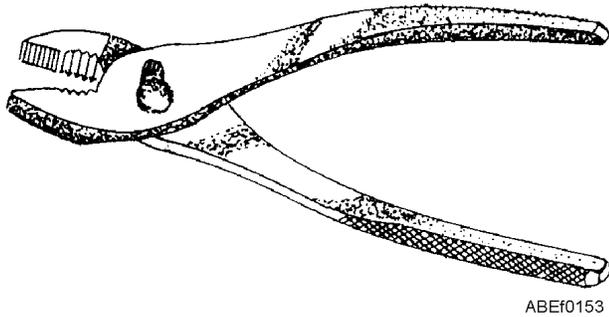


Figure 1-43.—Slip-joint pliers.

The combination pliers are handy for holding or bending flat or round stock. The long-nosed pliers are less rugged, and break easily if you use them on heavy jobs. Long-nosed pliers, commonly called needle-nose pliers, are especially useful for holding small objects in tight places and for making delicate adjustments. The round-nosed kind are handy when you need to crimp sheet metal or form a loop in a wire. The diagonal cutting pliers, commonly called "diagonals" or "dikes," are designed for cutting wire and cotter pins close to a flat surface and are especially useful in the electronic and electrical fields. The duckbill pliers are used extensively in aviation areas.

Here are two important rules for using pliers:

1. Do not make pliers work beyond their capacity. The long-nosed kind is especially delicate. It is easy to spring or break them, or nick their edges. After that, they are practically useless.
2. Do not use pliers to turn nuts. In just a few seconds, a pair of pliers can damage a nut. Pliers must not be substituted for wrenches.

### SLIP-JOINT PLIERS

Slip-joint pliers (fig. 1-43) are pliers with straight, serrated (grooved) jaws, and pivot where the jaws are fastened together to move to either of two positions to grasp small- or large-sized objects better.

Slip-joint combination pliers are pliers similar to the slip-joint pliers just described but with the

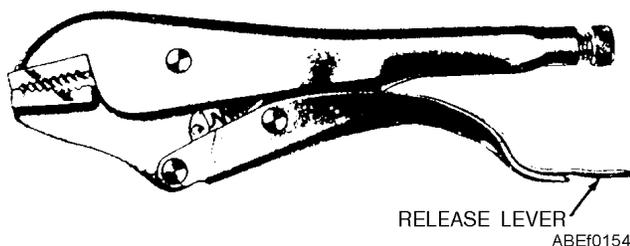


Figure 1-44.—Wrench pliers.

additional feature of a side cutter at the junction of the jaws. This cutter consists of a pair of square-cut notches, one on each jaw, which act like a pair of shears when an object is placed between them and the jaws closed.

### WRENCH PLIERS

Wrench pliers (visegrips) (fig. 1-44), can be used for holding objects regardless of their shape. A screw adjustment in one of the handles makes them suitable for several different sizes. The jaws of wrench pliers may have standard serrations such as the pliers just described, or they may have a clamp-type jaw. The clamp-type jaws are generally wide and smooth and are used primarily when working with sheet metal.

Wrench pliers have an advantage over other types of pliers in that you can clamp them on an object and they will stay. This will leave your hands free for other work.

A craftsman uses this tool a number of ways. It may be used as a clamp, speed wrench, portable vise, and for many other uses where a locking, plier-type jaw may be used. These pliers can be adjusted to various jaw openings by turning the knurled, adjusting screw at the end of the handle (fig. 1-44). Wrench pliers can be clamped and locked in position by pulling the lever toward the handle.

### CAUTION

Wrench pliers should be used with care, since the teeth in the jaws tend to damage the object on which they are clamped. They should not be used on nuts, bolts, tube fittings, or other objects that must be reused.

### WATER-PUMP PLIERS

Water-pump pliers were originally designed for tightening or removing water-pump packing nuts. They were excellent for this job because they have a jaw adjustable to seven different positions. Water-pump pliers (fig. 1-45) are easily identified by their size, jaw teeth, and adjustable slip joint. The inner surface of the jaws consists of a series of coarse teeth formed by deep

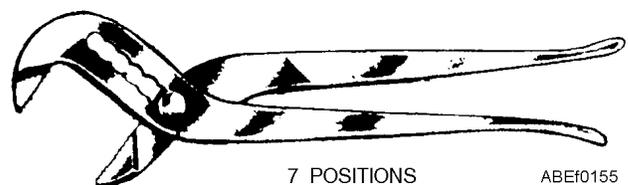


Figure 1-45.—Water-pump pliers.

grooves, a surface adapted to grasping cylindrical objects.

### GROOVE-JOINT PLIERS

Groove-joint pliers (fig. 1-46) are another version of water-pump pliers and are easily identified by the extra-long handles, which make them a very powerful gripping tool. They are shaped approximately the same as the pliers just described, but the jaw opening adjustment is effected differently. Groove-joint pliers have grooves on one jaw and lands on the other. The adjustment is effected by changing the position of the grooves and lands. The groove-joint pliers are less likely to slip from the adjustment setting when gripping an object. The groove-joint pliers will only be used where it is impossible to use a more adapted wrench or holding device. Many nuts and bolts and surrounding parts have been damaged by improper use of groove-joint pliers.

### DIAGONAL PLIERS

Diagonal cutting pliers (fig. 1-42) are used for cutting small, light material, such as wire and cotter pins in areas that are inaccessible to the larger cutting tools. Also, since they are designed for cutting only, larger objects can be cut than with the slip-joint pliers.

Because the cutting edges are diagonally offset approximately 15 degrees, diagonal pliers are adapted to cutting small objects flush with a surface. The inner jaw surface is a diagonal straight cutting edge. Diagonal pliers should never be used to hold objects, because they exert a greater shearing force than other types of pliers of a similar size. The sizes of the diagonal cutting pliers are designated by the overall length of the pliers.

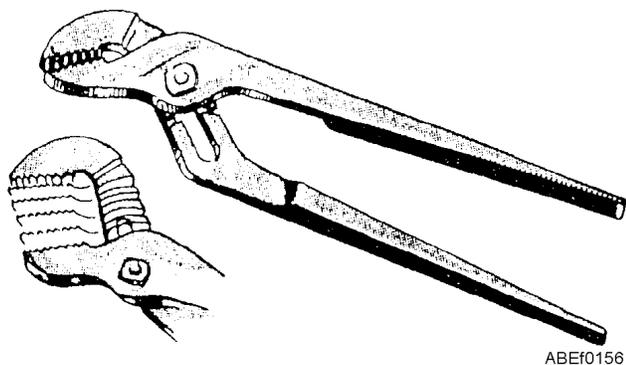


Figure 1-46.—Groove-joint pliers.

### SIDE-CUTTING PLIERS

Side-cutting pliers (sidecutters) are principally used for holding, bending, and cutting thin materials or small gauge wire. Sidecutters vary in size and are designated by their overall length. The jaws are hollowed out on one side just forward of the pivot point of the pliers. Opposite the hollowed out portion of the jaws are the cutting edges (fig. 1-42).

When holding or bending light metal surfaces, the jaw tips are used to grasp the object. When holding wire, grasp it as near one end as possible because the jaws will mar the wire. To cut small-diameter wire, the side-cutting edge of the jaws near the pivot is used. Never use sidecutters to grasp large objects, tighten nuts, or bend heavy gauge metal, since such operations will spring the jaws.

Sidecutters are often called electrician or lineman pliers. They are used extensively for stripping insulation from wire and for twisting wire when making a splice.

### DUCKBILL PLIERS

Duckbill pliers (fig. 1-47, view A) have long wide jaws and slender handles. Duckbills are used in confined areas where the fingers cannot be used. The jaw faces of the pliers are scored to aid in holding an item securely. Duckbills are ideal for twisting the safety wire used in securing nuts, bolts, and screws.

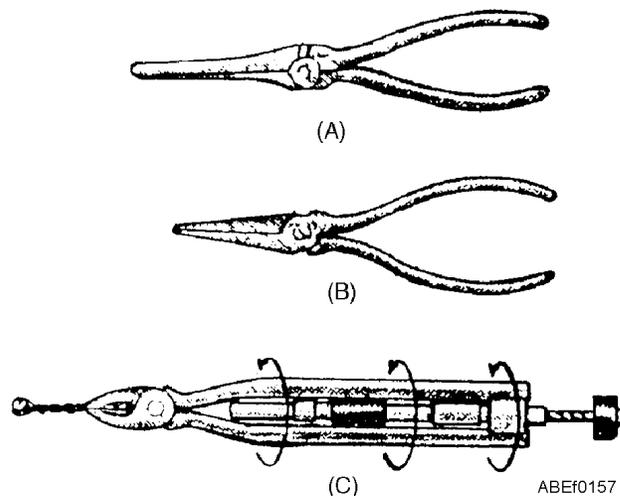


Figure 1-47.—Pliers; (A) duckbill, (B) needle-nose, and (C) wire twister.

## NEEDLE-NOSE PLIERS

Needle-nose pliers (fig. 1-47, view B) are used in the same manner as duckbill pliers. However, there is a difference in the design of the jaws. Needle-nose jaws are tapered to a point, which makes them adapted to installing and removing small cotter pins. They have serrations at the nose end and a side cutter near the throat. Needle-nose pliers may be used to hold small items steady, to cut and bend safety wire, or to do numerous other jobs that are too intricate or too difficult to be done by hand alone.

### NOTE

Duckbill and needle-nose pliers are especially delicate. Care should be exercised when using these pliers to prevent springing, breaking, or chipping the jaws. Once these pliers are damaged, they are practically useless.

## WIRE-TWISTER PLIERS

Wire-twister pliers (safety wire pliers) (fig. 1-47, view C) are three-way pliers: they hold, twist, and cut. They are designed to reduce the time used in twisting safety wire on nuts and bolts. To operate, grasp the wire between the two diagonal jaws, and the thumb will bring the locking sleeve into place. A pull on the knob twirls the twister, making uniform twists in the wire. The spiral rod may be pushed back into the twister without unlocking it, and another pull on the knob will give a tighter twist to the wire. A squeeze on the handle unlocks the twister, and the wire can be cut to the desired length with the side cutter. The spiral of the twister should be lubricated occasionally.

## MAINTENANCE OF PLIERS

Nearly all sidecutting pliers and diagonals are designed so that the cutting edges can be reground. Some older models of pliers will not close if material is ground from the cutting edges. When grinding the cutting edges, never take any more material from the jaws than is necessary to remove the nicks. Grind the same amount of stock from both jaws.

### NOTE

When jaws on pliers do not open enough to permit grinding, remove the pin that attaches the two halves of the pliers, so that the jaws can be separated.

The serrations on the jaws of pliers must be sharp. When they become dull, the pliers should be held in a

vice and the serrations recut by using a small three-corner file.

Pliers should be coated with light oil when they are not in use. They should be stored in a toolbox in such a manner that the jaws cannot be injured by striking hard objects. Keep the pin or bolt at the hinge just tight enough to hold the two parts of the pliers in contact, and always keep the pivot pin lubricated with a few drops of light oil.

## REVIEW QUESTIONS

- Q14. Identify the different types of pliers.
- Q15. What are wrench pliers used for?
- Q16. What are side-cutting pliers used for?
- Q17. What is used to sharpen the serrations on the jaws of pliers?

## STRIKING TOOLS

**LEARNING OBJECTIVES:** Identify the different types of striking tools. Describe the uses of different types of striking tools. Describe the proper care of striking tools. List the safety precautions that apply to striking tools.

