BULDING ELECTRICAL INSTALLATION LEVEL – I

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Module Title: - Perform Bench Work

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Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

OHS-Organization heathly& safety
TTLM -Teaching, Training and Learning Materials
PCB-Printed circuit board
TDS- Tap drill size
SPPT- Schematic of representing single turning tools

.

Introduction to the Module

In building Electrical installation filed; Perform Bench Work helps to know the Work instructions, Layout and mark dimensions/ features on work piece,Cut, chip and file flat, rectangular or round blocks,Drill, ream and lap holes,Cut threads andOff-hand grind cut tools.

This module is designed to meet the industry requirement under the occupational standard, particularly for the unit of competency: **Perform Bench Work**

This module covers the units:

- Layout and mark dimensions/ features on work piece
- Cut, chip and file flat, rectangular or round blocks
- Drill, ream and lap holes
- Cut threads
- Off-hand grind cut tools

Learning Objective of the Module

- Perform Layout and mark dimensions/ features on work piece
- Identify Cut, chip and file flat, rectangular or round blocks
- Perform Drill, ream and lap holes
- Apply Cut threads using tap and stock and die
- Understand Off-hand grind cut tools

Learning Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

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Unit One:- Layout and mark dimensions/ features on work piece

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- materials selection
- lay out and mark dimensions/features
- Tools and equipment.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Specify and Select materials
- Perform lay out and mark dimensions/features
- Identify Bench work tools and equipment.

Introduction to bench work

The term bench work relates to work performed by Electrician at the Electrical bench with hand tools rather than machine &Electrical tools. It should be understood that the terms bench work and vise work mean the same thing; the latter, strictly speaking, is the correct term, as in most cases the work is held by the vise, while the bench simply provides an anchorage for the vise and a place for the tools. However, these terms are used almost equally. Today, work at the bench is not performed as much as formerly; the tendency, with the exception of scraping, is to do more and more bench work with machines.

- **Apply OHS Requirement**

a) using **personal protective devices**

- **safety shoes:** Safety boots are equipped with three safety measures. It must have:

1. Toes protection hood A steel hood to protect the toes from down falling heavy thing
2. A steel layer inside the soles protects the carrier from stepping into a turned up nail.
3. Benzene and oil resistant soles



Fig 1.1: safety shoes

- **goggles:** Necessary during chiseling and grinding work protects against chips sparking around from the work piece

- ***Helmet:*** *Protects the carrier from down falling items. It should be a must for everybody who works or moves on a building site.*



Fig 1.2: helmet

- leather gloves: Leather gloves are protective apparels used by workers. Leather gloves are available in various sizes such as 14”, 16” a,18” etc. Leather gloves are manufactured with Chrome tanned split leather. Chrome tanned split leather can withstand the roughness and at the same time provides softness and flexibility for

the hand to move in the gloves easily while working in machine shop. The demand for such leather gloves is increasing in line with the rapid industrialization .They are used in all factories, defense, railways and other power stations



- **Applying safety procedures and tools, equipment's & materials**

Safety is to protect our self, co-worker, tools, equipment's & materials from danger or risk.

- Safety at all times should be positive. You must know what to do, what to use, what to prevent & what guards in the work area.
- Don't test sharpened tools with your finger.
- Don't use a file without handle.
- Use wire brush to remove metal chips, don't use your bare hands.
- Use sharp materials /tools properly used.
- Keep work area free from un necessary item, that cause slipping hazards.
- Avoid touch any machines & tools without the recognition
- Heavy hammers should not be done on a bench vise.

1.1. Materials Selection

1.1.1. Electrical wire
1.1.2. Clamp
1.1.3. Conduits
1.1.4. Nail
1.1.5. Junction box
1.1.6. Switches
1.1.7. Sockets
1.1.8. Lamp
1.1.9. Connectors

The two metals which comes under Non-Ferrous metals are

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a) **Aluminum: -** is a lightweight metal with good formability. The pure metal is soft and weak but when employed with copper, magnesium and silicon or other metals, it becomes harder and stronger and is employed for various egg. Applications

Properties of Aluminum:

- It occurs in the form of oxide
- it has FCC structure
- High electrical & thermal conductivity.
- Aluminum is nonmagnetic and has the property of corrosion Resistance.

b) **Copper**

- It has good electrical conductivity
- Corrosion resistance
- It is ductile and having the property of malleability
- Good thermal conductivity



Wire Splicing and Soldering

The wires of electrical systems often need repair or extension. When repairing cables only the damaged section of cable can be replaced saving time and wire cost. To do this the bad section of wire needs to be removed and a new section spliced into its place.

when installing a new section of wire, or when adding a junction to a pre-existing system. Wire and cables must have strong mechanical connections that also provide good electrical conductivity. Poor electrical connections lead to arcing and may produce enough heat to start a fire in high power circuits. Poor connections in lower power systems, such as electronic devices can produce intermittent open or short circuits that are difficult to troubleshoot and repair.

When using the soldering iron make sure to follow some simple rules to ensure safe practice and good solder joints. A good solder joint requires sufficient heat to cause the solder to flow and bond properly. Too cool of a temperature will not melt the solder and produces a dull, crystallized joint. All parts of a solder joint should be clean and free of contamination. Always clean and tin the tip of your soldering iron. Tinning a soldering iron means coating the tip of the soldering iron with a thin film of solder. This will allow maximum heat transfer from the soldering iron to the joint.

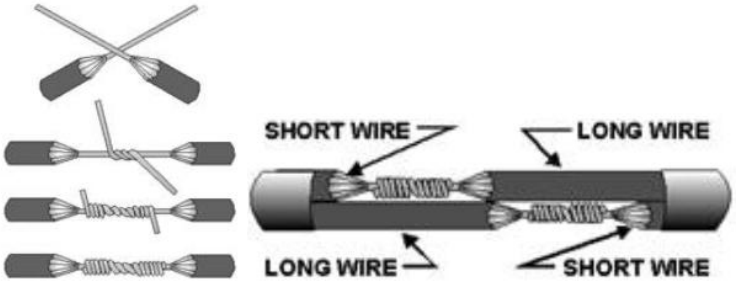
When soldering you are melting metal in order to create a bond and electrical connection

between two parts. This is why you should always practice good safety. Safety glasses should be worn at all times in order to minimize metal or other objects from entering the eye. When you are not using the soldering iron be sure to put it in its holder reduce chances of being burned chances of being burned and creating a fire hazard

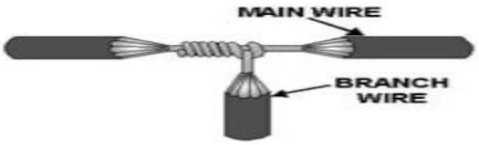
Procedure

1. Put on safety glasses, they should be worn for the entire time in the lab. Plug in the soldering iron and put it in its holder.

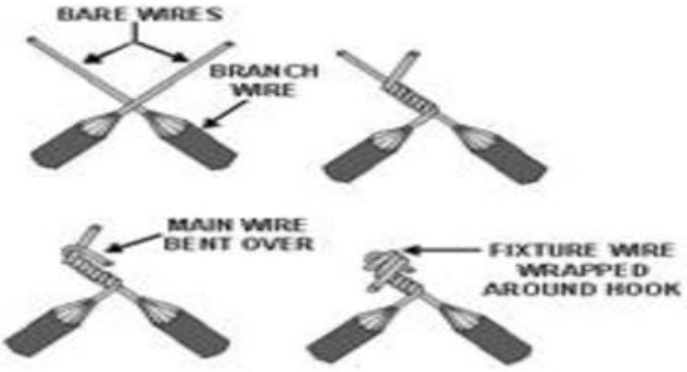
2. Strip two pieces of wire and perform a Western Union splice as seen below. Remember there should be 5-10 turns per side.



3. Strip two pieces of wire and perform tap splice as seen below.



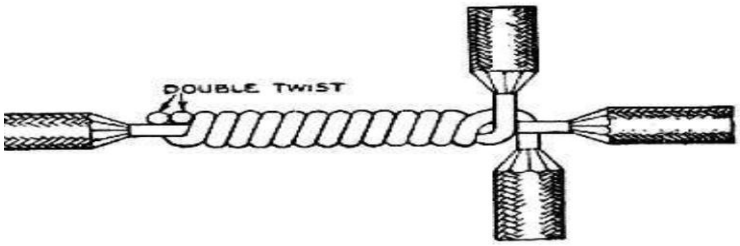
4. Strip two pieces of wire and perform the rat tail splice



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Duplex cross joint

This is a two-tap wire turned simultaneously an heavy tensile stress d is used where the two tap wire is under



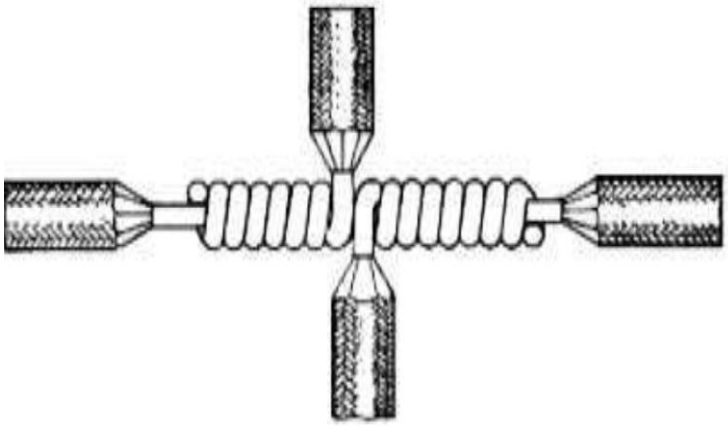
Western Union Short-tie Splice

This is the most widely used splice or joint in interior wiring installation to extend the length of wire from one point to another.



Cross joint.

• **The same application is done** as in plain tap and the only difference is that this tap is a combination of two plain taps place side by side with each other.



