

# Press Tool Technology

Introduction to Press Tools

Stock Material

Theory of Shearing

Cutting Force

Cutting clearance

Basic Design of Guide Plate

Elements of Guide Plate Tool

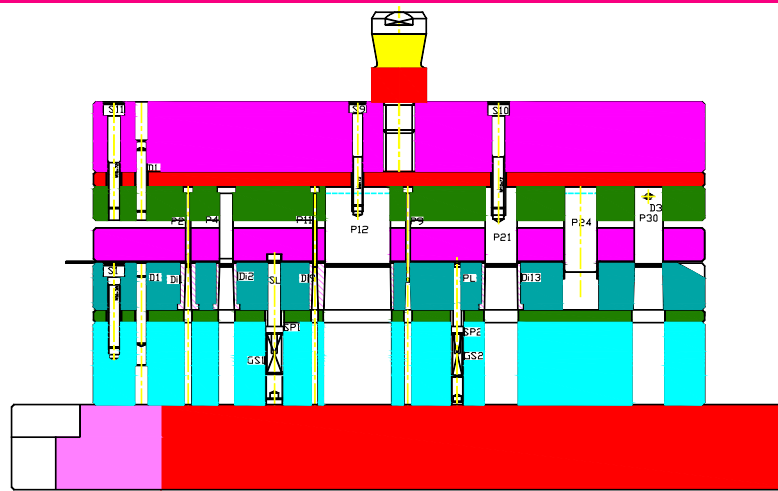
Land and Angular Clearance.

Progressive Tool

Strip layouts

Punches and buckling of punches

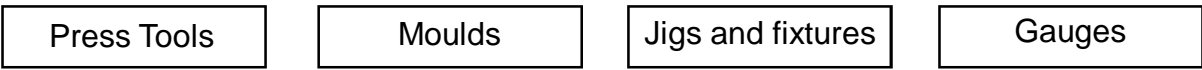
Die Blocks



(An ISO 9001:2000 Certified Training Institution)

Volume 1

The word tooling refers to the hardware necessary to produce a particular product. The most common classification of types of tooling are as follows:



The toolmaker manufactures the above items from the design supplied to him. On gaining experience the toolmaker will be able to design and manufacture simple tools.

### Press tools:

Press tools are special tools custom built to produce a component mainly out of sheet metal. The principle operations of sheet stampings include cutting operations (shearing, blanking, piercing, etc.) and forming operations (bending, drawing, etc.).

Sheet metal items such as automobile parts (roofs, fenders, caps etc.), components of aircraft, parts of business machines, household appliances, sheet metal parts of electronic equipments, precision parts required for homological industry etc., are manufactured by press tools.

### Various operations that are performed in Press tools

*The answer is we have prepared twenty types of operations, which are performed in tools.*

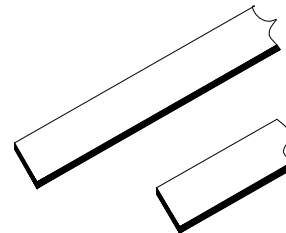
#### Blanking.

When a component is produced with one single punch and die with entire periphery is cut is called blanking. Stampings having an irregular contour must be blanked from the strip. Piercing, embossing, and various other operations may be performed on the strip prior to the blanking station.



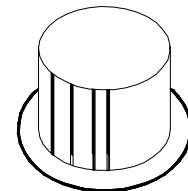
#### Cut-off.

Cut off operations are those in which strip of suitable width is cut to length in single. Preliminary operations before cutting off include piercing, notching, and embossing. Although they are relatively simple, cut-off tools can produce many parts.



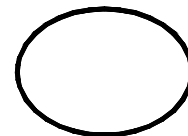
#### Parting off.

It is similar to cut off operation except the cut is in double line. This is done for components with two straight surfaces and two profile surfaces. Parting off produces waist.



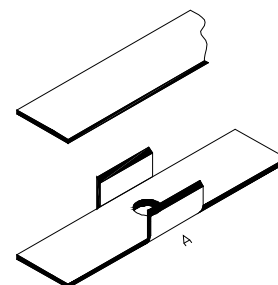
#### Trimming.

When cups and shells are drawn from flat sheet metal the edge is left wavy and irregular, due to uneven flow of metal. This irregular edge is trimmed in a trimming die. Shown is flanged shell, as well as the trimmed ring removed from around the edge. While a small amount of material is removed from the side of a component or strip is also called as trimming.



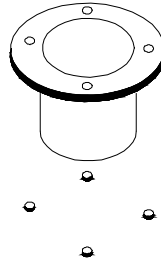
#### Piercing.

