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18ME35A/18MEA305

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Metal Cutting and Forming

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. What are the difference between orthogonal cutting and oblique cutting? (06 Marks)
b. Briefly explain the mechanism and types of chip formation. (08 Marks)
c. Draw Mechant's circle diagram and state the assumptions made in establishing the relationship among the various forces. (06 Marks)

OR

2 a. Differentiate between Capston and Turret lattice. (06 Marks)
b. Draw the tool layout for producing a hexagonal headed bolt or a caster lathe from a hexagonal bar stock. Assume the dimensions. (08 Marks)
c. List and explain the various operations carried out on lattice machine. (06 Marks)

Module-2

3 a. Define Milling. Explain with a neat sketch vertical milling machine. (10 Marks)
b. Define Drilling. With a neat sketch explain a radial drilling machine. (10 Marks)

OR

4 a. Sketch and explain the fundamental parts of a horizontal shaping machine. (10 Marks)
b. With a neat sketch, explain the centerless grinding machine. (10 Marks)

Module-3

5 a. Define load wear. Explain creator wear and flank wear. (06 Marks)
b. Write a note on functions and types of cutting fluids used in metal cutting. (06 Marks)
c. Define tool life and explain the factors which affect the tool of life. (08 Marks)

OR

6 a. Which are the different forms of wear on the cutting edge of a tool? With suitable sketch explain. (08 Marks)
b. Explain the choice of cutting speed a feed. (06 Marks)
c. Explain the critical cutting parameters which affect the tool life. (06 Marks)

Module-4

7 a. What is forging? Explain working of board hammer with sketch. (10 Marks)
b. With a neat sketch explain the classification of metal working process on the basis of force applied. (10 Marks)

OR

8 a. With a neat sketch, explain different types of rolling mill arrangement. (10 Marks)
b. With a neat sketch, explain the wire drawing process. (10 Marks)

Module-5

9 a. How sheet metal operations are classified? Explain with a neat sketch. (10 Marks)
b. What do you mean by dies? Write a note on : i) Progressive dies ii) Combination dies. (10 Marks)

OR

10 a. With a neat sketch, explain V-bending and edge bending operations. (10 Marks)
b. With a neat sketch, explain the parts of open back inclinable press. (10 Marks)

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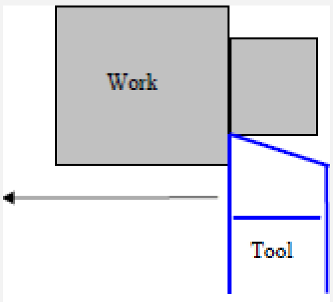
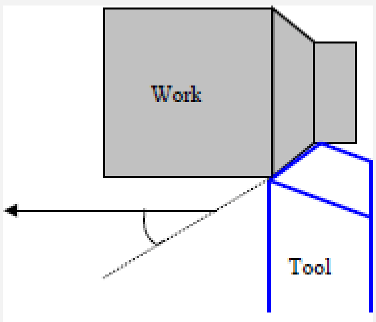
Metal Cutting and Forming

VTU Feb-March 2022,

1.

(A)

Orthogonal Cutting	Oblique Cutting
The cutting edge of the tool remains normal to the direction of tool feed or work feed.	The cutting edge of the tool remains inclined at an acute angle to the direction of tool feed or work feed.
The cutting edge of the tool remains inclined at an acute angle to the direction of tool feed or work feed.	The direction of the chip flow velocity is at an angle with the normal to the cutting edge of the tool. The angle is known as the chip flow angle.
Here only two components of forces are acting: Cutting Force and Thrust Force. So the metal cutting may be considered as a two-dimensional cutting	Here three components of forces are acting: Cutting Force, Radial force, and Thrust Force or feed force. So the metal cutting may be considered as a three-dimensional cutting.
The cutting edge being non-oblique, the shear force acts on a smaller area and thus tool life is decreased.	The cutting edge being oblique, the shear force acts on a larger area and thus tool life is increased
cutting edge is larger than cutting width.	Cutting edge may or may not be larger than cutting width.
The flow of the chip is perpendicular to cutting edge.	The flow of chip is not perpendicular to cutting edge
The tool has a lesser cutting life.	The tool has a lesser cutting life.
 Orthogonal cutting	 Oblique cutting

B. Types of chips in Metal Cutting:

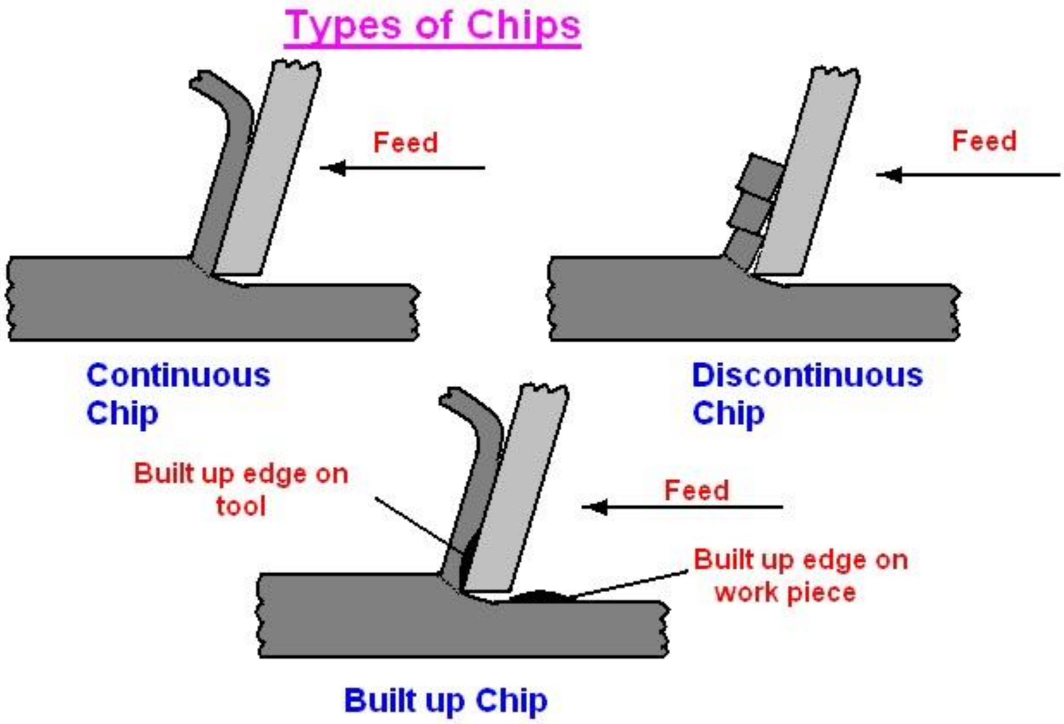
There are three basic types of chips in the metal cutting process:

1. Continuous Chips

2. Discontinuous Chips
3. Continuous Chips with Built-up Edges (BUE).

#1 Continuous chips:

When the chips formed during cutting operation is without any intervals such type of chips are called continuous chips. These chips are formed when a ductile material is cut, for example, steel.



Reasons for formation of Continuous chips:

- **The velocity of cutting should be high**: For the formation of continuous metal chips, it is required that the velocity of cutting or cutting velocity must be high. If the velocity is high enough the new material will get cut off before the breakage of the chip.
- **Rake angle must be large**: A greater rake angle will help in the smooth flow of metal chips thus creating continuous metal chips.
- **The material** must be ductile: The ductility of a material is one of the most important factors in the production of continuous chips. The greater the ductility, the more continuous chips will be produced.
- **The coefficient of friction must be low as possible**: If the coefficient of friction is high there will be a high amount of heat produced which will make the material brittle and not suitable for continuous chips to be produced.
- Depth of cut: The depth of cut for producing continuous chips must be low. If the depth of cut is more it will tend towards breaking of the chips. Effects of continuous chips and better surface finish. Due to the small depth of cut and high cutting velocity the surface finish obtained is excellent in the case of continuous chips.
- **Low power consumption**: Low coefficient of friction and use of lubricant causes less power to be consumed during the process of metal cutting in case of continuous chips.
- **Better tool life:** The life of the cutting tool increases as the material is ductile, friction is less**,** and lubricants are used.