Soldering

Soldering is a process used for joining metal parts to form a mechanical or electrical bond. It typically uses a low melting point metal alloy (solder) which is melted and applied to the metal parts to be joined and this bonds to the metal parts and forms a connection when the solder solidifies. It is different to welding in that the parts being joined are not melted and are usually not the same material as the solder

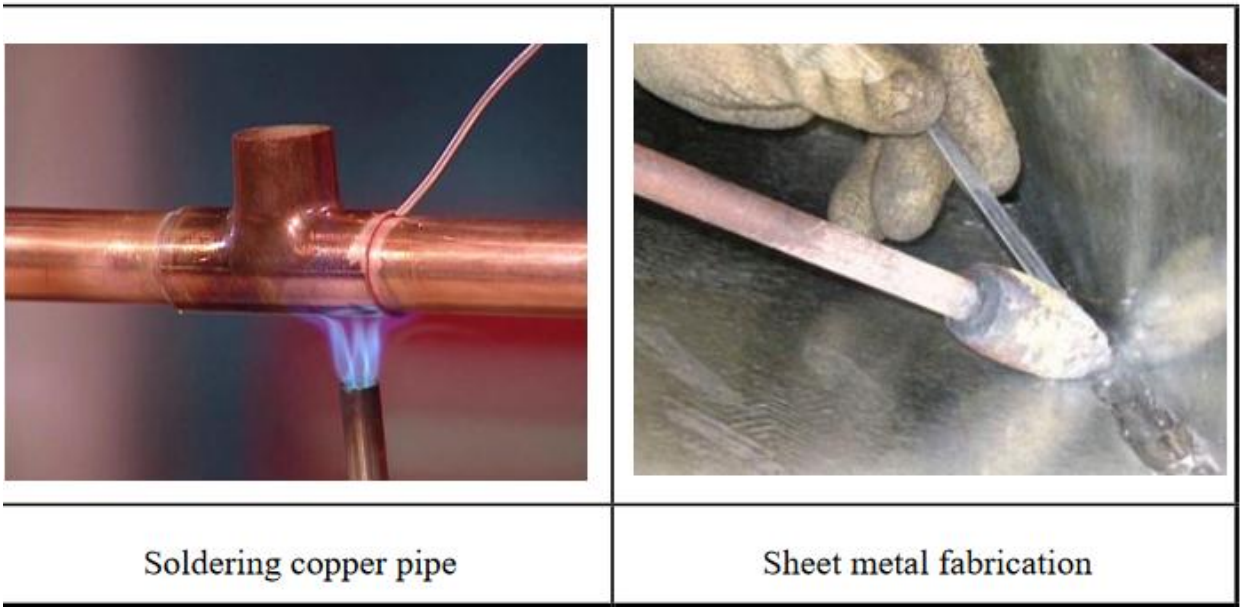


Fig-1.2.1 soldering copper pipe& sheet metal fabrication

Soldering is a common practice for assembling electrical components and wiring. Although it can be used for plumbing, sheet metal fabrication or automotive radiator repair the techniques and materials used are different to those used for electrical work. This document is intended to provide guidance on the safe working methods and proper tools and techniques for soldering of electrical component

Soldering Printed Circuit Boards

Soldering may be used to join wires or attached components to a printed circuit board (PCB). Wires, component leads and tracks on circuit boards are mostly made of copper. The copper is usually covered with a thin layer of tin to prevent oxidization and to promote better bonding to other parts with solder. When soldering bare copper wires they are often “tinned” by applying molten solder before making a joint.

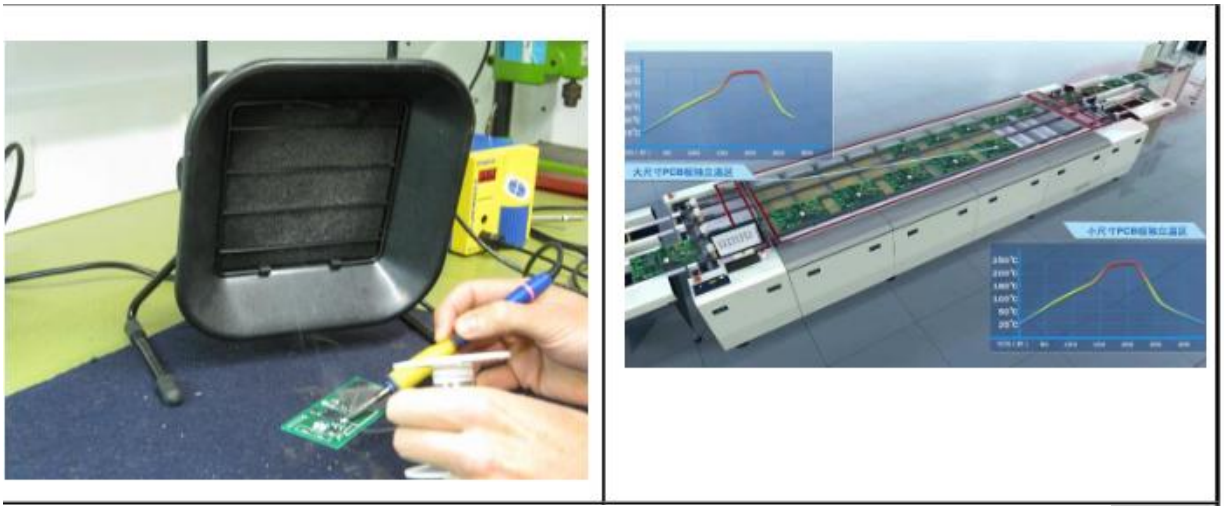


Figure 1.2 – Different Types of PCB Soldering

1.2. Bench work tools and equipment

1.2.1. The Bench work Equipment

The prime requirements for a machinist’s bench are that it should be strong, rigid, and of the proper width and height that the work can be performed conveniently. Correct height is important, and this will depend on the vise type used, that is, how far its jaws project above the bench. The location of the bench is important. It should be placed where there is plenty of light.

A great variety of tools is not necessary for bench work. They may be divided into a few general classes:

I Clamping tools

A) Vises A vise is a clamping device, usually consisting of two jaws that close with a screw or a lever, that is commonly attachable to a workbench; it is used for holding a piece of work firmly. There is a great variety of vises on the market, and they may be classed as follows:

- Blacksmith
- Machinist (plain, self-adjusting, quick-acting, or swivel)
- Combination
- Pipe

The machinist’s vise shown in Figure 1-1 is usually provided on machine shop workbenches. Several types are provided; some of their features are parallelism, swivel action, and quick-

acting jaws.
These vises will withstand terrific abuse and are well adapted for a heavy and rough class of work.

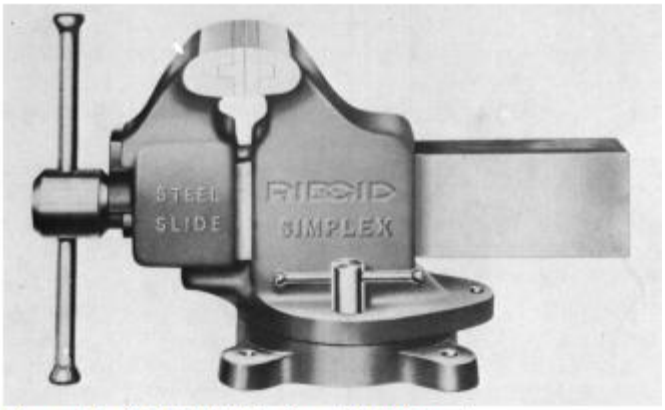
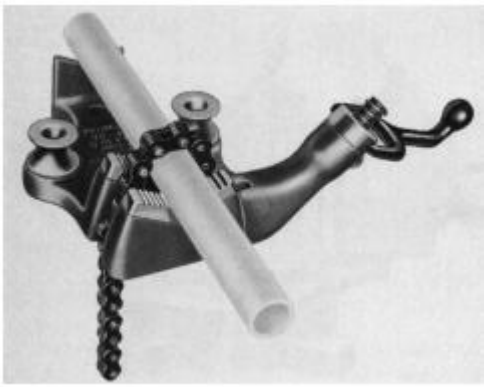


Figure 1-1 Machinist's vise. (Courtesy Ridge Tool Company.)



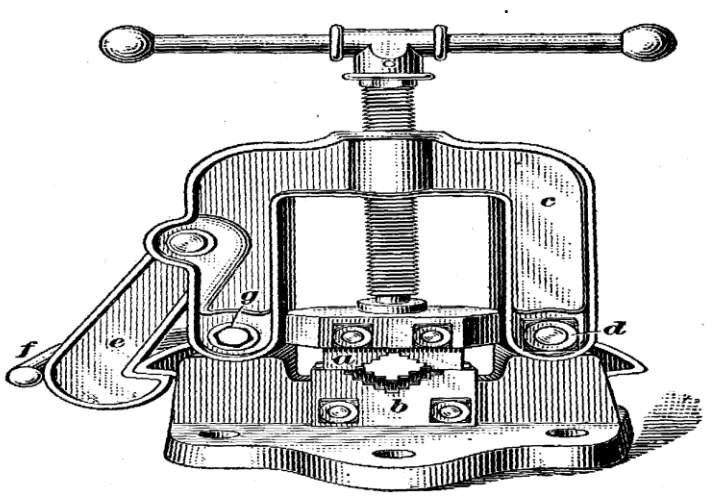
B. Hand vice :-used to grip very small objects. These are made in different shape and sizes. Commonly used hand at the bottom. A spring is provided between two legs. The jaws may be adjusted from a flange nut.



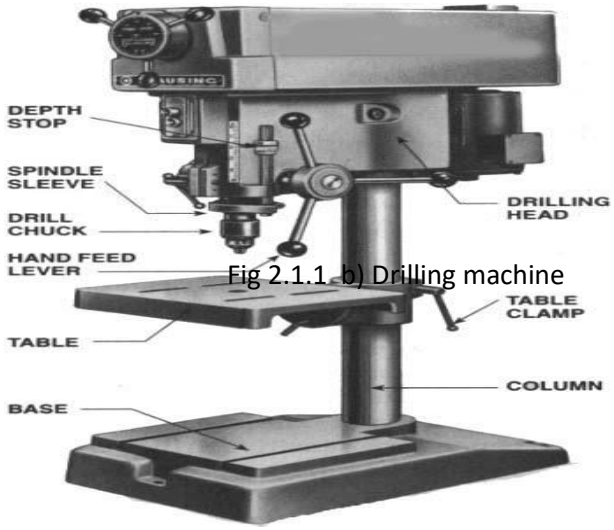
C, **pin vice**: - pin vice is used to hold wire or small diameter rods. It is also used for grinding small drills. It consists of a small chuck made up to tools steels and a mild steel handle.



D, **pipe vice: -** it is used to hold pipes. It consists of a vertical screw with guard threads. A handle is attaché on the top of the screw. A movable jaw is fixed on the lower end of the screw.



