Workshop & Technical Reports

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الرمز الكودي:	اسم المقرر: ورش وتقارير فنية	الفرقة / المستوى: 2
التخصص:	عدد الوحدات الدراسية	2 نظري 4عملي

2- هدف المقرر	**This course aims to:** • Declares the function of every tool in workshop • Illustrate the importance of engineering workshop and how itseffects on our life • Describes the mechanism of using tools and machines • Establishes a good knowledge to the fundamentals of engineering workshop
3- المستهدف من تدريس المقرر	Students for Technical Health Institutes
أ – المعلومات والمفاهيم	By the end of this course, the student should be able to: A1- Use the tools and operate the machines in the workshop. A2- List various measuring equipment. A3- Learn the accuracy of producing a product from the workshop. A4- Do the work an according to the manual of instructions and precautions.
ب – المهارات الذهنية	By the end of this course, the student should be able to: B1 - Recognize the tools used in the workshop and its functions. B2 - Learn the steps of finishing the work with specific accuracy. B3 - Make use of the available materials to make a good product.
ج – المهارات المهنية	By the end of this course, the student should be able to: C1 – Create a project with a specific dimensions and great accuracy. C2 – Cut a piece of metal or wood in a wanted shape. C3 – Make surface grinding to the piece of work. C4 – Use the suitable tools for every step during the production process. C5 – Take the safety measures when using sharp tools or machines.
د – المهارات العامة	By the end of this course, the students should be able to: D1- Write technical report. D2- Present scientific work. D3 - Work in a team.
4- محتوى المقرر	Chapter one: Hand processes Chapter two: Machining Processes Chapter three: Welding Chapter four: Engineering Metrology Chapter five: industrial safety

5 – اساليب التعليم والتعلم	4.1 – Lectures 4.2 - Assignments

4.3 - Project **4.4 - Site visit**	
Special care will be given for applicable and acceptable cases.	6- أساليب التعليم والتعلمللطلاب ذوى القدرات المحدودة
	7- تقويم الطلاب:
1. Assignments **2. Quizzes** **3. Midterm exam** **4. Site visit and/or Project** **5. Final exam**	أ- الأساليب المستخدمة
1. Assignments (1st to 13th week) **2. Quizzes (3rd, 8th, and 12th week)** **3. Midterm exam (6th week)** **4. Site visit and/or Project (14th week)** **5. Final exam (15th week)**	ب- التوقيت
1. Attendance and Participation (20) **2. Site visit and/or Project (40)** **3. Final exam (90)**	ج- توزيع الدرجات
- Introduction to Basic Manufacturing Processes and Workshop Technology, by RAJENDER SINGH - **https://www.google.com.eg/url?sa=t&source=web&rct=j&url=https://in.pearson.com/content/dam/region-growth/india/pearsonindia/Support/pdf/ECE_2017.pdf&ved=2ahUKEwjogZmJosPfAhUNaAKHbNQB7YQFjAJegQIBhAB&usg=AOvVaw1Mus_lSSXn9P7zMtJ9e6g**	8 – قائمة الكتب الدراسيةوالمراجع
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The course textbook.	ب – كتب ملزمة
-A Textbook of Production Engineering, by P C Sharma **-Pictorial Guide to Engineering Workshop Practice,** by H. Grisbrook, C. Phillipson **- MECHANICAL WORKSHOP PRACTICE,** by K. C. JOHN	ج – كتب مقترحة

1 Chapter

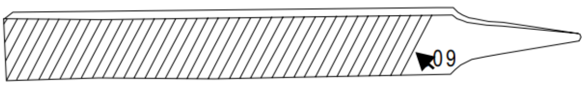
Hand processes

Overview

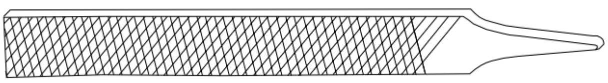
Hand tools are used to remove small amounts of material, usually from small areas of theworkpiece. This may be done because no machine is available, the workpiece is too large to go on a machine, the shape is too intricate or simply that it would be too expensive to set up a machine to do the work.Since the use of hand tools is physically tiring, it is important that the amount of material to be removed by hand is kept to an absolute minimum and that the correct tool is chosen for the task.Wherever possible, use should be made of the available powered hand tools, not only to reduce fatigue but also to increase the speed of the operation and so reduce the cost.

1.1 Engineer's files

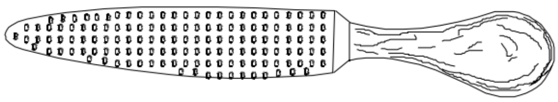
Files are used to perform a wide variety of tasks, from simple removal of sharp edges to producing intricate shapes where the use of a machine is impracticable. They can be obtained in a variety of shapes and in lengths from 150 mm to 350 mm. When a file has a single series of teeth cut across its face it is known as single-cut file, and with two sets of teeth cut across its face it is known as double-cut-file, Fig. 1.1.



(a) Single cut file



(b) Double cut file



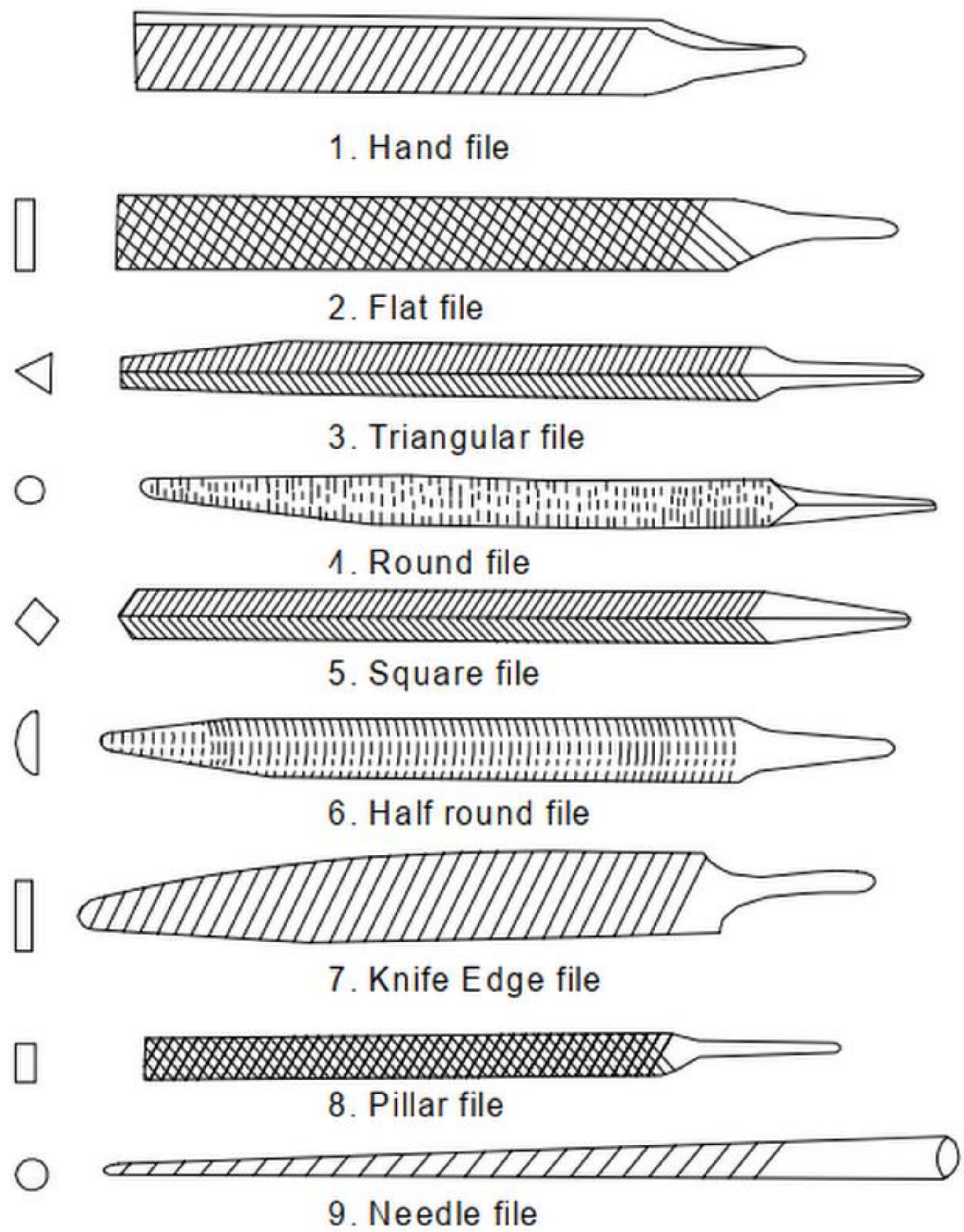
(c) Rasp cut file.

(Fig. 1.1)

The grade of cut of a file refers to the spacing of the teeth and determines the coarseness or smoothness of the file. Three standard grades of cut in common use, from coarsest to smoothest, are bastard, second cut and smooth. In general, the bastard it is used for rough filing to remove the most material in the shortest time, the second cut to bring the work close to finished size and the smooth cut to give a good finish to the surface while removing the smallest amount of material.

1.1.1 File identification

General classification of files based on shapes or cross sections are shown in Fig. 1.2 along with their uses are as under:

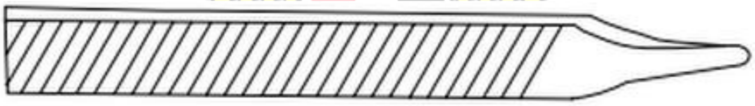


(Fig. 1.2): General classification of files based on shapes or cross sections

Types of file:

1.1.1.1 Hand file

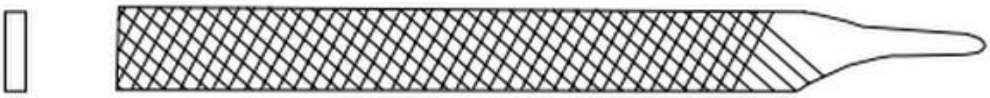
Hand files are commonly used for finishing surface work. Both faces of the file are doublecut. Either both edges are single cut or one is uncut to provide a safe edge.



(Fig. 1.3): Hand file

1.1.1.2 Flat files

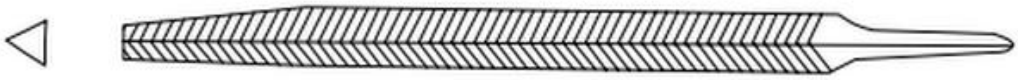
Flat files are generally used for filing flat surfaces in fitting shop.



(Fig. 1.4): Flat file

1.1.1.3 Triangular files

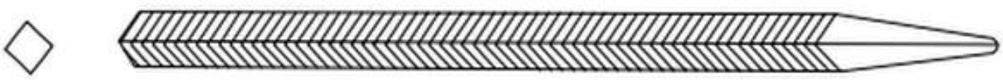
Triangular files are commonly used for filing corners between 60° and 90°. They aredouble cut on all faces.



(Fig. 1.5): Triangular file

1.1.1.4 Square files

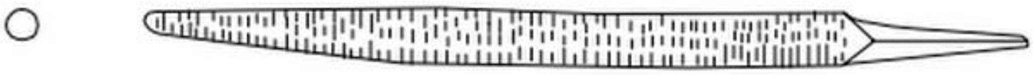
Square files are commonly used for filing in corners in jobs. They are double cut on allsides and tapers.



(Fig. 1.6): Square file

1.1.1.4 Round files

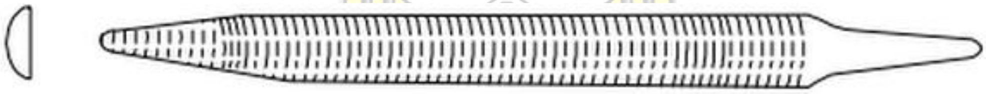
Round files are generally used for opening out holes and rounding inside corners. Rough,bastard, second cut and smooth files under 15 cm in length are single cut.



(Fig. 1.7): Round file

1.1.1.5 Half round files

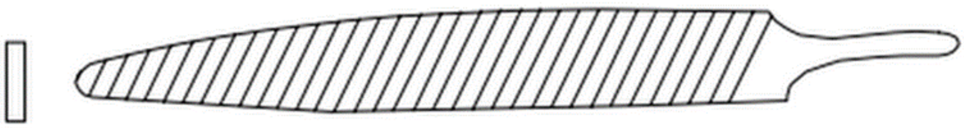
These files comprise of flat and half round sides. The flat side of half round file is usedfor general work and the half round side for filing concave surfaces. These files are doublecut on the flat side. The curved side is single cut, smooth or second cut.



(Fig. 1.8): Half round file

1.1.1.6 Knife-edge files

These files are commonly used for cleaning out acute-angled corners. The two faces ofthese files are double cut, while the edge is single cut. These files are made in sizes from10 to 20 cm of various shapes and cuts. They are extremely delicate and are used for finework such as pierced designed in thin metal



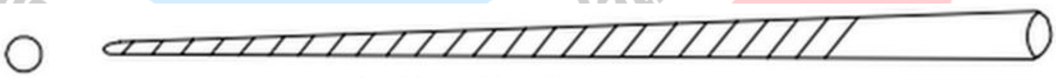
(Fig. 1.9): Knife-edge file

1.1.1.7 Mill files

Mill files are commonly used for filing half round recess and gullet of mill saw.

1.1.1.8 Needle files

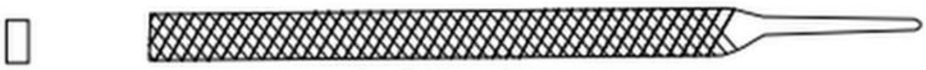
Needle files are generally used for filling keys tooth wheels of clocks and other curvedsurfaces.



(Fig. 1.10): Needle file

1.1.1.9 Pillar files

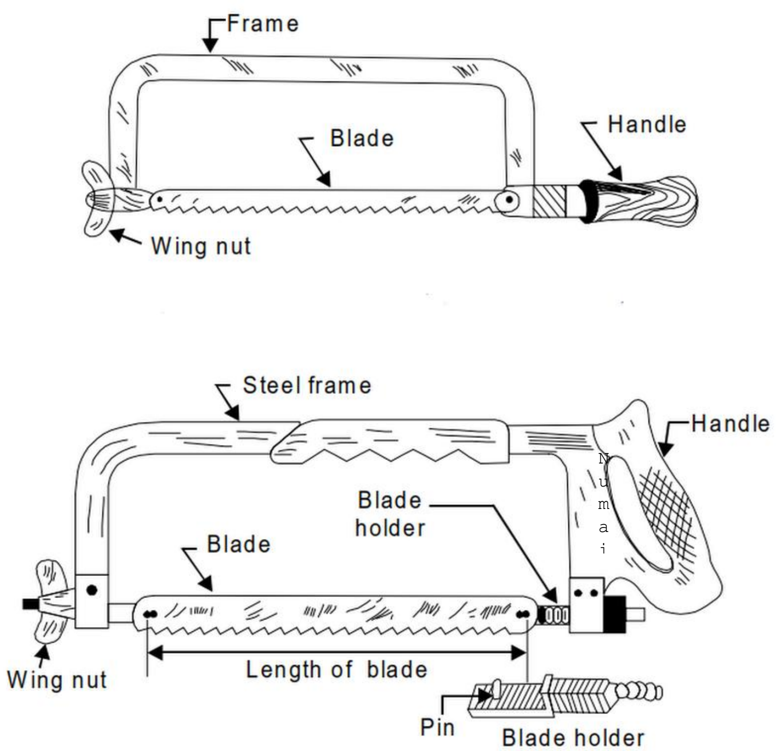
These files are used for finishing narrow slots. Both faces are double cut and either bothedges are single cut or one is uncut to provide a safe edge of the file.



(Fig. 1.11): Pillar file

1.2 Hand hacksaw

Hand hacksaws are made in two types namely a fixed frame and adjustable frame orientedas shown in Fig.1.11. The former possesses solid frame in which the lengthcannot be changed and whereas the latter comprises the adjustable frame which has a backthat can be lengthened or shortened to hold blades of different sizes. The hand hacksaws arecommonly used for sawing all soft metal. They consist of a frame, handle, prongs, tighteningscrew and nut, and blade as shown in figure. Its frame is made to hold the blade tightly.However,a power operated hacksaw can also be used for cutting raw materials in sizes in case ofcontinuous cutting generally occurring frequently in fitting or in machine shops.



(Fig. 1.11): a fixed frame and adjustable frame

The standard hacksaw blade is 300 mmlong×13mm wide×0.65mm thick and isavailable with 14,18, 24 and 32 teeth per 25 mm,i.e. for every 25 mm length of blade there are14 teeth, 18 teeth and so on.A hacksaw blade should be chosen to suit the typeof material being cut, whether hard or soft, andthe nature of the cut, whether thick section or thin.Two important factors in the choice of a blade arethe pitch, or distance between each tooth and thematerial from which the blade is made.When cutting soft metals, more material will becut on each stroke and this material must havesomewhere to go. The only place the materialcan go is between the teeth, and therefore if theteeth are further apart there is more space forthe metal being cut. The largest space is inthe blade having the least number of teeth,i.e. 14 teeth per 25 mm. The opposite is truewhen cutting harder metals. Less material willbe removed on each stroke, which will requireless space between each tooth. If less spaceis required, more teeth can be put in the blade,more teeth are cutting and the time and effort incutting will be less.When cutting thin sections such as plate, at leastthree consecutive teeth must always be in contactwith the metal or the teeth will straddle the thinsection. The teeth will therefore have to be closertogether, which means more teeth in the blade,i.e. 32 teeth per 25 mm.Like a file, the hacksaw cuts on the forwardstroke, which is when pressure should be applied.Pressure should be released on the return stroke.Do not rush but use long steady strokes (around70 strokes per minute when using high-speedsteel blades). The same balanced stance shouldbe used as for filing.Table 1.1 gives recommendations for the numberof teeth per 25 mm on blades used for hard andsoft materials of varying thickness.

Type	Number of teeth per inch	Uses
Rough	16-14	Sawing soft materials such as aluminum
Medium	22	Sawing construction steel, cast iron, non-ferrous medium hardness metals
Fine	32	Sawing hard materials such as tool steel

(Table 1.1)

1.2.1 The types of hacksaw

1.2.1.1 all-hard:

this type is made from hardened high-speed steel. Due to their all-throughhardness, these blades have a long blade life but are also very brittle and are easily broken if twisted during sawing. For this reason, they are best suited to the skilled user.

1.2.1.2 flexible:

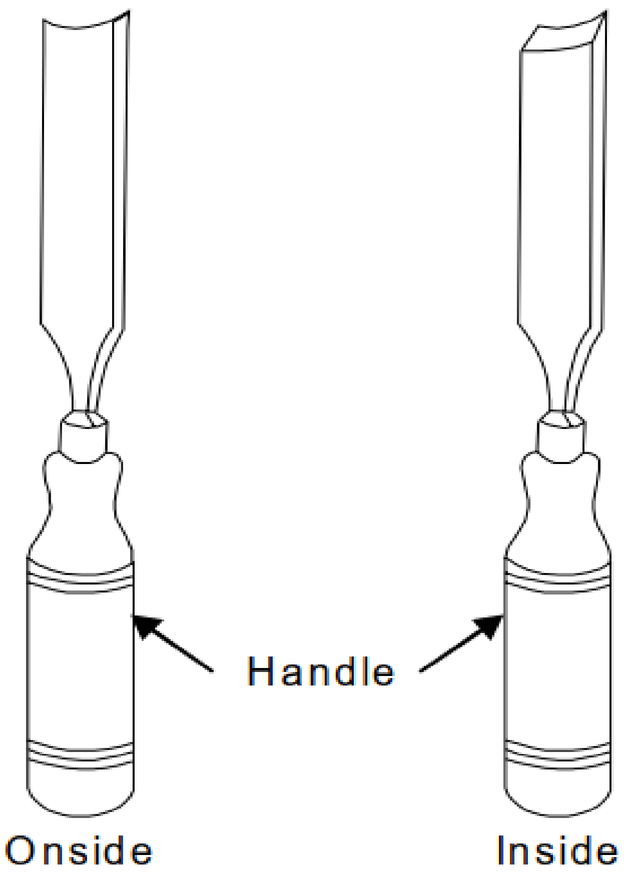
this type of blade is also made from high-speed steel, but with only the teeth hardened. This results in a flexible blade with hard teeth which is virtually unbreakable and can therefore be used by the less experienced user or when sawing in an awkward position. The blade life is reduced due to the problem of fully hardening the teeth only.

1.2.1.3 Bimetal:

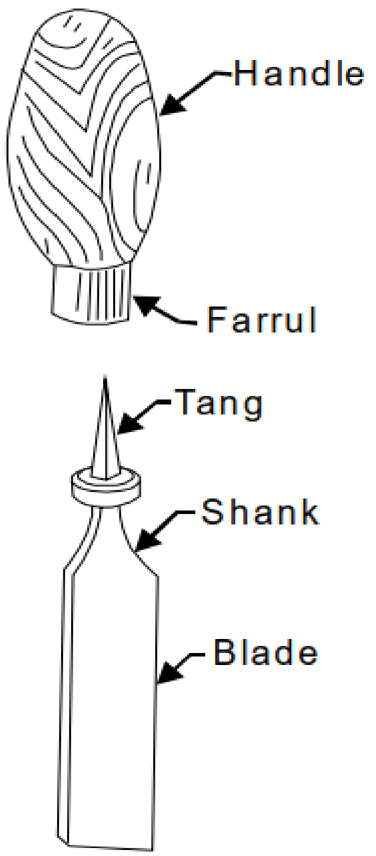
this type of blade consists of a narrow cutting-edge strip of hardened high-speed steel joined to a tough alloy-steel back by electron beam welding. This blade combines the qualities of hardness of the all-hard blade and the unbreakable qualities of the flexible blade, resulting in a shatterproof blade with long life and fast-cutting properties.

1.3 Chisels

A Chisel (Fig. 1.12) is a strong sharp edge cutting tool with asharp bevel edge at one end. Its construction is composed of handle,tang, ferrule, shoulder, and blade. Chisels are generally made up ofhigh carbon steel. They are used to shape and fit parts as requiredin joint making.A gouge (Fig. 1.13) is a curved chisel. It may be outside or insideground. Outside ground gouges are called firmer gouges and insideground gouges are called scribing gouges. The scribing gouges aremade long and thin, they are known as paring gouges. Several varietiesof chisels are available, each having special characteristics which fit it for its special use.There are two types of construction employed in the making of chisels named as tang andsocket types. The tang chisel is made with a rangedor pointed end which pierces into thehandle. The socket chisel reverses the process by having the handle fit into the socket collaron the blade.



