UNIT – 3

METAL FORMING PROCESS

FUNDAMENTALS OF METAL FORMING

There are four basic production processes for producing desired shape of a product. These arecasting, machining, joining (welding, mechanical fasteners, epoxy, etc.), and deformation processes. Casting process exploit the fluidity of a metal in liquid state as it takes shape and solidifies in a mold. Machining processes provide desired shape with good accuracy and precision but tend to waste material in the generation of removed portions. Joining processes permit complex shapes to be constructed from simpler components and have a wide domain of applications.

Deformation processes exploit a remarkable property of metals, which is their ability to flow plastically in the solid state without deterioration of their properties. With the application of suitable pressures, the material is moved to obtain the desired shape with almost no wastage. The required pressures are generally high and the tools and equipment needed are quite expensive. Large production quantities are often necessary to justify the process.

To understand the forming of metal, it is important to know the structure of metals. Metals are crystalline in nature and consist of irregularly shaped grains of various sizes. Each grain is made upof atoms in an orderly arrangement, known as a lattice. The orientation of the atoms in a grain is uniform but differs in adjacent grains. When a force is applied to deform it or change its shape, a lotof changes occur in the grain structure. These include grain fragmentation, movement of atoms, andlattice distortion. Slip planes develop through the lattice structure at points where the atom bonds ofattraction are the weakest and whole blocks of atoms are displaced. The orientation of atoms, however, does not change when slip occurs.

To deform the metal permanently, the stress must exceed the elastic limit. At room temperature, the metal is in a more rigid state than when at higher temperature. Thus, to deform the metal greater pressures are needed when it is in cold state than when in hot state.

When metal is formed in cold state, there is no recrystallization of grains and thus recovery from grain distortion or fragmentation does not take place. As grain deformation proceeds, greater resistance to this action results in increased hardness and strength. The metal is said to be strain hardened. There are several theories to explain this occurrence. In general, these refer to resistance build up in the grains by atomic dislocation, fragmentation, or lattice distortion, or a combination of the three phenomena.

The amount of deformation that a metal can undergo at room temperature depends on its ductility. The higher the ductility of a metal, the more the deformation it can undergo. Pure metals can withstand greater amount of deformation than metals having alloying elements, since alloying increases the tendency and rapidity of strain hardening. Metals having large grains are more ductile than those having smaller grains.

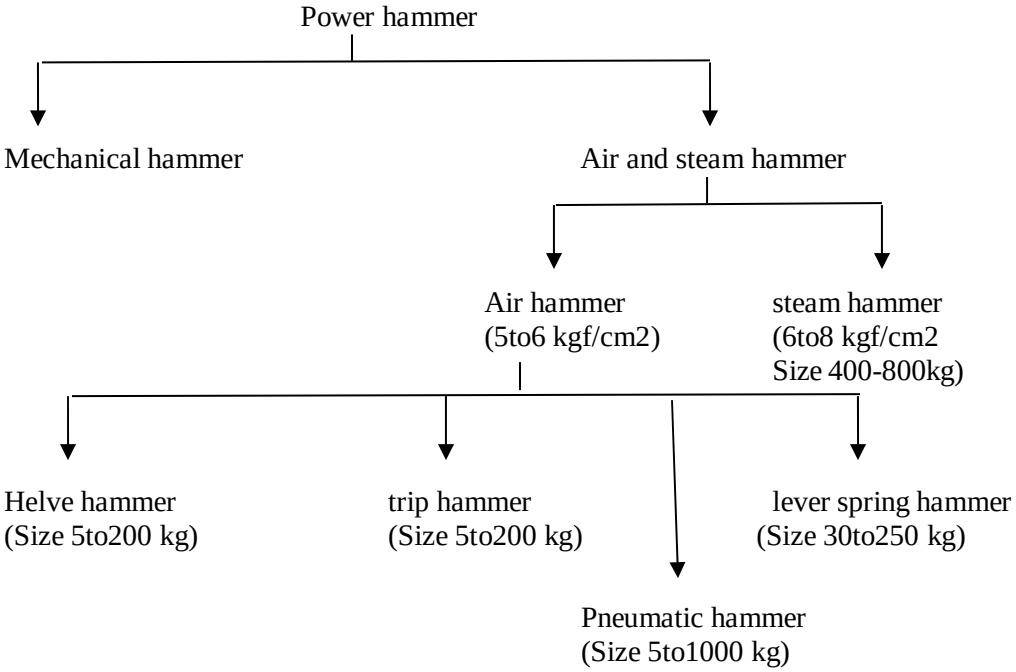
When metal is deformed in cold state, severe stresses known as *residual stresses* are setup in the material. These stresses are often undesirable, and to remove them the metal is heated to some temperature below the recrystalline range temperature. In this temperature range, the stresses are rendered ineffective without appreciable change in physical properties or grain structure.

1. Compare hot rolling and cold rolling

hot rolling	cold rolling
1. working above recrystalizationtemperature 2. new crystal are formed after hot worked 3. harden the metal 4. impurities are removed from the metal 5. elongation of metal takes place. 6. large size metals also deformed 7. surface finish is not good 8. internal stress is not formed 9. blowholes, cracks get welded during hot working	1. below recrystalization temperature 2. no recrystalization 3. no hardening 4. impurities are not removed 5. elongation decreases 6. limited to size 7. good surface finish can be obtained 8. stress formation in the metal will occur 9. ductility is obtained during cold working and it is useful for machining process

2. what are the types of power hammers available and explain the pneumatic hammer with aneat sketch or Classify the types of forging machines.

Types of power hammers the various types of hammers are used to perform forging operations they are

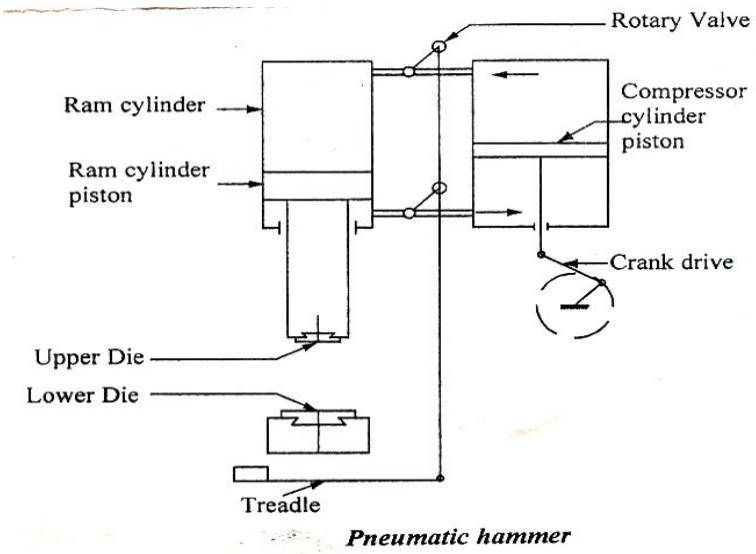


Pneumatic hammer:

The pneumatic hammers are having two cylinders.

1. Compressor cylinder
2. Ram cylinders

In these types of hammers, the compressor cylinder compresses the air and delivers it to the ram cylinder this compressed air pressure is used to actuate the ram cylinder piston. The blows range in the pneumatic hammer varies from 70 to 190 blows/min



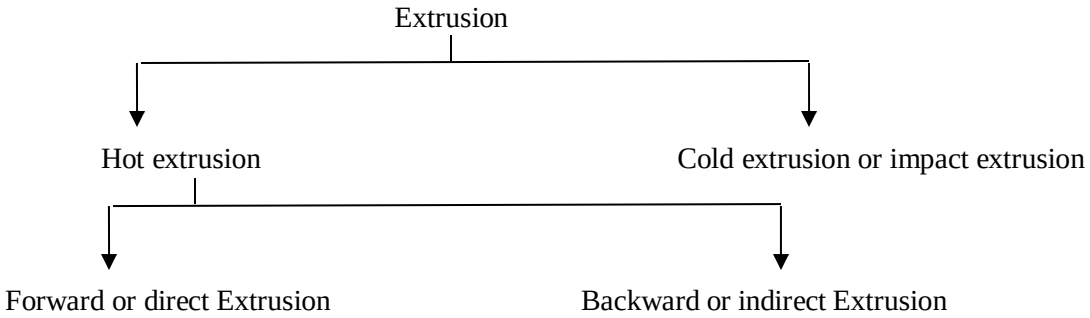
Pneumatic hammer

The weight the pneumatic hammer varies from 50 to 1000 kg. The compression of the reciprocating cylinder is obtained by crank drive and the crank is operated by a reduction gear drive. The reduction gear drive is operated by motor.