Piercing tools pierce holes in previously blanked, formed, or drawn parts. It is often impractical to pierce holes while forming because they would become distorted in the forming operation. In such cases they are pierced in a piercing tool after forming.



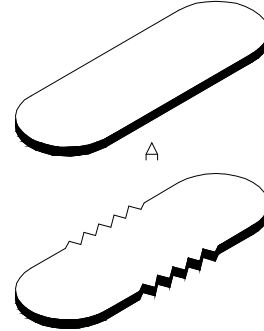
### Shaving.

Shaving removes a small amount of material around the edges of a previously blanked stamping or piercing. A straight, smooth edge is provided and therefore shaving is frequently performed on instrument parts, watch and clock parts and the like. Shaving is accomplished in shaving tools especially designed for the purpose.



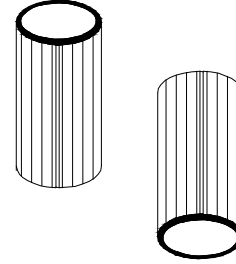
### Broaching.

Figure shows serrations applied in the edges of a stamping. These would be broached in a broaching tool. Broaching operations are similar to shaving operations. A series of teeth removes metal instead of just one tooth as in shaving. Broaching must be used when more material is to be removed than could effectively be done in with one tooth.



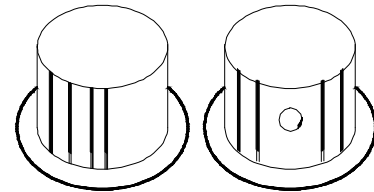
### Horning:

Horn tools are provided with an arbor or horn over which parts are placed for secondary operations such as seaming. Horn tools may also be used for piercing holes in the sides of shells.



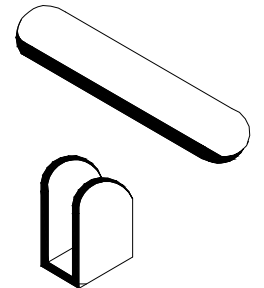
### Side piercing (cam operations).

Piercing a number of holes simultaneously around a shell is done in a side cam tool; side cams convert the up and down motion of the press ram into horizontal or angular motion when it is required in the nature of the work.



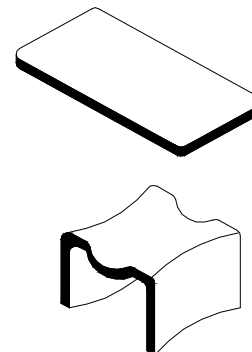
### Bending.

Bending tools apply simple bends to stampings. A simple bend is done in which the line of bend is straight. One or more bends may be involved, and bending tools are a large important class of press tools.



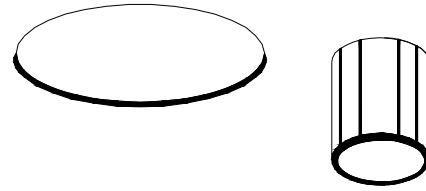
### Forming.

Forming tools apply more complex forms to work pieces. The line of bend is curved instead of straight and the metal is subjected to plastic flow or deformation.



### Drawing.

Drawing tools transform flat sheets of metal into cups, shells or other drawn shapes by subjecting the material to severe plastic deformation. Shown in fig is a rather deep shell that has been drawn from a flat sheet.



### Curling.

Curling tools curl the edges of a drawn shell to provide strength and rigidity. The curl may be applied over a wire ring for increased strength. You may have seen the tops of the sheet metal piece curled in this manner. Flat parts may be curled also. A good example would be a hinge in which both members are curled to provide a hole for the hinge pin.

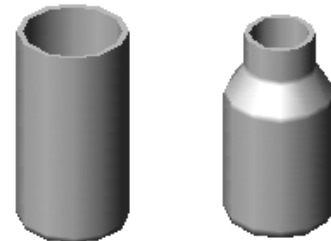


### Bulging.

Bulging tools expand the bottom of the previously drawn shells. The bulged bottoms of some types of coffee pots are formed in bulging tools

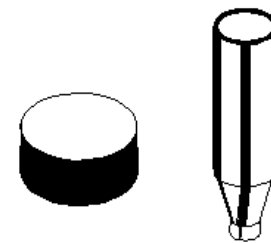
### Swaging.

In swaging operations, drawn shells or tubes are reduced in diameter for a portion of their lengths.



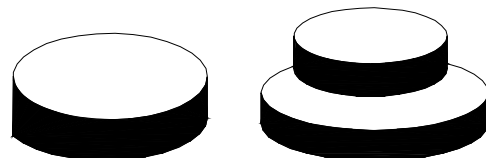
### Extruding.

