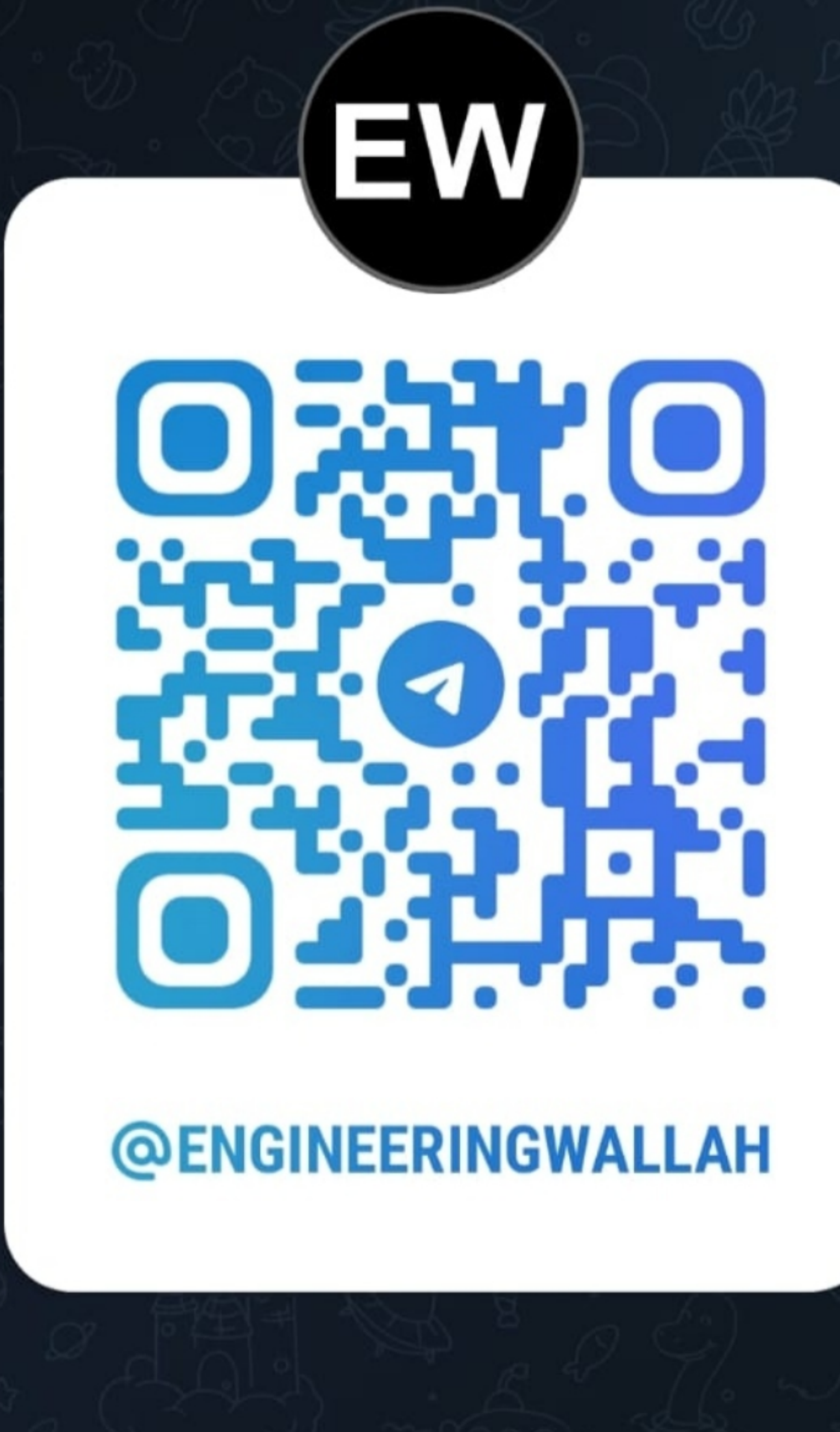
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UNIT V

Introduction to manufacturing

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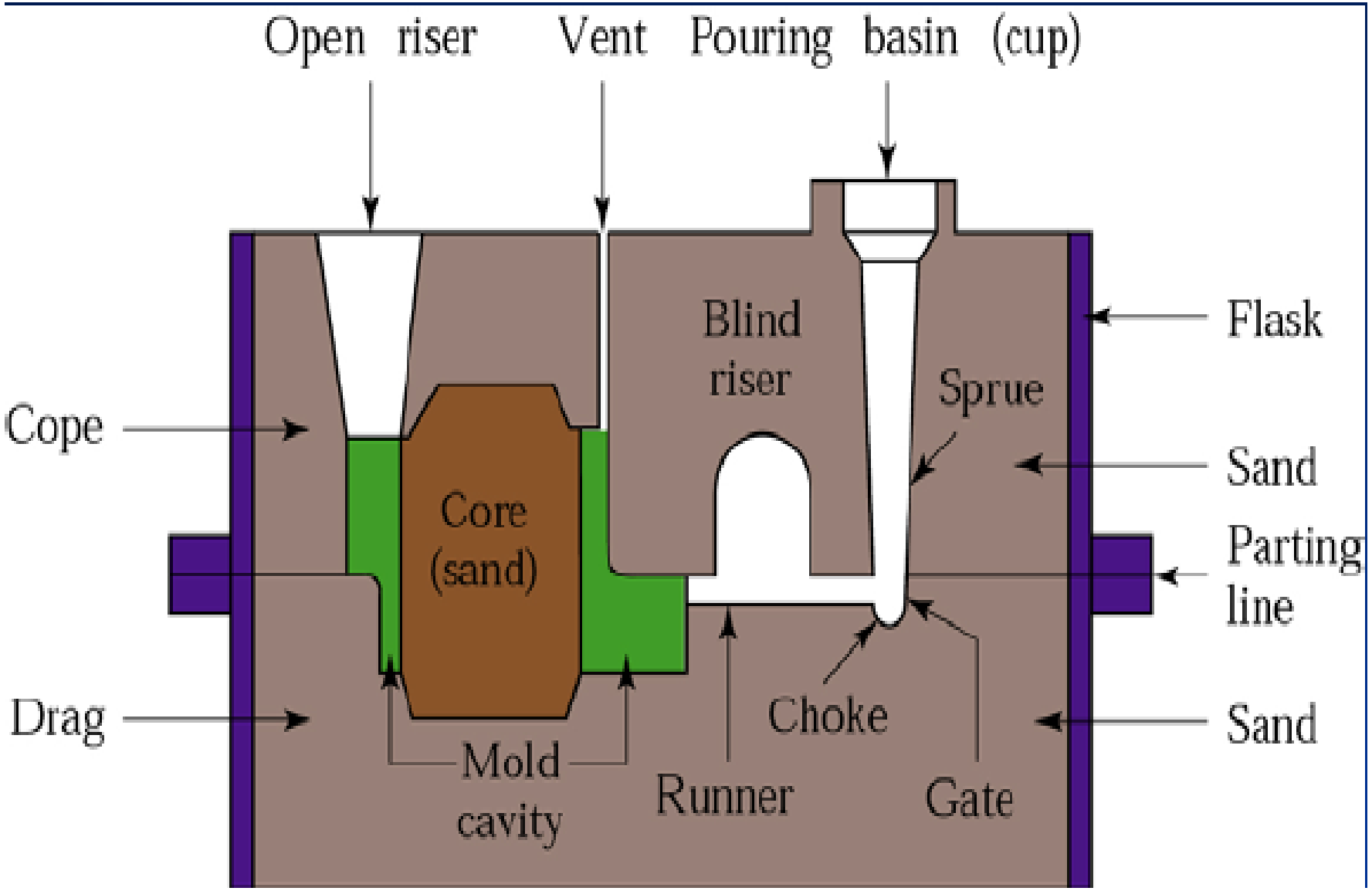
Casting

1. **Casting** is a manufacturing process by which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape, and then allowed to solidify.
2. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.
3. The place where castings are made is known as **Foundary**
4. the furnace is essential in casting


Open riser
Vent
Pouring basin (cup)
Blind riser
Sprue
Flask
Cope
Sand
Core (sand)
Parting line
Drag
Choke
Sand
Mold cavity
Runner
Gate

Mould

i. It is a container having a cavity of the shape which is to be manufactured
ii. The molten metal is poured in the mould
iii. Sand is used for mould
iv. The mould is made by using pattern

Pattern

i. It is a model or replica of the object to be cast
ii. Plastic, wood and Al can be used for pattern

Core

i. It is a part which doesn't permit the molten metal to fill the space occupied by the core
ii. It is used to obtain holes or hollow spaces

Mould box

i. It is the combination of two halves
ii. Uper half is known as cope
iii. Lower half is known as drag

Pouring cup

i. It is a funnel shape cup which forms the top portion of the sprue
ii. It makes easier to the operator to direct the flow of metal from laddle to sprue

Pouring basin

i. Molten metal is initially poured into a pouring basin
ii. It holds back the slag and dirt which floats on the top
iii. It alloy only the clean metal to enter into the sprue