The air distribution is made by rotary valves with ports, so, the air passes through the cylinder above and below the piston while operating the pneumatic hammers.

3. Classify the extrusion processes and describe any two.

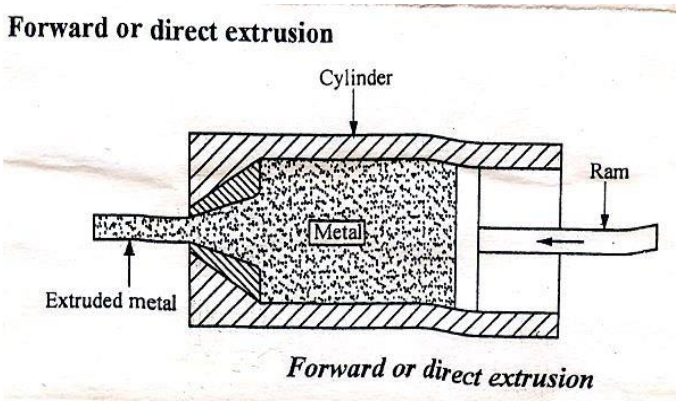
Types of extrusion



The hot extrusion process is classified into two types.

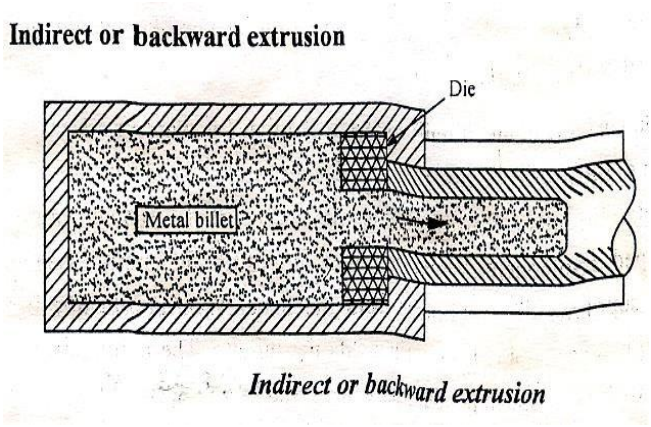
- Forward or direct extrusion
- Backward or indirect extrusion

1. Forward or direct extrusion



- The forward or direct extrusion process is explained by using the above fig.
- Then the heated billet metal is placed in a press, which is operated by the ram and a cylinder.
- The heated metal billet is pushed by the ram and with the application of ram pressure themetal first plastically fills the die.
- Then it is forced act through the die opening and finally cut at the die face.

2. Indirect or backward extrusion



- In that extrusion process, the extruded part is forced through the hollow ram
- The ram is operated by horizontal hydraulic drive.
- Working principle of this process is that, the heated metal is placed in the die and the forceis applied by the power operator hollow ram.
- The extracted metal is a pass through the hollow ram and it requires less force compared inthe direct extrusion.

4. With the aid of neat sketches explain the wire drawing process. Wire drawing process

- The diameter less than 16mm has drawn in the force form of wire coil.
- Initially the point of the wire is sized so it is freely enter into the die.

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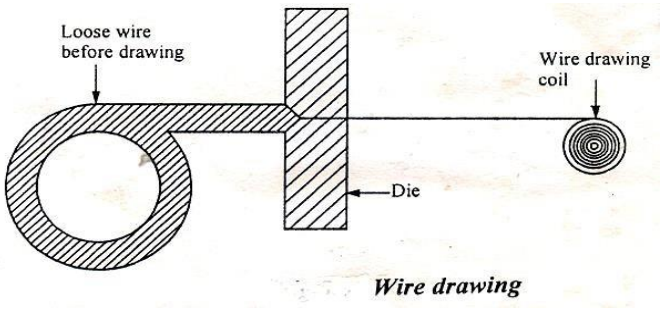


Wire drawing

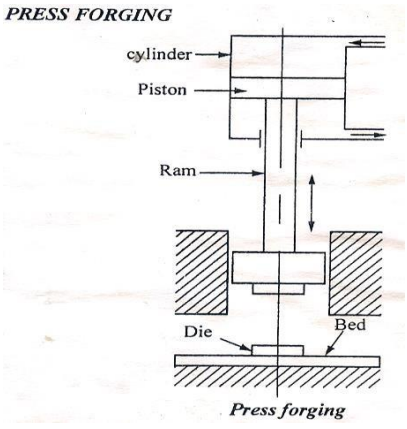
- This sized point coming out of the die orifice is fixed on the pliers or carriage. Which pullsthe rod through all the zones of die orifice.
- That will reduce the diameter of the rod.
- For making fine wire the rod is passed through the number of dies.
- Finally the wire is connected to the power reel to get the wire coil.

5. Describe the followings.

(i) Press forging **(ii) Upset forging**

Press forging

- Press forging is done in a press. the press may be operated either mechanically orhydraulically.
- it is a closed die forging operations
- The action is relatively slow squeezing rater than delivering heavy blows.
- There is anvil to fix the lower die and upper die is fitted fix in the ram.
- The ram is allowed to move down slowly and presses the metal slowly with high pressure.
- The finished component may be automatically removed by providing ejectors in the die set.
- The capacity range from 50x103 to 80x105 kg and speeds very from 34to 40 strokes perminute.



Press forging

Applications

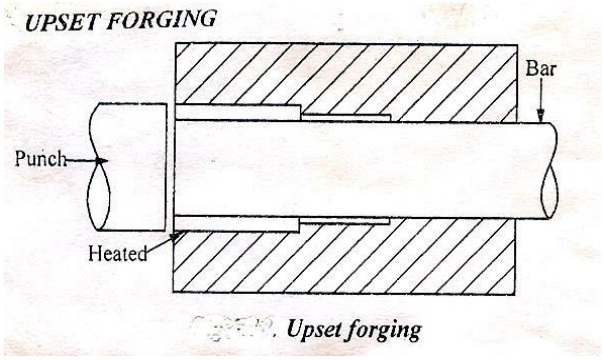
Press forging is used for making the parts.

1. spanner

2. connecting rod
3. machine components

Upset forging

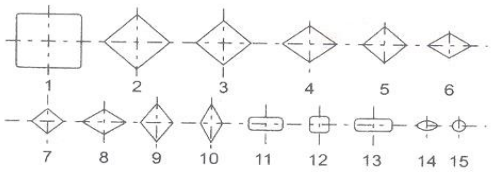
1. It is used to form head of bolt and rivet or pins.
2. The head may be square hexagonal or hemispherical.
3. The machine is having a die set.
4. The die set consists of a fixed die and movable punch.
5. The heated metal bar is held insides the solid die and force is given to the punch.
6. So, the punch will squeeze the heated metal to the shape of the die cavity.



Upset forging

6. How round section are manufactured by rolling process. Explain the various sequence of operation.

- A variety of sections can be produced by rolling.
- Some commonly produced shapes are shown in fig.
- It is important to mention here that desired shape of the rolled section is not achieved in asingle pass.
- It has to be rolled again and again several times before the desired shape and cross-section is obtained.
- Thus the figure shows the sequence of rolling and number of passes required to reduce thecross-section of a billet to a round steel bar.



