Unit - 3

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Extrusion (Eg→ Squeezing of tooth paste)

Extrusion is a metal working process in which cross section of metal is reduced by forcing the metal through a die orifice under high pressure.

Application [It is used to produce cylindrical bar, tubes & sections of any regular or irregular types.

Extra [Billet is a work piece whose desired shape is to be obtain.
→ used in extrusion

→ Classification of Extrusion

Extrusion processes can be classified as follows:

1. Hot Extrusion
   i) Forward or direct Extrusion
   ii) Backward or indirect extrusion

2. Cold Extrusion
   i) Impact Extrusion
   ii) Hydrostatic Extrusion

Extra (Ram & Plunger is same)

① HOT ~~Extos~~ Extrusion

→ Forward or Direct Extrusion

- ~~Forw~~ In this process, the metal billet is placed in a container and extruded through the ~~dye~~ die with the help of ram.
- Both the ram & workpiece (billet) move in same direction.
- A pressure plate is in contact with the billet and ram. The relative motion b/w billet & container wall creates high friction. Hence, power required is relatively high.

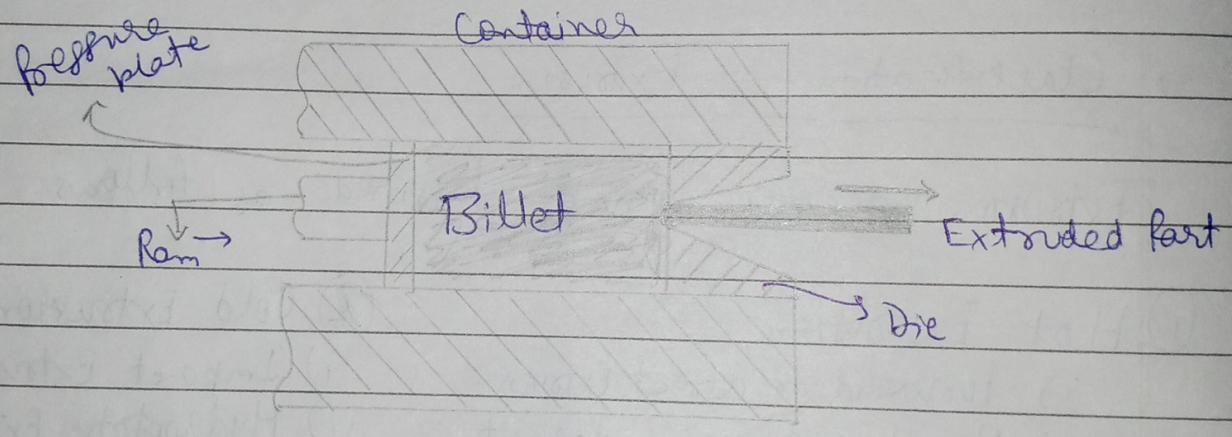
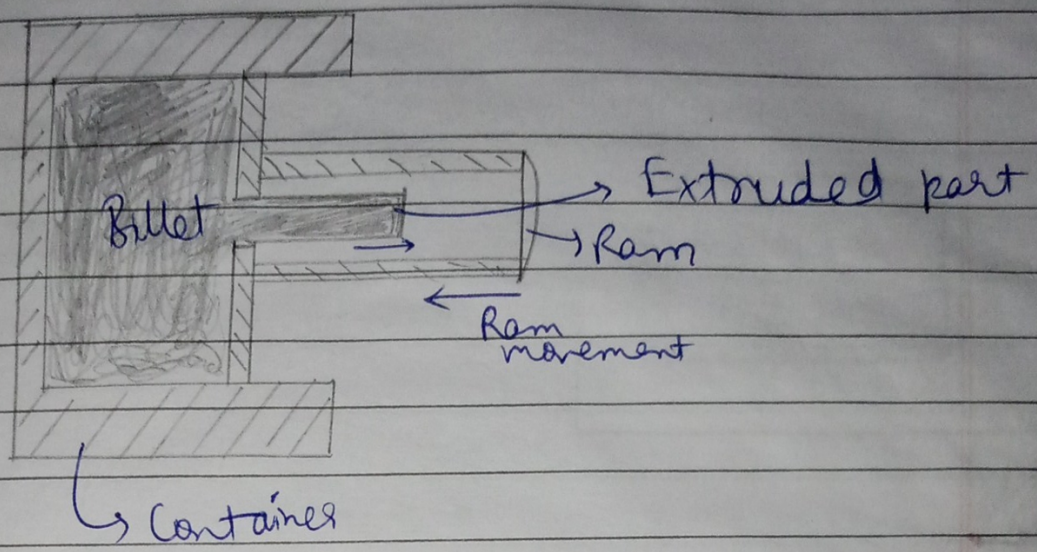


Fig. of Forward & Direct Extrusion

⇒ Backward ~~& Direc~~ or Indirect Extrusion

- A hollow ram compresses metal through a die in a direction opposite to ram motion.
- There is no relative motion b/w the billet & walls of container & friction is lower. And power required is relatively less.
- Limitation:
  Due to hollow ram, the load that can be applied is

limited & only small sections can be extruded.



→ Cold extrusion has the following advantages over hot extrusion:

- Improved mechanical properties resulting from work-hardening.
- Good control of dimensional tolerances, reducing the need for further machining or finishing operations.
- Improved surface finish, due to partly to lack of an oxide film, provided that lubrication is effective.
- No billet heating is required.
- Production rates and costs are competitive.

② COLD Extrusion

⇒ Impact Extrusion

- This process is used for soft & ductile materials operation is performed under cold condition.
- To form a component; work piece is kept on die and punch stroke the work piece is kept against the die.
- Due to application of pressure, metal extruded to the gap between punch and die opposite to punch movement and slide along side wall.
- Thin walled cans, collapsable tubes are formed by impact extrusion.

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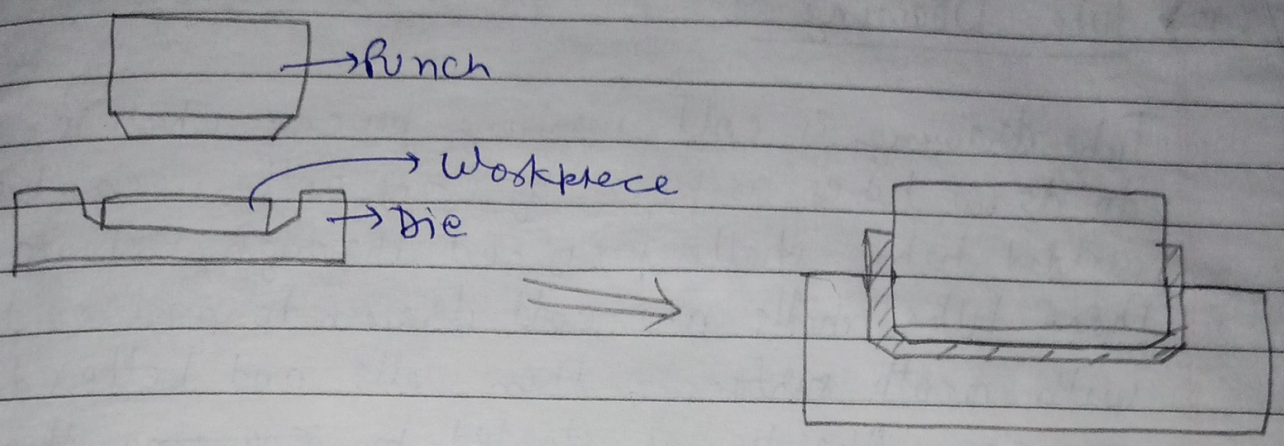
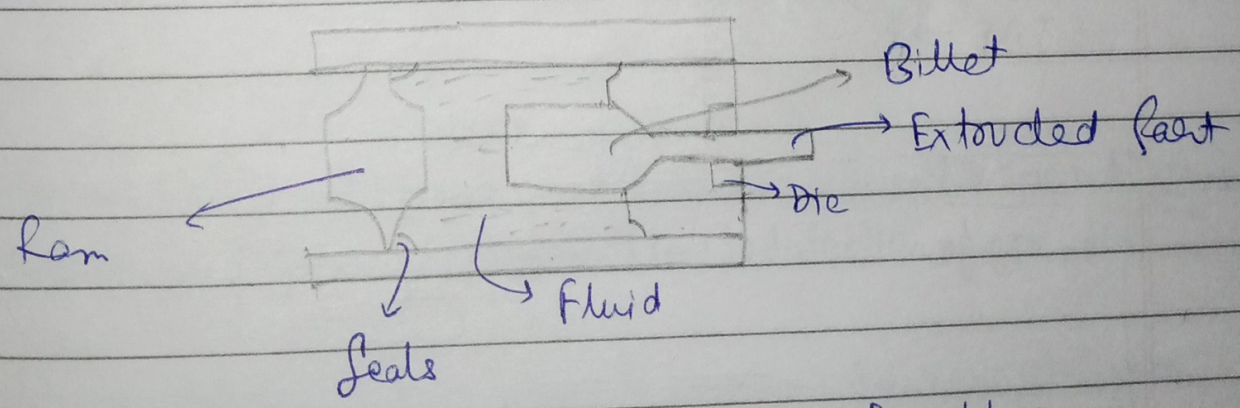


⇒ Hydrostatic Extrusion

- High pressure fluid is used to apply the force to extrude the work piece through a die.
- Friction is not present in billet, due to use of fluid which act as lubricant.



- There is no direct force b/w Ram & billet.
- There is fluid present which takes force from Ram & supplies force indirectly to billet.