Hammers, mallets, and sledges are used to apply a striking force. The tool you select (fig. 1-48) will depend upon the intended application.

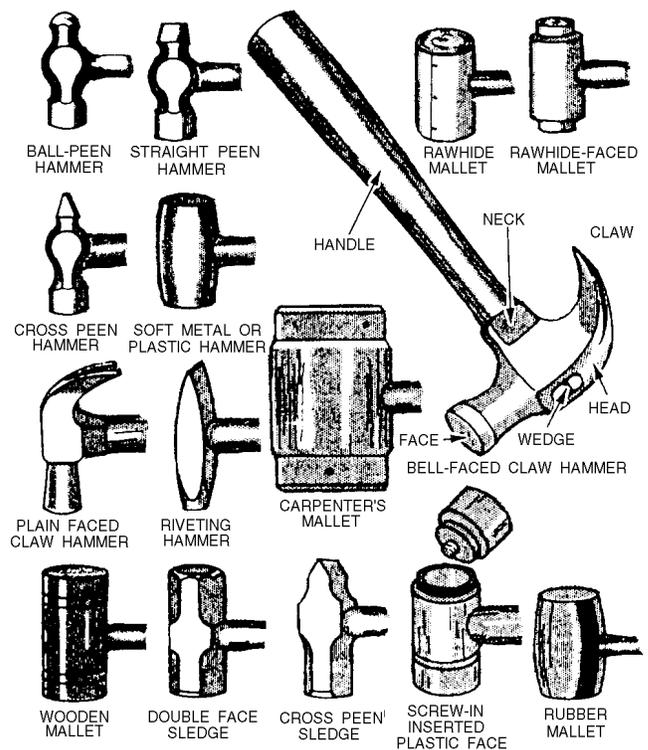


Figure 1-48.—Hammers, mallets, and sledges.

## HAMMERS

A toolkit for nearly every rating in the Navy would not be complete without at least one hammer. In most cases, two or three are included, since they are designated according to weight (without the handle) and style or shape. The shape will vary according to the intended work.

### Machinists' Hammers

Machinists' hammers are mostly used by people who work with metal or around machinery. These hammers are distinguished from carpenter hammers by a variable-shaped peen, rather than a claw, at the opposite end of the face (fig. 1-48). The ball-peen hammer is probably most familiar to you.

The ball-peen hammer, as its name implies, has a ball that is smaller in diameter than the face. It is therefore useful for striking areas that are too small for the face to enter.

Ball-peen hammers are made in different weights, usually 4, 6, 8, and 12 ounces and 1, 1 1/2, and 2 pounds. For most work a 1 1/2 pound and a 12-ounce hammer will suffice. However, a 4- or 6-inch hammer will often be used for light work such as tapping a punch to cut gaskets out of sheet gasket material.

Machinists' hammers may be further divided into hard-face and soft-face classifications. The hard-faced hammer is made of forged tool steel, while the soft-faced hammers have a head made of brass, lead, or a tightly rolled strip of rawhide. Plastic-faced hammers or solid plastic hammers with a lead core for added weight are becoming increasingly popular.

Soft-faced hammers (fig. 1-48) should be used when there is danger of damaging the surface of the work, as when pounding on a machined surface. Most soft-faced hammers have heads that can be replaced as the need arises. Lead-faced hammers, for instance, quickly become battered and must be replaced, but have the advantage of striking a solid, heavy nonrebounding blow that is useful for such jobs as driving shafts into or out of tight holes. If a soft-faced hammer is not available, the surface to be hammered may be protected by covering it with a piece of soft brass, copper, or hard wood.

### Using Hammers

Simple as the hammer is, there is a right and a wrong way of using it. (See fig. 1-49.) The most

common fault is holding the handle too close to the head. This is known as choking the hammer, and reduces the force of the blow. It also makes it harder to hold the head in an upright position. Except for light blows, hold the handle close to the end to increase leverage and produce a more effective blow. Hold the handle with the fingers underneath and the thumb along side or on top of the handle. The thumb should rest on the handle and never overlap the fingers. Try to hit the object with the full force of the hammer. Hold the hammer at such an angle that the face of the hammer and the surface of the object being hit will be parallel. This distributes the force of the blow over the full face and prevents damage to both the surface being struck and the face of the hammer.

## MALLETS AND SLEDGES

The mallet is a short-handled tool used to drive wooden-handled chisels, gouges, and wooden pins, or to form or shape sheet metal where hard-faced hammers would mar or damage the finished work. Mallet heads are made from a soft material, usually wood, rawhide, or rubber. For example, a rubber-faced mallet is used for knocking out dents in an automobile. It is cylindrically shaped with two flat driving faces that are reinforced with iron bands. (See fig. 1-48.) Never use a mallet to drive nails, screws, or any other object that can damage the face of the mallet.

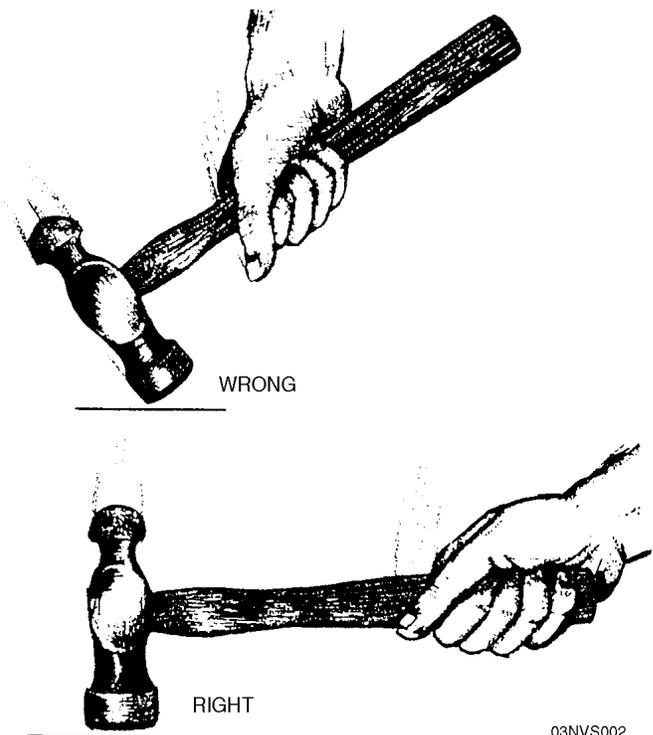


Figure 1-49.—Striking a surface.

03NVS002

The sledge is a steel-headed, heavy-duty driving tool that can be used for a number of purposes. Short-handled sledges are used to drive driftpins, and large nails, and to strike cold chisels and small hand-held rock drills. Long-handled sledges are used to break rock and concrete, to drive spikes or stakes, and to strike rock drills and chisels.

The head of a sledge is generally made of a high-carbon steel and may weigh from 2 to 16 pounds. The shape of the head will vary according to the job for which the sledge is designed.

## MAINTENANCE OF STRIKING TOOLS

Hammers, sledges, or mallets should be cleaned and repaired if necessary before they are stored. Before using them, make sure the faces are free from oil or other material that would cause the tool to glance off nails, spikes, or stakes. The heads should be dressed to remove any battered edges.

Never leave a wooden or rawhide mallet in the sun, as it will dry out and may cause the head to crack. A light film of oil should be left on the mallet to maintain a little moisture in the head.

The hammer handle should always be tight in the head. If it is loose, the head may fly off and cause an injury.

## SAFETY PRECAUTIONS

Hammers are dangerous tools when used carelessly and without consideration. Practice will help you learn to use a hammer properly.

Some important things to remember when using a hammer or mallet follow:

- Do not use a hammer handle for bumping parts in assembly, and never use it as a pry bar. Such abuses will cause the handle to split, and a split handle can produce bad cuts or pinches. When a handle splits or cracks, do not try to repair it by binding with string, wire, or tape. Replace it.
- Make sure the handle fits tightly on the head.
- Do not strike a hardened steel surface with a steel hammer. Small pieces of steel may break off and injure someone in the eye or damage the work. However, it is permissible to strike a punch or chisel directly with a ball-peen hammer, because the steel in the heads of

punches and chisels is slightly softer than that of the hammerhead.

## REVIEW QUESTIONS

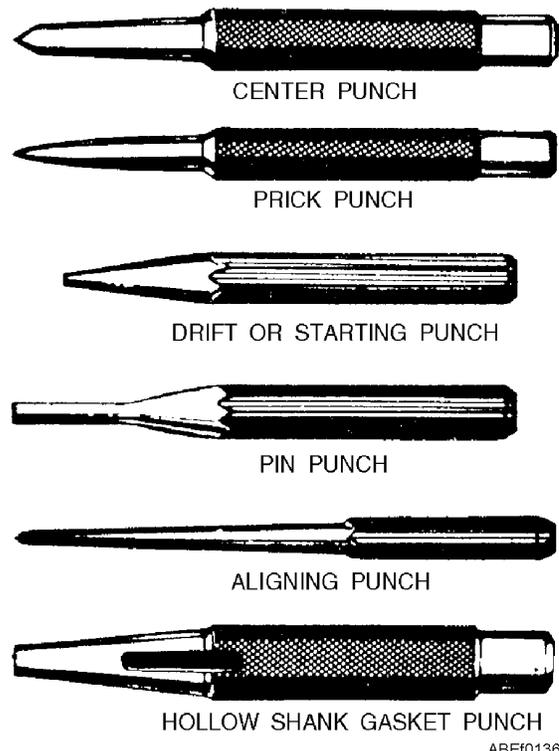
- Q18. Identify the different types of striking tools.
- Q19. Describe the uses of different types of striking tools.
- Q20. Describe the proper care of striking tools.
- Q21. List the safety precautions that apply to striking tools.

## PUNCHES

**LEARNING OBJECTIVES:** Identify the different types of punches. Describe the uses of different types of punches.

A hand punch is a tool that is held in the hand and struck on one end with a hammer. There are many kinds of punches designed to do a variety of jobs. Figure 1-50 shows several types of punches. Most punches are made of tool steel. The part held in the hand is usually octagonal in shape, or it may be knurled. This prevents the tool from slipping around in the hand. The other end is shaped to do a particular job.

When you use a punch, there are two things to remember:



ABE0136

Figure 1-50.—Punches.

1. When you hit the punch, you do not want it to slip sideways over your work.
2. You do not want the hammer to slip off the punch and strike your fingers. You can eliminate both of these troubles by holding the punch at right angles to the work and striking the punch squarely with your hammer.

The center punch, as the name implies, is used for marking the center of a hole to be drilled. If you try to drill a hole without first punching the center, the drill will "wander" or "walk away" from the desired center.

Another use of the center punch is to make corresponding marks on two pieces of an assembly to permit reassembling in the original positions. Before taking a mechanism apart, make a pair of center punchmarks in one or more places to help in reassembly. To do this, select places, staggered as shown in figure 1-51, where matching pieces are joined. First, clean the places selected. Then, scribe a line across the joint, and center punch the line on both sides of the joint, with single and double marks as shown to eliminate possible errors. In reassembly, refer first to the sets of punchmarks to determine the approximate position of the parts. Then line up the scribed lines to determine the exact position.

To make the intersection of two layout lines, bring the point of the prick punch to the exact point of intersection and tap the punch lightly with a hammer. If inspection shows that the exact intersection and the punchmark do not coincide, as in view A of figure 1-52, slant the punch as shown in view B and strike again with the hammer, thus enlarging the punchmark and centering it exactly. When the intersection has been correctly punched, finish off with a light blow on the punch held in an upright position. View C shows the corrected punchmark.