#2 Discontinuous chips:

When there is a breakage or fracture of chips in the process of metal cutting then such types of chips are called discontinuous chips. These chips are formed when brittle materials like cast iron, are cut.

Reasons for the Formation of Discontinuous Chips:

- **Low cutting speed**: A low cutting speed causes the chip to fracture before the cutting tool advances. This causes the production of discontinuous chips.
- **low rake angle**: A low rake angle pushes the chip out instead of curving it thereby producing discontinuous chips.
- **Brittle materials are used**: Unlike ductile materials, brittle materials have the tendency to break because of which there is a formation of discontinuous chips.
- **High frictional forces**: As discussed earlier high frictional forces causes heat generation which causes the material to become brittle, as a result of which there is a formation of discontinuous chips.
- **Greater depth of cut**: As the depth of cut increases the thickness of the material removed also increases. Increased thickness of material causes it to break which results in the formation of discontinuous chips.

Effects of Discontinuous Chips:

- **Greater material removal**: A greater amount of material is removed in the formation of discontinuous chips, this is of help when there is a huge difference of size between the workpiece and required dimension.
- **Increased tool life at low speed:** low rake angle helps in increasing tool life at low speeds.
- **Chips are convenient to dispose of:** Discontinuous chips are easy to handle and dispose off, because of small size and can be filled easily in some container to dispose or recycle.

#3 Continuous Chip with Built-up Edge (BUE):

This is the type of continuous chip formed when the friction between the tool and the workpiece is very high. Due to high friction and temperature, a very little amount of material gets welded on the chip.

Diagram of Continuous Chip with Built-up Edge, *Learn Mechanical*

Reasons for Formation of BUE:

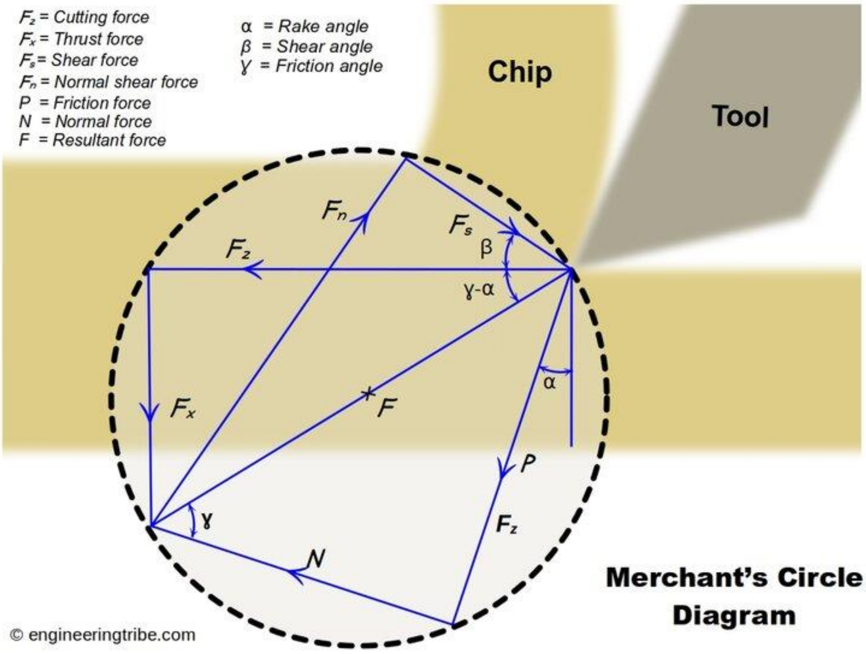
- **High temperature**: The main reason for the formation of a built-up edge is due to excess temperature. Because of very high temperature (more than the melting point of metal) some amount of metal gets welded up causing built up on the chip. The rest of the reasons are responsible for high temperature.
- **Very high friction**: The main reason for an increase in the temperature relative to tool and workpiece is due to high friction, which in turn becomes the prime reason responsible for the formation of built-up edge.
- **Insufficient coolant:** Another factor that is responsible for the increase in temperature is insufficient to use of coolant. The coolant used is generally a mixture of oil and water.
- **Type of material:** For the formation of a continuous chip it is necessary that the material should be ductile. Hence in ductile material, there is a formation of a built-up edge.

- **Small rake angle:** Small rake angle is one of the factors due to which there is a formation of built-up edge. This is because it is required for the formation of continuous chips.

Effects of Continuous Chips with Built-up Edges:

- **Increased tool life**: The tool life is increased because the chip which is formed, protects the tool from high temperature thus increasing the tool life.
- **Rough surface finish**: There is a formation of the rough surface due to the presence of built-ups on the working surface.
- **Increased power consumption:** Due to the small rake angle and great depth of cut the power consumption is increased.

C.



Assumptions for Merchant's circle diagram

The assumptions for the merchant circle diagram are as follows.

- The cutting tool must be sharp.
- There is no contact between the cutting tool and the clearance edge.
- The chip formation is in continuous form and without a built-up edge.
- The thickness of the uncut chip is constant.
- The workpiece moves with a uniform velocity during the cutting process.
- The width of the workpiece is always lesser than the cutting tool width.
- Shear occurs on a shear plane where the stress is uniformly distributed.

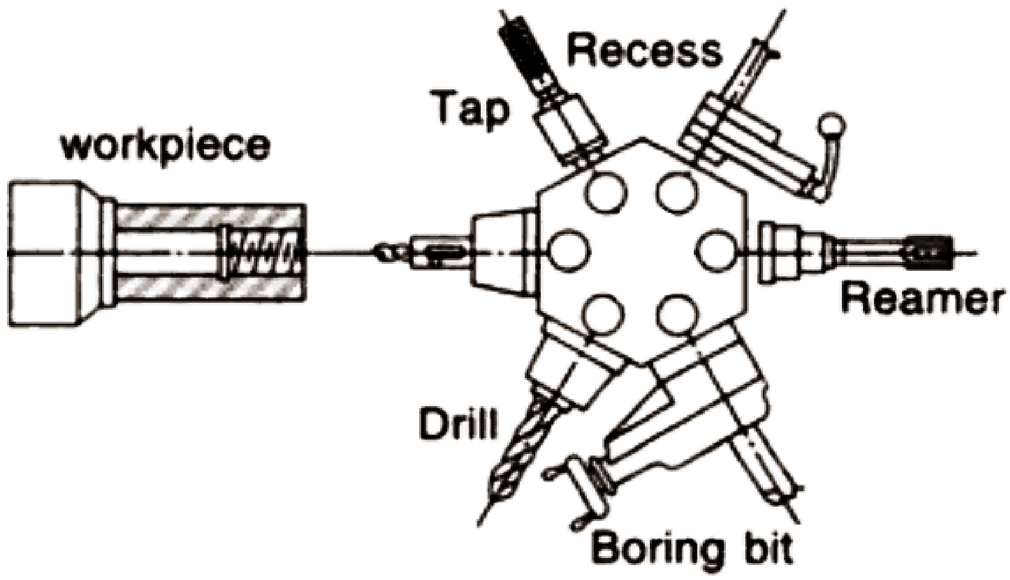
2.

A.

Capstan Lathe	Turret Lathe
It is a light-duty machine.	It is a heavy-duty machine.

