BIRLA VISHVAKARMA MAHAVIDYALAYA
ENGINEERING COLLEGE
(An Autonomous Institution)

Mission
'Produce globally employable innovative engineers with core values.'

Vision
- Re-engineer curricula to meet global employment requirements.
- Promote innovative practices at all levels.
- Imbibe core values.
- Reform policies, systems and processes at all levels.
- Develop faculty and staff members to meet the challenges.

ES112: Basics of Manufacturing Practices
Laboratory Manual
A.Y. 20 - 20

Semester	
Student Name	
Student ID No.	
Batch & Branch	

Department of Mechanical Engineering

BIRLA VISHVAKARMA MAHAVIDYALAYA

Engineering College
(An Autonomous Institution)
VALLABH VIDYANAGAR

CERTIFICATE

This is to certify that Mr. / Ms. ___________________________________ *I.D. No.*______________________ *Batch* __________ *Division* ______ *Branch* _____________ *has completed his/her term work in the course:* ***ES112 Basics of Manufacturing Practices*** *within the Workshop of the college during the* _________ *Semester of the year 202 - 202*

Date: ________________

Place: Vallabh Vidyanagar **Faculty's Signature**

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General Instructions

1. All students must wear shoes in the workshop.
2. Observe safety precaution carefully in the workshop.
3. In case of any damage, malfunction etc. immediately report to your concern instructor/teacher.
4. Strictly follow the practical schedule.
5. Maintain discipline, sincerity, regularity in practical.

1. Introduction to the Workshop Date:

OBJECTIVE:

To orient the students with facilities of the workshop.

Introduction:

The word workshop is a combination of two separate words "work" and "shop". Regarding work Mr. Webster says, "Work is physical or intellectual effort directed to some end either one, physical or intellectual effort taken alone is drudgery, if properly combined, it produces enthusiasm." Shop directs us to place where this work is being properly utilized. So workshop is the place where physical or intellectual efforts get proper utilization. Every engineer is one way or other associated with workshop, whether he may be Civil, Mechanical, Electrical or any other branch.
It is very important to get familiar with workshop i.e. to know:

1. Basic types of workshops.
2. Types of work carried out.
3. Various departments in workshop, their functions and responsibility.
4. Various type of layout.

There are three basic types of workshop:

1. Training workshop, 2. Production workshop, 3. Repair & Maintenance workshop

Training workshop:

Ours is a training workshop. The shop where students are trained is called training workshop. We have the following departments in our workshop.

Carpentry shop:

Here you will know about, various tools and machines used for working on wood, types of wood joints, etc.

Fitting shop:

Here you will learn about various hand tools used to work on metal. Here you will learn about marking, measuring, cutting techniques, etc. This shop will develop your skill to make a part fit with other.

Smithy shop:

This is a place where a work piece is heated and forged to obtain the required shape and size. You will learn various hand tools and equipment’s, processes and technique for the same.

Foundry shop:

Here the pattern is used to prepare mould, after preparing the mould in sand, the molten metal is poured into the mould and after solidification of the metal we will get required casting. To know in detail, we need to learn types of pattern, the processes of mould & the cores for obtaining hollow casting, the various processes to prepare them, sand and its properties and process for preparing sand mould and various techniques of testing above things, which lead to make a good casting.

Machine shop:

Here you will learn about the basic types of machine tools such as lathe, drilling, shaper, slotter, milling, grinding machines and their construction.

Fabrication shop:

Here you will learn about the welding machines, processes and basic fabrication process like metal joining by welding, soldering and brazing.

Sheet metal shop:

Here you will earn about the bending, cutting, shearing and riveting operations, etc. you will learn the use of various hand tools and basic sheet metal operations for metal forming and joining.

Plumbing shop:

Here you will learn about the use of various hand tools and pipe fittings used in plumbing work. Also you will learn to cut thread on pipe and bending operation with the use of pipe bending machine.

Production workshop:

Production or manufacturing can be further classified as below:

1. Mass production 2.Batch production 3.Job production

This classification is based on the nature of production or manufacturing. Where limited varieties of products are being manufactured in large volume can be known as mass production.

Batch production is a type of manufacturing where production is being carried out in some particular batch for some predefined time period for one variety of products. After that batch is over new product in predefined batch quantity is taken up for production for some predefined time span.

In job production, items are being produced as per the-size and design of individual customer.

This environment of production workshop is full of activities. You can see the workman doing his work like working himself, observing the work, guiding the workmen, operating machine, material handling, supervision, etc.

Repair and maintenance workshop:

In this type of workshop repair and maintenance work is carried out.

From the above discussion an engineer must try to learn following things during the workshop training:

(1) Various workshop processes use for changing the shape of material, various processes used for joining or assembling of different parts, etc.

(2) Understand the general routine procedure in the workshop, such as allotment of work, material, inspection, reporting of faults, first aid and reporting of accidents, etc.

(3) Majority of engineers are engaged in workshop on shop floor. This point will help in achieving successful career.

1. Ability to lead, guide and control the group of persons and take decisions.
2. Shop discipline.
3. Sense of cleanliness alertness about wastage of manpower, time and material,
4. Cost consciousness.
5. Safety consciousness.

REVIEW QUESTIONS

1. List various types of shops in BVM workshop.
2. List different type of workshop and give examples of each.

2. **Safety Aspects in the Workshop** **Date:**

OBJECTIVE:

To orient the students with safety aspects of the workshop.

Introduction:

Accidents are miss-happening which results in loss of life and property. Accidents occurring in the industries are called industrial accidents. These are generally due to faulty equipment and machinery or negligence on the part of the workman/ employee.

Definition:

An event or miss happening that occurs unexpected, which may cause or likely to cause an injury is called an accident.

Characteristics of accidents:

1. Accidents are unfortunate sudden happenings about which nothing is known in advance.

2 Life and property are affected by accidents.

3. Due to accidents, work is stopped for a certain length of time.

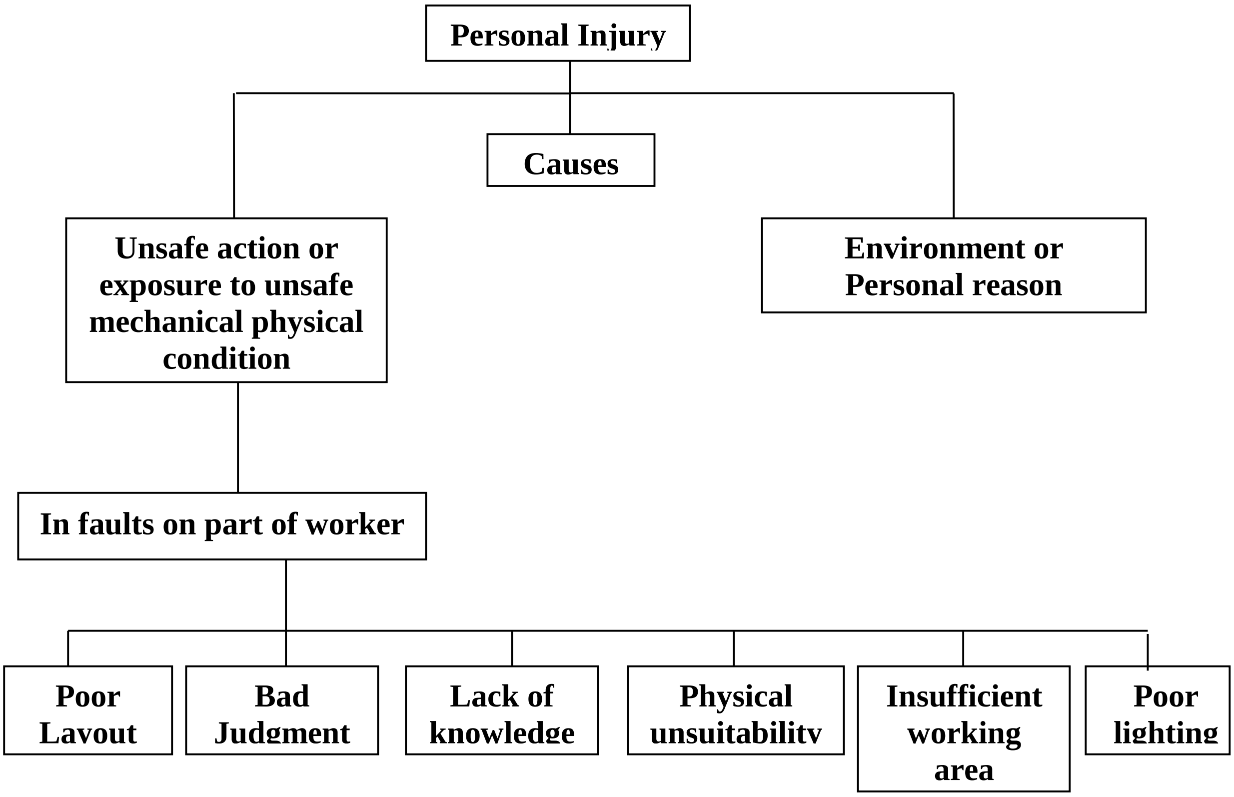
The accident occurrence can be explained by the following chart.

"PROPER DIAGNOSIS SHALL BE DONE FOR EACH ACCIDENT TO PREVENT ITS REOCCORRENCE IN FUTURE."

Cost of accident:

The complete cost of an accident consists of direct cost and indirect cost. Compensation and medical expenses are the direct cost of accidents. Loss of time of injured employee and other employees, supervisor, foreman, etc. , damage to machine or equipment, loss in profit due to less productivity are the indirect costs.

Directly or indirectly the accidents will put a heavy burden on industry and individual. Directly or indirectly the accidents will lead to increase in the cost of final product. Thus in a sense, every employee has to bear a proportion of the cost of accidents. Efforts should be made to prevent and eliminate all such accidents.



1. **Safe machine design:** it is also a responsibility of machine manufacturer to provide a few basic elements in the machine which help in preventing accidents.
2. **General safety hints for shop floor personnel:** over and above the different precautions at different levels, it is the shop floor workman/supervisor whose vigilance is required. The following points must be practiced by workman/supervisor whose vigilance is required:
    1. Do not remove any guard from the machine or any safety device. Any defective guard or device should be reported immediately to the concern supervisor.
    2. Learn to stop the machine first and then familiarize yourself with other operations completely.
    3. Before working on the machine, read the instruction manual carefully.
    4. Any injury must be reported to the concerned supervisor.
    5. Report immediately the faulty tool or machine that is likely to cause an accident. Put a sign board "DO NOT OPERATE" on the machine to avoid accident.
    6. Never wear loose clothing in the shop. Avoid wearing bracelets, finger rings and other jewelry. Avoid wearing synthetic clothes in shop.
    7. Avoid to wear full sleeve cloth and if wore, fold the sleeves.
    8. Always wear apron and safety shoes.
    9. Do not use damaged or worn out tools, as it may become cause of an accidents.
    10. Keep aisles, gangways, and your workplace clean and tidy.

11. Do not look at an electric arc during welding with bare eyes.
12. Always remember the fire exists and the place where fire extinguishers are located. Also know how to use fire extinguishers with respect to class of fire.
13. Do not play mischief in the workshop during working on job.
14. Always wear safety goggles during working.
15. While working on a machine which does not contain safety guards, do not stand in line with the moving machine elements.
16. Be safety conscious and make people safety conscious.

Safety in Workshop

General Safety Guidelines for Working in Workshop

- Do not wear necktie, loose sweater, wristwatch, bangles, rings, and loose fitting clothing while working in workshop,
- Wear overcoat or apron.
- Keep your body and clothes away from moving machine parts.
- Use proper lighting.
- Do not attempt to operate a machine until you have received instructions on its operations.
- Make sure that all guards are in their place before starting to operate a machine.
- Do not move around. Do not tinker with any machine.
- Keep your mind on the job, be alert, and be ready for any emergency.
- Be thoroughly familiar with the 'stop' button and any emergency stop buttons provided on the machines.
- Do not talk to anyone while operating the machine, nor allow anyone to come near you or the machine.
- Stop the machine before making measurements or adjustments.
- Stop machines before attempting to clean it.
- Remove burrs, chips and other unwanted materials as soon as possible. They can cause serious cuts.
- Do not leave loose rage on machines.
- Wash your hands thoroughly after working, to remove oils, abrasive particles, cutting fluid, etc.
- Report all injuries to the foreman, howsoever small. Have cuts and bruises treated immediately.

General Safety Guidelines for Machining Processes

The following guidelines are for every metal cutting or machining process. They must be strictly followed for safety. Specific safety guidelines for the machine process like lathe, drilling, shaping, milling, and finishing operations are also described in the following sections.

- Use the correct tools and work holding devices recommended for the process.
- Fix the work piece and tool securely on the machine.
- Clamp the tool correctly. An overhanging tool may cause catastrophic failure of the tool, work piece or the machine tool.
- Never try to remove chips from the machine with your hands. Use brush, never use compressed air.
- Stop machine before attempting to clean, removing tool or work piece.
- Do not touch a work piece with bare hand while doing inspection or removing it from the machine instead use gloves.
- Re-sharpen the tools immediately when it starts producing rough surfaces on the work piece or produces chatter.
- Run the machine at recommended operating conditions based on work material and tool material combination and other cutting conditions specified.
- Do not run the machines at speed higher than recommended. It may produce vibrations and chatter and damage work piece, tool, or both.
- In case of power failures, switch off the machine and retrieve tool from the work piece.
- 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.
- Wear goggles to protect eyes from flying chips.

Safety guidelines for lathe operations

- No attempt should be made to operate the lathe until the operation procedure is explained by the instructor.
- Make sure that tailstock, tool holder, and workplace are properly clamped before turning on the power.
- Never attempt to clamp or to adjust a tool while the lathe is running.
- Keep your hands off chuck rims and other moving parts when a lathe is in operation.
- Never apply a wrench to revolving work or parts.
- Never leave a chuck wrench in a chuck.
- Do not attempt to screw or unscrew the chuck onto the lathe spindle with the power on, as it may get cross-threaded and cause injury. Stop the machine, place a board under the chuck, and then screw or unscrew the chuck.
- Never try to stop rotating work piece or chuck by hand after the power is turned off. Let it slow down and stop on its own.
- Steady rests should be properly adjusted to conform to the material being worked on.
- Set the tool and feed before engaging the automatic feed.

- Do not keep tools and other implements on the lathe bed. Keep guide ways clear.
- Do not attempt to cut a work piece held between the centers using a parting tool.

Safety guidelines for drilling and allied operations

- Securely fasten the work piece. Never use hands to hold the work piece.
- Work being drilled must be held in a drill press vice or clamped to a table.
- Use a center punch to score the material before drilling.
- Keep head and hair away from the rotating spindle.
- Run the drill at the correct speed. Forcing or feeding too fast can break the drill bits.
- Pull back the drill out of deep holes frequently to clear the chips and cool the drill.
- Use reduced speed for tapping and boring operations. Ensure proper feed otherwise tool failure may occur.
- Never attempt to loosen the drill chuck unless the power is off.
- Lower the spindle before removing a drill chuck or drill from spindle.
- Withdraw drill frequently to clear chips.
- Do not try to stop the drill spindle by hand when power is turned off; let it stop on its own.
- Remove neckties and tuck in loose clothing (there are good chances of them setting tangled with the rotating drill, spindle, etc.).
- Securely clamp the drill in the spindle and drill chuck.
- Check the machine before starting drilling.
- All the guards must be in their place.
- Use sharp drills of correct size.
- For drilling through holes, place a piece of wood or soft scrap material below the work piece.

Safety guidelines for shaping and planning operations

- Do not overhang the tool.
- Fix the tool and work piece firmly.
- Use proper approach and over travel distances.
- Keep out of line of the stroke of shaper or planer & do not stand in front of Ram.
- Getting caught between the work piece and reciprocating tool is one of the most common injuries around the shaper. Prevent it.
- Position the ram properly so that the tool head and clapper box do not strike the shaper body and work piece on the return stroke.

Safety guidelines for milling operations

- Clamp the work and the tool properly.
- Use chip guards to protect yourself from flying chips.

- Use proper approach and over travel distances.
- Use recommended operating conditions.
- Never reach near or over the rotating cutter.
- Place milling cutters in the wooden trays and use gloves to handle the milling cutters.

Safety guidelines for finishing operations

- Before mounting a grinding wheel make sure that it has no cracks and is not damaged.
- Balance the wheel properly while mounting.
- Ensure that no combustible or flammable materials are nearby that could be ignited by sparks generated by welding of any such operations.
- Allow the grinding wheel to reach full speed before stepping it into the grinding position. Faulty wheels usually break at the start of an operation.
- Slowly move work pieces across the face of wheel in a uniform manner. This will keep the wheel sound.
- Replace grinding wheels that are badly worn or cracked.
- Never use a grinding wheel that has been dropped or dealt with a heavy blow, even if there is no apparent damage.
- Before using a new grinding wheel, let it run for a few seconds at the full speed to check and make sure that it is balanced.
- Do not operate the grinding wheel beyond its bursting speed.
- Wear goggles during grinding or allied processes.
- Follow the manufacturers' instructions for the correct use of the grinding wheels.

Safety Guidelines for Casting Processes

Like other manufacturing processes, safety precautions need to be taken in the casting process also.

- Use mask to avoid excessive inhalation of the dust, which may cause silicosis.
- Wear protective clothes to protect from the heat radiating from the process itself.
- Wear protective clothes, glasses, shoes, and gloves while handling molten metal.
- Be alert as severe burn injury can result from spillage of the molten metal.
- Use proper ventilation to protect from metal fumes and gases that evolve from the mould during pouring.
- Do not touch hot moulds and castings.
- Use earplugs to safeguard against the heavy noise.

Safety Guidelines for Metal Forming Operations

Metal forming operations make use of heavy presses, hammers, etc. Special safety guidelines in addition to general safety guidelines are required for these operations and these must be followed.

- Once puncher, shears, and benders are activated, it is impossible to stop them until the end of a cycle. Take extreme care when working with these machines.
- All the equipment must be maintained in a condition, which will ensure continuous safe operation.
- All manually operated safety valves and switches must be clearly identified and readily accessible. Test the working of these before starting the machine.
- Every power hammer must have a safety cylinder head to act as a cushion in case the material breaks or pulls out of the ram.
- When dies are being changed or maintenance is being performed on a press, ensure the following:
    1. The power to the press is locked out.
    2. The flywheel is at rest.
    3. The ram is blocked with a material of the appropriate strength.
- All up-setters, presses, and hammers must be installed so that they remain on their supporting foundations.
- While working in a high noise area, wear hearing protection such ear muffler and earplugs.
- Never attempt to bypass the safety procedures.
- Never try to reach beyond the safety guards.
- While doing sheet-metal operations, take care to ensure that it will not cut your skin.
- Remove sharp burrs from the sheet-metal with snips and shears.
- Do not leave the scrap of sheet-metal on the bench or shop floor.

Safety Guidelines for Joining Operations

Brazing and gas welding

- Never perform gas welding (or gas cutting) in the presence of flammable gases.
- Always leave oxygen and acetylene cylinders outside the tanks and other confined areas.
- Use protective clothing, goggles, and face shield.
- Never use a leaking gas cylinder.
- Never mix the gases in one cylinder.
- Wear goggles while observing any welding process.
- Do not see arc welding with naked eyes. Always use shield to observe the same.
- Never handle oxygen cylinders, valves, regulators, hoses or fittings with oily hands.
- Clearly mention on the cylinders the type of gas in it (i.e. oxygen, acetylene, etc.).
- Avoid skin contact with fluxes, which contain fluorides. If they penetrate the skin, they produce severe irritation.
- Do not weld the parts, which are coated with toxic material such as lead, cadmium, zinc, mercury, or paint containing toxic materials. Any such coatings must be removed prior to welding.

- Use nose masks where the local exhaust ventilation is not practicable. Insist the safety officer to provide proper ventilation system.
- Acetylene gas should not come in contact with the unalloyed copper, except in torch, which may result in a violent explosion.

Arc welding

- Use protective clothing and eye protection devices, otherwise radiation from electric arc will damage the retina of eyes. Make sure that people standing nearby also uses eye-protection devices.
- Use ear protection devices such as muffler because excessive noise caused during the process of arc welding can cause temporary or permanent hearing loss.
- Keep clothing and gloves dry.
- Always keep welding cables free of grease and oil.
- Prevent the non-insulated portion of the electrode holder from touching the welding ground or work piece when the current is on.
- Always keep the body insulated from both the work and the metal electrode holder.
- Carry out the welding process by standing on the insulating material like dry wood rather than on a grounded metal structure.
- It is easier and safer to establish an arc on a clean surface than on a dirty or rusty one.
- Always turn the welding machine off when it is not in use.
- Avoid using electrode holders with defective jaws or poor insulation.

REVIEW QUESTIONS

1. "Accidents do not happen, they are caused.' Discuss.
2. How does an accident affect the product cost?
3. What are the most common & resulting cause of accident in workshop and how to avoid the same.

3. **Lathe Machine** **Date:**

OBJECTIVE:

To demonstrate working of Lathe machine and its operations.

Basic Principle of Metal Cutting Process:

In Metal cutting process, the extra metal is removed from the work piece in the form of chips. Various machine tools and cutting tools are used to give the desired shape to work piece by creating relative motion between work piece and cutting tools.

Major Parts of Lathe

1. The lathe bed and slide ways
2. Head stock
3. Tail stock
4. Carriage (a) saddle (b) cross slide (c) compound slide (d) tool Post
5. Feed Mechanism
6. Screw cutting Mechanism
7. Drives

Work holding devices on a centre lathe:

a. Driving Plate
b. Centers
c. (i) Three Jaw chuck (ii) Four Jaw chuck
d. Face plate
e. Mandrel
f. Rests – Steady rest and follower rest

Major Operations can be performed on Lathe

Operations which are performed in a lathe either by holding the work piece between centers or by a chucks are:

- Straight turning
- Filing
- Forming
- Spinning
- Chamfering
- Facing
- Knurling
- Taper turning
- Grooving
- Thread Cutting

Operations which are performed by holding the work by a chuck or face plate or an angle plate are:

- Drilling
- Counter boring
- Tapping
- Reaming
- Taper boring
- Undercutting
- Boring
- Internal thread cutting
- Parting off

Operations which are performed by special attachments are

- Grinding
- Milling

REVIEW QUESTIONS

1. Define speed, feed and depth of cut in context to metal cutting operation with neat sketch.

2. Draw neat schematic diagrams of the following operations which can be perform on centre lathe showing direction of rotation, feed and depth of act:

   (i) Turning (ii) Facing (iii) Grooving
   (iv) Parting (v) Drilling (vi) Boring
   (vii) Knurling

3. State the difference between:
   i. Feed rod and Lead Screw
   ii. Steady rest and follower rest
   iii. Three Jaw chuck and Four Jaw Chuck

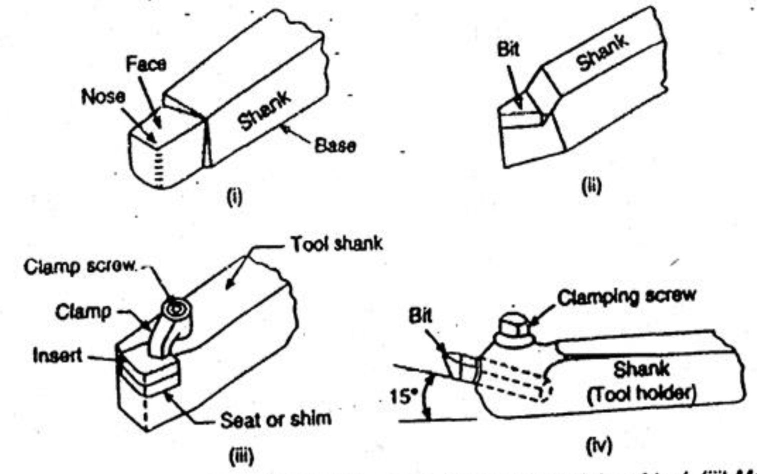


Fig. Different types of lathe tools: (i) Solid or forged tool, (ii) Brazed tipped tool, (iii) Mechanically held tool tip or insert and (iv) Tool bit held in a tool shank.

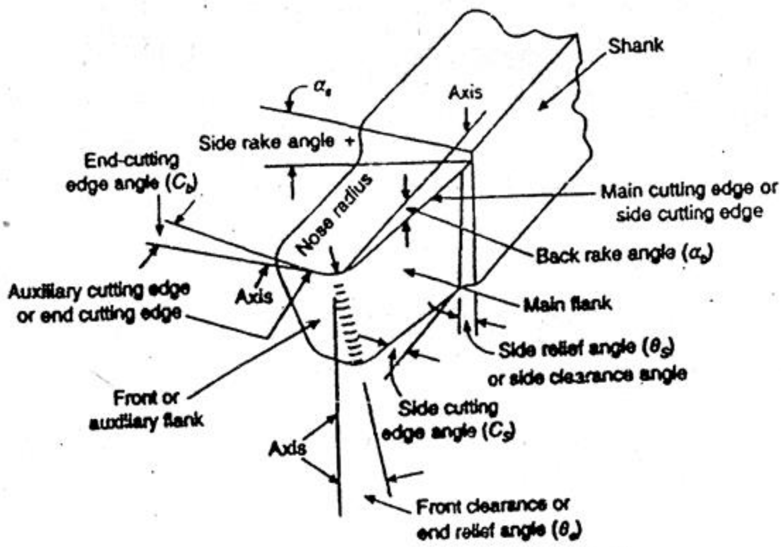


Fig. Geometry of a single-point cutting tool.