Sprue

i. It is the channel through which molten metal from pouring basin enters into the gate

ii. It can have square or round shape

Riser

It is a passage of sand to permit the molten metal to rise above the highest point in the casting after the mould cavity is filled up

Function

It indicates that, the mould cavity is completely filled or not

It permits escape of air and mould gases

Laddle

It is used to carry molten metal from furnace to the moulding boxes

Process of casting

1. Pattern making
2. Moulding
3. Core making
4. Melting
5. Pouring
6. Testing
7. Heat treatment
8. Re testing

Applications

m/c tool bed	Flywheel
gears	IC engine blocks
generator	Pulley
turbine disks	Compressor blades

Advantages

i. Low cost
ii. Complex design terms of shape, size and quality is possible
iii. High degree of accuracy
iv. Complex and uneconomical can easily produced by casting
v. A product obtained by casting is one piece

Disadvantages

i. component of thickness less than 6mm cant be manufactured
ii. Cast components are generally brittle
iii. Welding is difficult
iv. Limited to Metals with Low Melting Points.
v. Defects like cracks, blow holes makes casting weak
vi. Less accuracy
vii. Metal is melted which requires large amount of heat
viii. Hence it pollutes atm

Forging

Introduction

i.Forging is the process by which metal is heated and is shaped by plastic deformation by suitably applying compressive force.

ii.Usually the compressive force is in the form of hammer blows using a power hammer or a press.

iii.The place where forging takes place is known as smithshop

iv.It takes place under plastic condn

Material used

The material used for forging should have high ductility

Material used are

i.Steel

ii.Aluminium alloy

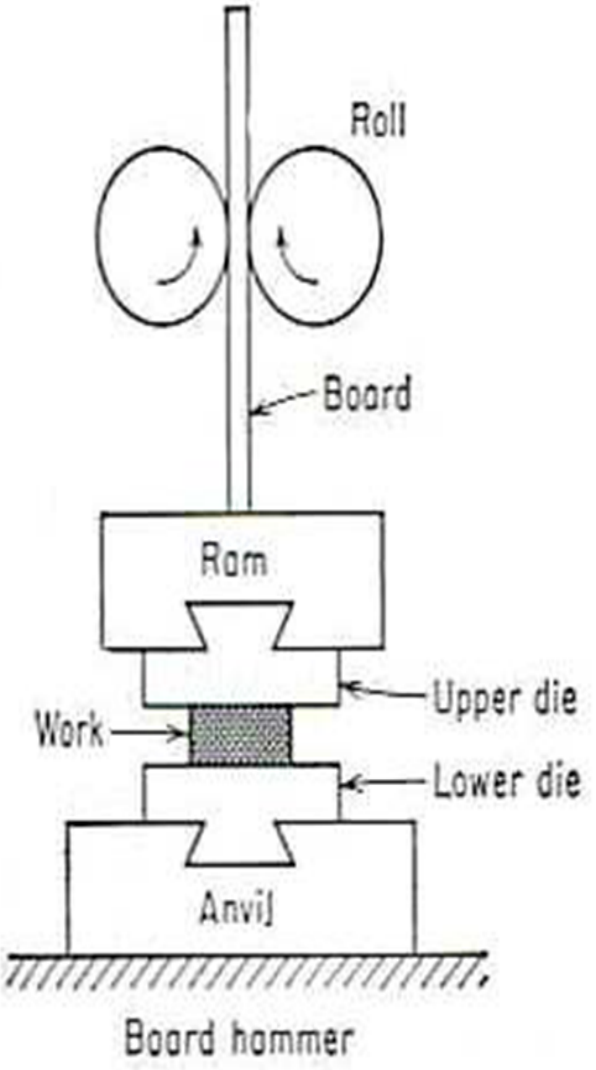
Construction

i. operated hydraulically

ii. used for shaping parts by drop hammering a heated bar or massive weight is applied by mech press and allows it to fall under gravity

iii. dies are in two halves
   - Lower : fixed to anvil
   - Upper : moves up and down with the ram.

iv. forging copper alloys and steel



Advantages

i. It requires minimum surface finish

ii. It gives high dimensional accuracy

iii. Forged components have better mech properties like strength, toughness

iv. Welding is easy

v. It produces component without blow holes

Disadvantages

i. The cost of die is very high.

ii. Initial cost of press machine is also high.

iii. Metals of thickness more than 10 mm are difficult to form.

iv. The operation produces more noise and vibrations.

v. It is nt applicable for brittle material

vi. Complex components cant be produced

Applications

i.Crankshafts
ii.Connecting rods
iii.Camshafts
iv.Bolts
v.Nuts
vi.railway car axles
vii.Chains
viii.Rivets

Types of forging

Open Die Forging

i. This is the type of forging in which the workpiece is deformed between two flat dies

ii. The shape of the dies are flat

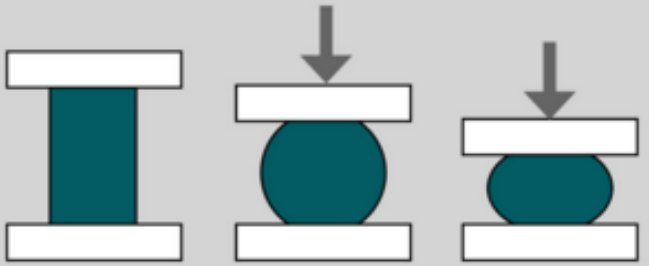
Closed Die Forging

i. This is the type of forging in which the workpiece is deformed between two dies having impression of of the desired shape

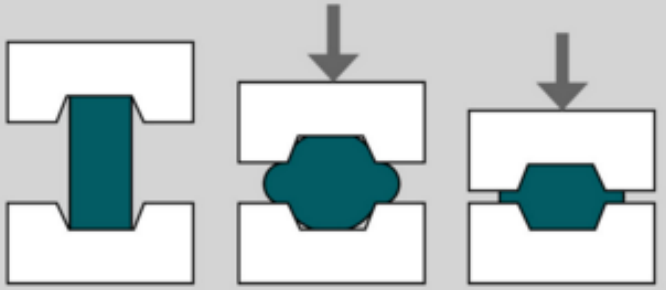
ii. The shape of the dies having impression of desired shape

Open and Closed Die Forging Processes

(1) OPEN-DIE FORGING



(2) CLOSED-DIE FORGING



Open Die Forging	Closed Die Forging
Advantages	
Better fatigue resistance and improved microstructure	The internal grain structure formation increases the tightness and strength of the products.
Continuous grain flow and finer grain size	Economic for large production runs.
Increased strength and longer part life	No material limitation
Less material waste	Better surface finish
Reduced chance of voids	Less or no machining required for its close tolerances
Valuable cost savings	Dimensions of tighter tolerances and net shapes can be achieved
Disadvantages	
It is not capable of forming close tolerance and higher precision parts	It is not very economical for short runs due to the high cost of die production
Machining is often required to achieve desired dimensions	Closed die forging presents a dangerous working environment

Sr	Parameters	castings	forging
1	**Esential parameter**	heat	compressive force
2	**plcae**	The place where castings are made is known as Foundary	The place where forging takes place is known as smithshop
		Advantages	**Disadvantages**
3	**suitability**	Almost all metals alloys can cast	Only for ductile material
4	**Size of components**	All size components can cast	Large size components are difficult to
5	**Shape of components**	Complex shape components easily produced by casting	Complicated shape components cant manufactured
6	**Initial investment**	low	high
8	**Cost of components**	low	high

Sr	Parameters	castings	forging
		Disadvantages	**Advantages**
9	**strength of components**	Less	more
10	**space requirement**	more	Less
11	**pollution**	high air pollution	high sound polution
12	**welding**	nt possible	possible
		Applications	
		Pistons Piston rings	Crankshafts Connecting rods Camshafts Bolts Nuts railway car axles Chains Rivets

Applications

i.Crankshafts
ii.Connecting rods
iii.Camshafts
iv.Bolts
v.Nuts
vi.railway car axles
vii.Chains
viii.Rivets