DRIFT punches, sometimes called "starting punches," have a long taper from the tip to the body.

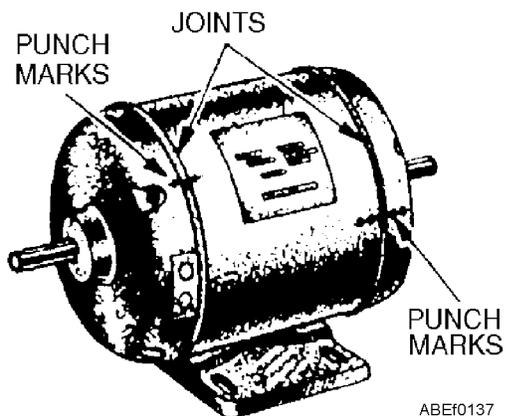


Figure 1-51.—Punch marking mating parts.

They are made that way to withstand the shock of heavy blows. They may be used for knocking out rivets after the heads have been chiseled off or for freeing pins that are "frozen" in their holes.

After a pin has been loosened or partially driven out, the drift punch may be too large to finish the job. The follow-up tool to use is the PIN PUNCH. It is designed to follow through the hole without jamming. Always use the largest drift or pin punch that will fit the hole. These punches usually come in sets of three to five assorted sizes. Both of these punches will have flat ends, never edged or rounded.

To remove a bolt or pin that is extremely tight, start with a drift punch that has an end diameter that is slightly smaller than the diameter of the object you are removing. As soon as the bolt or pin loosens, finish driving it out with a pin punch. Never use a pin punch for starting a pin, because it has a slim shank and a hard blow may cause it to bend or break.

For assembling units of a machine, an ALIGNMENT (aligning) punch is invaluable. It is usually about 1-foot long and has a long gradual taper. Its purpose is to line up holes in mating parts.

Hollow metal-cutting punches are made from hardened tool steel. They are made in various sizes and are used to cut holes in light gauge sheet metal.

Other punches have been designed for special uses. One of these is the soft-faced drift. It is made of brass or fiber and is used for such jobs as removing shafts, bearings, and wrist pins from engines. It is generally heavy enough to resist damage to itself, but soft enough not to injure the finished surface on the part that is being driven.

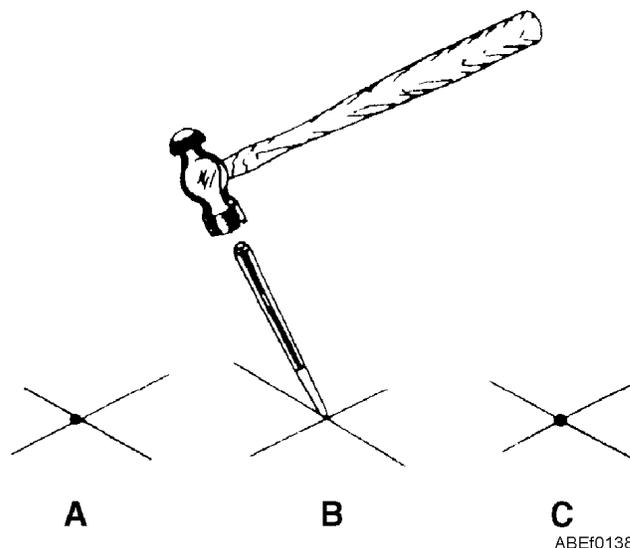


Figure 1-52.—Marking the intersection of lines with a prick punch.

You may have to make gaskets of rubber, cork, leather, or composition materials. For cutting holes in gasket materials, a hollow shank GASKET PUNCH may be used (fig. 1-50). Gasket punches come in sets of various sizes to accommodate standard bolts and studs. The cutting end is tapered to a sharp edge to produce a clean uniform hole. To use the gasket punch, place the gasket material to be cut on a piece of hard wood or lead so that the cutting edge of the punch will not be damaged. Then strike the punch with a hammer, driving it through the gasket where holes are required.

### REVIEW QUESTIONS

- Q22. Identify the different types of punches.  
 Q23. What is a center punch used for?  
 Q24. What is a prick punch used for?

### TAPS AND DIES

**LEARNING OBJECTIVES:** Identify the different types of taps and dies. Describe the uses of different types of taps and dies.

Taps and dies are used to cut threads in metal, plastics, or hard rubber. The taps are used for cutting internal threads, and the dies are used to cut external threads. There are many different types of taps. However, the most common are the taper, plug, bottoming, and pipe taps (fig. 1-53).

The taper (starting) hand tap has a chamfer length of 8 to 10 threads. These taps are used when starting a tapping operation and when tapping through holes.

Plug hand taps have a chamfer length of 3 to 5 threads and are designed for use after the taper tap.

Bottoming hand taps are used for threading the bottom of a blind hole. They have a very short chamfer length of only 1 to 1 1/2 threads for this purpose. This tap is always used after the plug tap has been used. Both the taper and plug taps should precede the use of the bottoming hand tap.

Pipe taps are used for pipefitting and other places where extremely tight fits are necessary. The tap diameter, from end to end of the threaded portion, increases at the rate of 3/4 inch per foot. All the threads on this tap do the cutting, as compared to the straight taps, where only the nonchamfered portion does the cutting.

Dies are made in several different shapes and are of the solid or adjustable type. The square pipe die (fig.

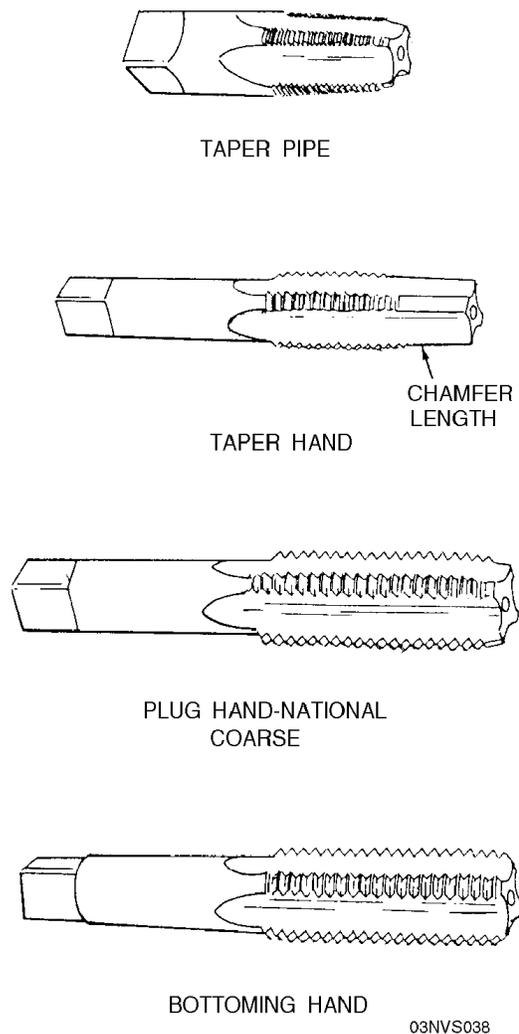


Figure 1-53.—Types of common taps.

1-54) will cut American Standard Pipe thread only. It comes in a variety of sizes for cutting threads on pipe with diameters of 1/8 inch to 2 inches.

A rethreading die (fig. 1-54) is used principally for dressing over bruised or rusty threads on screws or bolts. It is available in a variety of sizes for rethreading American Standard Coarse and Fine threads. These dies are usually hexagon in shape and can be turned

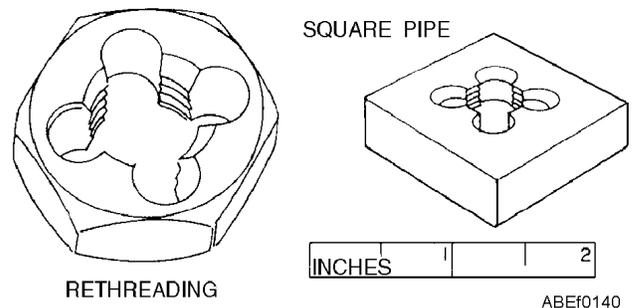
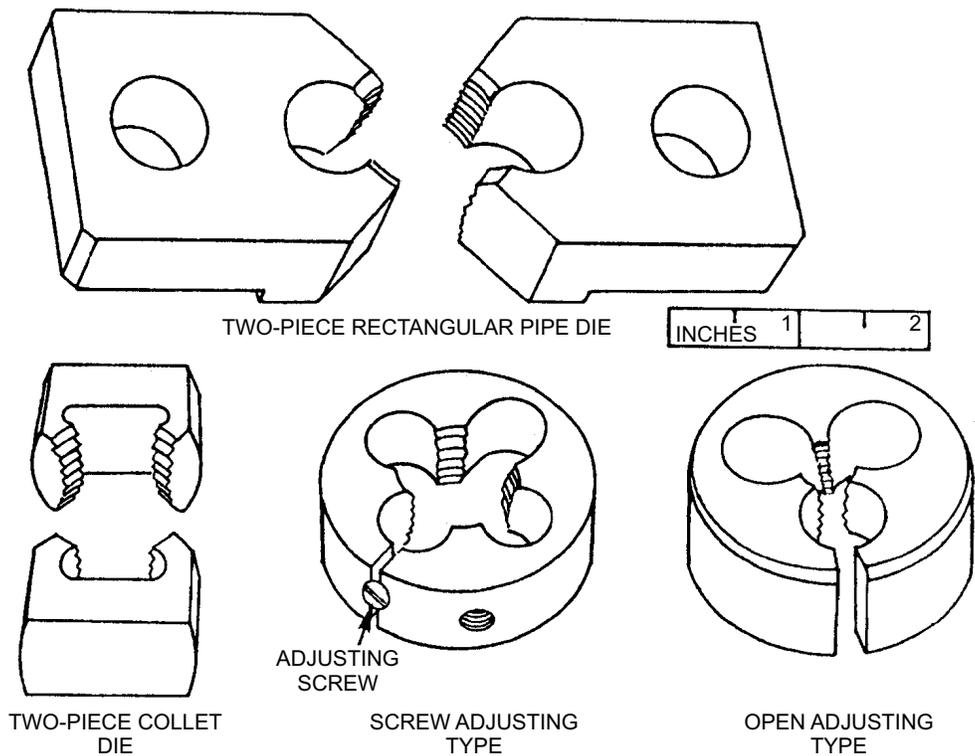


Figure 1-54.—Types of solid dies.