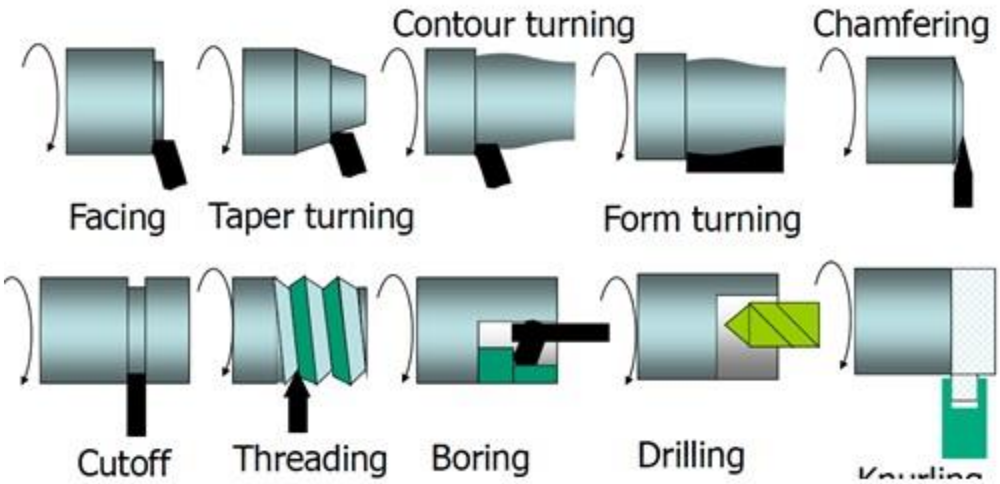
Capstan Lathe	Turret Lathe
The turret head is mounted on the ram and the ram is mounted on the saddle.	The turret head is directly mounted on the saddle and the saddle slides over the bed ways.
The saddle will not be moved during machining.	The saddle will not be moved during machining.
The lengthwise movement of the turret is less.	The lengthwise movement of the turret is more.
Short workpieces only can be machined.	Long workpieces can be machined.
It is easy to move the turret head as it slides over the ram.	It is difficult to move the turret head along with the saddle.
The turret head cannot be moved crosswise.	The turret head cannot be moved crosswise.
As the construction of lathe is not rigid, a heavy cut cannot be given.	As the construction of lathe is rigid, a heavy cut can be given.
It is used for machining workpieces up to 60mm diameter.	It is used for machining workpieces up to 200mm diameter.
Collet is used to holding the workpiece.	Jaw chuck is used to hold the workpiece.

B.



C. Types of Lathe Operation

The working of the lathe machine changes with every operation and cut desired. There are a lot of operations used for using the lathe machine. Some of the common lathe operations are:



Facing
This is usually the first step of any lathe operation on the lathe machine. The metal is cut from the end to make it fit in the right angle of the axis and remove the marks.

Tapering
Tapering is to cut the metal to nearly a cone shape with the help of the compound slide. This is something in between the parallel turning and facing off. If one is willing to change the angle then they can adjust the compound slide as they like.

Parallel Turning
This operation is adopted in order to cut the metal parallel to the axis. Parallel turning is done to decrease the diameter of the metal.

Parting
The part is removed so that it faces the ends. For this the parting tool is involved in slowly to make perform the operation. For to make the cut deeper the parting tool is pulled out and transferred to the side for the cut and to prevent the tool from breaking.

3.

A.

It is a machine which is used to remove metals from the workpiece with the help of a revolving cutter called milling cutter.

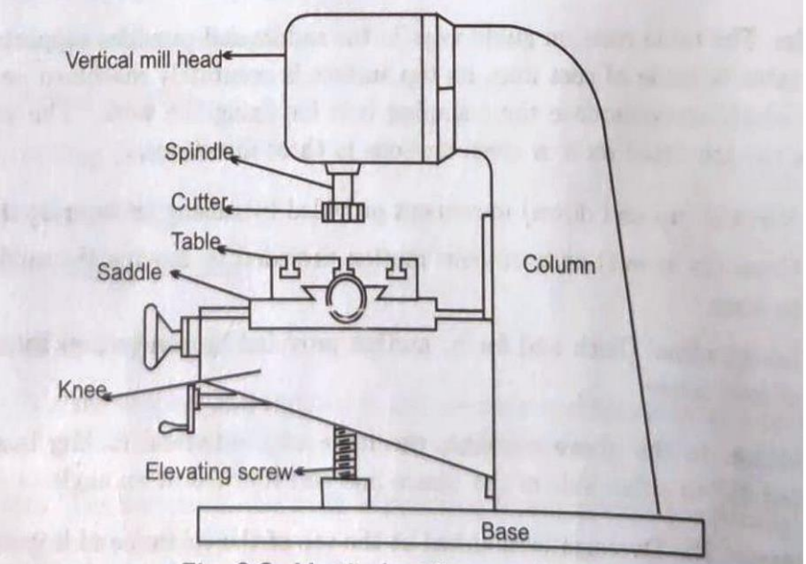


Fig. 2.3. Vertical milling machine

1. Column & Base

Column including base is the main casting that supports all other parts of milling machine.

- The column contains an oil reservoir and a pump which lubricates the spindle.
- The column rests on the base and base contains coolant reservoir and a pump which is used during machining operation that requires coolant.

2. Knee

It is a casting that supports the saddle and table. All gearing mechanism is enclosed within the knee.

- It is fastened to the column by dovetail ways.
- The knee is supported and adjusted by a vertical positioning screw (elevating screw).
- The elevating screw is used to adjust the knee up and down by raising or lowering the lever either with the help of hand or power feed.

3. Saddle and Swivel Table

The saddle is present on the knee and supports the table. It slides on a horizontal dovetail on the knee and dovetail is parallel to the axis of the spindle (in horizontal milling m/c).

- The swivel table (in universal machines only) is attached to the saddle that can be swiveled (revolved) horizontally in either direction.

4. Power Feed Mechanism

It is the knee which contains the power feed mechanism. It is used to control the longitudinal (left and right), transverse (in and out) and vertical (up and down) feeds.

5. Table

It is a rectangular casting which is present on the top of the saddle.

- It is used to hold the work or work holding devices.

- It contains several T-slots for holding the work and work holding devices (i.e. jigs and fixtures).
- The table can be operated by hand or by power.To move the table by hand, engage and turn the longitudinal hand crank. To move it through power, engage the longitudinal direction feed control lever.

6. Spindle

It is the shaft that is used to hold and drives the cutting tools of the milling machine.

- The spindle is mounted on the bearings and supported by the column.
- Spindle is driven by the electric motor through gear trains. The gear trains are present within the column.
- The face of the spindle which lies near to the table has an internal taper machined on it. The internal taper at the front face of the spindle permits only a tapered cutter holder or arbor. It has two keys at the front face which provides a positive drive for the cutter holder or arbor.
- The drawbolt and jam nut is used to secure the holder and arbor in the spindle.

B. Radial drilling Machine

The parts are as follows.

1.Base(Bed):

The base is made up of Cast Iron which has the capability of high compressive strength, good wear resistance and good absorbing capability(i.e. absorb the vibrations induced during working condition) and for these reasons, it acts as a base to the drilling machine.

2.Column: It is exactly placed at the center of the base which can act as a support for rotating the Swivel table and holding the power transmission system.

3.Swivel Table: It is attached to the column which can hold the machine vice in the grips and thereby, the workpiece is fixed in the machine vice to carry out the drilling operation.

The Swivel table can move up and down by means of rotational motion and can be locked to the column by means of locking nut.

4.Power Transmission system:

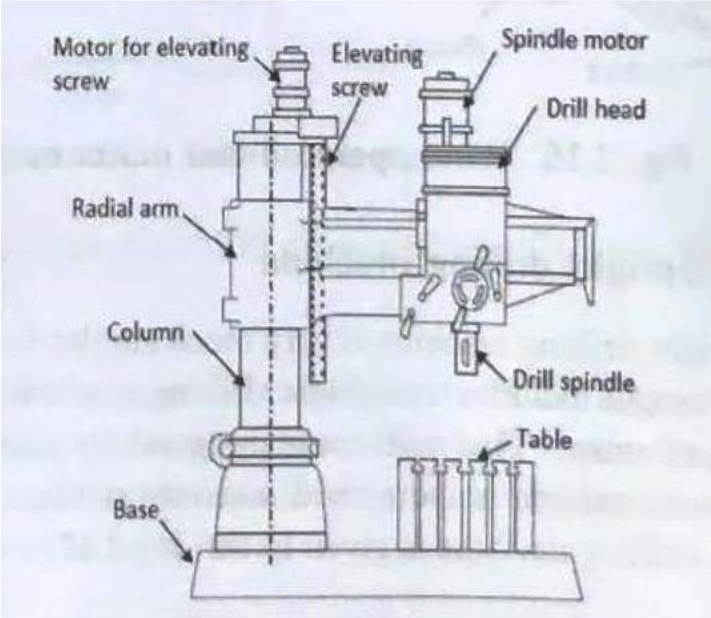
It consists of motor, stepped pulley, V-belt and the Spindle. The power transmission is explained in the working of the drilling machine.