MANUFACTURING PROCESS

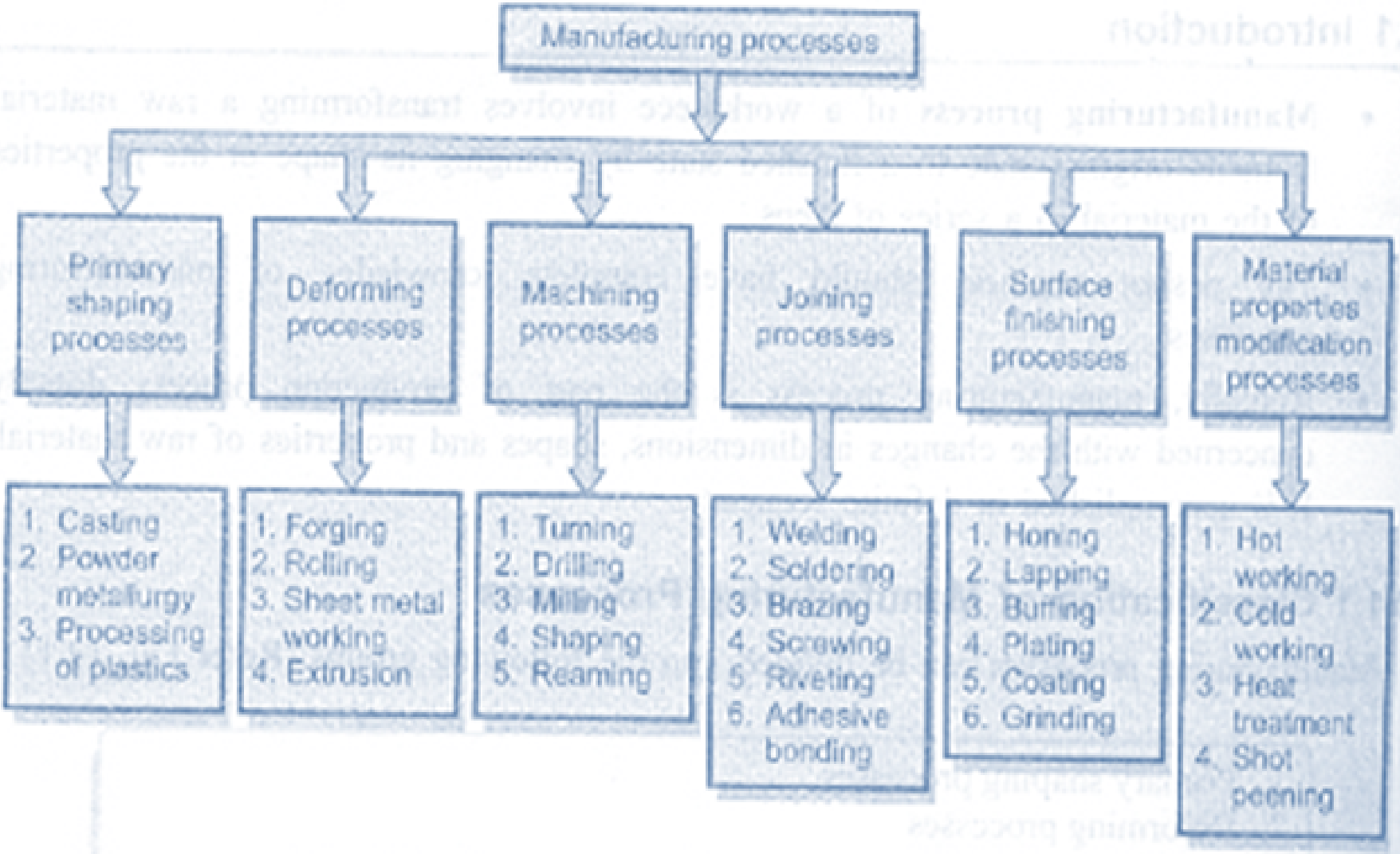


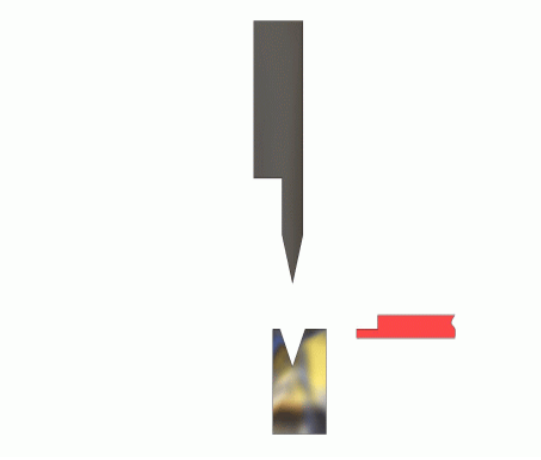
Fig. 13.1 : Classification of manufacturing processes

Sheet metal working

i. Sheet metal working is generally associated with press machines and press working.
ii. Thickness of metal varies from 0.1 to 10 mm.

Advantages

i. Sheet metal working is associated with ress machine on which number of operations can be performed.
ii. Metal sheets of less thickness can be formed into various shapes.
iii. Low cost
iv. Production rate of press machine is very high.
v. The process does not require skilled labour



Disadvantages

i. Sheet metal working is only used for mass production.
ii. The cost of die is very high.
iii. Initial cost of press machine is also high.
iv. Metals of thickness more than 10 mm are difficult to form.
v. The operation produces more noise and vibrations.

Applications

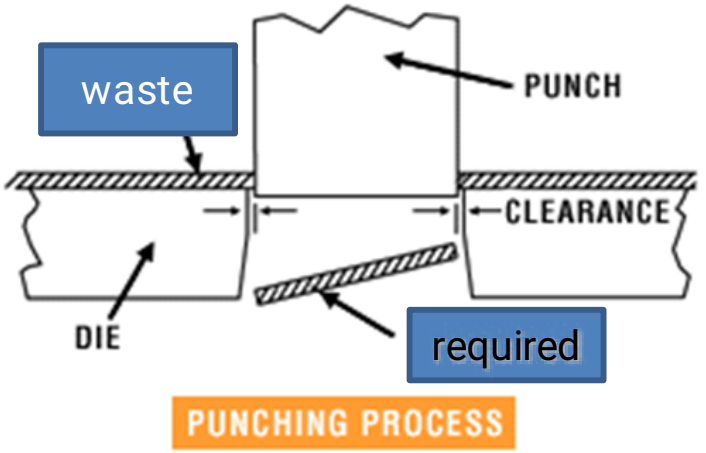
i. Press parts are widely used in automobiles industry like bikes , cars , trucks, buses.
ii. Vehicle parts like doors, roofs , fuel tanks, front guards etc can be produced.
iii. Aircraft industry , radio and telephone industry , electrical parts

Types of Sheet metal cutting operations

1. **Blanking**

i. it is the cutting operation of a flat metal sheet and the article punched out is known as blank.

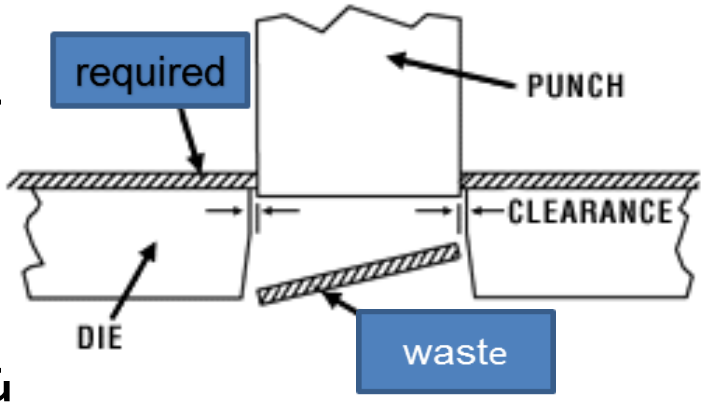
ii. In this the part which is cut is required and the metal left behind is the waste

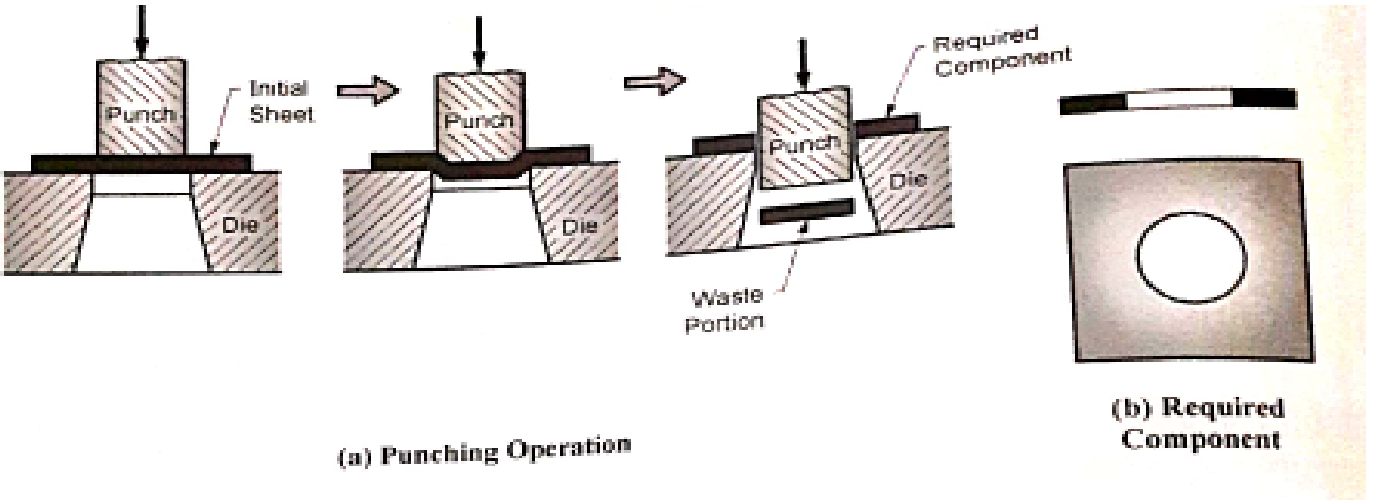


2. **Punching or Piercing**

i. holes of various shapes are produced ir the sheet metal.