Sequence of operation of a producing round steel bar from a steel billet

- In the process of rolling of ingots to bars, the ingots are first heated to the rolling temperaturein soaking pits and then converted into blooms in blooming mills.
- Blooming mills a provided with mechanical manipulators to turn the hot ingots or billetsthrough 90 after every pass.
- It enables all the surfaces of the ingots to come in contact with the rolls.

- Since the blooming mill is the first rolling mill through which the in got is passed it is alsoknown as mother mill.
- After requisite number of passes, the metal is passed through grooved rolls to get the desiredshape and size of cross-section.

7. with the help of neat sketches, explain how a hexagonal nut can be manufactured from a cylindrical rod

- The hexagonal nut can be manufactured by the extrusion process.
- Extrusion may be defined as manufacturing process in which a block of metal enclosed in a container is forced through the opening of a die.
- The hexagonal nut is manufactured either hot extrusion or cold extrusion process.
- The hot extrusion, first the billet is heated and then it is going to extrusion.
- In cold extrusion the cylindrical billet is introduce to extrusion without heating. Procedurefor producing hexagonal nut.
- The hexagonal shaped cross-sectional die opening is provided at one end of the container.
- The ram with mandrel is fitted at the end of the container.
- The cylindrical billet is either heated or unheated depends upon the types of extrusion processwill be choosed..
- Then it is placed in the die container.
- It is pushed by a ram with mandrel towards the die.
- The metal is subjected to plastics deformation slides along the walls of the container and isforced to flow through the die opening.
- Now, we obtain the axis symmetric hole with hexagonal shaped nut.

Tapping:-

- The internal thread is obtained by the tapping operation with aid of tapping tool.
- Hexagonal nut is prepared by forging and swaging operation.

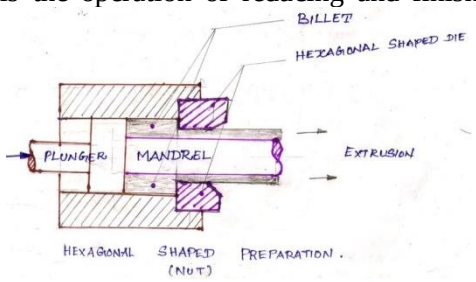
Forging:-

- The hexagonal nut is prepared from a cylindrical work piece by the following steps.

1. The cylindrical work-piece is placed in between the upper and bottom dies. The power hammer is used to forging the work-piece.
2. Similarly 60 is twisted the work piece and forged
3. Finally also the work-piece twisted to 60 and forged.

Swaging:-

Swaging is the operation of reducing and finishing the work-piece obtain from forging operation.



Tapping

The internal thread is obtained by the tapping operation with aid of tapping tool.

8.Distinguish between 'Open-die forging' and 'Closed-die forging'[APR/MAY-2010;NOV/DEC-2011]

S.NO	Open die Forging	Closed die Forging
1	The forging is done in a heated work at the workat the proper temperature by placing on flat surface of anvil through hammering the metal piece.	Impression dies called closed dies are used.The upper die is fitted on the ram and the lower die is fitted on the anvil.The metal piece is force between dies.
2	Hammering is done by giving repeated blows manually using hammer or by power hammer.	A single blow of press makes small and simple parts and large complicated shapes are made by number of steps.
3	This forging is very simple and flexible	This type of forging is complicated and rigid.
4	The pressure applied on metal piece is limited	Dies can be operated at maximum pressure without any limitations.
5	'U'bolts,Chisels,Rectangular,Circular,hexagonalshape are made by open die forging process	Spanner,automobile parts and machine parts are made by closed die forging process.

9.What are the defects in parts produced by rolling? Explain any four defects.[APR/MAY-2010, NOV/DEC 2013]

There are two types of defects which can occur in rolled products.
1.Surface defects
2.Internal structural defects

1.Surface defects

It includes scale,rust,scratches,cracks and pits.It is due to the impurities and inclusions in theoriginal cast material.

2.Internal structural defects

It includes the following defects

- Wavy edges
- Zipper cracks
- Edge cracks
- Folds
- Alligatoring
- Laminations

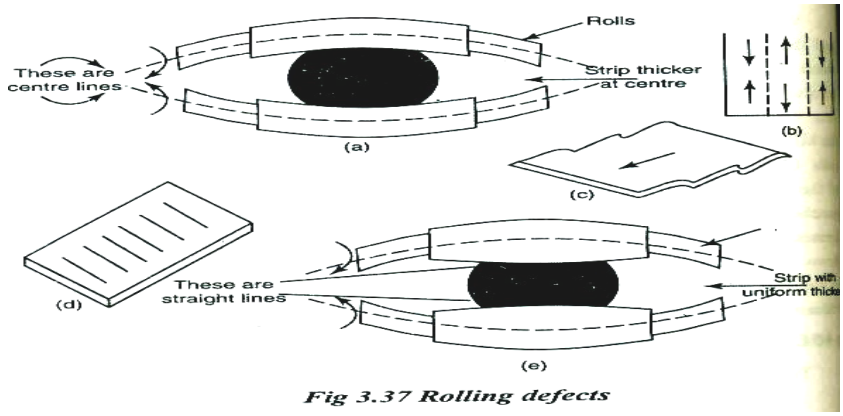


Fig 3.37 Rolling defects

The defects wavy edges and Zipper cracks occurs due to bending of rolls. Normally the rollsact as straight beams. If the material flow is continuous and to maintain this continuity, strains within the material should adjust. There are compressive strain on the edges and tensile strain atthe centre. Because of the edges are restrained from expanding freely in the longitudinal directionwavy edges on the sheet will be produced. The zipper cracks occur due to poor material ductilityat the rolling temperature.

To avoid this camber to be provided to the rolls i.e diameter of rolls is made slightly larger at the centre than the edges.

3. What are all the Other defects in rolling?

(i) In homogeneous deformation of elements across the width:

It is due to the decrease in thickness for the elements near the centre will be mainly convertedinto increase in length and near the edges the decrease in thickness is converted into lateral spread.

(ii) In homogeneous deformation in the thickness section:

It is due to in rolling the reduction in height is converted into increase in length and the thickness of the sheet does not undergo the same lateral deformation in the direction of rolling.

(iii) Folds:

It is created during plate rolling if the reduction per pass is very small.

(iv) Lamination:

Due to incomplete welding of pipe and blowholes during the rolling process the internal defects such as fissures are created.

10. Distinguish between wire drawing and tube drawing.[APR/MAY-2010]

S.NO	WIRE DRAWING	TUBE DRAWING
1	Wires are drawn without using a material.	Tubes are drawn with the use of plug or mandrels of required inside shape and size
2	In wire drawing,the number of passes is used to reduce the size of the wire	In tube drawing,Inside shape is formed inthe first pass of metal through dies and theoutside shape might be formed in the second pass or viceversa
3	The diameter 16mm has drawn in the form of wire coil	The diameter of the tube is not limited.
4	The process is simple.	Complex shape tubes can be drawn
5	The fixed shape of the wire can be drawn	Complex shape tubes can be drawn

11. Describe the principle of Hydrostatic extrusion[APR/MAY-2010, NOV/DEC 2013]

Hydrostatic extrusion is a process in which the billet is completely circumscribed by a pressurized liquid in all the cases,with the exception being the case where billet is in the contact with die.This process can be carried out in many ways including warm,cold or hot but due to thestability of the used fluid,the temperature is limited.Hydrostatic extrusion has to be carried out in a completely sealed cylinder for containing the hydrostatic medium.The fluid may bepressurized in following two ways

a.Constant rate extrusion: A ram of plunger is used for pressurizing the fluid in the container

b.Constant pressure extrusion: A pump with a pressure intensifier is used for pressurizing thefluid,which is then pumped into the container.