Forging operations

~~Hot Working & Cold Working~~

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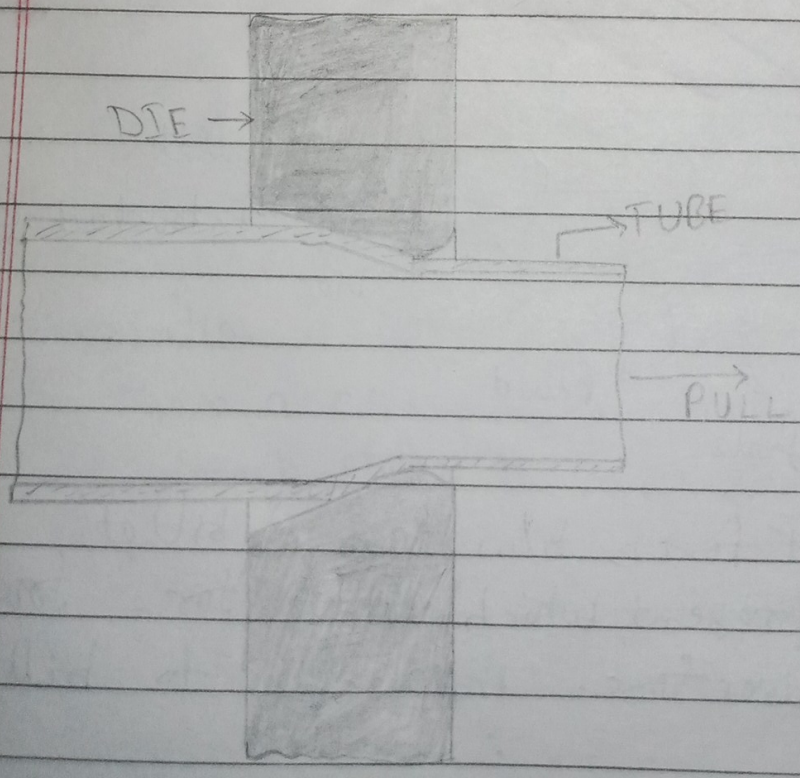
Tube Drawing (Short topic also rather than extrusion)

- Tube drawing is cold working process which is used to draw tubes or pipes by using hollow seamless and welded tube shells produced through hot working.
- These tube shells are cold drawn to produce tubes with smooth surface, thin walls and better dimensional accuracy. Operation is started by ~~swagging the~~ swaging the diameter of starting end to a smaller diameter to enable to pass ~~p~~ through die.
- After passing through the die, end is gripped in tongs and connected to draw bench for tube drawing.
- Outer diameter is controlled by die and internal diameter is controlled by internal mandrel.
- If mandrel is not used in tube drawing, then it is known as tube sinking.



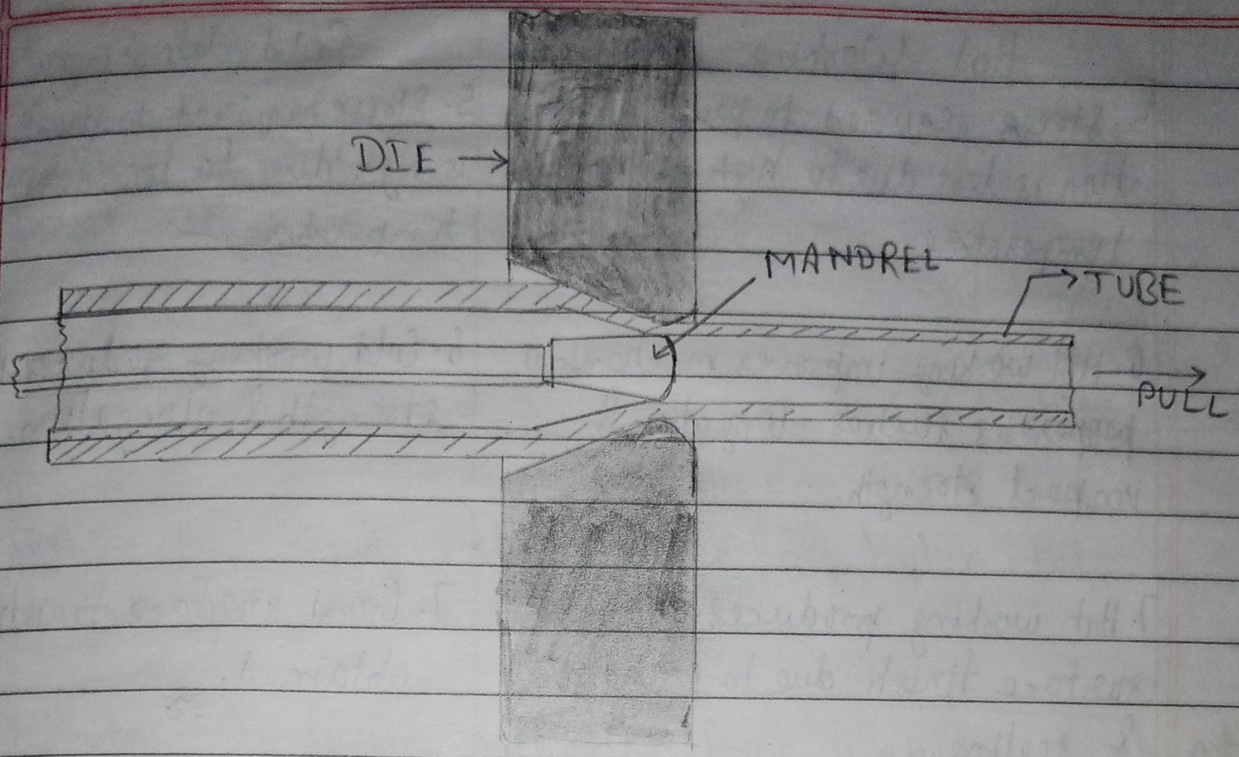


Fig. Tube Drawing with Mandrel

(100%)

V.V.imp [redacted] Hot Working V/S Cold Working (Deformation process ke andr Hot & Cold working of metal hai.)

Hot Working	Cold Working
1. Hot working is carried at a temp above recrystallization temp but below the melting point.	1. Cold Working is carried out at a temp below recrystallization temp.
2. Hot Working refines metal grains which result in improvement of mechanical properties.	2. Cold working doesn't refine metal grains & lead to distortion of grains.
3. Hardening of metal doesn't take place due to recovery & recrystallization.	3. Working below recrystallization temp induces hardness in workpiece.
4. During hot working internal or residual stresses are not developed.	4. During this process, internal or residual stresses are developed.

Hot Working	Cold Working
5. Stress required to pause deformation is less due to high deformation temperature.	5. Stress required to pause deformation is high due to low deformation temperature.
6. Hot working improves mechanical properties such as elongation & impact strength.	6. Cold working reduces impact strength & elongation.
7. Hot working produces poor surface finish due to oxidation & scaling.	7. Good surface finish is obtained.
8. It is typical to maintain closed dimension tolerence.	8. High dimensional tolerance can be maintained.
9. Existing cracks & blow holes are eliminated due to hot working.	9. In cold working, existing cracks propagates & new cracks may develop.

* Extra

Recrystallization temp = 70% MP

Above recrystallization temp fatigue happens.

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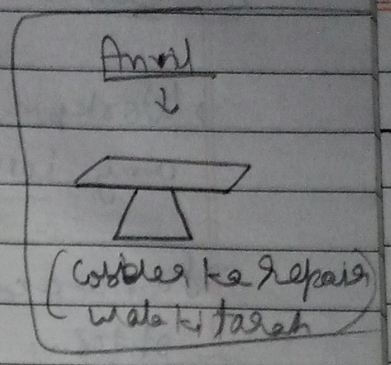
Forging Processes



→ Steps to be followed for forging:

Step1 ⇒ Heat the metal workpiece; generally in furnace.

Step2 ⇒ Keep hot metal on anvil.

Step3 ⇒ Then apply hammer force on hot metal.
→ Hence got desired shape.

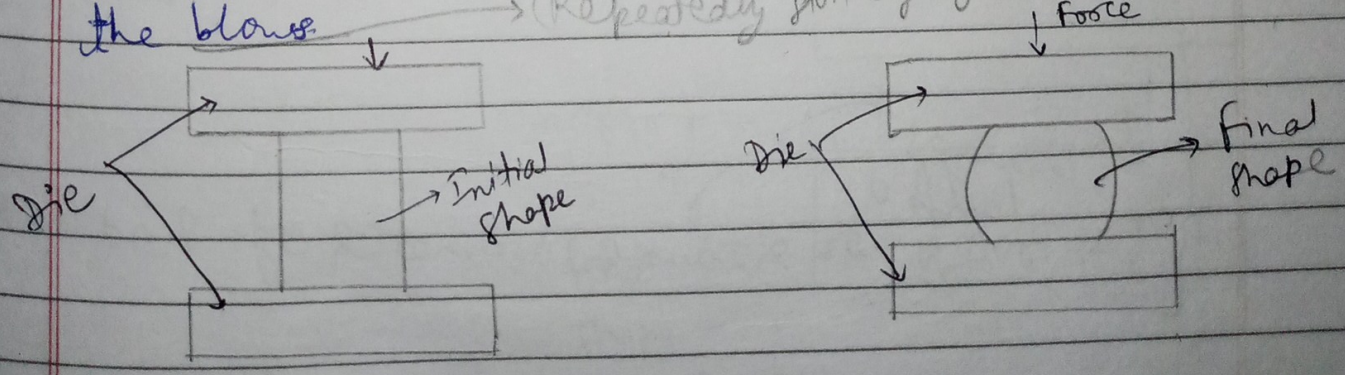
Definition: In forging operation, force is applied on heated metal manually or by means of power hammer; this applied force squeeze the metal b/w two or more dies & change the size & shape of ~~wort~~ workpiece.