ABEF0141

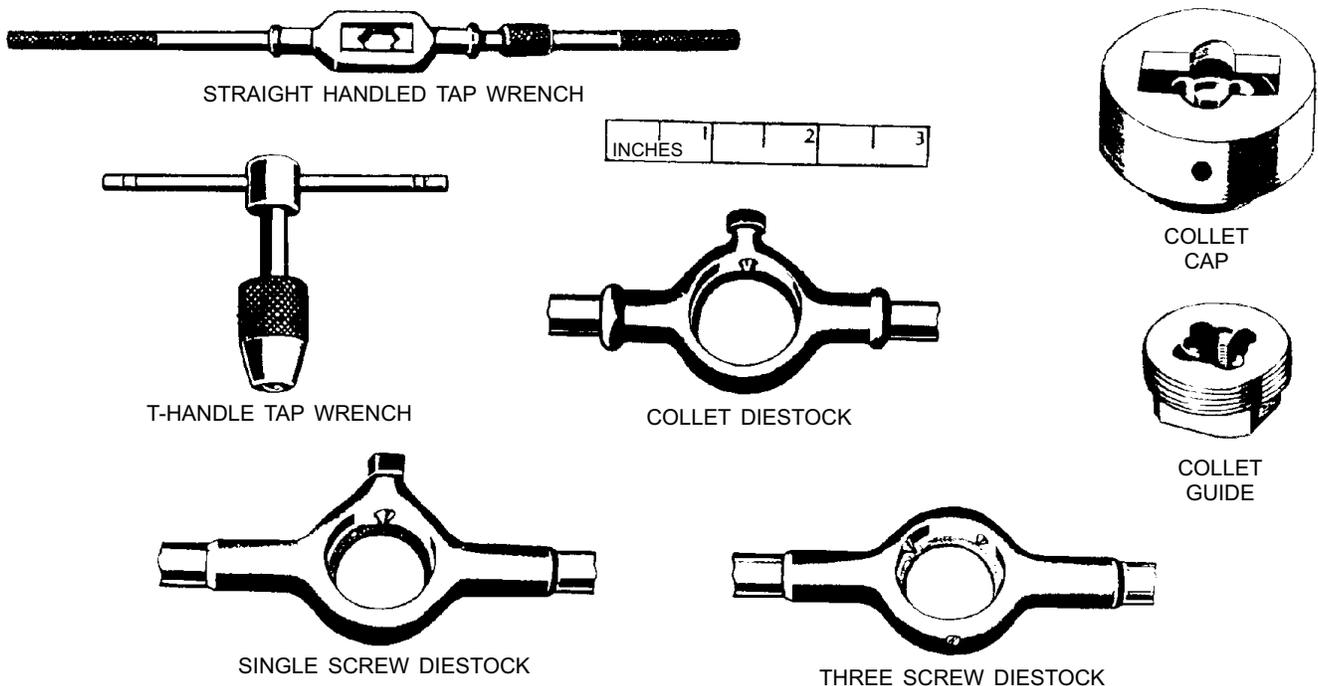
Figure 1-55.—Types of adjustable dies.

with a socket, box, open-end, or any wrench that will fit. Rethreading dies are available in sets of 6, 10, 14, and 28 assorted sizes in a case.

Round split adjustable dies (fig. 1-55) are called "Burton" dies and can be used in either hand diestocks or machine holders. The adjustment in the screw adjusting type is made by a fine-pitch screw, which

forces the sides of the die apart or allows them to spring together. The adjustment in the open adjusting type is made by means of three screws in the holder, one for expanding and two for compressing the dies.

Two piece collet dies (fig. 1-55) are used with a collet cap (fig. 1-56) and collet guide. The die halves are placed in the cap slot and are held in place by the



ABEF0142

Figure 1-56.—Diestocks, diecollet, and tap wrenches.

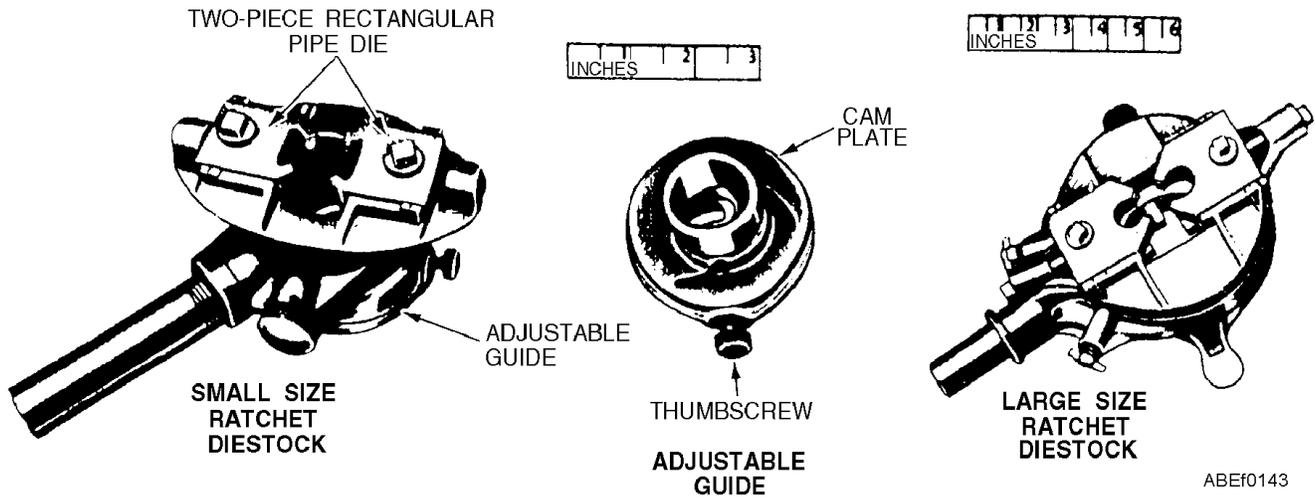


Figure 1-57.—Adjustable die guide and ratchet diestocks.

guide, which screws into the underside of the cap. The die is adjusted by setscrews at both ends of the interval slot. This type of adjustable die is issued in various sizes to cover the cutting ranges of American Standard Coarse and Fine and special-form threads. Diestocks to hold the dies come in three different sizes.

Two-piece rectangular pipe dies (fig. 1-55) are available to cut American Standard Pipe threads. They are held in ordinary or ratchet-type diestocks (fig. 1-57).

Threading sets are available in many different combinations of taps and dies, together with diestocks, tap wrenches, guides, and necessary screwdrivers and wrenches to loosen and tighten adjusting screws and bolts. Figure 1-58 illustrates typical threading sets for pipe, bolts, and screws.

Never attempt to sharpen taps or dies. Sharpening of taps and dies involves several highly precise cutting processes that involve the thread characteristics and chamfer. These sharpening procedures must be done by experienced personnel to maintain the accuracy and the cutting effectiveness of taps and dies.

Keep taps and dies clean and well oiled when not in use. Store them so that they do not contact each other or other tools. For long periods of storage, coat taps and dies with a rust-preventive compound, place in individual or standard threading set boxes, and store in a dry place.

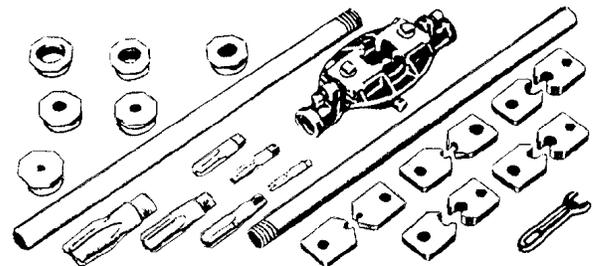
### REVIEW QUESTIONS

Q25. Identify the different types of taps.

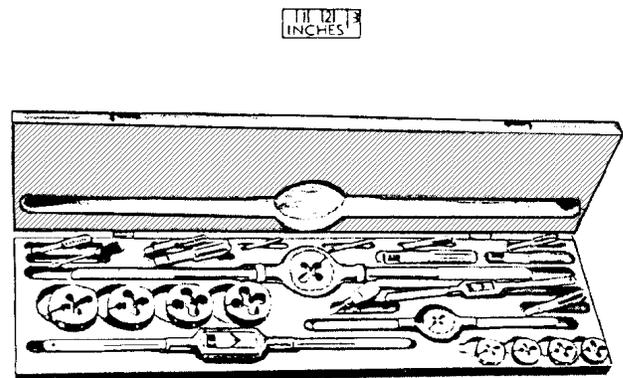
Q26. What are taper taps used for?

Q27. Identify the different types of dies.

Q28. What are two-piece rectangular pipe dies used for?



PIPE THREADING SET WITH RECTANGULAR ADJUSTABLE DIES, DIESTOCK, WRENCH, GUIDES AND TAPS



BOLT AND SCREW THREADING SET WITH ROUND ADJUSTABLE SPLIT DIES, DIESTOCKS, TAPS, TAP WRENCHES, AND SCREWDRIVERS

Figure 1-58.—Tap and die thread sets.

## POWER TOOLS

**LEARNING OBJECTIVES:** Identify the different types of power tools. Describe the uses of different types of power tools. List the safety precautions that apply to power tools. List the safety precautions that apply to extension cords.

Power tools have become so commonplace in the Navy that all ratings now use them in the performance of maintenance at one time or another.

The following paragraphs are devoted to the identification, general-operating practices, and care of these tools.

### DRILLS

The portable electric drill (fig. 1-59) is probably the most frequently used power tool in the Navy. Although it is especially designed for drilling holes, by adding various accessories you can adapt it for different jobs. Sanding, sawing, buffing, polishing, screw driving, wire brushing, and paint mixing are examples of possible uses.

Portable electric drills commonly used in the Navy have capacities for drilling holes in steel from 1/16 inch up to 1 inch in diameter. The sizes of portable electric drills are classified by the maximum size straight shank drill it will hold. That is, a 1/4-inch electric drill will hold a straight shank drill bit up to and including 1/4 inch in diameter.

The revolutions per minute (rpm) and power the drill will deliver are most important when choosing a drill for a job. You will find that the speed of the drill motor decreases with an increase in size, primarily because the larger units are designed to turn larger cutting tools or to drill in heavy materials, and both of these factors require slower speed.

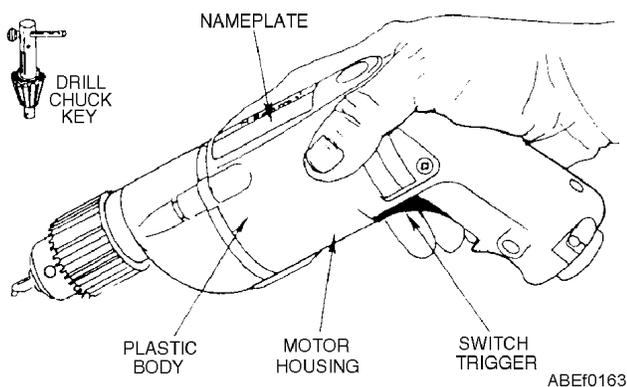


Figure 1-59.—1/4-inch portable electric drill.

If you are going to do heavy work, such as drilling in masonry or steel, then you would probably need to use a drill with a 3/8- or 1/2-inch capacity. If most of your drilling will be forming holes in wood or small holes in sheet metal, then a 1/4-inch drill will probably be adequate.

The chuck is the clamping device into which the drill bit is inserted. Nearly all electric drills are equipped with a three-jaw chuck. Some drills have a hand-type chuck that you tighten or loosen by hand, but most of the drills used in the Navy have gear-type, three-jaw chucks, which are tightened and loosened by a chuck key, shown in figure 1-60. Do not apply further pressure with pliers or wrenches after you hand tighten the chuck with the chuck key.

Always remove the key IMMEDIATELY after you use it. Otherwise the key will fly loose when the drill motor is started and may cause serious injury to you or one of your shipmates. The chuck key is generally taped on the cord of the drill; but if it is not, make sure you put it in a safe place where it will not get lost.

All portable electric drills used in the Navy have controls similar to the ones shown on the 1/4-inch drill in figure 1-59. This drill has a momentary contact trigger switch located in the handle. The switch is squeezed to start the electric drill and released to stop it.