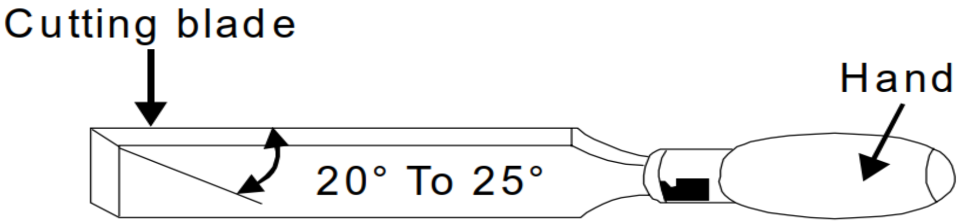
(Fig. 1.13): A gouge



(Fig. 1.12): A Chisel

1.3.1 Firmer Chisel

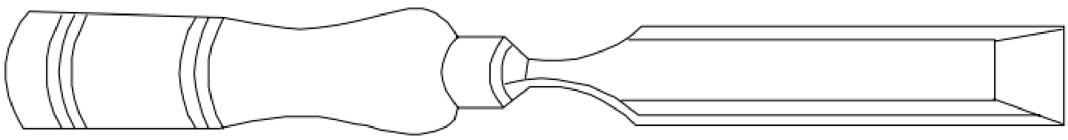
Firmer chisel is shown in Fig. 1.14 which possesses a blade of rectangular section. Itconsists of the following parts blade made of cast tool steel and it is used for general benchwork. The shoulder of the chisel prevents the tang from being driven farther into the handlewhen the chisel is struck with a mallet. The ferrule is short length of brass tube (mild steeltube in the case of some mortise chisels) which fits tightly over the lower end of the handle,and helps to prevent its splitting by the tang. The tang is not hardened as to fit in the handle.The handles turned from ash or beech wood as these timbers are resistant tosplitting.



(Fig. 1.14): Firmer Chisel

1.3.2 Beveled edge firmer chisel

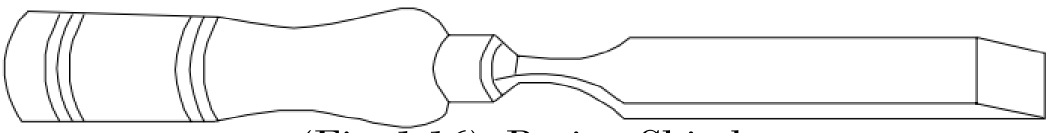
Beveled edge firmer chisel (Fig. 1.15) is identical to the firmer chisel except that theedges of the back of the blade are beveled. This enables the chisel to be used for cutting rightinto the corner of acute-angled wood work such as the base of a dovetail



(Fig. 1.15): Beveled edge firmer chisel

1.3.3 Paring Chisel

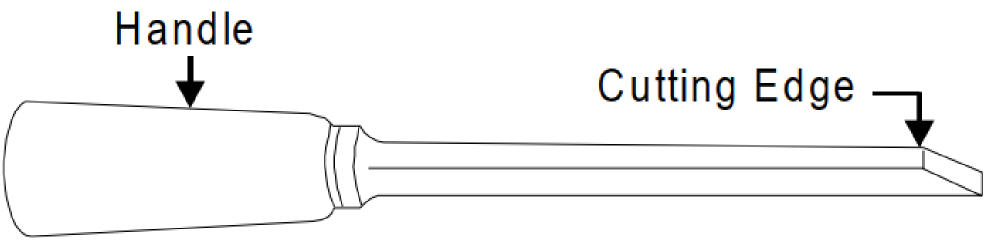
Paring chisel (Fig. 1.16) has a longer and usually slightly thinner blade than firmerchisel. It may be obtained with a blade of rectangular or beveled edge section and is used inpattern making and where long accurate paring is required. The paring chisel should not bestruck with a mallet. This chisel is intended for manipulation by hand only, and not fordriving with a mallet like a firmer chisel for cutting of wooden jobs.



(Fig. 1.16): Paring Chisel

1.3.4 Mortise Chisel

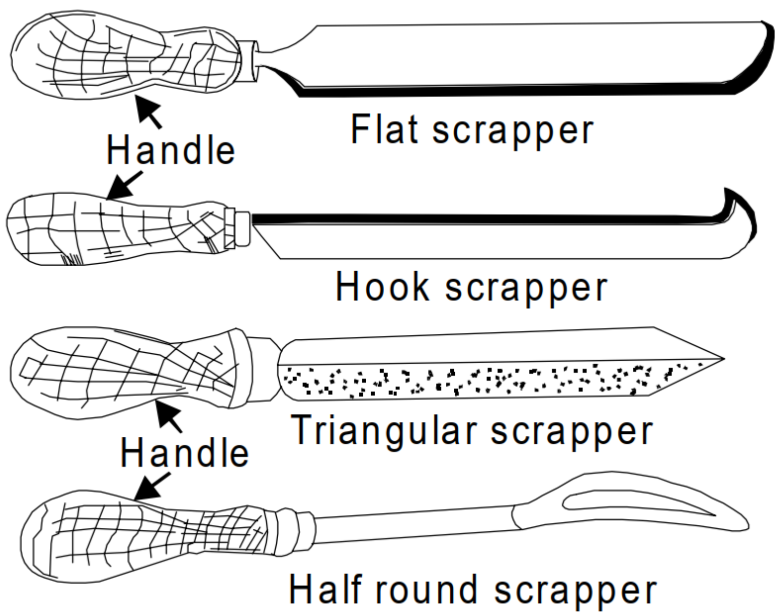
Mortise chisel (Fig. 1.17) is designed for heavy work. A mortise chisel has a blade whichis very nearly square in section and so may be used as a lever for removing chips and willwithstand heavy blows from a mallet. Various types of handles are fitted to mortise chiseldepending upon use. Mortise chisel has an oval beech handle, whilst the heaviest type of allhas a socket handle. This socket replaces the ferrule and affords greater resistance to splittingwhen used for very heavy work. The leather washer acts as a shock absorber.



(Fig. 1.17): Mortise Chisel

1.4 Scrapers

Scrapers are made up of old files and the cutting edge of scraper is hardened andtempered. They are mainly used to scrap metal surfaces by rubbing the work surface. Theyalso produce a bearing surface, which has been filed or machined earlier. The scrapers arehand cutting tools used for removing metal from surfaces in form of thin slices or flakes toproduce smooth and fine surfaces. Machined surfaces are not always perfectly true. If a verytrue surface is needed, the high spots must be located and removed. It is normally done withthe help of a scraper. The scrapers are made in a variety of lengths from 100 mm upwardsand in many shapes, depending upon the type of work to be done. The following types ofscrappers according to shape are commonly classified as



(Fig. 1.18): Common types of scraper

a) Flat
b) Hook
c) Triangular
d) Half round

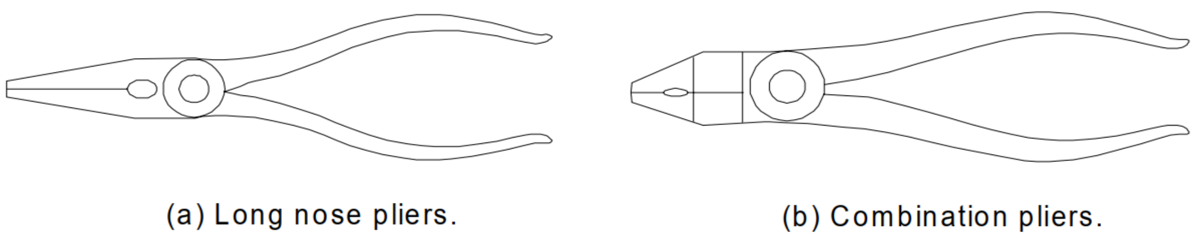
Fig 1.18 shows various scraper which aregenerally used for scraping job work in fittingshop.

1.5 Tightening Tools

The tightening tools include pliers, screw driver and wrenches, which are discussed asunder.

1.5.1 Pliers

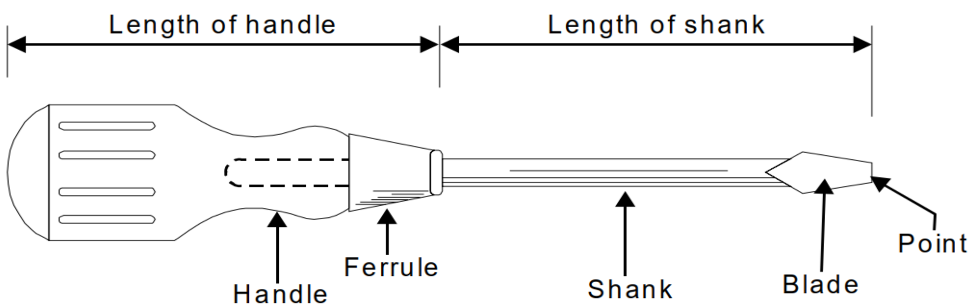
Pliers are namely ordinary needle nose and special type. Fig 1.19(a) shows a long nosepliers and Fig. 1.19(b) shows a combination pliers. These are commonly used by fitter andelectrician for holding a variety of jobs.



(Fig. 1.19): a long nose pliers anda combination pliers

1.5.2 Screw driver

Screw driver is a screw tightening tool. The most commonly used standard screw driverwith its parts is shown in Fig 1.20. It is generally used by hand for tightening the screws.It is also of various types depending upon the kind of work.



(Fig. 1.20): standard screw driver with its parts

1.5.3 Wrenches

Wrenches are commonly known as spanners. These generally come in sets and arecommonly identified by numbers. These are of various types and few general types involveopen single ended, open double ended, closed ended adjustable, ring spanner, offset socket,t-socket, box wrench, pipe wrench and Allen wrench.

1.6 Holding Tools

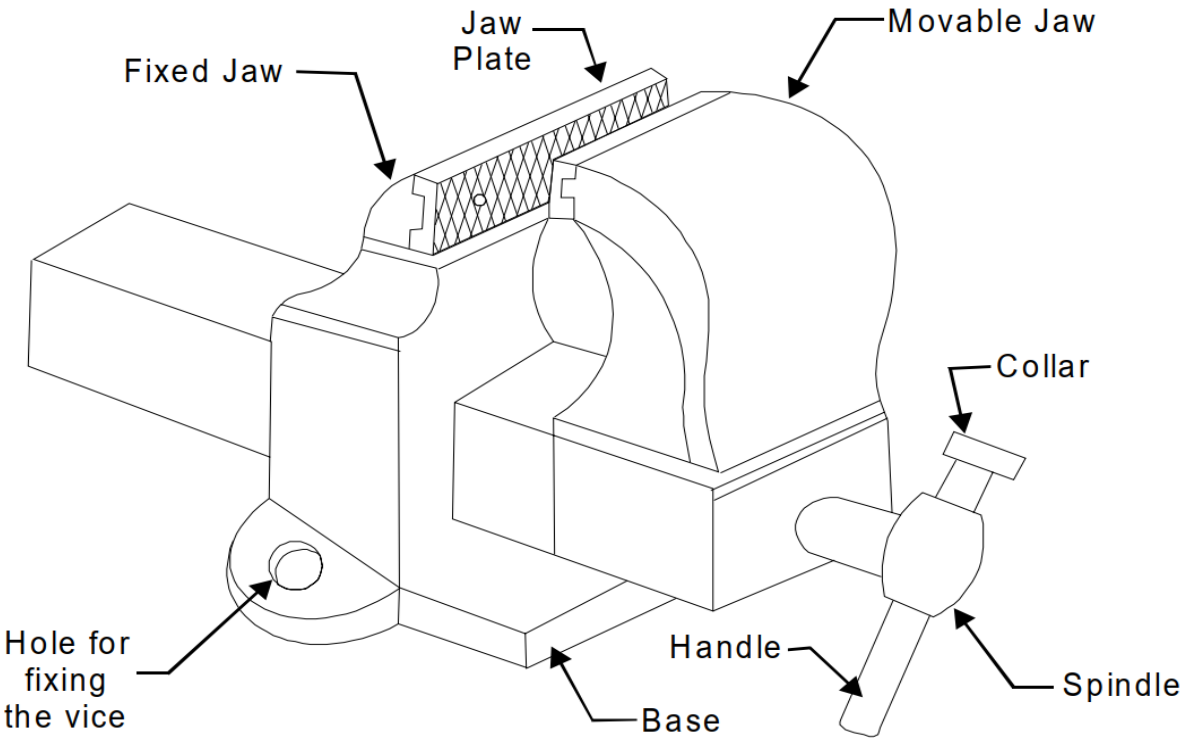
Holding tools used in fitting shop comprises of basically vices and clamps. The clamps areC or G clamp, plane slot, goose neck, double end finger, u-clamp, parallel jaw, and clampingblock. The various types of vices used in fitting shop are given as under:

1.6.1 Vices

The vices are hand vice, bench vice, machine vices, carpenter vice, shaper vice, leg vice,pipe vice, and pin vice.

1.6.1.1 Bench vice

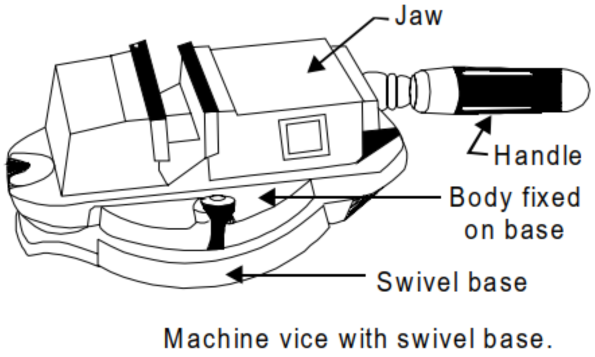
Fig 1.21 shows a bench vice commonly used in fitting shop for holding a variety of jobs.



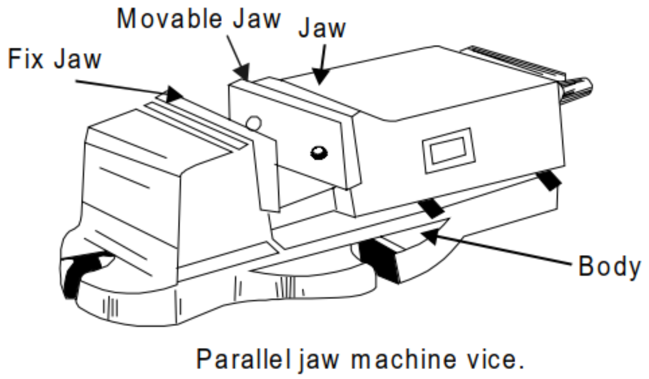
(Fig. 1.21)A bench vice

1.6.1.2 Machine vice

Fig 1.22 and Fig. 1.23 shows machine vice with swivel base and parallel jaw machinevice. These types of vices are commonly used in fitting shop for holding a variety of jobs. Theyare used for precision work on the machine table like shaping, milling, drilling and grinding.They are generally made of grey cast iron.



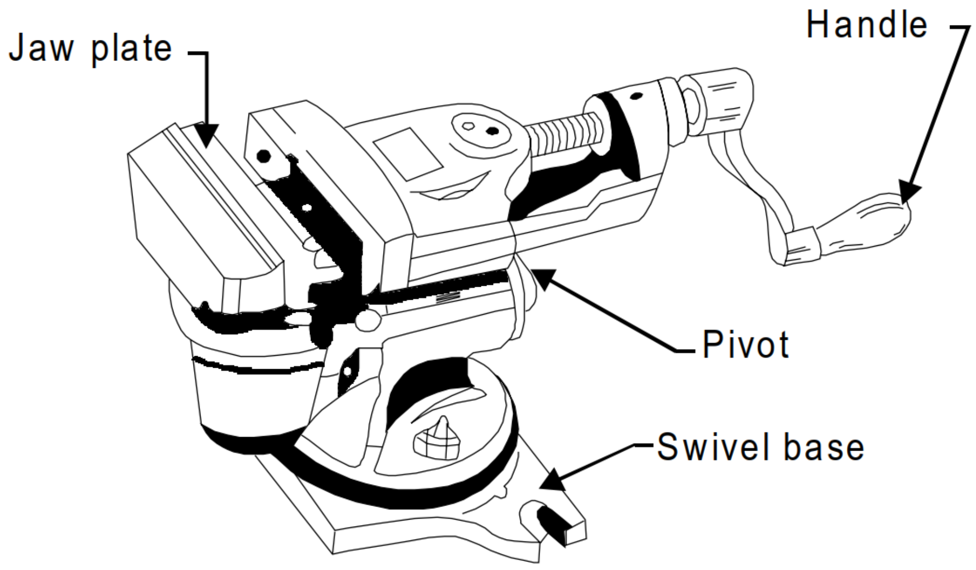
(Fig. 1.22)A machine vice with swivel base



(Fig. 1.23) A machine vice with parallel jaw

1.6.1.3 Universal swivel base machine vice

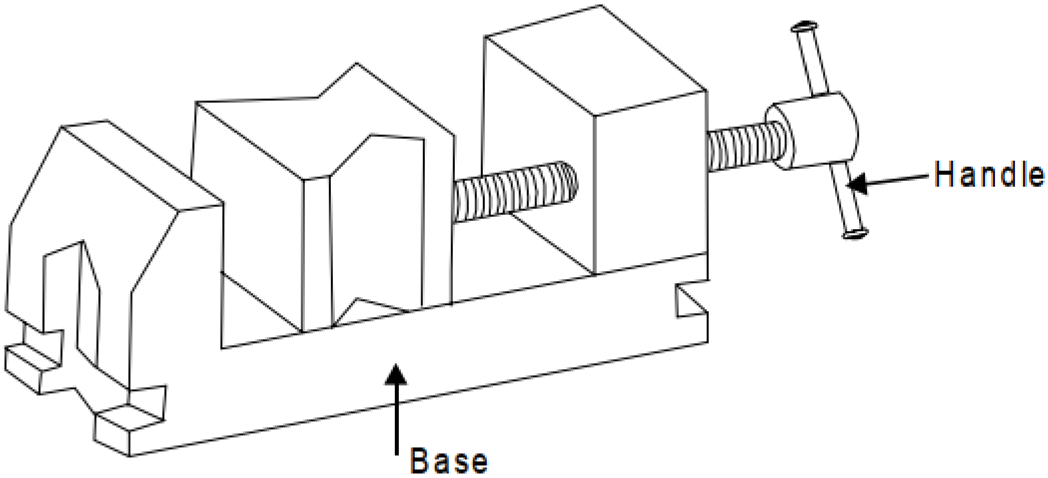
Fig. 1.24 shows a special type of universal swivel base machine vice made with swiveling head. It is commonly used in fitting shop for holding a variety of jobs. The jobs after holdingin jaws can be adjusted at any angle either horizontally or vertically with the help of swellinghead.



(Fig. 1.24) A universal swivel base machine vice

1.6.1.4 Toolmaker's vice

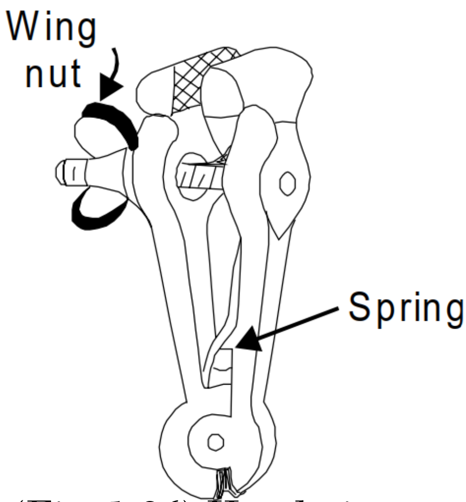
Fig 1.25 shows a small tiny vice known as tool maker vice. It is commonly used by toolmaker, watch maker, die maker and goldsmith for holding a variety of small parts for carryingsome operation.



(Fig. 1.25) A tool maker's vice

1.6.1.5 Hand vice

Hand vice is shown in Fig. 1.26 which is utilized for holdingkeys, small drills, screws, rivets, and other similar objects which arevery small to be easily held in the bench vice. This is made in variousshapes and sizes. It consists of two legs made of mild steel which holdthe jaws at the top and are hinged together at the bottom. A flatspring held between the legs which tend to keep the jaws open. Itsjaws can be opened and closed by a wing nut which moves through ascrew that is fastened to one leg and passes through the other.



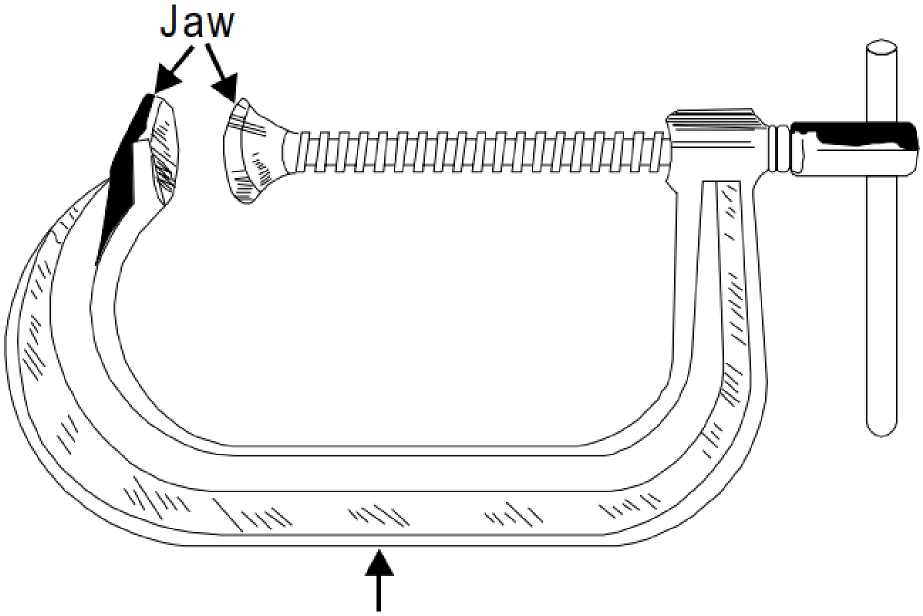
(Fig. 1.26) Hand vice

1.6.1.6 Pin vice

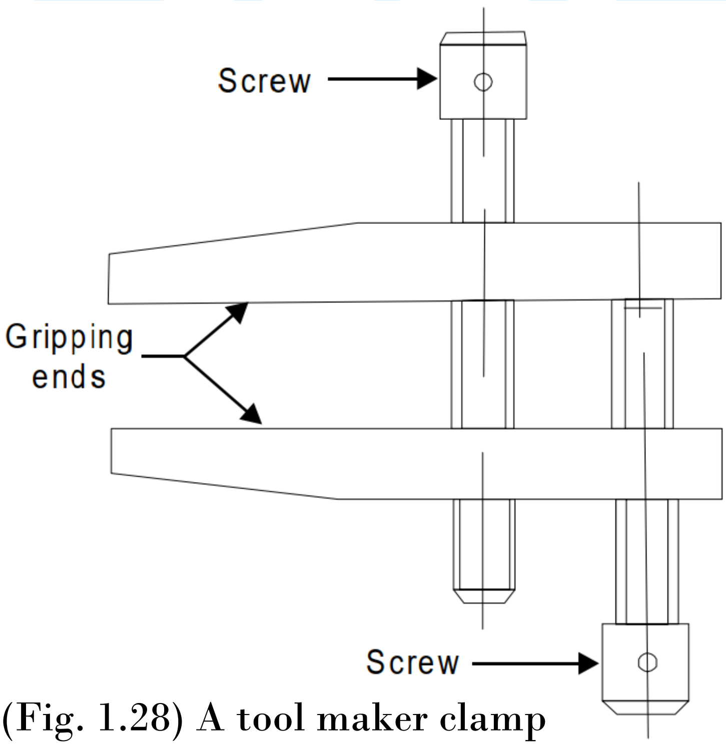
Pin vice is used for holding round jobs of small diameter such as wire and pins, duringworking. It also forms a very useful handle for small files. It consists of a handle and atapered nose covering a small collet chuck at its end. The chuck carries the jaws which areoperated by turning the handle. It is commonly used by a watch maker.