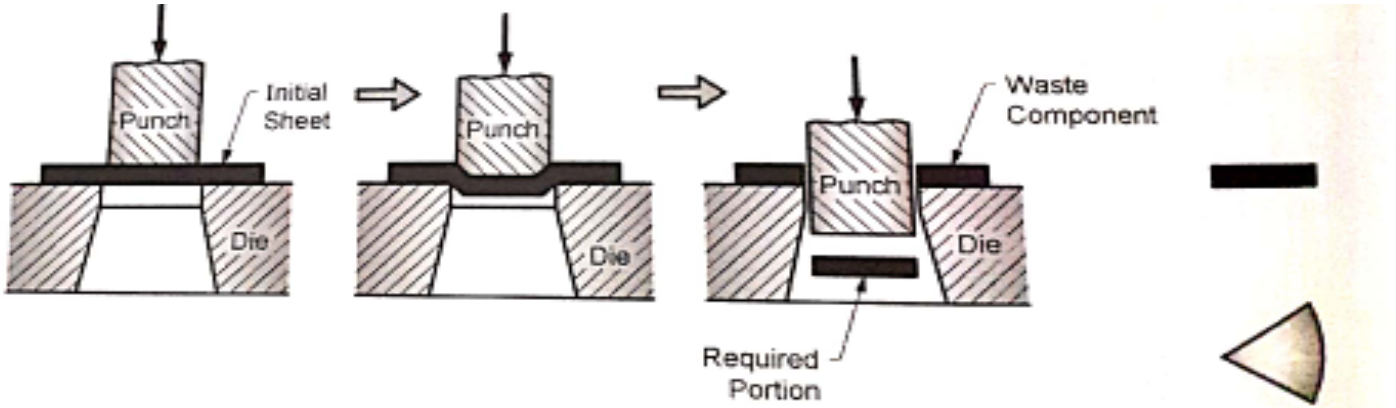
ii. In this the part which is cut is waste and the metal left behind is thr required