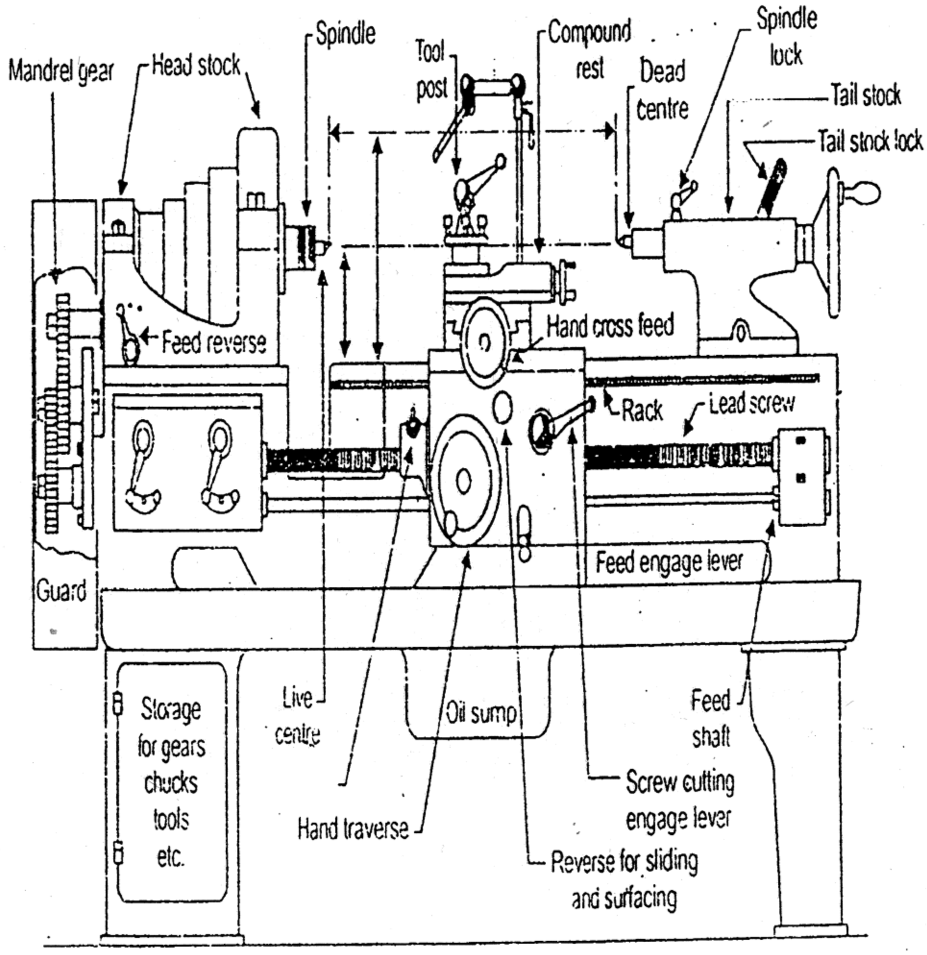


Fig. : Different parts of engine lathe or central lathe

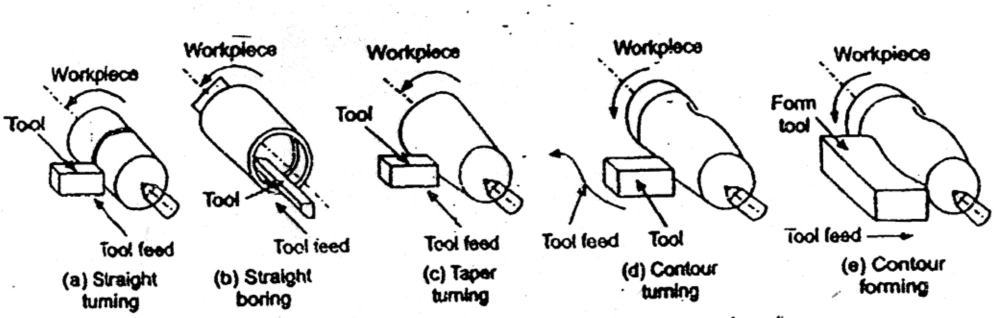


Fig. Showing how surfaces of revolution are produced.

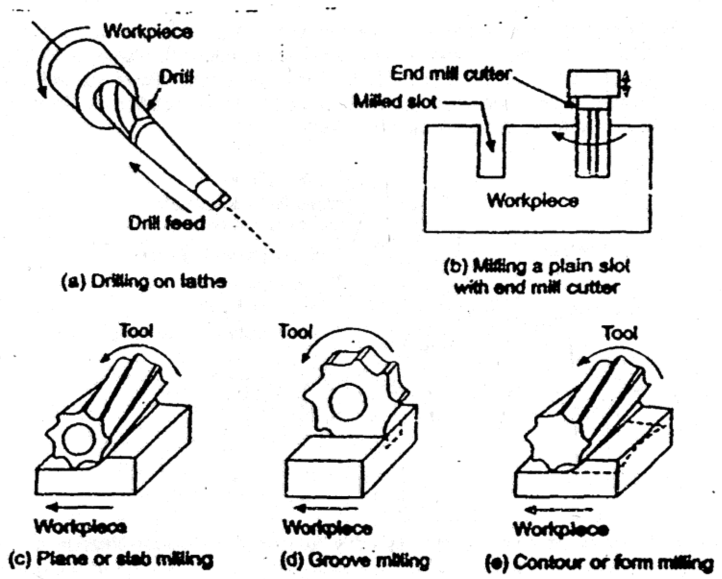


Fig. Various machining operations performed using multipoint tools.

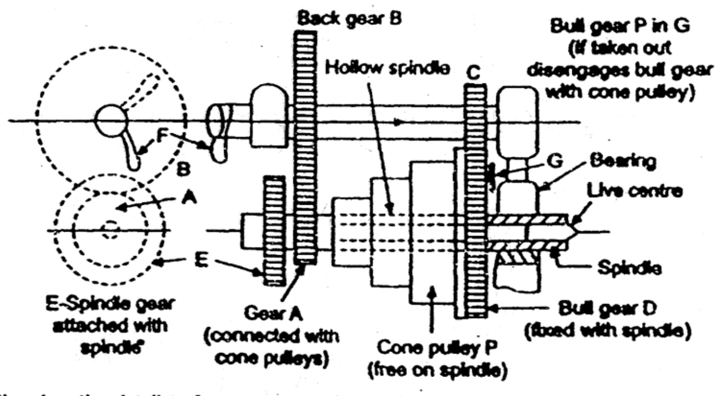


Fig. Showing the details of power transmission (within the head stock of a lathe) from spindle cone pulley (P) to the lathe spindle wherein the cone pulley (P) receives power from motor.

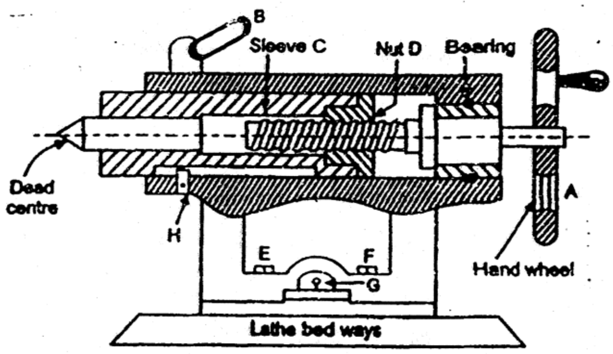


Fig. **Sectional view of the tail stock of lathe.**

A. Hand wheel to move sleeve (C) forward or backward; B. Handle for tightening the sleeve (C) and thereby holding the dead centre in any fixed position; C. Sleeve; D. Nut; E and F Bolts to clamp tail stock with lathe bed; G. Bolt when loosened, allows the tail stock set over (perpendicular to bed) for taper turning; H. Insert to check rotation of sleeve (i.e. allowing only linear movement of sleeve back and forth).

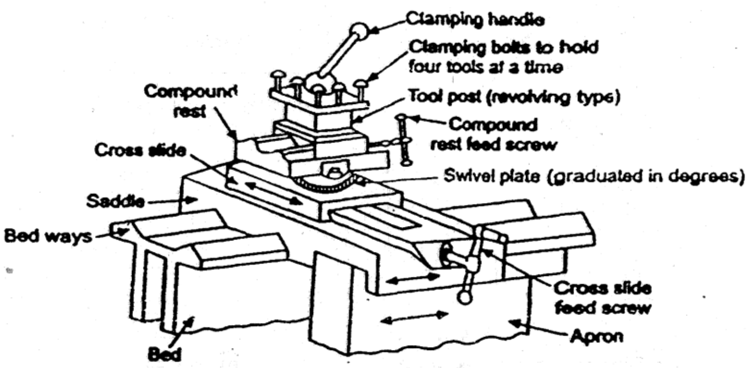


Fig. **Carriage is the name given to the assembly formed with the combination of saddle and apron. It moves along the bed ways. The saddle carries a cross slide with the tool post on it to hold the tool during machining. The cross slide moves perpendicular to the bed ways. Apron forms the hanging part of carriage and houses gear system for giving power feed for the longitudinal movement of carriage and the cross slide.**

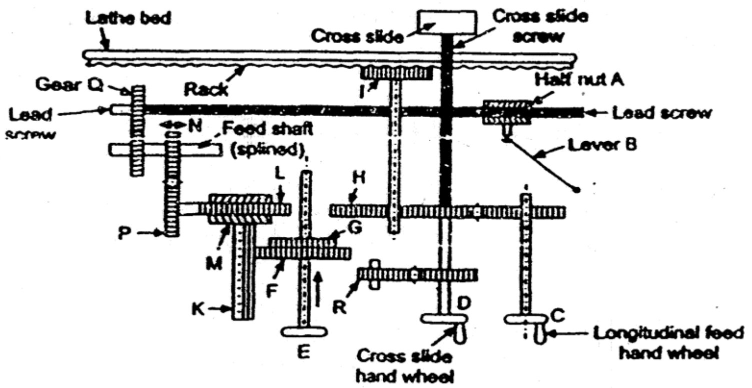


Fig. **Schematic details of apron mechanism with particular reference to power feeds for longitudinal and cross movement of the tool in relation to lathe bed and also the lead screw and half nut for thread cutting.**

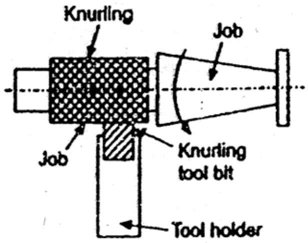


Fig. Knurling with a knurling tool bit.

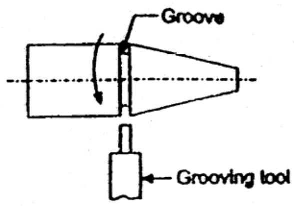


Fig. 6.56(b) Grooving (or under cutting) operation.

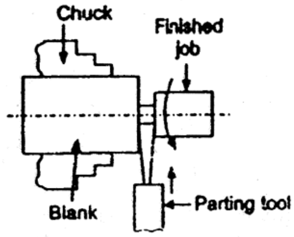


Fig. Parting off operation.

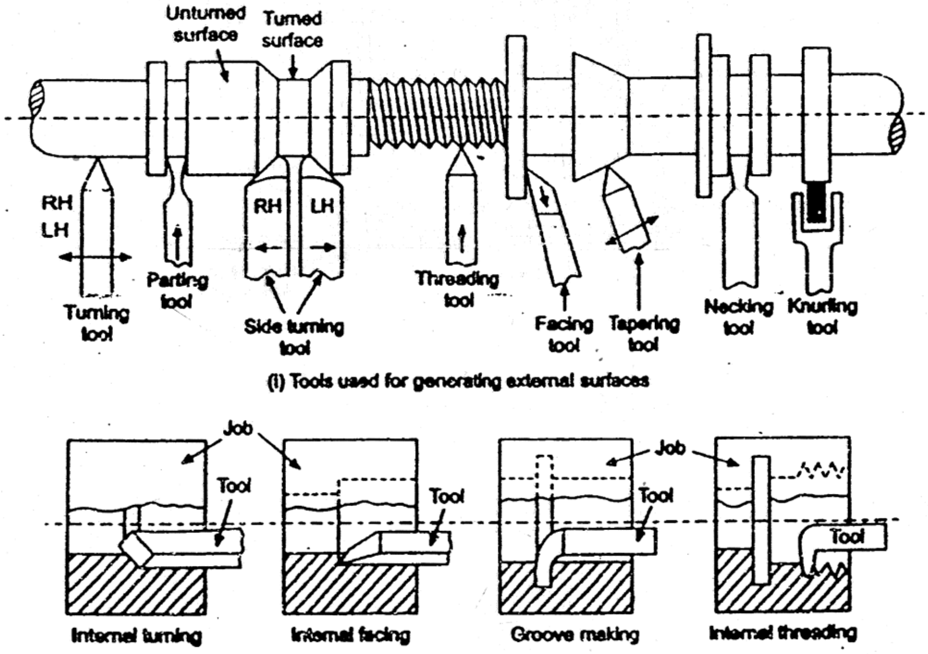


Fig. Different types of lathe tools. The tools used for generating external surfaces are shown at (i) and those used for generating internal surfacing are shown at (ii).

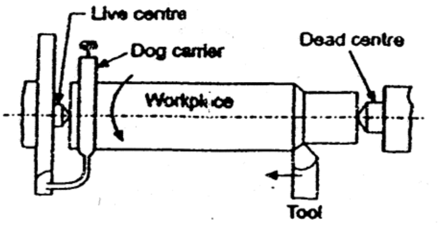


Fig. Plain turning between centres.

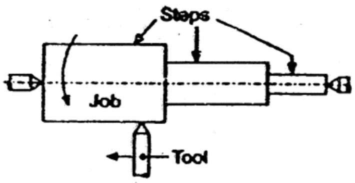


Fig. Step turning operation.

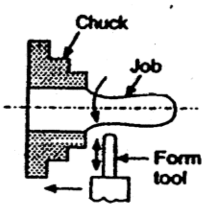


Fig. Form turning with a form tool.

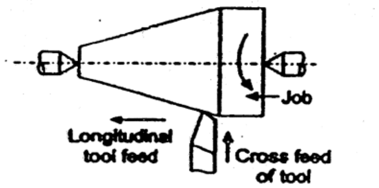


Fig. Taper turning using combined longitudinal and cross feed.

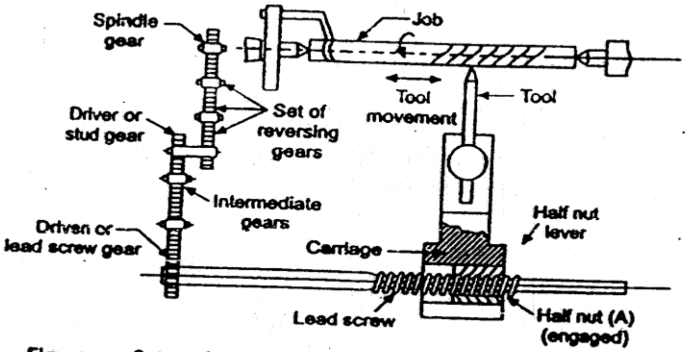


Fig. Set-up for thread cutting on a change gear type lathe.

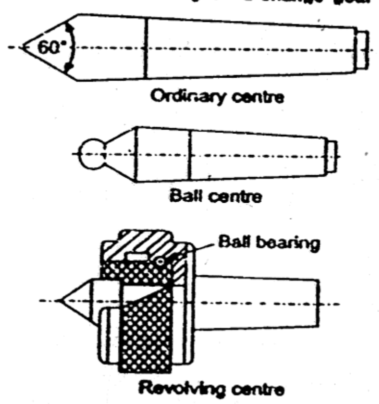


Fig. Lathe centres of different types. *Ordinary centres* are used for general purpose turning with included angle 60° for light work and 90° for heavy work. *Ball centres* are employed for taper turning with tail stock set over method to minimize wear and strain on centres. The *revolving centre* is used in tail stock for supporting a heavy job revolving at high speed and wherein this centre (unlike a dead centre) revolves with the job.

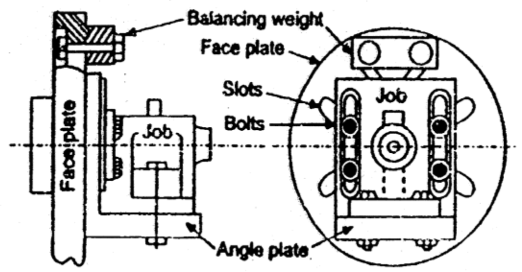


Fig. Showing the use of face plate with the job mounted on angle plate for carrying out boring operation on it.

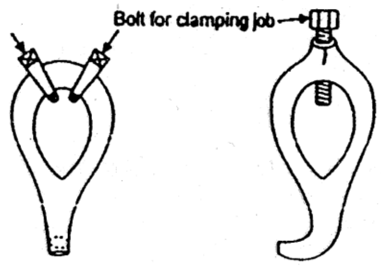


Fig. 6.63(d) Different types of lathe dog carriers.

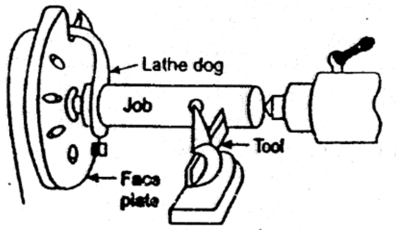


Fig. Use of dog carrier in turning a job between centres. The dog carrier at its one end is clamped with the job while its other end is engaged in the open slot of the face plate screwed on the lathe spindle.

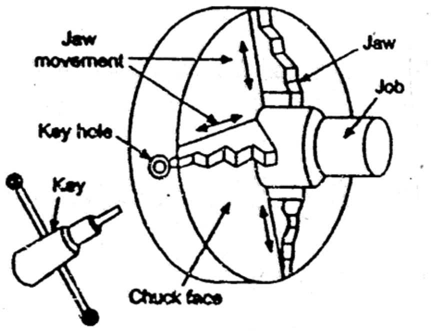


Fig. A four jaw independent chuck. It has four jaws, each jaw is independently actuated and adjusted (during holding the job) by a key. Almost all types of jobs, e.g. cylindrical, square and irregular shaped are easily held in this chuck.

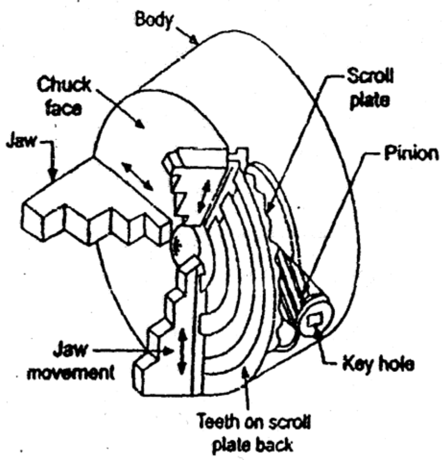


Fig. A three jaw self-centring chuck. It has three jaws, all of them are advanced or retracted simultaneously by turning the key placed in any of the three key holes made on the peripheral edge of the chuck.

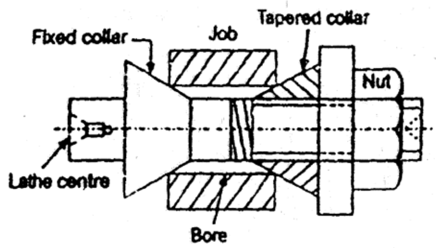


Fig. Showing the use of a taper collar mandrel in turning the surface of a job having its bore already made. The tapered collars, when fit properly in the bore and tightened, hold the job rigid with the mandrel, which is later revolved between the lathe centres.

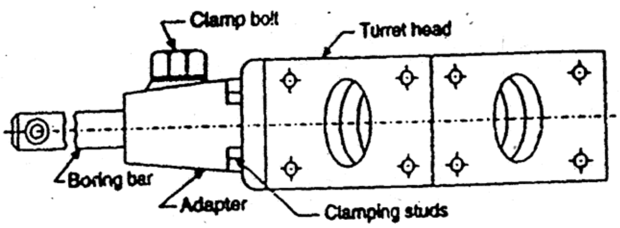


Fig. Showing mounting of a boring bar tool by directly bolting with turret face.

3. **Drilling Machine** **Date:**

OBJECTIVE:

To demonstrate working of Drilling machine and its operations.

Drilling Machine

In engineering "Drilling" means making a hole where none previously existed or enlarging a small hole to a large diameter. In a drilling machine holes may be drilled quickly and at a low cost. The hole is generated by the rotating edge of a cutting tool known as the drill, which exerts large force on the work clamped on the table. As the machine tool exerts vertical pressure to originate a hole it is loosely called a "Drill Press".

Major parts of drilling machine

Base	Column	Table
Head	Spindle	Drive Mechanism
Feed Mechanism	Work Clamping Device	

Major Operations can be performed on drilling Machine

Drilling	Reaming	Boring
Counter boring	Counter sinking	Spot facing

REVIEW QUESTIONS

1. How will you specify Drilling Machine?
2. Draw neat schematic diagrams of following operations that can be performed on a drilling machine, showing the direction of rotation, feed and depth of cut.

Drilling	Reaming	Boring
Counter boring	Counter Sinking	Spot facing
Tapping		

3. Differentiate between Drilling, Reaming and Boring operation.

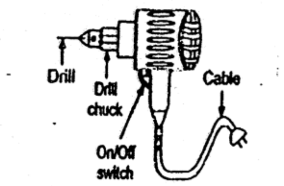


Fig. Portable drilling machine.

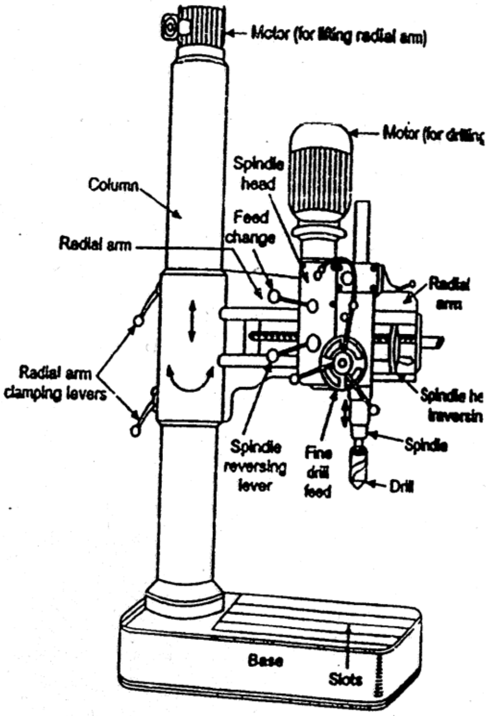


Fig. A radial drilling machine.

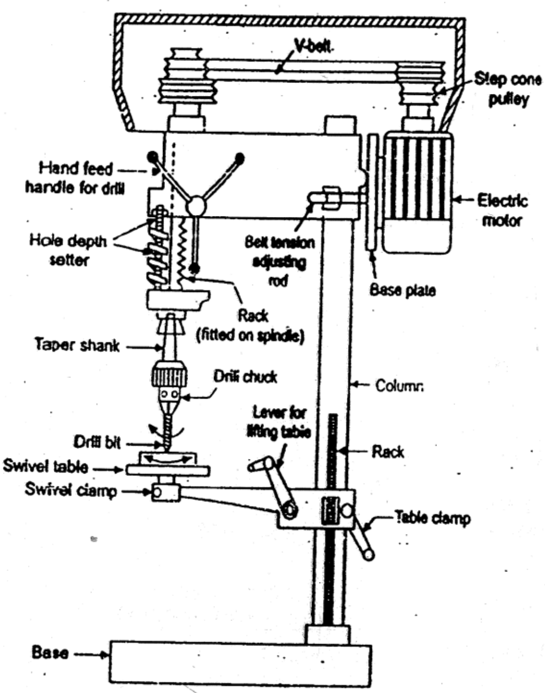


Fig. Bench or sensitive drilling machine.

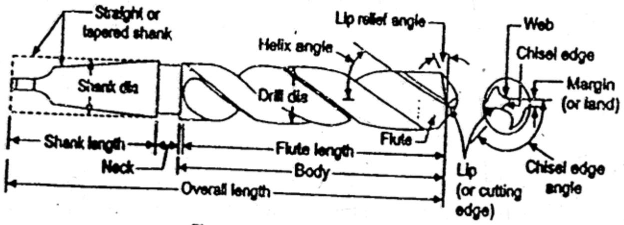


Fig. Parts of a twist drill.

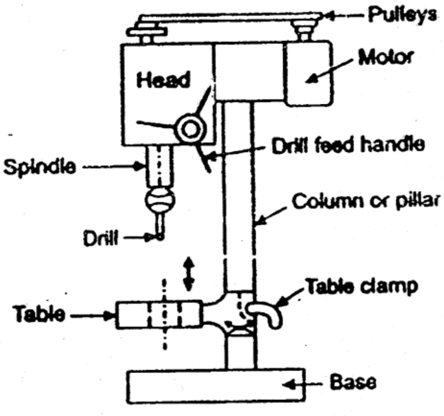


Fig. A drill press.

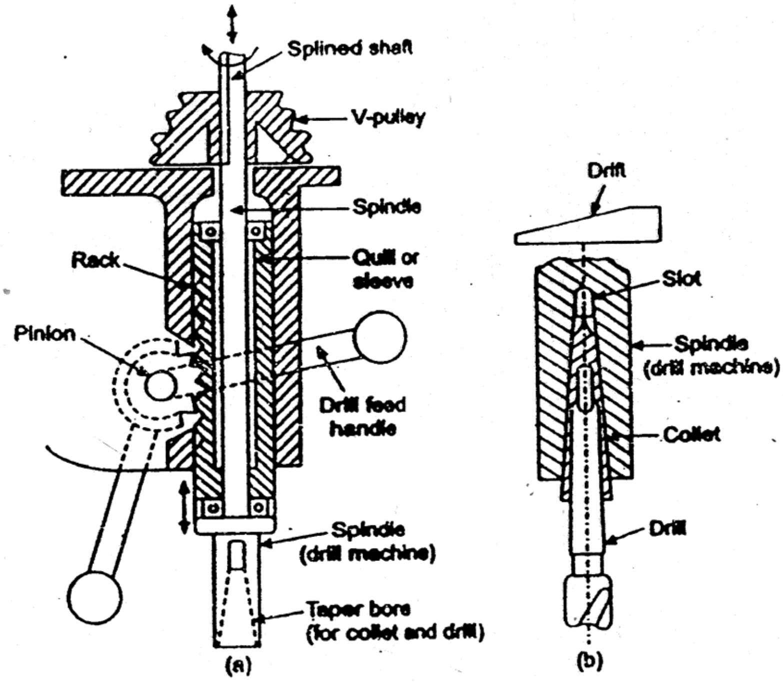


Fig. Details of a drill press spindle given at (a) and the method of attaching the drill to the drilling machine at (b). Spindle is a vertical shaft which holds drill. Spindle rotates within a non-rotating quill or sleeve and rack teeth are cut on its outer surface. The sleeve is moved up and down by a pinion meshing with rack and the pinion can be rotated with a drill feed handle. The movement (of sleeve) is imparted to the spindle to give required feed to the drill.

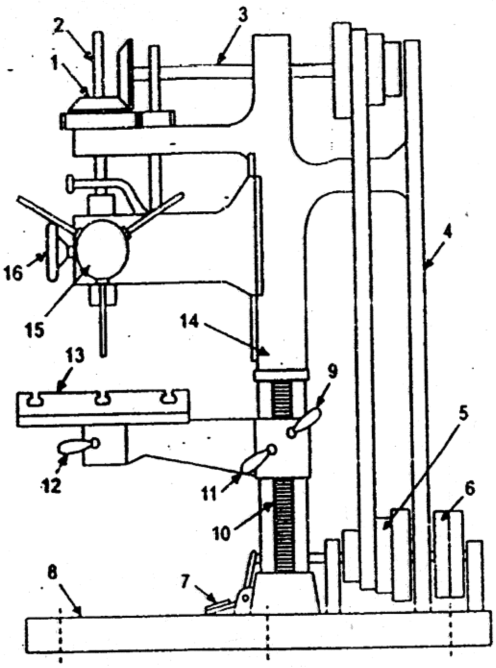


Fig Pillar drill or upright pillar drilling machine.