1.7 Clamping Devices

There are two types of clamps namely C clamp and tool maker clamp. A C-clamp isshown in Fig. 1.27 which is used for gripping the work during construction or assemblywork. Whereas tool maker clamp (Fig. 1.28) is used for gripping or holding smaller jobs.



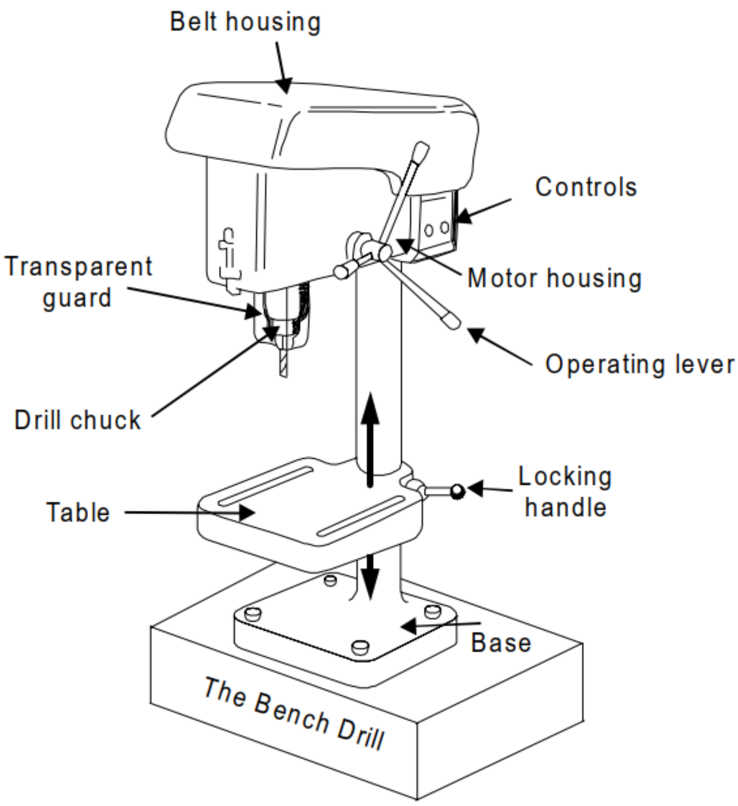
(Fig. 1.27) C-clamp



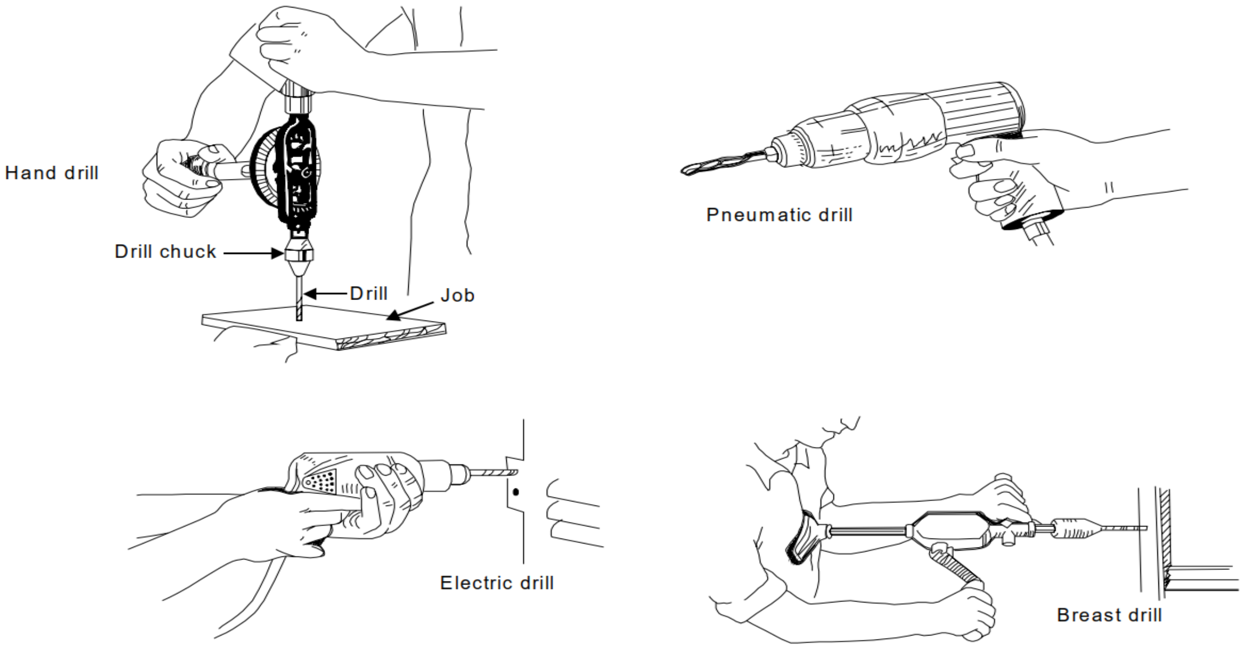
(Fig. 1.28) A tool maker clamp

1.8 Drill

Drill is a common tool widely formaking holes in a metal piece in fittingshop. It is generally held in chuck ofbench drilling machine shown in Fig.1.29. It usually consists of two cuttingedges set at an angle with the axis.There are three types of drills: (a) flatdrill, (b) straight fluted drill and (c) twistdrill. For fast and accurate drilling worktwist drills are commonly used. Ageneral twist drill comprises the cuttingangle of 118° and to obtain the correctdiameter of the hole. It should beground with both lips at 59° to the axisof the drill, with equal lengths of thecutting edges. The various hand drillsand their operations are shown inFig. 1.30



(Fig. 1.29): A bench drilling



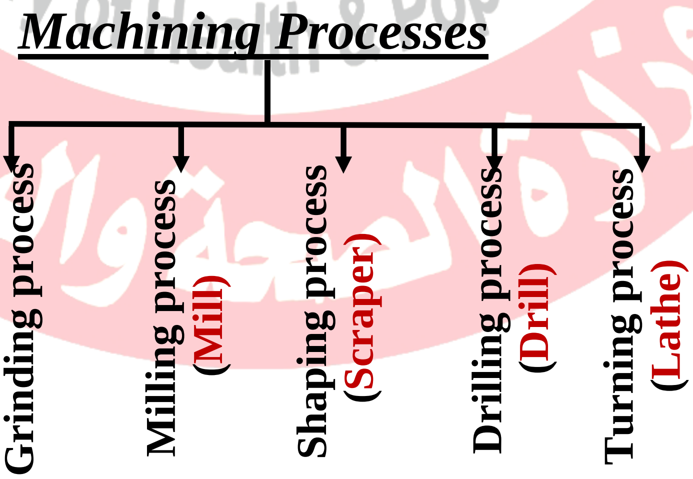
(Fig. 1.30): Types of hand drilling

2
Chapter

Machining Processes

Overview

Machining Processes is of the most widely used manufacturing operations. It is used to obtain parts with dimensional and geometrical accuracy and with good surface finish.
Machining is performed by removing the excess layer material (called machining allowance) in the form of chip.
Machining is considered the most accurate amongst manufacturing operations.
Due to the high cost of machining (30-40% of manufactured part cost), investments are continuously made in advanced and high efficiency machines and cutting tools in order to increase productivity and reduce cost.
Chip is removed through the relative motion between the cutting tool and the workpiece. This relative motion is generated using a Machine Tool.
Machining operations are generally more accurate and more productive than hand working operations.
The machining Processes are mainly of two types namely cylindrical and flats or prismatic. Cylindrical jobs are generally machined using lathe, milling, drilling and cylindrical grinding whereas prismatic jobs are machined using shaper, planner, milling, drilling and surface grinding.



2.1 Cutting-tools materials

Cutting tools are made from material harder than that of the workpiece.
Cutting tool material must possess high resistance to corrosion and to high temperature in order to be capable of cutting for a long time without the need for resharpening.
There are many materials used in cutting tools:

2.1.1 High Speed Steel (HSS):

Contains large quantity of alloying elements such as chrome, tungsten, cobalt, molybdenum and vanadium, which improves its properties. This material can withstand temperatures up to 550 degrees which translates in its ability to cut at higher speeds than tool steel.

2. 1.2 Carbon Tool Steel:

Cheap, used at temperatures up to 150 degrees. Used in tools those are capable of cutting speeds of 10-15 m/min.

2.1.3 Carbides:

Are made in the shape of inserts. Characterized by very high hardness and withstanding temperatures up to 1000 degrees, thus can be used to cut at speed higher than those possible with HSS. This translates into higher productivity, higher accuracy and better surface finish.

2.1.4 Ceramics:

White inserts made from aluminum oxide (AL2O3). Capable of maintaining its hardness up to 1200 degrees which allows cutting speed higher than those possible with carbide tools. One of its drawbacks is its fragility and low toughness.

2.1.5 Diamond:

Higher hardness than any other material. High temperature and corrosion resistance. Used speeds reaching 2000 m/min which is required in high precision turning, especially for nonferrous metals and alloys. But it is fragile, has low toughness, and expensive.

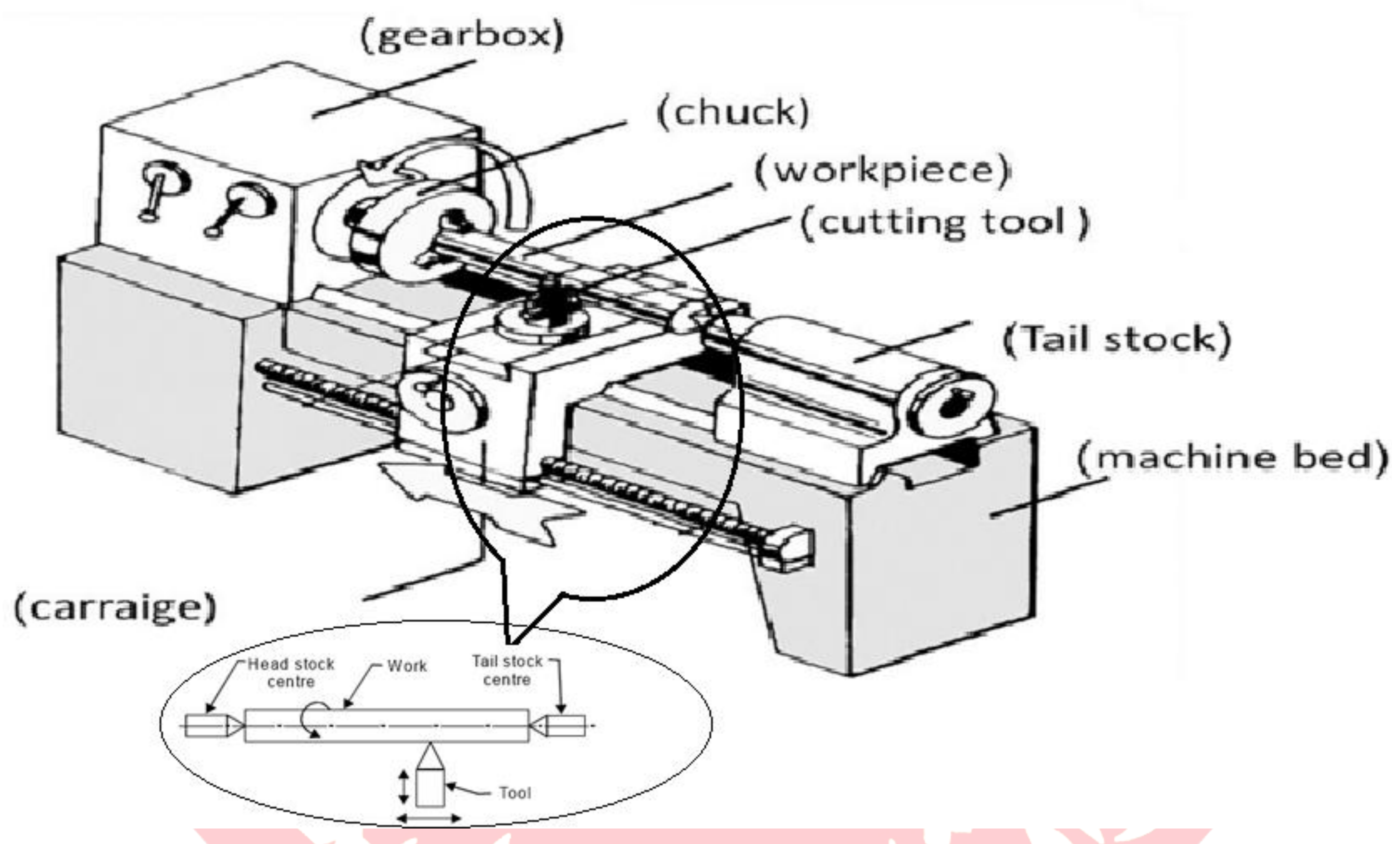
(Fig. 2.1): Cutting tools of Machines

2.2 Turning Machines (Lathe)

Lathe is one of the most versatile and widely used machine tools all over the world. The main function of a lathe is to remove metal from a job to give it the required shape and size.

The job is securely and rigidly held in the chuck or in between centers on the lathe machine and then turn it against a single point cutting tool which will remove metal from the job in the form of chips.

Fig. 2.1 shows the working principle of lathe. An engine lathe is the most basic and simplest form of the lathe. It derives its name from the early lathes, which obtained their power from engines. Besides the simple turning operation, lathe can be used to carry out other operations also, such as drilling, reaming, boring, taper turning, knurling, screw thread, cutting, grinding etc.



(Fig. 2.2): working principle of lathe

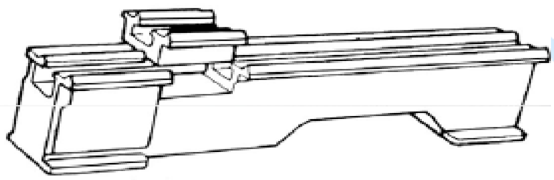
2.2.1 CONSTRUCTION OF LATHE MACHINE

The major parts of lathe machine are

1. Machine Bed	2. Head stock (Gearbox)	3. Tail stock
4. Carriage	5. Chuck	6. Cutting tools.

2.2.1.1 Machine Bed

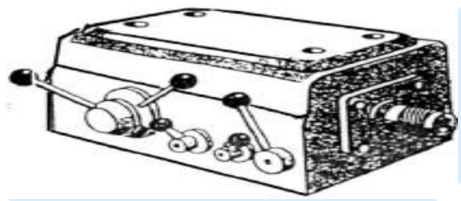
The bed of a lathe machine is the base on which all other parts of lathe are mounted. It is massive and rigid single piece casting made to support other active parts of lathe. On left end of the bed, headstock of lathe machine is located while on right side tailstock is located. The carriage of the machine rests over the bed and slides on it.



(Fig. 2.3): The bed of a lathe machine

2.2.1.2 Headstock assembly

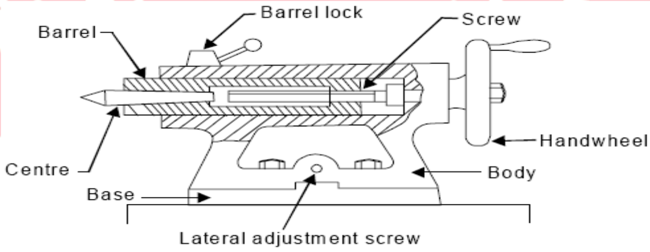
The headstock is the front section of machine that is attached to the bed. This assembly contains the motor and drive system which powers the spindle. The spindle supports and rotates the workpiece, which is secured in a workpiece holder or fixture, such as a chuck.



(Fig. 2.4): The headstock

2.2.1.3 Tail stock

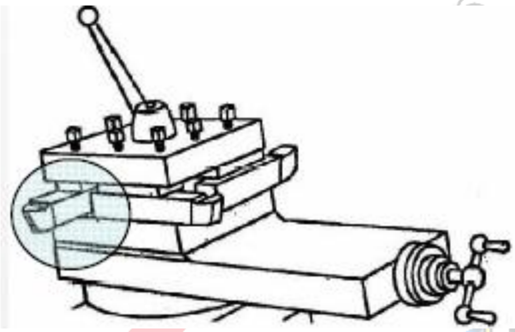
The Tail stock is the rear section of the machine that is attached to the bed. The purpose of this assembly is to support the other end of the workpiece and allow it to rotate, as it's driven by the spindle.

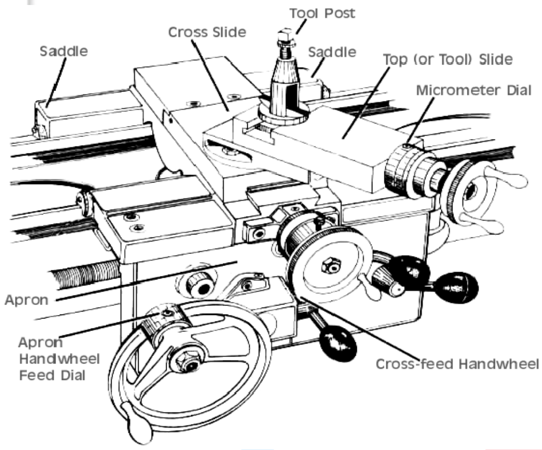


(Fig. 2.5): The headstock

2.2.1.4 Carriage

The carriage is a platform that slides alongside the workpiece, allowing the cutting tool to cut away material as it moves.

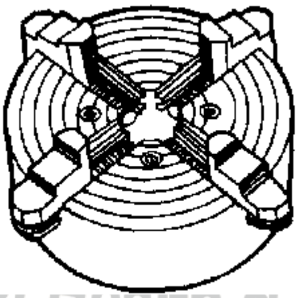




(Fig. 2.6) The carriage

2.2.1.5 Chuck

The chuck is one of the most important devices for holding and rotating a job in a lathe. It is basically attached to the headstock spindle of the lathe. The internal threads in the chuck fit on to the external threads on the spindle nose. Short, cylindrical, hollow objects or those of irregular shapes, which cannot be conveniently mounted between centers, are easily and rigidly held in a chuck.



(Fig. 2.7): The Chuck

2.2.2 Cutting Motions

For material removal by machining, the work and the tool need relative movements and those motions and required power are derived from the power sources and transmitted through the kinematic systems comprised of a number and type of mechanisms.
For machining flat or curved surfaces the machine tools need relative tool work motions, which are categorized in following two groups:

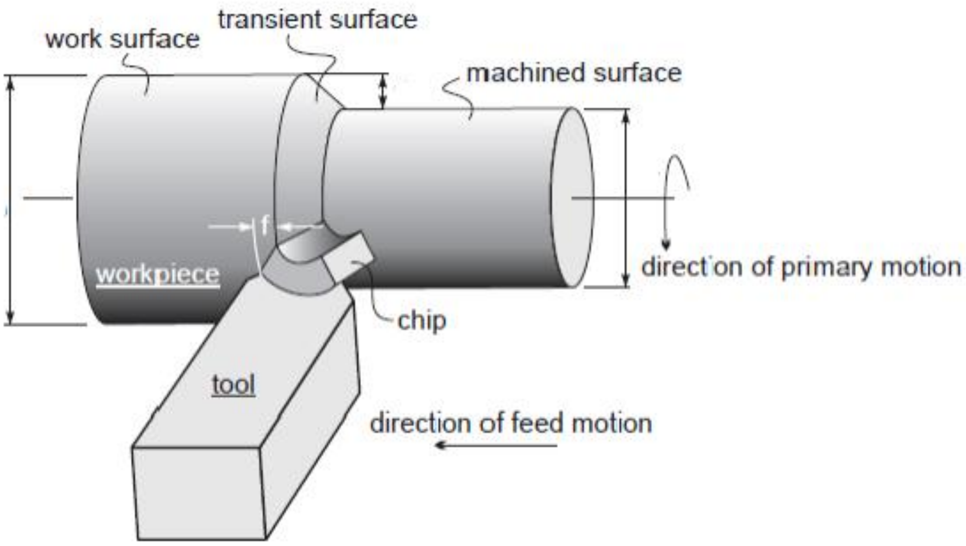
• Formative motions namely

- Cutting motion (CM) - Feed motion (FM)

• Auxiliary motions such as

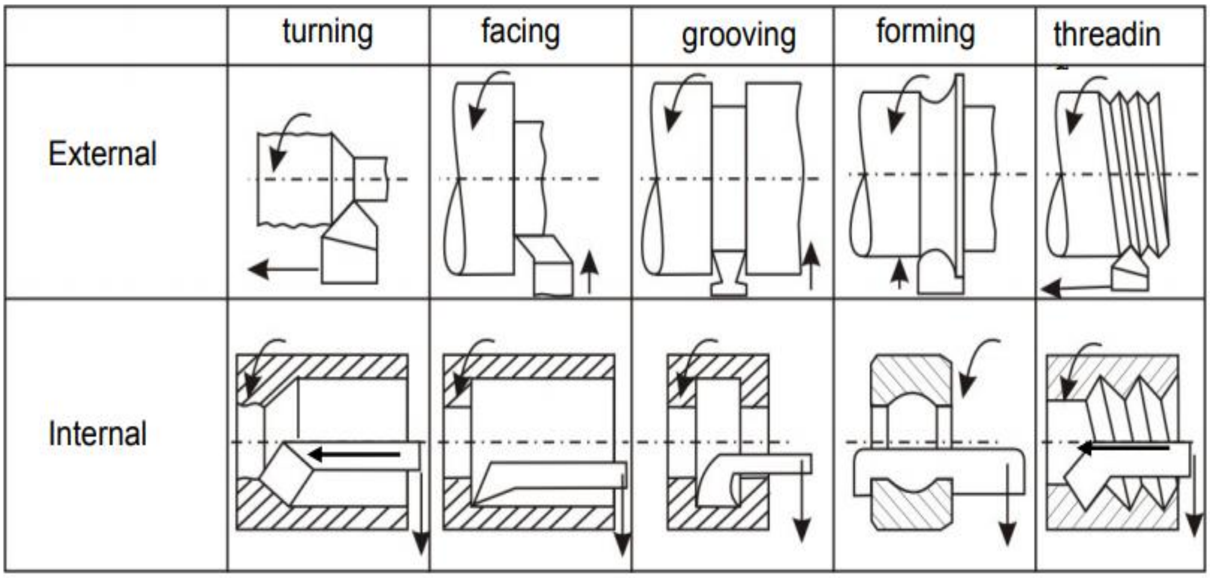
- Indexing motion - Additional feed motion - Relieving motion

The tool and the work and their motions generally remain interconnected and in different way for different machining work.
In the lathe the workpiece moves rotational movement on axis or along a specified path to form a rotational shape. (Main cutting motion) .
The cutting tool moves axially, along the side of the workpiece, (Feed motion).