⇒ Types of Forging

1. Open Die Forging

→ In this forging, metal is heated to proper temperature & impact is delievered by hammer.

→ The operators obtains desired ~~sh~~ shape by orienting & ~~positing~~ positioning the work piece b/w the blows → (Repeatedly striking of hammer)



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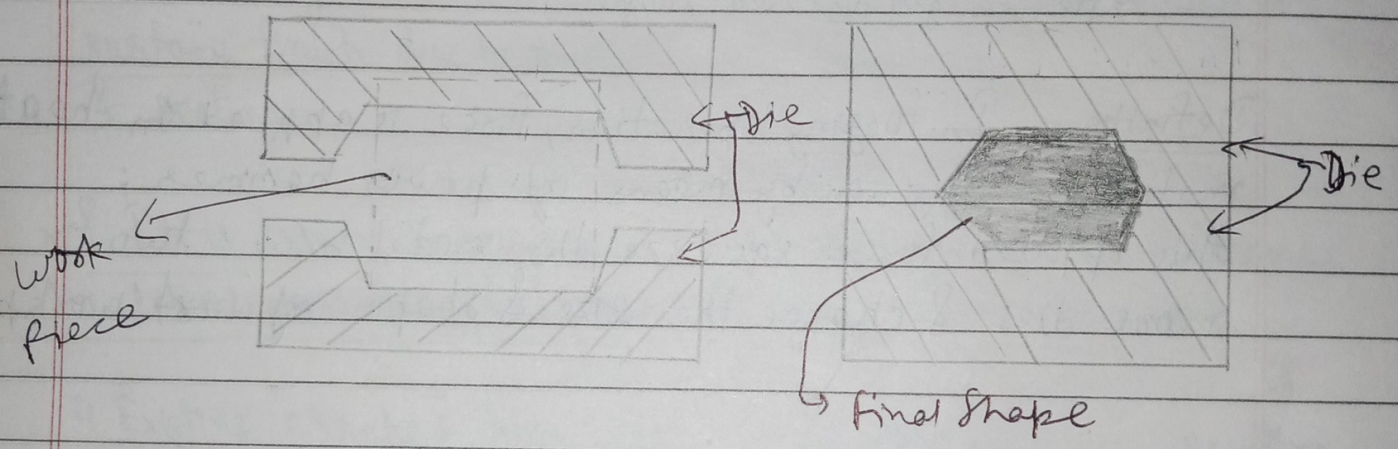
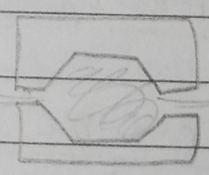
2. Closed Die Forging

→ Workpiece completely fill the die cavity without any loss of material.

→ So, accurate workpiece sizing is required to obtain forging of desired dimension & tolerence; proper die design are required.



(Extra: Impression die forging



→ Leak (called flash)

4. Press die forging

(continuous force (single hammer then desired shape)

5. Swaging die forging

→ Process to reduce diameter of rod or tube)

Forging Operations

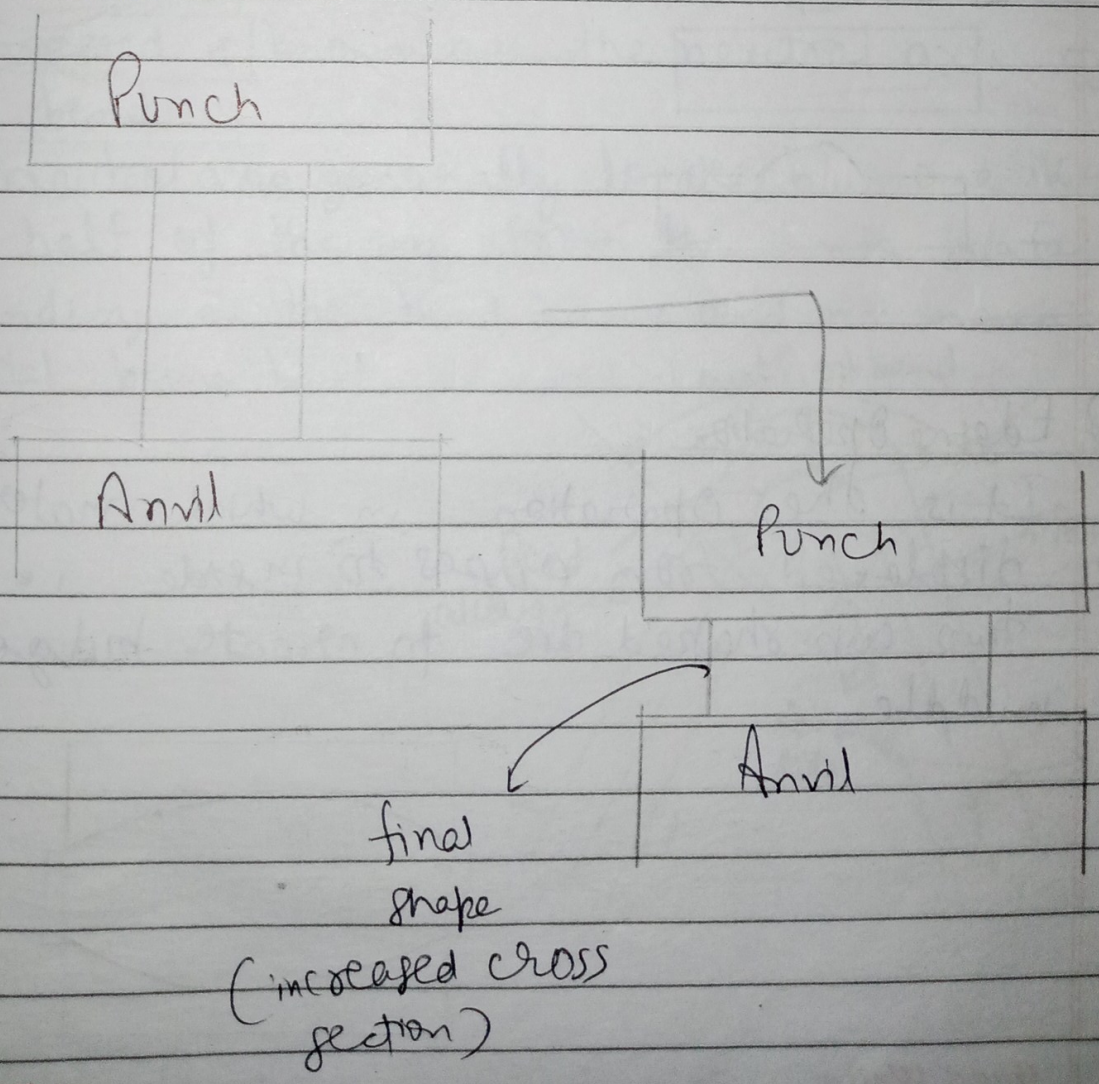
① Drawing Out

The operation in which cross section area reduces & length of stock increases is known as drawing out operation.

(Stock = billet)

② Upsetting Out

The operation in which cross section area increases & length of ~~billet~~ stock reduces is known as upsetting operation.



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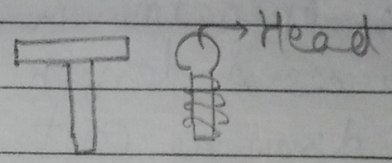
(3) Heading operation

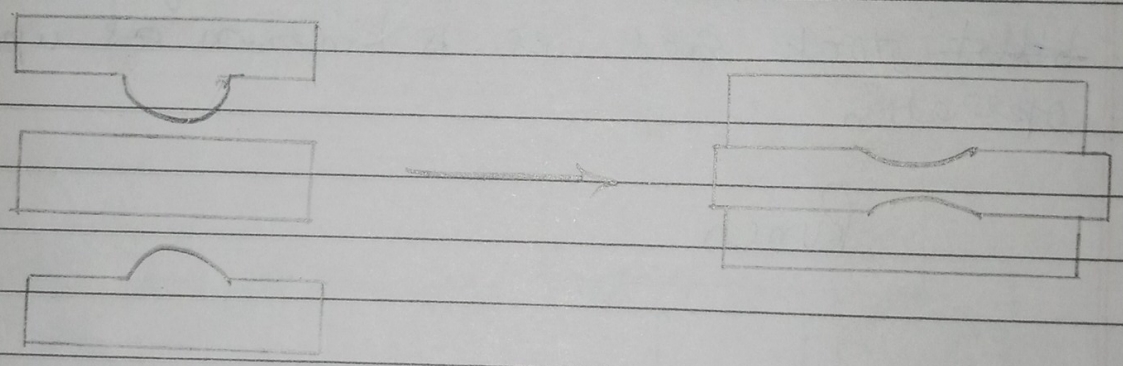
→ Heading operation is done at one end of the stock to produce large cross section.

→ Head of bolts, nails & screws are formed by heading operation.



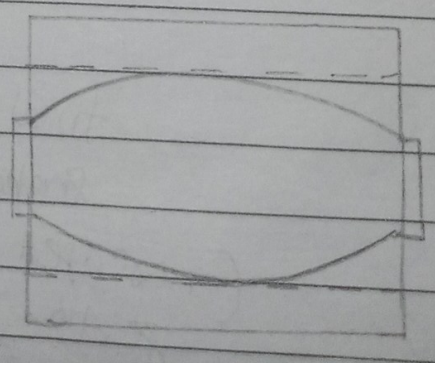
(4) Fullering Operation

It is the operation of displacing the metal away from centre to reduce thickness in middle & increase the length.