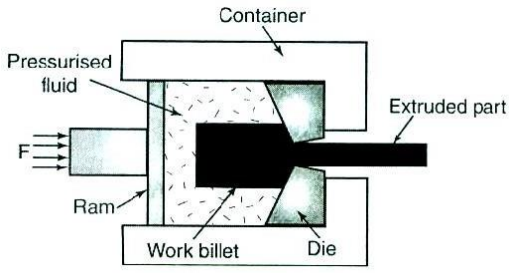


Figure: Hydrostatic extrusion

Advantages of Hydrostatic Extrusion:

- No friction amidst the container and billet.This minimizes the force requirementsallowing higher reduction ratios,faster speeds and lower billet temperatures.
- Friction of the die can be largely reduced by a film of pressurized lubricant amidst thedie surface and deforming metal.
- Even flow of material
- Large billets and large cross-sections are extruded
- Uniform hydrostatic pressure inside the container eliminates the requirement of billetsbeing straightened and extrusion of coiled wire.
- No billet residue is left on the walls of container.

Disadvantages of Hydrostatic extrusion:

- The billets have to be prepared by tapering one end so that it matches the die entry angle.This is essential for forming a seal at the starting of the cycle.Generally,the complete billet is required to be machined for the removal of surface defects.
- It can be difficult to contain the fluid,under the effects of high pressures
- Increaded handling for the injection and removal of the fluid for every extrusion cycle
- Decreased process efficiency in terms of billet to container volume ratio
- Enhanced complication when extrusions is done at elevated temperatures.

12. What is smith forging operation? [NOV/DEC-2011]

SMITH FORGING

The process involves heating the stock in the blacksmith's hearth and then beating it over the anvil. To get the desired shape, the operator has to manipulate the component in between the blows. The types of operations available are fullering, flattening, bending, upsetting and swaging.

In fullering, the material cross-section is decreased and length increased. To do this, the bottom fuller is kept in the anvil hole with the heated stock over the fuller. The top fuller is then kept above the stock and then with the sledge hammer, the force is applied on the top fuller. The fullers concentrate the force over a very small area, thus decreasing the cross-section at that point. Metal flows outward and away from the centre of the fullering die. Then the stock is advanced slightly over the fuller and the process repeated, as shown in Fig. 19.2.

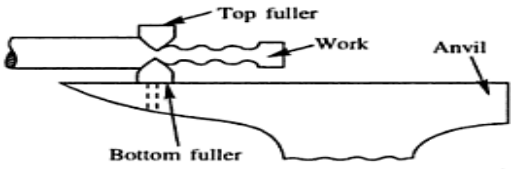


Fig. 19.2 Fullering operation

After fullering, the stock would have the fullering marks left which are then cleaned by means of flattening. To obtain specific shapes such as round, square, hexagon, etc. open general purpose dies called swages are used. The force for shaping is applied by manual hammering or by means of the forging hammers, the latter being the industrial practice.

Smith forging involves a lot of skill on the part of the operator and also is more time consuming. But since no special dies are used, smith forging is more beneficial in the manufacture of small lots or in trial production, because of the heavy cost of the closed impression dies cannot be justified in these cases.

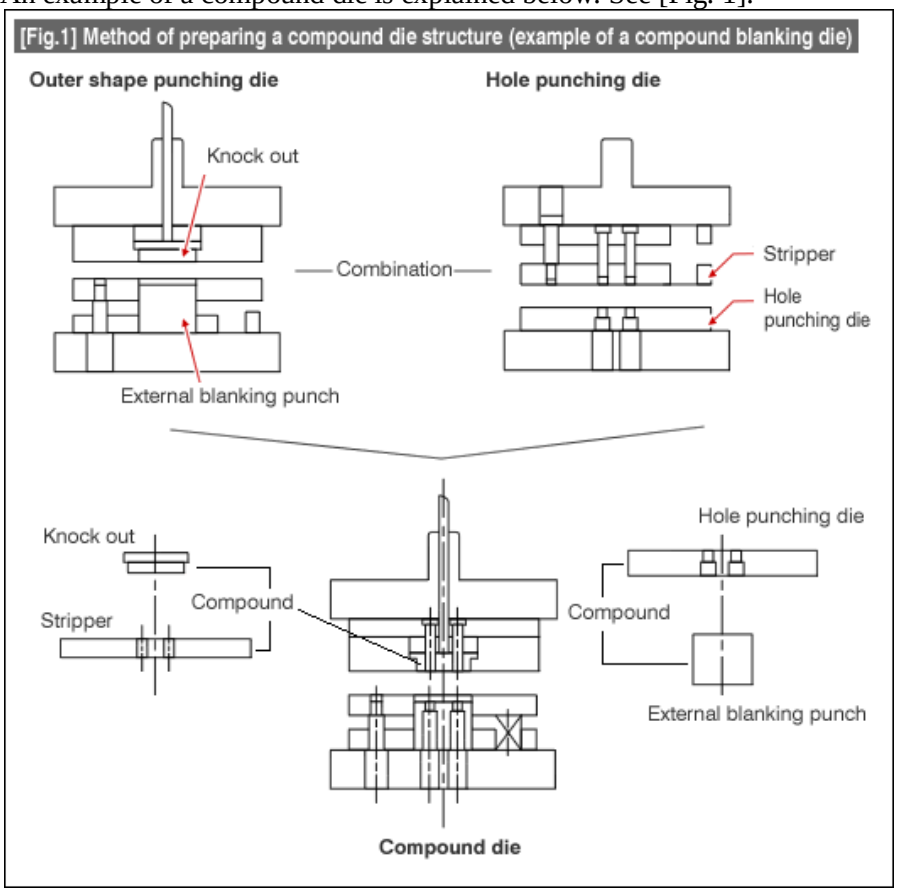
13. Briefly explain what are compound dies and progressive dies, with suitable sketches.[NOV/DEC-2011]

compound dies:

The structure for compound work such as compound blanking or blanking and drawing, etc., is made by combining the basic die structures. In such work, the outer shape (the blank) is prepared, and thenadditional work is made on it (such as hole punching, or drawing (extruding)).

In general, very often during such work the blank is punched upwards and the additional hole punching, etc. is done downwards. The basic die structures that permit such work are selected respectively and combined thereby creating a compound die structure.

An example of a compound die is explained below. See [Fig. 1].



In compound press work, the die carries out external shape punching and hole punching simultaneously. This is used because of its good aspects such as a good positional relationship between the external shape and the hole, even good flatness of the product, and that the direction ofburrs is the same in the external shape and the hole. Apart from this, there is also the advantage thatthe process can be shortened. However, since there is the disadvantage that, since the product enters the die (the top die), problems in taking out the product can easily occur.

The external shape forming work in [Fig. 1] uses a reverse placement variable stripper type structure and the product is removed upwards. Hole punching is done as usual downwards using theforward placement variable stripper type structure. Because of this relationship, the problem of processing the scrap in hole

punching will not be there. These two types of dies are combined into one unified structure. During such unification, the parts that are not common are left as they are. Two of each of the parts that interfere with each other, the external shape blanking punch, the hole punching die, the stripper, and the knock out are combined together and made into single parts. Such parts are called compound parts. The compound die structure is completed because of using these parts.

When interfering parts are unified at the time of carrying out compound work, a judgment shouldbe made as to whether the shape is suitable as a part of the die and as to whether there is any problemin terms of the strength, and the compound die is realized if there is no problem.

Since compound blanking or compound drawing or extrusion are used very frequently, even their structures are found in reference documents and they are used in a manner similar to ordinary dies, and hence these types of structures are used. Even compound dies for hitherto unknown compoundworks can be prepared using the procedure as described here.

Progressive die:

The sheet metal is fed through as a coil strip, and a different operation (such as punching, blanking,and notching) is performed at the same station of the machine with each stroke of a series of punches.