5.Hand wheel:

By the rotation of hand-wheel, the spindle moves up and down in the vertical direction in order to give the necessary amount of feed to the work.

Here, the rotational motion is converted into linear motion by means of a Rack and Pinion mechanism which was explained below.

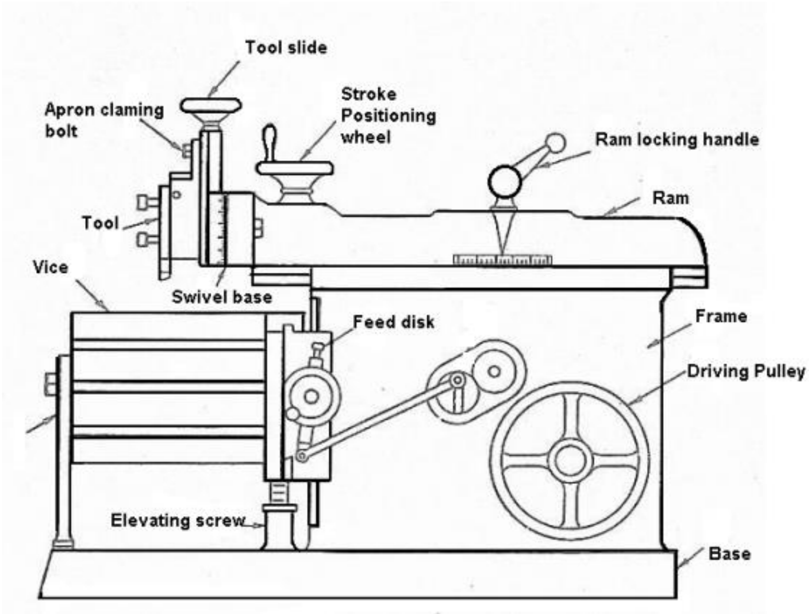
6.Chuck: It is used to hold the drill bit.



4.

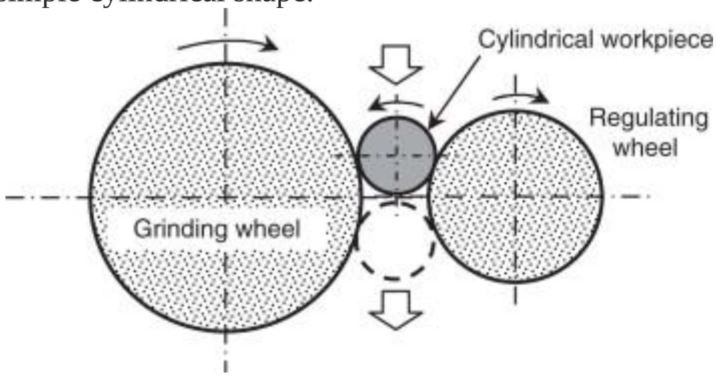
A.

1. Base: It is the main body of the machine. It consist all element of machine. It works as pillar for other parts. Base is made by cast iron which can take all compressive loads.
2. Ram: It is the main part of the shaper machine. It holds the tool and provides the reciprocating motion to it. It is made by cast iron and move over ways on column. It is attached by the rocker arm which provide it motion in crank driven machine and if the machine is hydraulic driven it is attached by hydraulic housing.
3. Tool head: It is situated at the front of the ram. Its main function is to hold the cutting tool. The tool can be adjusted on it by some of clamps.
4. Table: It is the metal body attached over the frame. Its main function is to hold the work piece and vice over it. It has two T slots which used to clamp vice and work piece over it.
5. Clapper box: It carries the tool holder. The main function of clapper box is to provide clearance for tool in return stock. It prevents the cutting edge dragging the work piece while return stock and prevent tool wear.
6. Column: Column is attached to the base. It provides the housing for the crank slider mechanism. The slide ways are attached upper section of column which provide path for ram motion.
7. Cross ways: It consist vertical and horizontal table sideways which allow the motion of table. It is attach with some cross movement mechanism.
8. Stroke adjuster: It is attached below the table. It is used to control the stroke length which further controls the ram movement.



B. Centerless Grinding Machines

In centerless grinding, the workpiece is held between two grinding wheels, rotating in the same direction at different speeds. One grinding wheel is on a fixed axis and rotates so that the force applied to the workpiece is directed downward. This wheel usually performs the grinding action by having a higher linear speed than the workpiece at the point of contact. The other movable wheel is positioned to apply lateral pressure to the workpiece and usually has either a rough or rubber-bonded abrasive to trap the workpiece. The relative speed of the two wheels provides the grinding action and determines the rate at which material is removed from the workpiece surface as shown in Figure 4.79. In the first of three types of centerless grinding, the through-feed type, the workpiece is fed through the grinding wheels completely, entering on one side and exiting on the opposite. The regulating wheel in through-feed grinding is canted away from the plane of the grinding wheel in such a way as to provide a lateral force component, feeding the workpiece through between the two wheels. Through-feed grinding can be highly efficient because it does not require a separate feed mechanism; however, it can only be used for a simple cylindrical shape.

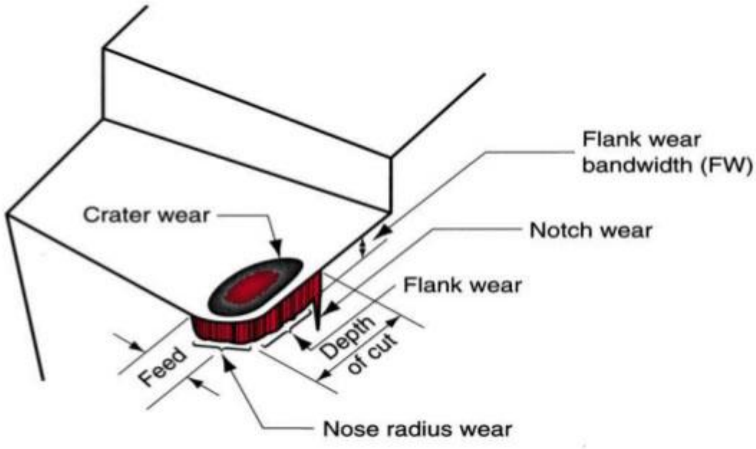


5.

A. Tool wear is the breakdown and gradual failure of a cutting tool due to regular operation

Flank wear

It is due to work hardening. Flank wear occurs at the tool flanks, where it contacts with the finished surface, as a result of abrasion and adhesion wear. The cutting force increases with flank wear. It affects the great extent of mechanics of cutting. The flank wear region is known as wear land and is measured by the width of wear land. If the width of wear land exceeds 0.5-0.6mm the excessive cutting forces cause tool failure.



Crater wear

Crater wear happens on the tool face at a short distance from cutting edge by the action of chip flow over the face at very high temperature. The crater wear is mainly due to diffusion and abrasion. They are commonly observed where the continuous chip is formed (usually in the ductile material). In the brittle material, the chip formation in the shape of a small segment, this loosely fragmented chip has low abrasive action on the face as compared to the continuous chip formation. The depth of crater measures the crater wear; the surface measuring instrument can measure it. The cutting edge may break from tool due to excessive cratering.

B. Cutting fluid is classified into the following types: –

#1. Straight Oil: Stroth oils are non-emulsifying. These oils are used without diluting them with water. The compositions of this type of oil are base minerals or petroleum oil. Examples of straight oil are paraffin oil, Naphthenic oil, vegetable oil. In systems where environmentally friendly oil is required, vegetable oil is used because it is biodegradable. Straight oils are best for lubricating, but they cannot serve as a good coolant because they have very cool properties.