(a) Punching Operation

(b) Required Component



(a) Blanking Operation

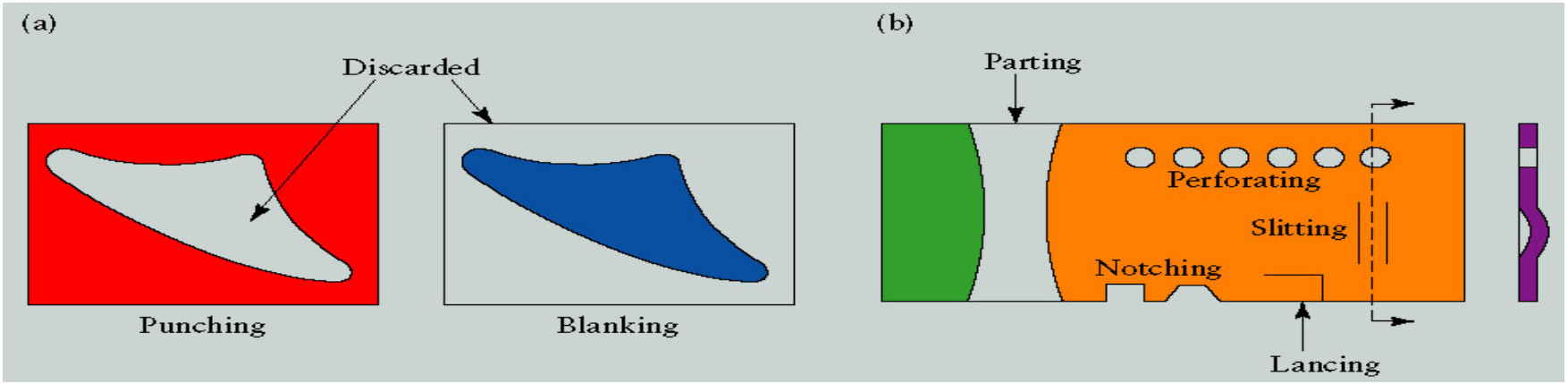
(b) Required Component

3. **Notching**

metal pieces cut from edges of sheet

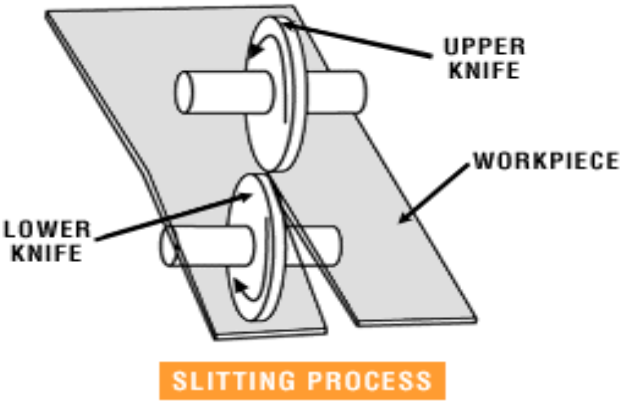
4. **Perforating**

punching a number of holes in a sheet



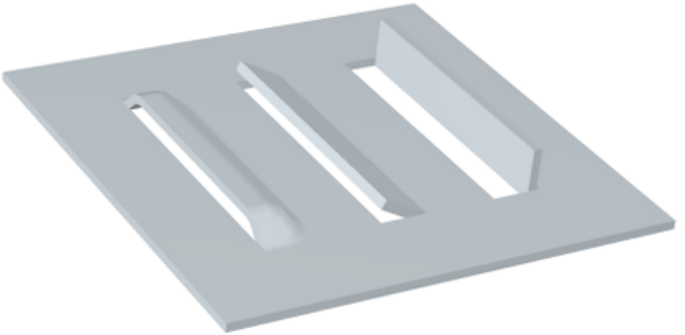
5. **Slitting**

unfinished cut through a limited length only



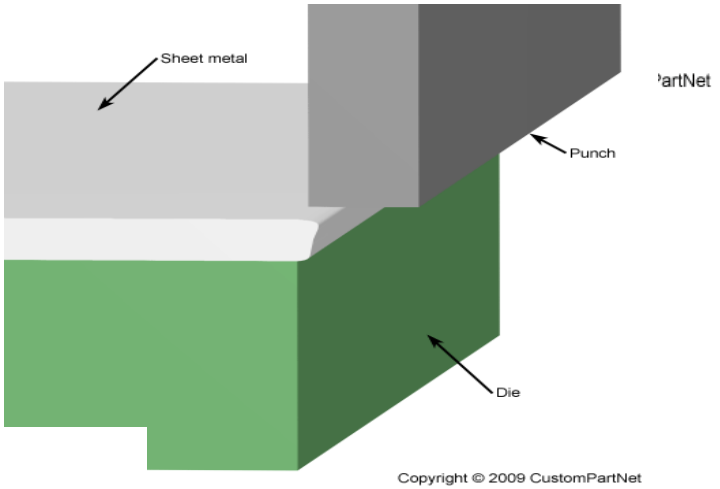
6. **Lancing**

leaving a tab without removing any m



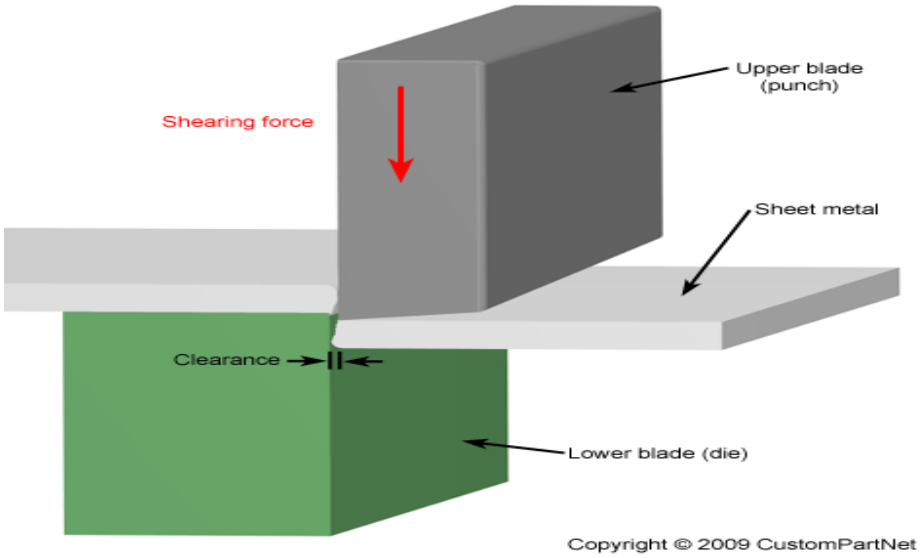
7. **Shaving**

cutting unwanted excess material

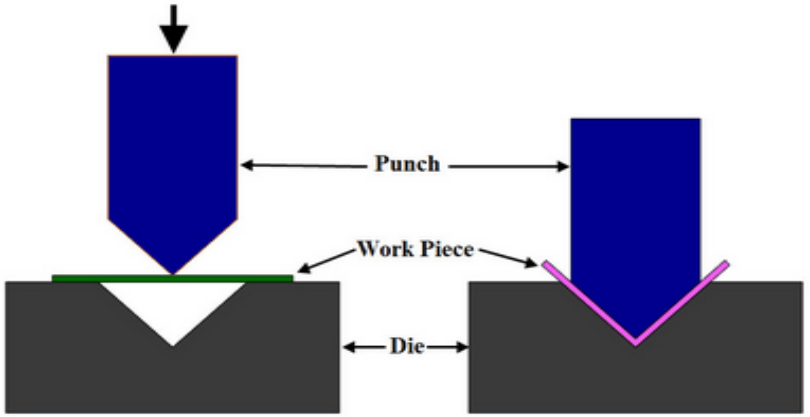


8. **Shearing-**

cut sheet along a single line



Types of Sheet metal forming operation



Common Die-Bending

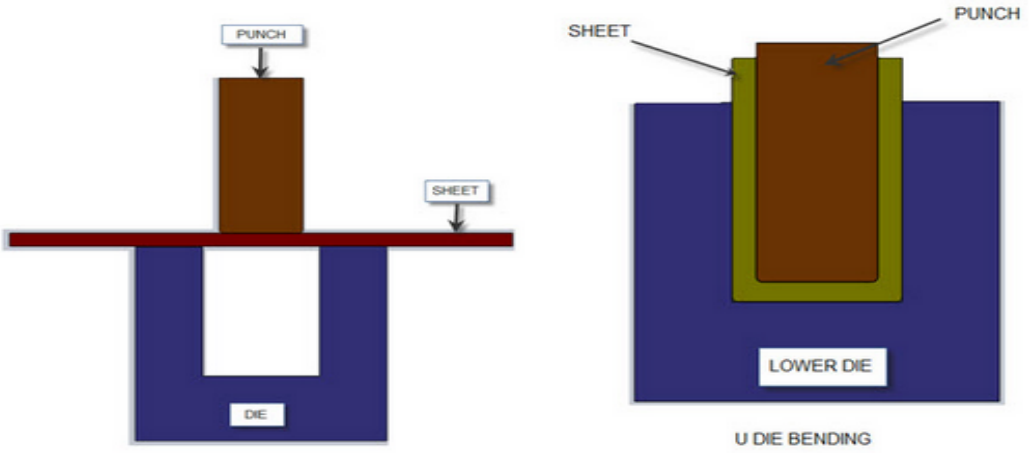


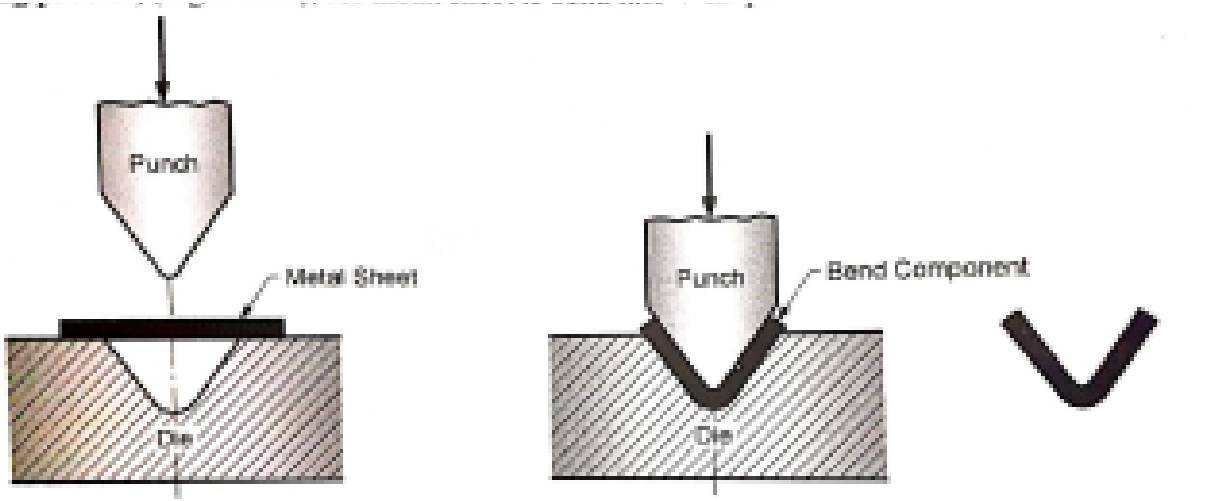
Figure: U Bending

1. **Bending**

   sheet metal to undergo the desired shape change by bending without failure