For components having relatively simple configuration, the progressive tools are used. Here there will be a single press. The tool will have multiple stations. The component is not separated from the strip. The material (strip) keeps on moving along with the die, perfectly equal moments (called pitch). The component will be isolated at the final stage

14. (i) With a neat sketch, explain the working of a Pneumatic Hammer for forging.(MAY/JUNE 2012) – REFER QUESTION NO. 2

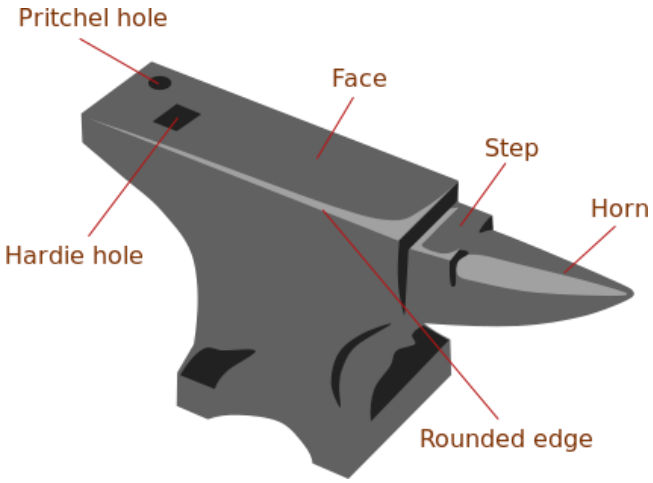
(ii) List four tools used for forging. Sketch any two of them. (MAY/JUNE 2012)

The various tools used for forging process are

- Anvil
- Hammer
- Chisel
- Tongs
- Fuller
- Hardy

Anvil

The anvil serves as a work bench to the blacksmith, where the metal to be forged is placed. Anvils are made of cast or wrought iron with a tool steel face welded on or of a single piece of cast or forgedtool steel. The flat top has two holes; the square hole is called the hardy hole, where the square shank of the hardy fits. The smaller hole is called the punch hole, used as a bolster when punching holes in hot metal.



Hammer

There are two types of hammer are used in workshop. (1)Hand hammer :it is used by smith himself.(a)ball peen hammer (b)cross peen hammer (c)straight peen hammer (2)Sledge hammer :it is used by striker.

Chisel

Chisels are made of high carbon steel. They are hardened and tempered at the cutting edge while thehead is left soft so it will not crack when hammered. Chisels are of two types, hot and cold chisels.The cold chisel is used for cutting cold metals while the hot chisel is for hot metals. Usually hot chisels are thinner and therefore can not be substituted with cold chisels

Tongs

Tongs are used by the blacksmith for holding hot metals securely. The mouths are custom made bythe smith in various shapes to suit the gripping of various shapes of metal. There are various types of tongs available in market. (1)flat tong (2)rivet or ring tong (3)straight lip fluted tong (4)gad tong

Fuller

Fullers are forming tools of different shapes used in making grooves or hollows. They are often usedin pairs, the bottom fuller has a square shank which fits into the hardy hole in the anvil while the top fuller has a handle. The work is placed on the bottom fuller and the top is placed on the work and struck with a hammer. The top fuller is also used for finishing round corners and for stretching or spreading metal.

Hardy

The hardy is a cutting tool similar to the chisel. It is used as a chisel or hammer for cutting both hotand cold metals. It has a square shank that fits into the hardy hole in the anvil, with the cutting edgefacing upwards. The metal to be cut is placed on the cutting edge and struck with a hammer. They are also used with set tools which are placed over the workpiece and struck.

15. (i) With neat sketches , explain the different types of roll stand arrangements used in therolling mills. (MAY/JUNE 2012)

The three principal types of rolling mills used for the rolling of steel are referred to as two-high, three-high, and four-high mills. This classification is based on the arrangement the rolls in the housings. Major features of those stands are listed below:

- two-high stand: consisting of two rolls, one above the other. On two-high reversing mills, the direction of rotation of the rolls can be reversed, and rolling is alternately in opposite directions.
- three-high stand: with three rolls, each of them revolves continuously in one direction; the top and bottom rolls in the same direction and the middle roll in the opposite direction. Thepiece is lifted from the bottom pass to the return top pass by mechanically-operated lift tables, or by inclined approach tables. Usually the large top and bottom rolls are driven, while the smaller middle roll is friction driven.
- four-high stand: with four rolls, particularly used for rolling flat products, like sheets and plates, for both hot and cold rolling. The large backing-up rolls are employed to resist the tendency of long working rolls to deflect, and to permit the use of small-diameter working rolls for producing wide plates.

For rolling thin product, such as sheet, smaller rolls are preferred. At one hand, smaller rolls requiresmaller roll load. On the other hand, smaller rolls have lower elastic deformation and make it possible to roll the sheet to a thinner gauge. If the sheet thickness is equal to near to the roll elastic deformation, the sheet thickness cannot be reduced any more - this is the minimal thickness that canbe rolled.

However, a small roll has big roll deflection which makes the things worse if no backup roll workswith it. In practice, there are also six-roll, twelve-roll, and twenty-roll arrangements, beside four-rollmills. The more the rolls, the smaller the possible work roll diameter, and consequently, the high thecost. Fig. 1 shows the major roll arrangements nentioned above. While four-high mill can be used for both hot and cold rolling, the six-high, twelve-high and twenty-high mills are primarily used to roll very thin cold sheet.

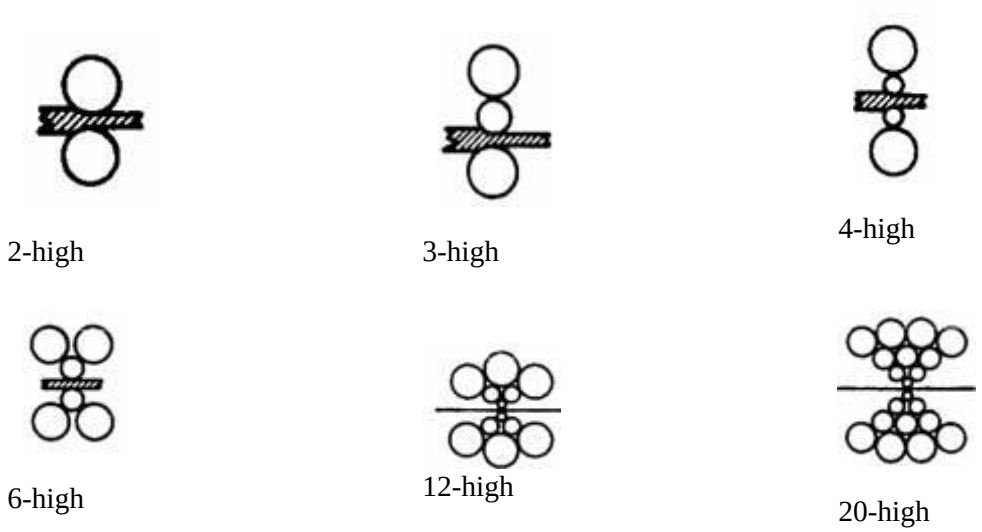


Fig. 1: Major roll arrangements for flat rolling

Fig. 2 illustrates a three-high reversing mill, with guides and guards displayed. For reversing mill, both sides of the mill need to be provided with guides and guard. Guides are employed in order to prevent collaring and to insure that the piece enters and leaves the pass in the correct position, whileguards are used mainly on the delivery side of the mill to control the direction of the piece after leaving the pass.

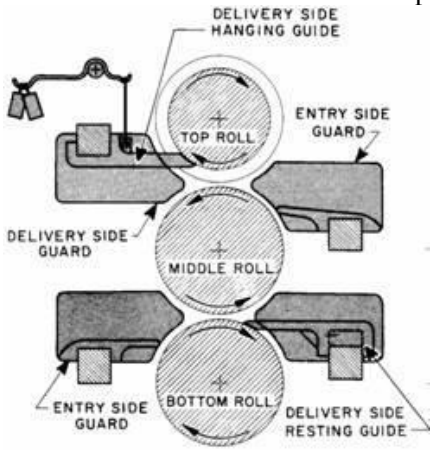


Fig. 2: A three-high reversing mill with guides and guards

There are also several other arrangements of rolls. One example is the Sendzimir planetary mill (Fig.3) and Taylor mill. In the planetary mill, a great number of small rolls, which in turn serve as work rolls, are mounted on the surface of two large backup rolls. Since multiple sets of rolls work on the strip simultaneously, the pass reduction can be very high. In Fig. 3, due to the high complicity, a pairof feed rolls are installed.