#2. Soluble Oil: Soluble oils are made by mixing mineral oil, water, & coupling agents. It provides good lubrication between water-inaccurate liquids. Soluble oils are used in the machining of both ferrous and non-ferrous metals when high cooling quality is required & chip bearing capacity is not very high.

This soluble oil works well in its diluted form and provides great lubrication in addition to heat transfer. Soluble oils are the most widely used liquids in the industry, and also they are very cheap.

#3. Mineral Oil: Mineral oils are typically found in high production machines that have high metal removal rates. They are used in heavy cutting operations as they have very good lubricating properties. A disadvantage of these oils is that they are corrosives and therefore are not used for copper or its alloys.

#4. Synthetic Liquids: As these are synthetic liquids, they do not contain mineral oil or petroleum. These are water-based liquids, and water provides very good cooling properties.

The problem with synthetic fluids is that it is not a good lubricant and also causes corrosion. Corrosion or corrosion can be prevented by adding corrosion inhibitors to synthetic liquids. Typically, synthetic fluids are used in grinding liquids.

#5. Semi-Synthetic Fluids: Semi-synthetic fluid is made from a combination of synthetic fluid and soluble oils. For semi-synthetic liquids, approximately 5 to 20% of mineral oil is emitted with water to produce microabrasion. The size of microalgae particles varies from 0.01 to 0.1 mm, which can easily transmit all light. Semi-synthetic fluids have very good cooling properties and cost between synthetic fluid and soluble fluid costs. Some examples are molybdenum disulfides, graphite, wax stick, etc.

#6. Solid and Paste Lubricants: These lubricants are in the solids phase or as a paste. These lubricants are placed directly on the workpiece or tool. Some examples of this are molybdenum disulfide, graphite, wax stick, etc.

#7. Cutting Oil: Cutting oil is made by mixing minerals oil & fatty oil. It is used as both a coolant and a lubricant.

C.

Tool life is a most important factor in the evaluation of machinability, it is the period of time in which the tool cuts effectively and efficiently. Tool life is defined as the time period between two successive grinding of tool and two successive replacement of tool. A cutting tool should have long tool life. The cost of grinding and replacement is very high, so the short tool life will be uneconomical. Now a day’s tool material improvement increases the tool life.

When a tool no longer performs the desired function then it is said that tool reaches end of useful life. The following signs indicate that the tool life is over.

A. Poor surface finish, and dimensional error and presence of chatter marks on the workpiece.
B. Overheating of workpiece - tool interface due to friction.
C. Spoiled cutting edges.
D. A sudden increase in power consumption.

6.

A. Tool Wear Mechanism:

1. Abrasive wear: This wear is depends upon work hardening of work piece. When the tool cut the work piece, some small chips are forms which act as hard particle. These hard particle acts as small cutting edge like grinding wheel, which cause tool wear.

2. Adhesion wear: This tool wear is due to sliding of chips over the tool. The chips forms by metal cutting are hard and have high temperature. This is wear is due to rubbing of these chips over the tool. This wear cause due to high friction and high temperature of chips flowing over tool face.

3. Diffusion: Diffusion means diffuse of hard metal into soft metal due to high temperature of contact surface between hard material and soft material. In tool wear chips act as hard material and tool act as soft material.

4. Oxidation: Oxidation mean diffuse of oxygen particle tool face. It is also depend surface temperature of tool and tool material.

5. Chemical decomposing: Due to high temperature and pressure there is change in chemical composition of tool which reduces its life.

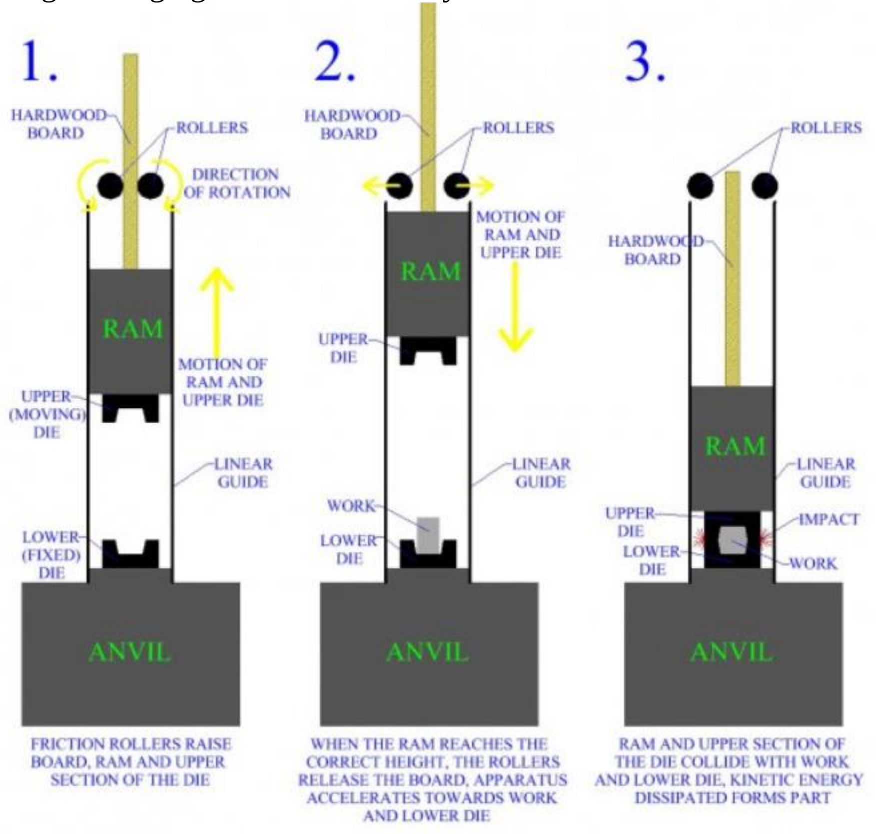
B. Factors affecting tool life

The tool life will be affected by various factors, which are mentioned below

- Tool material and its properties
- Properties of Workpiece material - Tensile strength, hardness, and microstructure of a material; Degree of heat treatment of the material.
- Finish required on the product.
- Tool geometry - profile of cutting tool
- Machining conditions like temperature, the cutting fluid used.
- Machining variables - Feed, cutting speed, and depth of cut.
- Types of machining operation- continuous and intermittent cutting.

7.

A. Forging is a metal working process that manipulates, shapes, deforms, and compresses metal to achieve a desired form, configuration, or appearance outlined by a metal processing design or diagram
The board drop hammer is a drop forging machine tool that relies only on gravity. A hardwood board is attached to the ram, rollers grip the board and can raise the board and ram due to friction forces between the board and rollers. Once the ram is raised to the height needed, the rollers can be pulled apart and the apparatus will be released, sending the forging hammer on its way.



B. Typically, metal forming processes can be classified into two broad groups.

1. Bulk Forming Processes –

One is bulk-forming and the other is sheet metal forming. Bulk deformation refers to the use of raw materials for forming which have a low surface area to volume ratio. Rolling, forging, extrusion, and drawing are bulk forming processes. In bulk deformation processing methods, the nature of force applied may be compressive, compressive and tensile, shear or a combination of these forces.

Bulk-forming is accomplished in forming presses with the help of a set of tool and die. Examples for products produced by bulk-forming are gears, bushed, valves, engine parts such as valves, connecting rods, hydraulic valves, etc.

2. Sheet Metal Processes –

Sheet metal forming involves the application of tensile or shear forces predominantly. Working upon sheets, plates and strips mainly constitutes sheet forming. Sheet metal operations are mostly carried out in presses – hydraulic or pneumatic. A set of tools called die and punch are used for the sheet working operations. Bending, drawing, shearing, blanking, punching are some of the sheet metal operations.