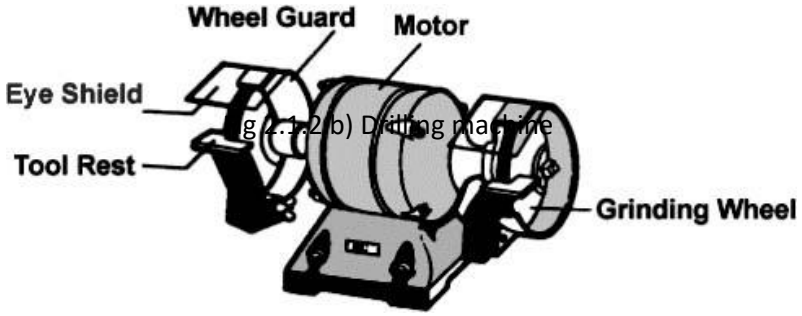
II. Drilling machine: - A drilling machine is a tool used to make holes in metal, wood, or concrete. The drill has to be fitted with a drill bit, which does the boring. The drill provides the power.



. Fig 2.1.1. b) Drilling machine

5. Grinding Machine

In the fields of production and maintenance, bench and pedestal type grinding machines are used which are equipped with two grinding wheels, mostly of a different grain size.



1.2.2. g 2.1.2 b) Drilling machine

Bench work hand Tools

a) Hammers :- Hammers find frequent use in bench work. Machinist's hammers may be classed with respect to the peen as follows:

b) File :-File is used throughout the industry wherever metal must be removed rapidly and finish is of secondary importance. They include flat, hand, round, half-round, square, pillar, three-square, warding, knife, and several less commonly known kinds of files. Most machinist's files are double-cut.



Fig 2.1.2 b) File

Uses of file should be used in perfect horizontal position. Most of the file their teeth pointing for ward. The pressure should be applied on the forward.

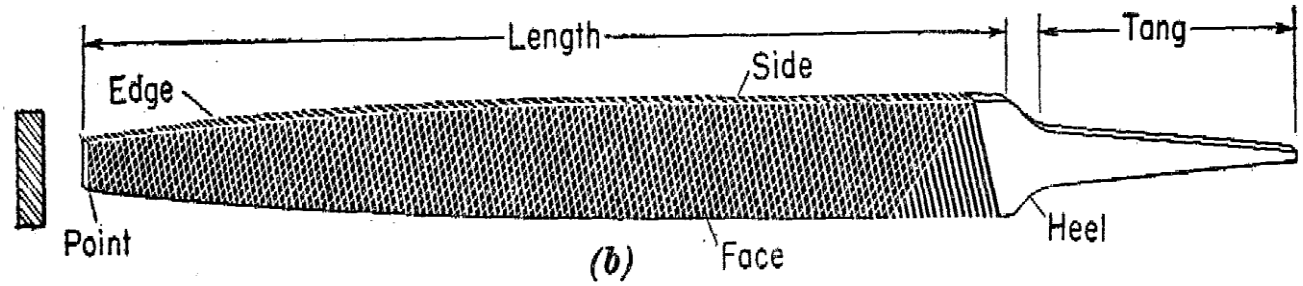


FIG. 44. NAMES OF FILE PARTS

Parts of file

- **The tang**: - is a pointed or ends of file which fit in to the handle.
- **The point**: - is the end opposite of a tang.
- **The heel**: - is next to the handle or a tang.
- **The edge**: - is the side of a file which has no teeth.
- **Teeth**: - is the cutting edge of a file surface.

Uses of file should be used in perfect horizontal position. Most of the file their teeth pointing forward. The pressure should be applied on the forward.

- **Hand File** - The common file used for roughing and finishing. It is rectangular in cross section and parallel in width. It has double cut teeth on both faces, single cut teeth on one edge, and one save edge.



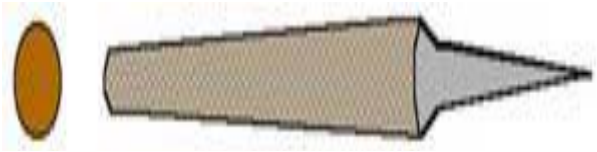
Hand File

- . **Half-round File** – The cross section is a chord of circle with its taper towards the tip. It is used for forming radii, grooves, etc. Its flat side is used for finishing flat surfaces.



Half-round File

- . **Round File** - This is a round shaped cross section file with tapering toward the end. It is used for enlarging holes and producing internal round corners. It usually has double cut teeth in the larger sizes, and single cut teeth for the smaller sizes.



Round File

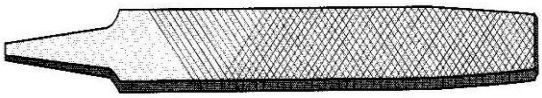
- **Square File** - This is a file with square in section and taper towards the tip. It usually has double cut teeth on all four faces. It is used for filing rectangular slots or grooves.



Square File

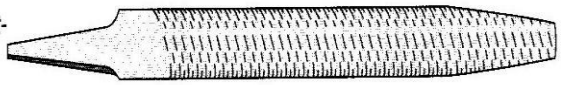
- **Three Square File** - It is also known as triangular file. It is triangular in cross section with taper towards the tip. It has double cut teeth on both faces. It is used for filing corners or angles less than 90°.





Flat file
Coarse, general-purpose file for smoothing wood and sharpening tool blades and scrapers.

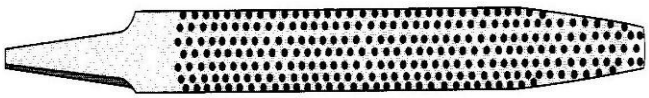
Half-round file
Features both flat and curved cutting faces for smoothing similar-shaped surfaces.

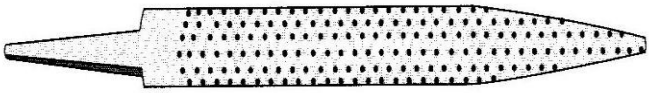




Triangular file
Used to clean out angles, cut grooves or notches, and sharpen tools; available with coarse or fine teeth and in various sizes from 6 to 10 inches.

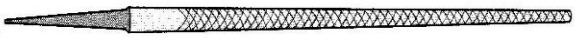
Patternmaker's rasp
Used for shaping irregular surfaces; similar in profile to the half-round file. Its teeth provide smoother cutting than with a standard rasp.





Concave rasp
Staggered rows of teeth on this knife-shaped rasp allow it to cut smoothly on concave surfaces.

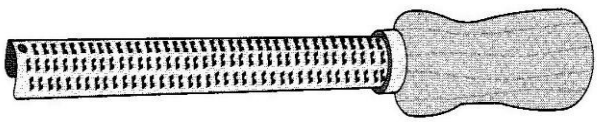
Round file
Also known as a rat-tail file; used for filing tight curves and smoothing or enlarging holes. Tapers toward the tip.



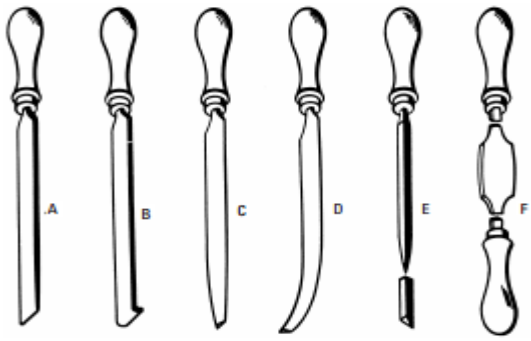


Needle rasp
Ideal for detailed shaping work and carving; typically about 6 inches long and available in a variety of shapes.

Planer rasp
Useful for shaping curved surfaces; its stamped tubular blade cuts with rasp-like action, but allows debris to pass through perforations without clogging. Different profiles are available.



6. **Scrapers:-**Scraping is the operation of correcting the irregularities of machined surfaces by means of scrapers so that the finished surface is a plane surface. Although it is impossible to produce a true plane surface, scrapers are used to approach a plane surface, or for truing up a plane surface. Scrapers are also used for truing up circular surfaces such as bearings.



Chisel: - this is used for chipping away the material from the work piece. This are made up of high carbon steel. Generally 6" to 8" long.

Chipping:- is the process of cutting metal with **chisel**.

Chisel: - this is used for chipping away the material from the work piece. This are made up of high carbon steel. Generally 6" to 8" long. This top is flattened and a sharp cutting edge is made on the bottom side.

Types of chisel

There are **four** types of cold chisel are commonly used in metal works shop.

- **Flat chisel** used for general work cross cut chisel of half round chisels are used for grousing and diamond point chisels is used for precision work.



- **Diamond point chisel:-** is used for **V- shaped groves**& corners.
- **Cape chisel:-** is used for chipping **key ways**& cutting **rectangular grooves**.
- **Round nose chisel:-** is used for producing **round**& semicircular grooves**& inside round corner surfaces.**

- **Striking tools**

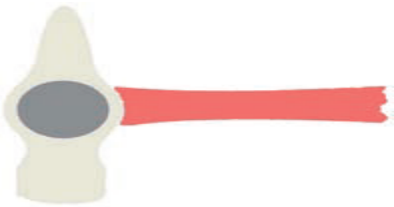
- Hammers:-are only tools generally used for striking in fitting shop. These are used for chipping, fitting punching etc a hammer consists of a heavy iron body with a wooden handle.

The common types are:-

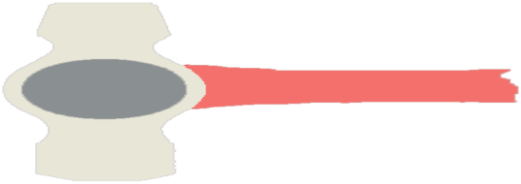
- **Ball pen hammer:-**is used for **general purpose** of work. It is also used for riveting. A hammer consists of a **heavy iron body** with a wooden handle.



- **Cross pen hammer:-**this hammer inside curves for bending or stretching metals. The larger striking surface is the face & the smaller end is peen.