Other roll arrangements, such as universal mill and three-roll mill (e.g. Kocks mill), are discussed in a separate paper on shape rolling rolls and mill arrangements.

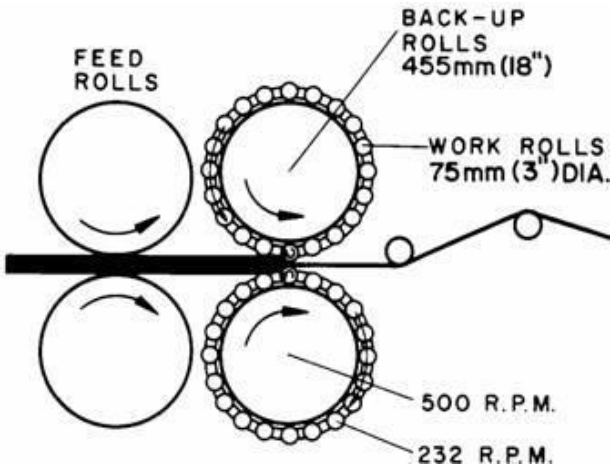


Fig. 3: Planetary mill [21]

A continuous mill consists of several stands of rolls arranged in a straight line (in tandem), with each succeeding stand operating with roll surface speed greater than its predecessor. This type of mill is in very common usage for rolling strip, sheet, billets, bars, rods, etc. Any part of the workpiece, afterpass through the roughing, intermediate and finish stands, is rolled from initial shape into the finish

one, and emerges from the last roll stand. A semi-continuous mill comprises also a reversing roughing stand for reducing the piece prior to entering the continuous mill for reduction to the finished shape. This arrangement gives moderately high production with lower first cost than a continuous mill.

(15) State clearly for what purpose each arrangement is used. (MAY/JUNE 2012)

The operation in which we decrease the thickness of the plate by increasing the length with the help of cylindrical rolls is known as rolling process. There are number of arrangements used in practical life for rolling operation.

This arrangement gives moderately high production with lower first cost than a continuous mill.

(16) With a neat sketch, explain the principle used in tube drawing process ? (MAY/JUNE2012)

Tube piercing is nothing but tube drawing with mandrel. In tube drawing, cylinders andtubes which are made by extraction process in finished by drawing process.

Tube drawing is classified into

1. Tube sinking
2. Tube drawing with plug
3. Tube drawing with mandrel

In tube sinking process, the outer diameter of the tube only reduced. For reducing the inner diameterof the tube the other two process.

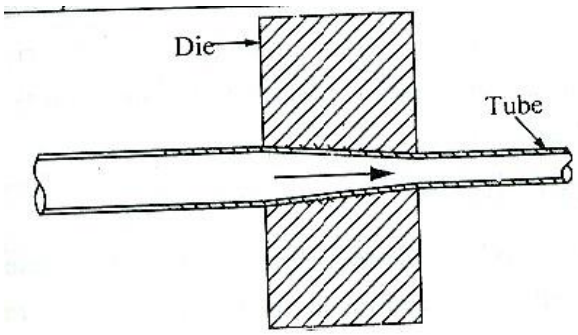


Fig Tube sinking

i.e., tube drawing with plug or Tube drawing with mandrels is used.

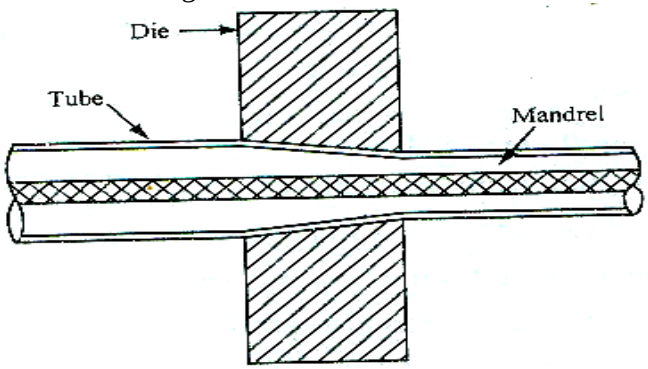


Fig Tube mandrel

In tube mandrel, the mandrel is placed in the tube and the pull is given to the tube. It will reducethe inside diameter of the tube.

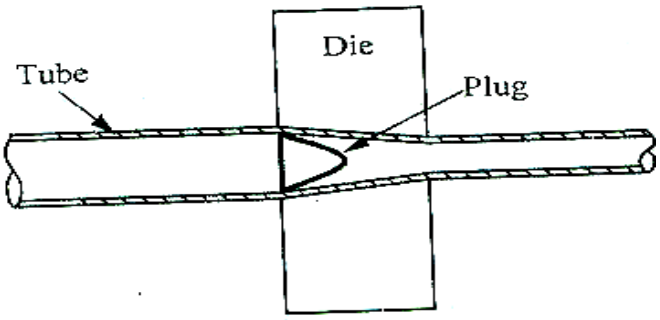


Fig Tube plug

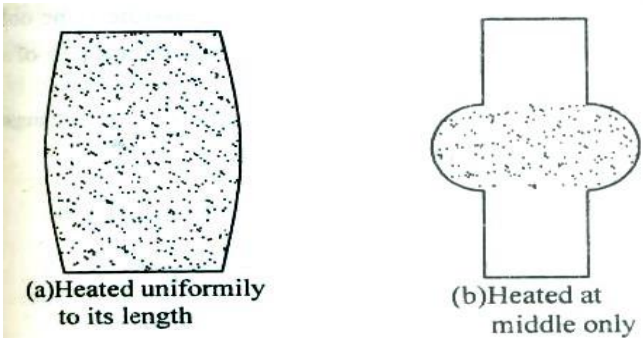
In plug drawing, both internal and external surface of the tube is controlled and the dimensionalaccuracy is good compared with other two methods. In this process the plug is fixed or floating. Thefriction obtained in fixed plug is more than floating plug and drawing load is high in fixed plug andless in floating plug.

16. With neat sketches. Explain the following smith forging operations. (NOV/DEC 2012)

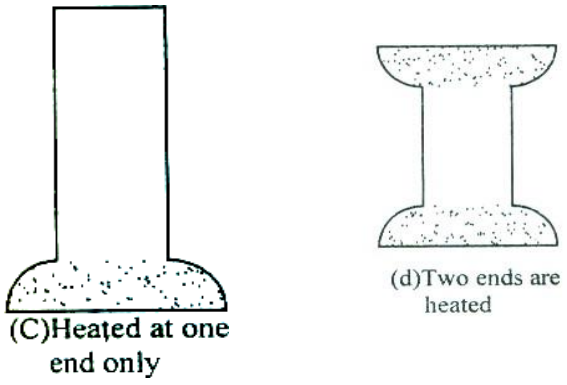
i. **Upsetting**
ii. **Bending**
iii. **Swaging**
iv. **Fullering**
v. **Punching and drifting**
vi. **Edging**

i. Upsetting

This process is called as hot heading. In this operation, the metal is heated at one end and it is rest on the



anvil and force is applied on the other end by using hammer. So, this force will increasethe cross sectional area and decrease the length. This operation of reducing cross sectional area is known as **upsetting.** The equipment used in this operation is called is called upsetter.