3. Powder Metal Forming :

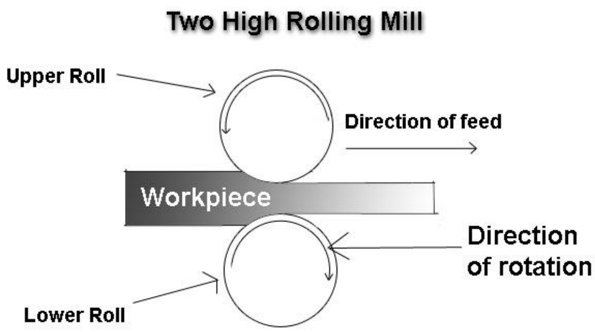
A new class of forming process called powder forming is gaining importance due to its unique capabilities. One of the important merits of powder forming is its ability to produce parts very near to final dimensions with minimum material wastage. It is called near-net-shape forming. Material compositions can be adjusted to suit the desirable mechanical properties. The formability of sintered metals is greater than conventional wrought materials. However, the challenge in powder forming continues to be the complete elimination or near-complete elimination of porosity. Porosity reduces the strength, ductility and corrosion resistance and enhances the risk of premature failure of components

8.

A.

i) Two high rolling mills :-

This type of mill has two rollers arranged as shown in figure below. Both the roller revolves at same speed but in opposite direction. The space between the rollers can be adjusted by raising or lowering the upper roll which is adjustable. To reduce the thickness of workpiece, it can be feeded from one direction only. However, there is another kind of two high rolling mills in which workpiece can be feeded frim both direction.



Based on the direction of feed available, two high rolling mills are further divided into types :-

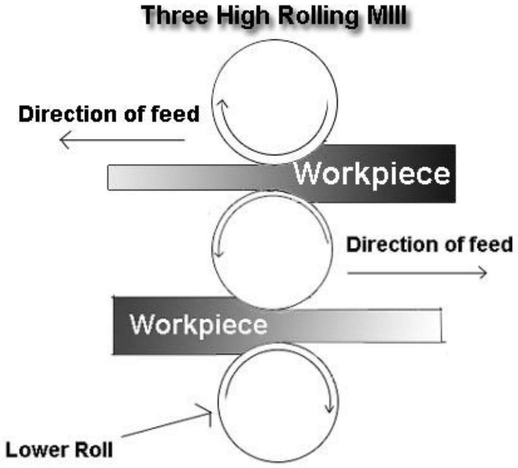
a) Non -Reversilng two high rolling mill

In this type of rolling mill, the rolls can rotate in one direction only and hence the workpiece can be feeeded from one direction only.

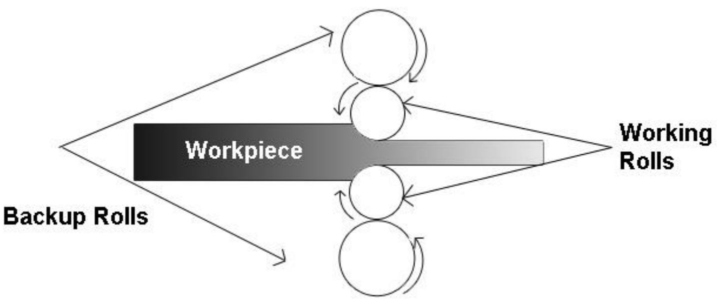
b) Reversilng two high rolling mill

In this type of rolling mills, the rolls can rotate in both direction forward and reverse and hence the workpiece can be feeded from both the direction.

ii) Three High Rolling Mills :-
This type of rolling mills consists of three rolls arranged one above other as shown in figure. The direction of rotation of upper and lower rolls are same but the middle roll rotates in the opposite direction. This type of rolling mills are used for rolling of continuous passes in a rolling sequence without reversing the drives. This results in a higher rate of production then the two-high rolling mill.

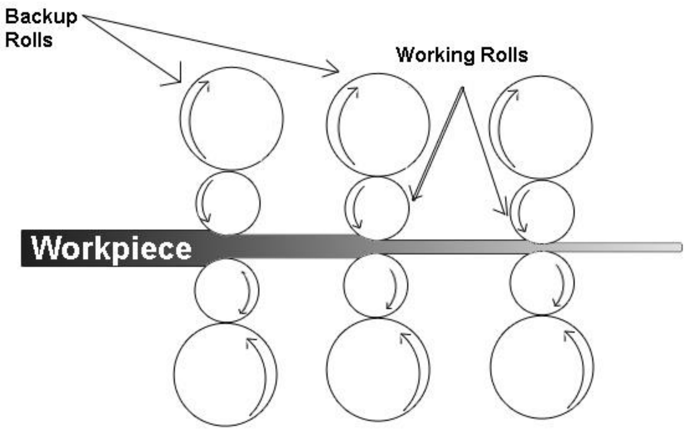


iii) Four High Rolling Mill :-
In this type of rolling machine, two rolls are in direct contact with the workpiece and the other two rolls are used as backup rolls. The two rolls which are in direct contact with the workpiece are smaller than backup rolls and are called working rolls. Backup rolls are used to prevent the deflection of the smaller rolls, which otherwise would result in thickenning of rolled plates at the centre.



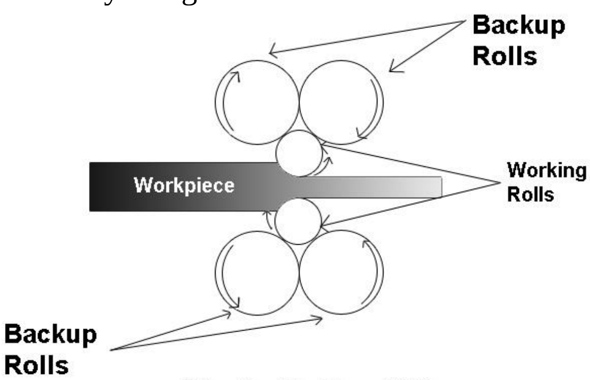
Four High Rolling Mills

iv) Tendem or Continuous rolling Mill :-
It consists of a number of non reversing two-high rolling mills arrange one after other. So that the material can be passed through all of them in sequence.It is suitable for mass production work only, because for smaller quantities quick changes of set upwill be required and they will consume lot of labor and work.



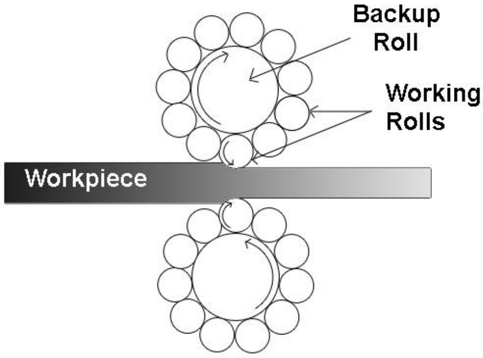
Tendem or Continuous Rolling Machine

iv) Cluster Rolling Mill :-
In this type of rolling mill, each of working roll is backed up by two or more larger backup rolls. These rolls are arranged as shown in figure. This rolling mill are used in rolling hard thin materials. For rolling hard thin materials, it may be necessary to employ work rolls of very small diameter but of considerable lenght . In such cases adequate support of the working rolls can be obtained by using a cluster-mill.



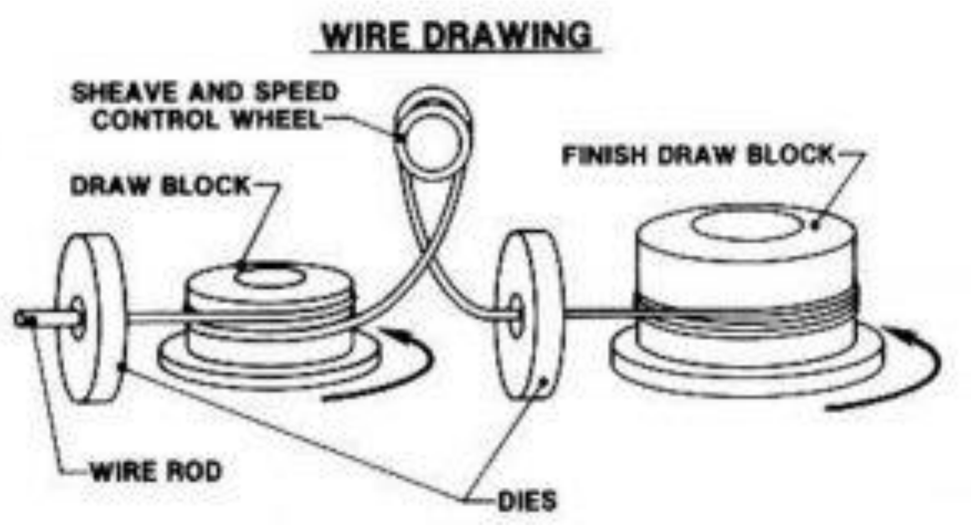
Cluster Rolling Mills

v) Planetary Rolling Mill :-
In this type of rolling mill, a large backup roller is surrounded by many planetary working rolls. Each planetary rolls gives constant reduction. It is used to reduce large thickness of single pass of steel strip. Its rolling capacity is more than cluster rolling mill but less than rolling mill.