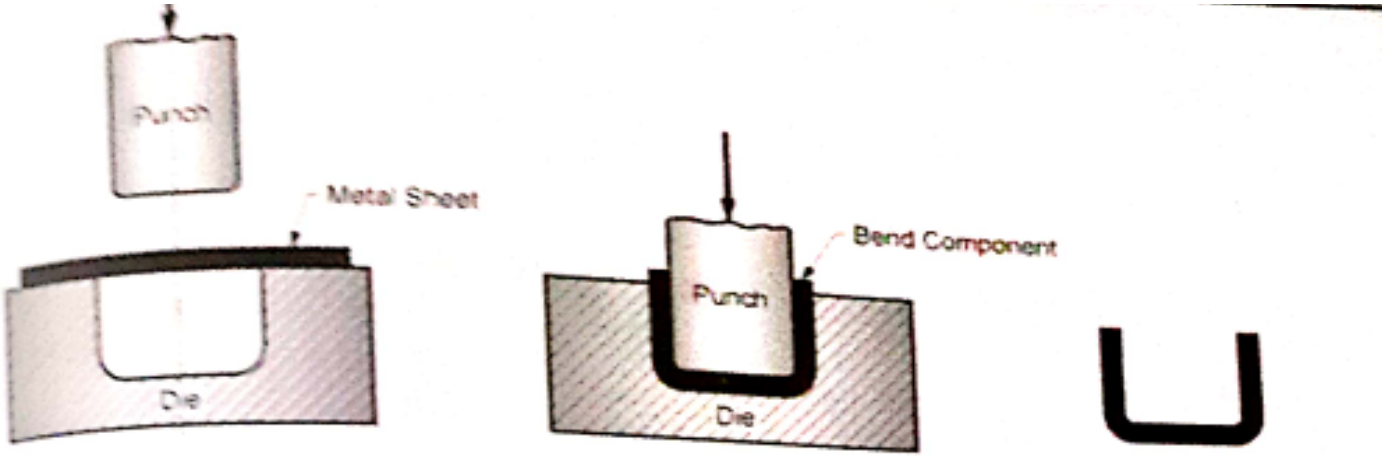
   Types of bending

1. V bending
2. U bending
3. Angle bending
4. Curling
5. Edge bending



(a) Before Bending (b) After Bending (c) Final Component

Fig. 5.6.11 : V-bending Process



(a) Before Bending (b) After Bending (c) Final Component

Fig. 5.6.12 : U-Bending (Channel Bending) Process

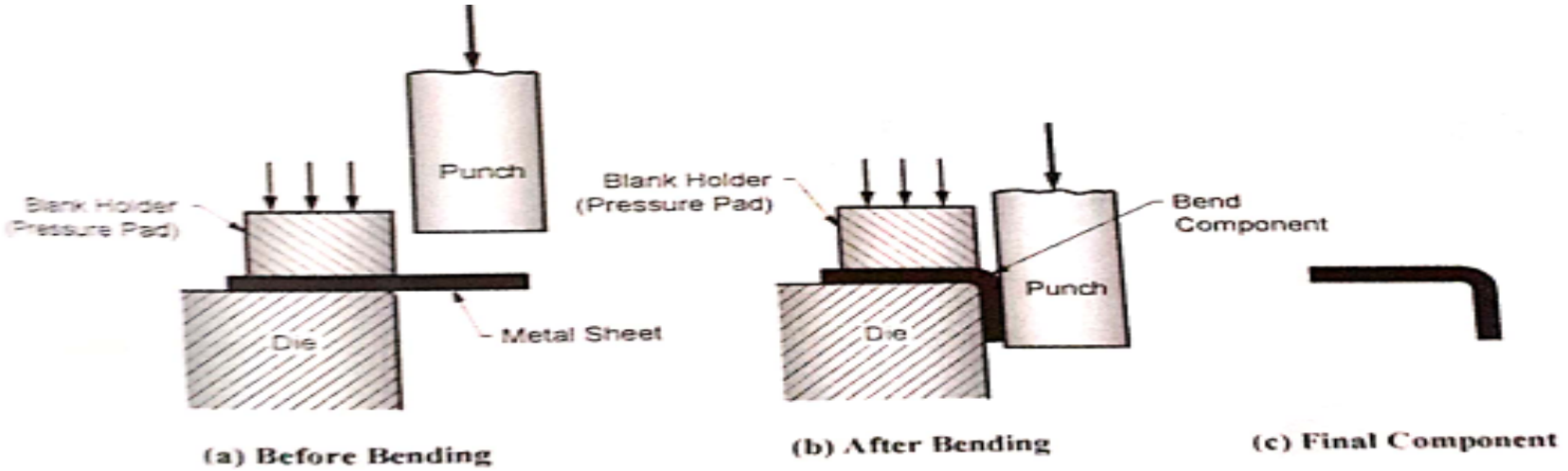


Fig. 5.6.13 : Edge Bending Process

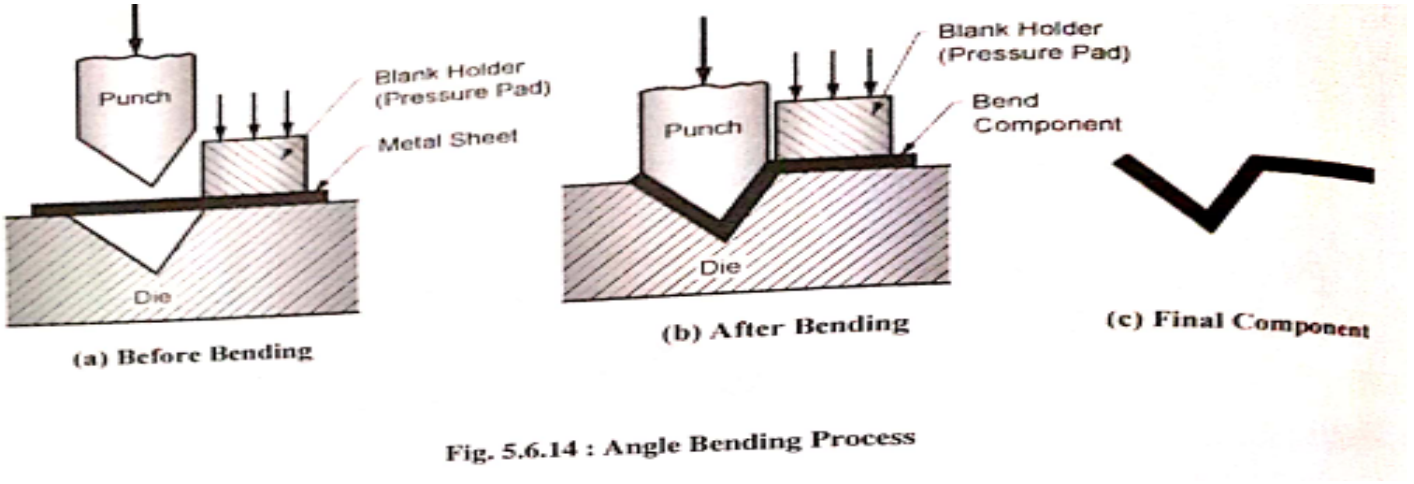
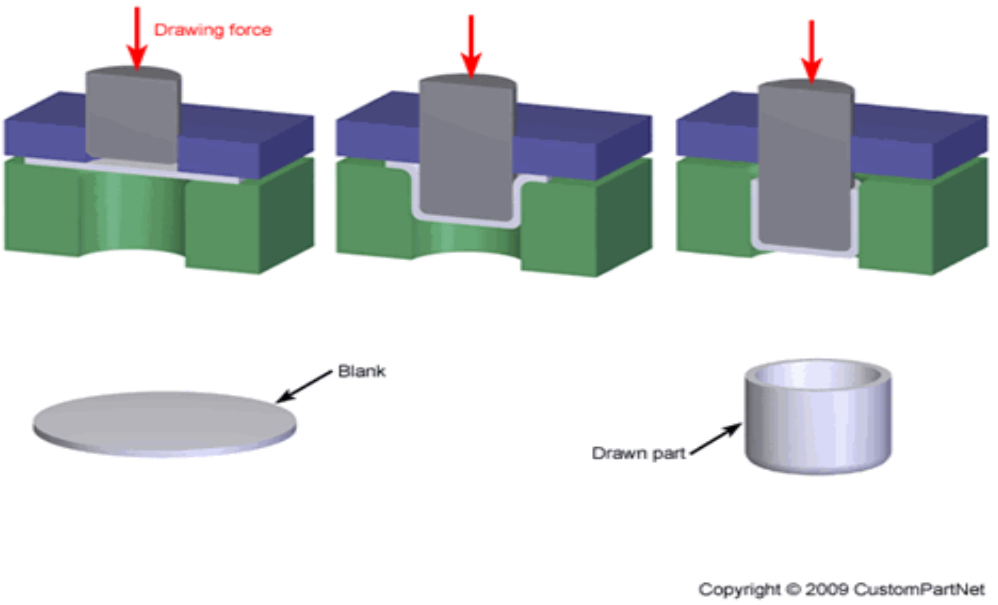


Fig. 5.6.14 : Angle Bending Process

2. Drawing

Drawing is a process of formin a flat metal sheet into a three dimensional hollow shape by means of a punch that causes the metal to flow into the die cavity.



3. Embossing

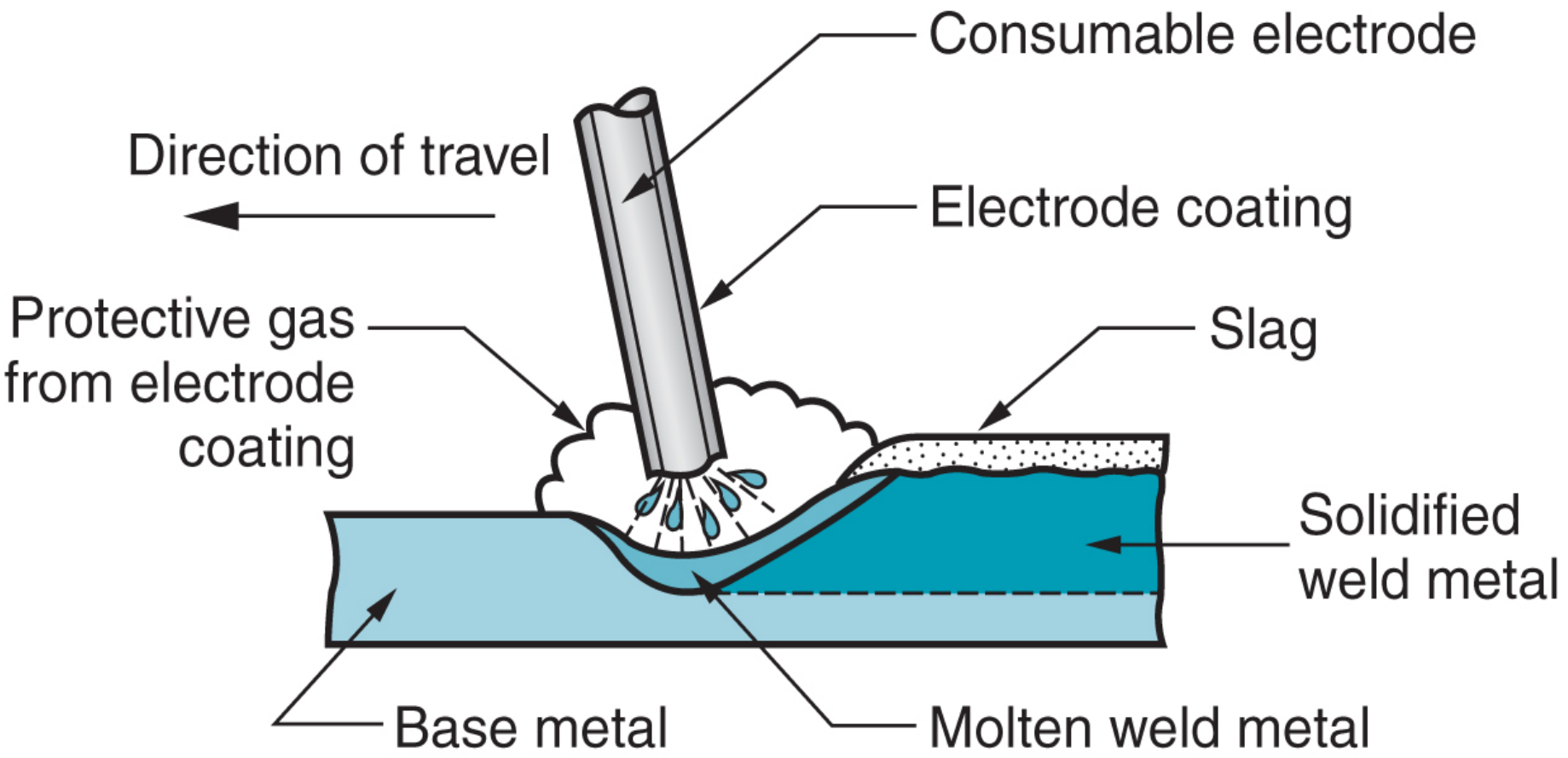
i. Embossing is the process of producing th depressed or raised impression of letters, figures or design on metal sheet.

ii. Embossing process is used in the producti of name plates, identification tags.