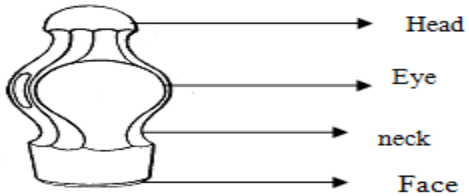
- **Straight peen hammer:-** is used for stretching the metal by hammering or by Full erring



- **Mallet hammer:-** is used to strike **finished surfaces** with out causing damage or to position the work piece



- **Claw hammer:-** is used to drive nails in to woods. It is used only for driving & pull Nails



III **Different parts of hammer** **Measuring and**

marking tools

a) Try-square

It is used for checking squareness of two surfaces. It consists of a blade made up of steel which is attached to a base at 90o. The base is made up of cast iron and steel try square is also used for marking right angle and measuring straightness of surfaces.



b) Combination square

It is a multipurpose instrument that can be use a level, miter, and try square.





c) Scriber

it made up of height carbon steel and hardened from the front edge. It used to marking line.



d) Center punch

it is like dot punch except the angle of the punching end is 90o. it is used to make the center of the hole before drilling.

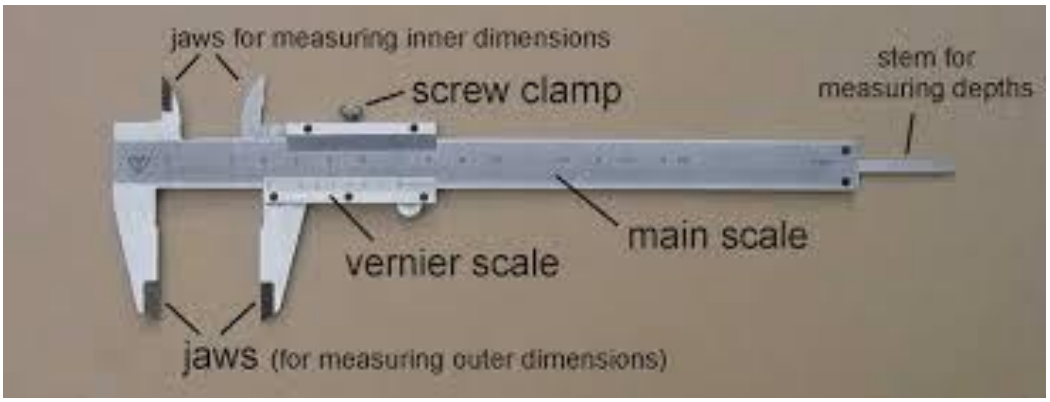
e) Steel rules:

these are made up of stain less steel are available in many sizes ranging from ½ ft to 2ft. these are marked in inches or millimeters.



f) Venire caliper:-

venire caliper is a precision instrument used for measuring length and diameter. it can be used for measuring external and internal dimensions**.**



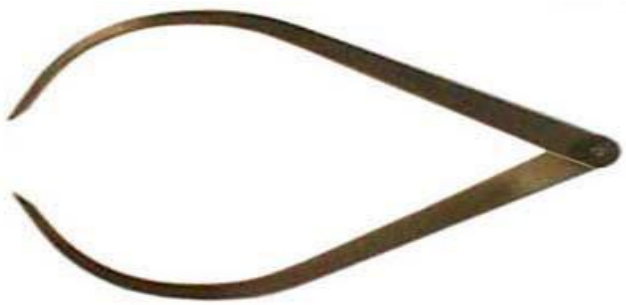
Venire caliper: - venire caliper is a recession instrument used for measuring length and diameter.

III (a) Parts of venire caliper

- **Outside jaw:-**is used to measure external diameter or width of an object.
- **Inside jaw/ear**:- is used to measure internal diameter of an object.
- **Main scale**:- is used to scale marked every millimeter, inches & fractions.
- **Venire scale/movable scale:-** is gives interpolated measurements to the division of 1/10, 1/20, 1/50mm etc.
- **Depth gauge**:- is used to measure depth of an object or a hole.
- **Locking screw**:- it is tighten & loosening of the sliding parts.

Two types of calipers

– **Outside calipers,** as shown in are used for measuring external dimensions such as the length, diameter, or even the thickness of a solid



Inside calipers, as shown in are used for measuring internal dimensions such as the diameter of a hole, or the width of a slot, etc.



It can be used for measuring external and internal dimensions. It consists of a graduated bar of rectangular section. It has two jaws one is movable with a small venire head and the other is fixed.

A fine adjustment nut is also attached to the head. The dimension is measured by the jaw and is indicated on graduated bar. Minimum dimension that can be expressed on vainer caliper is 0.001 or 0.02mm generally. The material of the part is stainless steel.

- **Divider**:- these are a made up of steel. Dividers have two legs having sharp feet. These are hinged at the top. It is used for marking arcs dividing a line or transferring the dimensions. The blade should be tightened sufficiently.



Scriber: - It made up of height carbon steel and hardened from the front edge. It used to marking line.

Dot punch: -It used for marking dotted line. It made up of high carbon steel or high speed steel one end is sharpened.



H. **Center punch**: - it is like dot punch except the angle of the punching end is 90o. it is used to make the center of the hole before drilling.

IV Cutting tools

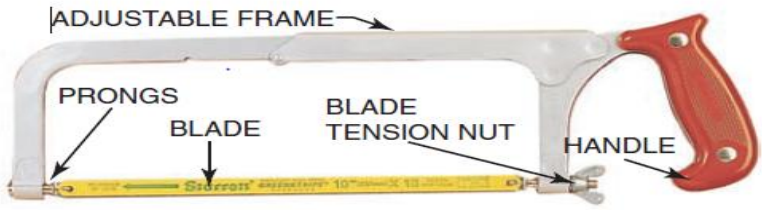
The tools which are used to remove the material are known as cutting tools.

- **Hacksaw**: it used for cutting of rods, flats etc. The blade of the hack saw is made up of high carbon steak or high carbon steel and the frame is made from mild steel. The blade is placed inside the frame. The teeth of saw blade are generally forward cut.

3. Cutting tools: - the tools which are used to remove the material are known as cutting tools.

Hacksaw: it used for cutting of rods, flats, conduit, pipe, heavy size cable etc

The blade of the hack saw is made up of high carbon steak or high carbon steel and the frame is made from mild steel. The blade is placed inside the frame. The teeth of saw blade are generally forward cut.



Types of hacksaw frames

There are two types of hack saw frames

a. Fixed frame
b. Adjustable frame

In fixed frame only one the type of blade is where as in adjusted frame, can be increased or decreased as per requirement and the blade from 8 to long can be used in to.

Use of hack saw the material to be cut with hack. Saw is clamped in to vice and mark that material the handle of hack saw is held in right hand and the left hand is kept on the frame start sawing at the marking, keeping the blade slightly inclined to the horizontal. The hack saw should be moved perfectly straight and horizontal.

Care of hack saw, the following precautions should be observed. While using hacksaw.

1, Always move the hacksaw in perfect straight and horizontal direction

2, Never tile (intend) the frame while sawing.

3, while cutting thin section wooden piece must be clamped along with the work piece.

4, Don’t use a new blade in the cut made be another blade.

Dipper: - it is generally used for measure the inside and outside diameters. It is made different sizes and shapes.

It consists of two bent legs connected at one end by means of rivet or bolts. The edge are made to just touch the job. The dimension is with the help of steel rules.

Self check-1

Short answer

1. Explain at least three types of bench vice?
2. What is the use of combination square?
3. Describe methods of reading veneer caliper?
4. List parts of veneer caliper?
5. Explain inside and outside caliper

.

Unit Two: Cut, chip and file flat, rectangular or round blocks

This unit to provide you the necessary information regarding the following content coverage and topics:

- Clamp work pieces
- Cut Work pieces
- dull hacksaw blades
- bench work operations

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Clamp work pieces
- Specify Cutting Work pieces
- Replace broken or dull hacksaw blades
- Perform bench work operations

2.1 . Clamp work pieces

2.1.1. Concepts of clamping

Once work piece is located, it is necessary to press it against locating surfaces and hold it there against the force acting upon it. The tool designer refers to this action as clamping and the mechanisms used for this action are known as clamps. It is necessary that the work should be properly and securely held on for machining operations, a VISE is an effective work holding device.

Vises: Vises are the most common appliances for holding work on table due to its quick loading and unloading arrangement.

Types of work holding devices

- **Bench vice**

A bench vise is like an extra hand and is a common tool found in any shop or garage. It is attached to a workbench and its purpose is to hold material steady, allowing you to use both hands to work on the material with other tools. They are ideal for sawing, sanding, planing, drilling, screwing, soldering and more.

- **Bench Vice**
- **with Swivel Base**

There are mainly three types of vises commonly used:

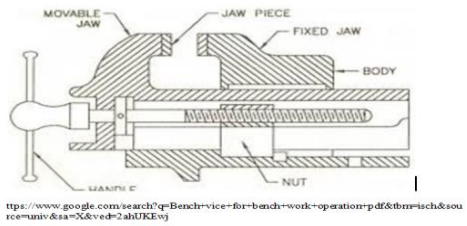
- Plain vise
- Swivel vise
- Tool makers universal vise

1 Removable hardened alloy steel jaw inserts.

2 Completely enclosed center screw.

3 Attractive hammered enamel finish *Machine vice*

bench vice



ttps://www.google.com/search?q=Bench+vice+for+bench+work+operation+pdf&tbm=isch&source=univ&sa=X&ved=2ahUKEwj



Figure 1 Bench Vises

- **V-block**

V-block is rectangular or square block with a V-groove on one or both sides opposite to each other. The angle of the 'V' is usually 90^0. V-block with a clamp is used to hold cylindrical work securely, during layout of measurement, for measuring operations or for drilling for this the bar is faced longitudinally in the V-Groove and the screw of V-clamp is tightened. This grip the rod is firm with its axis parallel to the axis of the v-groove

- **C-Clamp**

This is used to hold work against an angle plate or v-block or any other surface, when gripping is required. Its fixed jaw is shaped like English alphabet 'C' and the movable jaw is round in shape and directly fitted to the threaded screw at the end .The working principle of this clamp is the same as that of the bench vice.

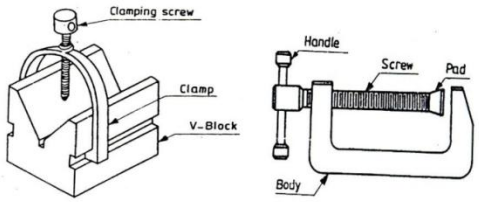


Figure 2.2 V-Block C- Clamp

Cut Work pieces

2.1.1. Introduction to Cutting metals

Sawing is the process of cutting metal stock that is impractical to use a file, a chisel or a machine with a multi-point cutting tool called a hand hack saw. A hand hack saw can also be used for cutting off a jammed bolt, pipes, tubing and rods for special or custom fittings on the job (on the field work).