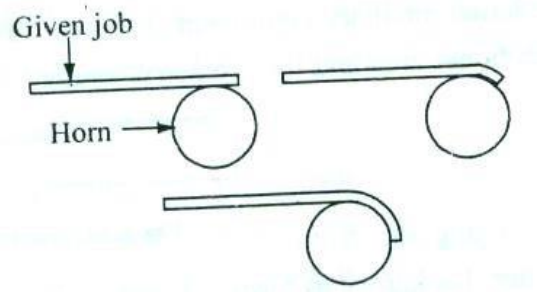


The dies used on these machines are so designed that the complete operation is performed in severalstages and the final shape attained gradually. The operation is performed with the help of a die anda punch

ii.Bending

Shapes like angles, ovals, and circles etc can be done by this method. Befor going to this operation, the

job is heated in the appropriate portion. Then the job is placed over the anvil (over thehorn) and the force is applied through the hammer. Bending of bars, flats are done in smithy shop for making a right angle bend that particular portion of stock is heated and jumped on the outer surface. So, it provides an extra material at that particular place which compensates for the elongation of the outer surface due to hammering during bending. After bending, the outside bulgingis finished by means of a flatter but the inside one by means of a set hammer. For mass production of bending , jigs and fixtures are used.



iii.Swaging

Reducing or changing the cross sectional area of the metal is known as **Swaging operation.**

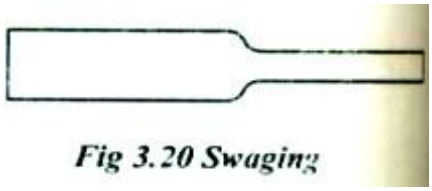
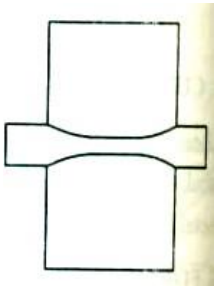


Fig 3.20 Swaging

iv.Fullering

Reducing the stock or job and increasing the length of the work piece by applying pressure on itis known as **fullering**



v.Punching and drifting

Punching is defined as making of a hole in a given job. The principle operation of this process isplacing the heated job over a correct hole of the swage or die and forcing the punch into it by hammer. The work piece is initially heated to nearly white heat and then placed flat on the anvil face. If a small hole is to be produced, the second stage of the operation can be performed by placingthe work on the anvil face.

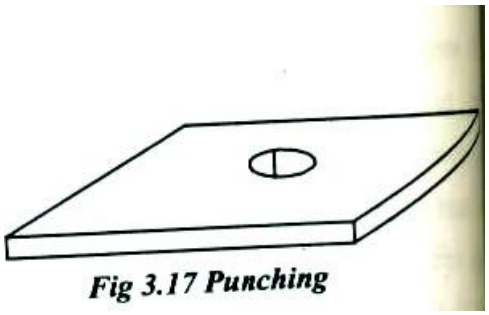


Fig 3.17 Punching

11. With suitable sketches. Explain the following: (NOV/DEC 2012)

i. Stages involved in "Shape rolling" of structural sections .
ii. Cold extrusion forging
iii. Seamless tube drawing[AU-MAY/JUNE-2013] [Refer Pg.No:26, Q.No: 16)

i. Stages involved in "Shape rolling" of structural sections .

In shape rolling process the various shapes can be produced. Example: Straight and long structural shapes, solid bars, I-beams, Channels, railroad rails. The various stages in shape rolling process are given below.

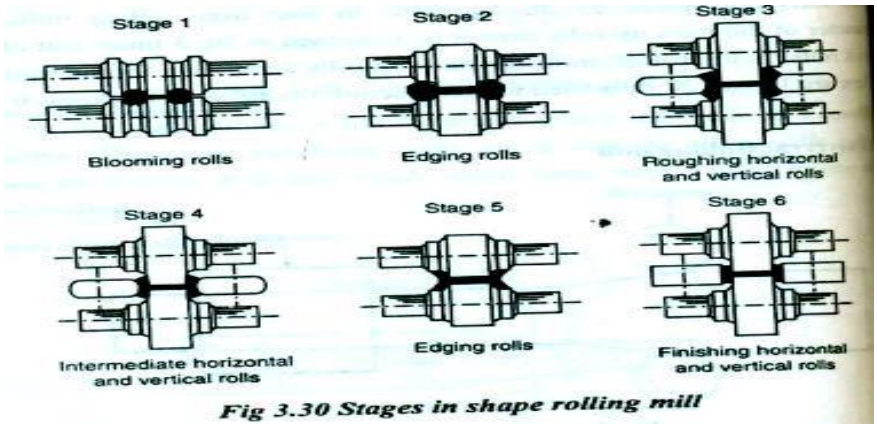
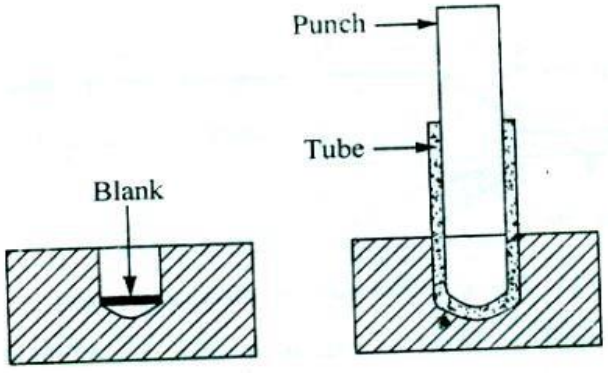


Fig 3.30 Stages in shape rolling mill

ii. Cold extrusion forging



This process also called cold extrusion. Working principle of this process is that work materialis placed between the die and ram. The punch is connected with the ram. When the sudden impact is given to the ram, the metal flows plastically in the upward direction, metals like aluminum, tins are extruded in an Impact extrusion.

The various items of daily use such as tubes for shaving creams, tooth pates and paints, condensercans and tin walled products are impact extruded. The metal flows up along the surface of the punch, forming a cup shaped component. When the punch moves up, the compressed air is used to separatethe component from the punch. The production rate is fairly high, giving about 60 components per minute. The main advantages of this process, it speed product uniformity and low scrap yield.

12.Briefly explain about flat strip Rolling.[AU-MAY/JUNE-2013]

In rolling plates and sheet with high width to thickness ratios, the width of the material remains essentially constant during rolling process. For square section, the width increases considerably in the roll gap. The increase in width of a strip in flat rolling is shown in fig.

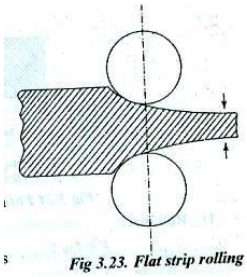


Fig 3.23. Flat strip rolling

The increased width in rolling is called spreading. For calculating the rolling force, the width is taken as average width. The spreading can be prevented by using vertical rolls.

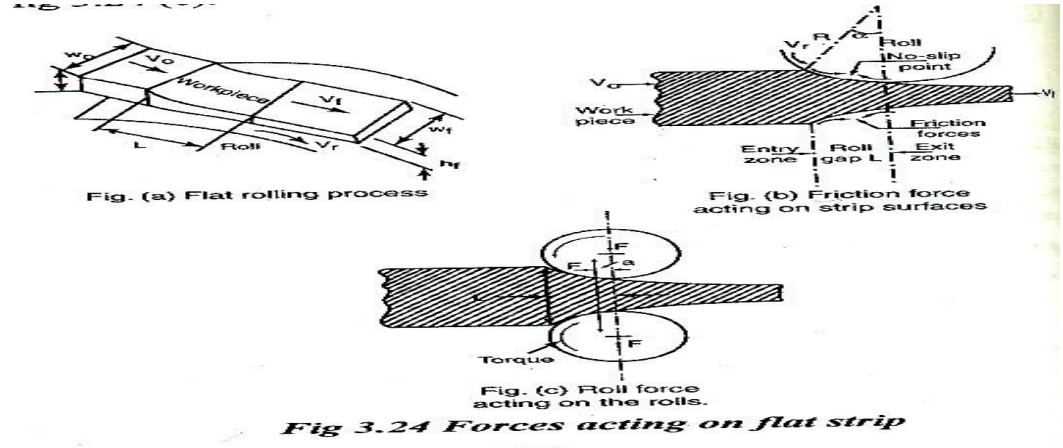


Fig 3.24 Forces acting on flat strip

The schematic diagram of flat strip rolling is shown in fig. The thick of strip h_0 is reduced to hf bya pair of rotating mills. The velocity of the strip increases from v_o to $v_{f..}$ Since the surface speed of the roll is constant in the roll gap L.The frictional forces which are acting on the flat strip and the roll force and power requirement for the rolling

1. Roll force:

$F=Lw\ Y_{avg}$

Where,L=Roll strip contact lengthW=Width of the strip

Y_{avg}=Average of the true stress

2. Power per roll

Power= $\frac{2\pi FLN}{6000} kW$

Where,F=Force in Newton N=Speed of the roll in rpm

3. Roll strip contact length(L):

$L=\sqrt{R(h_0-h_f)}$
h_0-h_f=Difference between initial and final thickness

R=Roll radius

13. Explain with a neat sketch the process of wire drawing. [AU-MAY/JUNE-2013]

The diameter less than 16 mm has drawn in the form of wire coil. Initially the point of the wire issized so it is freely enter into the die.