1. Bevel gear drive to spindle, 2. Spindle, 3. Overhead shaft, 4. Back stay, 5. Counter shaft cone pulleys, 6. Fast and loose pulley, 7. Foot paddle for fast and loose pulley, 8. Base, 9. Table elevating handle, 10. Rack on column, 11. Table elevating clamp handle, 12. Table clamp, 13. Table, 14. Column, 15. Star wheel for quick power feed for drill and 16. Hand wheel for sensitive hand feed for drill.

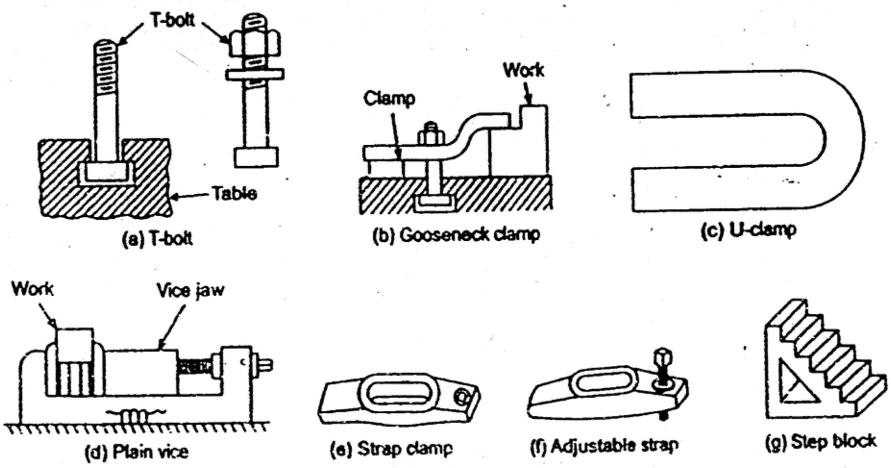


Fig. Work holding devices used on a drilling machine.

4. Shaper, Slotter and Planer Machine   Date: _______

OBJECTIVE:

To demonstrate working of shaper, slotter and Planner machine.

Major parts of shaper

- Base
- Column
- Cross rail
- Saddle
- Table
- Ram
- Tool head
- Drive Mechanism
- Feed Mechanism
- Work holding devices

Major operations performed on a shaper:

- Machining horizontal surface
- Machining vertical surface
- Machining angular surface
- Cutting slots and Keyways

Major Parts of slotter Machine

- Base
- Column
- Saddle
- Cross slide
- Rotating Table
- Ram and Tool head Assembly
- Ram Drive Mechanism
- Feed Mechanism
- Work holding devices

Mechanism of shaper:

Quick Return Mechanism   Pawl & Ratchet Mechanism

Major Operations performed on a slotting machine:

- Machining flat surface
- Machining cylindrical surface
- Machining slots, keyways and grooves

Major Parts of Planer Machine

- Bed
- Table
- Tool head
- Cross rail
- Housing of column or upright

The two important mechanism of a planer are:

1. Table drive mechanism :
   (a) Open and cross belt drive **(b)** Reversible Motor drive **(c)** Hydraulic drive

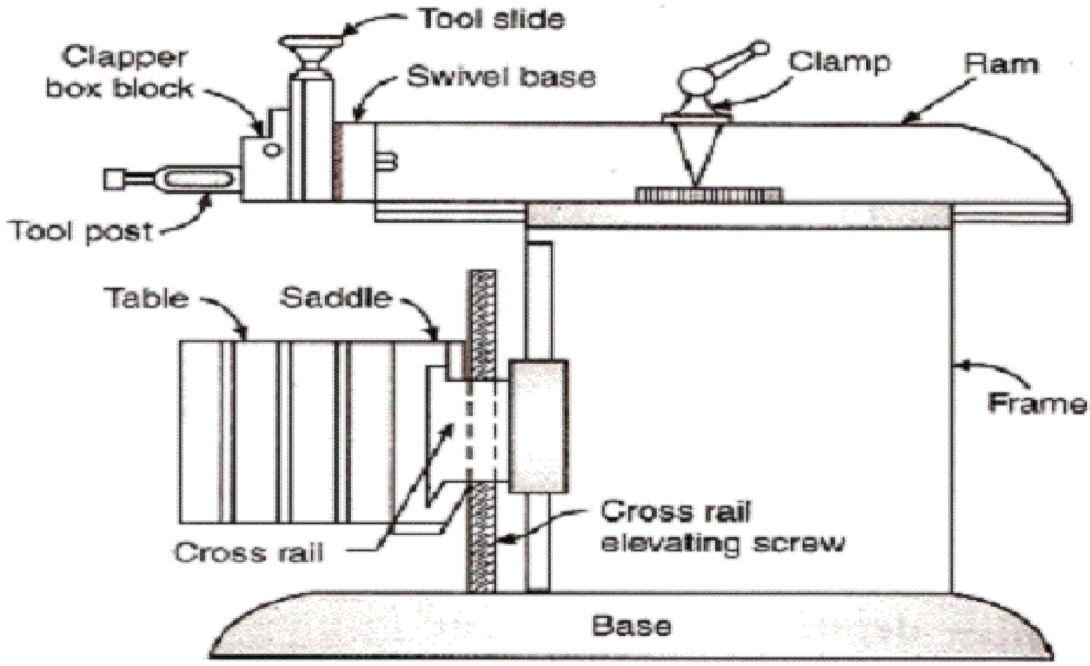
2. Feed Mechanism

Major Operations performed on a planning Machine

- Planning flat horizontal surfaces
- Planning vertical surfaces
- Planning at an angle and machining dovetails
- Planning curved surfaces
- Planning slots and grooves

REVIEW QUESTIONS

1. How will you specify? (1) Shaper (ii) Slotter (iii) Planer
2. List the differences between shaper and planer.
3. Sketch the operations which can be performed on shaper, slotter and planning machines showing direction of stroke, feed and depth of cut.
4. State the use of clapper box in shaper machine.
5. Why quick return mechanism is used in shaper and planer machine.



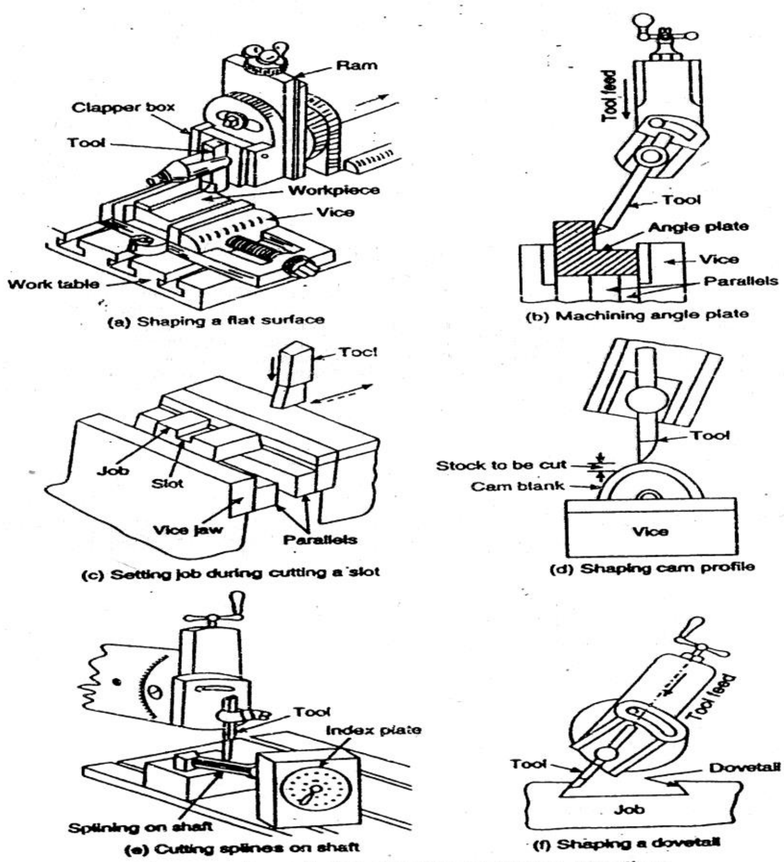


Fig. Some typical examples of shaping operations.

PM = position of rocker arm showing extreme backward position of ram stroke
PN = position of rocker arm showing extreme forward position of ram stroke
C_1 = crank pin position at the beginning of forward stroke of ram
C_2 = crank pin position at the end of forward stroke of ram
R = crank radius
P = rocker arm pivot

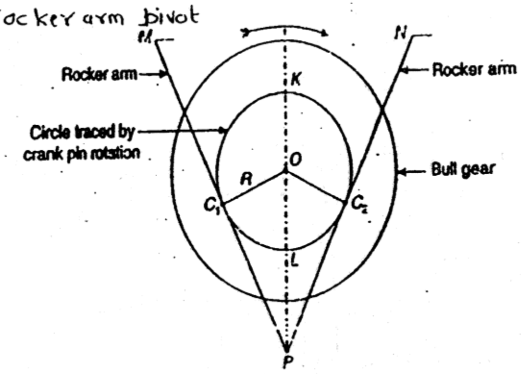


Fig. . Principle of quick return operation.

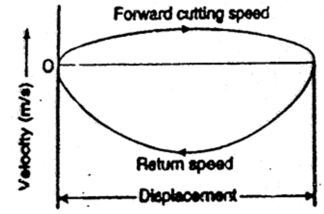


Fig. Velocity diagram of crank and slotted link mechanism

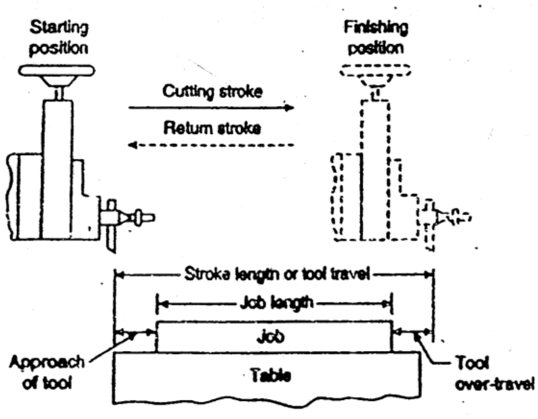


Fig. Adjusting the tool travel.

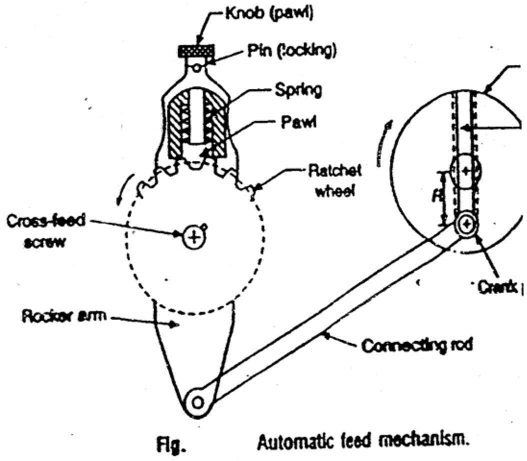


Fig. Automatic feed mechanism.

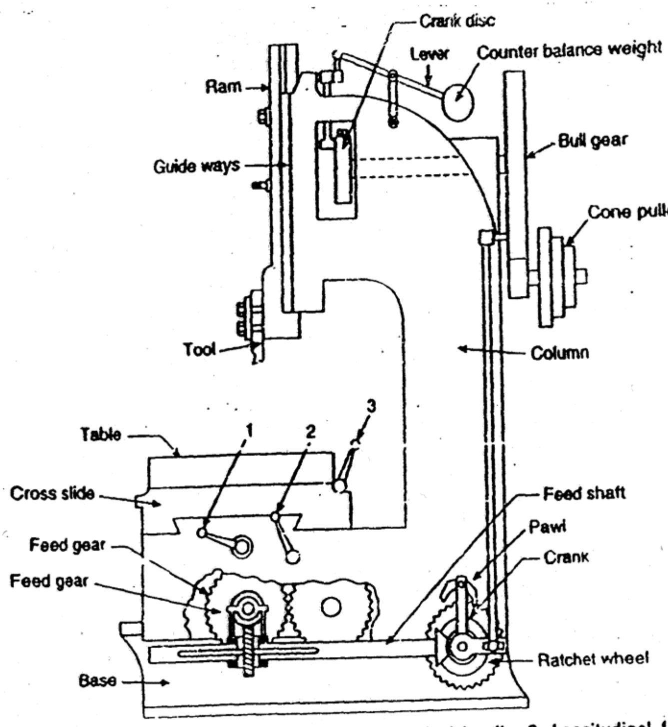


Fig. . : Main features of a slotting machine: 1. Cross feed handle, 2. Longitudinal feed handle, 3. Table circular feed handle.

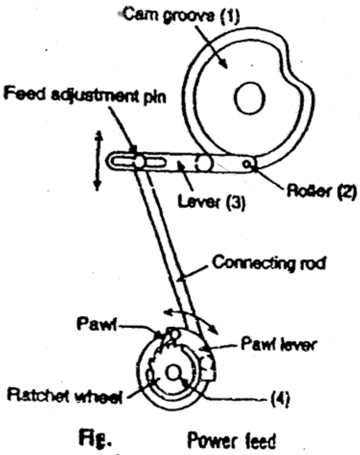


Fig. Power feed mechanism of a slotter.

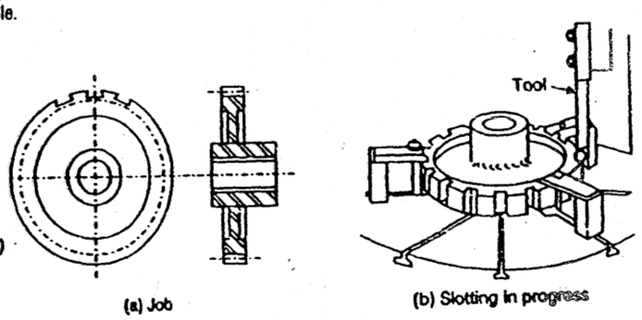
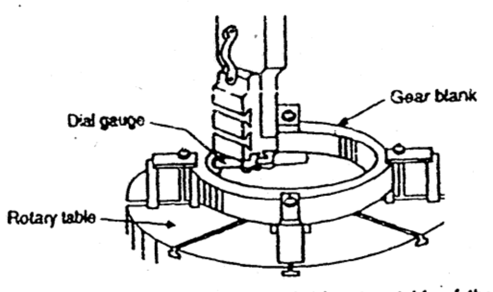


Fig. Machining indexed external dovetail slots on a slotter.



Checking the concentricity of the gear blank (with rotary table of the slotter) using a d gauge. The set-up is being prepared for cutting internal teeth in the gear blank with a fo cutter.

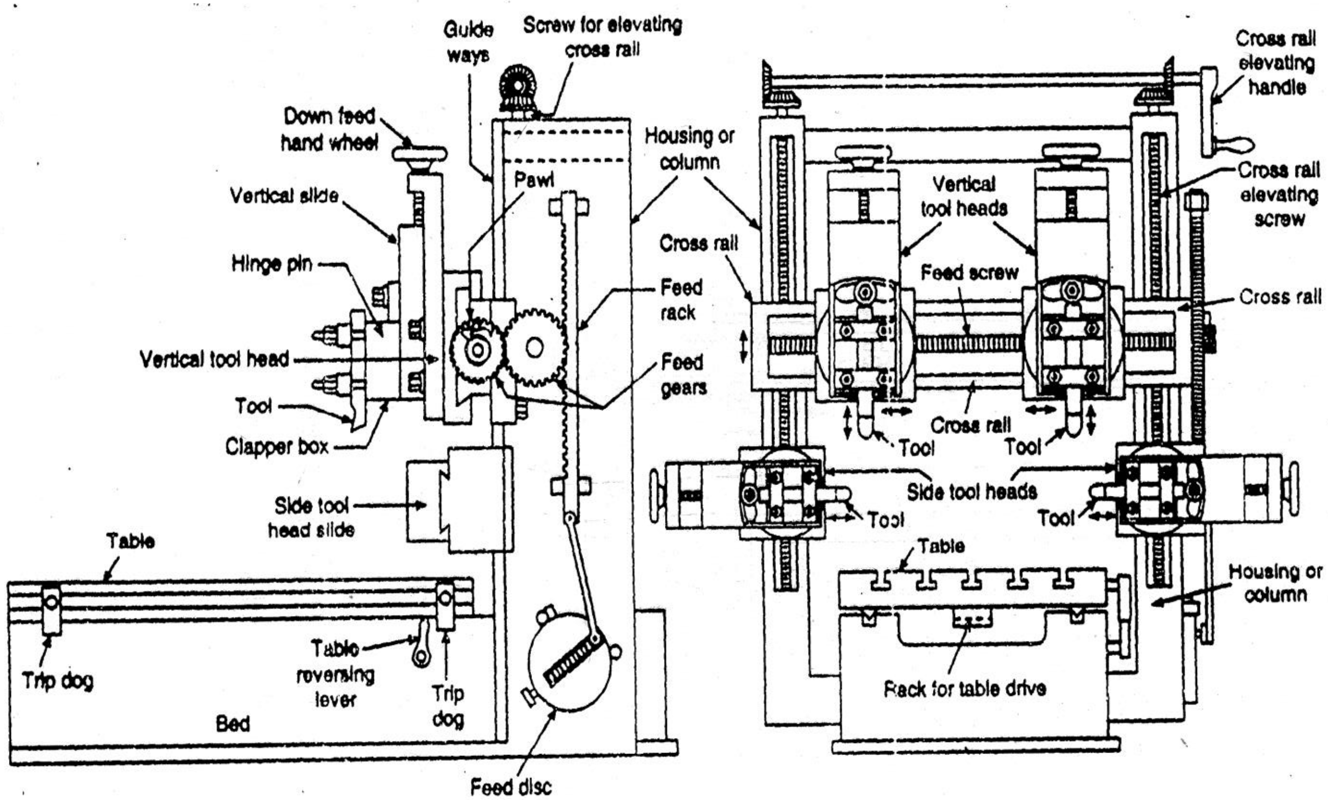
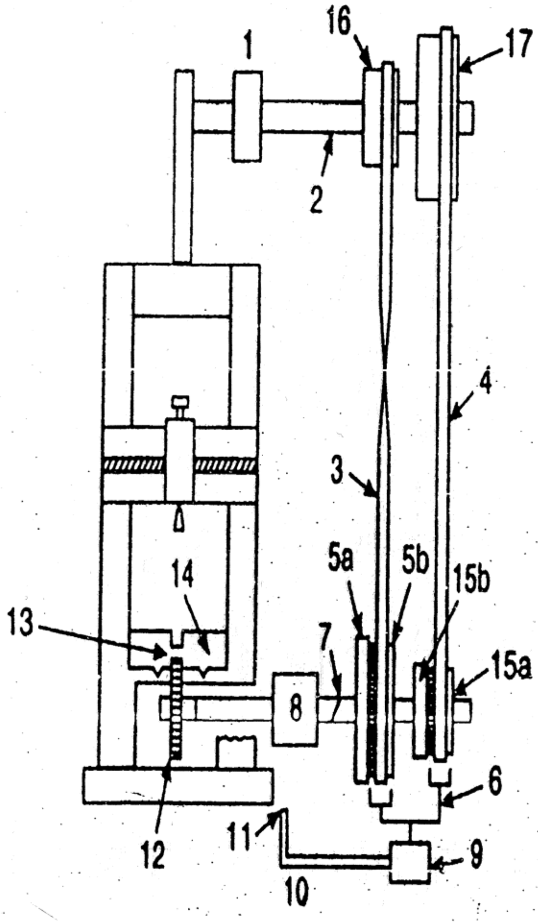


Fig. Standard double housing planer.



Schematic of planer table drive with fast and loose pulley.

1. Pulley to receive power from motor, 2. Counter shaft, 3. Cross-belt, 4. Open belt, 5(a). Fast pulley, 5(b). Loose pulley, 6. Belt shifter, 7. Main driving shaft, 8. Speed reducer 9. Cam, 10. Lever, 11. Lever end where table type dogs strike, 12. Pinion, 13. Rack 14. Planer table; 15(a). Fast pulley, 15(b). Loose pulley, 16. and 17. Pulleys.

5. Milling Machine Date:

OBJECTIVE:

To demonstrate working of milling machine and its operations.

MILLING MACHINE

A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The cutter rotates at a high speed and because of the multipoint cutting edges it removes metal at a very fast rate. The machine can also hold one or more number of cutters at a time. This is superior to other machines as regards accuracy and better surface finish and is designed for machining a variety of tool room work.

Major parts of a Milling Machine

- Base
- Overhand arm
- Arbor
- Work holding devices
- Column
- Front brace
- Drives
- Cutter holding devices
- Knee Table
- Spindle
- Feed mechanism

Major Operations performed on milling machines

- Plain milling
- Straddle milling
- Form milling
- Thread Milling
- Helical Milling
- Face milling
- Angular milling
- Profile milling
- Milling key ways, grooves & slots
- Slide milling
- Gang milling
- End milling
- Gear Cutting

Milling Cutters

Milling Cutters may be classified:

1. According to the constructional features of the cutter (a) Solid cutter (b) Tipped Solid Cutter (c) Inserted teeth cutter.
2. According to the method of mounting the cutter (a) arbor type cutter (b) shank type cutter (c) Facing type cutter.
3. According to the direction of rotation of the cutter (a) Right hand rotational cutter (b) Left hand rotational cutter.
4. According to the relief characteristics of the cutter (a) Profile relieved cutter (b) form relieved cutter.
5. According to the direction of helix of the cutter teeth (a) Parallel or Straight teeth cutter (b) Right hand helical cutter (c) Left hand helical cutter (d) Alternate helical teeth cutter
6. According to purpose or use of the cutter (a) Standard milling cutter (b) special milling cutter.

REVIEW QUESTIONS

1. How the size of column and knee type milling machine is specified?
2. Write use of following on milling machine :
   (a) Arbor (b) Spindle (c) vice
3. Write specific use of following
   (a) Side and face milling cutter (b) Key way milling cutter
   (c) Angle milling cutter (d) End milling cutter (e) Gear Cutter.
4. Differentiate between up-milling and down-milling.

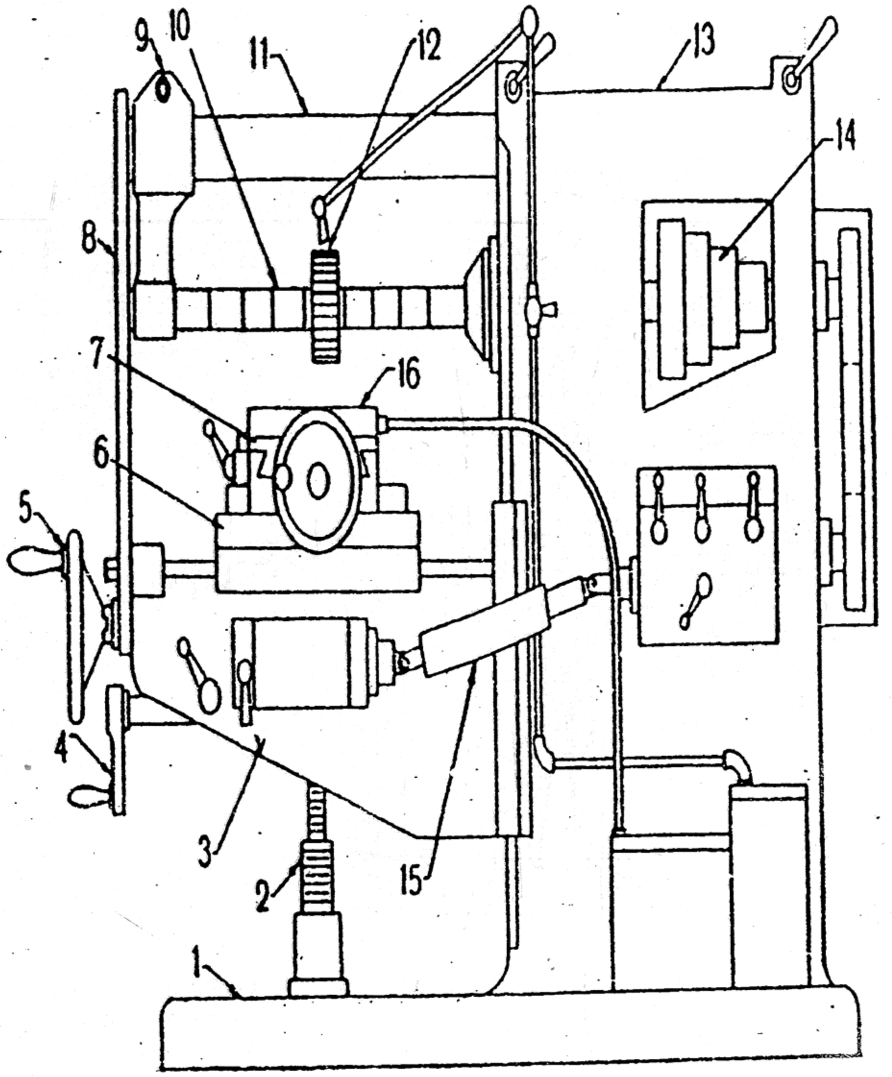
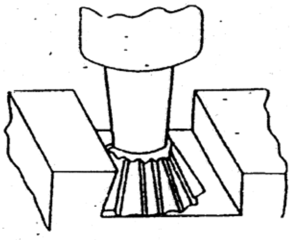
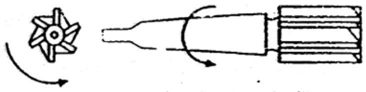


Figure Column and knee type milling machine

1. Base, 2. Elevating screw, 3. Knee, 4. Knee elevating handle, 5. Crossfeed handle, 6. Saddle, 7Table, 8. Front brace, 9. Arbor support, 10. Conepulley, 15. Telescopic feed shaft.