Some of the most common tools used to cut metals are **hacksaws**, **band saws**, **cold chisels**, **bolt cutters, tin snips, and abrasive saws**. Large stock is sawed, while bar stock is either sawed or cut with a cold chisel. Sheet metal is usually cut with metal snips. In fabrication facilities, large amounts of metal are cut with horizontal band saws or metal shears, commonly called "ironworkers. Layout tools are used to measure and mark metal stock before cutting, shaping, and doing other types of work with cold metal.

- **Saws**

Saws are used to cut material that is not needed away from material which is. Saw blades have alternate teeth bent out or 'set' in opposite directions. This is so that when they cut, they make a gap, called the kerfs. The kerfs must be wider than the saw blade so that the blade cannot get stuck. When using a saw, you should always cut to the waste side of the marked line so that you leave a small amount for finishing by either sanding or filing. Whatever you are cutting, it is important to keep as many teeth in contact with the piece being cut as possible. You should choose the correct saw for the type of material you are using. Table 2.3 on the next page shows the most common types of saws used in school workshops.

2.1.2. Cutting process

The saw is moved from the right to left and shows how the chip is formed. The cutting process is the result of the horizontal cutting direction and the pressure on the work piece. The angle of the teeth enables the saw to cut the material effectively. The teeth are set (bent out) that they do not get jammed in the cut.

Steps to Follow in Making the Cut with a Hacksaw

Place the metal to be cut in a vise and mark it. The mark should be placed near the jaws, especially if the metal is thin. It may be necessary to use boards between the vise jaws to prevent scarring the work. Mark over the original mark with a file.

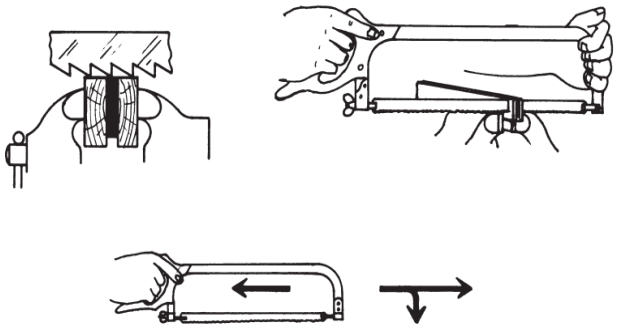


Figure 2.2.1 Using a hack saw

Depending upon the direction of cut, blades are classified as:

- ✓ Forward cut
- ✓ Backward cut.

Depending upon the pitch of the teeth (Distance between the two consecutive teeth) blades is classified as:

- ✓ Coarse (8-14 teeth per Inch)

- ✓ Medium (16-20 teeth per inch)
- ✓ Fine (24-32 teeth per inch)

- **Parts of a hacksaw**

1. Saw frame
2. Handle protector
3. Handle
4. Tang
5. Blade holder
6. Blade
7. Pins
8. Wing-Nut
9. Pins

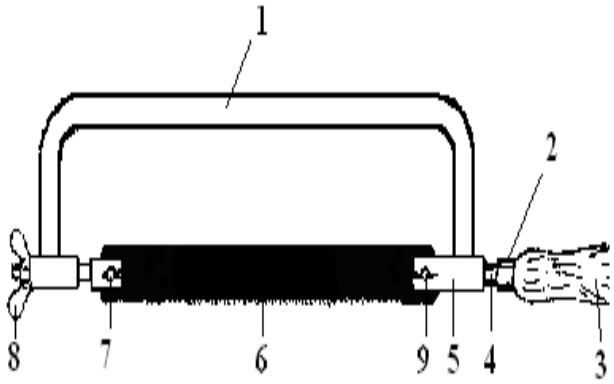


Figure 2.2.3 Parts of hack saw

- **Types of blades for hacksaws**



One side toothed

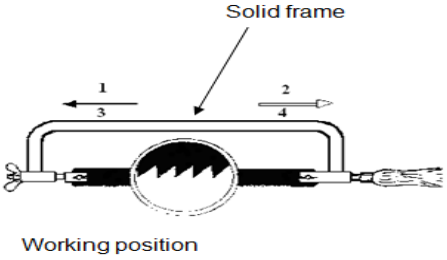


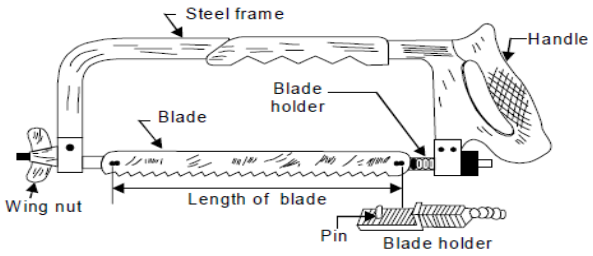
Both sides toothed.

How to handle a hacksaw?

1 and 3 indicate the forward stroke with pressure

2 and 4 the backward stroke without pressure the circle shows the direction of teeth (facing the front of the hacksaw) all strokes should be in a straight line and along the whole length of the blade.

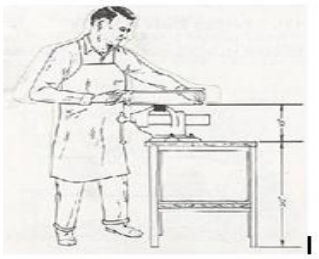




Non- adjustable frame (fixed frame)

Aadjustable frame

The work piece must be clamped to allow free movement when sawing. Left-handed people clamp their work to the right of the vice and right-hander people to the left.



Working Position

Body position when sawing.

Figure 2.2.4. Working position

Table2.2.2. Saw teeth for different materials

No of teeth /inch	Functions
14	For solid sections of soft materials
18	Suitable for general use. Solid sections of soft materials and large sections of hard materials (e.g. alloy steel)
24	Small solid sections, between 3 and 6 mm(e.g. heavy tubing and sheets)
32	For sections less than 3 mm thick

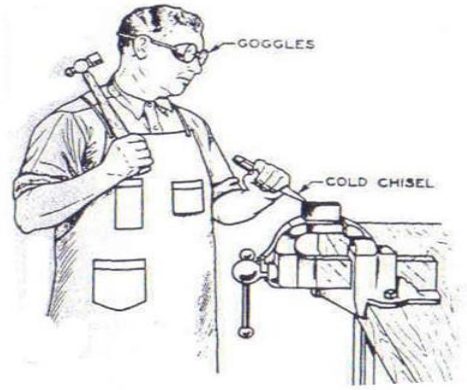
Note: At least three consecutive teeth should be in contact with the material. If the material is soft and has a large section, use a blade with few teeth per 25 mm (14 or 18 teeth per 25 mm) Use a fine-tooth blade when cutting a fairly thin section.

Hacksaw blades are made of high-speed steel.

There are two types: all-hard and flexible. The difference between the two is that the all-hard snaps easily, and it is therefore not recommended for school work. The blades come in the following lengths: 200, 250 and 300 mm. They are also available with 14, 18, 24 and 32 teeth per 25 mm for cutting different materials

2.1.3.Chipping

Removing the metal with a chisel is called chipping and is normally used where machining is not possible. While chipping, safety goggles must be put on to protect eyes from the flying chips. To ensure safety of others, a chip guard is placed in position. Care should be taken to see that the chisel is free from mushroom head.



Proper body position when chiseling and holding the hammer

Figure 2.2.5 Proper body position when chipping

- **Types of chisels:**

These are sometimes referred to as cold chisels because they are used to cut cold metals. They are made of cast steel or alloy steel, with a hardened and tempered cutting edge.

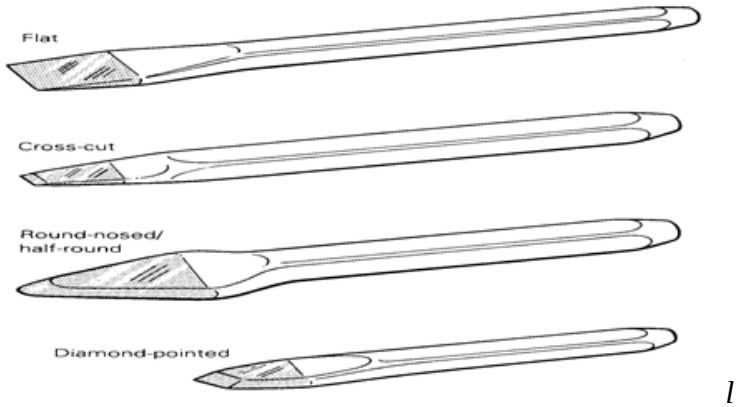
The common types of chisel (Figure 3.8) include:

1. **The flat chisel**: used for general-purpose chiseling;

2. **The cross-cut chisel**: used for cutting grooves such as keyways, and for chipping;

3. **The half-round-nosed chisel**: used for cutting grooves (which are either curved or half-round);

4. **The diamond-pointed chisel**: used for working into corners and cutting small grooves.



l

Figure2.2.6 Common types of chisel

- **Filing**

Filing is a method of removing metal, and the file (Figure 3.9), which is the most widely used hand tool in the school workshop, is used for this cutting operation. It is made of carbon tool steel containing about 1.3 per cent carbon.

- **The Main Parts**

A file is a hand cutting tool made of high-carbon steel, having a series of teeth cut on the body by parallel chisel cuts. The parts of a file are shown in figure. 3.9. Files are used to remove surplus metal and to produce finished surfaces.

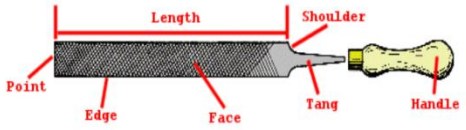


Figure 2•The Main Parts

2.2.Dull hacksaw blades

2.2.1. The blades of hack saw break or dull .

As a blade becomes dull, the kerf (slot made by the blade) becomes narrower. If you try to continue the cut in the same slot, the new blade will usually bind and be ruined in the first few strokes. If possible, **rotate the work and start a new cut on the other side**

2.2.2 Bench work operations

Bench work operations for the manual mill often occur before and after the machining of part. These operations are commonly performed on a standard workbench with the Part secured in a **vise**, or secured to the worktable depending on the operation. Bench work operations involve processes that allow the work piece to achieve the accuracies specified by the blueprint. These operations require operator skill and attention to detail.

Follow safety and correct working procedures to perform bench work operations. Bench work operations performed prior to machining include the following: Layout Cutting: in the metal work shop materials (especially metals) are cut to shape before filing. There are numerous types of cutting operations.