(Fig. 2.8): Cutting Motions in lathe

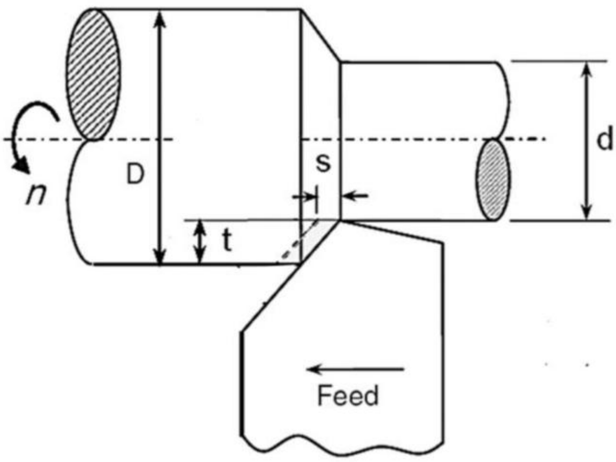
2.2.3 LATHE OPERATIONS



(Fig. 2.9) LATHE OPERATIONS

2.2.4 Cutting speed of a Turning Operation

The figure shows the main elements of a turning operation such that:
D: workpiece initial diameter in (mm)
d: workpiece final diameter in (mm)
s: feed rate in (mm/rev)
t: depth of cut in (mm)
n: workpiece rotation speed in (rpm)



(Fig. 2.10) Cutting speed

The cutting speed v_c can be calculated as follows:

$$v_c = \frac{\pi D n}{1000} \text{ (m/min)}$$

The depth of cut t can be calculated as follows:

$$\text{(mm)} \quad t = \frac{D-d}{2}$$

The machining time can be calculated as follows:

$$\text{(min)} \quad t_m = \frac{L}{s \times n}$$

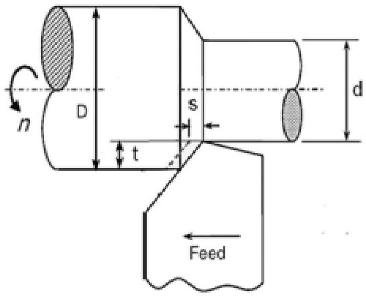
Where L is the workpiece length in (mm)

Example 1

Example 1: Calculate the machining time required to machine the external surface of a cylinder on a centre lathe if the initial diameter of the workpiece is 40 mm, its final diameter is 37 mm, knowing that the depth of cut is 1.5 mm, the rotational speed is 600 rpm, the feed is 0.1 mm/rev and the length of the workpiece is 200 mm.

Givens: D= 40 mm, d= 37 mm, t= 1.5 mm, n=600 rpm, L= 200 mm, s= 0.1 mm/rev
Required: t_m
Solution:

$$\mathbf{t_m = \frac{L}{s * n} = \frac{200}{0.1 * 600} = 3.333\ min}$$



Example 2

Example 2: Calculate the total time required to machine the external surface of a cylinder on a center lathe if the initial diameter of the workpiece is 60 mm, the final diameter is 54 mm knowing that the maximum depth of cut is 1.5 mm, the cutting speed is 32 m/min, feed is 0.2 mm/rev and the workpiece length is 250 mm.
Givens: D= 60 mm, d= 54 mm, t= 1.5 mm, v_c= 32 m/min, L= 250 mm, s= 0.2 mm/rev
Required: t_m
Solution:

$$v_c = \frac{\pi * D_1 * n_1}{1{,}000}$$

$$32 = \frac{\pi * 60 * n_1}{1{,}000}$$

$$n_1 = 169.765\ rpm$$

$$t_m^1 = \frac{L}{s * n_1} = \frac{250}{0.2 * 169.765} = 7.363\ min$$

$$D_2 = D_1 - 2 * t = 60 - 2 * 1.5 = 57\ mm$$

$$v_c = \frac{\pi * D_2 * n_2}{1{,}000}$$

$$32 = \frac{\pi * 57 * n_2}{1{,}000}$$

$$n_2 = 178.7\ rpm$$

$$t_m^2 = \frac{L}{s * n_2} = \frac{250}{0.2 * 178.7} = 6.99\ min$$

$$\mathbf{t_m = t_m^1 + t_m^2 = 7.363 + 6.99 = 14.35\ min}$$

2.2.5 Computer Numerical Control Lathe (CNC)

What is a CNC Machine?

Conventionally, an operator decides and adjusts various machines parameters like feed, depth of cut etc depending on type of job , and controls the slide movements by hand. In a CNC Machine functions and slide movements are controlled by motors using computer programs.

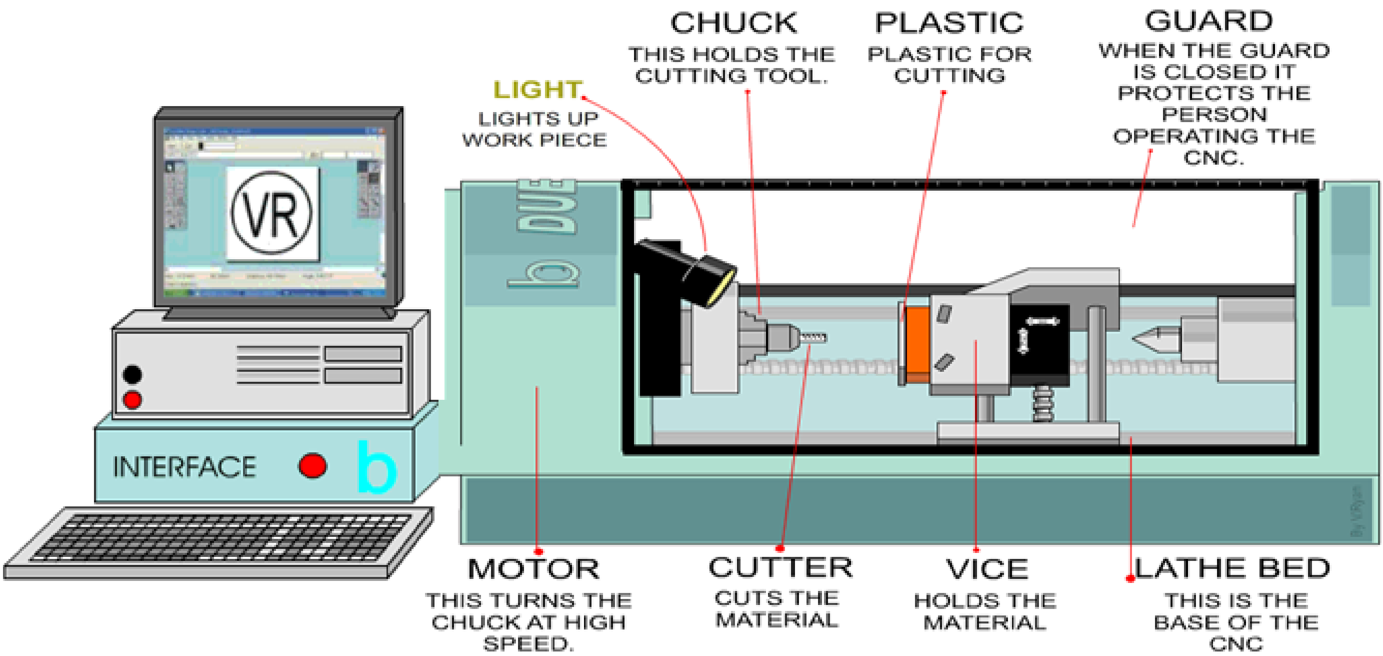
Automated version of a manual lathe programmed to change tools automatically, used for turning and boring wood, metal and plastic.

How CNC Lathe Works:

Controlled by codes are automatically generated by the computer software.
These are number values and co-ordinates.
Each number or code is assigned to a particular operation.

Programming types for CNC machines

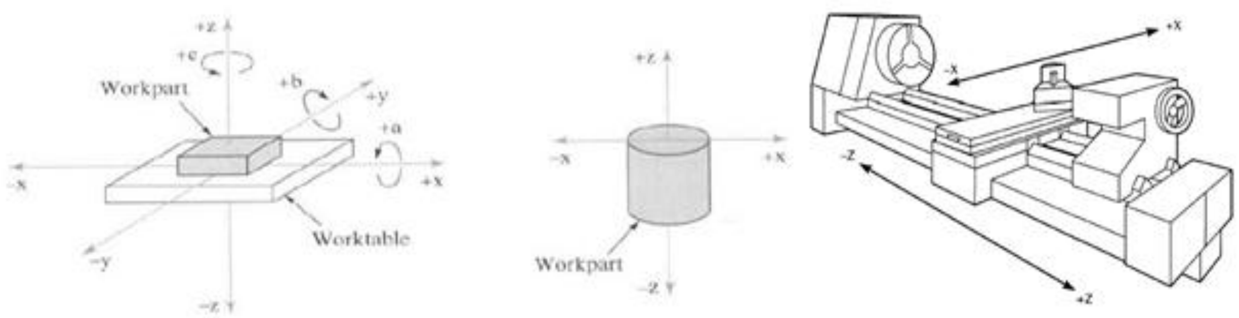
- Manual programming: Direct preparation of the operational program by the production engineer.
- Automated programming: is the indirect preparation of the operational program through the use of computerized design and manufacturing system (CAD/CAM - Computer Aided Design / Computer Aided Manufacturing)



(Fig. 2.11) CNC Lathe

2.2.5.1 Basic CNC Principles:

All computer controlled machines are able to accurately and repeatedly control motion in various directions. Each of these directions of motion is called an axis. Depending on the machine type there are commonly two to five axes. Additionally, a CNC axis may be either a linear axis in which movement is in a straight line or a rotary axis with motion following a circular path.



(Fig. 2.12) CNC principles

2.2.5.2 CNC Machines -Advantages/Disadvantages:

Advantages:

• High Repeatability and Precision e.g. Aircraft parts
• Volume of production is very high
• Complex contours/surfaces need to be machined .etc
• Flexibility in job change, automatic tool settings, less scrap
• More safe, higher productivity, better quality
• Less paper work, faster prototype production, reduction in lead times

Disadvantages:

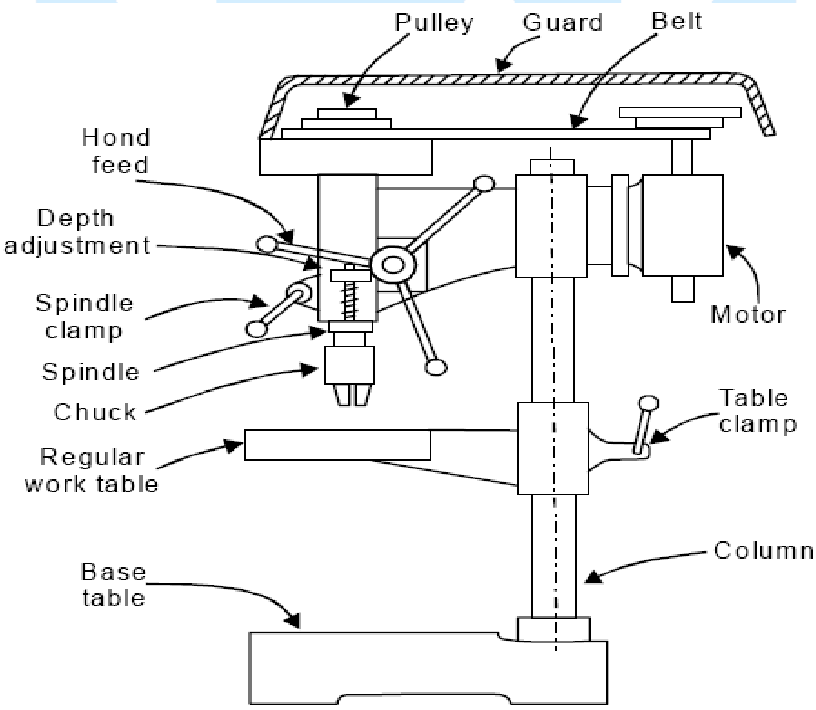
• Costly setup, skilled operators
• Computers, programming knowledge required
• Maintenance is difficult

2.3 Drill

Drilling machines are used to generate holes and enlarging them using a pointed tool called twist drill.
Drilling machines are also used to drill grooves for screw heads, finishing holes using reamers, and generating internal threads.
A twist drill consists of two helical flutes in its working section. These flutes remove chip and allow the delivery of cutting fluids to the cutting zone.

2.3.1 CONSTRUCTION OF DRILLING MACHINE

1. Base table
2. Column
3. Main drive (Motor)
4. Chuck
4. Drill spindle
5. Feed handle
6. Work table

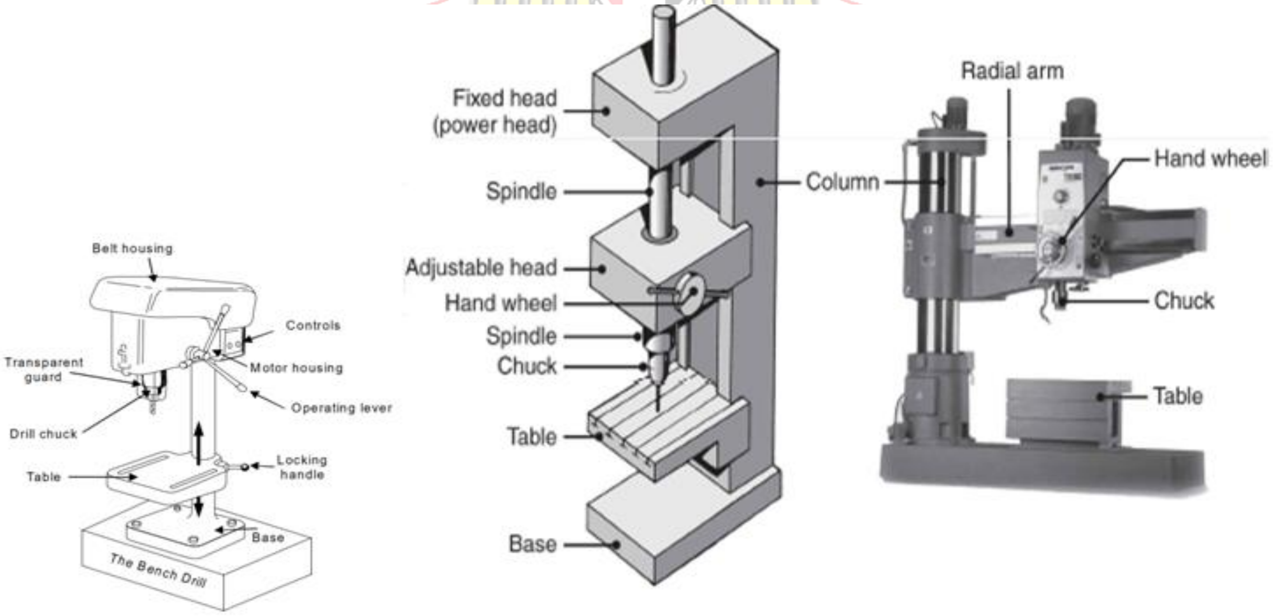


(Fig. 2.13) Drilling Parts

2.3.2 Types OF DRILLING MACHINE

Drilling machines are classified on the basis of their constructional features, or the type of work they can handle. The various types of drilling machines are:

(1) Bench drilling machine,
(2) Column drilling machine,
(3) Radial drilling machine,
(4) Automatic drilling machine.

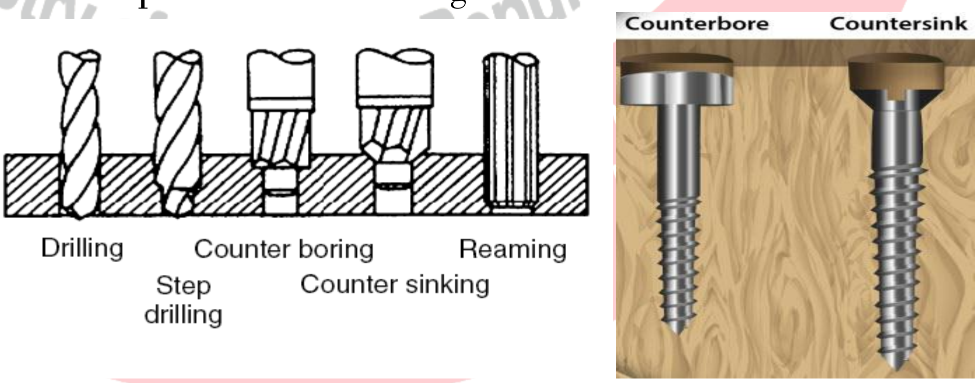


(Fig. 2.14) Drilling Types

2.3.3 OPERATIONS PERFORMED ON DRILLING MACHINE

A drill machine is versatile machine tool. A number of operations can be performed on it. Some of the operations that can be performed on drilling machines are:

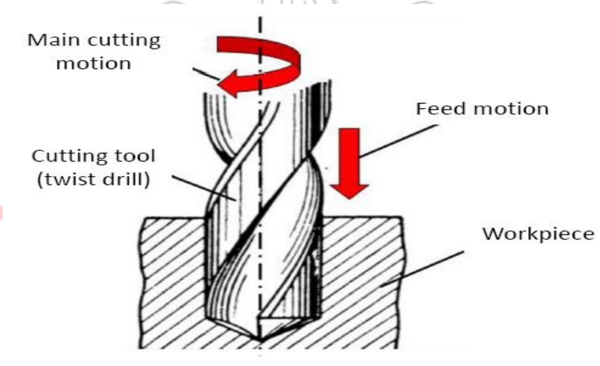
1. Drilling
2. Reaming
3. Counter boring
4. Counter sinking



(Fig. 2.15) Drilling OPERATIONS

2.2.4 Cutting Motions of Drilling machines

The cutting tool moves speed rotational movement (Main cutting motion) .and the cutting tool also moves linear motion (Feed motion) up/down in direction workpiece to make holes.



(Fig. 2.16): Cutting Motions in drilling

2.3.5 Cutting speed and machining time of a Drilling

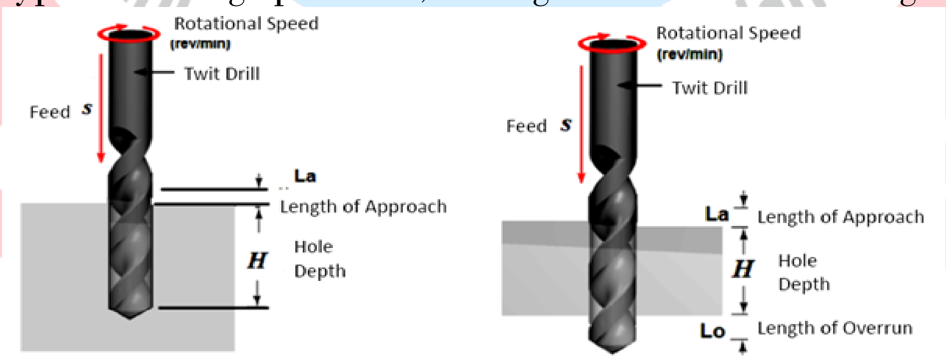
In drilling operations, cutting speed (*Vc*) is calculated like in turning:

$$v_c = \frac{\pi D n}{1000} \ (\text{m/min})$$

Where D is the drill diameter, n is the twist drill rotational speed (rev/min)
To calculate the machining time (*tm*) in drilling, the following equation is used:

$$t_m = \frac{L}{s \times n} \ (\text{min})$$

There are two types of drilling operations, drilling blind holes and drilling through holes.



$$t_m = \frac{H + 0.3D + La}{s * N} \qquad t_m = \frac{H + 0.3D + La + Lo}{s * N}$$

(Fig. 2.17): machining time in drilling

Example 3

Calculate the required machining time to drill a through hole with a 10 mm diameter in an Aluminum workpiece with a thickness of 50 mm, a rotational speed of 750 rev/min, a feed of 0.5 mm/rev, and lengths of approach and overrun of 3 mm.

Solution:

$$L_0 + L_a = 3 + 3 = 6 \text{ mm (through hole)}$$

$$t_m = \frac{H + 0.3 * D + L_0 + L_a}{s * n} = \frac{50 + 0.3 * 10 + 6}{0.5 * 750}$$

$$\mathbf{t_m = 0.157\ min}$$

Example 4

Calculate the machining time required to drill a blind hole if the cutting speed is 28 m/min, suggested feed is 0.2 mm/rev, hole depth is 40 mm, length of approach is 3 mm, and hole diameter is 12 mm.