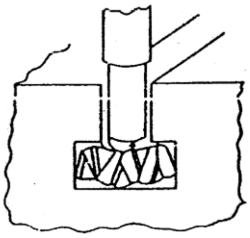


(f) Single angle angular milling cutter

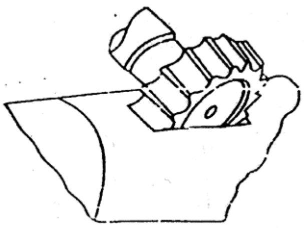


(g) Right hand taper shank end mill cutter

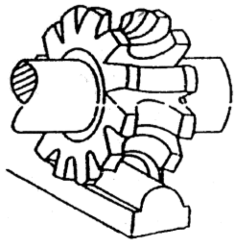
(h) Straight shank end mill cutter



(i) T-slot milling cutter

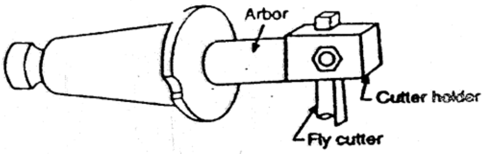


(j) Woodruff-key slot milling cutter



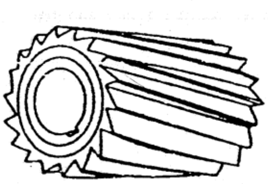
(k) Formed relieved cutter

(l) Involute gear cutter

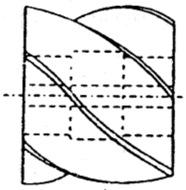


(m) Fly cutter

Fig. Types of standard milling cutters.

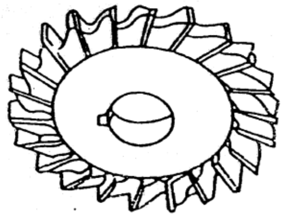


Straight teeth plain milling cutter (light duty)

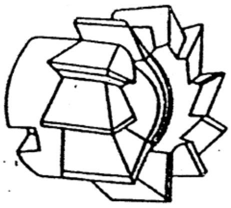


Helical plain milling cutter (heavy duty)

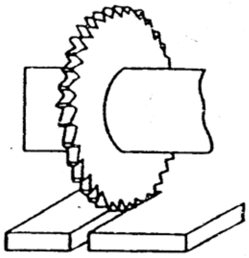
(a)



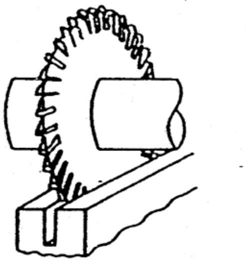
(b) Plain side milling cutter



(c) Face milling cutter (shell-end mill type)



(d) Plain metal slitting cutter



(e) Side teeth slitting cutter

Fig. *(Contd.)*

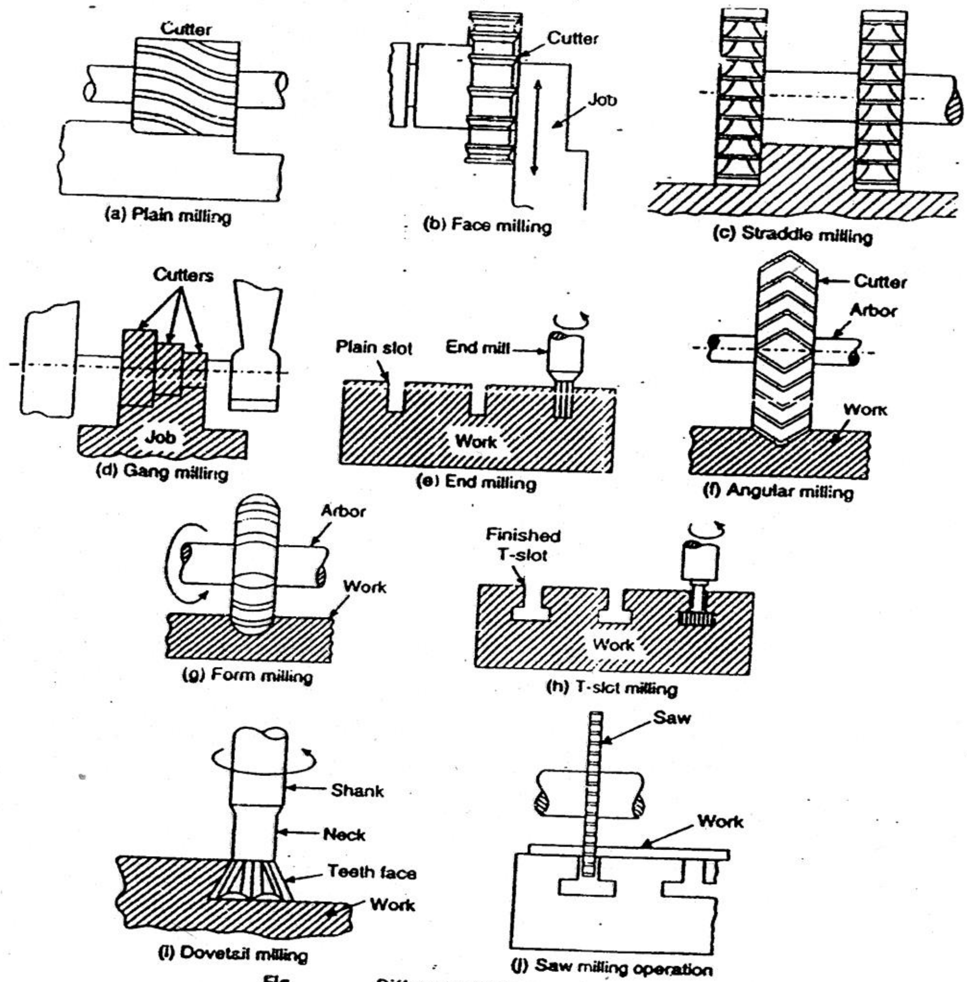


Fig. Different milling operations.

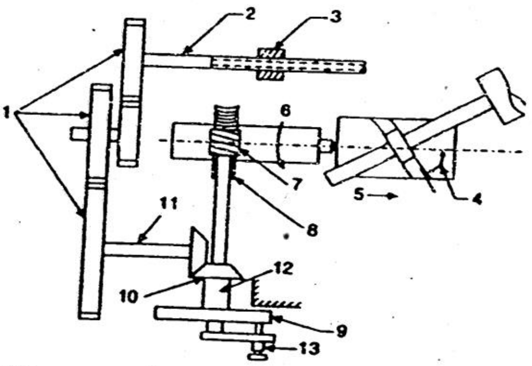


Fig. Gearing arrangement for helical milling.

6. Grinding Machines Date:

OBJECTIVE:

To demonstrate working of grinding machine and its operations.

GRINDING MACHINE

Grinding is metal cutting operation performed by means of a rotating abrasive wheel that acts as a tool. This is used to finish work pieces which must shows a high surface quality, accuracy of shape and dimension.

Major parts of Cylindrical centre type grinding machine

- Head Stock
- Tailstock
- Base
- Grinding wheel
- Upper table
- Cross feed
- Wheel head
- Lower table

Major operations performed on grinding machine

- Grinding of external and internal surfaces
- Formed surfaces
- Tapered surfaces
- Gear teeth

Standard grinding wheel shapers:

- Straight wheels
- Cup wheel
- Tapered face straight wheel
- Dish wheel
- Cylindrical

Mostly grinding is the finishing operation because it removes comparatively little metal, 0.25 to 0.50 mm in most operations and the accuracy in dimensions is in the order of 800025mm. Grinding is also done to machine materials which are too hard for other machines methods that use cutting tools.

REVIEW QUESTIONS

1. Draw a neat sketch of standard grinding wheel shapes and state their use.
2. Identify the following grinding wheel.
   W A 46 H 8 V 15
3. Differentiate between cylindrical grinding machine & surface grinding machine.

Sequence :

Prefix	Abrasive	Grain size	Grade	Structure	Bond type	Suffix
W	**A**	**46**	**K**	**5**	**V**	**17**

Prefix: Manufacturer's abraisive type symbol (use optional)

Abrasive:
A=Aluminium oxide
C=Silicon Carbide
D=Diamond

Grain size:

Coarse	Medium	Fine	Very fine
10	30	80	220
12	36	100	240
14	46	120	280
16	54	150	320
20	60	180	400
24			500
			600

Structure:

Dense	To open
1	9
2	10
3	11
4	12
5	13
6	14
7	15
8	Etc

(use optional)

Bond type:
V=Vitrified
B=Resinoid
R=Rubber
E=Shellac
S=Silicon
O=Oxychloride

Suffix: Manufacturer's abraisive type symbol (use optional)

Grade Scale { A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Soft: A–J; Medium: K–S; Hard: T–Z

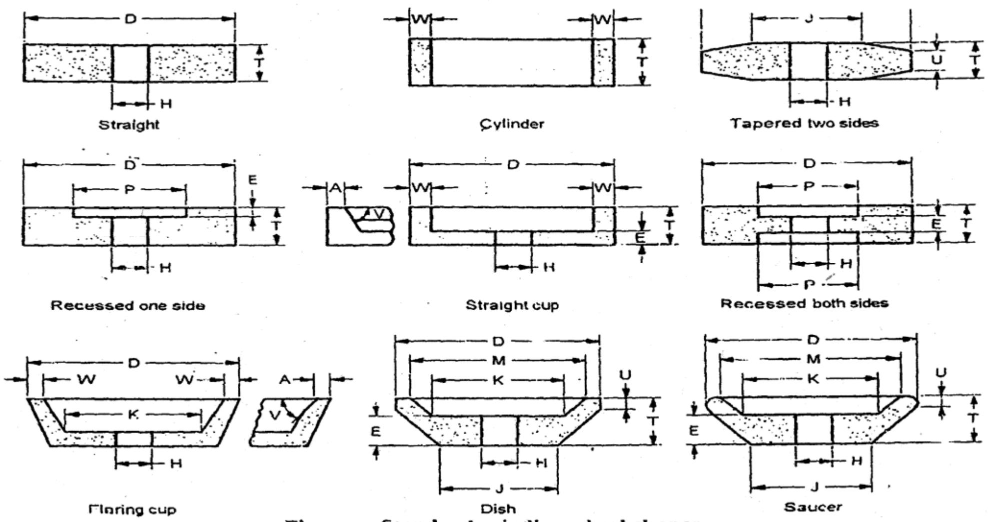


Fig. Standard grinding wheel shapes

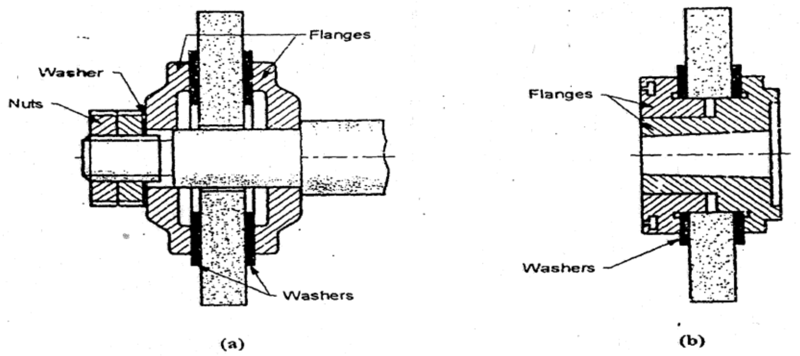
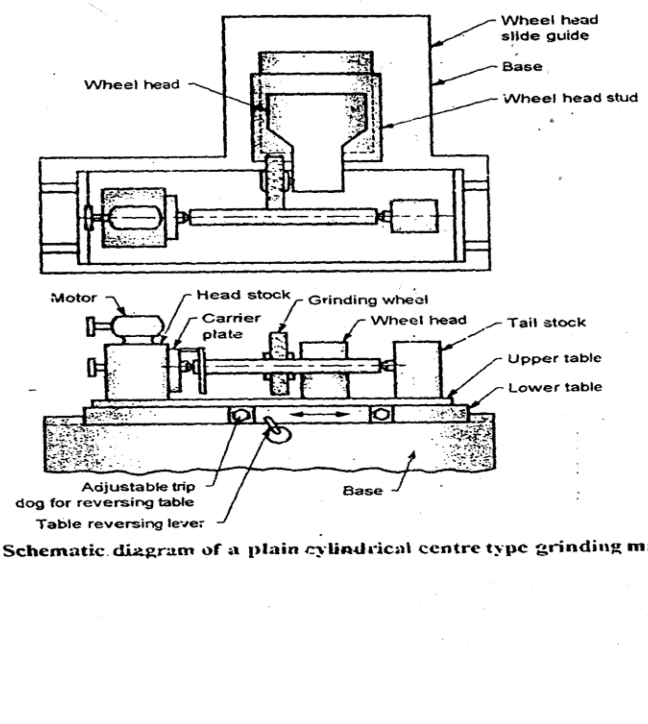


Fig. Mounting of a grinding wheel



Schematic diagram of a plain cylindrical centre type grinding machine

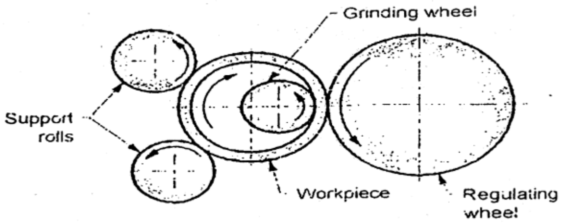


Fig. 9.12 : Internal centreless grinding

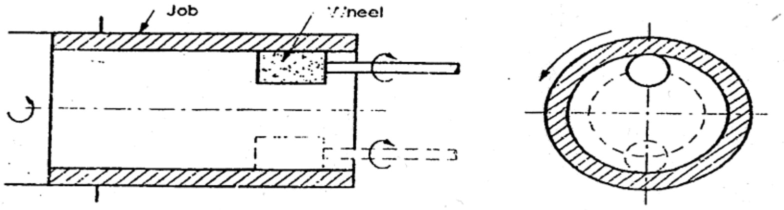
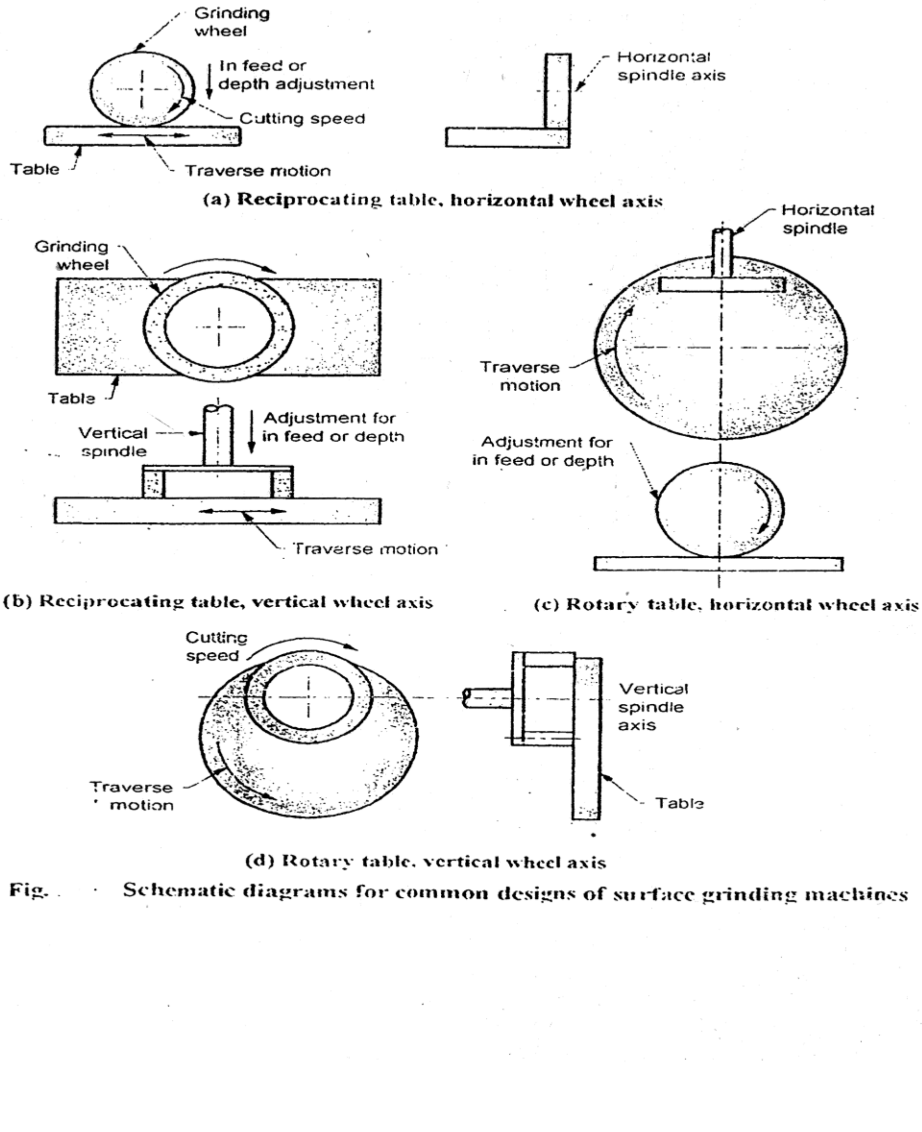


Fig. 9.13 : Schematic diagram of planetary internal grinder



(a) Reciprocating table, horizontal wheel axis

(b) Reciprocating table, vertical wheel axis

(c) Rotary table, horizontal wheel axis

(d) Rotary table, vertical wheel axis

Fig. . Schematic diagrams for common designs of surface grinding machines

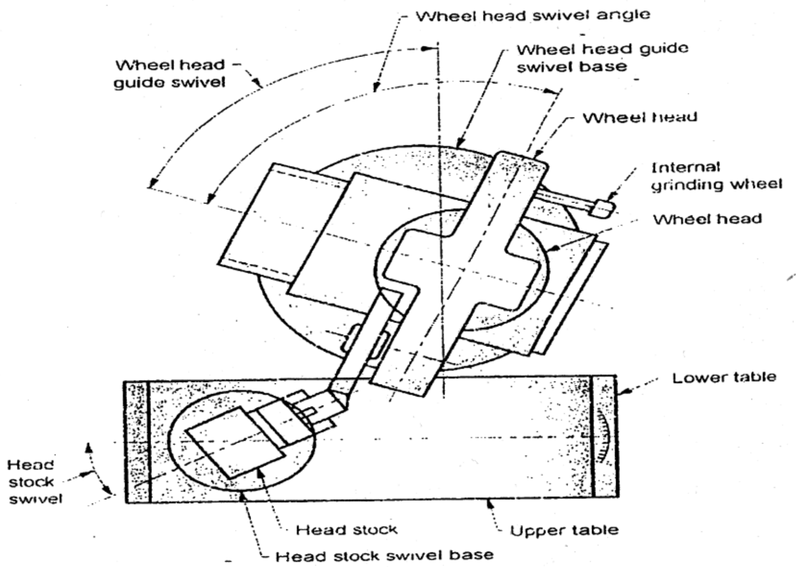
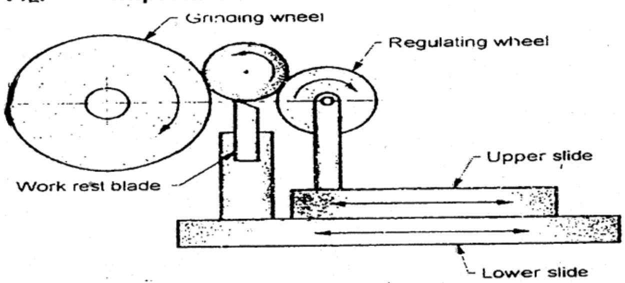


Fig. Important features of a universal cylindrical grinding machine



Schematic diagram of a centre less grinding machine

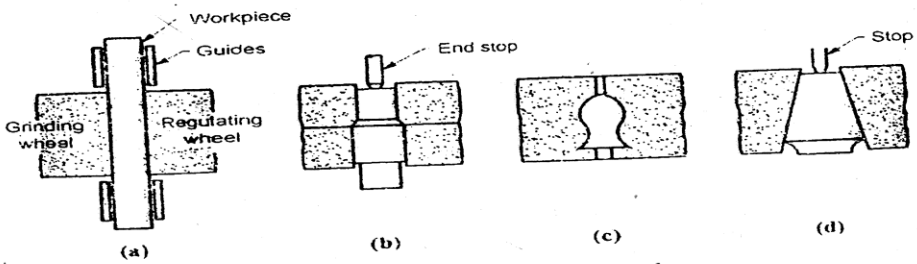


Fig. Centreles Grinding Operations

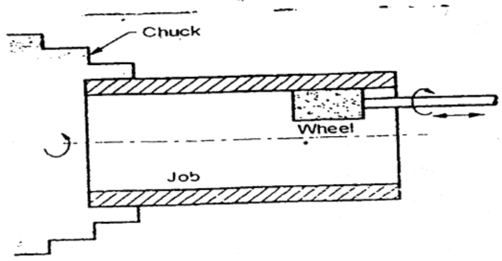


Fig. Plain internal cylindrical grinding

7. Fitting Shop Date:

OBJECTIVE

To demonstrate different types of hand tools and machines used in fitting shop.

INTRODUCTION:

In engineering workshop, the processes of material removal and forming of materials are major activities. They are usually accomplished by machine tools, but occasions arise when it is necessary to use hand tools. The term “bench work” generally denotes the production of an article by hand on the bench. “Fitting” is the assembling together of parts and removing metals to secure the necessary fit and may or may not be carried out at the bench. A considerable skill is required to execute the fitting job and hence lot of practice and concentrations are important factors for fitting job.

OPERATIONS USE IN BENCH AND FITTING WORK

1. Chipping	2. Filling	3. Scrapping	4. Grinding
5. Polishing	6. Sawing	7. Marking	8. Drilling
9. Reaming	10. Tapping	11. Dieing	

1. **Chipping:** Chipping is the process of removing thick layers of metal by means of cold chisels.
2. **Filling:** Filling is the most important operation that a metal worker has to learn. Filling is usually an after treatment and usually done after chipping. It serves to remove the burr from cuts and clean the face of the cuts, and to finish the final shape of a work piece.
3. **Scrapping:** Scrapping means shaving or paring off thin slices or flakes of metal to make a fine smooth surface. This is done with tools called scrapers which have a very hard cutting edges – scraping is used for obtaining a true flat surface than can be produced by machining or filling.
4. **Grinding:** Grinding is the process of removing metal usually 0.25 to 0.5 mm in most operations, by the use of a grinding wheel.
5. **Polishing:** Polishing is the process of making a flat, scratch – pee, mirror like finish. The polishing procedure generally consists of rough grinding, intermediate grinding, rough polishing and fine polishing.
6. **Sawing:** Hack sawing is the quickest method of severing, shaping and slotting cold metal.
7. **Marking Out:** Marking out consists of marking on the job a series of definite lines or positions.
8. **Drilling:** It is the operation of producing circular holes in a metal piece. This is done with the help of a drilling machine.
9. **Reaming:** Hand reaming is done when exactness is required. When an accurate hole with a smoother finish is required a reamer is used to remove a little metal from the hole and to bring it to the correct size. The reamers are supposed to remove minimum amount of metal from 0.1 to 0.15 mm for rough reaming and 0.05 t0 0.02 mm for finish reaming.
10. **Tapping:** Cutting inside threads is called tapping. After the hole has been drilled with the tap drill, it is ready for tapping.
11. **Dieing:** Cutting external threads o around rod or bolt with a die and stock is called dieing or external threading.

TOOLS AND EQUIPMENTS USED IN FITTING SHOP:

1. **Vice**: The vice is the most common tool for holding work. Various types of vices are used for various purposes. They include bench vice, leg vice, pipe vice, hand vice, pin vice and tool makers vice.
2. **Hammer**: Hammers are used to strike a job or a tool. They are made of forged steel of various sizes (weights) and shapes to suit various purposes. Hammers are classified, according to the shape of the peen as ball peen, cross peen and straight peen hammers.
3. **Chisel**: Cold chisels are used for cutting and chipping away pieces of metal, are made of carbon steel usually of rectangular, hexagonal, or octagonal cross section. They are forged to shape, roughly ground, and then hardened and tempered. The five most common types are the flat, the cross-cut, the diamond pointed, the half round, and the side chisels.
4. **File:** The most widely used hand tools to be found in an engineering workshops the file. A file is a hardened piece of high grade steel with slanting rows of teeth. It is used to cut, smooth or fit metal parts. It cuts all metals except hardened steel.
   Files are classified and names according to three principal factors – sizes, type or cut of teeth and sectional form.
   Size of file is its length. This is the distance from the paint to the heel without the tang.
   Cut of teeth: Cuts of files are divided into two groups as single cut and double cut. Single cut and double cut files are further divided according to the coarseness or spacing between the rows of the teeth. In descending order of roughness they are listed as – (1) Rough (R); (2) Bastard (B); (3) Second Cut (SC); (4) Smooth (S); (5) Dead Smooth (DS); (6) Super Smooth (SS).
   Shapes: The shape of a file is its general outline and cross-section. Most commonly files of following shapes are widely used. They are Flat, Hard, Square, Pillar, Round, Triangular, Half round, Knife edge.
5. **Scraper:** Scrapers removes very thin chips. The material is a good quality forged steel and the cutting edge is usually left very hard. Scrapers are made in a variety of lengths from 100 mm upwards and in many shapes. Such as flat, triangular and half round scraper.
6. **Grinding Wheel:** A grinding wheel is made up of particles of hard substance called the abrasive embedded in a matrix called the bond. These abrasives form the cutting points in a wheel and are termed as grains. Two types of abrasive – Natural and artificial.
   Polishing: Emery paper and emery cloths are used for polishing purposes.
7. **Hacksaw:** Hack saw is used for sawing all metals except hardened steel. A hand hack saw consists of a frame, handle, prongs, tightening screw and nut and blade. Hack saw blades are made of special steels. For hand saws either high carbon steel, low alloy steel or high speed steel is used.
8. **Power Hack Saw:** The power hack saw is very similar to the hand hack saw with the addition of a suitable driving mechanism.
   Marking Tools:

1. Surface plate	2. Scriber	3. Punch
4. V-block	5. Angle plate	6. Try square.

1. **Surface plate**: Used for testing the flatness of work itself and is also used for marking out work. This is used for small pieces of work while the marking to table is used for large jobs; surface plats are made of grey cast iron and of solid design or with ribs. They are made in two grades of accuracy A & B. Grade surface plates are scrapped to within 0.005 mm of flatness while grade B plates are 0.02 mm of flatness.
2. **Scriber:** A piece of hardened steel about 150 to 300 mm long and 3 to 5 mm in diameter pointed one or both ends like needle. It is held like a pencil to scratch or scribe lines on metal.