Planetary Rolling Machine

B. Wire drawing is a metalworking process used to reduce the cross-section of a wire by pulling the wire through a single, or series of, drawing die(s). There are many applications for wire drawing, including electrical wiring, cables, tension-loaded structural components, springs, paper clips, spokes for wheels, and stringed musical instruments. Although similar in process, drawing is different from extrusion, because in drawing the wire is pulled, rather than pushed, through the die. Drawing is usually performed at room temperature, thus classified as a cold working process, but it may be performed at elevated temperatures for large wires to reduce forces.

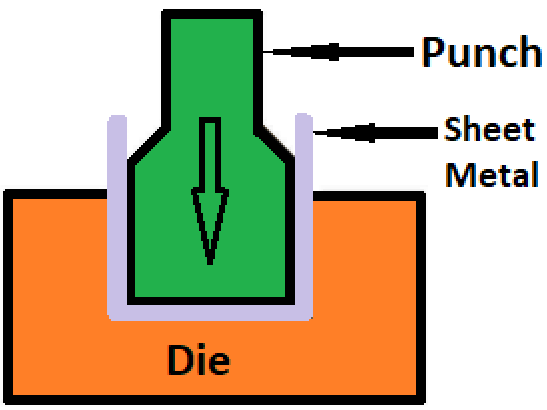


9.

A.

1) <u>Bending Operations:</u> The metal forming processes, in which a sheet metal piece is caused to bend and get formed in the desired shape by the application of a force, are called Bending Operations. The types of bending operations are explained as follows:

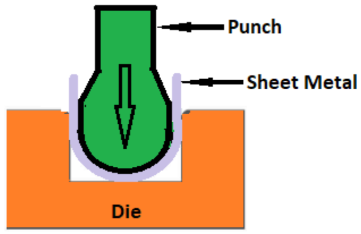
<u>Channel Bending</u>: In this type of bending, there is a die of channel shape and also a punch according to the shape of the die.



As shown in the above image, the sheet metal piece is placed in-between die and punch. When a force is applied to the punch to move into the die, the sheet metal piece, in between, gets the shape according to the shape of the die and punch (i.e., a channel shape).

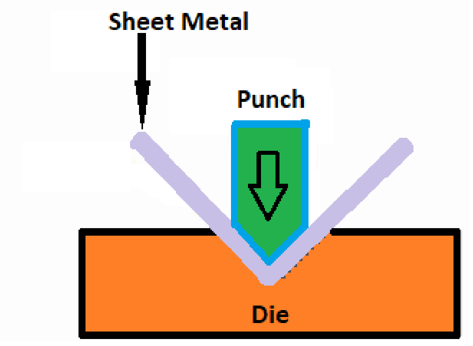
U-Bending:

In this bending operation, there is a die of U-shape and the punch is also according to that as shown in the image given below:



When the punch is pressed by a force to move into the die, the sheet metal piece (in between the die and punch) gets formed in a U-shape.

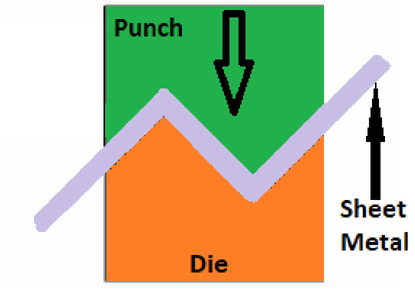
V-Bending:



In the V-Bending operation, the die and punch are according to V-shape, as shown in the image given above. In this kind of sheet metal operation also, when the sheet metal piece is pressed between the die and punch; it gets formed into the shape of the die i.e. V-shape.

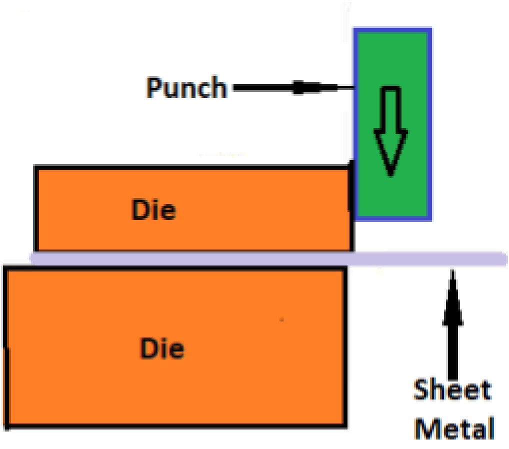
Offset Bending:

In this type of bending operation, the sheet metal piece is formed in an offset shape.



As shown in the image given above, the punch and die are also according to this shape so that the sheet metal piece can be formed into the desired shape.

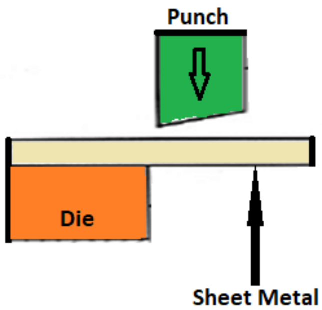
Edge Bending:



In edge bending operation, an edge of the sheet metal piece is bent. In this operation, the sheet metal piece is fixed or held in between two dies from one end, as shown in the above image. Then a punch is forced to strike upon the other end which is free (or unfixed). Thus the open/unfixed edge of the sheet metal piece is bent to complete the forming process.

2) Shearing Operation

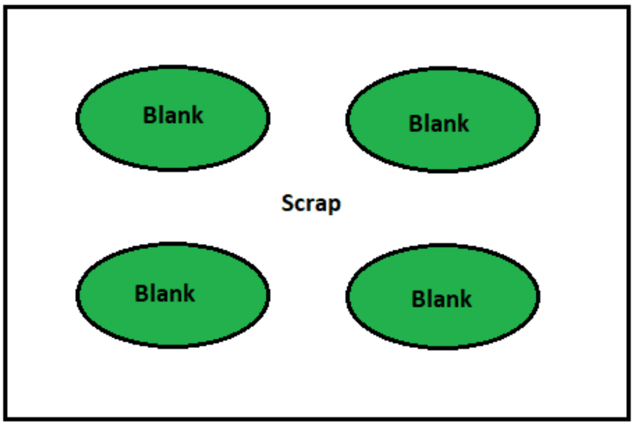
Shearing is the metal forming process in which a sheet metal piece is separated into two parts.



In this, the sheet metal piece is placed or held in between two dies from one end (as shown in the image above). And, the punch is impacted on the other end of the sheet, causing the shearing effect. Thus the piece is divided into two parts.

3) Blanking Operation

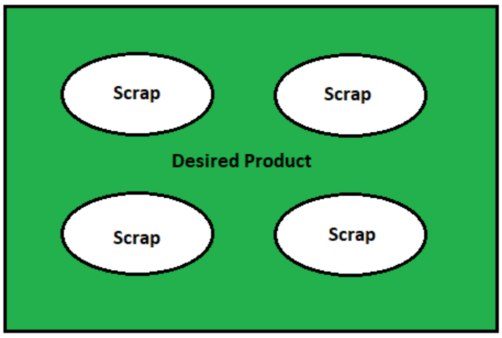
In this type of sheet metal operation, small piece/pieces of a circular shape or any other shape is sheared from the center of a large piece of sheet metal.



In this, the small piece which comes out is called a Blank (desired product) and the remaining material in the large piece (after blanking) is called scrap, as shown above. A Punch and a Die is used for this blanking operation.