- ✓ Points to watch when using the hack saw:
    1. Hold the work securely in the vice.
    2. Grip the hack saw firmly, using both hands.
    3. Use the same stance as filing.
    4. Use the full length of the blade.

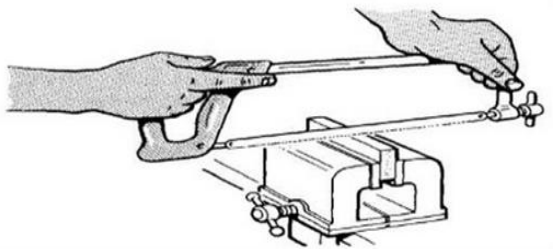


Figure 3 Sawing operation

Chipping operation

- ✓ chipping metal (chiseling)

Chiseling is one of the methods of cutting materials.

-you can chip the metal to produce grooves or to reduce the width or thickness.

Procedures to chip metal:

1. hold the metal in the vice
2. Hold the chisel at an angle of about 45^0 to the work.
3. Hammer to remove the chip.
4. Filing: is a method of removing metal.
5. Filing: is a skill that is difficult to learn. It is not easy to explain how to use a file.

Self-Check-2

Instructions I*:*

Answer all the questions listed below. Illustrations may be necessary to aid some explanations

1. write the Types of scrappers
2. Identifies the methods of filing system.
3. write the types of files based on their shapes:

Instructions II*:*

From the following alternative question choose the correct answers

1. depend up on the shapes of scraper which one of them are uncludeded

A. Flat scraper B. Half round bearing scraper C. Triangular scraper D. all of them are included.

2. Removing the metal with a chisel is called _____

A. Chipping B. Filling C. Drilling D. all

3. Half round bearing scraper used to _____

A. used for scraping curved and cylindrical surface split bearings, big bush bearings

B. Used for scraping curved surfaces, holes and bores. Specification is by length

C. Used for removing metal from flat surfaces.

D. all

.

Unit Three: Drill, ream and lap holes

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Drill, ream, spot-face and lap Hole

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Drill, ream, spot-face and lap Hole
- Perform drill, ream and lap Hole operations

.

3.1 Drill, ream, spot-facing and lapping hole

In order to make a macro-scale hole on a solid surface, a series of different machining processes are carried out depending on the finish and tolerance level requirement. One typical series of hole production can be

(i) Centering,
(ii) Drilling,
(iii) Boring,
(iv) Reaming, and
(v) Honing.

The Centering is performed to locate the hole center, drilling is carried out to originate a hole and boring is carried out to enlarge the hole diameter. Reaming and honing are carried out to improve the finish of the hole surface at different levels and to improve the dimensional accuracy and tolerance.

Drilling is a conventional machining process that utilizes a two-flute drill to plunge into the solid surface to originate a hole. Diameter of the hole is limited by the drill diameter; in fact, they are equal. Sometimes to enlarge the hole diameter, boring is carried out after drilling. Both of these processes offer bulk removal that indicates high material removal rate (MRR). However, neither drilling nor boring can provide high levels of dimensional accuracy and surface finish. For improving surface quality and tolerance level, reaming is sometimes carried out after drilling or boring. Sometimes very high accuracy and tight tolerance are required for assembly purposes, particularly in press fit or leak-proof joining.

Reaming process utilizes a multi-point cutter (called reamer) to remove very small volume of material to improve upon dimensional accuracy and tolerance. Since reaming smoothens the hole surface, so a hole is prerequisite for reaming, and thus drilling must be carried out prior to reaming. As usual reaming produces better surface finish as compared to drilling. Following sections elaborate various similarities and differences between drilling and reaming.



Typical metal cutting drills
(Marox Tools Industrial Co. Ltd.)



Typical reamers
(Shenzhen Bwin Precision Tools Co. Ltd.)

Figure 3.1 Drill, ream

3.1.2 Differences between drilling and reaming

Drilling	**Reaming**
Drilling is performed to originate a hole on a solid surface.	Reaming is performed to finish internal surface of an existing hole.
Drilling is the first step of hole making. After drilling either boring or reaming can be carried out depending on the requirement.	Reaming can be carried out only if a hole exists. So reaming is performed only after drilling (or boring).
Cutting tool used in drilling operation is called Drill.	Cutting tool used in reaming operation is called Reamer.
Metal cutting drill usually consists of two cutting edges. So drill is considered as a double point cutting tool.	Reamer contains large number of cutting edges (minimum 4). So reamer is a multi-point cutting tool.
Surface of a drilled hole is not highly finished (i.e. high surface roughness).	Reaming is performed to highly finish (i.e. reducing the roughness) the internal surface of the holes.
Tight tolerance cannot be obtained by drilling operation alone. Sometimes tight tolerance is required	Reaming can easily provide tight tolerance.

for assembly, especially for press fit applications.	
Axial length of hole can be easily increased by drilling operation.	Axial length of the hole cannot be altered by reaming. Only diameter of the hole can be increased slightly.
Material Removal Rate (MRR) in drilling is significantly higher.	MRR in reaming operation is comparatively lower.

3.2.1 Drill press

A drill press is typically used to drill holes of varying sizes into materials like wood, plastic, and metal. Often, holes are made in preparation for screws or other fasteners. A drill press consists of a motor that spins a spindle with an attached chuck. The chuck secures the drill to the spindle. While the drill is spinning, the user rotates a handle which lowers the drill into the material. The user has fairly fine control over the depth and speed of the drill. A drill press can be safely used by a person who is tall enough to comfortably reach the material table and handle, and is able to physically support and secure the material to the table. The motor provides the power to cut the material, not the operator. Though some strength is required, good technique and proper set up are the keys to using a drill press safely and effectively

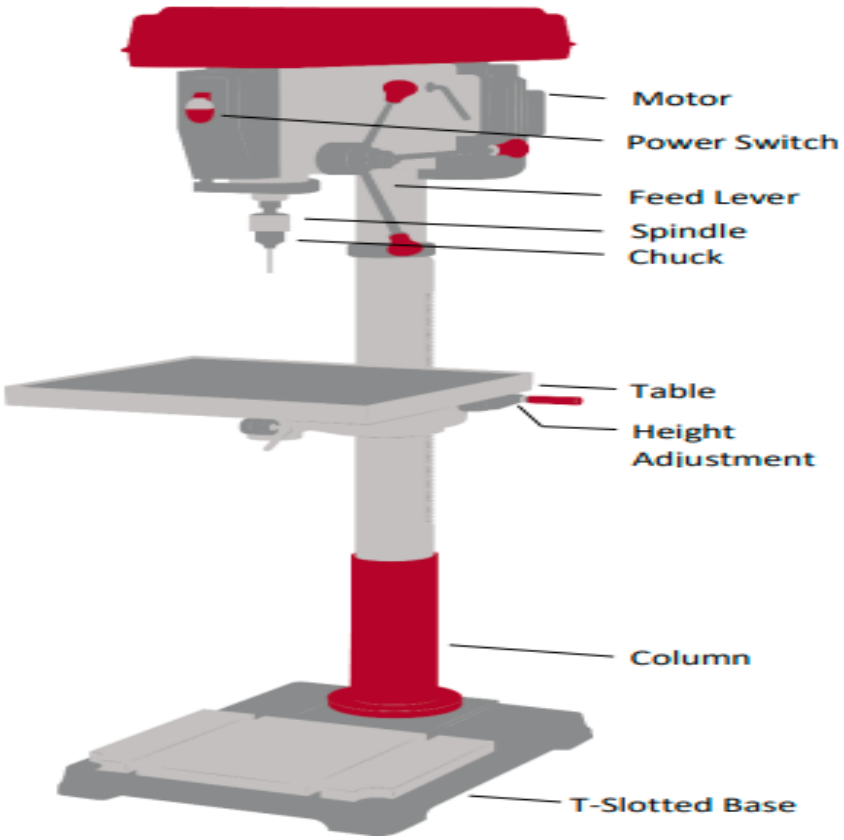


Figure **3.2 drill press**

3.2.2 HOW TO USE: Drill press

1. Mark the center of desired hole on material
2. Select drill bit of desired size from drill index.
3. Attach drill bit to drill press by loosening chuck, tightening it around drill bit, then securing it with the chuck key. Insert drill bit as far as possible leaving the flutes of the drill bit completely exposed.

Decide how the material will be fixture (held in place) on the table. Common methods include using a drill-press vise, c-clamps, or holding the part securely by hand.

a. Cylindrical material can be held in a drill press vise to keep it from rotating. The vise is then held by hand or clamped to the table.
b. b. Small pieces of any shape can be held in a drill-press vise, which is then secured to the table by hand or with a clamp.
c. Large pieces can be held by hand as long as the piece is big enough to hold securely
d. Small or hard to hold pieces can be clamped to the table.

e. Small pieces of any shape can be held in a drill-press vise, which is then secured to the table by hand or with a clamp
f. Large pieces can be held by hand as long as the piece is big enough to hold securely
g. Small or hard to hold pieces can be clamped to the table

4. Adjust height of table so drill will travel the desired distance into the material.
5. Check that you have secured clothing, jewelry, hair, etc. that will get close to the machine.
6. Turn on drill press
7. Check to see that drill bit is not wiggling. Turn off machine and re-install drill bit if needed
8. Lower handle to drill hole to desired depth. For deep holes, lower and raise the drill at intervals to clear the chips from the drill bit
9. Raise handle to remove drill bit from material and turn off drill press
10. Unclamp material and clean up chips
11. Remove drill bit and replace in drill index.

Self-check-3

Test-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point

A	B
3. Centering	a. carried out to originate a hole
4. drilling	b. performed to finish internal surface
5. Reamer	c. performed to locate the hole center

Operation sheet 3

Practice applications for drill pressed

Purpose: To practice and Operation

Title: Procedures drill pressed steps

Demonstrate the knowledge and skill required how to uses drilling press

- Instruction: your Trines' is gives sheet metal or plastic for sample with follow as measurements. Depend up on the instruction Apply the following procedure.