Solution:

$$V = \frac{\pi * D * n}{1{,}000}$$

$$28 = \frac{\pi * 12 * n}{1{,}000}$$

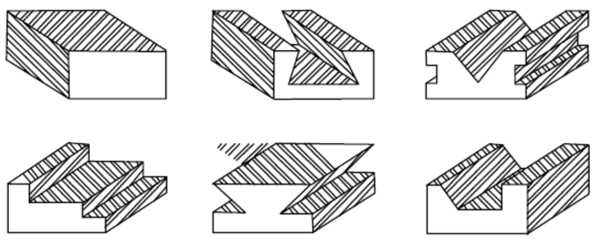
$$n = 742.723 \text{ rpm}$$

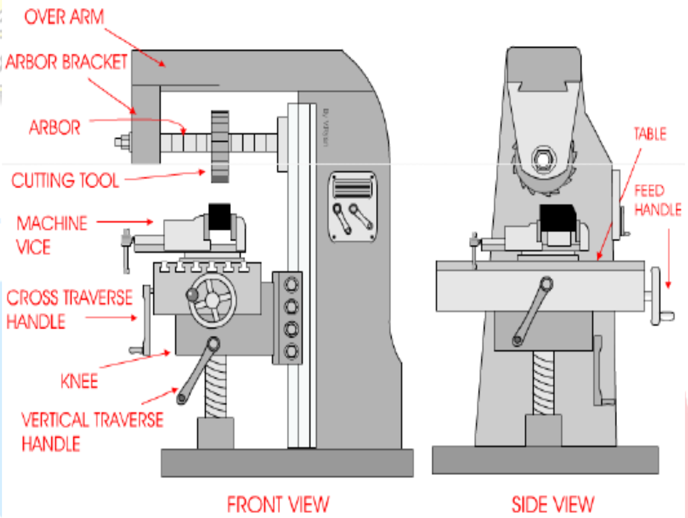
$$t_m = \frac{H + 0.3 * D + L_a}{s * n} = \frac{40 + 0.3 * 12 + 3}{0.2 * 742.723}$$

$$\mathbf{t_m = 0.314\ min}$$

2.4 Milling Machines

A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The milling cutter rotates at high speed and it removes metal at a very fast rate with the help of multiple cutting edges. One or more number of cutters can be mounted simultaneously on the arbor of milling machine. This is the reason that a milling machine finds wide application in production work. Milling machine is used for machining flat surfaces, contoured surfaces, surfaces of revolution, external and internal threads, and helical surfaces of various cross-sections.
Typical components produced by a milling are used in many applications, due to its higher production rate and accuracy.

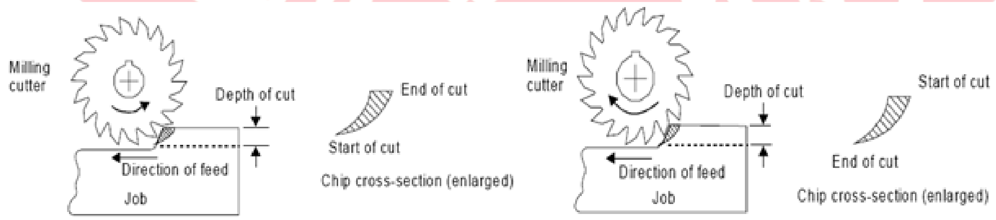




(Fig. 2.18): Job surfaces generated by milling

2.4.1 PRINCIPLE OF MILLING

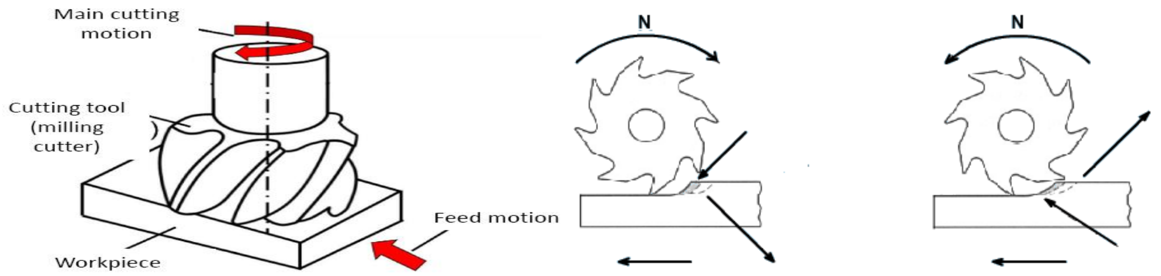
In milling machine, the metal is cut by means of a rotating cutter having multiple cutting edges. For cutting operation, the workpiece is fed against the rotary cutter. As the workpiece moves against the cutting edges of milling cutter, metal is removed in form chips of trochoid shape. Machined surface is formed in one or more passes of the work. The work to be machined is held in a vice, a rotary table, a three jaw chuck, an index head, between centers, in a special fixture or bolted to machine table. The rotatory speed of the cutting tool and the feed rate of the workpiece depend upon the type of material being machined.



(Fig. 2.19): PRINCIPLE OF MILLING

2.4.2 Cutting Motions of Milling Machines

The cutting tool (milling cutter) moves speed rotational movement (Main cutting motion). and the workpiece moves linear motion (Feed motion).

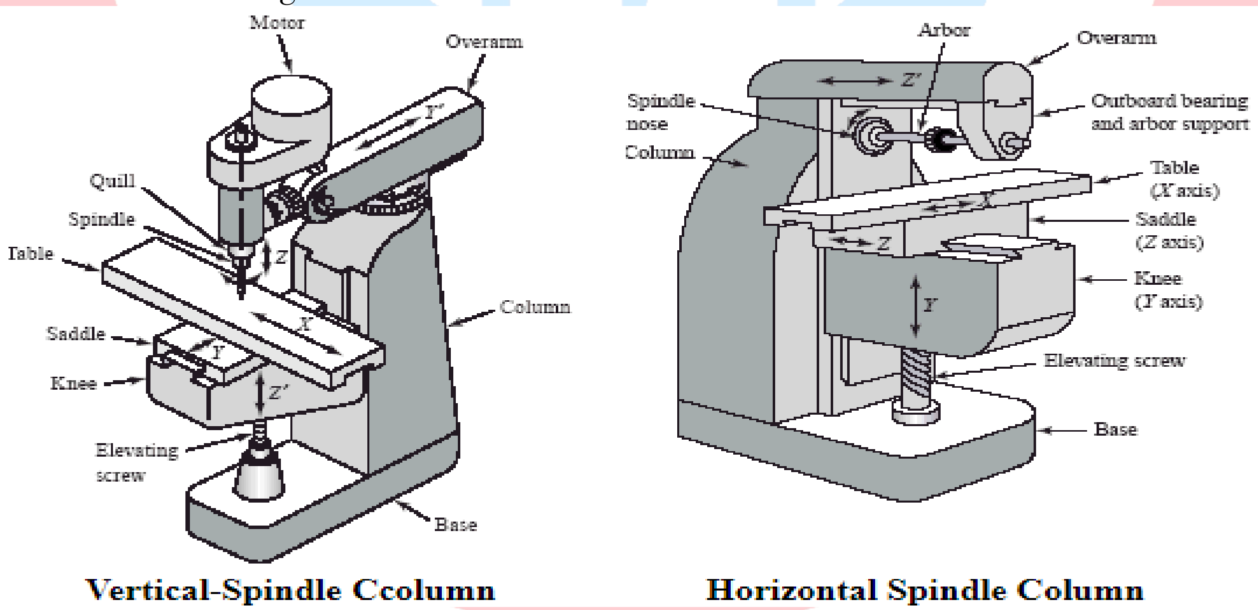


(Fig. 2.20): Cutting Motions in milling

2.4.3 TYPES OF MILLING MACHINES

Milling machine rotates the cutter mounted on the arbor of the machine and at the same time automatically feed the work in the required direction. The milling machine may be classified in several forms, but the choice of any particular machine is determined primarily by the size of the workpiece to be undertaken and operations to be performed. With the above function or requirement in mind, milling machines are made in a variety of types and sizes. According to general design, the distinctive types of milling machines are:

1- Horizontal milling machine
2- Vertical milling machine
3- Universal milling machine

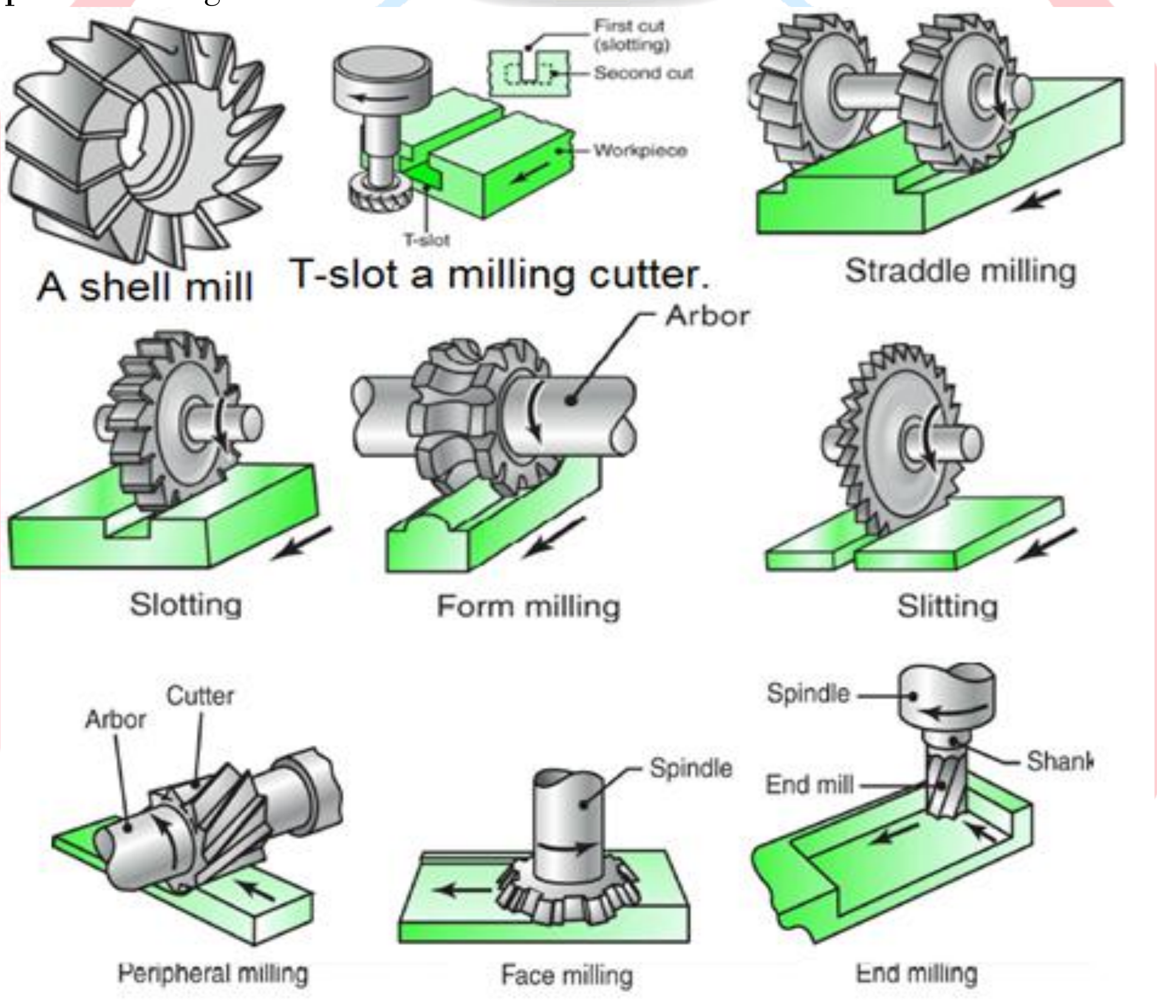


(Fig. 2.21): Types of milling machines

2.4.4 TYPES OF MILLING CUTTERS

Milling cutters are made in various forms to perform certain classes of work, and they may be classified as:

(1) Plain milling cutters,
(2) T-slot milling cutter,
(3) Staddle milling cutter,
(4) Slotting milling cutters,
(5) Form milling cutter,
(6) Slitting saw cutter,
(7) Face milling cutter,
(8) End milling cutters,
(9) Peripheral milling cutter.



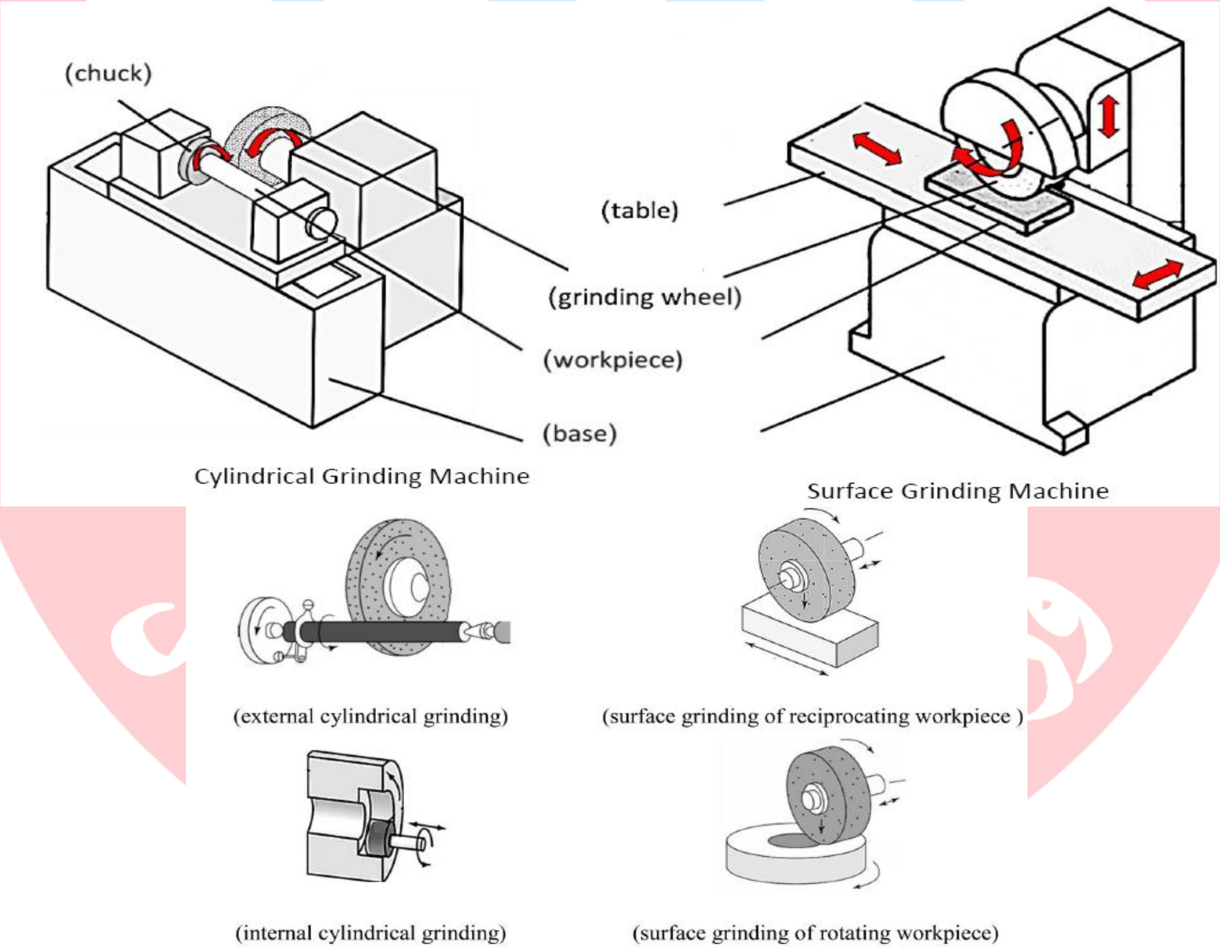
(Fig. 2.22): Types of milling cutters

2.5 Grinding Machines

A grinding machine, often shortened to grinder, is a machine tool used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the workpiece via shear deformation.

2.5.1 Grinding Machines Types

1- Cylindrical grinder:
A cylindrical grinder may have multiple grinding wheels. The workpiece is rotated and fed past the wheel(s) to form a cylinder.
2- Surface grinder:
A surface grinder has a "head" which is lowered, and the workpiece is moved back and forth past the grinding wheel on a table that has a permanent magnet for use with magnetic stock.



(Fig. 2.23): Types Grinding Machines

3
Chapter

WELDING

3.1 Introduction:

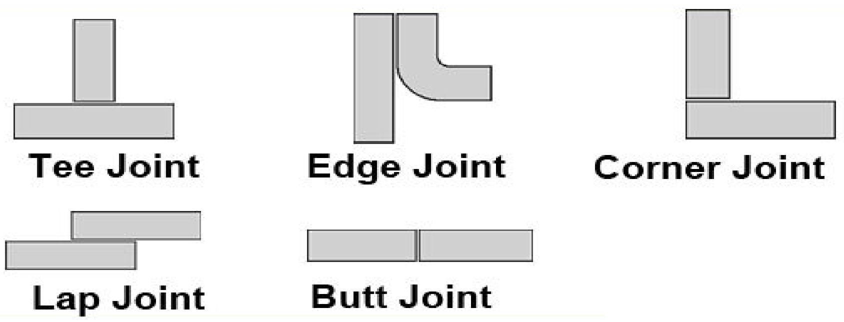
Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction. During some type of welding processes, pressure may also be employed, but this is not an essential requirement for all welding processes. Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication and repairing process in industries. Some of the typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, off-shore platform, bridges, welded pipes, sealing of nuclear fuel and explosives, etc.

ELEMENTS OF WELDING PROCESS

The elements of welding process used with common Welding joints, Metal welding, Heat.

3.1.1 Welding joints

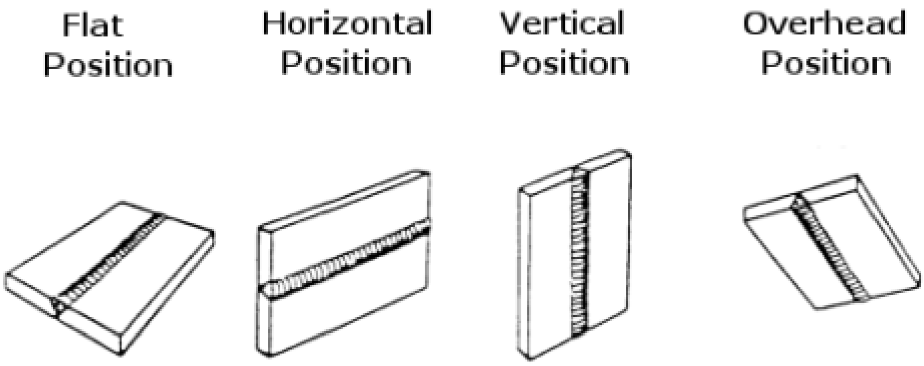
1- Tee Joint
2- Edge Joint
3- Corner Joint
4- Lap Joint
5- Butt Joint



(Fig. 3.1): Welding Joint

3.1.2 Welding Positions

1. Flat or down hand position
2. Horizontal position
3. Vertical position
4. Overhead position



(Fig. 3.2): Welding Joint

3.1.3 Welding processes classified

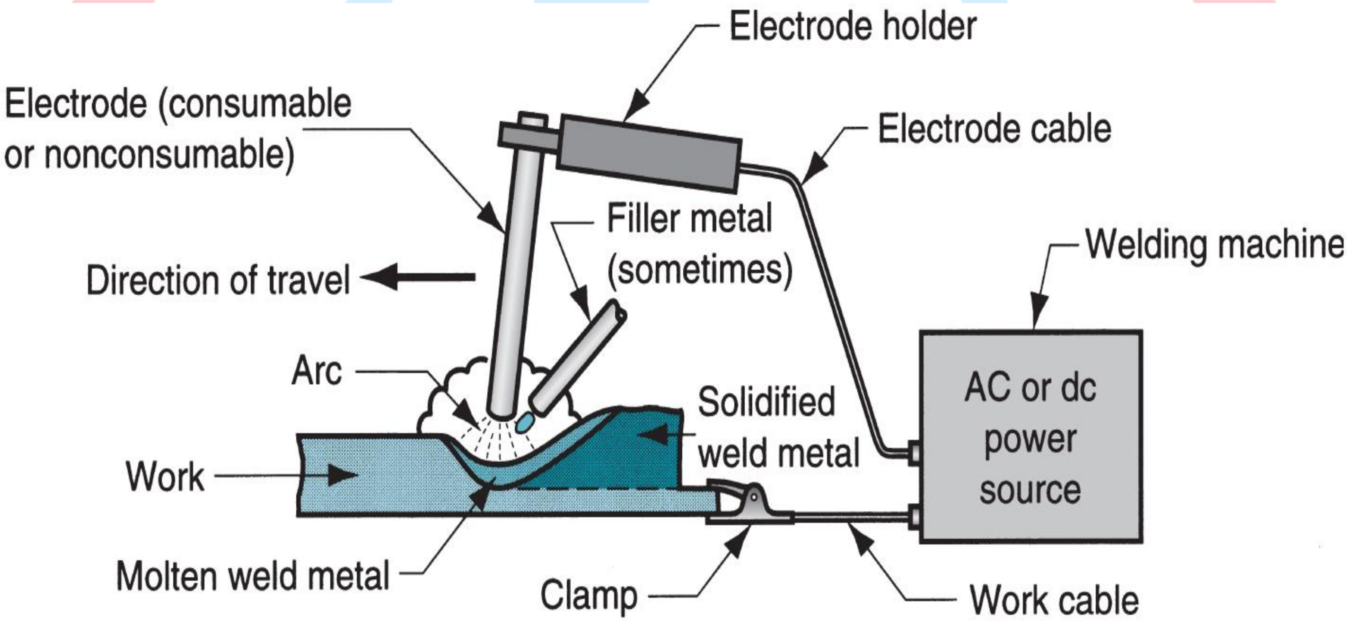
Welding processes are classified into two major groups:

1. Fusion welding: In this process, base metal is melted by means of heat. Often, in fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the joint. Commonly used fusion welding processes are: arc welding, resistance welding, oxyfuel welding, electron beam welding and laser beam welding.
2. Solid-state welding: In this process, joining of parts takes place by application of pressure alone or a combination of heat and pressure. No filler metal is used. Commonly used solid-state welding processes are: diffusion welding, friction welding, ultrasonic welding.