(5) Edging Operation

It is the operation in which material is displaced from edges to inside i.e. b/w two cup shaped die to create bulge in the middle.



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(6) Bending Operation

→ In bending operation; dies are shaped to produce directional change in the workpiece.

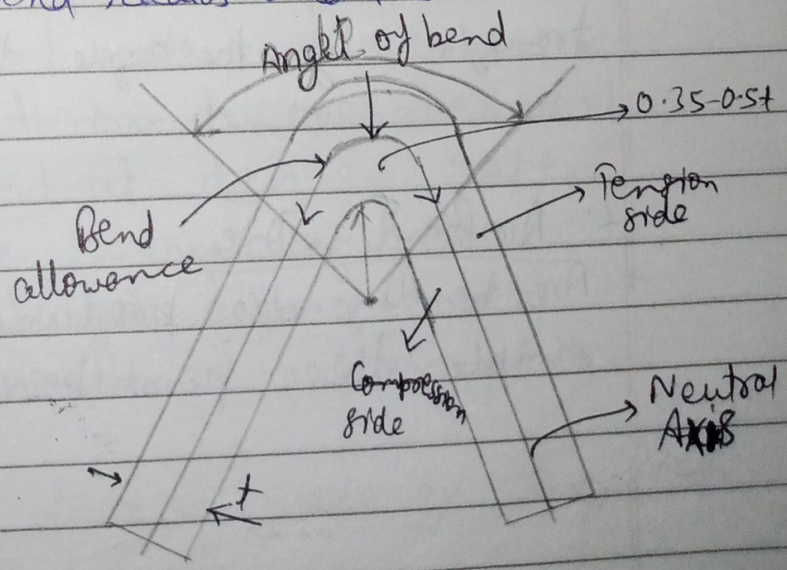
→ Bending is the plastic deformation of metals about a linear axis with little or no change in the surface area.

→ The bars, rods, wires, tubes & sheet metal may be bent to many shapes in the cold condition with the help of dies.

→ When the metal is bent beyond the elastic limit, the metal on the outside is stretched (tensile stress) while that on the inside is compressed.

→ The location that is neither stretched nor compressed is known as the neutral axis of the bend.

→ The neutral axis generally locates b/w one third or one half of the way from the inner surface, depending on the bend radius and the ~~meant~~ material being bent.



- Spring Back

→ Because all materials have a finite modulus of elasticity. Plastic deformation is followed by some elastic recovery when the load is removed. This recovery is called spring back.

→ The final bend angle is smaller after spring back.
→ Spring back is usually compensated for by over bending the part.

- Bending Dies

1. V-Die

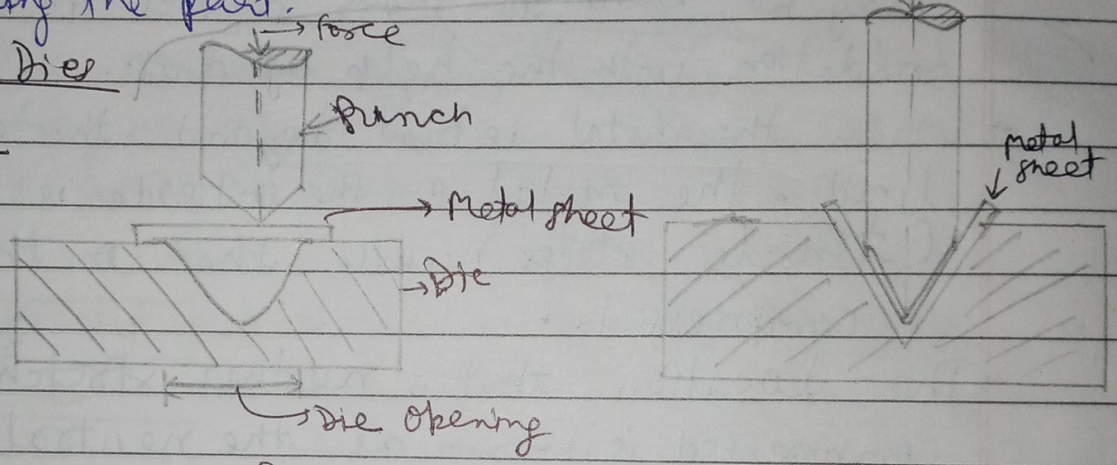


Fig. V Die

→ V dies are used in angle bending.
→ Metal sheet is placed between punch & die and then punch is pressed against the die and transferring the angle to the sheet.

2. Air Bending Die

→ Air bending die produces the geometry by simple three point bending.

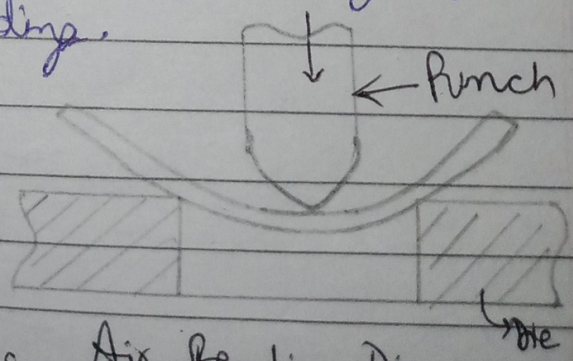


Fig. Air Bending Die

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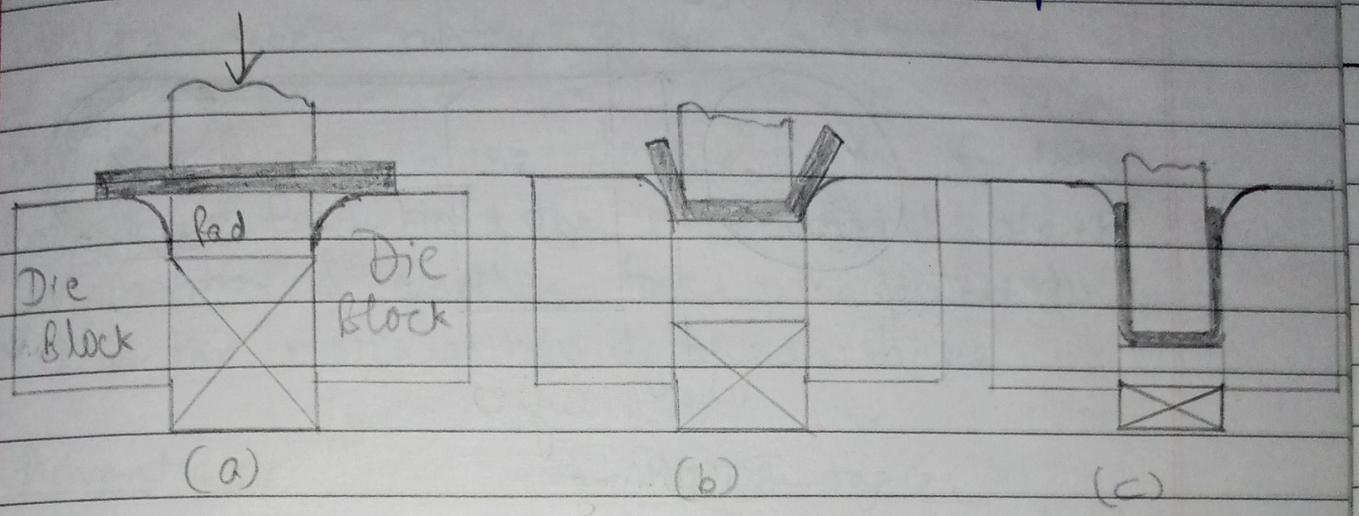
3. U - Die

U-die is used to bend the sheet in U shape.



Wire Drawing

→ Wire Drawing is a process in which rod or wire of large diameter passed through conical die to obtain wire.

→ At the start of wire drawing the front end of the ~~door~~ rod or wire is pointed by cutting or squeezing so that it can freely enter through die opening.

→ This end is ~~cooled~~ pulled through the die to obtain sufficient length; so that wire can be attached ~~throw~~ to operated reel.

→ Reel is then rotated at desired rate to draw the wire through the die to reduce the large diameter into very thin wire. operation is performed in no. of passes.

→ Contact region of die are made of tungsten carbide or diamond.