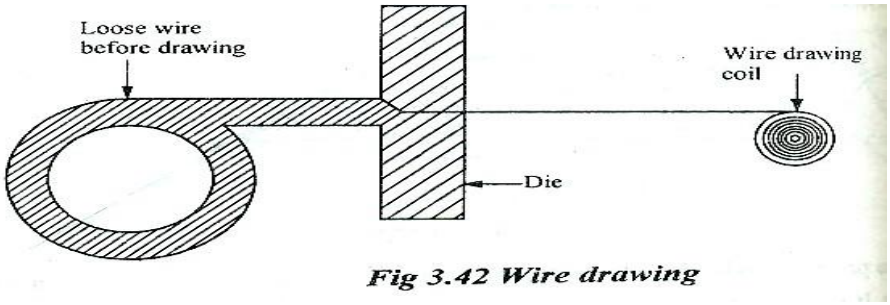


Fig 3.42 Wire drawing

This sized point coming out of the orifice is fixed on the pliers or carriage, which pulls the rod through all the zones of the die orifice. That will reduce the number of dies. Finally the wire is connected to the power reel to get the wire coil.

14. Explain with neat sketch Hot working and Cold working of metals. [AU-MAY/JUNE-2013]

HOT WORKING OF METALS:

Mechanical working of a metal above the recrystallization temperature but below the melting pointis known as hot working. It may also be defined as the plastic deformation of metals and alloys underthe conditions of

temperature and strain rate

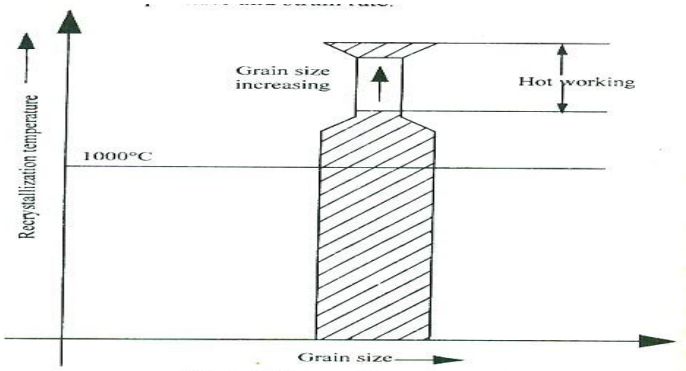


Fig 3.1 Hot working of metal.

In this process the metal is heated above the recrystallization temperature of the metal but below themelting point of metal.Normally the recrystallization temperature of metal will be about 30 to 40% of its melting temperature.

ADVANTAGES:

- Force requirement is less when compared to cold working process for making the requiredshape.
- As grain structure is refined,toughness,ductility and resistance can be improved
- It is quick and economical process
- Porosity is eliminated and density of the metal is increased
- This process is very suitable for all metals

DISADVANTAGES:

- Surface finish may be poor due to oxidation and scaling
- Close tolerance and automation cannot be achieved due to high working temperature.
- Tooling and handling cost are high.
- Sheets and wires cannot be produced.

COLD WORKING:

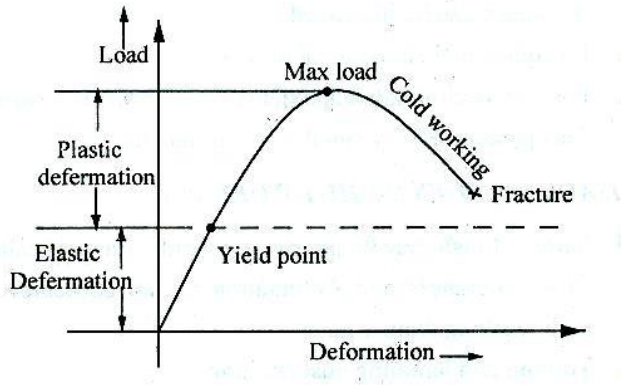


Fig 3.2 Load deformation curve

Plastic deformation of a metal to the required shape being performed below the recrystallisation temperature is known as cold working process.

The recrystallisation temperature is defined as the minimum temperature at which the complete recrystallisation of a metal takes place with in a specified time.The recrystallisation temperature is about one half of the absolute melting temperature but generally cold working is carried out only at room temperature.

ADVANTAGES:

- It is widely applied as a forming process for steel
- Better surface finish is being obtained
- This process provides higher dimensional accuracy
- Thin material can be obtained
- It is more suitable for mass production.

Limitations:

- The surface finish may be poor.
- Close tolerance cannot be achieved
- Stress formation in the metal during cold working is higher.

15. Explain with neat sketch of Roll Ring Process. [AU-MAY/JUNE-2013]

In ring rolling process, a thick ring is expanded into a large diameter ring with a reduced cross section. First , the ring is placed in between the two rolls and one of the roll is driven and the ring thickness is reduced by bringing the rolls closer together as they rotate.

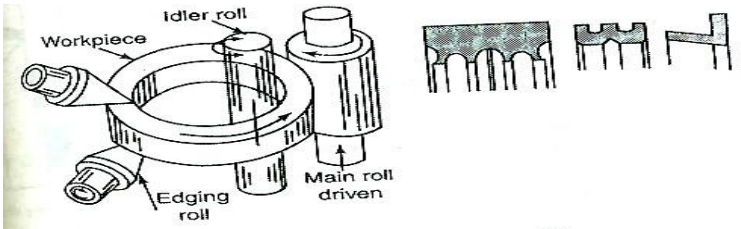


Fig 3.31 Ring rolling mill

The reduction in thickness of the ring is compensated by an increase in the rings diameter. The figureshows procedure for producing a seamless ring for a tapered roller bearing.

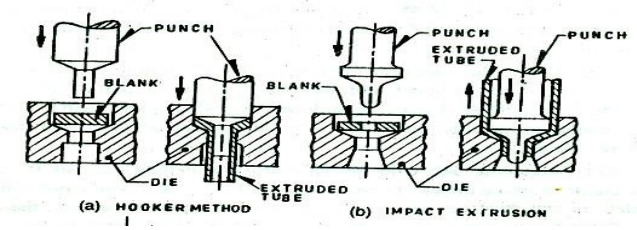
The ring rolling process has the advantages of short production times, close tolerances , material savings. It can carried out at room temperature depends upon the size, strength and ductility of the material.

16. Write short notes on impact extrusion process. (Nov/Dec 2013)

The cold impact extrusion method consists in placing a flat blank of specified diameter in the diecavity

and striking it by a punch with a powerful blow. The materials get heated up and become plastic and is forced to squirt up around the punch, shown in (figure).

Thin walled tubes of low flow strength materials (tin, lead, aluminium etc.) are rapidly formed by this method. The end of the tube will correspond to the shape of the die cavity and also of the punch. The outside diameter of the tube takes the shape of the die and the wall thickness is equal to the clearance between the punch and the die. The operation is fully automatic and the production rate is as high as 50 tubes or more per minute.



When the punch is on its upward stroke, the tube sticks to it. To effect release, either a stripper (shown in figure) or compressed air is directed against the tube, thus stripping it from the punch. Threads may be formed at the end of these collapsible tubes by retractable die portions or by other methods. These collapsible tubes are used for cosmetics (cream, shaving cream), tooth paste, greaseetc.

Other product applications include: Cans, fire extinguisher cases, radio shields, food containers,boxes for condensers and cigarette lighter cases.