3.2 Arc Welding (AW)

A fusion welding process in which coalescence of the metals is achieved by the heat from an electric arc between an electrode and the work

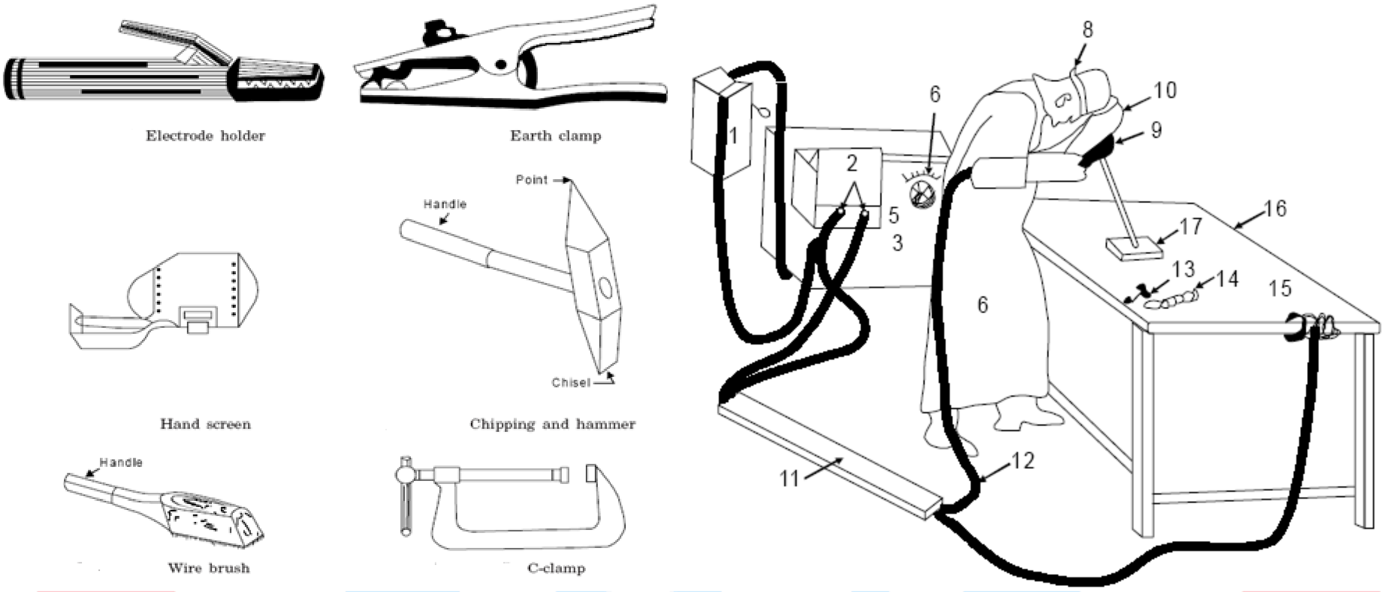
- Electric energy from the arc produces temperatures (5500 C), hot enough to melt any metal
- Most Arc Welding processes add filler metal to increase volume and strength of weld joint
- An electric arc is a discharge of electric current across a gap in a circuit It is sustained by an ionized column of gas (plasma) through which the current flows To initiate the arc in Arc Welding, electrode is brought into contact with work and then quickly separated from it by a short distance
- A pool of molten metal is formed near electrode tip, and as electrode is moved along joint, molten weld pool solidifies in its wake



(Fig. 3.3): Arc Welding

3.2.1 Arc Welding Parts

(1) Switch box. (2) Secondary terminals. (3) Welding machine.
(4) Current reading scale. (5) Current regulating hand wheel. (6) Leather apron.
(7) Asbestos hand gloves. (8) Protective glasses strap. (9) Electrode holder.
(10) Hand shield. (11) Channel for cable protection. (12) Welding cable.
(13) Chipping hammer. (14) Wire brush. (15) Earth clamp.
(16) Welding table (metallic). (17) Job.



(Fig. 3.4): Arc Welding Parts

3.2.1.1 Arc Welding Power Source

Both direct current (DC) and alternating current (AC) are used for electric arc welding, each having its particular applications. DC welding supply is usually obtained from generators driven by electric motor or if no electricity is available by internal combustion engines.

For AC welding supply, transformers are predominantly used for almost all arc welding where mains electricity supply is available. They have to step down the usual supply voltage (200-400 volts) to the normal open circuit welding voltage (50-90 volts).

3.2.1.2 Welding cables

Welding cables are required for conduction of current from the power source through the electrode holder, the arc, the workpiece and back to the welding power source. These are insulated copper or aluminum cables.

3.2.1.3 Electrode holder

Electrode holder is used for holding the electrode mannually and conducting current to it. These are usually matched to the size of the lead, which in turn matched to the amperage output of the arc welder.
Electrode holders are available in sizes that range from 150 to 500 Amps.

3.2.1.4 Welding Electrodes

An electrode is a piece of wire or a rod of a metal or alloy, with or without coatings. An arc is set up between electrode and workpiece. Welding electrodes are classified into following types:-

1- **Consumable**: Consumed during welding process, source of filler metal in arc welding

<u>Forms of consumable electrodes</u>

- Welding rods (a.k.a. sticks) are 9 to 18 inches and 3/8 inch or less in diameter and must be changed frequently
- Weld wire can be continuously fed from spools with long lengths of wire, avoiding frequent interruptions

In both rod and wire forms, electrode is consumed by the arc and added to weld joint as filler metal

2- **Nonconsumable:** not consumed during welding process and filler metal must be added by a separate wire fed into weld pool are made of tungsten which resists melting.

3.2.1.5 Hand Screen

Hand screen used for protection of eyes and supervision of weld bead.

3.2.1.6 Chipping hammer

Chipping Hammer is used to remove the slag by striking.

3.2.1.7 Wire brush

Wire brush is used to clean the surface to be weld.

3.2.1.8 Protective clothing

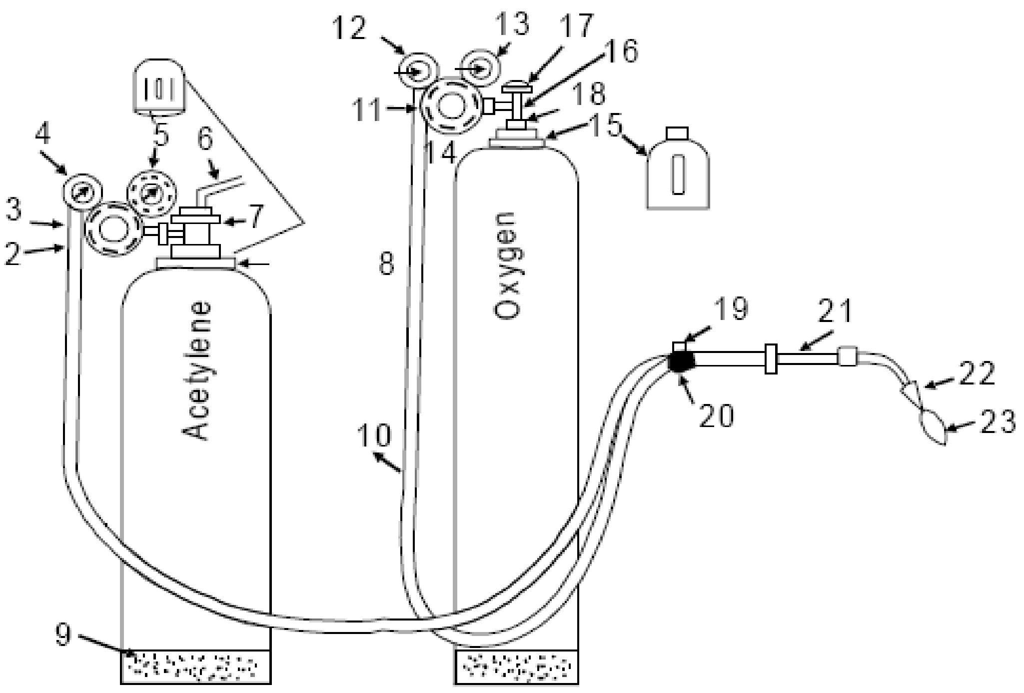
Operator wears the protective clothing such as apron to keep away the exposure of direct heat to the body.

3.3 Oxy-Acetylene Welding

In this process, acetylene is mixed with oxygen in correct proportions in the welding torch and ignited. The flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal. The oxy-acetylene flame reaches a temperature of about 3300°C and thus can melt most of the ferrous and non-ferrous metals in common use. A filler metal rod or welding rod is generally added to the molten metal pool to build up the seam slightly for greater strength.

3.3.1 Oxy-Acetylene Welding Parts

1. Acetylene hose
2. Adjusting screw
3. Acetylene regulator
4. Regulator outlet pressure gauge
5. Cylinder pressure gauge
6. Valve wrench
7. Acetylene cylinder valve
8. Cylinder cap
9. Fusible plugs
10. Oxygen hose
11. Oxygen regulator
12. Regulator outlet pressure gauge
13. Cylinder pressure gauge
14. Cylinder cap
15. Oxygen cylinder valve
16. Oxygen cylinder valve
17. Hand wheel
18. Bursting disc
19. Acetylene valve
20. Oxygen valve
21. Welding torch
22. Torch tip
23. Flame



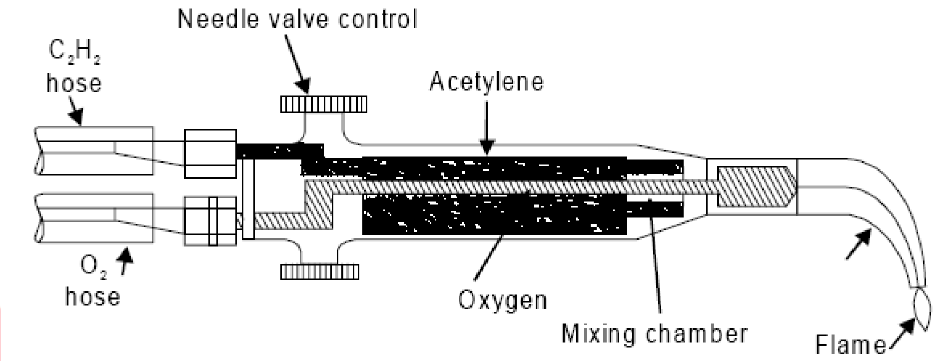
(Fig. 3.5): Oxy-Acetylene Welding Parts

3.3.1.1 Gas pressure regulators

Gas pressure regulators are employed for regulating the supply of acetylene and oxygen gas from cylinders. A pressure regulator is connected between the cylinder and hose leading to welding torch. The cylinder and hose connections have left-handed threads on the acetylene regulator while these are right handed on the oxygen regulator. A pressure regulator is fitted with two pressure gauges, one for indication of the gas pressure in the cylinder and the other for indication of the reduced pressure at which the gas is going out.

3.3.1.2 Welding torch

It is a tool for mixing oxygen and acetylene in correct proportion and burning the mixture at the end of a tip. Gas flow to the
torch is controlled with the help of two needle valves in the handle of the torch.
There are two basic types of gas welding torches:
(1) Positive pressure (also known as medium or equal pressure), and
(2) Low pressure or injector type
The positive pressure type welding torch is the more common of the two types of oxyacetylene torches.



(Fig. 3.6): Welding torch Parts

3.3.1.3 Hose pipes

The hose pipes are used for the supply of gases from the pressure regulators. The most common method of hose pipe fitting both oxygen and acetylene gas is the reinforced rubber hose pipe. Green is the standard color for oxygen hose, red for acetylene, and black hose for other industrially available welding gases.

3.3.1.4 Filler rods

Gas welding can be done with or without using filler rod. When welding with the filler rod, it should be held at approximately 900 to the welding tip. Filler rods have the same or nearly the same chemical composition as the base metal. Metallurgical properties of the weld deposit can be controlled by the optimum choice of filler rod. Most of the filler rods for gas welding also contain deoxidizers to control the oxygen content of weld pool.

3.3.1.5 Fluxes

Fluxes are used in gas welding to remove the oxide film and to maintain a clean surface. These are usually employed for gas welding of aluminum, stainless steel, cast iron, brass and silicon bronze. They are available in the market in the form of dry powder, paste, or thick solutions.

3.4 RESISTANCE WELDING

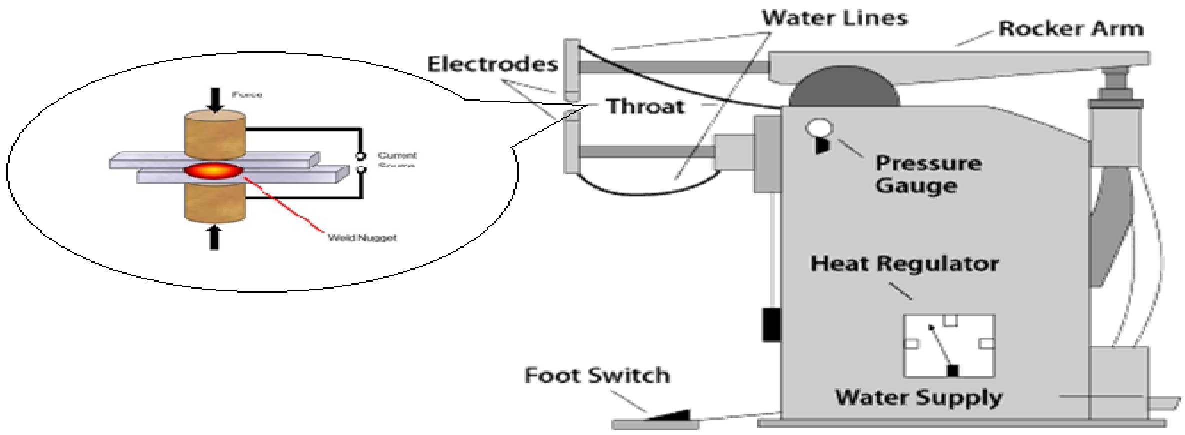
In resistance welding the metal parts to be joined are heated by their resistance to the flow of an electrical current. Usually this is the only source of heat, but a few of the welding operations combine resistance heating with arc heating, and possibly with combustion of metal in the arc.
In resistance welding processes no fluxes are employed, the filler metal is rarely used and the joints are usually of the lap type.
The amount of heat generated in the workpiece depends on the following factors:
(1) Magnitude of the current,
(2) Resistance of the current conducting path, and Mathematically, $H = I^2 Rt$
Where H = heat generated in joules
I = current in Amp.
R = resistance in ohms
t = time of current flow in seconds.

3.4.1 Types of Resistance Welding

The major types of resistance welding are given as under:
(1) Spot Welding
(2) Seam Welding

3.4.1.1 Spot Welding

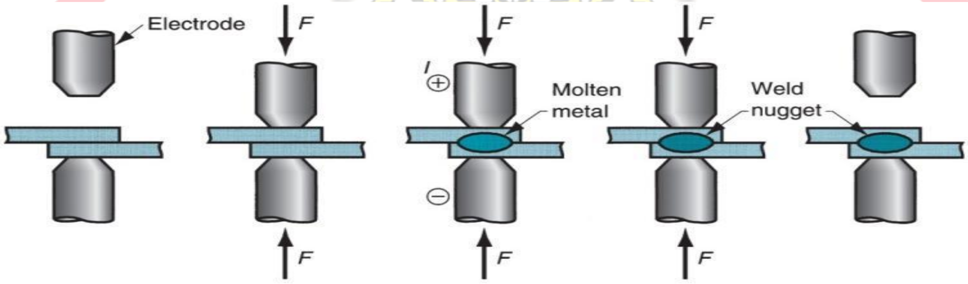
In this process overlapping sheets are joined by local fusion at one or more spots, by the concentration of current flowing between two electrodes. This is the most widely used resistance welding process. A typical resistance spot welding machine.
It essentially consists of two electrodes, out of which one is fixed.The other electrode is fixed to a rocker arm (to provide mechanical advantage) for transmitting the mechanical force from a pneumatic cylinder.



(Fig. 3.7): Spot Welding

A resistance welding schedule is the sequence of events that normally take place in each of the welds. The events are:

1. The squeeze time is the time required for the electrodes to align and clamp the two work-pieces together under them and provide the necessary electrical contact.
2. The weld time is the time of the current flow through the work-pieces till they are heated to the melting temperature.
3. The hold time is the time when the pressure is to be maintained on the molten metal without the electric current. During this time, the pieces are expected to be forged welded.
4. The off time is time during which, the pressure on the electrode is taken off so that the plates can be positioned for the next spot.



(Fig. 3.8): Spot Welding Steps

<u>Applications of Spot Welding</u>

(i) It has applications in automobile and aircraft industries

(ii) The attachment of braces, brackets, pads or clips to formed sheet-metal parts such as cases, covers or trays is another application of spot welding.

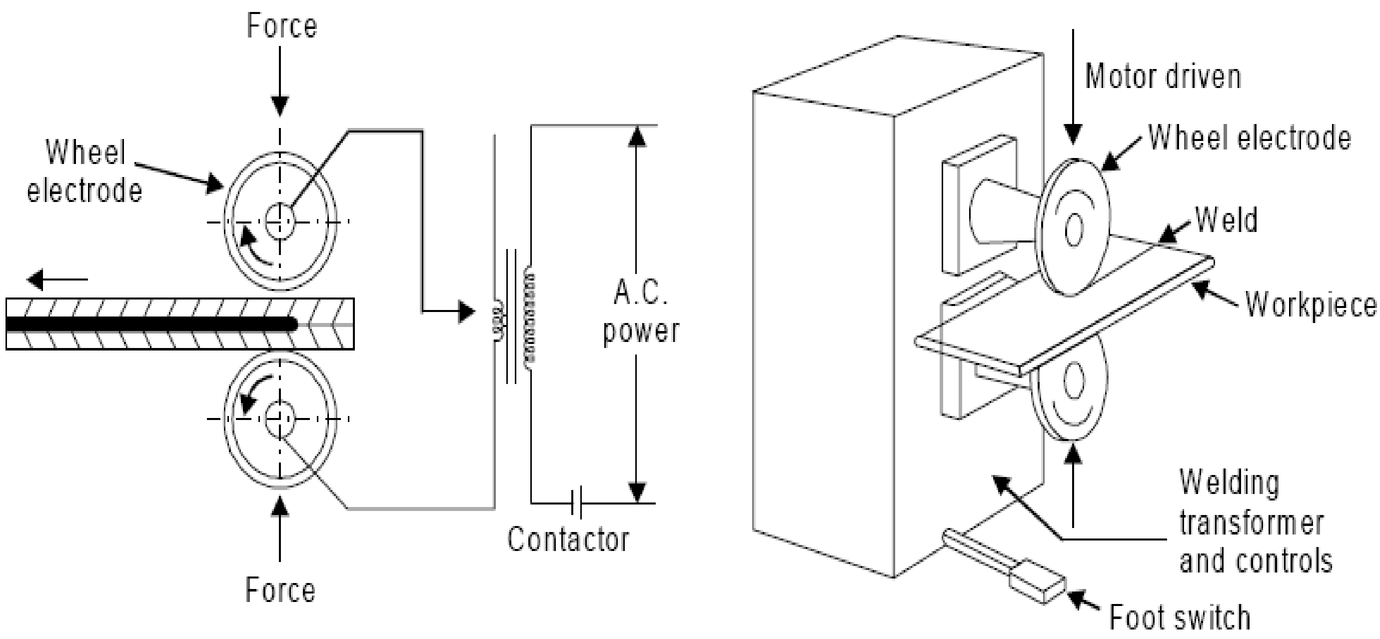
(iii) Spot welding of two 12.5 mm thick steel plates has been done satisfactorily as a replacement for riveting.

(iv) Many assemblies of two or more sheet metal stampings that do not require gas tight or liquid tight joints can be more economically joined by spot welding than by mechanical methods.

(v) Containers and boxes frequently are spot welded.

3.4.1.2 Resistance Seam Welding

It is a continuous type of spot welding wherein spot welds overlap each other to the desired extent. In this process coalescence at the faying surfaces is produced by the heat obtained from the resistance to electric current (flow) through the work pieces held together under pressure by circular electrodes.
The resulting weld is a series of overlapping resistance-spots welds made progressively along a joint by rotating the circular electrodes.
The seam welding is similar to spot welding, except that circular rolling electrodes are used to produce a continuous air-tight seam of overlapping welds. Overlapping continuous spot welds seams are produced by the rotating electrodes and a regularly interrupted current.



(Fig. 3.9): Resistance Seam Welding

Applications

1. It is used for making leak proof joints in fuel tanks of automobiles.
2. Except for copper and high copper alloys, most other metals can be seam welded.
3. It is also used for making flange welds for use in watertight tanks.

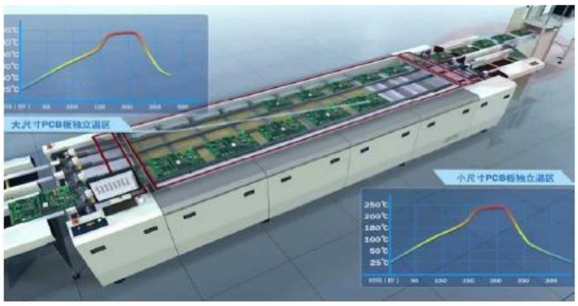
3.5 Soldering

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 bond 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.

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 components.

3.5.1 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.

	
Hand soldering components on PCB	Industrial oven for surface mount

(Fig. 3.10): Different Types of PCB Soldering

3.5.2 Types of Solder

There are different types of solder used for electrical work. They are broadly classified as tin/lead solders or lead free solders.

3.5.3 Types of PCB

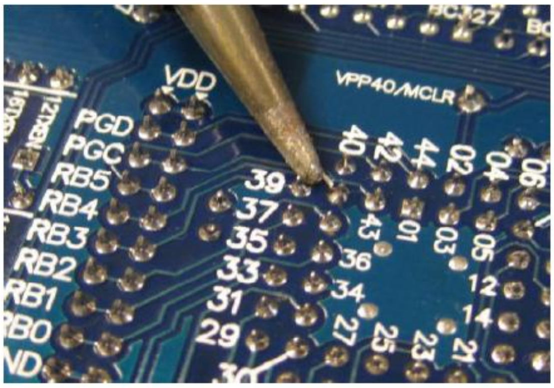
Printed circuit boards (PCBs) are populated by electronic components and these may be "surface mount" or "through-hole" types.

3.1 Through-Hole Components:

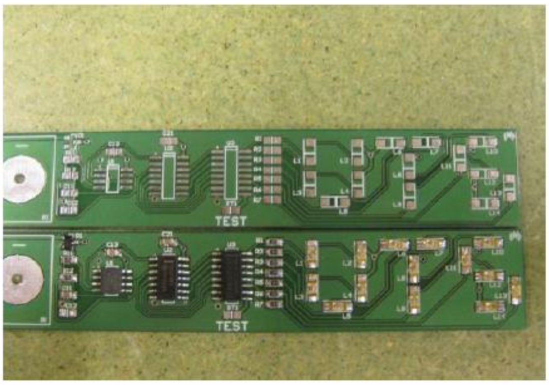
As the description "through-hole" suggests, the leads of the component are passed through holes in the PCB and then soldered to a "pad" on the reverse side of the PCB. Soldering is accomplished by heating the component lead and PCB pad with a soldering iron and melting solder wire into the joint.

3.2 Surface Mount Components:

Commercial circuits are mostly of the surface mount type as these are cheaper to make, more compact and easier to automate assembly. For surface mount construction the component's pads are on the same side of the PCB as the component and the component connections sit onto these pads. Soldering is accomplished by applying solder paste onto component pads on the PCB, placing the component onto the paste and then heating the entire assembly to melt the solder. Commercial assembly uses ovens to heat the boards.



Through-hole PCB
(non-component side)



Surface mount PCB
(component side)

(Fig. 3.11): Different Types of PCB

3.5.4 Flux

For electrical soldering both solder wire and solder paste contain flux. This helps to clean the surfaces being soldered and prevent oxidization of the hot solder. The composition of the flux will vary depending on whether it is in a paste or wire, leaded or unleaded solder. Solder wire usually contains a flux called "rosin". Most fluxes will produce fumes when the solder is heated and these fumes are likely harmful to your health. For occasional soldering it may be sufficient to have a well-ventilated workspace but for longer or repeated exposure a fume extractor should be used. Solder flux can also cause solder to spatter and eye protection should be worn when soldering.