3. **Punch:** A punch is used in bench work for marking out, locating centers etc. in a more permanent manner. Two types of punches are used : (i) Prick Punch & (ii) Centre punch
4. **V-block:** The V-block is a block of steel with V shaped grooves. Round shaped work pieces which are to be marked or drilled are placed on V-supports.
5. **Angle plate:** The angle plate which is made of grey cast iron has two plane surfaces at right angles to each other. This is used in conjunction with the surface plate for supporting work in the perpendicular position. It has various slots in it to enable the work to be held firmly by bolts and clamps.
6. **Try square:** The try square is made in one piece, both blade and beam. This is used when it is necessary to get another edge or surface exactly at right angles to an already trigged edge or surface and also for laying out work.
7. **Drill:** A drill is a tool for making holes in a metal piece. It usually consists of two cutting edges set at an angle with the axis. There are three types of drills (i) Flat drill (ii) straight fluted drill & (iii) twist drill.
8. **Reamer:** When an accurate hole with a smoother finish is required a reamer is used to remove a little metal from the hole and to bring it to the correct size. Reamers are of following types: (i) Hand Reamer (ii) Machine Reamer (iii) Expanding Reamer.
9. **Tap:** A tap is a screw like tool which has threads like a bolt and three or four flutes cut across the thread. It is used to cut thread on the inside of a hole as in a nut. They are made from carbon steel or high speed steel and hardened and tempered, Hand taps are usually made in sets of three (i) Taper Tap (ii) Second Tap (plug type) (iii) bottoming tap.
10. **Dies and Stocks:** Dies are used to cut threads and round bar of metal, such as the threads on a bolt. It is a round, or square block of hardened steel with a hole containing threads and flutes which form cutting edges. There are mainly two types of dies in common use (i) Solid die (ii) adjustable die.

Review Questions:

1. Why the jaws of fitters vice are serrated?
2. For what purpose is a soft headed hammer used?
3. Give examples of where the following hand files are used? (i) Square file (ii) Half round file (iii) Triangular file.
4. State when each of the following methods of filing should be used (i) Cross filing (ii) Draw filing (iii) straight filing.

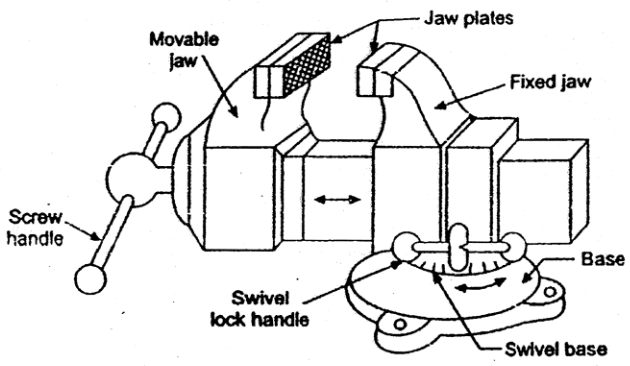
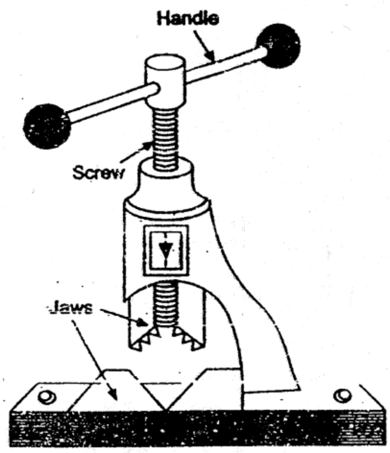
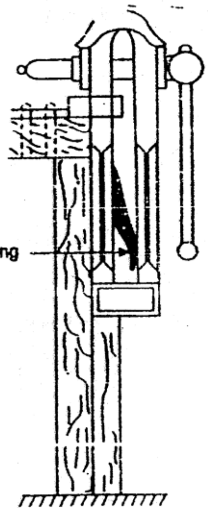


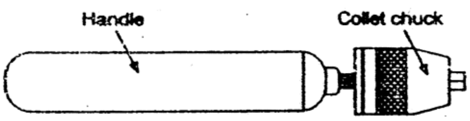
Fig. Engineer's parallel jaw vice.



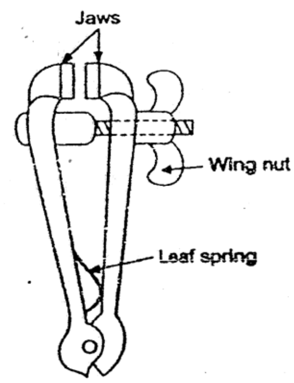
(a) Pipe vice



(b) Leg vice



(c) Pin vice



(d) Hand vice

Fig. Other variety of fitter's vices

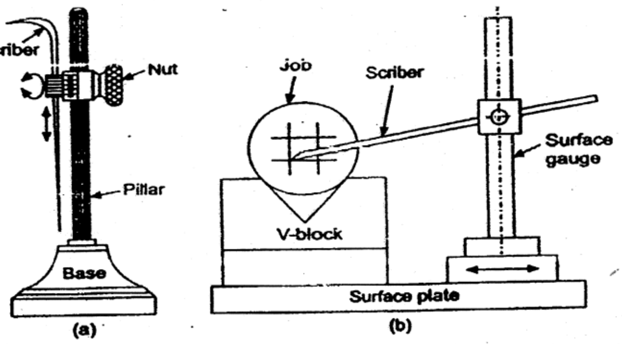


Fig. A vertical pillar type surface gauge (or marking block) is shown at (a) and its use for finding the centre of a shaft at (b).

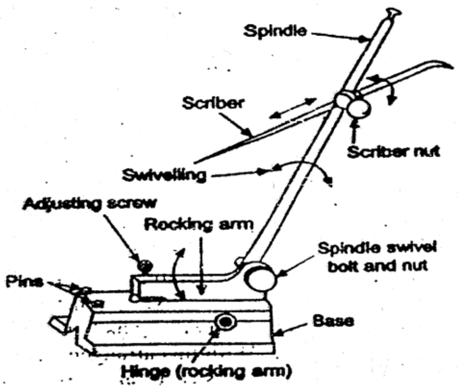


Fig. A universal surface gauge.

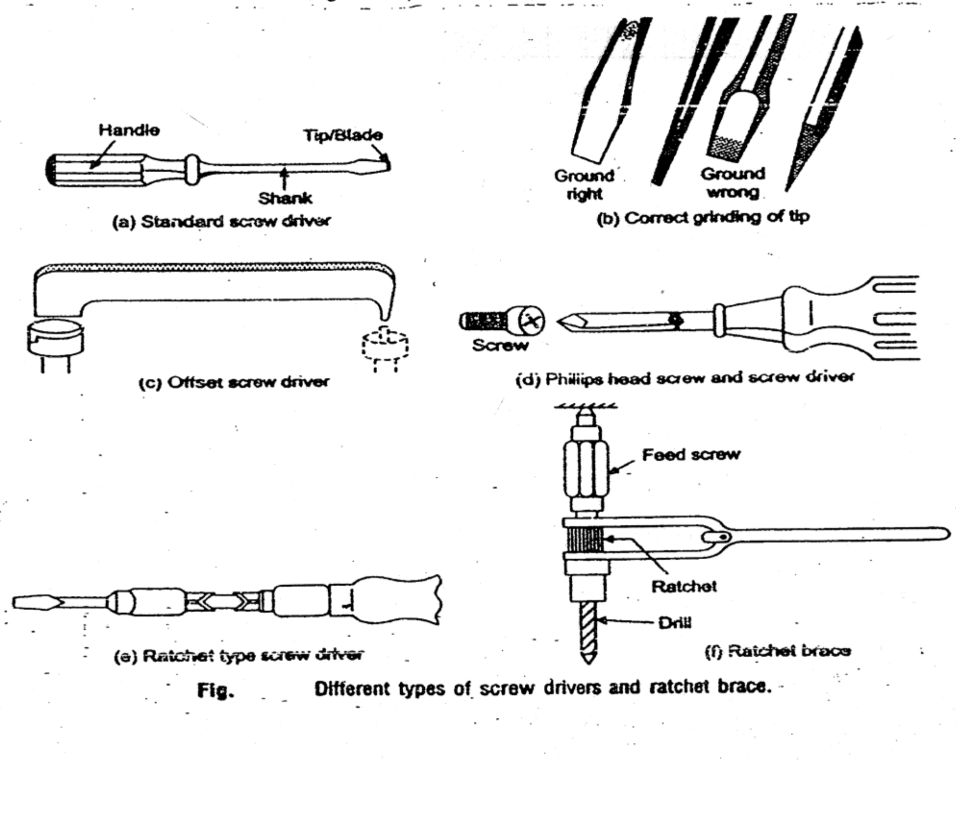


Fig. Different types of screw drivers and ratchet brace.

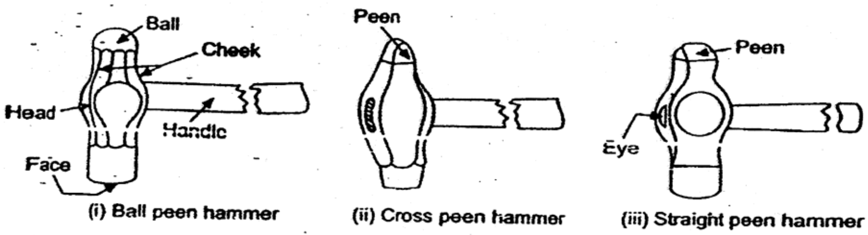


Fig. Three most popular types of fitter's hammers (or hand hammers).

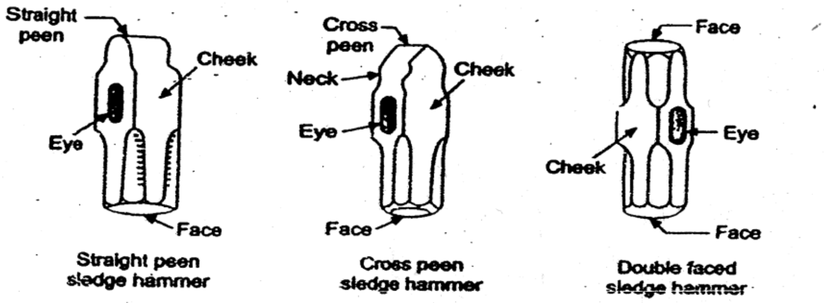


Fig. Different types of sledge hammers.

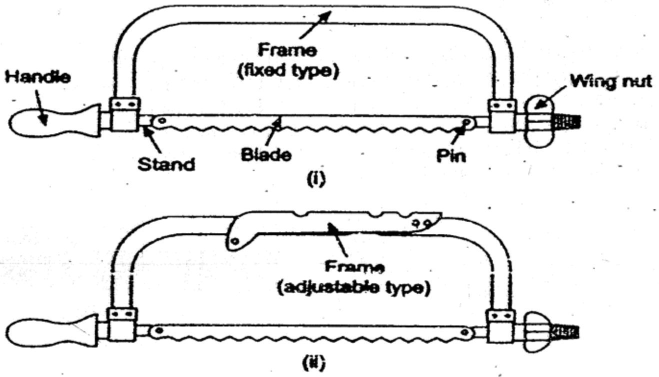


Fig. Two types of hacksaws: (i) fixed frame type and (ii) adjustable frame type.

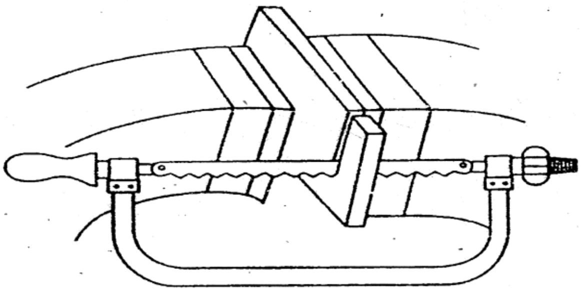


Fig. Taking deeper cuts (more than overall depth of hacksaw frame) by tilting the hacksaw at 90° to its normal vertical working position.

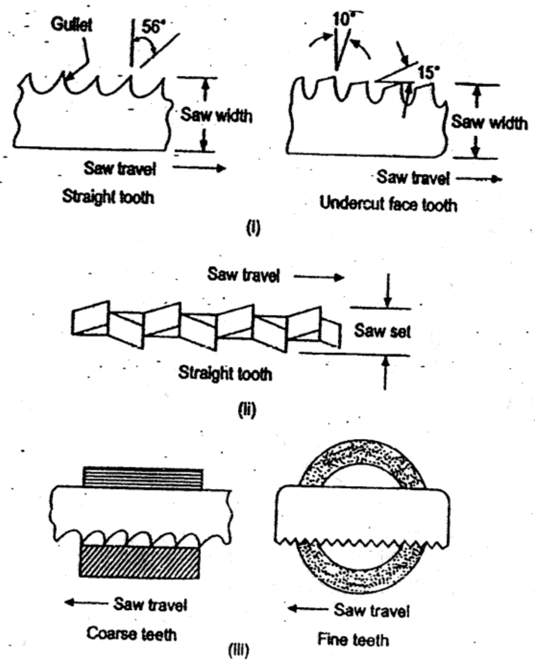
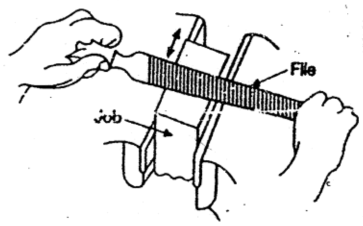


Fig. Geometry of the hacksaw blade and its teeth. Straight tooth and undercut face tooth are shown at (i), saw set for straight tooth at (ii) and limitations of using coarse teeth blade and fine teeth blade at (iii). Note that coarse teeth are good for cutting wide surfaces (thick sections) as they allow fast cut with space for chips. Fine teeth are good for cutting narrow surfaces (thin sections) because at least two teeth on the thin wall of the job at one time will prevent stripping teeth.



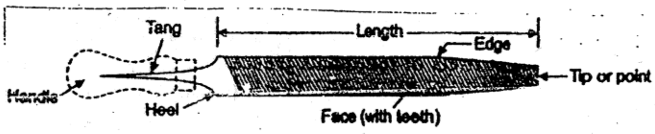
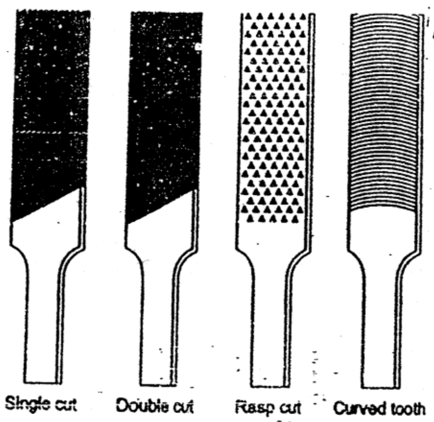


Fig. Parts of a file.

Fig. Draw filing for fine finishing.



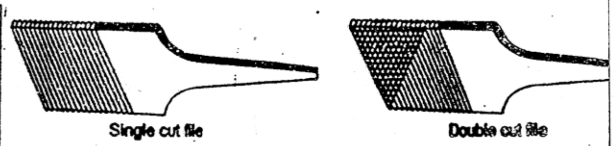


Fig. Different cuts (or types of teeth) of a file.

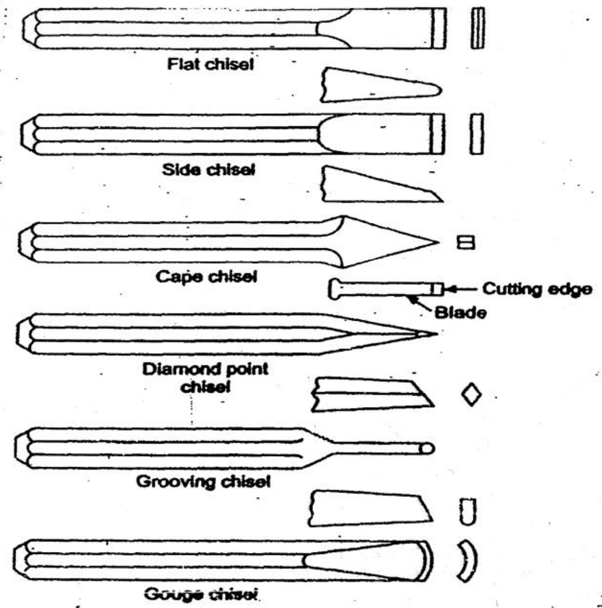


Fig. Different types of chisels.

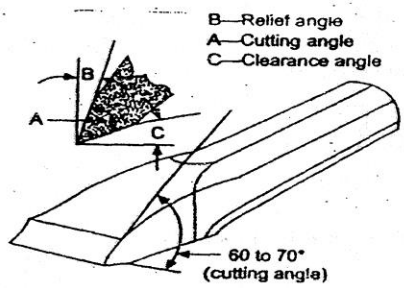


Fig. Angles of a cold chisel. The cutting angle of the chisel is kept about 70° for cutting cast steel, 60 to 70° for cast iron, 55 to 60° for mild steel, 50 to 65° for brass and 45 to 50° for cutting copper.

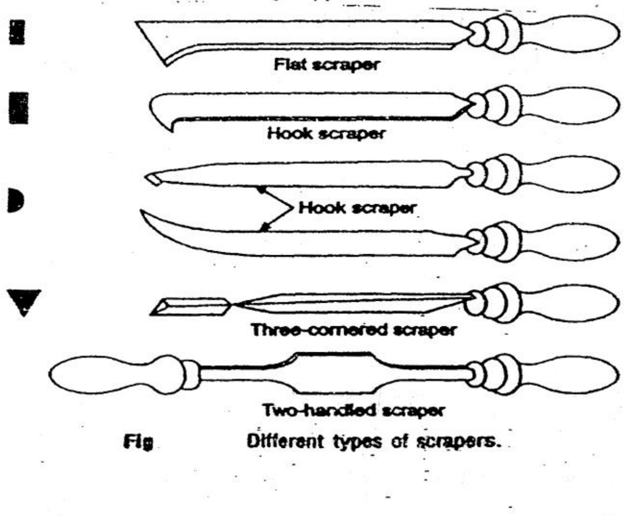


Fig Different types of scrapers.

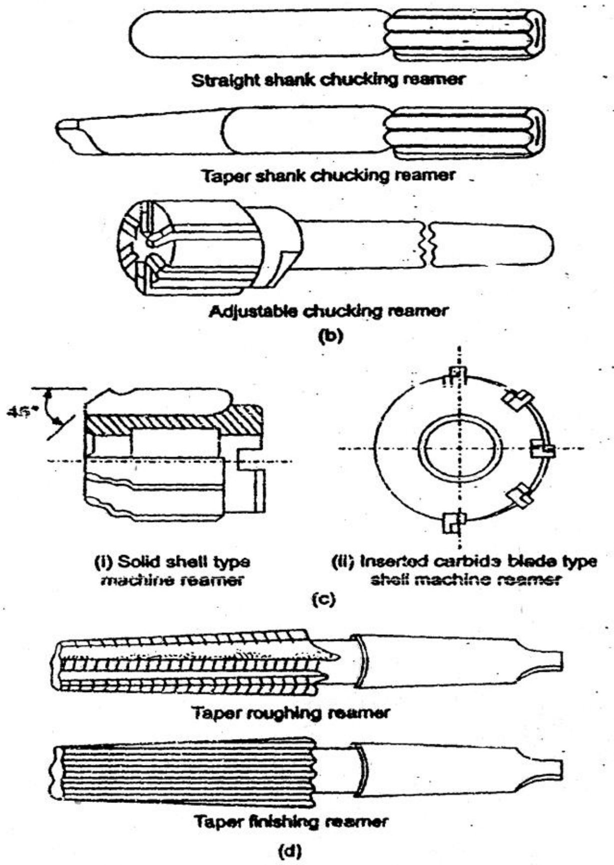


Fig. Different types of reamers.

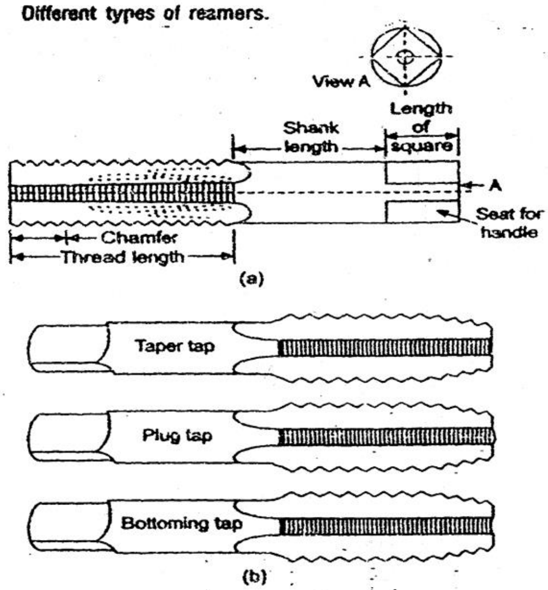


Fig. Geometry of a tap is shown at (a) and the three different taps (forming part of a set of taps) are shown at (b).

8. Carpentry Shop Date:

OBJECTIVE:

To demonstrate different types of hand tools and machines used in carpentry shop.

INTRODUCTION:

Carpentry and joinery are common terms used with any class of work with wood, carpentry deals with all works as roofs, floors, partitions etc. of a building. While joinery deals with the making of doors, windows, cupboards, dressers, stairs and all the interior fitments for a building.

Timber is the basic material used for any class of wood working. The term timer is applied to the trees which provide us with wood. Timbers, for commercial purposes are divided into two classes:

(i) Soft wood (Pinewood, Deodar)

(ii) Hard wood (Teak wood, Mango, Babul, Neem etc.)

Timber available in different firms:

1.	Log	:	Trunk of a tree
2.	Balk	:	Rough and square log
3	Posts	:	Square and round sectioned pieces ranging from 175 to 300 mm size.
4	Planks	:	Parallel side pieces 275 mm to 450 mm wide and approximately 75 mm to 100 mm thick and 2.5 to 6.5 m long.
5	Deals	:	Parallel side 225 mm wide and approximately 100 mm thick.
6	Batten	:	Rectangular pieces up to 175 mm wide and 35 mm to 50 mm thick
7	Board	:	Swan pieces less than 35 mm thick and over 150 mm wide.

Seasoning:

Seasoning of timber is the process whereby the surplus moisture is drawn from the green timber by evaporation, thus allowing the natural juices to harden. The trees are felled when reaching maturity. The advantage of seasoning is that it makes the timber lighter in weight, more resilient and less liable to twist, warp and split. It is also in a better condition to retain its size and shape after being made into pieces of joinery. Seasoning can be through a natural process or an artificial process.

Carpentry

Carpentry and joinery work involves a no. of hand operations to finish the work to the desired shape and size with required accuracy. The following are the principal processes used in carpentry.

i)	Marking	ii)	Sawing (cutting)	iii)	Planning
iv)	Chiseling	v)	Boring	vi)	Grooving
vii)	Rebating	viii)	Molding		

Marking is the process of setting out dimensions on a piece of wood for producing the required shape.

Sawing is one of the basic operations carried out in a carpentry shop. A wood is required to be as vain along the grains or across the grains and in many shapes such as straight, inclined or curved.

Planning is the operations of truing up a piece of wood by a planer (facing and edging).

Chiseling is the process of cutting a small stock of wood to produce the desired shape.

Boring is the process of producing the round holes, through or blind in the wood.

Grooving is the operation of making grooves and tongues that are usually cut on the edges of planks and boards to join them together to form big boards of large width.

Rebating is the process of making a rebate or recess taken out of the edge of a piece of wood.

Molding is the process of cutting convex and other curved surfaces along the length of a piece of wood.

Carpentry Joints

1. **Halving Joint (**Corner, tee, dovetail, cross, and bevel type).

2. **Mortise and Tenon joint**

It consists of a rectangular peg (Tenon) fitting into a rectangular hole. (Mortise). (Plain, grooved, divided, barefaced, double, rebated and fox wedged Tenon and section.)
Other joints are Bridle, Butt, Dowel, Tongue and groove, screw and slot, Dovetail & Corner Joints.

Carpentry Tools

In order to successfully work different forms to accurate shapes and dimensions the wood worker must know the use of a large number of tools.

1. **Marking and Measuring Tools:** Rules, straight edge, Try square, Bevel Square, Combination square, marking knife.
   Gauges are used to mark lines parallel to the edge of a piece of wood. Marking gauge, mortise gauge, cutting gauge.
   Other tools are wind compass, Trammel Divider, caliper, spirit level and plumb bob are used in carpentry.
2. **Cutting tools:** Cutting tools include saws, chisels and gauges.
   Saws: Rip saw and cross cut saw, panel saws, Tenon or back saw, Dovetail saw, Bow Saw, Coping saw, Compass saw, pad or key-hole saw.
   Chisels: Wood chisels most commonly in use include firmer, chisels, square or beveled edge, paring chisels, and mortise chisels.
   Planes: The planes in general use are the jack, trying and smoothing planes. Others are Rebate, Plough Router and spoke share plane. Metal plane include Metal Jack Plane,

Compass or Circular Plane, Bull nose rebate plane, Shoulder plane, block plane and molding plane.

Boring tools: Boring tools are frequently necessary to make round holes in wood and they are selected according to the type and purpose of the hole. They include bradawl, gimlet, brace, bit and drill.

Striking Tools: Include hammers and mallets hammers (Warrington, claw type). Warrington hammers are mostly used for bench work and all light jobs.

Claw hammer serves the dual purpose of a hammer and to pick nails.

Mallet – wooden headed hammer of round or rectangular cross section.

Holding tools: Bench Vice, Bench Stop, Bench holdfast, Sash clamp, G Clamp, Hand Screw.

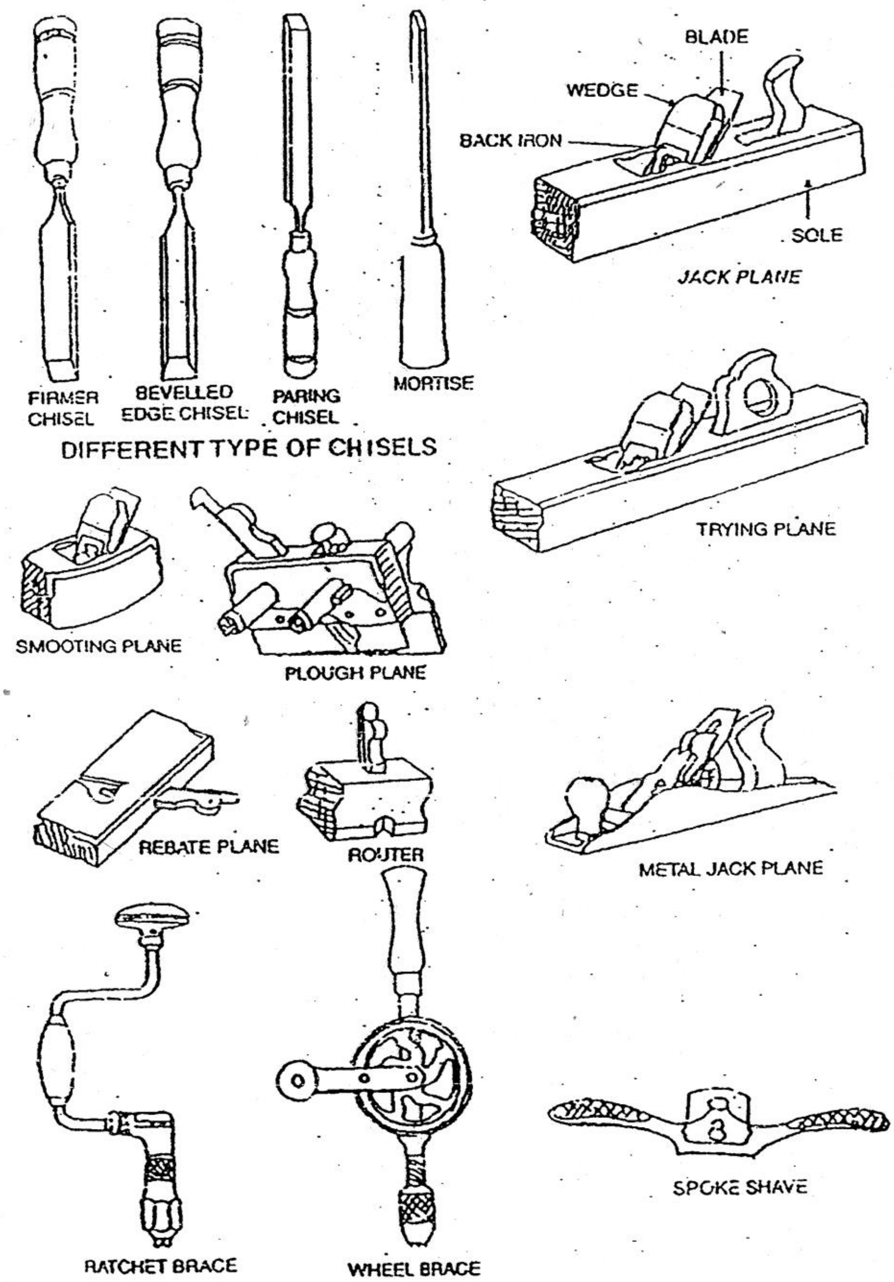
Miscellaneous tools: Rasps and Files, Scrapers, oilstone, Glass paper, pincer, screw driver, ratchet screw driver.