Safety Guidelines for Operating a Drill Press:

- Always use safety goggles
- Remove the chuck key and replace in storage area after tightening chuck
- Always check that the cutting edge of the drill bit is sharp and undamaged
- Avoid getting the bit jammed or the part heating up by clearing the hole in sections
- Check that the material is fixture securely
- Never touch an active drill bit
- Never wear gloves near the active drill
- Wear a mask when operating for long periods of time or working with harmful material
- Immediately lift drill and turn off machine if the bit becomes loose

Lap Test: 3

1. Specify desired hole, select appropriate drill bit
2. Install drill bit into drill press chuck
3. Use key appropriately and put away
4. Determine appropriate fixture for material to be drilled and secure material
5. Drill-press vise

6. Clamp to table
7. Drill a blind hole
8. Drill a through hole
9. Remove the drill bit and replace in the drill index.

.

Unit Four: Cut threads using tap and stock and die

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Cut thread
- Cut thread tap sequence
- thread cut operations(using personal protective devices)

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Cut thread
- Follow Cut thread tap sequence
- Perform thread cutting operations (using personal protective devices)

4.1Cutting thread and fit gage system

Another one of the most commonly used methods for producing or cutting threads is with the use of a die. Dies can be used in lathes, screw machines and CNC lathes to produce both internal and external threads by cutting or by rolling. When using a die, there are several thread chasers that cut the thread then back away from the work to permit fast removal of the tool.

Dies: are made either of high-carbon steel or of high-speed steel. Unlike taps, dies are used for cutting external (male) threads. There are three types (Figure blow). The circular split die is a circular piece with a split across one of the flutes. The split is provided to enable small adjustments to be made, using three set screws in the stock. The half die comprises two loose pieces, which are held in the stock. There is a small screw on the stock for adjustment. The die nut has a hexagonal body. This type, strictly speaking, does not cut new threads but is used to 'clean up' threads that are damaged.

Taps and dies: Screwing is a temporary method of fastening parts together. Methods for cutting screw threads include the use of the center lathe. For bench work, however, taps and dies are used.

Taps: These are the tools used for cutting internal (female) threads. They are made of high-carbon steel or high-speed steel. The tap has a shank with a square end to take the tap wrench or holder. The shank is smaller than

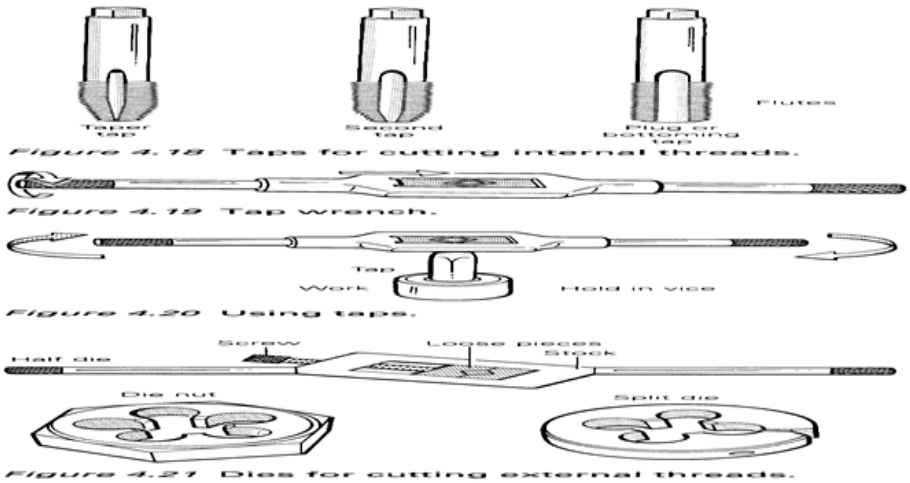


Figure 4.1Taps

The procedure for cutting external threads is as follows.

Square the end of the work and chamfer it (using a file, grinding machine or center lathe) for an easy start. Grip the die, held in the stock, firmly and squarely on the work. Turn clockwise, about a quarter-turn, and ease back to remove chippings.

Apply a good supply of oil (lubricant).
Make adjustments of the screws after making a full cut until the depth required is achieved.

- **Care and maintenance is important:**
- Do not use either the stock or the die as a hammer; the threads may be broken.
- Remove the die from the stock after every thread cutting, clean them and pack them into their boxes.
- Use plenty of oil during cutting to reduce friction.

4.1.1 Perform the Sequence of tapping

Tap Drill Size: Before a tap is used, the hole must be drilled to the correct tap drill size. This is the drill size that would leave the proper amount of material in the hole for a tap to cut a thread. When a chart is not available, the tap drill size for the ISO (International Standards Organization) thread can be found easily by applying this simple formula:

$$TDS = M - P$$

TDS = tap drill size
M = metric diameter of the tap
P = pitch of the thread in millimeters

4.1.2Hand Tap:

A tap is a cutting tool used to cut internal threads. Normally it's made of high-speed steel (HSS). Hand taps are usually made in sets of three, because it is better to distribute all the cutting work during the thread−process to three taps.

No. 1 (taper) tap: 1 ring on shank

No. 2 (plug) tap: 2 rings on shank

No. 3 (bottoming) tap: without ring

The most common taps have two or three flutes in order to form the cutting edges, transport the chips out of the hole and give way for the lubricant. The end of the tap is square so that a tap wrench can be used to turn it into a hole.

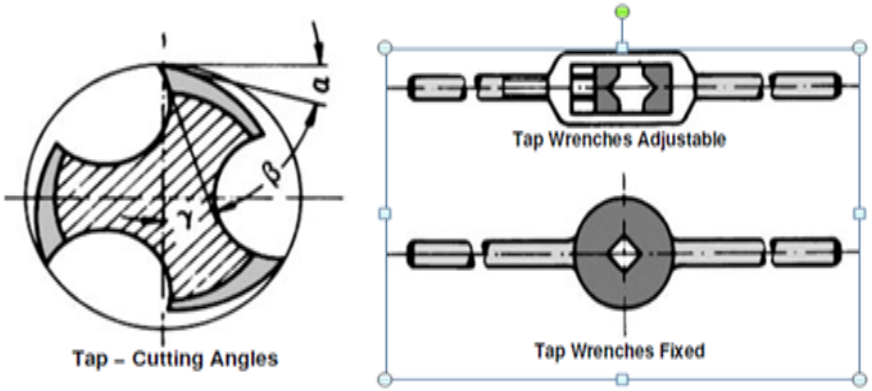


Figure 4.2 Hand Tap.

4.1.3Tapping of Hole:

Before a tap is used, a hole must be **drilled** in the work piece to the correct tap drill size. The tap drill size (T.D.S.) is the size of the drill that should be used to leave the proper amount of material in the hole for a tap to cut threads. Then **countersink** both sides of the hole.

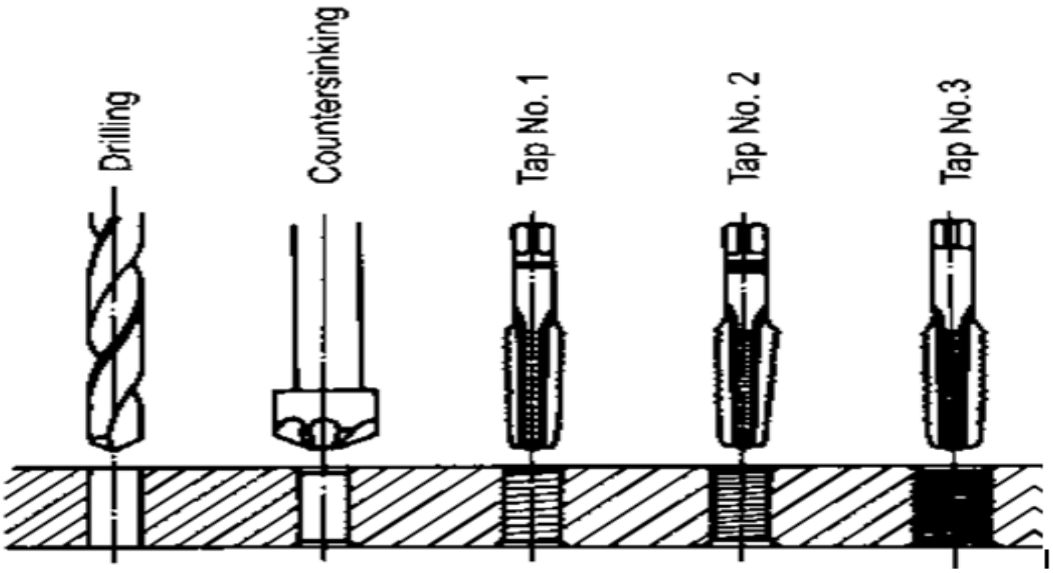


Figure 4.3 Tapping of Hole

Working Steps for Hand Tapping

1. Select the correct size and type of tap for the job (blind hole or through hole).
2. Select the correct tap wrench for the size being used.
3. Use a suitable cutting fluid (No cutting fluid for brass or cast iron).
4. Place the tap in the hole as near to **vertical** as possible.
5. Apply equal down pressure on both handles, and turn the tap clockwise (for right-hand thread) for about two turns.
6. Remove the tap wrench and check the tap for squareness. Check at two positions 90 degree to each other.
7. If the tap has not entered squarely, remove it from the hole and restart it by applying slight pressure in the direction from which the tap leans. Be careful not to exert too much pressure in the straightening process, otherwise the tap may be broken.
8. Turn the tap clockwise one−half turn and then turn it backward about one−quarter of a turn to break the chip. This must be done with a steady motion to avoid breaking the tap.
9. Turn the die forward one turn, and then reverse it approximately one half of a turn to break the chip .Apply cutting fluid frequently during the threading process.

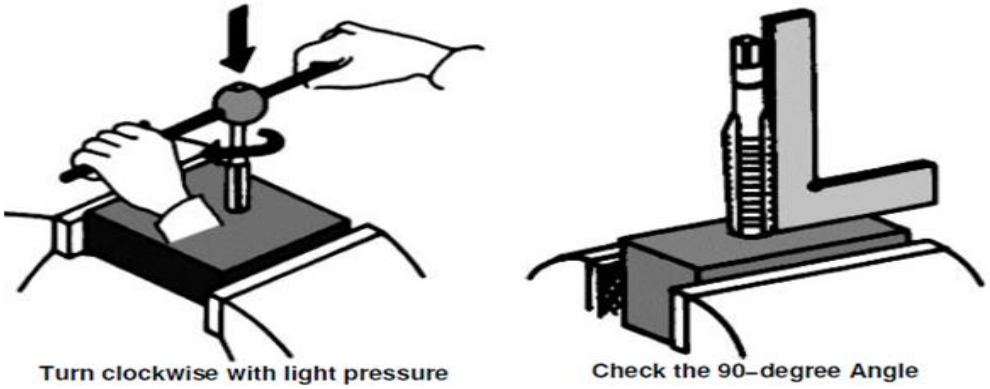


Figure 4.5 Working Steps for Hand Tapping

4.1.4Threading Dies

A threading die is used to cut external threads on round work pieces. The most common threading dies are the adjustable and solid types. The round adjustable die is split on one side and can be adjusted to cut slightly over or undersized threads. It is mounted in a die stock, which has two handles for turning the dies onto the work. The solid die, cannot be adjusted and generally

used for re cutting damaged or oversized threads. Solid dies are turned onto the thread with a **special** diestock, or adjustable wrench.