The trigger latch is a button in the bottom of the drill handle. It is pushed in while the switch trigger is held down to lock the trigger switch in the ON position. The trigger latch is released by squeezing and then releasing the switch trigger.

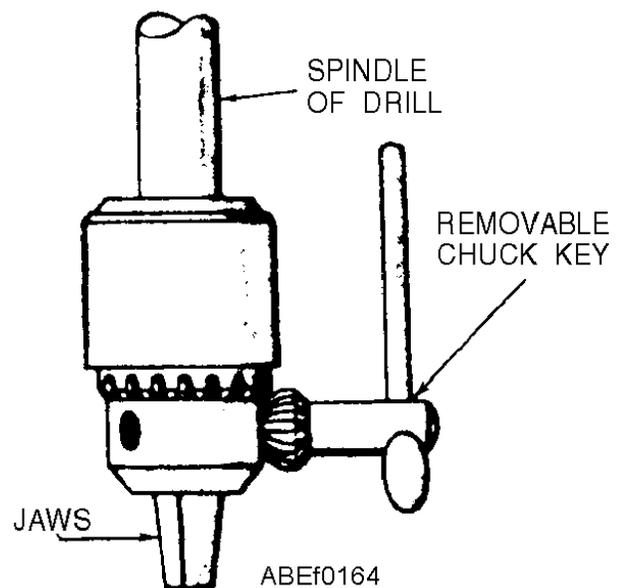


Figure 1-60.—Three-jaw chuck and chuck key.

## DISK SANDER

Electric disk sanders (fig. 1-61) are especially useful on work where a large amount of material is to be removed quickly, such as in scaling surfaces in preparation for painting. This machine, however, must not be used where a mirror-smooth finish is required.

The disk should be moved smoothly and lightly over the surface. Never allow the disk to stay in one place too long, because it will cut into the metal and leave a large depression.

## PORTABLE GRINDERS

Portable grinders are power tools that are used for rough grinding and finishing of metallic surfaces. They are made in several sizes; however, the one used most in the Navy uses a grinding wheel with a maximum diameter of 6 inches. See figure 1-62.

The abrasive wheels are easily replaceable so that different grain size and grades of abrasives can be used for the various types of surfaces to be ground and the different degrees of finish desired.

A flexible shaft attachment is available for most portable grinders. This shaft is attached by removing the grinding wheel, then attaching the shaft to the grinding wheel drive spindle. The grinding wheel can then be attached to the end of the flexible shaft. This attachment is invaluable for grinding surfaces in hard-to-reach places.

## ELECTRIC IMPACT WRENCH

The electric impact wrench (fig. 1-63) is a portable, hand-type reversible wrench. The one shown has a 1/2-inch-square impact-driving anvil, over which 1/2-inch-square drive sockets can be fitted. Wrenches also can be obtained that have impact driving anvils ranging from 3/8 inch to 1 inch. The driving anvils are

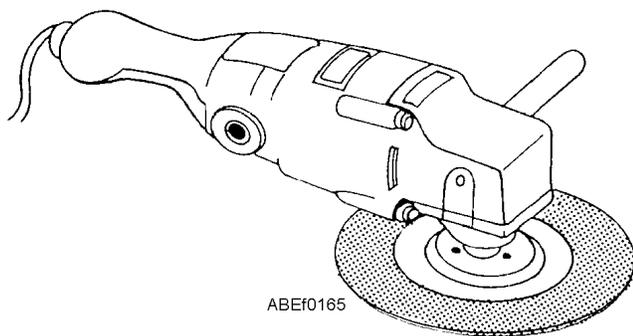


Figure 1-61.—Portable electric sander.

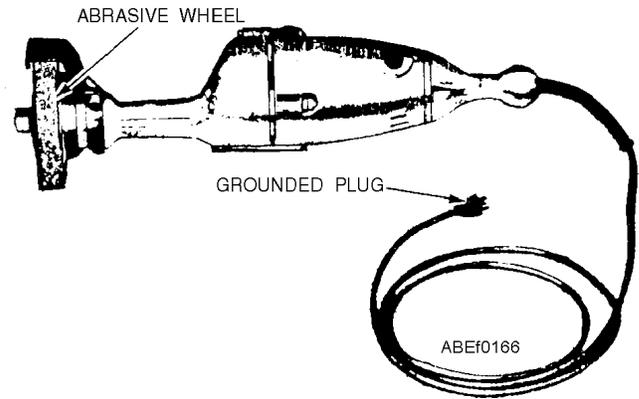


Figure 1-62.—Portable grinder.

not interchangeable, however, from one wrench to another.

The electric wrench with its accompanying equipment is primarily intended for applying and removing nuts, bolts, and screws. It may also be used to drill and tap metal, wood, plastics, and so on, and to drive and remove socket-head, Phillips-head, or slotted-head wood, machine, or self-tapping screws.

Before you use an electric impact wrench, depress the on-and-off trigger switch and allow the electric wrench to operate a few seconds, noting carefully the direction of rotation. Release the trigger switch to stop the wrench. Turn the reversing ring, located at the rear of the tool; it should move easily in one direction (which is determined by the current direction of rotation). Depress the on-and-off trigger again to start the electric wrench. The direction of rotation should now be reversed. Continue to operate for a few seconds in each direction to be sure that the wrench and its reversible features are functioning correctly. When you

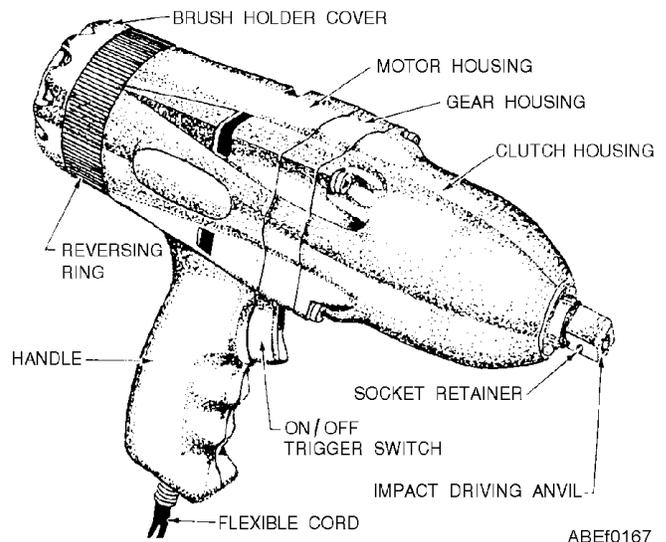


Figure 1-63.—Reversible electric impact wrench.

are sure the wrench operates properly, place the suitable equipment on the impact-driving anvil and go ahead with the job at hand.

### **SAFETY PRECAUTIONS FOR USE WITH PORTABLE ELECTRICAL TOOLS**

When portable electric tools are used, you should use the following procedures:

- Before portable electrical tools are used they must be inspected and approved for shipboard use by the ship's electrical safety officer.
- Prior to the use of any portable electric tools, you should make sure the tools have a current ship's inspection mark. Additionally, visually examine the attached cable with the plug and any extension cords for cracks, breaks, or exposed conductors and damaged plugs. When any defects are noted, the tools should be turned in to the ship's electrical shop for repair before use. Before plugging in any tool, be sure the tool is turned off.
- Personnel using portable electric tools are required to wear safety glasses/goggles.
- Portable electric tools producing hazardous noise levels in excess of the limits set forth in OPNAVINST 5100.19 (Series) are required to be conspicuously labeled. Personnel using tools designated as producing hazardous noise levels are required to wear proper ear protection, as issued by the medical department.
- Only explosion-proof (class I, group D, or better) portable electric tools should be used where flammable vapors, gases, liquids, or exposed explosives are present.
- Hand-held portable electric tools authorized for use on board ship shall be equipped with ON/OFF switches, which must be manually held in the closed ON position to maintain operation.
- Rubber gloves must be worn when you are using portable electric tools under hazardous conditions; for example, wet decks, bilge areas, working over the side, in boats, and so forth.
- Leather glove shells should be worn over rubber gloves when the work being done, such as sheet metal work, could damage the rubber gloves.

### **SAFETY PRECAUTIONS FOR USE WITH EXTENSION CORDS**

You should use the following procedures when using extension cords:

- Only three-wire extension cords that have three-pronged plugs and three-slot receptacles should be used.
- Because a metal hull ship is a hazardous location, personnel who must use portable electric devices connected to extension cords should take the time to plug the device into the extension cord before the extension cord is inserted into a live bulkhead receptacle. Likewise, the extension cord should be unplugged from the bulkhead receptacle before the device is unplugged from the extension cord.
- Electrical cords shall be cared for as follows:
  - Cords should not be allowed to come in contact with sharp objects. They should not be allowed to kink nor should they be left where they might be damaged by vehicle/foot traffic. When it is necessary to run electrical leads through doors and hatches, the cords must be protected to guard against accidental closing of the doors/hatches.
  - Cords must not come in contact with oil, grease, hot surfaces, or chemicals.
  - Damaged cords must be replaced. They are not to be patched with tape.
  - Cords must be stored in a clean, dry place where they can be loosely coiled.
  - Cords extending through walkways should be elevated so they do not become a tripping hazard or interfere with safe passage.
  - Extension cords should be no longer than 25 feet (except repair locker and CV flight deck cords, which are 100 feet long). No more than two such cords should be connected together for the operation of portable equipment.

### **REVIEW QUESTIONS**

- Q29. Identify the different types of power tools.*
- Q30. What are electric drills used for?*

- Q31. List the safety precautions that apply to power tools.
- Q32. List the safety precautions that apply to extension cords.

## PORTABLE PNEUMATIC POWER TOOLS

**LEARNING OBJECTIVES:** Identify different types of portable pneumatic power tools. Describe the uses of different types of portable pneumatic power tools. List the safety precautions that apply to portable pneumatic power tools.

Portable pneumatic power tools are tools that look much the same as electric power tools but use the energy of compressed air instead of electricity. Because of the limited outlets for compressed air aboard ship and shore stations, the use of pneumatic power tools is not as widespread as electric tools. Portable pneumatic tools are used most around a shop where compressed air outlets are readily accessible.

### PNEUMATIC CHIPPING HAMMER

The pneumatic chipping hammer (fig. 1-64) consists basically of a steel piston that is reciprocated (moved backward and forward alternately) in a steel barrel by compressed air. On its forward stroke the piston strikes the end of the chisel, which is a sliding fit in a nozzle pressed into the barrel. The rearward stroke is cushioned by compressed air to prevent any metal-to-metal contact. Reciprocation of the piston is automatically controlled by a valve located on the rear end of the barrel. Located on the rear end of the barrel is a grip handle, containing a throttle valve.

The pneumatic hammer may be used for beveling; caulking or beading operations; and for drilling in brick, concrete, and other masonry.

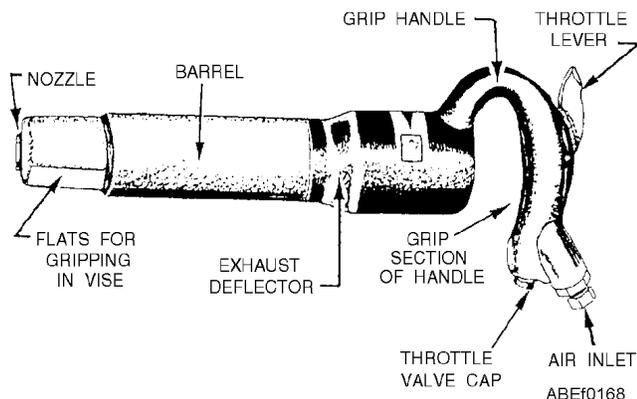


Figure 1-64.—Pneumatic chipping hammer.