Welding

i. Welding is a process for joining two similar or dissimilar metallic parts together by heating them to a plastic or semi-molten state ,with or without the application of a pressure and with or without a filler material
ii. Weld ability– The capacity of a material to be welded under fabrication condition imposed in a specific and suitably designed structure.

Shielded Metal Arc Welding (SMAW)



Construction

This consists of

A.C. & D. C. machine

Electrode & holder

Wire brush

Cable and connector

Earthing clamps

Safety goggles

Hand gloves, apron, ettc

Electrode & Electrode holder

Working

i. Required heat for welding is obtained from the arc struck between the coated electrode and the work piece.

ii. The arc temperature is about 2400^0 2600^0 C.

iii. The arc melts the electrode and the work piece.

iv. Material droplets are transferred from the electrode to work piece through the arc and deposited along the welded joint.

v. The coating of flux melts and produces a gaseous shield and slag to prevent atmospheric contamination of the molten weld metal.

vi. As the electrode is non consumable, separate filler material is required

Advantages Of Welding

i. more economical and is much faster process.
ii. Large number of metals and alloys both similar and dissimilar can be joined
iii. equipment is not very costly
iv. Portable welding equipments can be easily made available
vi. Welding permits considerable freedom in design
vii. Welding can join welding jobs through spots, as continuous pressure tight seams, end-to-end
viii. Welding can also be mechanized

Disadvantages Of Welding

i. It results in residual stresses and distortion of the work pieces.
ii. Welded joint needs stress relieving and heat treatment
iii. harmful radiations (light), fumes and spatter
iv. Jigs, and fixtures may also be needed to hold and position the parts
v. Edges preparation of the welding jobs are required
vi. Skilled welder is required

Applications

i. Fabrication of bridges ,electric towers etc
ii. Building of ships and aircrafts.
iii. Manufacturing of boilers ,pressure vessels , storage tanks pilelines etc.
iv. Manufacturing of steel furniture's ,window and door frames , window grills etc.

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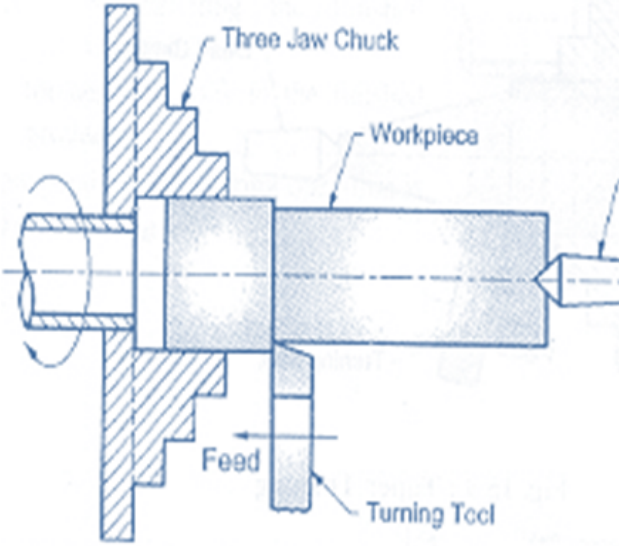
metal cutting processes

1. Turning

i. The process of removing the material from the cylindrical surface of the work piece, i.e.. to reduce the diameter.

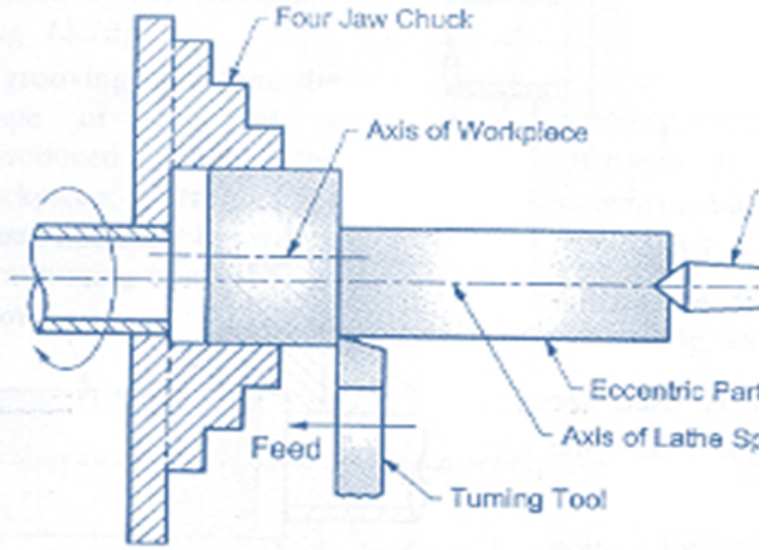
ii. Cutting tool moves parallel to axis of the work piece



2. Eccentric Turning

i. The process of removing the from the material cylindrical surface of the workpiece to reduce the diameter about axis offset from the axis of w/p.

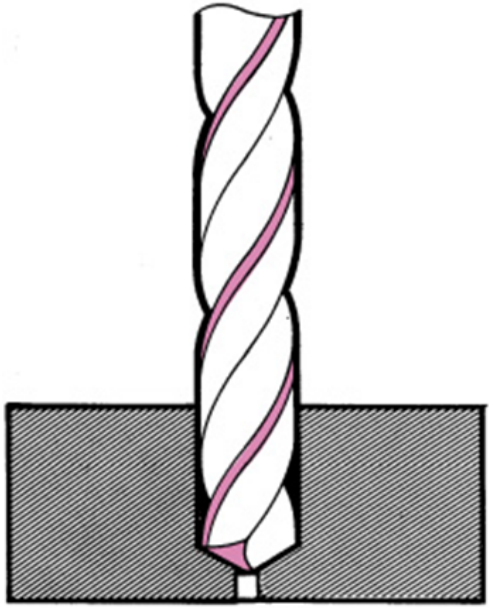
ii. Cutting tool moves parallel to axis of the work piece



3. **Drilling**

i. It is the operation of producing circular holes in a solid metal by using revolving tool

ii. Before drilling center of hole is located on work piece by drawing two lines at right angle to each other.



iii. Center punch is used to produce an identification mark at the center.

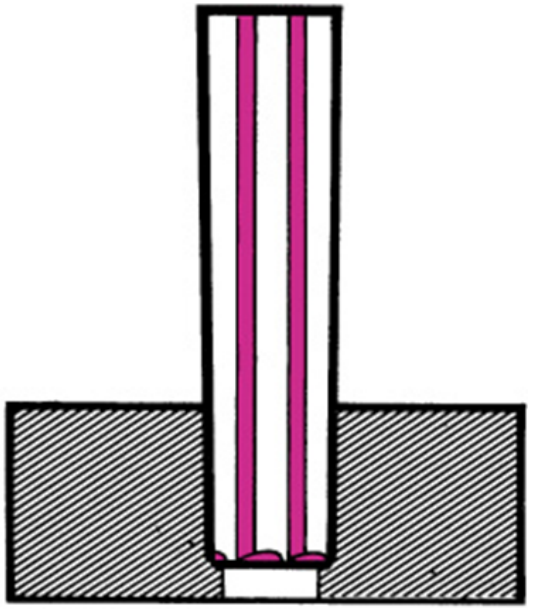
4. **Reaming**

i. It is the operation of finishing the hole which

ii. has been drilled previously.

iii. This operation is performed using multi-tooth

iii. tool called as reamer.



•Reamer cannot produce hole, it follows path which has been drilled previously.

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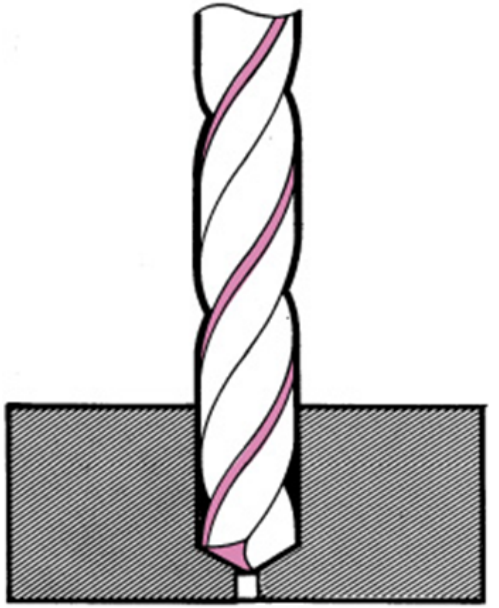