Extruding tools cause metal to be extruded or squeezed out, much as toothpaste is extruded from its tube when pressure is applied. Figure shows a collapsible tool formed and extruded from a solid slug of metal.



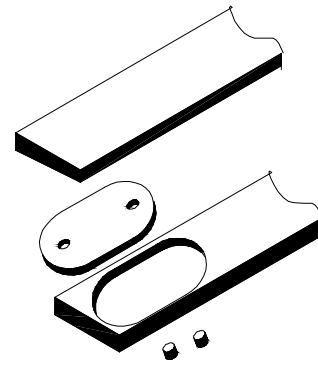
### Cold forming.

In cold forming operations, metal is subjected to high pressure and caused to and flow into a pre determined form. In coining, the metal is caused to flow into the shape of the die cavity. Coins such as nickels, dimes and quarters are produced in coining tools.



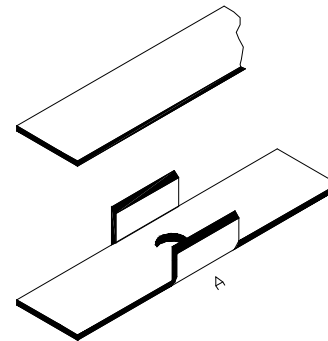
### **Compound.**

Compound tools pierce and blank Simultaneously at the same station. They are more expensive to build and they are used where considerable accuracy is required in the part.



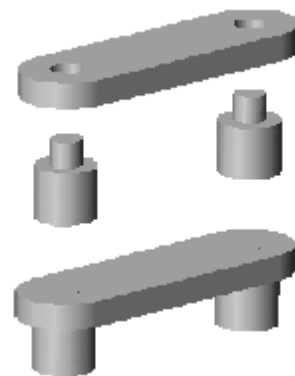
### **The Progressive operations.**

Progressive operations are those in which progressive tools perform work at a number of stations simultaneously. A complete part is cut off, blanked at the final station, with each stroke of the press.



### **Assembly tools**

Represented is an assembly tool operation where two studs are riveted at the end of a link. Assembly tools assemble the parts with great speed and they are being used more and more.



### **Sub press operations**

Sub press tools are used for producing tiny clock, and instrument components, represented by the watch needles shown. Sub presses are special types of tools used only for such precision work.

As you study the sections to follow, you will be introduced, step-by-step; to the fundamental die components and you will learn the methods by which die designers assemble these components in designing tools. When you have completed you will know the elements of die design quite thoroughly. Knowledge such as this is well paid for industry. You will have acquired the foundation of a career that can benefit you for the rest of your life.

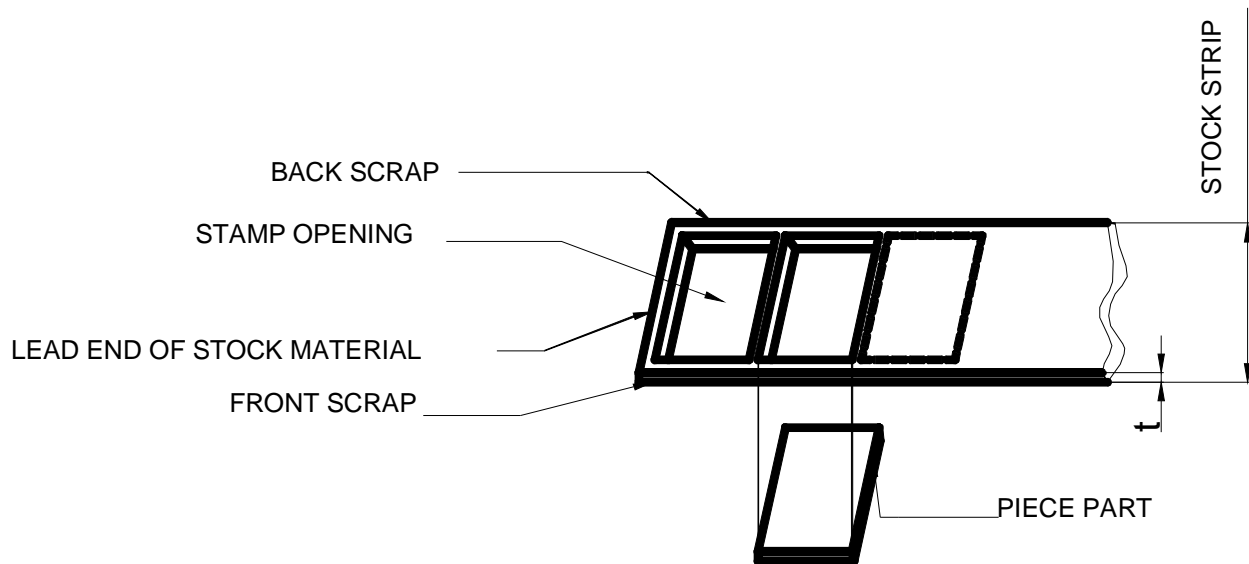
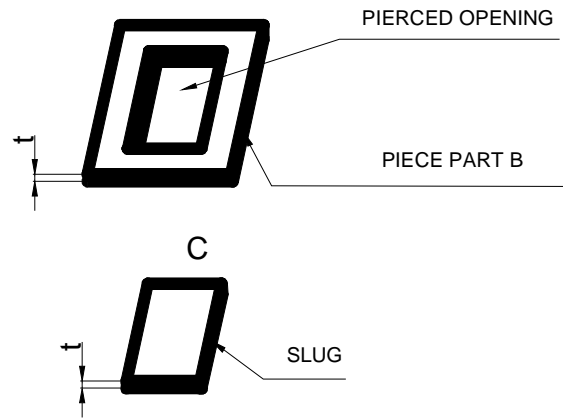
**RELATIONSHIP OF PIECE PART AND STOCK STRIP:**