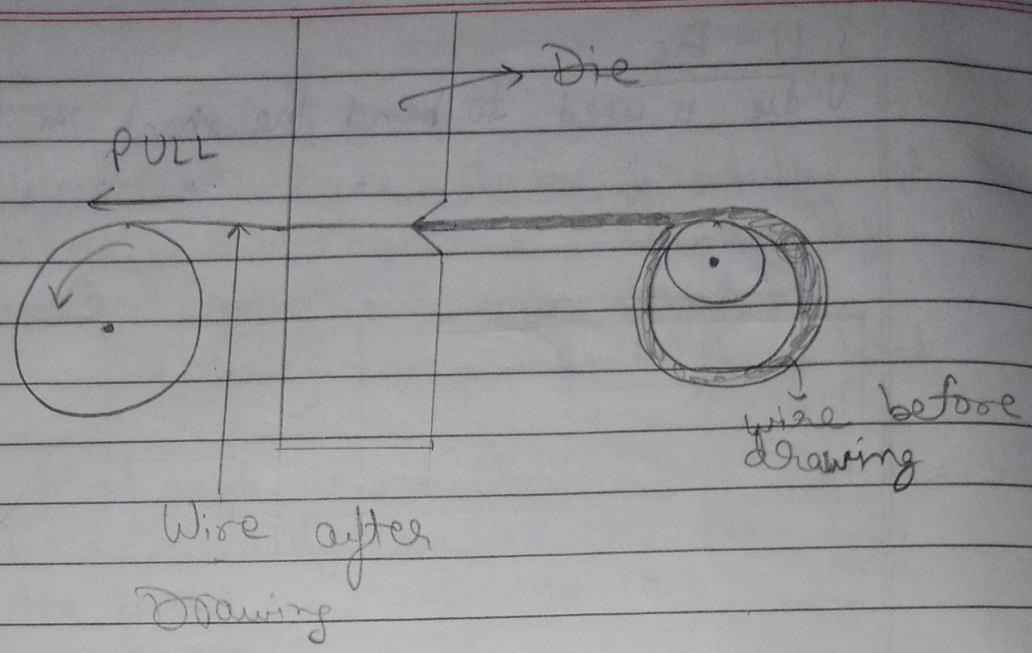


Fig. Wire Drawing

Deep Drawing

→ Deep drawing is used to form containers or objects with depth. It is plastic deformation in which flat sheet or plate is formed into 3-D parts with depth several times the thickness of metal.

→ The process is accomplished with use of hydraulic or mechanical press.

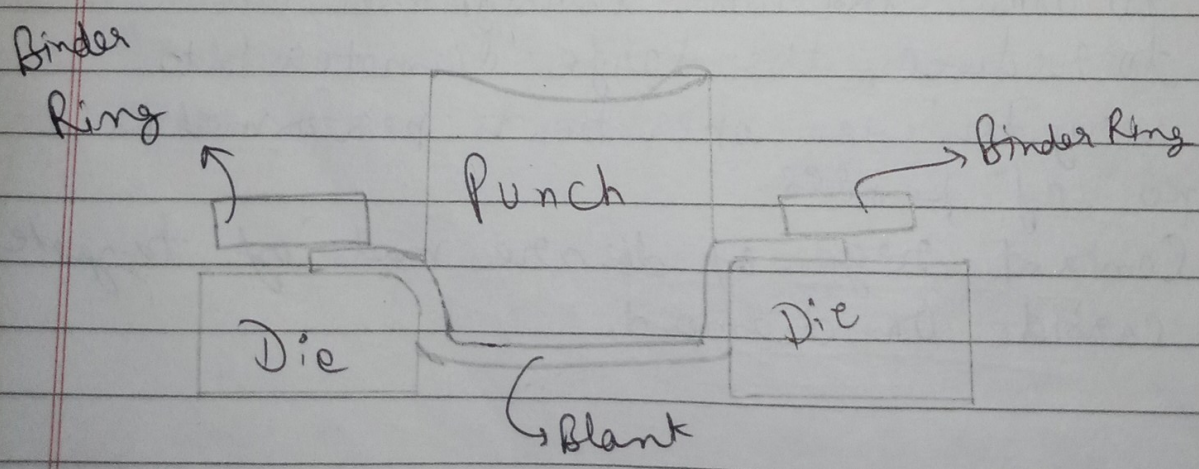


Fig: Deep Drawing

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→ The process begins with flat sheet metal blank held on upper surface of die.

→ This process require double action force.
→ One force ~~fold~~ hold the sheet metal blank in position & another force, the punch to draw the material into desired shape.

Advantages	Disadvantages
i) Production of shallow or deep parts	i) High cost of tools used in deep drawing.
ii) High production rate.	

Rolling of metals

→ Rolling is the process of reducing the thickness or changing the cross section of long work piece by applying compressive forces through set of rolls.

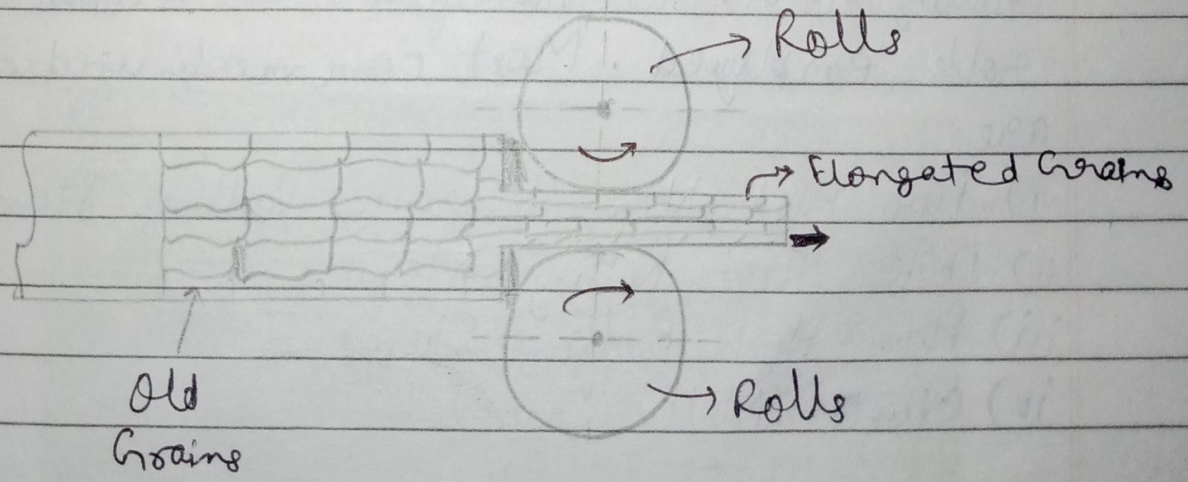


Fig. Rolling of metals

Principle of Rolling

In the process of rolling, stock enters the rolls with a speed less than ~~peripehral~~ peripheral roll speed. The metal emerges from the roll travelling at higher speed than it enters. At a midway b/w A & B metal speed is same as the roll peripheral speed.

(Quantity entered) (Quantity exit)

$$Q_1 = Q_2$$

$$A_1 V_1 = A_2 V_2$$

$$\boxed{\frac{A_1}{A_2} = \frac{V_2}{V_1}}$$

where Q_1 → Quantity of metal going into roll
Q_2 → Quantity of metal leaving the roll
A_1 → Area of element in front of roll
A_2 → Area of element after the roll
V_1 → Velocity in element before roll
V_2 → Velocity in element after roll

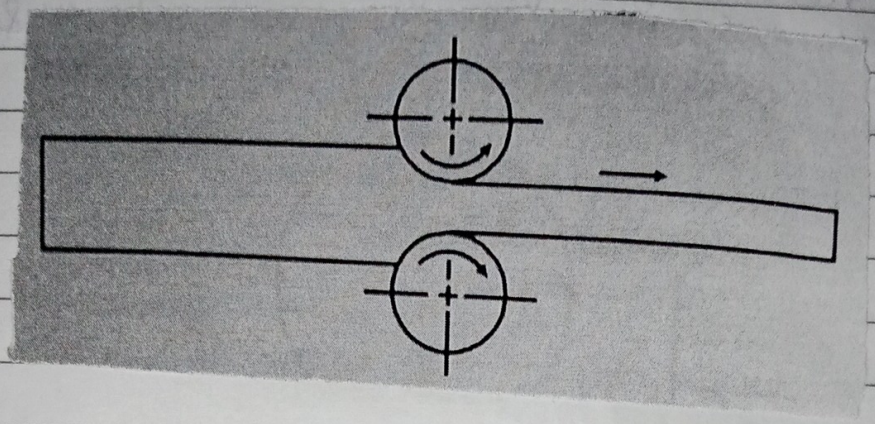
Arrangement of rolls in rolling mills are called rolling stand. Their names are based upon number of rolls employed. Most commonly used arrangements are:

i) Two High Non-Reversing Rolling Stand
ii) Three High Rolling Stand
iii) Four High Rolling Stand
iv) Cluster Mill

i) Two High Non-Reversing Rolling Stand

It has two rolls positioned with one roll directly above the other. The rolls are supported in bearings

and always move in only one direction. The upper roll may be raised or lowered to adjust the distance between the rolls.



ii) Three High Rolling Stand

Three high rolling stand are used to eliminate the need of reversing the rolls. In this arrangement, workpiece is feed in b/w upper & middle rolls in a direction opposite to the direction of feeding of workpiece b/w lower & middle rolls, resulting in high rate of production.

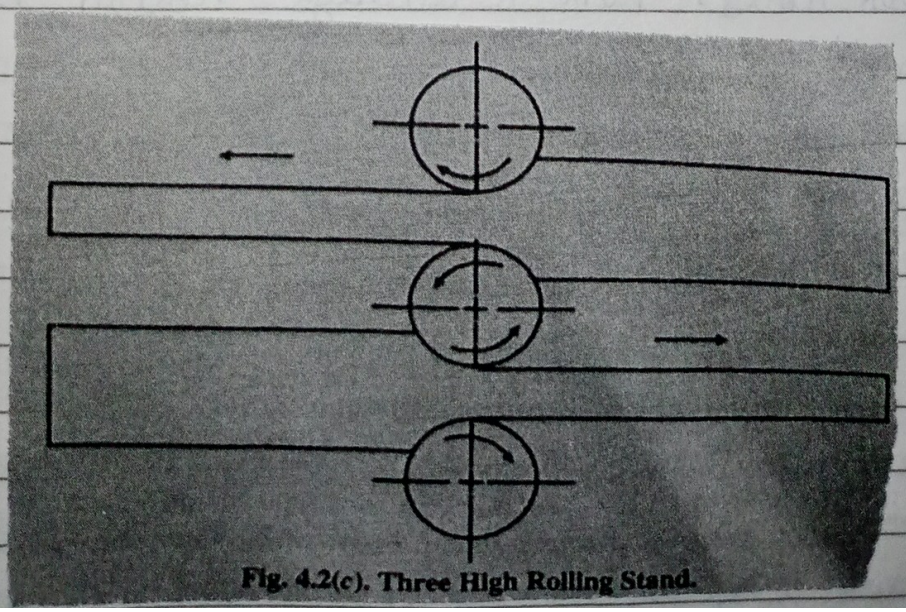


Fig. 4.2(c). Three High Rolling Stand.