Wood working machine:

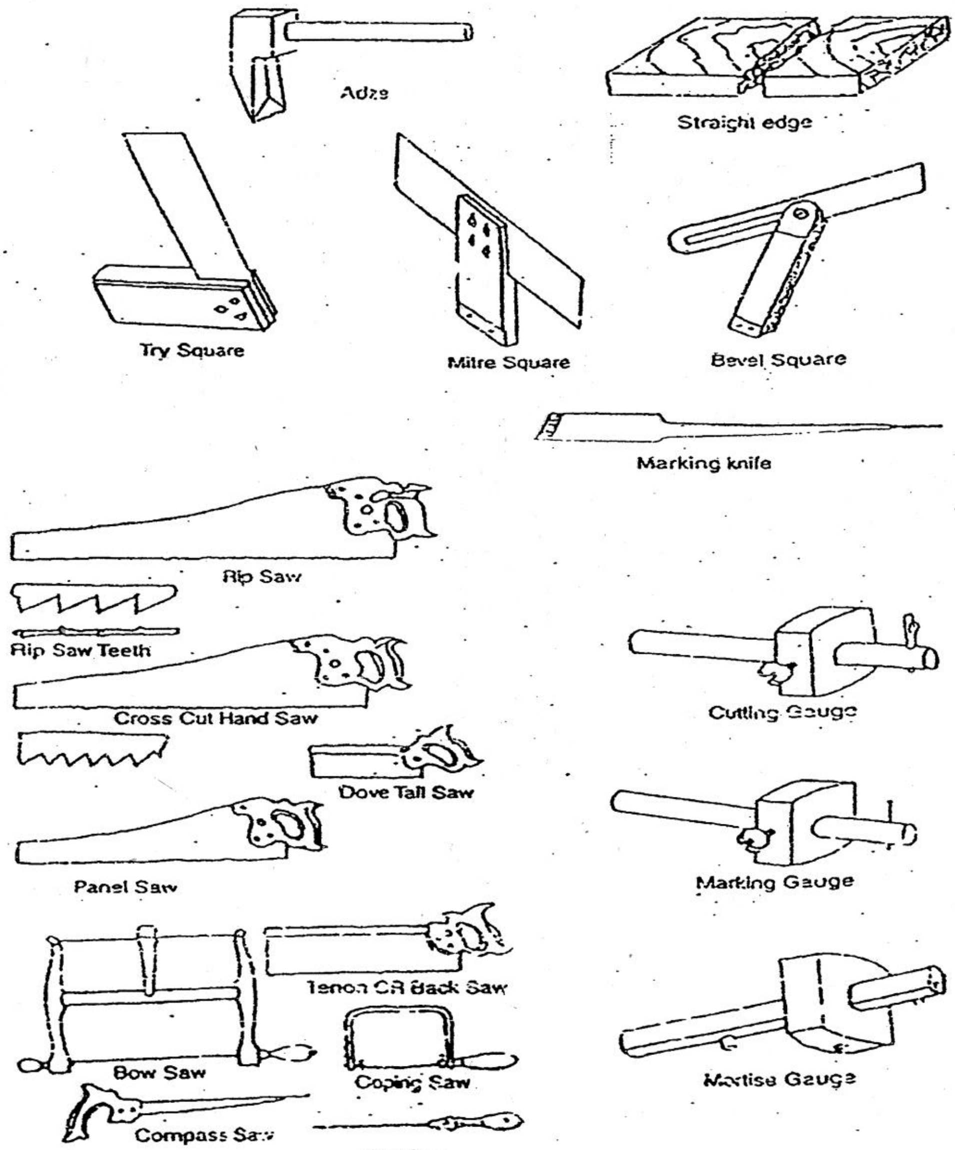
They are power driven and use for large scale production. They are wood working lathe, circular saw, Band Saw, jigsaw or scroll saw, Jointer wood Planer, Mortiser, Sanding Machines and Grinder.

REVIEW QUESTIONS:

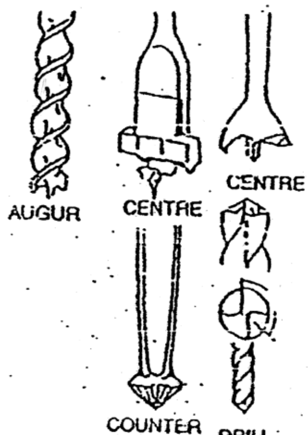
1. Why seasoning is necessary for wood?
2. Draw neat sketch of common joints used and state its use.
3. Write the specific use of following tools
   (i) Holding and Supporting tools
   (ii) Striking tools
   (iii) Bits and braces.


BLADE
WEDGE
BACK IRON
SOLE
JACK PLANE
FIRMER CHISEL
BEVELLED EDGE CHISEL
PARING CHISEL
MORTISE
DIFFERENT TYPE OF CHISELS
TRYING PLANE
SMOOTING PLANE
PLOUGH PLANE
REBATE PLANE
ROUTER
METAL JACK PLANE
SPOKE SHAVE
RATCHET BRACE
WHEEL BRACE

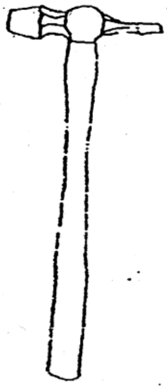
CARPENTRY



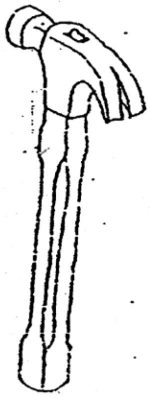
DIFFERENT TYPE OF SAWS



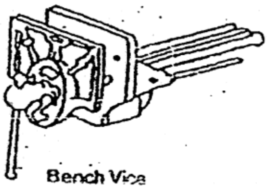
DIFFERENT TYPES OF BITS



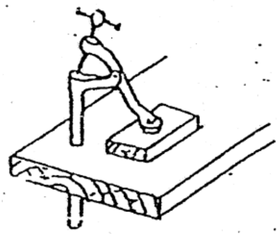
Warrington Hammer



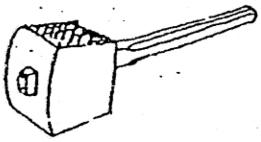
Claw Hammer



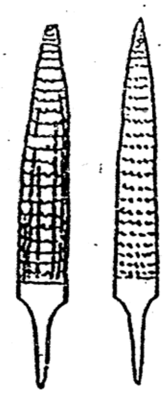
Bench Vice



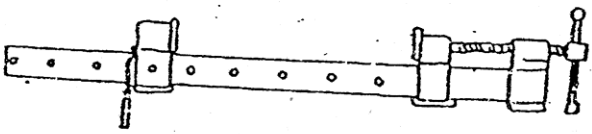
Bench Hold Clamp



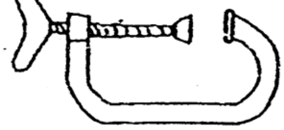
Mallet



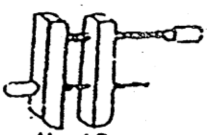
Rasp



Sash OR Bar Clamp



C.Clamp



Hand Screw

9. Welding   Date:

OBJECTIVE:
To demonstrate Welding process.

INTRODUCTION:
In many situations the desired shape and size of the materials can be obtained by joining two parts of same or different materials. The joining processes are categorized as (a) Temporary Joint and (b) Permanent Joint. The common joining processes are welding, soldering, brazing and mechanical fastenings and adhesive bonding.

WELDING
Welding is a process of joining similar and dissimilar metals by the applications of heat with or without application of pressured and addition of filler metal in such a way that the result is continually of homogeneous material. The welded components result in continuity of a homogenous material having same compositions and characteristics as the two parts to be joined together. Weldability defined as the capacity of being welded into separable joints having specified properties such as definite weld strength, proper structure etc.

Classification of Welding
1. Based on source of heat: Brazing and soldering

2. Based on application of pressured welding processes are of following types:

   Gas welding   Arc welding   Resistance welding

Types of welded joints

- Lap joint
- Butt joint
- Corner joint
- Tee joint
- Edge joint

Types of Welds

- Fillet
- Groove

Welding edge preparation

- Square
- Single V
- Double V
- Single U
- Double U

Welding Techniques

- Forehand welding
- Backhand welding

Gas Welding Equipments

a) Welding torch   b) Welding tip   c) Pressure regulator
d) Pressure Regulator   e) Hose and Hose fitting   f) Goggles, Gloves and Spark lighter
g) Gas cylinder

Arc Welding Equipments

AC or DC Power Source	Electrode	Electrode holder	Cables, cable connections
Cable lag	Chipping hammer	Earthing clamps	Wire brush
Helmet	Safety goggles	Hand gloves	Aprons and sleeve

Gas Welding

A fusion welding process which joins metals, using the heat of combustion of an oxygen / air and fuel gas (acetylene, hydrogen, propane or butane) mixture is usually referred as "Gas Welding". The intense heat (flame) thus produces melts and fuses together the edges of the parts to be welded generally with the addition of a filler metal. The oxy Acetylene flame produces the highest flame temperature of approximately 3300° C.

Types of Flame

Carburizing flame: (Reducing Flame):

It is obtained when Acetylene is in excess. Hence flame temperature is low. Available carbon is not burn completely because of less oxygen and* left over carbon is forced into the molten metal. The excess of carbon gets absorbed in ferrous metals, making the weld bead hard and brittle.

Oxidizing flame:

Consist of excess of oxygen. Oxidizing flame produces the hottest flame that can be produced by any oxygen fuel source. Since the flame contains excess of oxygen, it causes the metal to burn or oxidized quickly.

Neutral Flame - contains equal proportion of oxygen and acetylene. It has little effect on the base metal. It produces hard weld bead when compared to carburizing and oxidizing flames.

Fluxes - Flux added to the welded metal removes oxides from the surfaces of the parent metals and helps oxides to float up in the molten metal pool. Flux reacts with oxides to produce slag. The common fluxes used in the gas welding are made of sodium, potassium, Lithium and borax.

Filter Materials - is generally added in the gas welding. The filler is melted by the flame and is added to the molten metal that fills the space between the pieces being joined.

Arc Welding

Arc Welding is widely accepted as the best, most economical and most practical method of joining the metals. In principle, the process of arc welding requires a suitable electrode, low voltage - high current producing electrical equipment, cables and work piece. The work piece is attached to one of the cable and the electrode, to the other cable. An electric arc is then struck between work piece and the electrode and a large current between the electrode and the work piece produces immense heat. Next, the electrode is moved along the seams of the metals to be welded, allowing sufficient time for the arc heat to melt and fuse the metal.

Resistance Welding

All of us know that when electric current flows through a wire, it generates heat due to the resistance offered by the metal of the wire to the flow of electrons. In resistance welding the heat required for welding is produced by, means of the electrical resistance between the two members to be joined. This process is also known as electric welding. The heat is generated in resistance welding is given by:

$$H = I^2RTK$$

H = Heat generated in pulse (watt sec)
I = Current in Amperes
R = Resistance in Ohms
T = Time of current flow in seconds
K = Constant to account for losses due to radiation and conduction. The value of K is normally less than one.

Review Question

1. Draw a neat sketch of three types of flame used in gas welding, indicate temperature in each and also state application.
2. Explain (i) Filler rod (2) Electrode (3) consumable electrode and non-consumable electrode (4) Bare and coated electrode
3. Explain Arc welding, Gas welding, and Resistance welding process.
4. What are different types of weld joints?
5. Why edge preparation is required before arc welding?
6. What is full form of SAW, GTAW/TIG, MMAW/SMAW, and MIG?

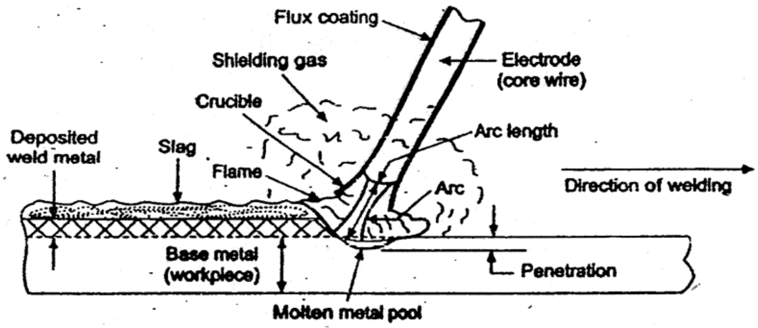


Fig. Essentials of shielded metal-arc welding process. The crucible or cup formed at the lower end of the flux coated electrode helps in concentrating the arc heat right on the weld zone and also ensures a consistent arc length.

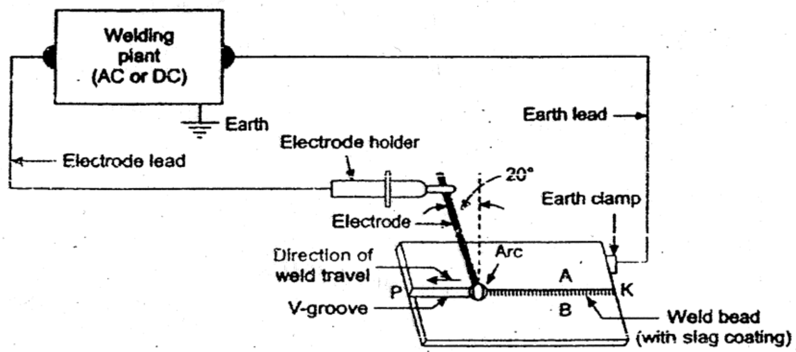


Fig. Essentials of an electric arc welding process. The mating edges of the two workpieces (plates A and B) are first prepared for welding by grinding them slant such that when placed parallel and touching to each other along the mating line PK, a V-groove is formed to receive molten metal. The electrode is usually inclined to about 20° from the vertical position towards the direction of weld travel.

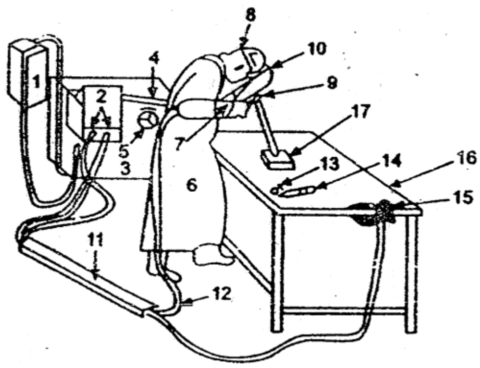


Fig. Arc welding set-up: (1) Switch box, (2) Secondary terminals, (3) Welding machine, (4) Current reading scale, (5) Current regulating hand wheel, (6) Leather apron, (7) Leather hand gloves, (8) Protective glasses strap, (9) Electrode holder, (10) Hand shield, (11) Channel for cable protection, (12)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

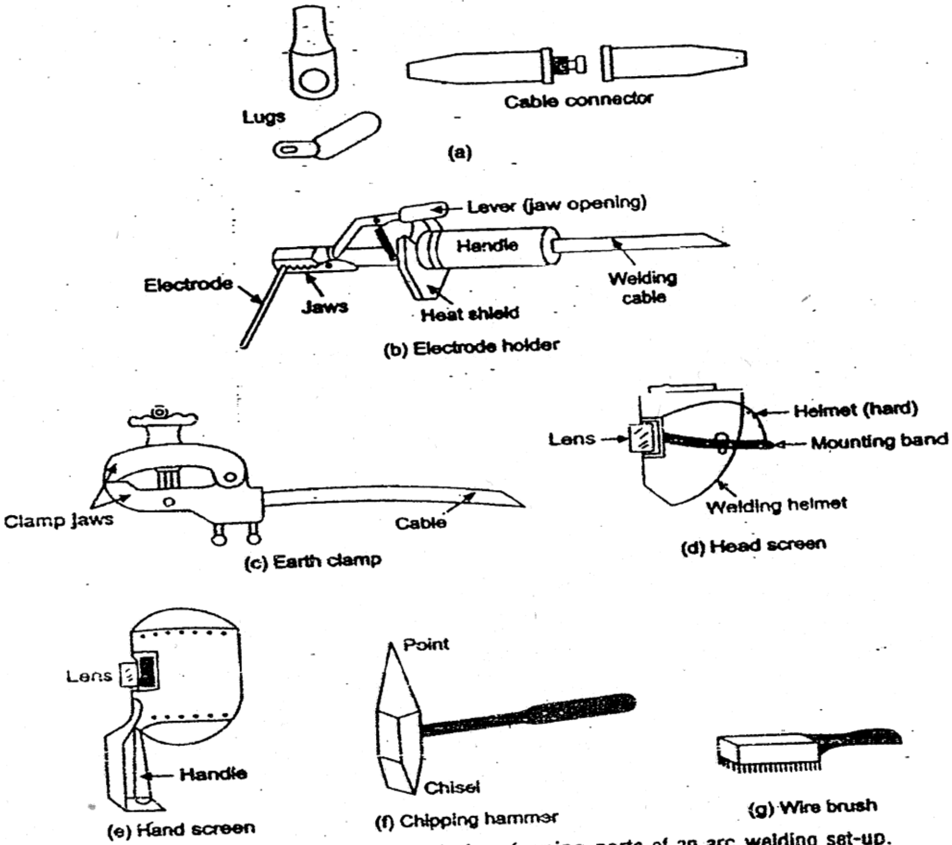


Fig. Various equipment or devices forming parts of an arc welding set-up.

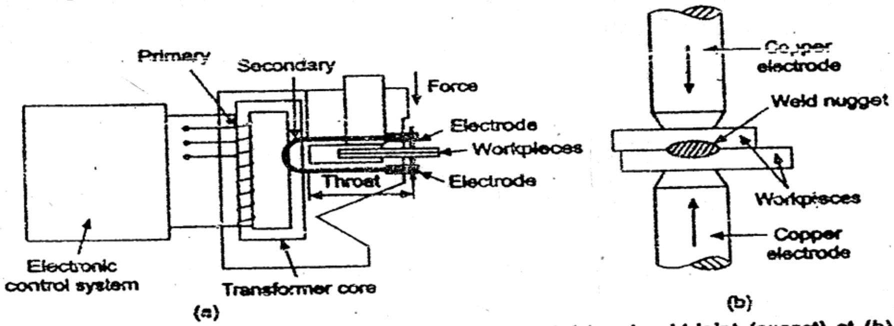


Fig. Showing essentials of spot welding set-up at (a) and weld-joint (nugget) at (b).

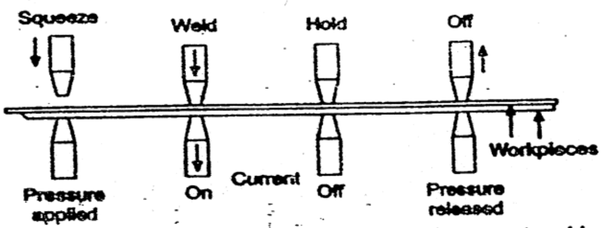


Fig. Showing various stages in making a spot weld.

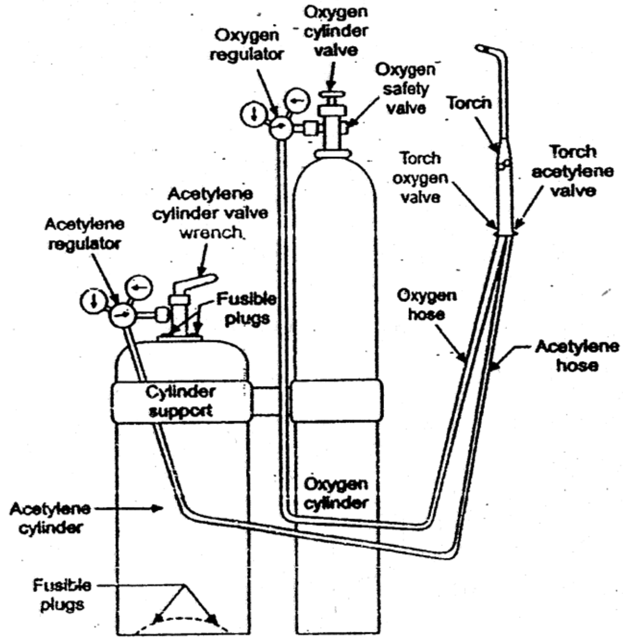


Fig. Oxy-acetylene welding outfit.

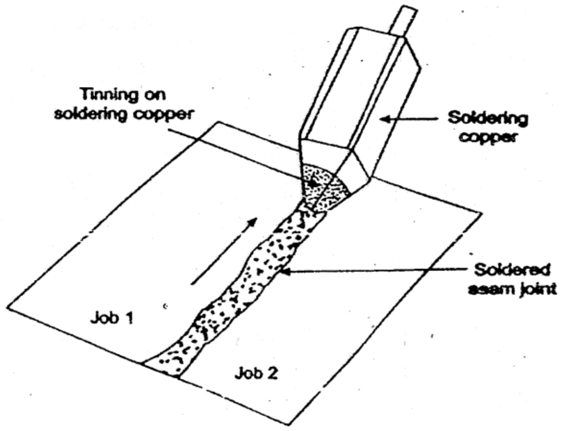


Fig. . Soldering iron method.

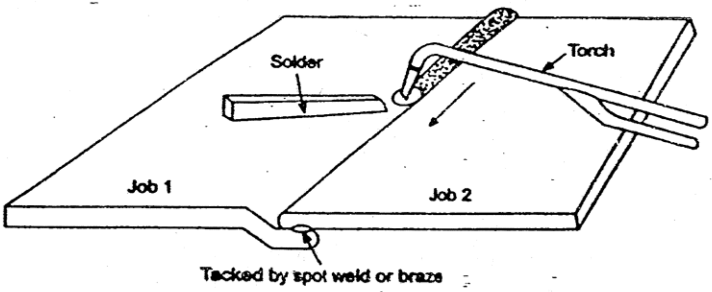


Fig. . Soldering torch method.

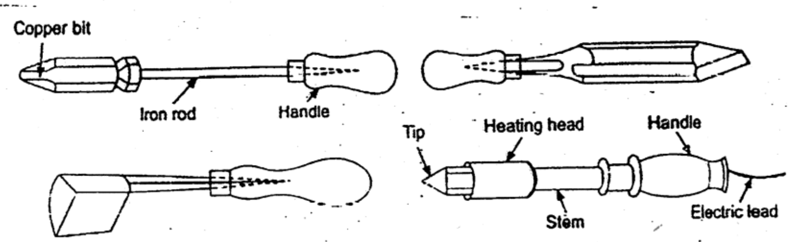
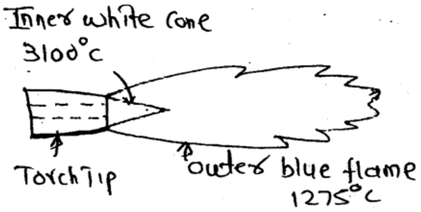
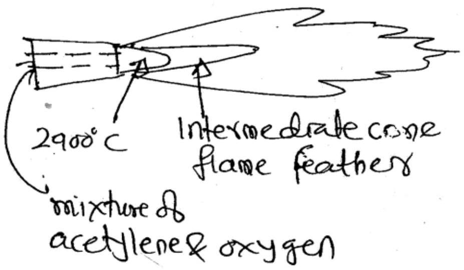


Fig. Various types of soldering irons.



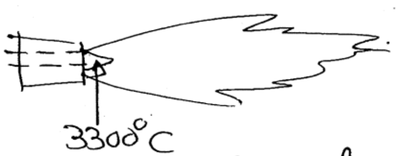
(a) Neutral Flame

Neutral Flame is used for normal welding of steel, cast iron.



(b) carburising flame

carburising flame is used for welding nickel, monel.



(c) oxidising flame

oxidising flame is used for welding brass and is also used for cutting the metals-

Fig. Different types of oxy-acetylene welding flames

10. Foundry Shop Date:

OBJECTIVE:

To demonstrate pattern making, molding and casting process.

INTRODUCTION:

Casting process is based on the property of liquids to take up the shape of the vessel containing it. Molten Metal when poured into a cavity of desired shape (called mould) and when this metal solidifies, it has the shape and size of the mould. Mould is prepared by use of molding sand. The cavity in mould is prepared by use of pattern. For Hollow casting core is used. Hence, a casting may be defined as a metal object obtained by pouring molten metal into a mould and allowing it to solidify.

The section of the workshop where metal castings are produced is known as the Foundry or Foundry shop.

Castings have several characteristics that clearly define the role in modern equipment used for transportation, communication, power, agriculture, construction, engineering and other industries.

A pattern is defined as a model of casting.

A mould is the cavity, made in a suitable refractory material that can withstand the high temperature of the molten metal, into which molten metal can be poured.

The basic sequences of the operations required for making metal castings are:

- Pattern making
- Mould making
- Core
- Core making
- Melting of metal and Pouring
- Cooling and solidification
- Cleaning of castings and inspection

Commonly used pattern materials are wood, metal, plastic, and polystyrene.

Patten used in foundry work can be classified as:

- Solid Pattern
- Split Pattern
- Loose piece pattern
- Gated pattern
- Match plate pattern

In order to provide a casting of proper size and shape and for many mechanical and metallurgical reasons, allowances are provided on the patterns.