Chipping hammers should not be operated without safety goggles, and all other persons in the immediate vicinity of the work should wear goggles.

While working, never point the chipping hammer in such a direction that other personnel might be struck by an accidentally ejected tool. When chipping alloy steel or doing other heavy work, it is helpful to dip the tool in engine lubricating oil about every 6 inches of the cut and make sure the cutting edge of the tool is sharp and clean. This will allow faster and easier cutting and will reduce the possibility of the tool breaking.

When nearing the end of a cut, ease off on the throttle lever to reduce the intensity of the blows. This will avoid any possibility of the chip or tool flying.

If for any reason you have to lay the chipping hammer down, always remove the attachment tool from the nozzle. Should the chipping hammer be accidentally started when the tool is free, the blow of the piston will drive the tool out of the nozzle with great force and may damage equipment or injure personnel.

### ROTARY AND NEEDLE IMPACT SCALERS

Rotary and needle scalers (figs. 1-65 and 1-66) are used to remove rust, scale, and old paint from metallic and masonry surfaces. You must be especially careful when using these tools since they will "chew" up anything in their path. Avoid getting the power line or any part of your body in their way.

The rotary scaling and chipping tool, sometimes called a "jitterbug," has a bundle of cutters or chippers for scaling or chipping (fig. 1-65). In use, the tool is pushed along the surface to be scaled, and the rotating chippers do the work. Replacement bundles of cutters are available when the old ones are worn.

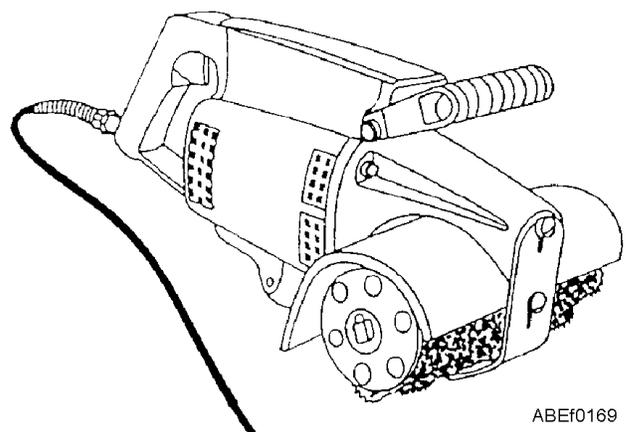


Figure 1-65.—Rotary impact scaler.

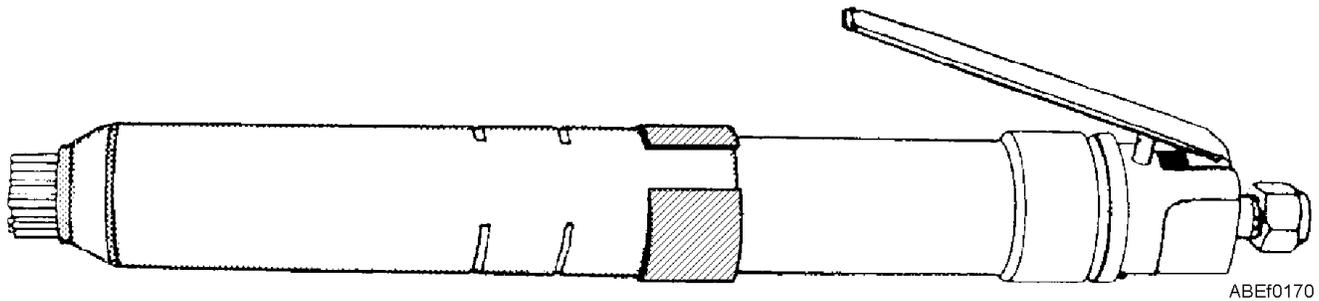


Figure 1-66.—Needle impact scaler.

**BE SURE YOU ARE NOT DAYDREAMING** when you use the rotary scaler.

Needle scalers accomplish their task with an assembly of individual needles impacting on a surface hundreds of times a minute. The advantage of using individual needles is that irregular surfaces can be cleaned readily. See figure 1-66.

### PORTABLE PNEUMATIC IMPACT WRENCH

The portable pneumatic impact wrench (fig. 1-67) is designed for installing or removing nuts and bolts. The wrench comes in different sizes and is classified by the size of the square anvil on the drive end. The anvil is equipped with a socket lock, which provides positive locking of the socket wrenches or attachments.

Nearly all pneumatic wrenches operate most efficiently on an air pressure range of 80 to 100 psi. Lower pressure causes a decrease in the driving speeds, while higher pressure causes the wrench to overspeed with subsequent abnormal wear of the motor impact mechanisms.

Before operating the pneumatic impact wrench, make sure the socket or other attachment you are using is properly secured to the anvil. It is always a good idea to operate the wrench free of load in both forward and reverse directions to see that it operates properly. Check the installation of the air hose to make sure it is in accordance with the manufacturer's recommendation.

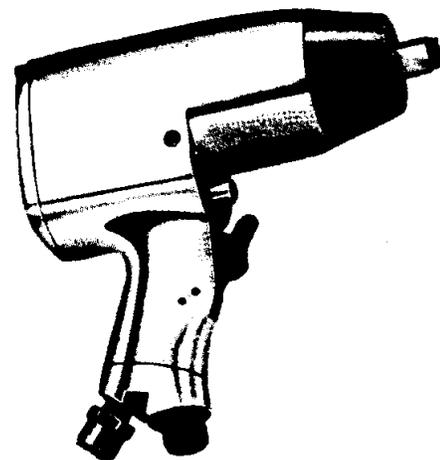
### SAFETY PRECAUTIONS FOR USE WITH PNEUMATIC TOOLS—GENERAL

When using pneumatic tools, you should use the following procedures:

- You should wear and use necessary personnel protective devices. Pneumatic tools shall not be connected to, or driven by, air pressure in excess

of that for which the tools are designed. The wearing of appropriate eye protection equipment is mandatory for Navy personnel when operating pneumatic tools.

- You should be authorized and trained to operate pneumatic tools.
- Pneumatic tools should be laid down in such a manner that no harm can be done if the switch is accidentally tripped. No idle tools should be left in a standing position.
- Pneumatic tools should be kept in good operating condition. They should be thoroughly inspected at regular intervals with particular attention given to the ON-OFF control valve trigger guard (if installed), hose connections, guide clips on hammers, and the chucks of reamers and drills.
- Pneumatic tools and air lines may be fitted with quick-disconnect fittings. These should incorporate an automatic excess-flow shutoff valve. This valve automatically shuts off the air



ABDf0171  
Figure 1-67.—Pneumatic impact wrench.

at the air lines before changing grinding wheels, needles, chisels, or other cutting or drilling bits.

- The air hose must be suitable to withstand the pressure required for the tool. A leaking or defective hose should be removed from service. The hose should not be laid over ladders, steps, scaffolds, or walkways in such a manner as to create a tripping hazard. Where the hose is run through doorways, the hose should be protected against damage by the doors' edges. The air hose should generally be elevated over walkways or working surfaces in a manner to permit clear passage and to prevent damage to it.
- All portable pneumatic grinders must be equipped with a safety lock-off device. A safety lock-off device is any operating control that requires positive action by the operator before the tools can be turned on. The lock-off device must automatically and positively lock the throttle in the OFF position when the throttle is released. Two consecutive operations by the same hand are required, first to disengage the lock-off device and then to turn on the throttle. The lock-off device should be integral with the tool. It should not adversely affect the safety or operating characteristics of the tools, and it should not be easily removable. Devices, such as a "dead-man control," that do not automatically and positively lock the throttle in the OFF position when the throttle is released are not safety lock-off devices.

For detailed information on safety precautions, see *Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19 (latest series)*.

### SAFETY PRECAUTIONS FOR USE WITH PNEUMATIC TOOLS—SPECIFIC

In operating or maintaining air-driven tools, take the following precautionary measures to protect yourself and others from the damaging effects of compressed air:

- Inspect the air hose for cracks or other defects; replace the hose if found defective.

### WARNING

Before opening the control valve, see that nearby personnel are not in the path of the airflow. Never point the hose at another person.

- Open the control valve momentarily before connecting an air hose to the compressed air outlet. Then, make sure the hose is clear of water and other foreign material by connecting it to the outlet and again opening the valve momentarily.
- Stop the flow of air to a pneumatic tool by closing the control valve at the compressed air outlet before connecting, disconnecting, adjusting, or repairing a pneumatic tool.

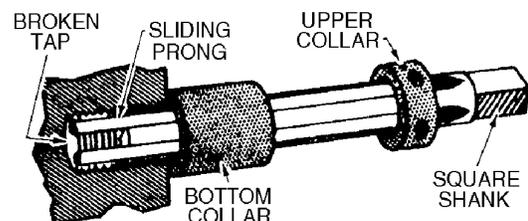
### REVIEW QUESTIONS

- Q33. Identify different types of portable pneumatic power tools.
- Q34. What are rotary and needle sanders used for?
- Q35. List the safety precautions that apply to portable pneumatic power tools.

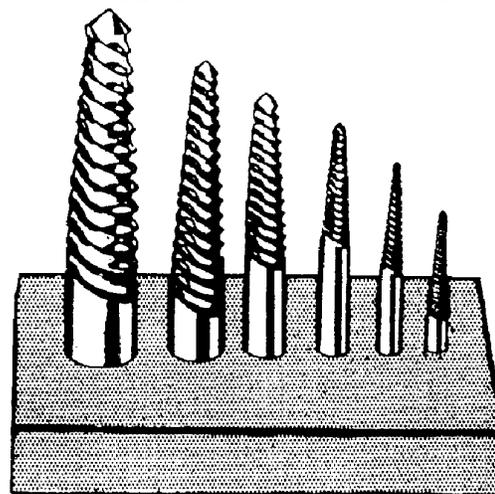
### SCREW AND TAP EXTRACTORS

**LEARNING OBJECTIVE:** State the purpose of screw and tap extractors.

Screw extractors are used to remove broken screws without damaging the surrounding material or the threaded hole. Tap extractors are used to remove broken taps (fig. 1-68, view A).



A. STRAIGHT TAP EXTRACTOR



B. SPIRAL SCREW EXTRACTORS

ABEF0145

Figure 1-68.—Screw and tap extractors.

Screw extractors (view B) are straight, with spiraling flutes at one end. These extractors are available in sizes to remove broken screws having 1/4- to 1/2-inch outside diameters (ODs). Spiral tapered extractors are sized to remove screws and bolts from 3/16 inch to 2 1/8 inches OD.

Most sets of extractors include twist drills and a drill guide. Tap extractors are similar to the screw extractors and are sized to remove taps ranging from 3/16 inch to 2 1/8 inches OD.

To remove a broken screw or tap with a spiral extractor, first drill a hole of proper size in the screw or tap. The size hole required for each screw extractor is stamped on it. The extractor is then inserted in the hole, and turned counterclockwise to remove the defective component.

### REVIEW QUESTIONS

Q36. State the purpose of screw and tap extractors.