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iii) Four High Rolling Stand

In four high rolling stand, back up rolls provides the necessary rigidity to smaller rolls and prevent their deflection. It is used for hot & cold rolling of wide plates and sheets.

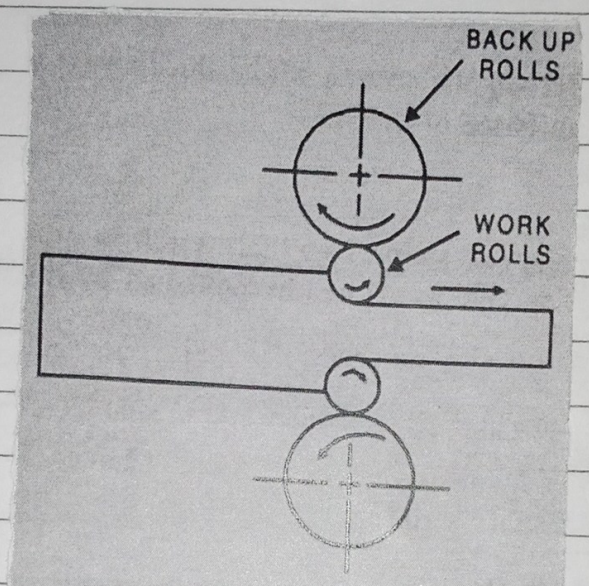

Fig. 4.2(d). Four High Rolling Stand.

iv) Cluster Mill

~~In four h~~ It consists of two to work rolls of smaller ~~distance~~ diameter and four or more backup rolls. Backup rolls support the smaller work rolls. Foil is always rolled on cluster mills.

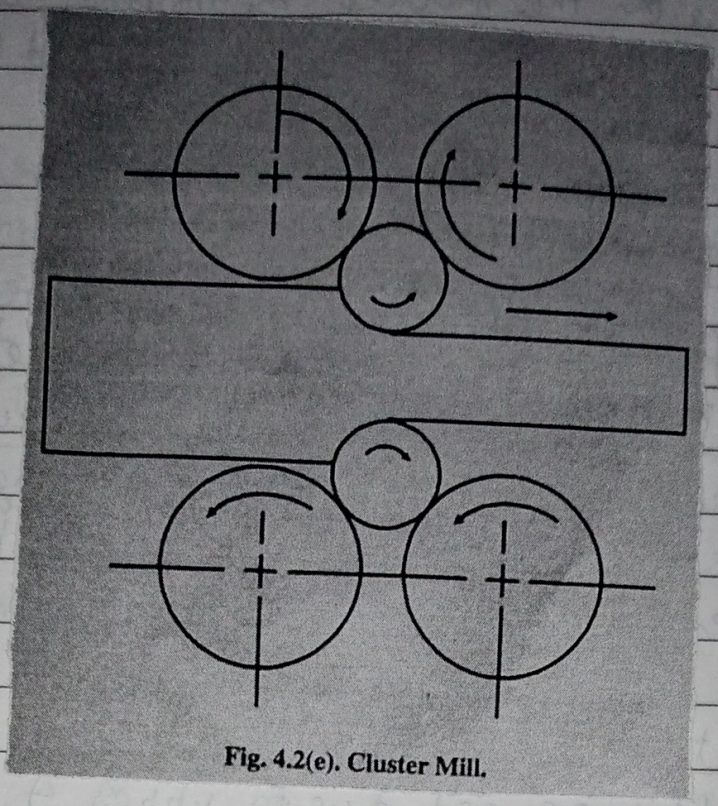

Fig. 4.2(e). Cluster Mill.

Forging Defects

Main causes due to which defect occur in forgings are improper heating, incorrect die design, uneven cooling of stock, defect in the original metal, improper forging operation, incorrect forging conditions, etc. Some common defects found in forgings are:

i) Cold Shuts

Cold shuts are short cracks. They are caused due to folding of metal surface against itself during forging. It can be avoided by rounding the sharp corners

ii) Pitting

Pitting is caused by scales which is not completely removed ~~from~~ from the die cavities and is worked ~~into~~ as the surface of the forging. Scale produces shallow

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depressions on the surface of forging. It can be avoided by cleaning of dies and proper control of forging temperature.

iii) Incomplete Filling of Dies

This defect occurs due to incomplete filling of closed impression die cavity. It occurs due to many reasons such as poor forging design, wrong amount of stock, incorrect die design, poor heating of metal, insufficient no. of blows during forging, etc.

iv) Die Shift

Die shift is caused due to upper & lower die misalignment. This defect is caused due to ~~loss~~ loose wedges. So wedges should be rigidly fixed.

v) Fins & Rags

Fins & Rags are small projections or pieces of loose metal driven into the surface of forging. To control this defect; proper die design is required.

vi) Burnt & Overheated Metal

This defects occurs when the metal is heated for too long time or at too high temperature. Proper heating to control this defect.

vii) Cracks

Both transverse & longitudinal cracks occur on forging surface. It occurs due to improper heating of forgings, bad quality of ingot & improper cooling of alloy

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steels.

viii) Flakes

Flakes are internal breaks and ruptures caused due to rapid cooling ~~to~~ of forging. To remove this defect proper cooling is required.

ix) Hair Line Cracks

They are very fine cracks on the surface of the forgings caused due to rapid cooling of forging & defective metal piece.

x) Dents

Dents are produced due to ~~carles~~ careless working.

□ Rolling Defects

Various defects found in rolling products are:

i) Surface Defects

Various surface defects are scale, cracks, scratches, pits and rust. These defects occur due to:

ⓐ Impurities and inclusions in the billet.

ⓑ Improper conditions related to material preparation & rolling operation.

ii) Internal Structural Defects

Various structural defects are:-

(a) Wavy Edges : This defect is caused by roll bending. Due to bending of rolls, the edges of the strip are compressed more than ~~cord~~ central

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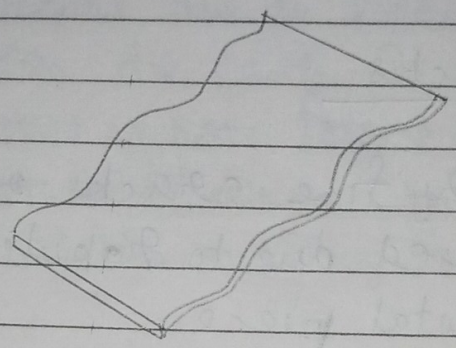
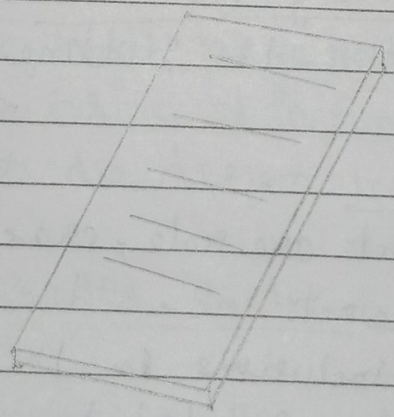
portion resulting in more elongation of strip at edges than at centre.

But to maintain the continuity of material edges are restrained from expanding freely in longitudinal direction leading to wavy edges.



(b) Zipper Cracks

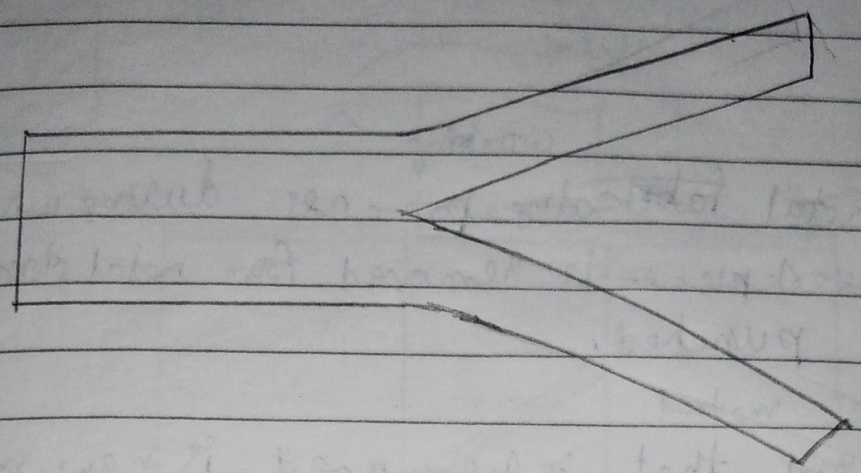
Zipper crack occur at the centre of sheet due to roll bending and poor ductility of material at rolling temperature.



(c) Alligatoring

→ It is encountered due to non uniform deformation during rolling or due to presence of defect in billet.

→ In alligatoring the sheet splits along a horizontal plane and follows the path of their respective rolls.



(d) Folds

Folds occur during plate rolling due to very small reduction per pass.