Sand is the principle materials used in the foundry for making mould. Molding sand possess the necessary properties-high fusion temperature and good thermal stability for making moulds.

The principle ingredients of molding sand are: Silica and grains, clay, moisture, and special additives like coal dust - to improve surface finish, fuel oil – to improve mold ability, and pearlite – to improve thermal stability. The amount of clay, which acts as a binder imparting plasticity to the molding sand in moist state, increases its strength after drying and determines the strength of the molding sand.

Molding sand can be classified or Green sand, Dry sand, Loam sand, Parting sand and core sand. Molding sand should possess certain properties to produce good moulds and castings. These properties are – strength or cohesiveness, chemical resistivity, permeability, flow ability, adhesiveness, refractoriness and collapsibility.
In foundry shop many different types of tools and equipment's are used for making mould and producing sound castings. Tools for filling the flasks and compacting the sand are shovels, riddles and rammers, and those used for finishing mould are trowels, draw spikes, spore pins and molding boards others are vent rod, bellows, molding boxes.

Types of molding processes

Bench Molding	Flour Molding	Pit Molding
Hand Molding	Machine Molding	

Cores

To get holes or other internal cavities in castings, cores are used.
A core may be defined as a sand shape or form, that makes the contour of a casting for which no provision has been made in the pattern. Core may be made from sand, metal, plaster or ceramics. After the molten material is solidified, cores are ejected or broken and the cavities are obtained in the castings.

Defects in Castings

The common defects are found in castings arc – Blow holes, Shrinkage. Hot tears (internal or external cracks or discontinuities on the casting surfaces), Misruns, Cold shuts, pour short inclusions (Any separate undesirable foreign material present within the metal of a casting, is known as inclusions).
For melting of Metals, furnaces are used:
(i) Pit Furnace (ii) Oil fired tilting furnace (iii) Cupola furnace

REVIEW QUESTIONS

1. Define (a) Pattern (b) Mold (c) Casting
2. State specific use of following :
   (a) Solid Pattern (b) Split Pattern (c) Gated pattern
   (d) Match plate pattern (e) Skeleton pattern
3. Draw a neat sketch of two box mold method for making a mold.
4. List five typical component produced by casting process.
5. List different furnace used in casting.

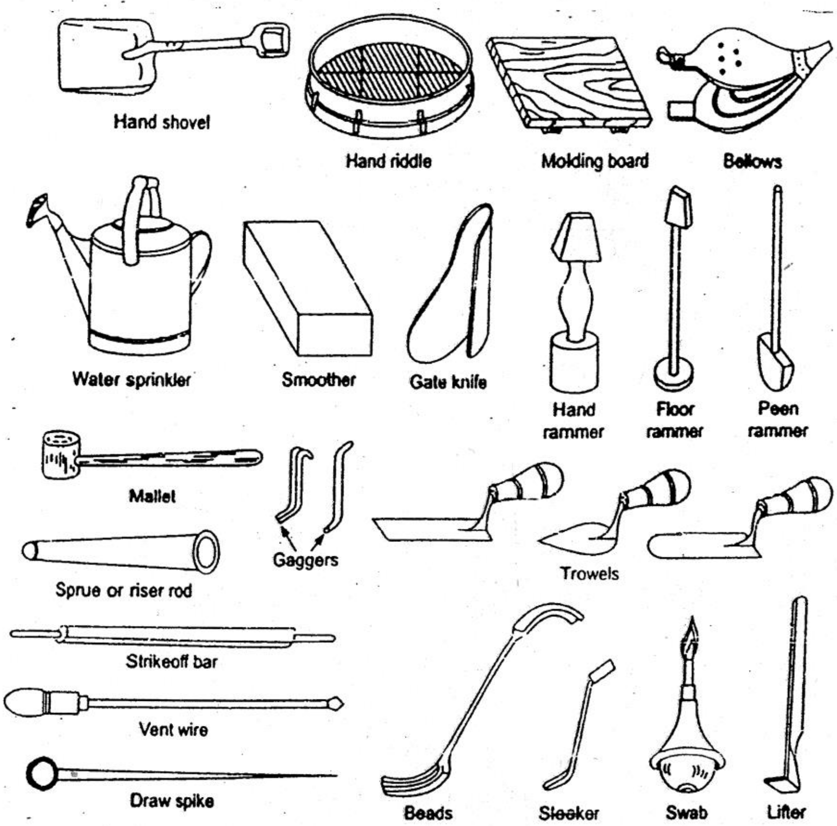


Fig. Hand tools used by a molder.

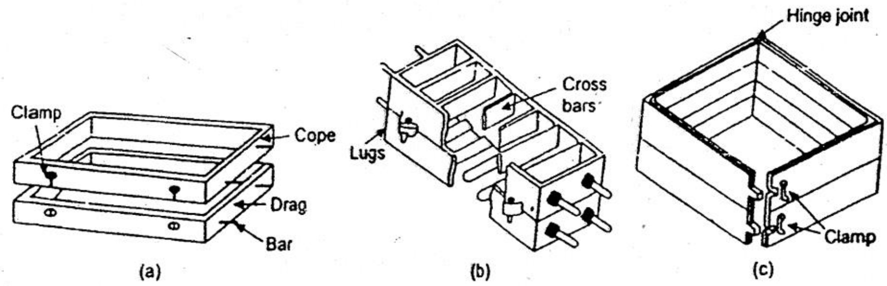


Fig. Molding boxes (or flasks): (a) Rectangular type molding boxes, (b) A pair of molding boxes with strengthening cross bars and (c) A wooden snap flask.

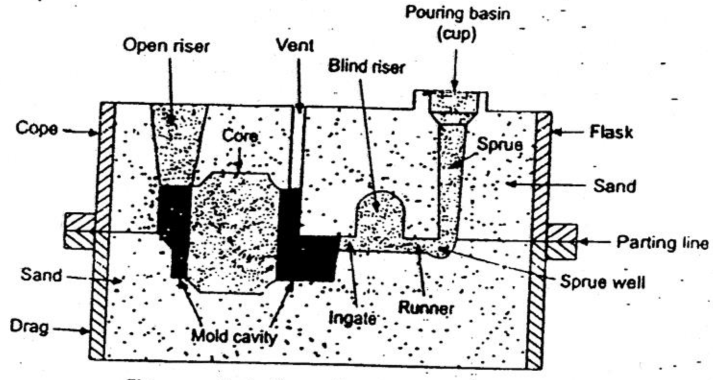


Fig. Illustrating salient features of a sand mold.

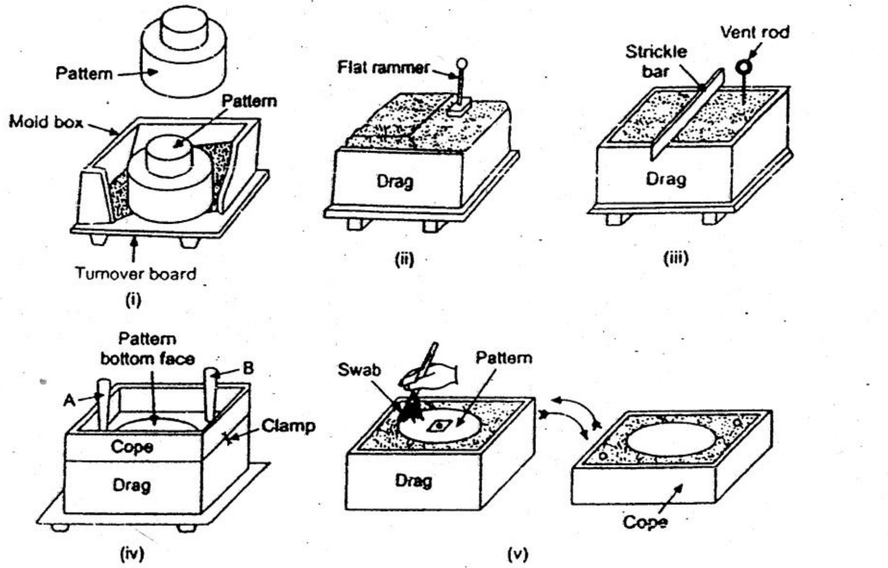


Fig. Steps involved in molding a simple block.

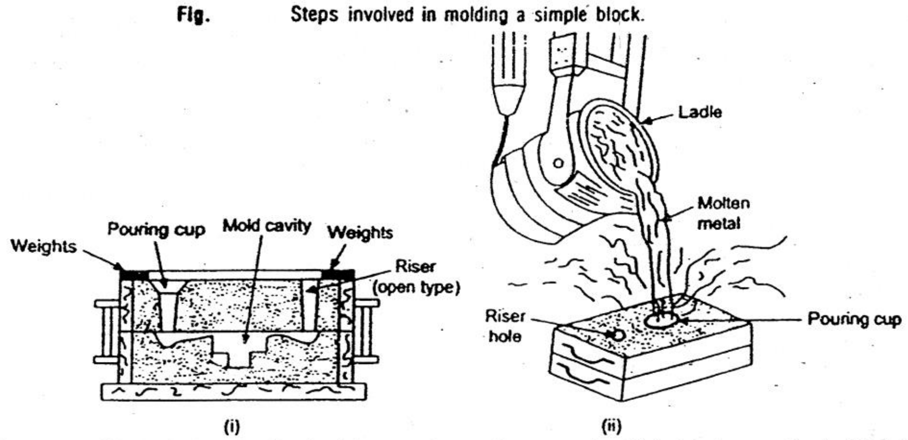


Fig. Sectional view showing (weights not shown). The state of mold just before pouring metal at (i) and metal pouring in the mold at (ii).

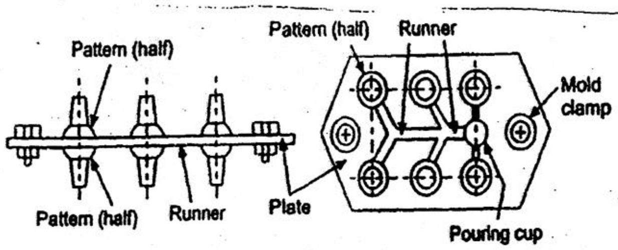


Fig. Showing a typical match plate pattern used for making six castings in one go. Patterns are split along the parting line formed by the plate, cope patterns are on one side of the plate and drag patterns on the opposite side. The patterns carry a common runner and separate gates to feed metal. Molding is often done on molding machines. The pattern plate is coupled between the cope and drag with the help of two mold clamps.

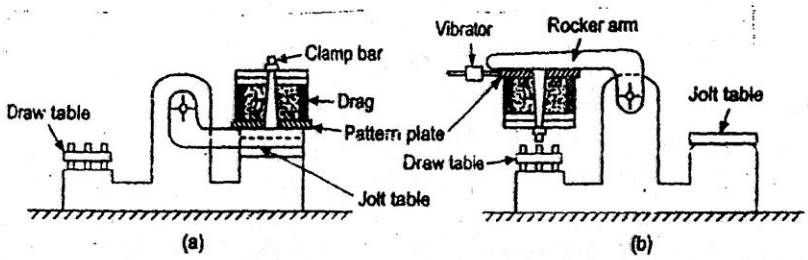


Fig. A jolt roll-over pattern-draw molding machine used for making drag molds.

(a) Drag mold box is placed on the pattern plate forming part of rocker arm. The mold box is sand filled and compacted by jolting. Top of the drag mold is covered with a plate which is clamped to the mold.

(b) Mold is rolled over by 180° with the help of rocker arm. The draw table rises up and the mold is placed on the draw table. Mold is unclamped. Vibrator raps the pattern as the draw table comes down slowly, separating the mold from the pattern.

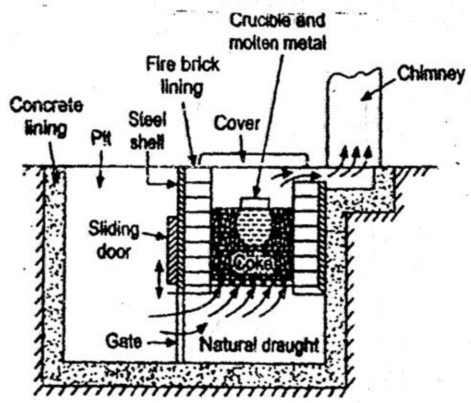


Fig. A natural draft pit furnace.

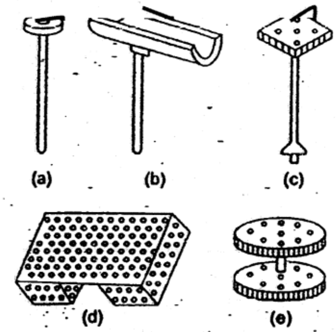


Fig. Chaplets for supporting cores in the mold: (a) Stem chaplet, (b) Pipe chaplet, (c) Radiator chaplet, (d) Perforated chaplet and (e) Double headed or stud chaplet.

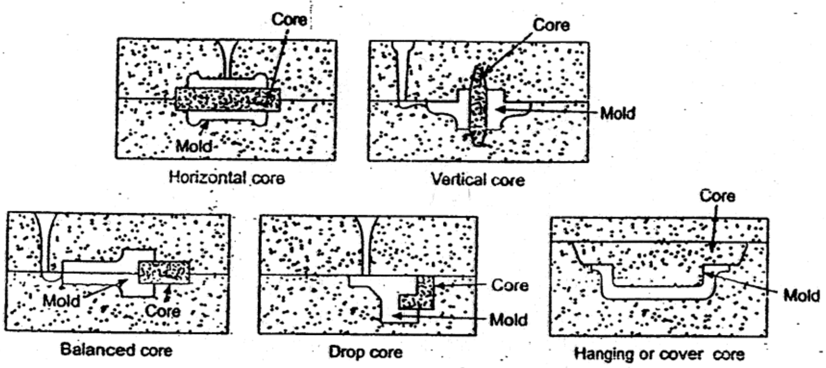


Fig. : Different types of cores.

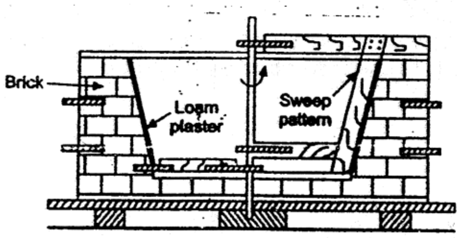


Fig. Preparing a loam sand mold using a sweep pattern.

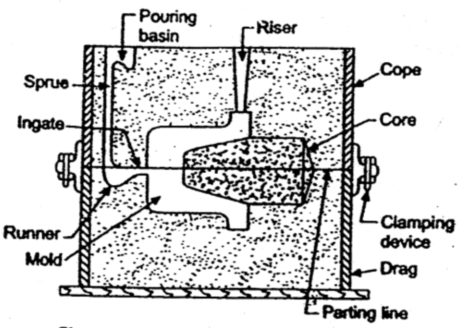


Fig. Two box bench molding.

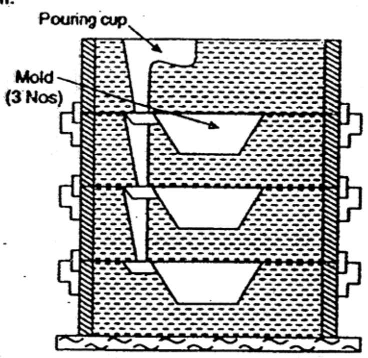


Fig. Stack molding.

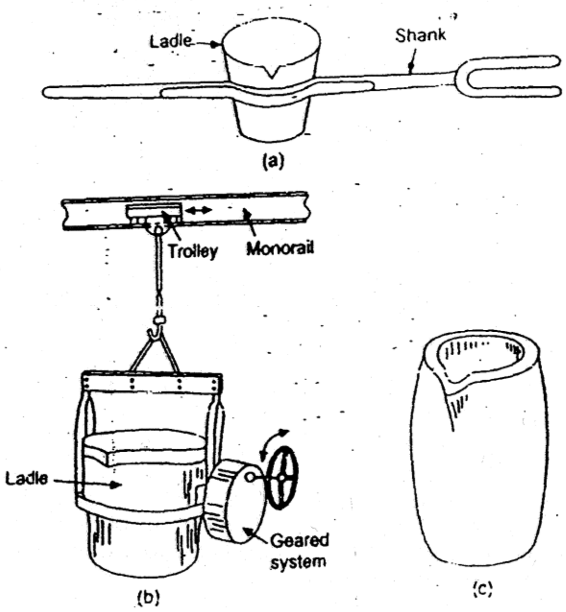


Fig. (a) Hand shank laddle. (b) A tilting type geared crane ladle hanged to a trolley which can move to and fro on a monorail. (c) A crucible.

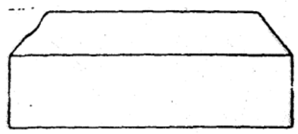


Fig. A solid pattern.

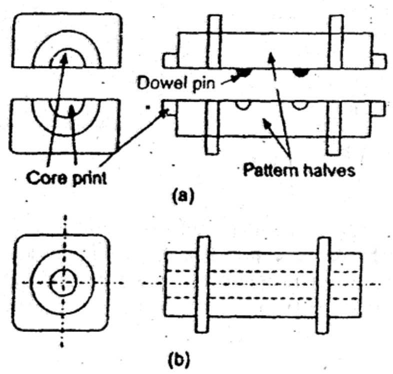


Fig. A split or two-piece pattern. The two halves of the pattern are shown at (a) whereas the casting made by this pattern is shown at (b).

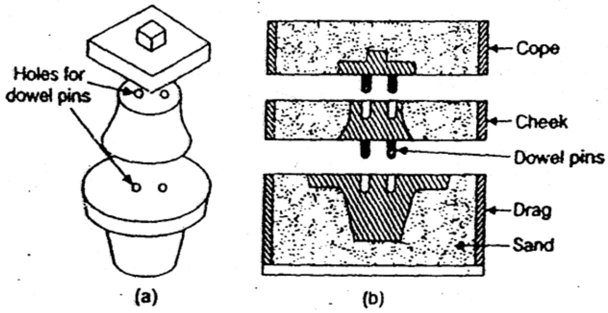


Fig. A multipiece (three-piece) pattern. The exploded view of the three-piece pattern is shown at (a) while the method of molding with the three-piece pattern is shown at (b) using three molding boxes.

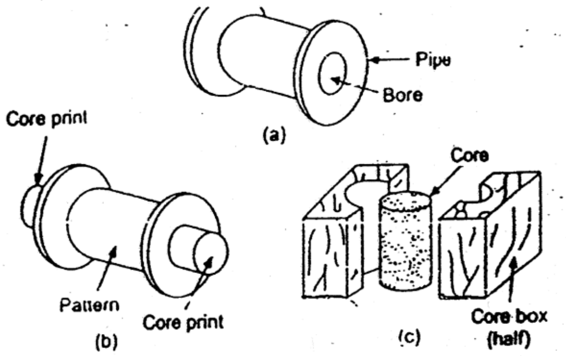


Fig. A split type core box for making a straight core for a two-flanged pipe shown at (a). The pattern for the pipe is shown at (b). The core box, in two halves, for making the core, is shown at (c). Note that the length of the core includes the length of the pipe and the length of both the core prints shown at the ends of the pipe pattern.

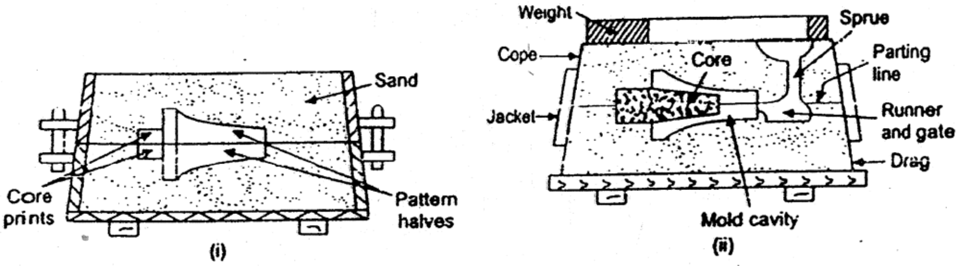


Fig. Illustrating the use of a split type pattern for making a mold cavity in the sand. The split type (or two halves) pattern embedded and rammed in the sand in the cope and drag is shown at (i). Note that the core print forms the extended part of the pattern and is used to make a cavity or impression (extra to the mold) in the sand for supporting the core in the mold cavity. After the two pattern halves are taken out of sand leaving the mold cavity behind in the sand, the core is placed in position in the mold cavity as shown at (ii). Sprue hole, runner and gate are made in the sand for pouring molten metal. With a weight placed on the top of cope (to counteract the upthrust of molten metal during casting), the mold is ready for pouring metal.

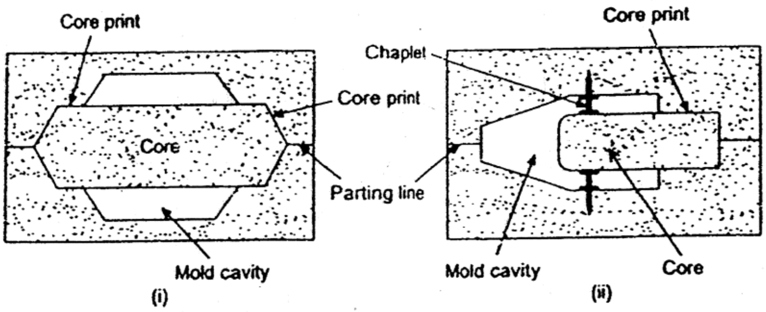


Fig. Setting and supporting a core inside a mold cavity. A core is supported in a mold either in the cavity formed in sand by the core prints as at (i) or with the help of chaplets or both as at (ii).

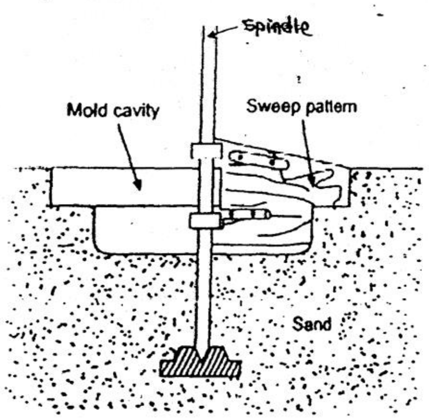


Fig. A sweep pattern and its use in making a mold cavity in the sand.

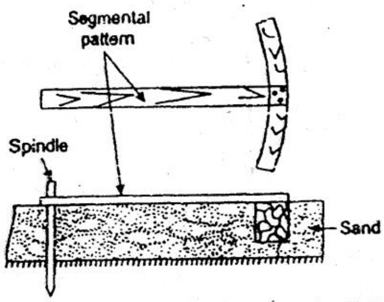


Fig. A segmental pattern used for molding a ring-shaped casting. Bottom of the mold is first rammed and levelled and the spindle (or pivot) is erected vertical in the sand in the centre of mold. Segmental pattern is fastened to the spindle and sand is rammed underside the pattern. After levelling the sand, the first setting of pattern is thus completed. Later, the pattern is unfastened from the spindle and is drawn out of the sand. The next position of the pattern will be the one just adjoining its first setting and like that the process is continued till the complete periphery of the ring-shaped casting is molded.

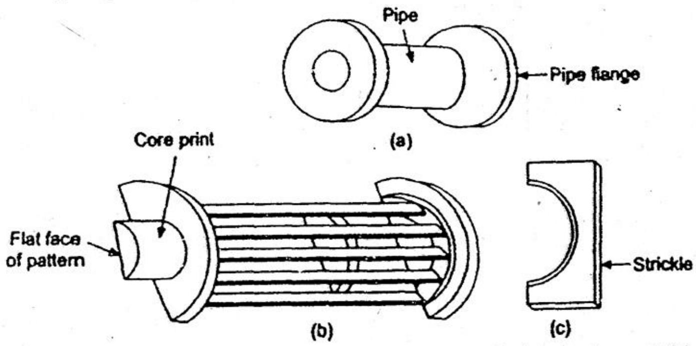


Fig. A skeleton pattern for molding a large pipe with flanges at both ends shown at (a). The skeleton pattern (b) is set on the compacted and levelled sand floor with its flat face. Its hollow portions are filled with sand and rammed and the final cylindrical shape to the pattern is given by using the strickle (c). Molding flask is placed enclosing the pattern and the sand pattern dusted with parting sand. Later, molding sand is rammed in the flask. This way, half of the mold is prepared. Pattern may be drawn from the flask sand. Similarly, the other half of the mold may be prepared.

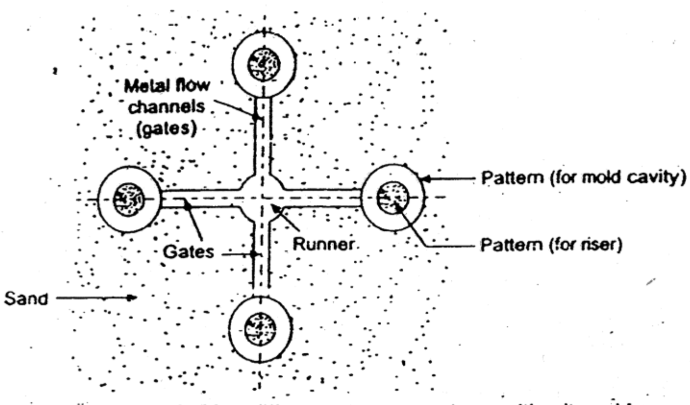


Fig. Gated pattern composed of four different patterns to make a multicavity mold complete with gates, runners and risers.

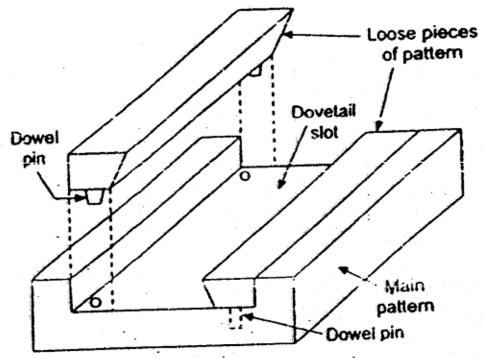


Fig. A loose-piece pattern for making a casting with a dovetail slot.