### PIPE AND TUBING CUTTERS AND FLARING TOOLS

**LEARNING OBJECTIVES:** State the purpose of pipe cutters, tube cutters, and flaring tools.

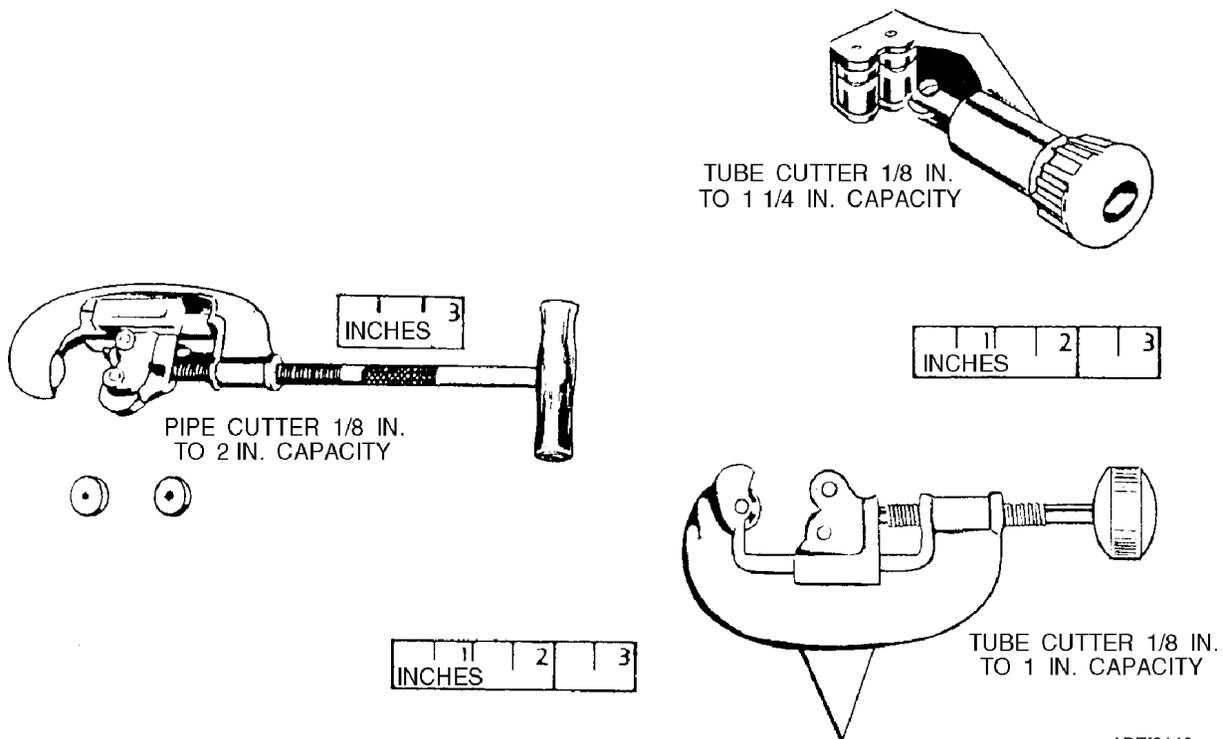
Pipe cutters (fig. 1-69) are used to cut pipe made of steel, brass, copper, wrought iron, or lead. Tube cutters

(fig. 1-69) are used to cut tubing made of iron, steel, brass, copper, or aluminum. The essential difference between pipe and tubing is that tubing has considerably thinner walls. Flaring tools (fig. 1-70) are used to make flares in the ends of tubing.

Two sizes of hand pipe cutters are generally used in the Navy. The No. 1 pipe cutter has a cutting capacity of 1/8 inch to 2 inches, and the No. 2 pipe cutter has a cutting capacity of 2 to 4 inches. The pipe cutter (fig. 1-69) has a special alloy-steel cutting wheel and two pressure rollers, which are adjusted and tightened by turning the handle.

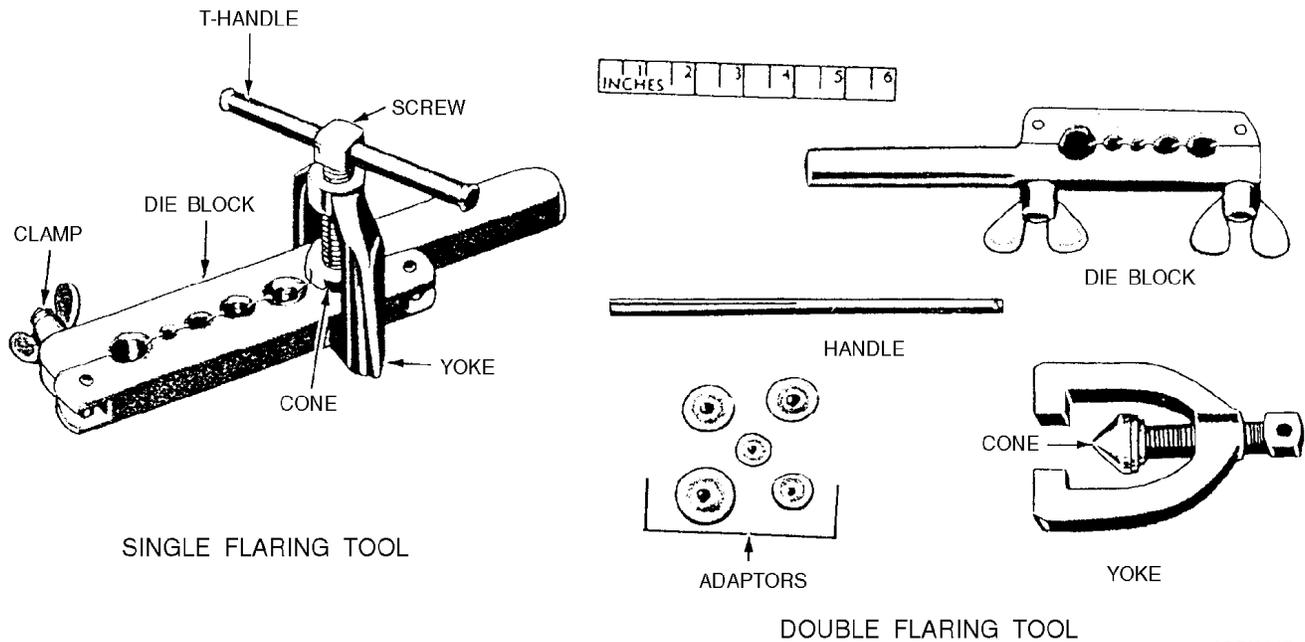
Most TUBE CUTTERS closely resemble pipe cutters, except that they are of lighter construction. A hand screw feed tubing cutter of 1/8-inch to 1 1/4-inch capacity (fig. 1-69) has two rollers with cutouts located off center so that cracked flares may be held in them and cut off without waste of tubing. It also has a retractable cutter blade, which is adjusted by turning a knob. The other tube cutter shown is designed to cut tubing up to and including 1 inch OD. Rotation of the triangular portion of the tube cutter within the tubing will eliminate any burrs.

FLARING TOOLS (fig. 1-70) are used to flare soft copper, brass, or aluminum. The single flaring tool consists of a split die block, which has holes for 3/16-, 1/4-, 5/16-, 3/8-, 7/16-, and 1/2-inch OD tubing; a clamp to lock the tube in the die block; and a yoke,



ABEF0146

Figure 1-69.—Pipe and tubing cutters.



ABEf0147

Figure 1-70.—Flaring tools.

which slips over the die block and has a compressor screw and a cone that forms a 45-degree flare or a bell shape on the end of the tube. The screw has a T-handle. A double flaring tool has the additional feature of adapters, which turn in the edge of the tube before a regular 45-degree double flare is made. It consists of a die block with holes for 3/16-, 1/4-, 5/16-, 3/8-, and 1/2-inch tubing; a yoke with a screw and a flaring cone; plus five adapters for different size tubing, all carried in a metal case.

### REVIEW QUESTIONS

- Q37. What are pipe cutters used for?  
 Q38. What are tube cutters used for?  
 Q39. What are flaring tools used for?

### SCREWDRIVERS

**LEARNING OBJECTIVES:** Identify the different types of screwdrivers. List the safety precautions that apply to screwdrivers.

A screwdriver is one of the most basic of handtools. It is also the most frequently abused of all hand tools. It is designed for one function only—to drive and to remove screws. A screwdriver should not be used as a pry bar, a scraper, a chisel, or a punch.

### STANDARD

There are three main parts to a standard screwdriver. The portion you grip is called the handle, the steel portion extending from the handle is the shank, and the end that fits into the screw is called the blade (fig. 1-71).

The steel shank is designed to withstand considerable twisting force in proportion to its size, and the tip of the blade is hardened to keep it from wearing.

Standard screwdrivers are classified by size, according to the combined length of the shank and blade. The most common sizes range in length from 2 1/2 to 12 inches. There are many screwdrivers smaller and some larger for special purposes. The diameter of the shank, and the width and thickness of the blade are generally proportionate to the length, but again there are special screwdrivers with long thin shanks, short thick shanks, and extra wide or extra narrow blades.

When using a screwdriver, you should select the proper size so that the blade fits the screw slot properly. This prevents burring the slot and reduces the force required to hold the driver in the slot. Keep the shank perpendicular to the screw head (fig. 1-72).

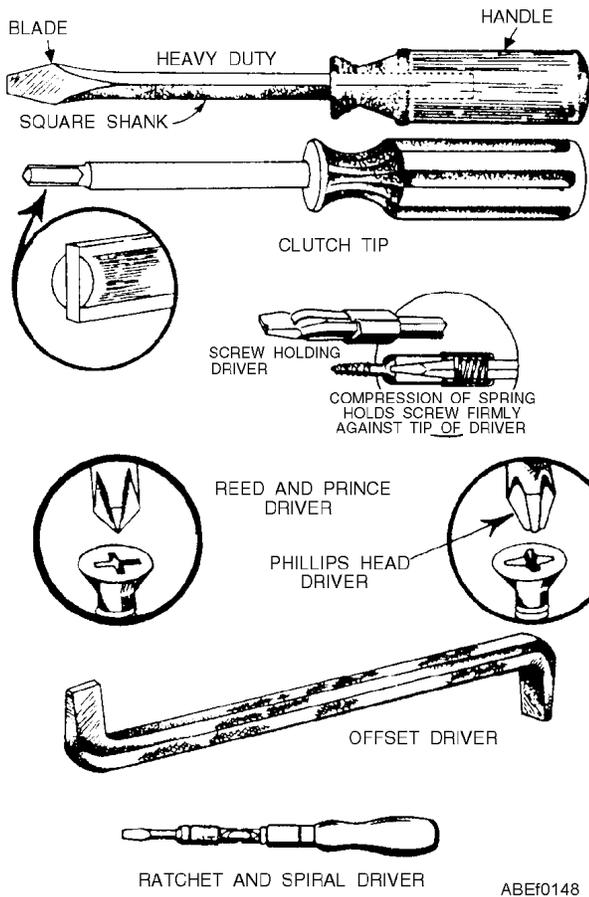


Figure 1-71.—Types of screwdrivers.

## RECESSED

Recessed screws are now available in various shapes. They have a cavity formed in the head and require a specially shaped screwdriver. The clutch tip (fig. 1-71) is one shape, but the more common include the Phillips, Reed and Prince, and newer Torq-Set types (fig. 1-73). The most common type of screw found is the Phillips head. This requires a Phillips-type screwdriver (fig. 1-71).