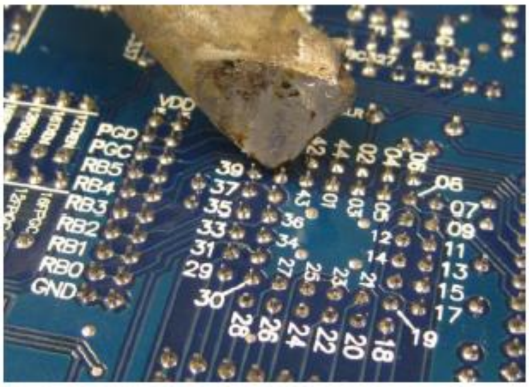
3.5.5 Soldering Irons

Soldering irons come in many varieties and sizes. Soldering irons may be electric, gas powered or externally heated. Most common types are electric. Simple electric soldering irons have no controls and you simply plug them in and wait for them to heat up. Their temperature is regulated by the power of the heating element and heat loss to the environment. Some soldering irons have temperature controls which allow the user to set a desired operating temperature for the soldering iron. This is useful if the soldering iron is being used for different types of solders which have different melting points or if the soldering iron is being used for other purposes such as heating heat shrink.

A temperature of around 320 °C works well for 60/40 leaded solder. Some temperature controlled soldering irons use interchangeable tips to change the temperature at which they operate.

Heat is transferred from the tip of the soldering iron to the joint by thermal conduction enabled by metal to metal contact between the tip and joint. The tips of soldering irons come in various shapes and sizes to enable the best contact to be made. Most tips are either conical or chisel shapes. The shape is largely a personal preference and you can use whichever type works best for you. The size of the tip should be selected to allow the tip to be placed against the joint being soldered without interfering with adjacent parts. The tip should be large enough to conduct sufficient heat into the joint to allow the solder to melt and flow properly. The choice of tip size is not a precise calculation and a “normal” size tip will work for most joints on a PCB.

A range of electric soldering irons

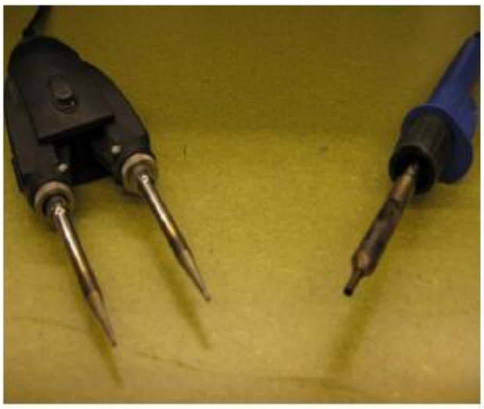


Choose an iron appropriate for your task!

(Fig. 3.12): Types of soldering irons

3.5.6 Desoldering

If a part that has been soldered needs to be replaced it needs to be “de-soldered”. Depending on the part and type of joint it may be possible to simply re-melt the solder and remove the part, or it may be necessary to remove the solder from the joint so the part can be freed. Some methods for removing solder are solder wick, solder sucker or de-soldering tool. Solder wick is a copper braid which is applied to the joint and heated with a soldering iron. As the solder in the joint is melted it is drawn into the solder wick like a sponge and is removed from the joint. A solder sucker is a spring loaded syringe or rubber bulb. The tip of the solder sucker is placed near the joint as the joint is melted by a soldering iron. When the sucker is operated a vacuum is created which draws the molten solder from the joint into the body of the sucker. A de-soldering tool is a type of soldering iron with a hollow tip and is connected to a pump or vacuum source. The tip of the de-soldering tool is placed onto the joint, typically over a component lead, and once the solder has melted the pump is operated to draw the molten solder away.

	
Solder wick, syringe type sucker, vacuum de-soldering tool	Hot tweezers or Hot air nozzle are options for SMDs

(Fig. 3.12): Desoldering tools

3.5.7 Hazards involved in soldering

3.5.7.1 Heat

Although solder has a relatively low melting point this temperature is more than high enough to cause serious burns to people or objects. It is important to hold the soldering iron only by the insulated handle, never touch the heating element or tip when the soldering iron is on.

3.5.7.2 Toxic materials

Leaded solder contains lead which is a harmful material. Use of this type of solder will probably involve handling it and your skin may become contaminated by it. Although it is unlikely that the lead can be absorbed directly through your skin it may be ingested indirectly if it is transferred by handling food whilst your skin is contaminated. Always wash your hands thoroughly before eating or handling food.

Solder flux creates fumes when heated during soldering which may be harmful if inhaled. Use a fume extractor to avoid inhaling fumes.

3.5.7.3 Spattering

Solder and flux can spit or spatter when heated. Always wear eye protection (safety glasses) when soldering.

3.5.7.4 Electrical Safety

Electric soldering irons are plugin appliances and must have a current safety test tag. The test will confirm that the soldering iron conforms to electrical safety standards and has not been damaged at the time of the test. Before use you should visually check that the soldering iron does not have damage such as melted insulation on the lead, broken or cracked handle or exposed conductors. Don't use damaged equipment and report the damage.

For electrical safety the exposed metal parts such as the tip and heating element are earthed. Don't solder on any live equipment as contact with the earthed tip may cause damage to the equipment or soldering iron.

4
Chapter

Engineering Metrology

4.1 Measuring Instruments

Some common measuring instruments generally used in bench work or fitting shop aremicrometer, Vernier caliper, depth gauge, and Vernier height gauge. These are discussed as under.

4.1.1 Micrometers

The micrometers are commonly employed for measuring small dimensions with extremeaccuracy of 0.01 mm. They may be of the three kinds -

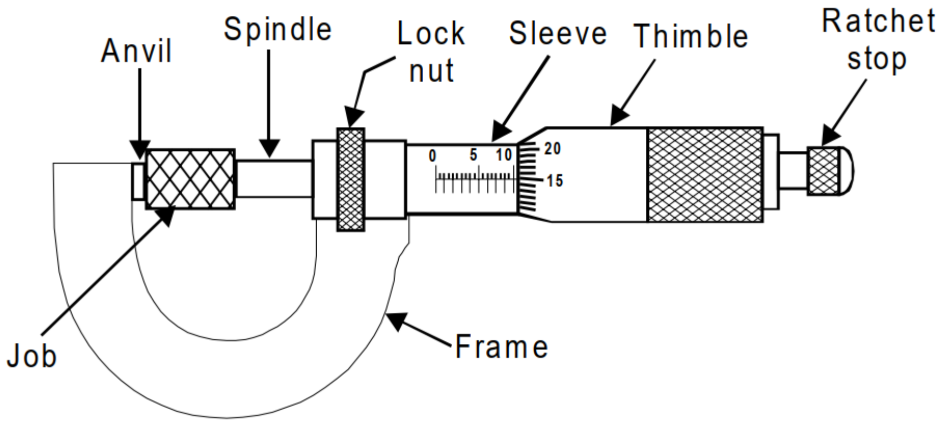
a) External micrometer for measuring external dimensions,
b) Internal micrometer for measuring internal dimensions, and
c) Depth micrometer for measuring depths.

For measuring a dimension in external micrometer, the work piece is held between thefixed anvil face and the spindle face of the micrometer. The spindle of the micrometer isallowed to move linearly towards the work by rotating thimble. When the spindle will touchthe work piece properly, the ratchet will give its sound. The small locking lever is thenrotated to clamp the spindle so that reading can be taken more accurately. Outside micrometersare used for measuring the outside dimensions of jobs, such as diameter of a bar, rod andthickness of plate. Generally, until and unless they are provided with the Vernier attachment,the former can read up to 1/1000 or 0.001 inch and the latter up to 0.01 mm. The former isknown as inches micrometers and the latter metric micrometers, which are gradually replacingthe former due to the introduction or adopting of metric system. Inside micrometers arecommonly used for measuring inside dimensions of the objects, such as inside dia. of a hole,width of a slot or cavity, etc. The outside micrometers are the most extensively used inindustrial applications. All the micrometers, irrespective of the fact as to whether they carrygraduations in inches or millimeters, are similar in construction. An out-side micrometer isdiscussed as under.

4.1.1.1 Outside micrometer

Fig. 4.1 shows an outside micrometer. It consists of the following main parts.

1. Metallic frame
2. Axial graduated sleeve
3. Circumferential screwed spindle
4. Hardened steel anvil
5. Thimble
6. Ratchet stop screw
7. Lock nut



(Fig. 4.1): Outsidemicrometer

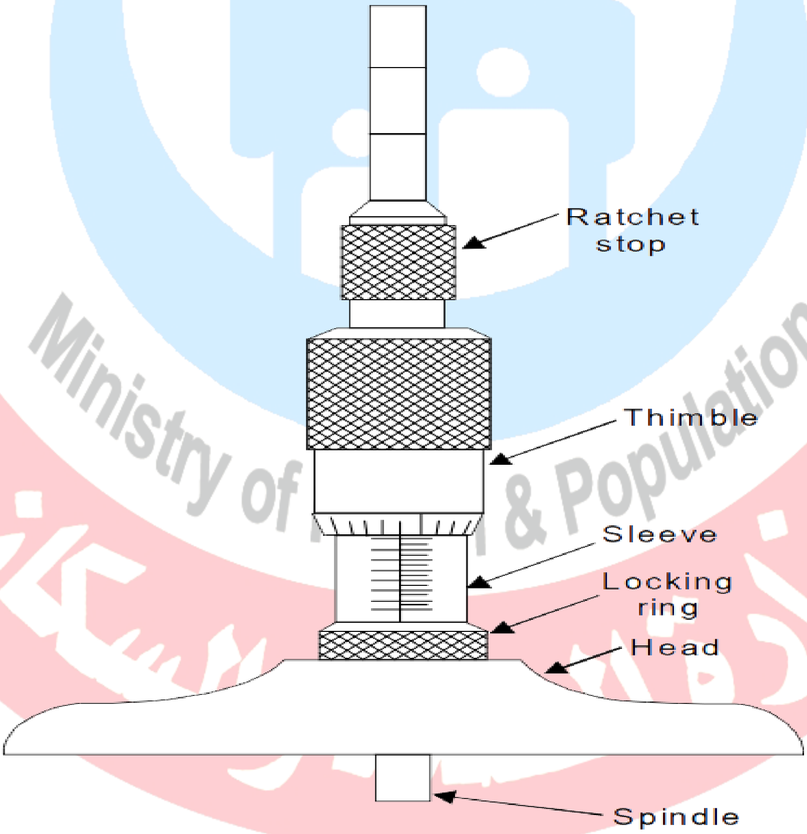
Micrometer works commonly on the principle of nut and bolt assembly. The sleevecarries inside threads at the end, which forms the nut, and the screwed part of the spindlepasses through it. The spindle and the thimble are secured to each other such that by rotatingthe thimble the spindle rotates. With the result, when the thimble is revolved, it advancestowards or retards away from the fixed anvil, together with the spindle of the micrometer.The sleeve carries the graduations, which, in conjunction with the beveled and graduated partof the thimble, give the measure of the opening between the end faces of the anvil and thespindle. The ratchet arrangement provided at the end of the thimble prevents the spindlefrom pressing further against the surface of the piece being measured after the required feelhas been attained, thus facilitating a uniform reading and preventing the instrument frombeing damaged. Lock nut or locking lever is used for locking the micrometer for a desiredamount of time after taking or setting the reading. The construction of the outside micrometers discussed as under.

COMMON PARTS OF OUTSIDE MICROMETER

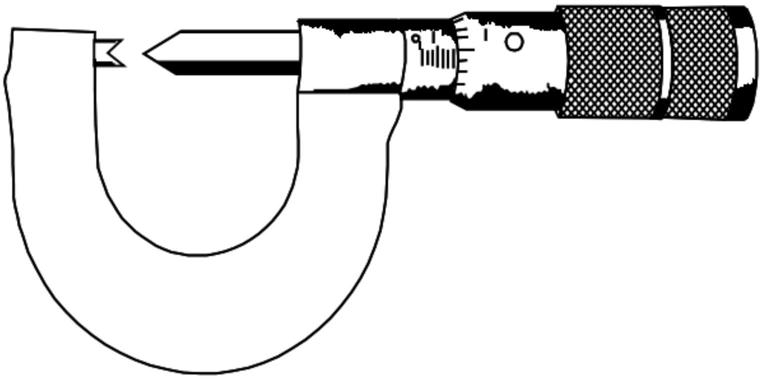
(1) Frame. The U frame of micrometer is made of steel, cast steel, malleable cast iron or light alloy.
(2) Hardened anvil. It protrudes from the frame for a distance of at least 3 mm for holding and supporting the jobs for measurement.
(3) Screwed spindle. It does the actual measuring and possesses threads of 0.5 mm pitch.
(4) Barrel or Sleeve. It has datum or fiducially line and fixed graduations.
(5) Thimble. This is a tubular cover fastened with the spindle and moves with the spindle. The beveled edge of the thimble is divided into 50 equal parts, every fifth being numbered.
(6) Ratchet. This part is commonly recognized as friction stop of the micrometer, which acts as a precautionary measure also. It is a small extension to the thimble in which the ratchet slips when the pressure on the screw exceeds a certain amount. This produces uniform reading and prevents any damage or distortion of the instrument.
(7) Spindle clamp. It is used to lock the instrument at any desired setting or at any particular reading.

4.1.1.2 Readingonmicrometer

It works on the fine assembly of nut and bolt principle where pitch of both nut and bolt playsa big role. The graduation on the barrel of micrometer is in two parts, namely one above thereference line and the other below. The higher line graduation above the reference line isgraduated in 1 mm intervals. The first and every fifth are long and numbered 0, 5, 10, 15,20 and 25. The lower or small graduations are graduated in mm intervals but each graduationshall be placed at the middle of the two successive upper graduations to be read 0.5 mm. Themicrometer screw has a pitch of 0.5 mm, while the thimble has a scale of 50 divisions roundits circumference. Thus, on making or rotating through one complete turn, the thimblemoves forward or backward by one thread pitch of 0.5 mm, and one division of its scale is,therefore, equivalent to a longitudinal movement of $0.5 \times 1/50$ mm = 0.01 mm. It is the valueof one division on the thimble, which is the least that can be correctly read with the help ofa micrometer and is known as the least count. For measurement, the job is kept betweenthe end of the spindle and the fixed anvil, which is fitted to the frame. When the micrometeris closed, the line marked 0 (zero) on the thimble coincides with the line marked 0 (zero) onthe graduated sleeve. In metric outside micrometer, the pitch of the spindle screw is 0.5 mmand the graduations provided on the spindle of themicrometer is in millimeters and subdivided into0.5 mm. Now in one turn of the thimble of themicrometer, owing to the 0.5 mm. pitch of thespindle screw, the spindle will move through 0.5mm and therefore, the corresponding openingbetween the faces of the fixed anvil and the spindlewill be 0.5 mm. This opening will go on increasingby the same distance 0.5 mm for each furtherrotation of the thimble. The beveled edge of thethimble carries 50 equal divisions on its peripheryin which every 5th division is marked. It is seenabove that for one complete turn of the thimblethe spindle moves through 0.5 mm. Now let thethimble is rotated one small division on its bevelededge i.e. 1/50 of the turn. The correspondingdisplacement of the spindle will then be 0.5 × 1 /50 = 0.01mm.Depth micrometer is used for measuring depth ofholes and is shown in Fig. 4.2. Screw threadmicrometer (Fig. 4.3) is used to measure the pitchdiameter of the thread to an accuracy of 0.01mmand 0.001 inches. It comprises of similar parts asthat of outside micrometer accept the shapes of fixedand moveable anvils. The fixed and moveable anvilspossess the thread profiles for thread adjustmentfor measurement of the pitch diameter.



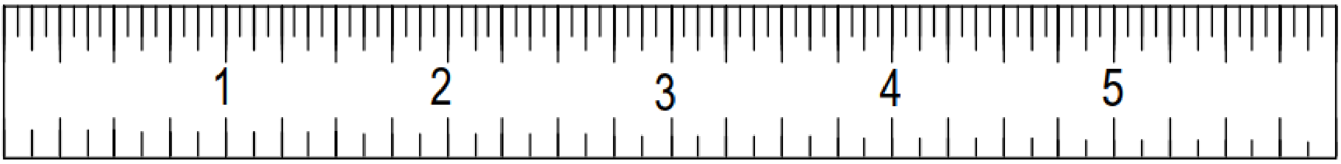
(Fig. 4.2): A depth micrometer



(Fig. 4.3): A screw thread micrometer

4.1.2 Steel Rule

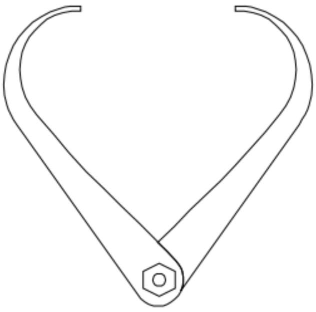
It is the simplest measuring tool just like a scale used in fitting shop. A six inch semiflexible rule is shown in Fig. 4.4 Other types of rules are described in the chapter oncarpentry shop. Most of the dimensions are measured by the steel rule in workshops.



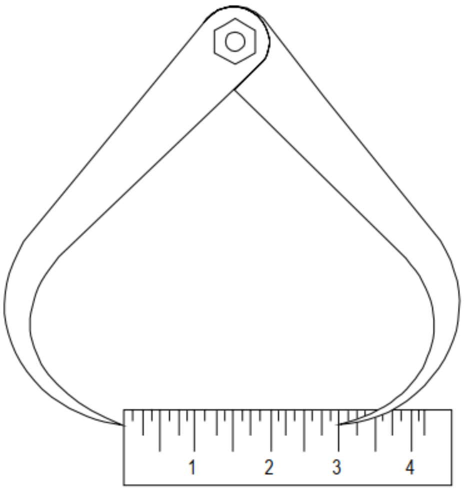
(Fig. 4.4): Steel Rule

4.1.3 Caliper

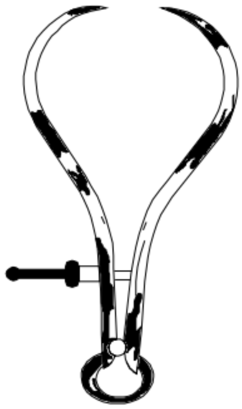
Calipers are generally of two types inside and outside to make internal or externalmeasurements. They do not have direct scale reading. They transfer the measurement fromjobs to scale or vice versa. Fig. 4.5 shows a simple outside caliper. The caliper is held ina rule as shown in Fig. 4.6 to read the size. It is used to make external measurement suchas thickness of plates, diameter of sphere and cylinders. Fig. 4.7 shows the standard springjoint outside caliper.



(Fig. 4.5): A simple outsidecaliper



(Fig. 4.6): A caliper held in rule

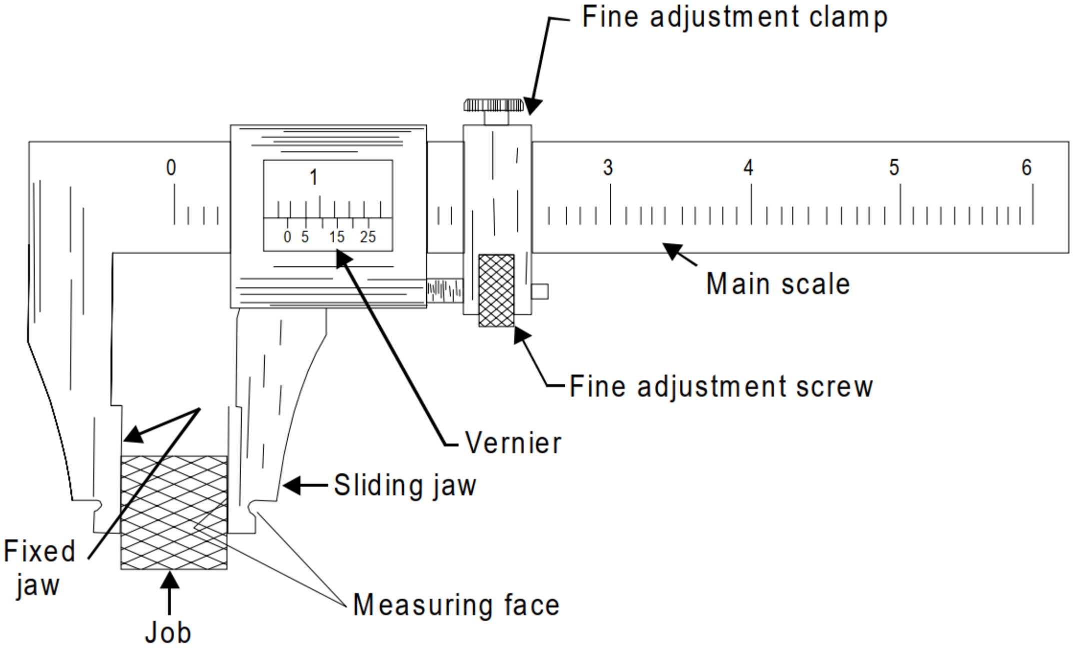


(Fig. 4.7): A standardspring joint outside caliper

4.1.4 Vernier Caliper

Fig. 2.8 shows the Vernier caliper, which is commonly used to measure accurately

(1) outside diameters of shafts,
(2) thicknesses of various parts,
(3) diameters of holes or rings and
(4) internal dimensions of hollow jobs or articles.



(Fig. 4.8): A Vernier caliper

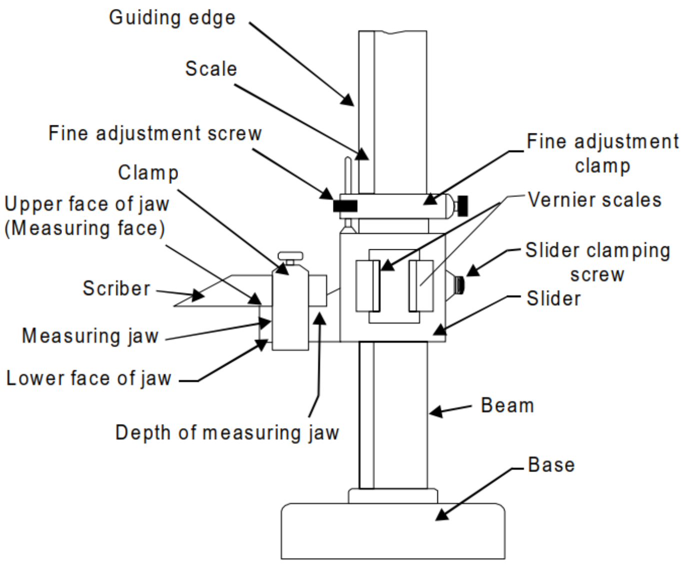
It works on the principle of Vernier and can measure the dimensions to an accuracy of0.02 mm. For making a measurement of external dimensions, the job is placed between thefixed and the movable jaws. The movable or the sliding jaw is moved until it almost contactsthe job kept against the fixed jaw. The sliding jaw assembly of the Vernier caliper that carriesthe fine adjustment screw should be clamped to the graduated beam with the help of adjustmentclamp. The two jaws are then brought into contact with the job by moving the sliding jawwith the help of fine adjustment screw. The jaws should make now definite contact with thejob but should not be tight. The main slide assembly is then locked to the beam with helpof clamp. The caliper is then carefully removed from the job to prevent springing the jawsand the reading is taken. For making a measurement of internal dimensions, the job is placedoutward between the fixed and the movable jaws meant for measuring inner dimension.