2 marks
note: Difference b/w Blanking & Punching

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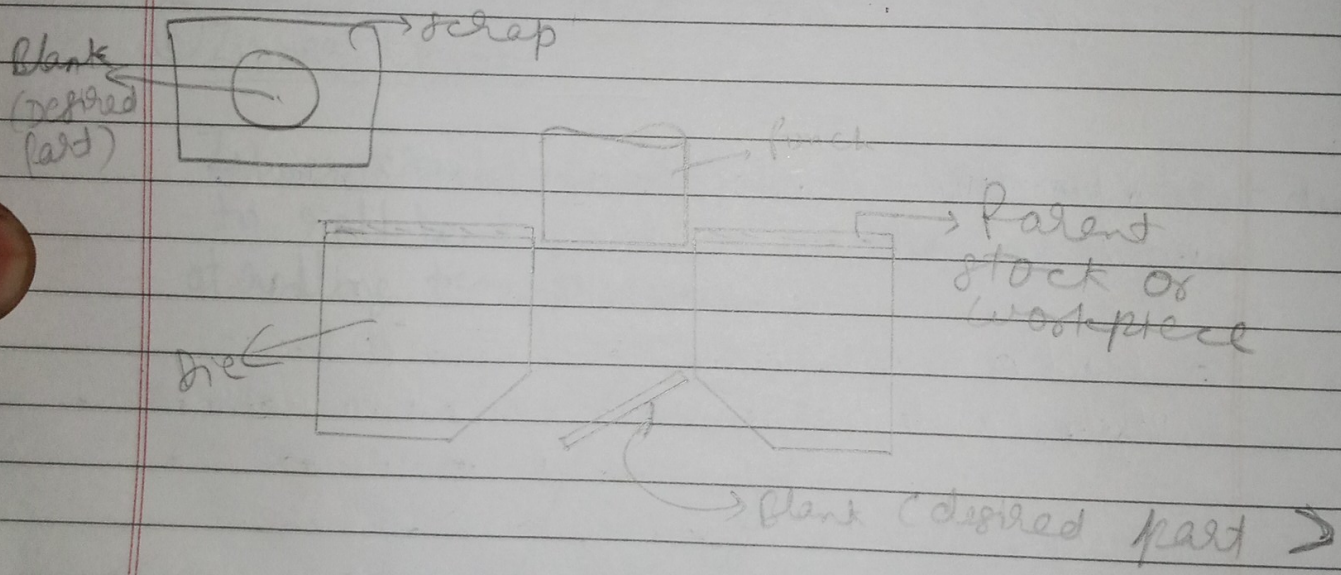
Sheet metal Operations

① Blanking

→ It is a metal ~~fabricating~~ working process during which a metal workpiece is removed from metal strip or sheet then it is punched.

→ The ~~material~~ metal that is removed is new ~~matter~~ metal workpiece

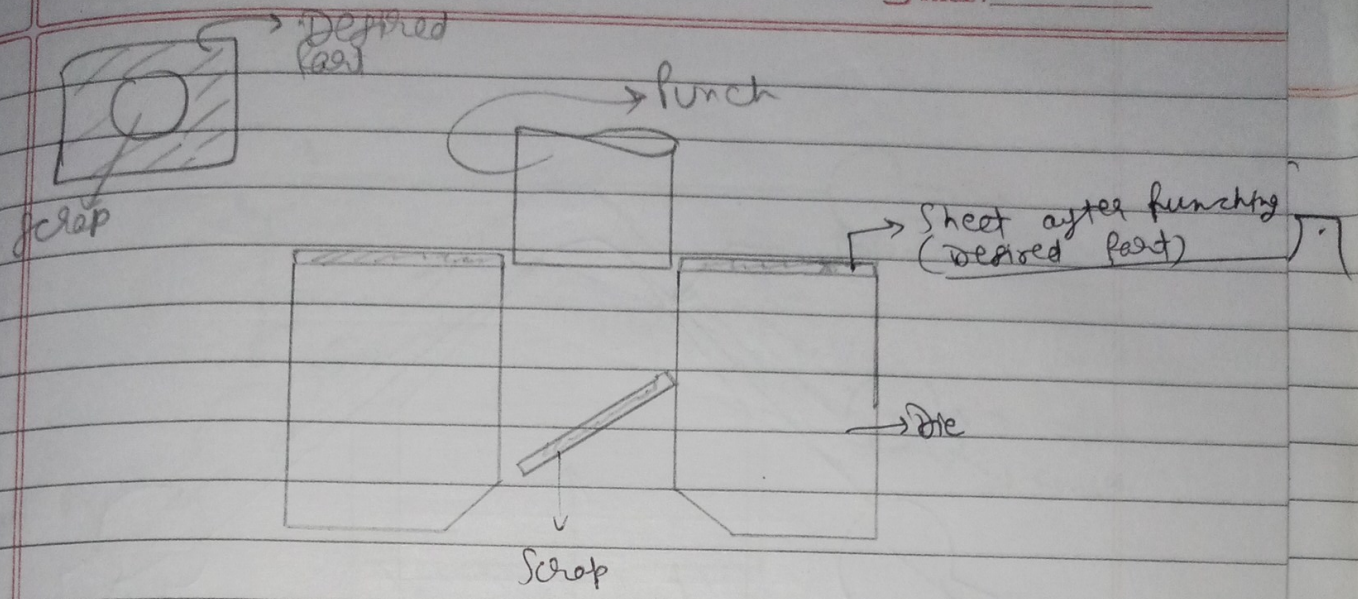
→ Primary workpiece is scrap & punched part is desired new metal workpiece.



② Punching

→ In this process, the punched out part is scrap & primary sheet left after punching is useful part.

→ It is used for cutting holes, slots in sheet metal plates or parts.



Stretch Forming

→ It is the process of producing contoured parts by stretching metal sheets over a shaped form block.

→ Stretch forming strains the metal beyond the elastic limit, to give the workpiece a permanent set.

→ Two methods are used in stretch forming. They are:
i) Form Block Method.
ii) Movable Jaws Method.

• Form Block Method

In this method, grips are stationary and the form block moves upward to provide the necessary tension and motion. Fig. 28.35

Piercing ; छेद करना in workpiece & give shape other than circle

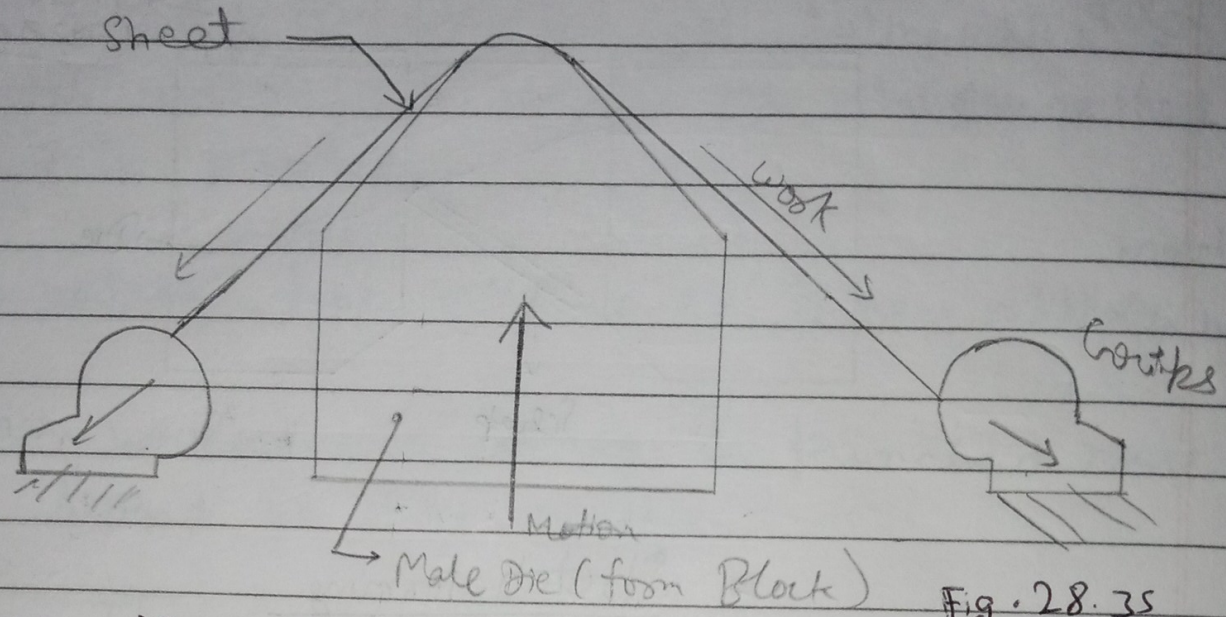


Fig. 28.35

- **Movable Jaws Method**

In this method; the ~~jaw~~ jaws first stretch the work and then wrap it around the form block. In this machine; the jaws can be easily and rapidly positioned in close proximity to form block edges to eliminate ~~excessive~~ excessive material waste.

→ This method has the advantage over other forming methods as spring back is either greatly reduced or completely eliminated, since direct bending stresses are never introduced. So, all of the plastic deformation.