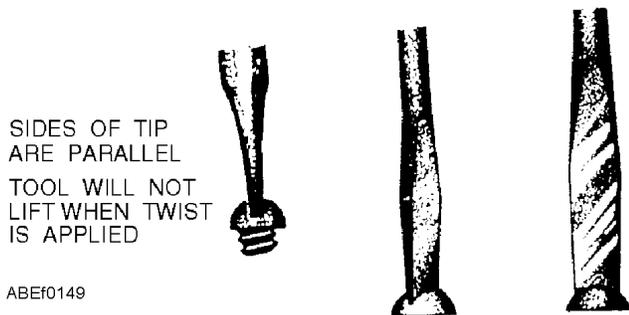


Figure 1-72.—Positioning screwdrivers.

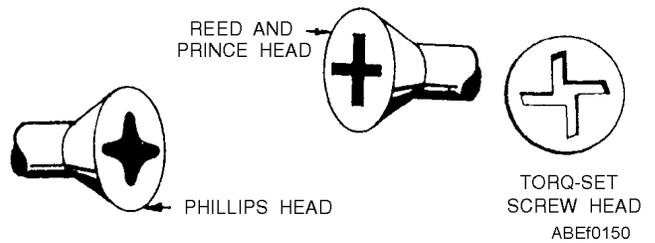


Figure 1-73.—Comparison of Phillips, Reed and Prince, and Torq-Set screwheads.

## Phillips Screwdriver

The head of a Phillips-type screw has a four-way slot into which the screwdriver fits. This prevents the screwdriver from slipping. Three standard-sized Phillips screwdrivers handle a wide range of screw sizes. Their ability to hold helps to prevent damaging the slots or the work surrounding the screw. It is a poor practice to try to use a standard screwdriver on a Phillips screw, because both the tool and screw slot will be damaged.

## Reed and Prince Screwdriver

Reed and Prince screwdrivers are not interchangeable with Phillips screwdrivers. Therefore, always use a Reed and Prince screwdriver with Reed and Prince screws, and a Phillips screwdriver with Phillips screws, or a ruined tool or ruined screwhead will result.

To distinguish between these similar screwdrivers, refer to figure 1-74.

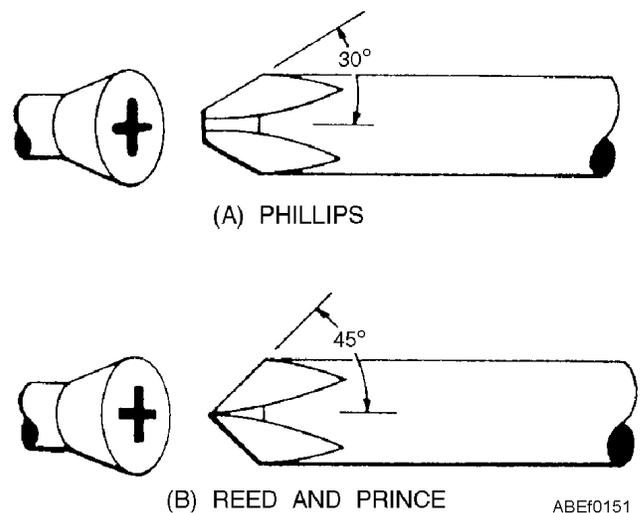


Figure 1-74.—Matching cross-slot screws and screwdrivers.

The Phillips screwdriver has about 30-degree flukes and a blunt end, while the Reed and Prince has 45-degree flukes and a sharper, pointed end. The Phillips screw has beveled walls between the slots; the Reed and Prince, straight, pointed walls. In addition, the Phillips screw slot is not as deep as the Reed and Prince slot.

Additional ways to identify the right screwdriver are as follows:

1. If the screwdriver tends to stand up unassisted when the point is put in the head of a vertical screw, it is probably the proper one.
2. The outline of the end of a Reed and Prince screwdriver is approximately a right angle, as seen in figure 1-74.
3. In general, Reed and Prince screws are used for airframe structural applications, while Phillips screws are found most often in component assemblies.

### **Torq-Set Screws**

Torq-Set machine screws (offset cross-slot drive) have recently begun to appear in new equipment. The main advantage of the newer type is that more torque can be applied to its head while tightening or loosening than to any other screw of comparable size and material without damaging the head of the screw.

Torq-Set machine screws are similar in appearance to the more familiar Phillips machine screws.

Since a Phillips driver could easily damage a Torq-Set screwhead, making it difficult if not impossible to remove the screw even if the proper tool is later used, maintenance personnel should be alert to the differences (fig. 1-73) and make sure the proper tool is used.

### **OFFSET SCREWDRIVERS**

An offset screwdriver (fig. 1-71) may be used where there is not sufficient vertical space for a standard or recessed screwdriver. Offset screwdrivers are constructed with one blade forged in line and another blade forged at right angles to the shank handle. Both blades are bent 90 degrees to the shank handle. By alternating ends, most screws can be seated or loosened even when the swinging space is very restricted. Offset screwdrivers are made for both standard and recessed-head screws.

### **RATCHET SCREWDRIVER**

For fast, easy work, the ratchet screwdriver (fig. 1-71), is extremely convenient, as it can be used one-handed and does not require the bit to be lifted out of the slot after each turn. It may be fitted with either a standard-type bit or a special bit for recessed heads. The ratchet screwdriver is most commonly used by the woodworker for driving screws in soft wood.

### **SAFETY**

Screwdrivers, like any other hand tool, are dangerous when not used properly. Therefore, the following safety precautions should always be followed:

- Never use a screwdriver to check an electrical circuit.
- Never try to turn a screwdriver with a pair of pliers.
- Do not hold work in your hand while using a screwdriver—if the point slips, it can cause a bad cut. Hold the work in a vise, with a clamp, or on a solid surface. If that is impossible, you will always be safe if you follow this rule: **NEVER GET ANY PART OF YOUR BODY IN FRONT OF THE SCREWDRIVER BLADE TIP.** That is a good safety rule for any sharp or pointed tool.

### **REVIEW QUESTIONS**

- Q40. Identify the different types of screwdrivers.*
- Q41. List the safety precautions that apply to screwdrivers.*

### **MECHANICAL FINGERS**

**LEARNING OBJECTIVES:** Describe the use of mechanical fingers.

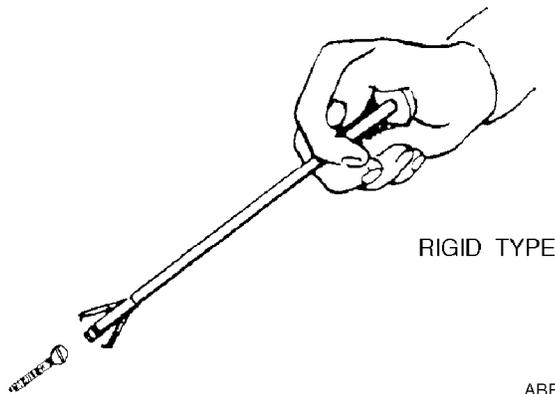
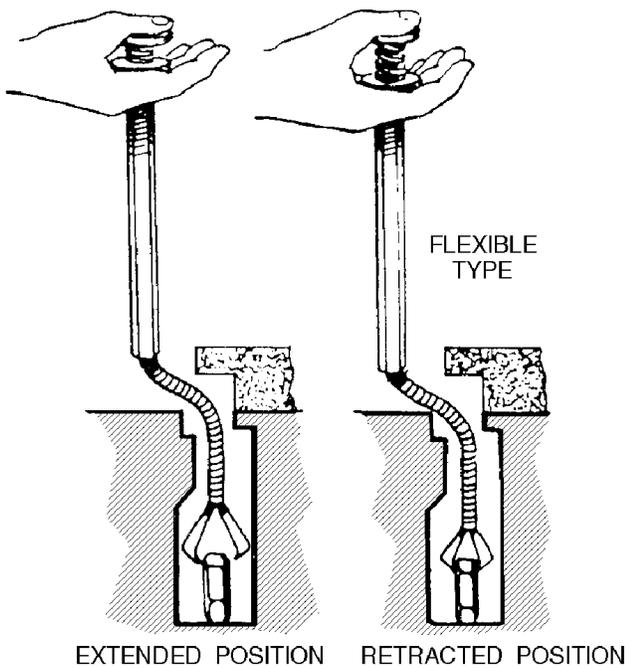
Small articles that have fallen into places where they cannot be reached by hand may be retrieved with mechanical fingers. Mechanical fingers, shown in figure 1-75, have a tube containing flat springs, which extend from the end of the tube to form clawlike fingers, much like the screw holder. The springs are attached to a rod that extends from the outer end of the tube. A plate is attached to the end of the tube, and a similar plate to be pressed by the thumb is attached to the end of the rod. A coil spring placed around the rod

between the two plates holds them apart and retracts the fingers into the tube.

With the bottom plate grasped between the fingers and enough thumb pressure applied to the top plate to compress the spring, the tool fingers extend from the tube in a grasping position. When the thumb pressure is released, the tool fingers retract into the tube as far as the object they hold will allow. Thus, enough pressure is applied on the object to hold it securely. Some mechanical fingers have a flexible end on the tube to permit their use in close quarters or around obstructions (fig. 1-75).

**NOTE**

The fingers are made of thin sheet metal or spring wire and can be easily damaged by overloading.



ABEF0158

Figure 1-75.—Mechanical fingers.

**REVIEW QUESTIONS**

Q42. What are mechanical fingers used for?

**FLASHLIGHT**

**LEARNING OBJECTIVES:** Identify the type of flashlight that belongs in every toolbox.

Each toolbox should have a standard Navy vaporproof two-cell flashlight. The flashlight is used constantly during all phases of maintenance. Installed in both ends of the flashlight are rubber seals, which keep out all vapors. The flashlight should be inspected periodically for these seals, the spare bulb, and colored filters, which are contained in the cap.

**NOTE**

Do not throw away the filters; they will be necessary during night operations.

**REVIEW QUESTION**

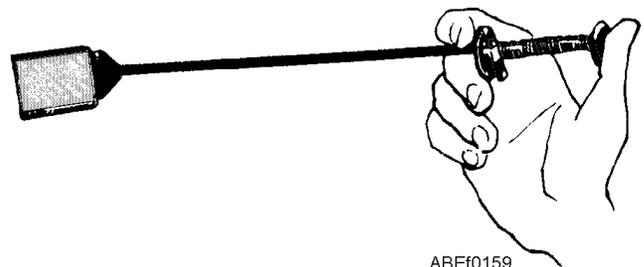
Q43. Identify the type of flashlight that belongs in every toolbox.

**INSPECTION MIRROR**

**LEARNING OBJECTIVES:** Describe the use of inspection mirrors.

Several types of inspection mirrors are available for use in maintenance. The mirror is issued in a variety of sizes and may be round or rectangular. The mirror is connected to the end of a rod and may be fixed or adjustable (fig. 1-76).

The inspection mirror aids in making detailed inspections where the human eye cannot directly see the inspection area. By angling the mirror, and with the aid of a flashlight, it is possible to inspect most required areas. One model of inspection mirror features a built-in light to aid in viewing those dark places where use of a flashlight is not convenient.



ABEF0159

Figure 1-76.—Adjustable inspection mirror.

## **SUMMARY**

This chapter introduced you to the specific purposes, correct uses, and proper care of some of the common hand tools and power tools that you will use as an ABE. You should be able to select, maintain, and safely use tools required for maintenance of catapults

and arresting gear. Blueprints, electrical prints, piping prints, and aperture cards were discussed. By thoroughly understanding this chapter, you, as an ABE, will be able to perform your daily duties more efficiently and safely.