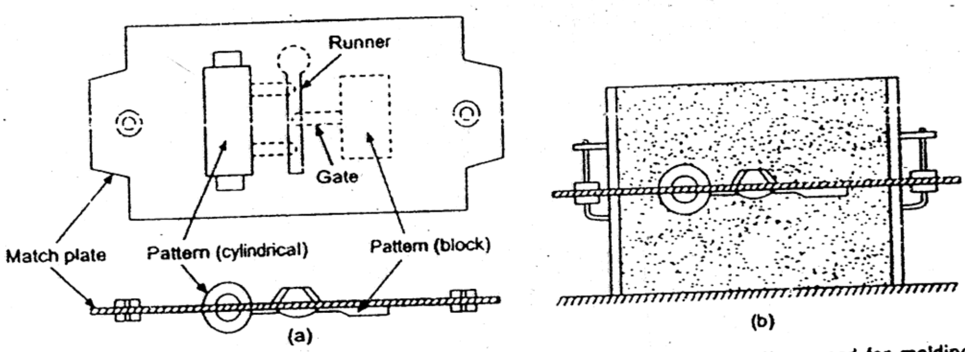


Fig. Match plate pattern showing: (a) Two views of a typical match plate pattern used for molding simultaneously the two objects of different shapes; patterns for a cylindrical casting and a block casting attached to the plate on its opposite sides, (b) A match plate pattern being used for making a mold using two mold boxes.

11. Soldering and Brazing Date:

OBJECTIVE:
To demonstrate Brazing and Soldering.

INTRODUCTION:
Soldering and brazing provide permanent joint to bond metal pieces. Soldering and brazing process lie somewhere in between fusion welding and solid state welding. These processes have some advantages over welding process. This can join the metal having poor weldability, dissimilar metal and wherein very less amount of heating is needed. The major disadvantage is that joints made by soldering and brazing have low strength as compared to welded joints.

PRINCIPLE OF BRAZING:
In case of brazing joining of metal pieces is done with the help of filler metal. Filler metal is melted and distributed by capillary action between the faying surfaces of the metallic parts being joined. In this case only filler metal melts. There is no melting of work piece metal. The filler metal (brazing metal) should have the melting point more than 450^{o}C. Its melting point should be lesser than the melting point of work piece metal. The metallurgical bonding between work and filler metal and geometric constrictions imposed on the joint by the work piece metal make the joint stronger than the filler metal out of which the joint has been formed.

PRINCIPLE OF SOLDERING:
Soldering is very much similar to brazing and its principle is same as that of brazing. The major difference lies with the filler metal, the filler metal used in case of soldering should have the melting temperature lower than 450 ^{o}C. The surfaces to be soldered must be pre-cleaned so that these are faces of oxides, oils, etc. An appropriate flux must be applied to the faying surfaces and then surfaces are heated. Filler metal called solder is added to the joint, which distributes between the closely fitted surfaces. Strength of soldered joint is much lesser than welded joint and less than a brazed joint.

DIFFERENT TYPES OF SOLDERS:
Most of the solder metals are the alloy of tin and lead. These alloys exhibit a wide range of melting point so different type of soldering metal can be used for variety of applications. Percentage of lead is kept least due to its toxic properties. Tin becomes chemically active at soldering temperature and promotes the wetting action required for making the joint. Copper, silver and antimony are also used in soldering metal as per the strength requirements of the joint. Different solder their melting point and applications are given in the Table.

A solder is selected on the basis of its melting point. If metals to be joined have higher melting point solder of higher melting point is generally selected. Solder of high melting point provides better strength of the joint.

Filler Metal Compositions					Melting Point	Applications
Tin	**Lead**	**Silver**	**Zinc**	**Antimony**		
-	96	04	-	-	305^{o}C	Joint making at elevated temperature
60	40	-	-	-	188^{o}C	Electronic circuits
50	50	-	-	-	199^{o}C	Wire joining
40	60	-	-	-	208^{o}C	Automobile radiators
91	-	-	09	-	200^{o}C	Joining of aluminum wires
95	-	-	-	05	238^{o}C	Plumbing, etc.

Table: Common Soldering Alloys and their Applications

TYPES OF SOLDERING FLUXES:

Soldering fluxes can be classified as:

(a) Organic fluxes

(b) Inorganic fluxes

Organic Fluxes

Organic fluxes are either rosin or water soluble materials. Rosin used for fluxes are wood gum, and other rosin which are not water soluble. Organic fluxes are mostly used for electrical and electronic circuit making. These are chemically unstable at elevated temperature but non-corrosive at room temperature.

Inorganic Fluxes

Inorganic fluxes consists of inorganic acids; mixture of metal chlorides (zinc and ammonium chlorides). These are used to achieve rapid and active fluxing where formations of oxide films are problems.

Fluxes should be removed after soldering either by washing with water or by chemical solvents. The main functions performed by fluxes are:

(a) Remove oxide films and tarnish from base part surfaces,

(b) Prevent oxidation during heating, and

(c) Promote wetting of the faying surfaces.

The fluxes should

(a) Be molten at soldering temperature,

(b) Be readily displaced by the molten solder during the process, and

(c) Leave a residue that is non-corrosive and non-conductive.

SOLDERING METHODS

There is a lot of similarity between soldering and brazing processes. The major difference between them is less heat and lower temperature is required in case of soldering. The different processes (methods) used in soldering are touch soldering, furnace soldering, resistance soldering, dip soldering and infrared soldering. All the above methods are common to both soldering and brazing processes. There are some more methods used in case of soldering only, these are hand soldering; wave soldering and reflow soldering. These methods are described below.

Hand Soldering

Hand soldering is done manually using solder iron. Small joints are made by this way in very short duration approximately in one second.

Wave Soldering

Wave soldering is a mechanical and technique that allows multiple lead wires to be soldered to a Printed Circuit Board (PCB) as it passes over a wave of molten solder. In this process a PCB on which electronic components have been placed with their lead wires extending through the through the holes in the board, is loaded onto a conveyor for transport through the wave soldering equipment. The conveyor supports the PCB on its sides, so its underside is exposed to the processing steps, which consists of the following:

(a) flux is applied through foaming, spraying, brushing, and

(b) Wave soldering is used pump liquid solder from a molten both on to the bottom of board to make soldering connections between lead wire and metal circuit on the board.

Reflow Soldering

This process is also widely used in electronics to assemble surface mount components to print circuit boards. In this process a solder paste consisting of solder powders in a flux binder is applied to spots on the board where electrical contacts are to be made between surface mount components and the copper circuit. The components are placed on the paste spots, and the board is heated to melt the solder, forming mechanical and electrical bonds between the component leads and the copper on the circuit board.

SOLDERING TOOLS

The main tool used for soldering is the soldering iron. In addition to soldering some consumable are also used in the process of soldering like fluxes, solder wire or stick and spelter. These are described below:

Soldering Iron

It consists of a copper bit attached to iron rod at its one end, and a wooden handle at the other end. It is used to melt the filler metal and paste it to make the joint. A soldering iron can be a forge soldering iron which is heated in a furnace to have sufficient temperature to melt the filler metal or it can be electric solder iron. Electric solder iron is heated by passing electric current through it. Use of electric solder iron is popular and cost effective. It is used in making very precise joints in electronic and electrical equipment.

Spelter

Spelter is an alloy of zinc and copper in equal proportion. This is one of the filler metal with low melting point with other desirable properties to make good quality solder joint.

Different types of solders and fluxes, which are common consumables used in soldering have already been described. Some precautions are to be followed to keep the soldering tools as described below:

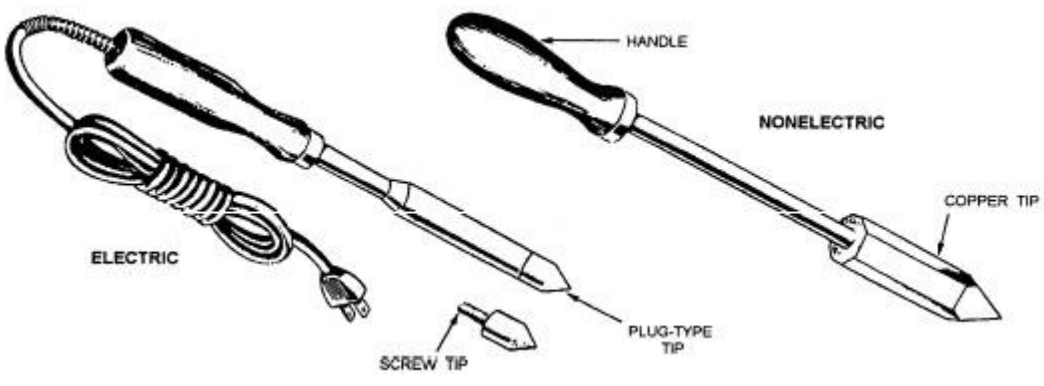
(a) Selection of correct tool according to the process. A defective tool should not be used.

(b) Electrically heated solder iron should have proper earthing.

(c) Hot solder iron, when idle, should be placed on its proper stand.

(d) Tip of the solder iron should be cleaned before, its use.

(e) Solder iron should be gripped at its handle while in use.



Soldering Iron

SOLDERING PROCEDURE

Following sequential steps should be carried out as soldering procedure.

Work Preparation

Work pieces which are to be joined together should be perfectly clean. There should not be any dirt, dust, rust, paint or grease. This is so that the solder or spelter can stick to the joint with proper strength. Cleaning is done with the help of a file or sandpaper. In case of joining of conducting wires, insulation of portion to be joined should be perfectly removed. Sometimes chemicals are used to clean the work pieces. De-scaling (removal of scaling) is done by dipping the work pieces into dilute HCl.

Preparation of Joint

After cleaning work pieces should be kept together in correct position to make the final joint. Work pieces should be clamped to avoid any relative movement between them that may disturb the joint making. At the joint smaller grooves are made on the work pieces to facilitate better flow of molten solder and so good strength of the joint. There may be the two objectives of joint:

- To bear load, and
- To make electrical contact.

In case of load bearing joints lap joint or butt joints are preferred. It is important to note down that strength of a soldered joint cannot be compared with welded joint. If electrical contact is to be made the solder should be so selected that resistance of joint should match with the resistance of the conductor.

Fluxing

Fluxing includes selection of appropriate flux and its application to the joint. Selection of flux depends on the material of work piece keeping its purpose in view. It is applied to the joint with the help of a brush before soldering. It avoids oxidation of molten metal, helps in flow of molten solder into the joint and so maintains strength of the joint.

Tinning

In this step of soldering procedure, the bit of solder iron is cleaned; application of flux is done over it. It is brought in contact of solder wire so the bit carries sufficient amount of molten solder over it. After that it is used to make tags of solder at various processes throughout the joint. If soldering is done to make electrical contacts of conductivity wires the complete joint is made by tagging few times. In case of long joint, after tagging the molten solder is filled to the joint by bringing hot bit of solder iron and solder wire together in contact with the joint.

Filling the joint with molten solder and allowing solidifying is the last step of the procedure called soldering.

SAFETY PRECAUTIONS IN SOLDERING

(a) Keep solder iron always on its stand.
(b) All electrically operated instruments/equipment should have proper earthing.
(c) Sometimes emission of (smoke) soldering operation may be poisonous due to a particular type of flux. Operator should have protection from the same.
(d) Flux should be applied gradually while soldering.
(e) While diluting HCl, water should not be added to HCl but HCl should be mixed into the water drop by drop, to avoid accident.
(f) Work place should have enough ventilation and smoking should be strictly prohibited during the operation. Work place should have the facility of first aid.
(g) It should be noted down good quality surface preparation always contributes to good quality joint.

BRAZING PROCESSES

All the processes covered here can also be applied to soldering processes. These common processes are being described below:

Torch Brazing

In case of torch brazing, flux is applied to the part surfaces and a torch is used to focus flame against the work at the joint. A reducing flame is used to prevent the oxidation. Filler metal wire or rod is added to the joint. Torch uses mixture of two gases, oxygen and acetylene, as a fuel like gas welding.

Furnace Brazing

In this case, furnace is used to heat the work pieces to be joined by brazing operation. In medium production, usually in batches, the component parts and brazing metal are loaded into a furnace, heated to brazing temperature, and then cooled and removed. If high production rate is required all the parts and brazing material are loaded on a conveyer to pass through then into a furnace. A neutral or reducing atmosphere is desired to make a good quality joint.

Induction Brazing

Induction brazing uses electrical resistance of work piece and high frequency current induced into the same as a source of heat generation. The parts are pre-loaded with filler metal and placed in a high frequency AC field. Frequencies ranging from 5 to 5000 kHz are used. High frequency power source provides surface heating; however, low frequency causes deeper heating into the work pieces. Low frequency current is recommended for heavier and big sections (work pieces). Any production rate, low to high, can be achieved by this process.

Resistance Brazing

In case of resistance welding the work pieces are directly connected to electrical --- rather than induction of electric current line induction brazing. Heat to melt the filler metal is obtained by resistance to flow of electric current through the joint to be made. Equipment for resistance brazing is same that is used for resistance welding, only lower power ratings are used in this case. Filler metal into the joint is placed between the electrodes before passing current through them. Rapid heating cycles can be achieved in resistance welding. It is recommended to make smaller joints.

Dip Brazing

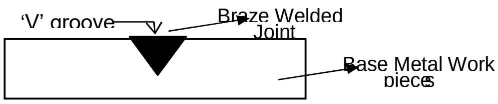
In this case heating of the joint is done by immersing it into the molten soft bath or molten metal bath. In case of salt bath method, filler metal is pre-loaded to the joint and flux is contained in to the hot salt bath. The filler metal melts into the joint when it is submerged into the hot bath; the solidification and formation of the joint takes place after taking out the work piece from the bath. In case of metal bath method, the bath contains molten filler metal. The joint is applied with flux and dipped to the bath. Molten filler metal fills the joint through capillary action. The joint forms after its solidification after taking it out from molten metal bath. Fast heating is possible in this case. It is recommended for making multiple joints in a single work piece or joining multiple pairs of work pieces simultaneously.

Infrared Brazing

It uses infrared lamps. These lamps are capable of focused heating of very thin sections. They can generate up to 5000 watts of radiant heat energy. The generated heat is focused at the joint for brazing which are pre-loaded with filler metal and flux. The process is recommended and limited to join very thin sections.

Braze Welding

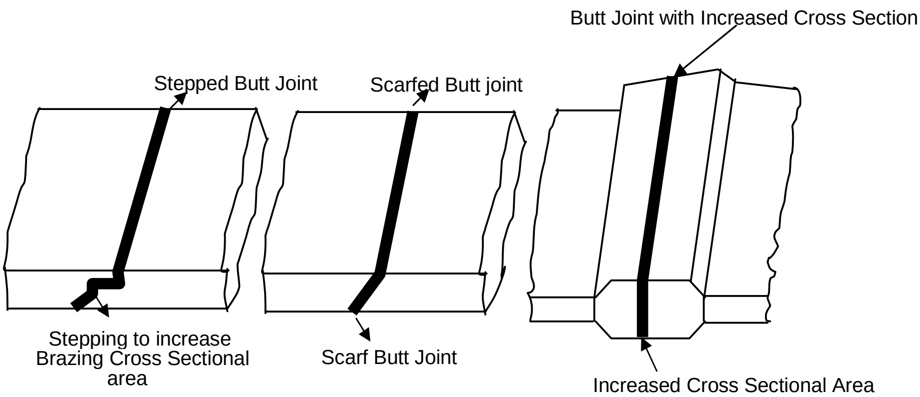
This process also resembles with welding so it is categorize as one of the welding process too. There is no capillary action between the faying surfaces of metal parts to fill the joint. The joint to be made is prepared as 'V' groove as shown in the Figure 6.1, a greater quantity of filler metal is deposited into the same as compared to other brazing processes. In this case entire 'V' groove is filled with filler metal, no base material melts. Major application of braze welding is in repair works.



Braze Welding

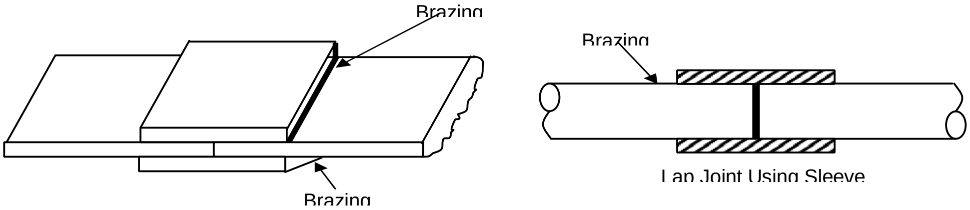
BRAZING JOINTS AND SURFACE PREPARATION

Common categorization of joint is butt joint and lap joint is also applicable to brazing joints. Normally a butt joint provides very limited area for brazing. We know the strength of the joint depends on the brazing area and so limited brazing area is responsible for week joint formation. To increase the brazing area the mating parts are often scarified or stepped by altering them through extra processing. This are demonstrated in Figure. The extra processing makes the alignment of parts, during brazing, slightly difficult.



Brazed Butt Joints

The other type of joint used in brazing is lap joint. Lap joint can provide relatively larger overlapping area and so better strength. The parts (work pieces) to the joined are kept so that some of their contact area should remain overlapped. Brazing is done on the overlapped edges of both the parts. Some examples of lapped brazed joints are shown in figure.



Examples of Lap Joints by Brazing

In case of lapped joints overlap of at least three times the thickness of the thinner part is recommended. An advantage of brazing over welding while making lap joints in that the filler metal is bonded to the work pieces throughout the entire interface area between the parts rather than only at the edges. Clearance between the mating surfaces should be large enough so that molten filler metal can flow throughout the entire overlapped area. At the same time clearance should be small enough so that capillary action can exists to facilitate the flow of molten filler metal between the overlapped areas. Recommended clearance is up to 0.25 mm. Other important instruction for making brazing joint is cleanliness of mating surfaces. The mating surfaces should be free of oxides, oils, grease, etc. to make wetting and capillary action comfortable. Cleaning may be done using mechanical means or by chemical treatments depending on the situation.

BRAZING FLUXES, EQUIPMENTS and FILLER METAL

Main property of brazing filler metal is its fluidity, its capability of penetration into the interface of surfaces. Melting point of filler metal must be compatible with work piece metal. Molten filler metal should also be chemically insensitive to the work piece metal. Filler metal can be sued in any form including powder or paste. Purpose of brazing flux is same it is in case of welding. It prevents formation of oxides and other unwanted by products making the joint weaker.

Characteristics of a good flux are:

(a) Low melting temperature,

(b) Less viscosity so that filler metal (molten) can displace it, and’

(c) Adhering to the work piece.

Common fluxes are borax, borates, chlorides and fluorides.

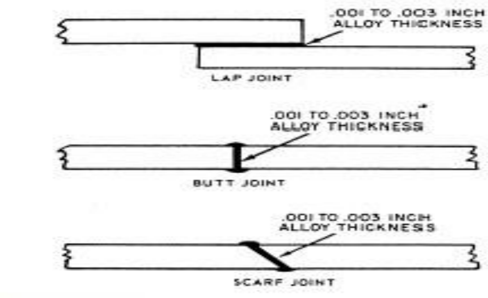
Method of Brazing:

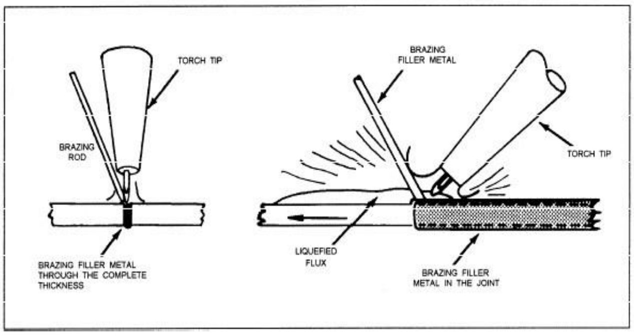
The step by step procedure for brazing is as follows:

- The metal parts which are to be brazed must be thoroughly cleaned.
- The flux must be applied to the surface.
- The parts are to be clamped in the required position.
- The flux ha to be applied on the surfaces.
- The job has to be heated using the blow torch or the furnace etc.
- The molten spelter has to be allowed to flow by capillary action into the joint.
- The job has to be allowed to cool slowly.

Advantages:

- Even dissimilar metal pieces can be united.
- No metallurgical damage to base metals.
- Provides stronger joints than hard soldering





Common joint designs for brazing **Brazing a Butt joint**

Soldering and Brazing

In soldering and brazing processes, the metal parts being joined are heated but not melted and a molten filler metal is made to flow between the two closely placed adjacent surface by capillary action. A strong joint between two parts is formed on cooling to room temperature by the bond formed at the high temperature between the parent metal atoms and the filler metal atoms. These processes are suitable for joining the dissimilar metals also.
Brazing is distinguished from soldering by the melting temperatures of the filler material. If the filler materials melts below 450°C it is soldering, but if the filler materials melt above this temperature the process is brazing.

Basic Operations in Soldering
1. Shaping and fitting of metal parts together
2. Cleaning of surfaces
3. Flux application
4. Application of heat and solder

Solder: Most solders are alloys of lead and tin.
Flux: The function of flux is to remove the non-metallic oxide film from the metal surface during the heating and soldering operation so that the clean metals may make mutual metallic contact. Zinc chloride, ammonium chloride and hydrochloric acid are common fluxes used in soldering.

Terms used in the process of welding.
Base Metal: The work pieces to be joined are knows as base metals.
Weld bead: It is the material, which is deposited by the process of welding it.
Puddle: It is the portion of the base metals of the joint, which is melted by the heat during welding.
Weld pass: It is the movement of welding torch from one end of the joint to the other end, which results in a joint.
Tack weld: A temporary small weld done at the ends of the work pieces to hold the Work piece together during welding

Review question

1. Distinguish clearly between Soldering and Brazing.
2. List out various brazing process and explain any one in detail.

12. Plastic Molding and Glass Cutting Date:

OBJECTIVES

To demonstrate Plastic molding and Glass cutting processes.

INJECTION MOLDING

Equipment: Injection molding machine.
Material Required: High grade poly ethylene
Procedure:

- Pour the raw material in the hopper.
- Place the die in such a way that its hole coin sides with the central axis of the cylinder.
- Heat the cylinder by pouring plastic pallets in it.
- When the metal is heated at 800C to 1000C it is converted into molten metal.
- Press the lever so that the softened plastic will enter into the die and gets the desired shape of the mould.
- Allow it to cool for some time.
- Open the die and eject the article.

Injection molding is the one of the most commonly used manufacturing process for the plastic components. It is used to manufacture thin walled plastic parts for a wide variety of shapes and sizes. In this process, the plastic material is melted in the injection chamber and then injected into the mold, where it cools and finally the finished plastic part is ejected.

Working Principle: In this process, the plastic materials usually in the form of powder or pellets are fed from hopper into the injection chamber. The "piston and cylinder" arrangement is used to forward the material inserted from the hopper in to the injection chamber. The plastic material is heated in the injection chamber with the application of heating elements. The cooling system is also used to maintain the temperature of the injection chamber. The molten plastic material is then injected into the mold cavity through a nozzle. The molded part is cooled quickly in the mold. Thereafter, the final plastic part is removed from the mold cavity. The process cycle for injection molding is very short, typically between 2 to 60 seconds. The complete injection molding process is divided into four stages: clamping, injection, cooling and ejection.

Clamping: The two halves of the mold must be tightly closed, before the molten plastic material is injected into the mold. One half of the mold is attached to the injection unit (nozzle) and other half is allowed to slide on the guide ways. The clamping of mold is operated hydraulically which it pushes the moving half part of the mold towards the fixed part to make an air tight chamber. The force and the time required for opening and closing the mold depends upon the machine capability.

Injection: During this process, the plastic material is melted by the application of heat and forwarded through the piston towards the nozzle and finally into the mold. The function of torpedo in the heating zone is to spread the molten plastic into the thin film. The molten plastic is then injected into the mold cavity quickly. The amount of material that is injected into the mold is referred to as the shot volume. The injection time can be estimated by the shot volume, injection power and pressure. The schematic of injection molding process is shown in figure 1.

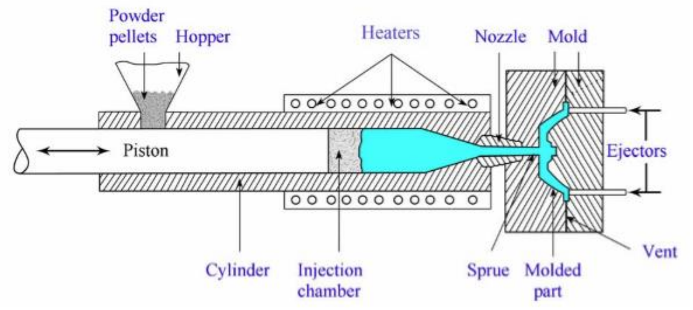


Figure 1 Injection molding setup

Cooling: The injected molten plastic begins to cool as soon as it comes in contact with the mold surfaces. As the molded part cools, it will solidify into the desired shape of the product.

Ejection: The molded part, which is attached to the rear half of the mold has to be ejected from the mold. When the mold is opened, an ejector mechanism is used to push the part out of the mold. Force must be applied to eject the plastic part because during cooling the molded part shrinks and adheres to the mold surface. A mold release agent should be sprayed onto the mold surfaces prior to injection of the material. Once the molded part is ejected, the mold will be closed for the next shot to be injected. The important process parameters that have to be considered during the injection molding process are: injection temperature and pressure, shot volume, mold temperature, cooling time, ejection temperature, and cycle time. Some of the common injection molding defects are flash, blister, warping, bubbles, unfilled sections, jetting, sink and ejector marks. These defects can be eliminated by optimal selection of the process parameters.

Materials Used: The injection molding process can be used to process materials such as Acetal, Acrylic, Acrylonitrile Butadiene Styrene (ABS), Cellulose Acetate, Polyamide (Nylon), Polycarbonate, Polyester, Polyether Sulphone (PS), Polyetheretherketone (PEEK), Polyetherimide, Polyethylene, Polyphenylene Oxide, Polyphenylene Sulphide (PPS), Polypropylene (PP), Polyvinyl Chloride (PVC), and Elastomers.

Application: This process can be used to manufacture thin walled plastic housing products which require many ribs and bosses on the interior surfaces. These housings are used in a variety of products including household appliances, electronics, and automotive dashboards. Other common thin walled products include different types of open containers, such as buckets. It is also used to produce several daily use items such as toothbrushes or small plastic toys, many medical devices, including valves and syringes.

Advantages

1) Higher production rate
2) Close tolerances on small intricate parts
3) Minimum wastage of material
4) Complex geometry can be easily produced

Disadvantages

1) Tooling cost higher
2) High setup cost
3) Large undercuts cannot be formed

Glass cutting

Select a glass tube of appropriate diameter for drawing a jet.

- Cut the glass tube of desired length with the help of a triangular file.
- Heat the tube in the hottest portion of the Bunsen burner flame by holding it at both the ends.
- Rotate the tube slowly until the portion, which is kept in the flame, becomes red hot and soft.
- Remove the tube from the flame and pull the ends apart slowly and smoothly until it becomes narrow in the middle and then stretches into a fine jet as
- Cut the tube in the middle and make the jet uniform and smooth by rubbing it with sand paper and by fire polishing.

REVIEW QUESTIONS:

1. Explain injection molding process in brief.
2. Differentiate between thermosetting and thermoplastic.