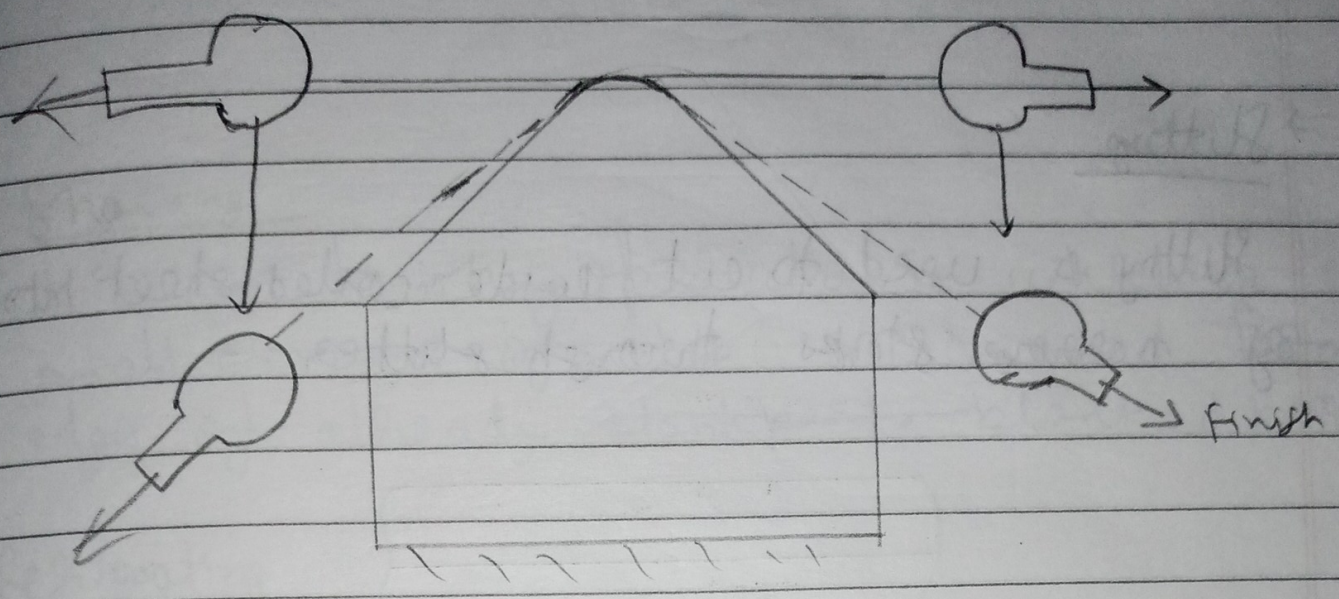
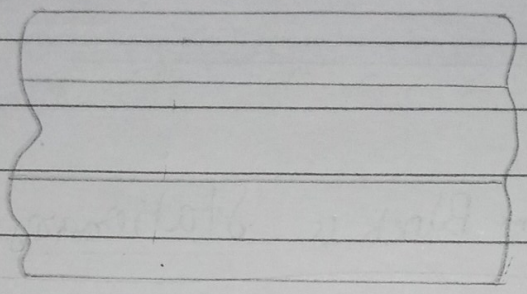


fig. Form Block is Stationary

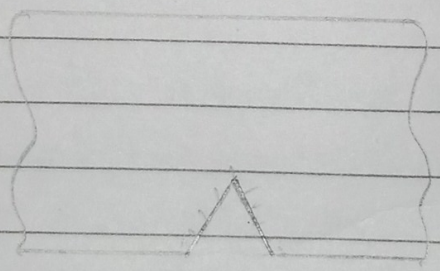
→ Slitting

Slitting is used to cut wide coiled sheet into no. of narrow strips through slitter



→ Notching

In this operation, a specified portion of metal toward end of stock is removed.



→ Trimming

→ In trimming operation, small amount of unwanted material known as flash is removed.

→ Flash is generally formed during die casting & drop forging.

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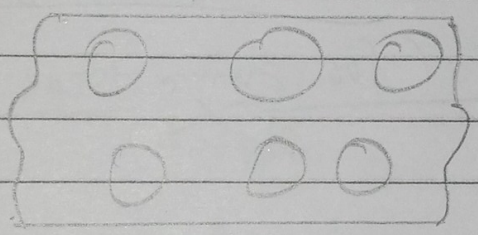
⇒ Shaving

It is a finishing operation in which a small amount of metal is removed from edge of already ~~blank part.~~ blanked part.

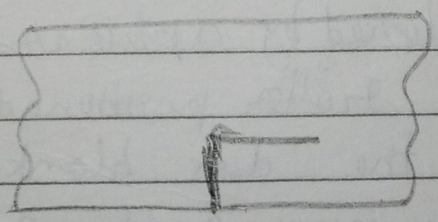
⇒ Perforating

In this operation, large no. of closely spaced holes are produced; these holes are ~~identical~~ identical & arranged in regular pattern.



⇒ Lancing

It is a cutting operation that forms a line cut in the metal.

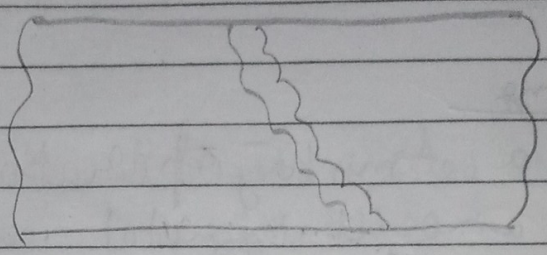


⇒ Nibbling

It is used to remove the metal in small increments. In this operation, contour is cut out from sheet metal by producing a

Good Write

series of overlapping slit or notches either from outer boundary or from punched holes.



→ Design named is contour

• Metal Spinning

(for symmetrical round or cylindrical object)

→ Metal spinning or spin forming is a metal working process that transform a flat circular blank or disk shaped workpiece into axially symmetrical round shapes.

→ It is accomplished by application of lateral force by a roller positioned against the surface of the disk blank and a mandrel that is spinning on its axis at high speed.

→ The Mandrel serves as support for the workpiece and help in giving its final shape.

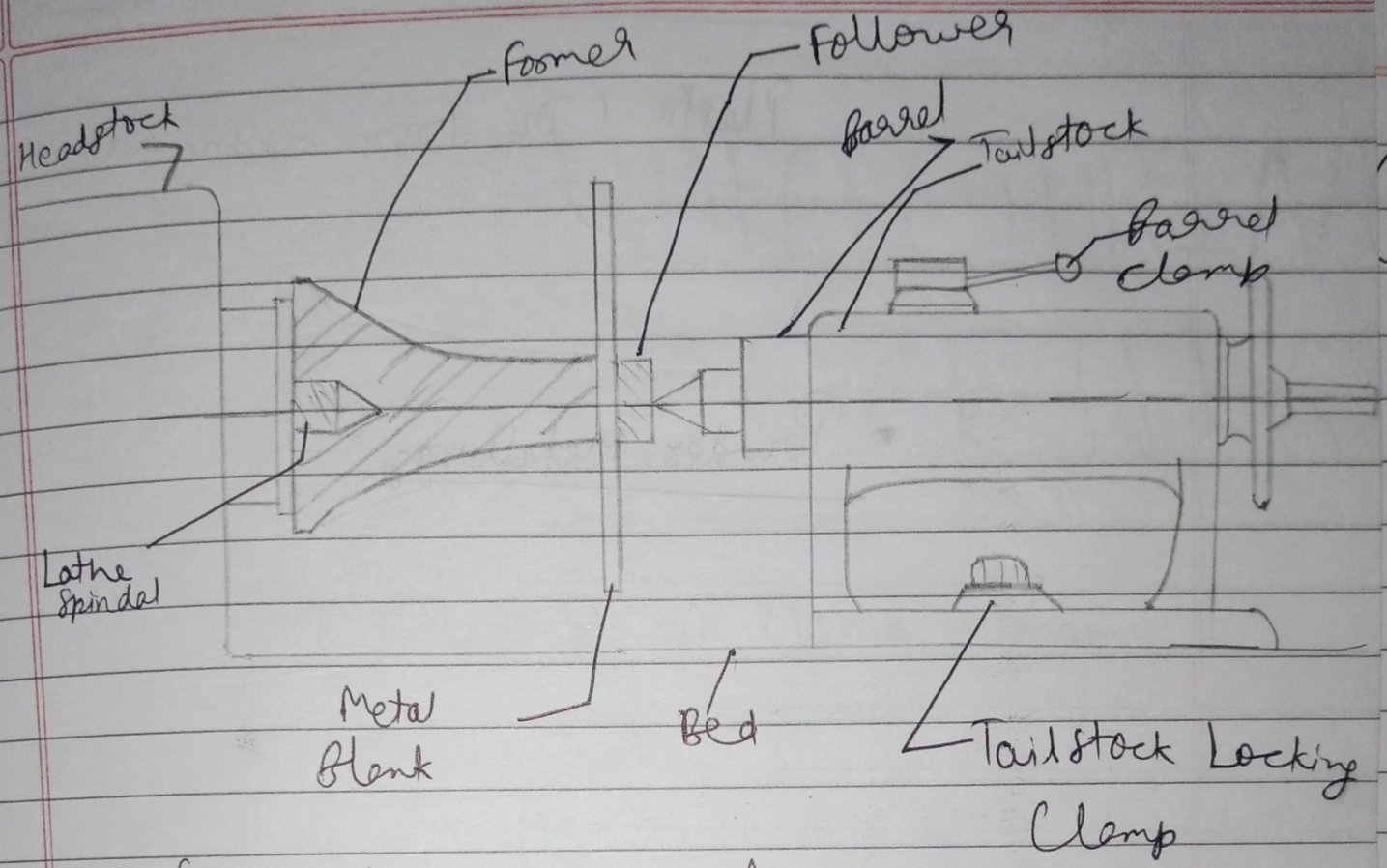


fig. Metal Spinning Machine