4) <u>Punching Operation</u>

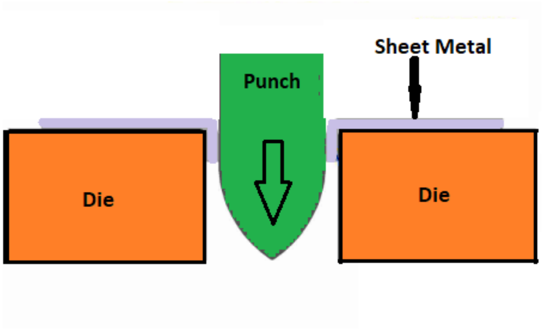
Punching is also an operation just like Blanking. But the main difference is that the Blank piece which was the desired product in blanking is the scrap here in the punching operation. And, the remaining material which was the scrap in blanking is the final/desired product in this punching operation, as shown in the image given below.



So it is just the opposite of Blanking but the process is almost the same. Punch and die are also used here just like blanking operation.

5) <u>Piercing Operation</u>

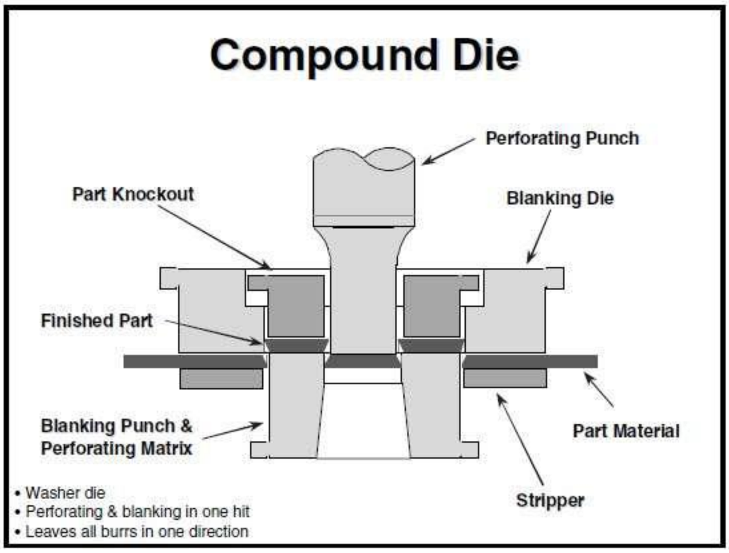
Piercing is the operation in which very small holes are created in the sheet metal piece without removing any material from the sheet or by removing a very little quantity of material (shown below in the image).



Punch & die both are used in this process also. The punch used in the Piercing operation is generally of bullet shape.
6) Trimming Operation
Trimming is the operation that involves creating complex shapes or intricate designs in small objects. Excess metal is shredded off to make final designs.
7) Embossing Operation
Embossing creates raised surfaces or indentations like alphabets, numbers, etc., on metal sheets. The thickness of the metal sheet remains unchanged, and changes and textures are seen.
8) Drawing Operation
Drawing is a technique that produces metal products shaped like vessels, cylinders, and hallows. Deep drawing makes cylinders with a larger width, and shallow drawing makes vessels with a smaller width.
9) Squeezing Operation
The squeezing is used to alter the thickness of the metal, generally ductile metals. Thick metals are easily changed to get a slimmer size.

B.

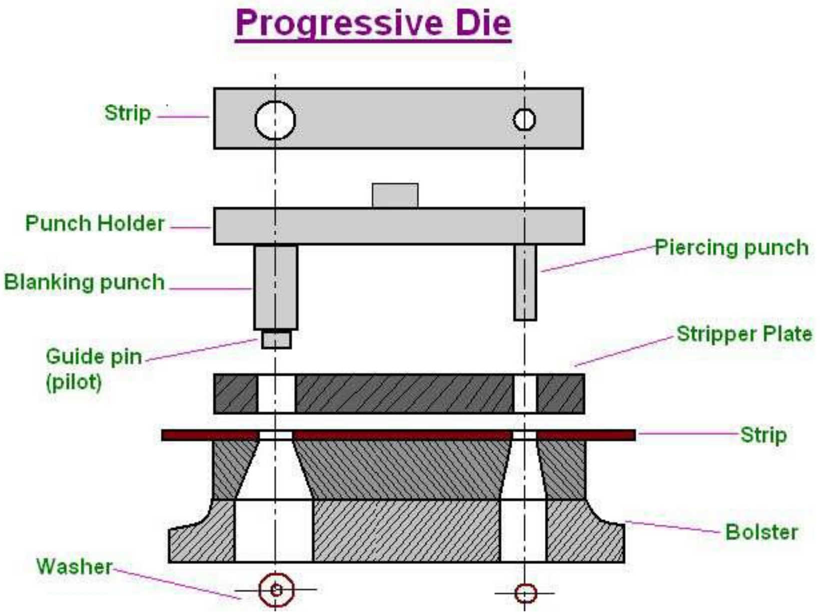
In these dies, two or more operations may be performed at one station.
 Such dies are considered as cutting tools since, only cutting operations are carried out.



Progressive Die

- A progressive or follow on die has a series of operations. At each station, an operation is performed on a work piece during a stroke of the press.
- Between strokes the piece in the metal strip is transferred to the next station.
- A finished work piece is made at each stroke of the press.

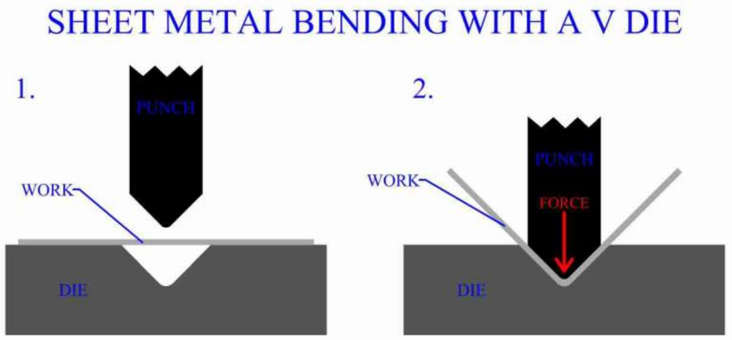
- While the piercing punch cuts a hole in the stroke, the blanking punch blanks out a portion of the metal in which a hole had been pierced at a previous station.
- Thus after the first stroke, when only a hole will be punched, each stroke of the press produces a finished washer.



10.

A.

Edge bending is another very common sheet metal process and is performed with a wiping die. Edge bending gives a good mechanical advantage when forming a bend. However, angles greater than 90 degrees will require more complex equipment, capable of some horizontal force delivery. Also, wiping die employed in edge bending must have a pressure pad. The action of the pressure pad may be controlled separately than that of the punch. Basically the pressure pad holds a section of the work in place on the die, the area for the bend is located on the edge of the die and the rest of the work is held over space like a cantilever beam. The punch then applies force to the cantilever beam section, causing the work to bend over the edge of the die.



Rotary bending forms the work by a similar mechanism as edge bending. However, rotary bending uses a different design than the wiping die. A cylinder, with the desired angle cut out, serves as the punch. The cylinder can rotate about one axis and is securely constrained in all other degrees of motion by its attachment to the saddle. The sheet metal is placed cantilevered over the edge of the lower die, similar to the setup in edge bending. Unlike in edge bending, with rotary bending, there is no pressure pad. Force is transmitted to the punch causing it to close with the work. The groove on the cylinder is dimensioned to create the correctly angled bend. The groove can be less than or greater than 90 degrees allowing for a range of acute and obtuse bends. The cylinders V groove has two surfaces. One surface contacts the work transmitting pressure and holding the sheet metal in place on the lower die. As force is transmitted through the cylinder it rotates, causing the other surface to bend the work over the edge of the die, while the first surface continues to hold the work in place. Rotary bending provides a good mechanical advantage.

This process provides benefits over a standard edge bending operation, in that it eliminates the need for a pressure pad and it is capable of bending over 90 degrees without any horizontally acting equipment. Rotary bending is relatively new and is gaining popularity in manufacturing industry.