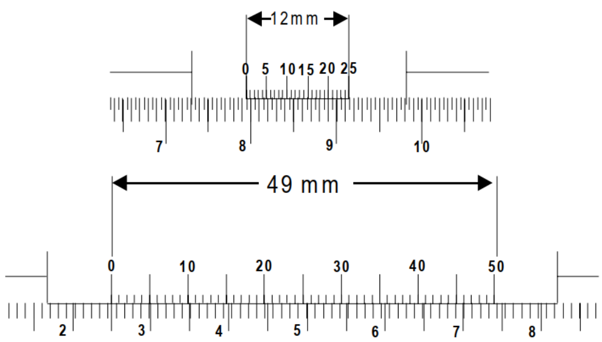
4.1.5 Vernier Depth Gauge

Vernier depth gauge is basically employed for checking depths of blind holes such asgrooves, slots, depth of key ways and heights of shoulders, etc. The principle on which itworks is the same as that of a Vernier caliper. It is available with similar measuring accuraciesas the Vernier caliper and readings are taken the similar manner. It consists of a movablehead with a base, which moves along the beam. A main scale on the beam and Vernier scaleon the sliding head with fine adjustment screw are incorporated in the similar manner as ina Vernier caliper.

4.1.6.Vernier Height Gauge

Fig. 2.9 illustrates the Vernier height gauge, which is employed for measuring theheight of parts and in precision marking work. It consists of a heavy base, an accuratelyfinished bottom, a vertical bar mounted square to the base, carrying the main scale, a slidinghead with Vernier, an auxiliary head with fine adjustment screw and nut and a bracketattached to the sliding head. This bracket is provided with a clamp by means of whichinterchangeable jaws can be fixed over there. The jaws can be fixed for measuring height orreplaced by scribing jaws according to requirement or need. The graduations on the heightgauge are given in Fig. 4.10.



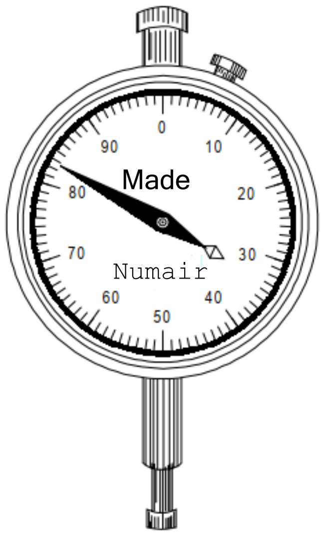


(Fig. 4.10): A graduation on the Vernier height gauge

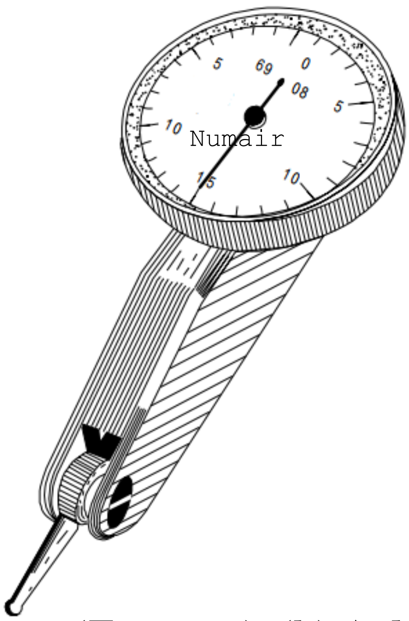
(Fig. 4.9): Vernier Height Gauge

4.1.7 Dial Indicators

The dial indicators are also known as dial gauges and are shown in Fig. 4.11 (a, b). Theyare generally used for testing flatness of surfaces and parallelism of bars and rods. They arealso used for testing the machine tools. They are available in both metric as well as in inchesunits. Inches dial indicator of 0.001" measuring accuracy is in commonly used but they arealso available up to an accuracy of 0.0001". The commonly used metric dial indicator has anaccuracy of 0.01 mm. Those having 0.001 mm accuracy are also available, however they areused in highly precision measurement work.



(Fig. 4.11): (a) A continuous typedial indicator



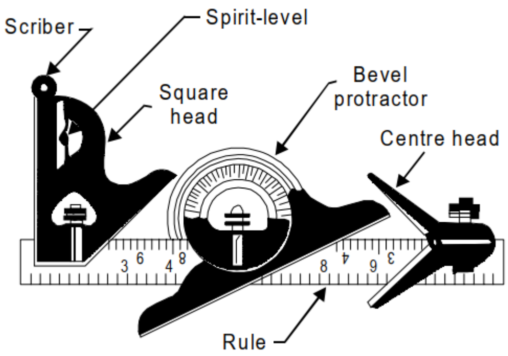
(Fig. 4.11): (b) A dial indicator ofBrown and Sharp Co.

4.1.9 Bevel Gauge

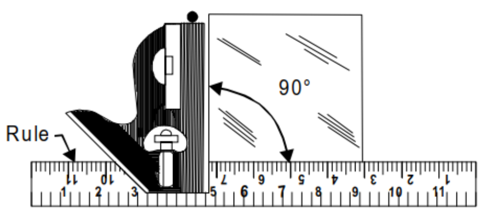
An adjustable bevel gauge is widely used for checking, comparing or transferring anglesand laying out work. It comprises of two adjustable blades, which can be positioned intoalmost any orientation to adjust any required angle. However, the direct reading is notobtained and the angle must be set or checked from some other angular measuringinstrument.

4.1.10 Combination Set

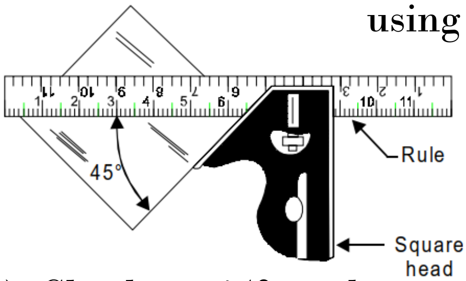
Combination set is an important instrument which has the combination of instrumentsnamely square head, a center head, and a bevel protractor and sprit level as depicted in Fig.4.13. It is a very useful instrument frequently utilized in the bench work and machine shopmeasurements. The three portions of the combination set are used separately being heldin at any desired position by nuts which engage in a slot machined on the whole length ofthe beam at its back. The beam of the instrument acts as a rule, which is marked in inchesor centimeters or in both for measuring the length and height as and when required. Thesquare head possesses one edge square to the rule, giving a right angle, whereas the otheredge form an angle of 45°. It is provided with a spirit level. The scale on the protractor maybe divided into degrees or a Vernier attached whereby the angle can be measured in degreesand minutes. It is also fitted with a spirit level to help in leveling the work of setting itat an angle. The center head with the rule fastened to it is called a center square. It hastwo arms at right angles to one another and is so set on the rule that this angle is exactlydivided in two by the edge of the rule. It may be used to find the center of a round bar orshaft. Spirit level is commonly used for checking levels and other measurement. It isdesigned to handle measurements, layout and checking of angles. The square head is usedfor checking 90° angle or as a square as shown in Fig 4.14. The protractor head may beutilized with a rule to measure angles or to measure the slope of a surface as shown inFig. 4.15



(Fig. 4.13): A combination set



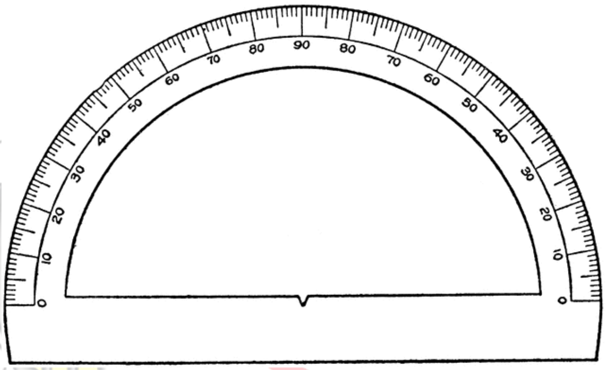
(Fig. 4.14): Checking 90° angle using combination set



(Fig. 4.15): Checking 45° angle using combination set

2.1.11 Semi-circular Protractor

It resembles with a semi-circular protractor and is commonly used is geometrical drawings.Protractor used in sheet metal work is made from steel and often required for making ormeasuring angles.



4.1.12 Slip Gauges

Slip gauges are also called as precision gauges blocks. They are made of rectangular blocksusing alloy steel, which are being hardened before finishing them to size of high degree ofaccuracy. They are basically used for precise measurement for verifying measuring tools suchas micrometers, comparators, and various limit gauges. The distance between two oppositefaces determines the size of the gauge. They are made in higher grades of accuracy. The grademost commonly used in the production of components, tools, and gauges is Grade I, for roughwork. Grade II and for checking other gauges. They are supplied in sets, the size of whichvaries from a set of about 112 pieces down to one containing 32 pieces. In English measurementthere are five sets containing 81,49,41,35 and 28 pieces. An 81-set has a wide range of combinationbut for general purpose a 49-set is usually preferred. The measurement is made by end to endassembly of slip gauge blocks and very little pressure in wring form is being applied.

5
Chapter

Industrial Safety

5.1 COMMON SAFTY METHODS

The common methods of safety are as follows:

1. Safety by construction or design.
2. Safety by position.
3. Safety by using fixed guards.
4. Safety by using interlock guards.
5. Safety by using automatic guards.
6. Safety by using trip guards.
7. Safety by using distance guards.
8. Safety by workplace layout and proper working conditions.
9. Safety by proper material handling.
10. Safety by using personal protective devices.

5.1.1 Safety by Construction

Whenever the new tools, devices, equipment and machine are designed, they should beensured that all their dangerous parts are either enclosed in suitable housings or providedwith suitably designed safety guards in order to eliminate any chances of danger that couldoccur due to exposure of the dangerous parts. A common example involve belt drive andmotor in a in drilling machine, lathe, milling or in other machines are enclosed, the backgears and tumbler gears in a lathe are either enclosed or provided with cast iron guards orcovers. All control levers and handles of machines should be carefully located to ensureadequate safety in their operation. Generally, lubricating points are provided on the outersurface that the interior parts are not required to be opened every now and then.

5.1.2 Safety by Position

The main principle involved in the method for safety by position is to design the machineinsuch a way that the dangerous parts are so located or placed that they are always beyondreach of the operator. It is therefore always advisable that all the dangerous parts of themachine should invariably be guarded or enclosed in the body or housing of the machines asfar the design conditions permit. If it is not possible suitable external fencings must beincorporated suitably.

5.1.3 Safety by Using Fixed Guards

Such fixed guards either form an integral part of the machine or are so tightly secured tothem that they are not easily removable. In all cases, fixed guards are developed to have arobust and rigid construction and they should be so placed that any access to the dangerousparts of the machine is totally prevented from all directions particularly in the runningcondition of the machines. Fixed guards adjusted in position remain fixed and they areneither moved nor detached. In some cases the fixed guards are provided at a distance fromthe danger point. Such a provision will carry a remote feeding arrangement and, therefore,the operator will not be required to go near the dangerous points.

5.1.4 Safety by Using Interlock Guards

An interlocking guard may be mechanical, electrical, pneumatic or some sort of a combinationof these. Such guards cannot be removed and the dangerous parts are not exposed until andunless the machine is totally stopped. Similarly, the machine cannot be started to work unlessthe guards return in position and protects the dangerous parts. It is essential that suchguards should always acquire their positions to guard the dangerous parts before the machinecan be started,. Such arrangements prevent the starting and operation of the machine in casethe interlocking device fails and remain closed in position until the dangerous part is completelyat rest. Scotch interlocking and control interlocking designs of these guards are common usedto protect accidents. The former interlocking consists of a solid metal piece, called scotchconnected to it which is so located that it remains between two moving parts of the machine.This prevents the machine from starting so long as the same is not removed and the guardbrought in proper position for protection. The latter comprises of the movable portion of theguard as connected to some starting device or mechanism of the machine viz., fast and loosepulleys, clutch, starter of the motor or tile hydraulic valve, etc. This connection is made insuch a way that it will not allow the operation of the said device or mechanism until andunless the guard is brought in protecting position, which automatically enables its removal from that position from where it prevents the operation of the starting mechanism.

5.1.5 Safety by Using Automatic Guards

The main principle of an automatic guard is that its operation is actuated by some movingpart of the machine. Automatic guard and machine operation is so linked that the part willautomatically bring the guard in protecting position before the operation of the machinestarts. The design of this guard is of such a kind that it automatically forces the operator tomove away from the dangerous area of work before the operation starts. Such arrangementof such guard does not permit the operator access to this area again until and unless themachine stops. The use of such guard is largely favored for heavy and slow acting machineslike heavy power presses.

5.1.6 Safety by Using Distance Guards

Distance guard helps to fence the dangerous components of machine such as bars or rails andposition them at a suitable distance from the machine such that even operator by chance,extends his hands over it, his fingers, clothes or any of the body does not reach within thearea of dangerous parts. For additional safety, some sort of tripping device should always beincorporated to stop the machine rapidly in case of an accident.

5.1.7 Safety by Using Trip Guards

Trip guard in machine is comprised with tripping device which enables quick stopping orreversal of the motion of machine as soon as the operator approaches within the reach ofdangerous parts. Tripping device and the trip guard works in close conjunction with eachother during problematic situations.

5.1.8 Safety by Workplace Layout and Proper Working Conditions

Some safety using workplace layout and proper working conditions are given as under:

1. A suitable layout and proper working conditions play an important role in preventing accidents which would have otherwise occurred.
2. Moving path or passage ways should be clearly marked and never be obstructed.
3. Every employee should have enough space to move and operate the machine.
4. The floor condition must be of non-skid kind. It should act as a satisfactory plane which can be easily cleaned.
5. Height of working rooms should be adequate for proper ventilation and lighting.
6. Fire walls should be used to separate various compartments.
7. Windows should have adequate size and should be in adequate numbers.
8. Illumination should be sufficient, continuous, uniform and free from glare.
9. Proper ventilation should be there in workplace.
10. Noise level should be proper if any. If it is high, use silencers to minimize the noise level.

5.2 TYPES OF SAFETY

The following general types of safety are considered in the workshop

1. Safety of self.
2. Safety of job.
3. Safety of machines tools.

However there are general safety precautions to be adopted while working in any workshop

5.2.1 General Safety Precautions while Working in a Workshop

1. One should not leave the machine ON even after the power is OFF and until it has stopped running completely. Someone else may not notice that the machine is still in motion and be injured.
2. Operator should not talk to other industrial persons when he is operating a machine.
3. One should not oil, clean, adjust or repair any machine while it is running. Stop the machine and lock the power switch in the OFF position.
4. One should not operate any machine unless authorized to do so by the authorize person in the shop.
5. Always check that work and cutting tools on any machine are clamped securely before starting.
6. The floor should be kept clean and clear of metal chips or curls and waste pieces.Put them in the container provided for such things. Scraps and chips or curls maycut through a shoe and injure the foot.
7. Defective guards must be replaced or repaired immediately.
8. One should not operate any machinery when the supervisor or instructor is not in the shop.
9. All set screws should be of flush or recessed type. Projecting set screws are very dangerous because they catch on sleeves or clothing.
10. One should not try to stop the machine with hands or body.
11. Only trained operator should operate machine or switches as far as possible.
12. Always take help for handling long or heavy pieces of material.
13. Always follow safe lifting practices
14. No one should run in the shop at work time.

15. Always keep your body and clothes away from moving machine parts. Get first aid immediately for any injury.
16. Never talk to anyone while operating the machine, nor allow anyone to come near you or the machine.
17. Stop the machine before making measurements or adjustments.
18. Operator should concentrate on the work and must not talk unnecessarily while operating the machines.
19. Never wear necktie, loose sweater, wristwatch, bangles, rings, and loose fitting clothing while working in workshop.
20. Always wear overcoat or apron.
21. Stop machines before attempting to clean it.
22. Make sure that all guards are in their place before starting to operate a machine.
23. Do not attempt to operate a machine until you have received operating instructions.
24. Be thoroughly familiar with the 'stop' button and any emergency stop buttons provided on the machines.
25. Remove burrs, chips and other unwanted materials as soon as possible. They can cause serious cuts.
26. Do not leave loose rags on machines.
27. Wash your hands thoroughly after working to remove oils, abrasive particles, cutting fluid, etc.
28. Report all injuries to the foreman, howsoever small. Cuts and burns should be treated immediately.
29. Keep the work area clean.
30. Keep your mind on the job, be alert, and be ready for any emergency.
31. Always work in proper lighting.
32. On should not lean against the machines.

5.2.2 Safety Precautions while Working with Different Hand Tools

(A) Screw Drivers

1. When working on electrical equipment use only a screw driver with an approved handle.
2. One should wear goggles when re-sharpening screw-driver tips.
3. Screws with burred heads are dangerous and must be replaced or the burrs removed with file or an abrasive cloth.
4. One should use the correct tip of screw drivers while screwing. Too arrow or too wide tip will damage the work.

(B) Wrenches

1. One should not hammer a wrench to loosen a stubborn fastener, unless the tool has been specially designed for such treatment.
2. Always pull on a wrench. One can have more control over the tool if pulling instead of pushing and there is less chance of injury.
3. It is dangerous practice to lengthen the wrench handle for, additional leverage. Use a larger wrench.
4. Choose a wrench that fit properly. A loose fitting wrench may slip and round off the corners of the bolt head and nut.
5. When using wrenches clean grease or oil from the floor in the work area. This will reduce the possibility of slipping and losing balance.

(C) Hammers

1. One should not operate the hammer unless its head is tightly fixed to the handle.
2. Place the hammer on the bench carefully. A falling hammer can cause serious foot injuries.
3. Never strike two hammers together. The faces are very hard and the blow might cause a chip to break off.
4. Never hold the hammer too far on the handle when striking a blow.
5. Unless the blow is struck squarely, the hammer may glance of the work.

5.2.3 Safety Precautions while Working with Different Cutting Tools

(A) Files

1. One should always use a file card to clean the file. Never use your hand. The chips may penetrate in hand and cause a painful infection.
2. One should not use a file without a handle.
3. Short burns formed in filling may cause serious cuts. Always use a piece of cloth to wipe the surface being field.
4. Files are highly brittle and should never be used as a hammer otherwise the file will break.
5. Never hammer on a file. It may shatter and chips fly in all directions.

(B) Chisels

1. One should always hold the chisel in such a manner that the hammer blow may not miss the chisel to injure your hand.
2. Edges of metal cut with the chisel are often sharp and cause bad cuts.
3. Flying chips are dangerous. Wear transparent plastic safety goggles and use a shield, when using a chisel, to protect yourself and those working near you.
4. Sharp edges of chisels are removed by grinding or filing.
5. Mushroomed head of the chisel should be removed by grinding.

(C) Saws

1. One should not test the sharpness of the blade by a running a finger across the teeth.
2. One should not brush away the chips with your hand.
3. All hard blades can shatter and produce flying chips. Wear your toggles.
4. One should not be sure that the blade is properly tensioned.
5. Store the saw so that you will not accidentally reach into the teeth when you pick it up.
6. If the blade breaks while you are on cutting stroke, your hand may strike the works and cause an injury. Therefore saw operator should work carefully.

(D) Reamers

1. One should remove all bars from the reamed holes.
2. Never use your hands to remove chips and cutting fluids from the reamer and work. One should use a piece of cotton waste.

(E) Taps and Dies

1. One should use a brush to clean away chips formed by hand threading. Never use your hand.
2. One should always wear goggles if the tap, die or threaded piece is to be cleaned with compressed air.
3. Tap operator should also be careful that other person working in the area also wearing goggles.
4. Handle broken taps as you would handle broken glass. They are sharp edges and are dangerous to handle.
5. Wash your hands after using cutting fluid. Skin-rashes caused by some cutting fluids can develop into a serious skin disorder if they are left on the skin for a long period.
6. Take care of any cuts immediately. Infection may occur when injuries are not properly treated.

(F) Abrasives

1. If the lathe is used for polishing make sure that the machine is protected from the abrasive grains that fall from the polishing wheels during polishing. They can cause rapid wear of the precision parts.
2. One should not rub fingers or hand across a piece that has just been polished by abrasive.
3. Cuts and burns should always be treated immediately by using first aid facility.
4. One should remove all abrasive particles by washing them thoroughly after the polishing operation.

5.2.4 General Safety Precautions while Working in Machine Shop

The following safety precautions or guidelines are generally adopted for every metal cuttingor machining shop. They must be strictly followed for safety. Specific safety guidelines forsome of the machine process like lathe, drilling, shaping, planning slotting, grinding, milling,and finishing operations are also described in the following sections.

1. One should use the correct tools and work holding devices recommended for the process.
2. One should hold the work piece and tool securely on the machine.
3. One should clamp the tool correctly. An overhanging tool may cause catastrophic failure of the tool, work piece or the machine tool.
4. One should not try to remove chips from the machine with your hands.
5. Never use compressed air from mouth. Use brush.
6. One should not touch a job-piece with bare hands while doing inspection or removing it from the machine. Use gloves always.
7. One should operate the machine at recommended operating conditions based on work material and tool material combination and other cutting conditions specified.
8. One should use recommended coolant depending upon work-tool material combination.
9. During machining ductile materials, use chip breakers and chip guards.
10. One should re-sharp the tools immediately when it starts producing rough surfaces on the job-piece or produces chatter.
11. One should not run the machines at speed higher than recommended. It may produce vibrations and chatter and damage job-piece, tool, or both.
12. Provide sufficient approach and over travel distances wherever necessary.
13. In case of power failures, switch off the machine and retrieve tool from the workpiece.
14. One should wear goggles to protect eyes from flying chips.
15. Machines are governed by the old clinch garbage input, garbage output. The skill of the operator is often the limiting factor for the machining operation.
16. Stop machine before attempting to clean, removing tool or workpiece.

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General Directorate of Technical Education for Health