Table of Drill sizes

Metric	Pitch mm	Drill Ø mm		UNC	TPI	Drill Ø mm		UNF	TPI	Drill Ø mm
M 3	0.50	2.5		1/4“	20	5.1		1/4“	28	5.5
M 4	0.70	3.3		5/16”	18	6.6		5/16”	24	6.9
M 5	0.80	4.2		3/8”	16	8.0		3/8”	24	8.5
M 6	1.00	5.0		7/16”	14	9.4		7/16”	20	9.9
M 8	1.25	6.8		1/2”	13	10.8		1/2”	20	11.5
M 10	1.50	8.5		9/16”	12	12.2		9/16”	18	12.9
M 12	1.75	10.2		5/8”	11	13.5		5/8”	18	14.5
M 16	2.00	14.0		3/4”	10	16.5		3/4”	16	17.5
M 20	2.50	17.5		7/8”	9	19.5		7/8”	14	20.4
M 24	3.00	21.0		1”	8	22.25		1”	12	23.25

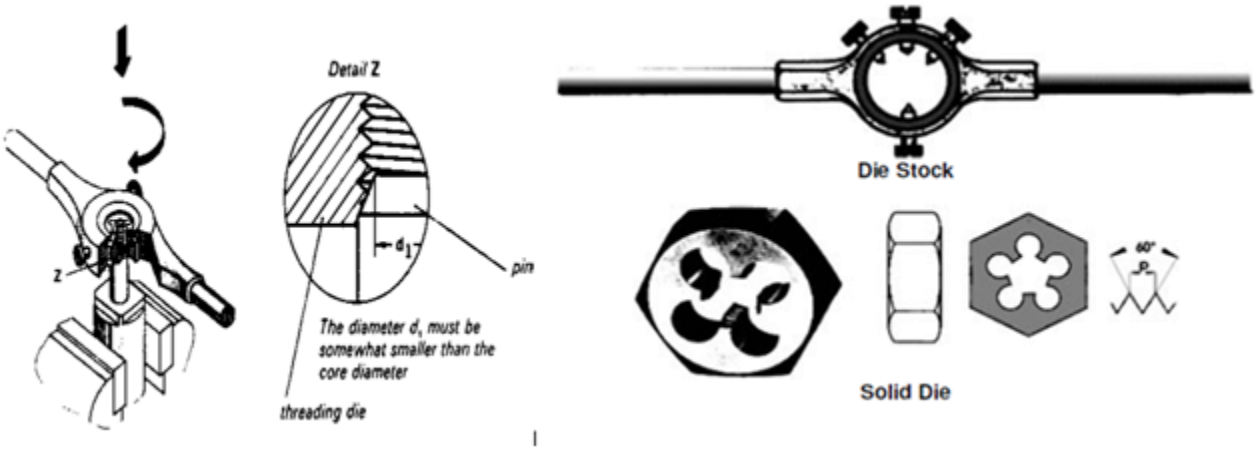


Figure 4.6 Threading Dies

4.2.5. Thread with a Hand Die Working Steps

The threading process requires the machinist to work carefully to produce usable parts and avoid damage. The following describes the procedure to be used.

Chamfer the end of the work piece with a file or on the grinder. Consider that a 3/4” thread requires a bolt with an outside diameter of 3/4”.

Fasten the work piece securely in a vise. Hold small diameter work short to prevent it from bending.

Select the proper die and die stock.

Lubricate the tapered end of the die with a suitable cutting lubricant.

Place the tapered end of the die squarely on the work piece.

I. Apply down pressure on both die stock handles and turn clockwise several turns.

Check the die to see if it has started squarely with the work.

II. If it is not square, remove the die from the work piece and restart it squarely, applying slight pressure while the die is being turned.

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Self-Check -4

Directions: choose the best answer for the following question (1 point each):

1. Removing the metal with a chisel is called_____

A. Scrapping
B. Filling
C. Chipping
D. All

2. Depend on the shapes of scraper which one of them are unincluded

A. Flat scraper B. Half round bearing scraper C. Triangular scraper D. all of them are included.

3. Half round bearing scraper used to _____

B. used for scraping curved and cylindrical surface split bearings, big bush bearings
C. Used for scraping curved surfaces, holes and bores. Specification is by length
D. Used for removing metal from flat surfaces.
E. all

Unit Five: - Off-hand grind cutting tools

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Hone(sharp) cut edges
- Sharpe cutter.
- Grind cutters.
- safety procedures

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Hone cut edges
- Use Sharpening cutter.
- Perform Grind cutters.
- Follow safety procedures

5.1 Perform Hone and Cutting edges.

Edge honing, also referred to as edge rounding or radiusing, stabilizes the cutting edge of cutting tools made from brittle materials such as carbide to greatly extend their flake and wear resistance. This increases cutting tool life to save you money, raises productivity by reducing tool changes and improves quality through better cutting action.

What is a cutting edge? It's Function, Sharpness, and Numbers Cutting edge is the intersection of two tool point surfaces. Cutting Tool is basically a wedge shaped device that actually removes (shears off) excess material from a preformed blank in order to obtain desired shape, size and accuracy**.**

What is Cutting Edge in Cutting Tool? It's Function, Sharpness, and Numbers Cutting edge is the intersection of two tool point surfaces. Cutting Tool is basically a wedge shaped device that actually removes (shears off) excess material from a preformed blank in order to obtain desired shape, size and accuracy. During machining or metal cutting operation, the cutting tool forcefully compresses a thin layer of material of the work piece and shears it off.

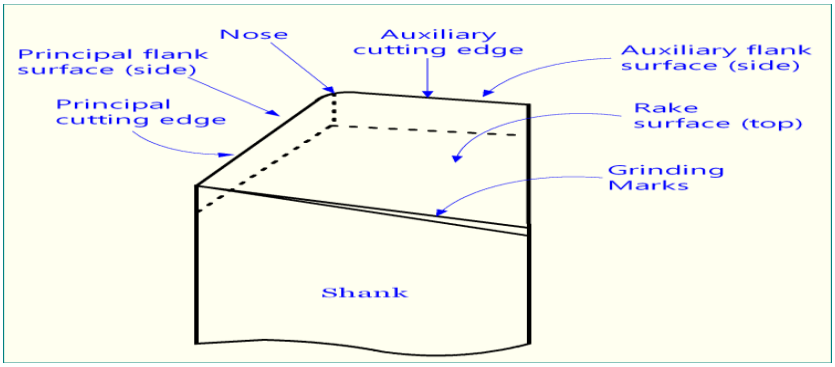
Every cutting tool consists of at least two surfaces, namely, rake surface and flank surface. Rake surface is the chip flowing surface; whereas, flank surface slides over the finished surface of the work piece. Intersection of these surfaces produces cutting edge.

5.1.1 Functions of cutting edge in machining

As the name suggests, the primary function of the cutting edge is to cut or shear off material in order to fulfill ultimate objective of machining. However, all cutting edges may not equally participate in cutting action. For example, in a turning tool, principal cutting edge usually removes material, whereas auxiliary cutting edge partially removes material only in some specific operations. In fact, a turning tool has two different cutting edges, as provided below.

Principal cutting edge: The intersection between rake surface and principal flank surface produce principal cutting edge. This cutting edge cuts material during machining.

- Auxiliary cutting edge: It occurs at the intersection of rake surface and auxiliary flank surface. It can also perform cutting action in some specific type of operations, such as thread cutting.



Schematic of representation a single point turning tool (SPTT) that indicates two cutting edges.

Does the cutting edge always straight**?** The cutting edge may or may not be a straight line. For example, for a single point turning tool (SPTT), the cutting edges are straight. Similarly, in milling cutter and drill, it is usually straight. However, if you consider abrasive cutters, it may not necessarily straight.

How sharp a cutting edge is? Can you directly measure sharpness? No! The sharpness of any physical object is indicated by edge radius and they are inversely proportional. That means, the small is the edge radius, the sharper it is. Therefore, theoretically, the maximum sharpness or minimum edge radius is limited to atomic radius of the material. You cannot go below it.

Although atom radius is too small (few nm), in high precision cutting tools, the cutting edges are sharp in that range. Edge radius of precision turning diamond cutter is 10 – 100nm, while that for micro-end mills is 1 – 5µm. However, in convention turning, milling, drilling, etc. cutters, the edge radius usually much higher, around tens of microns. It is worth mentioning that sharper tools need lesser cutting power for material removal but are very prone to catastrophic breakage.

5.2 Single point, double point and multi-point cutting tools

A cutting tool may have one or more cutting edges, and therefore, it can be classified into three categories those are

Single point cutting tools

Double point cutting tools:

multi-point cutting tools

Classification of cutting tools	
Single point cutting tool	Multi-point cutting tool
Single point cutting tool consists of only one main cutting edge that can perform material removal action at a time in a single pass. 1. Turning tool 2. Shaping tool 3. Planing tool 4. Slotting tool 5. Boring tool 6. Fly cutter	A multi-point cutting tool contains more than two main cutting edges that simultaneously engage in cutting action in a pass. 1. Milling cutter 2. Reamer 3. Broach 4. Hob 5. Grinding wheel 6. Hone

Single point cutting tools: these tools consist of only one cutting edge that can perform metal removal action at a time. Turning tool is the perfect example of a single point tool. Shaping, planning, slotting, boring tools are also single point tool.

Double point cutting tools: These tools have two cutting edges and both the edges can perform material removal action simultaneously. Drill is the only example for this category.

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Self-Check -5

Writing part

1. Write the three type of cutting tolls
2. Define cutting Edge
3. Write the difference B/N Single point cutting toll & Multi point cutting tolls

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MINISTRY OF LABOR AND SKILLS

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