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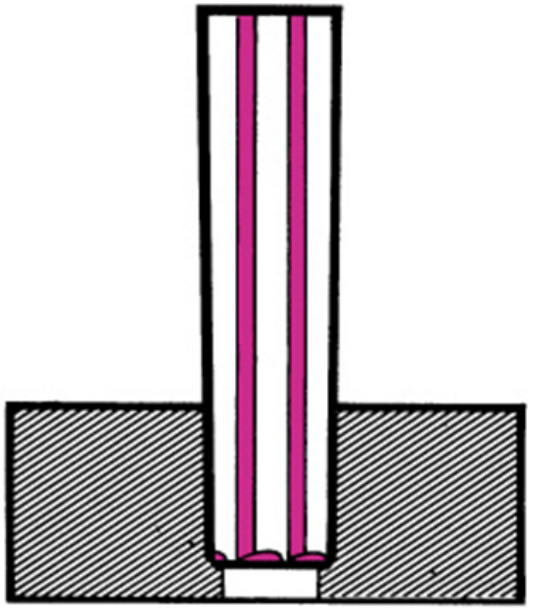
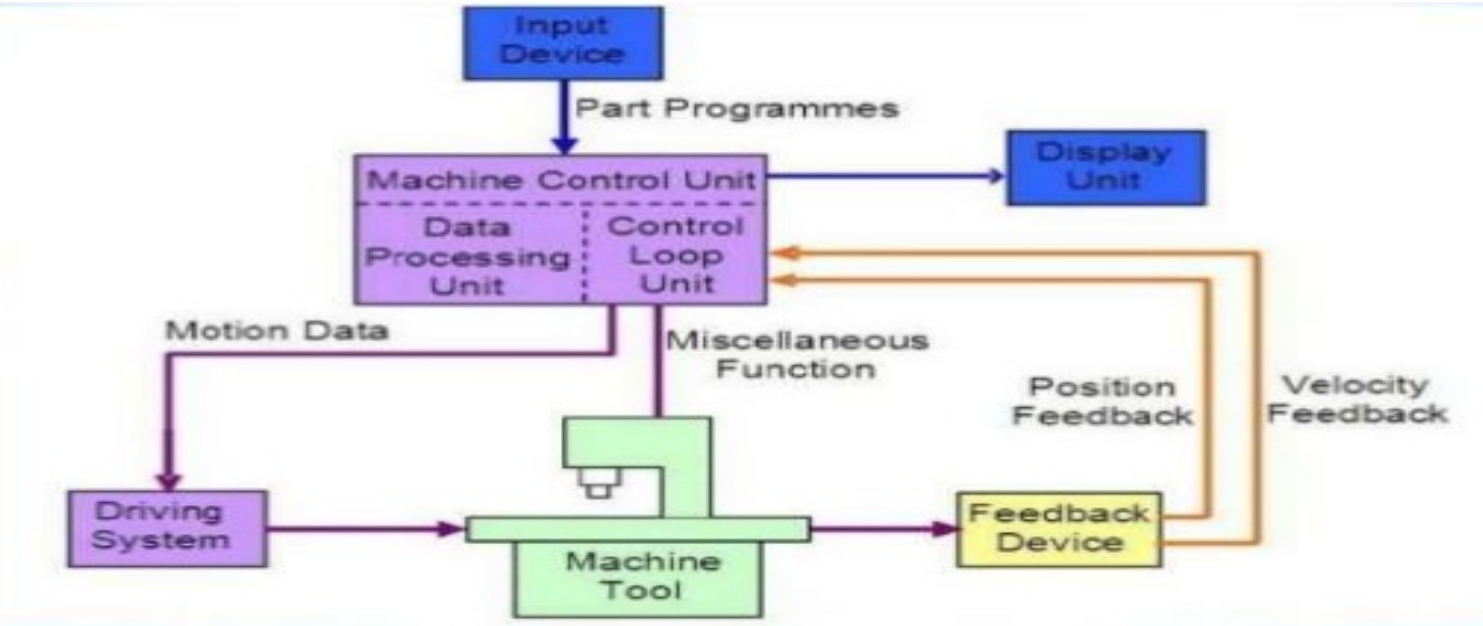


•Reamer cannot produce hole, it follows path which has been drilled previously.

Computer Numerically Controlled

CNC stands for Computer Numerically Controlled and basically means that the physical movements of the machine are controlled by instructions, such as co-ordinate positions that are generated using a computer.



Parts of the CNC machines

A CNC machine consists of many parts and they are as follows

1. Program input device
    i. The program input device is a way of entering the program into the CNC control.
    ii. The program input devices like punch tape reader, magnetic tape reader are the most commonly used program machine
    iii. control unit is an important part of CNC device

2. Memory
    i. Memory consists of ROM
    ii. The memory stores the programe

3. Microprocessor

   i. It receives the data stored in the memory

   ii. The data is converted into instructions to m/c tool

4. Machine tools

i. To control the machine tools the CNC controls are used.

ii. The machine is controlled along the x-axis and y-axis whereas the spindle runs along the z-axis.

5. Drive System

   The drive system consists of drive motors and much more.

6. Feedback unit

   Feedback unit takes the Feedback from m/c tool and send to microprocessor for action

Codes used in CNC m/c

1. **G-code**

G (geometric/preparatory) codes relate to the motion or positioning of the tool relative to the workpiece.

Common used g codes

G00 Rapid traverse

G01 Linear interpolation

G02 Circular interpolation CW

G03 Circular interpolation CCW

G04 Dwell

G09 Exact stop

G10 Programmable data input

G20 Input in inch

2. M codes

M (miscellaneous) codes relate to other functions such as coolant, speed, or tool changes.

Commonly used m codes

M00 Program stop

M01 Optional program stop

M02 End of program

M03 Spindle start forward CW

M04 Spindle start reverse CCW

M05 Spindle stop

M06 Too change

M08 Coolant ON – Flood coolant

Advantages

i. Machining is accurate
ii. Time taken to perform a job is very less
iii. Safe to operate
iv. Number of operators required to operate a machine are reduced
v. No possibility of human error
vi. Reliable
vii. Even very complex designs can also be made
viii. Low maintenance required
ix. They are versatile
x. Uniformity in designs
xi. They could run continuously
xii. Skill operator is nt required as the programe is set

Disadvantages of CNC machines

i. are costly
ii. Trained operator is required to operate the machine
iii. In case of breakdown a highly skilled professional is required to solve the problem
iv. The CNC machine operator only needs basic training and skills, enough to supervise several machines.
v. Investment in CNC machines can lead to unemployment.

Applications of CNC machines

i. Metal removal industries
ii. Material fabrication industries
iii. For non-conventional machining industries where the machining task is difficult to perform manually
iv. Electrical Discharge Machining Industry

3D Printing

Introduction

i. 3D Printing is a process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of a material.

ii. It brings a digital object (its CAD representation) into its physical form by adding layer by layer of materials.

Component of 3D Printing system

i.Pre processing computer
ii.System computer
iii.Control unit
iv.Inkjet prints
v.Liquid adhesive supply system
vi.Powder feed
vii.Powder feed plat form and supply
viii.Part platform and cylinder

Steps in 3D Printing

1. Technologies
    i. While all 3D printers create objects using additive methods (the opposite of a CNC machine), different approaches exist to actually physically depositing the material.
    ii. The most common methods are:
    - Fused Deposition Modeling
    - Selective Laser Sintering
    - Powder Bed and Binder
    - Stereolithography

2.3D Printers

While there are countless 3D Printers in process, several models and brands are the most common and well known.

- ➤Dimension Elite
- ➤Objet Connex 500
- ➤Pintrbot
- ➤Solidoodle

3.Materials

i.Materials vary from technique to technique.

ii.The most common for FDM is spooled ABS style plastic filament.

iii.However, many other materials can be printed, including ceramic, metal, rubber, clear plastic, glass and others.

iv.The materials available are dependent on the method of printing.

4. Design and Print
    i. When it comes to modeling 3D files for a printer, the most commonly accepted format is an STL file, which is essentially a mesh made of triangles.
    ii. preferred CADD software to create the model.

Advantages of 3D Printing

i. Using 3D Printing the prototype can produced in short period
ii. It reduces the cost of making prototype
iii. Complex parts can manufactured
iv. It reduces the material waste
v. Quality of product is better
vi. With 3D Printing the feedback of the customer can incorporated in the product design

Disadvantages of 3D Printing

i. High Energy Consumption.
ii. 3D Printing Technology is Expensive. ...
iii. Limited Materials.
iv. 3D Printers Aren't that User-friendly.
v. Harmful Emissions.
vi. Too Much Reliance on Plastic.
vii. 3D Printers are Slow.
viii. Investment in CNC machines can lead to unemployment.

Applications of 3D Printing

concept models
Functional models

Micromaching

Introduction

Micromaching is a technique of producing the components with a dimensions ranging from few microns to few hundred microns

Necessity

i. In many of the systems like MEMS system (micro-electrochemical system) the dimensions are ranging from few microns to few mm

ii. The machining of MEMS can done with Micromaching

Micromaching processes

i. Micro turning
ii. Micro milling
iii. Micro machining
iv. Micro Electrical Discharge Machining

Advantages

i. Systems are highly flexible
ii. Ability to machine almost any material including metals, polymers, glass, ceramics and silicon wafers.
iii. Capability to achieve features as small as 1 micron with submicron tolerances.
iv. Cost-effective for both small and large volume applications.