**STOCK STRIPS:**

Stock strips are fed into the die and advanced by the required advance distance at each press stroke for a series of repetitive operations.

**PIECE PART:**

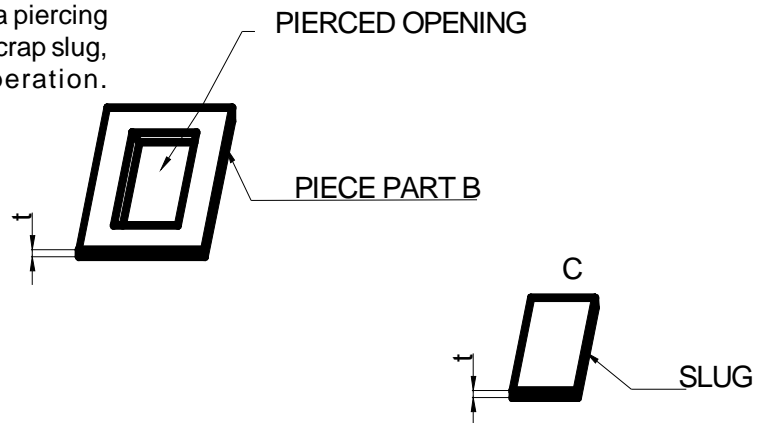
A piece part is the product of a die. It may be a complete product in itself or it may be only component of a product consisting of many and different parts. The die may or may not produce the piece part in the finished state.



**UNIT STOCK:**

The term unit stock is applied to pieces of material, which are fed individually into dies for processing. In the case of large stamping, a standard mill size sheet metal might be practical as unit stock. At times unit stock may be produced from strip stock by means of a chop off die.

The rectangular piece of unit stock is fed into a piercing die to produce the piece part B. Disc C is the scrap slug, produced by the piercing operation.



### **STOCK MATERIAL:**

The materials out of which stampings are made are known as stock materials. Stampings can be metallic or nonmetallic. Metallic materials include ferrous metals like hot rolled steels, cold rolled steels, stainless steels, spring steels, silicon steels etc and non ferrous metals like copper, brass, bronze, phosphor bronze, aluminum, tin, zinc etc. non metallic materials like plastic, rubber, wood, cloth and paper are also used as stock materials to produce stampings. Every stock material has got its own chemical and physical properties. The product designer as well as the tool designer should have a thorough knowledge of these properties. The following standards give the chemical composition and physical properties of ferrous metals generally used in stamping industry. Surface finish of all these types can be coarse or rough medium or fine, dull or bright.

### **FERROUS METALS:**

Refer Indian standards for the property of materials.

IS 513 – Cold rolled carbon steel sheets.

IS 1079 – Hot rolled carbon steel sheets and strips.

IS 2507 – Cold rolled spring steel strips.

### **HOT ROLLED STEEL SHEETS:**

These can be formed easily. Low carbon hot rolled sheets are used for barrels, pails, farm implements, lockers, cabinets, truck bodies and other applications, where scaling and discolouration are not objectionable, as the surfaces are painted after forming.

### **PICKLED AND OILED SHEETS:**

Pickling or the immersing of hot rolled steels in acid solutions result in smooth clean scale free surface having a uniform grey colour. Oiling protects the surfaces against rust. Pickled and oiled sheets are used for household appliances, automobile parts, toys etc, because of long lasting painting it can take due to the absence of scales.

### **MEDIUM CARBON STEELS:**

Hot rolled steels having 0.4 to 0.5 % of carbon provide hardness toughness and resistance to abrasion. They can be heat-treated. They are mainly used in the manufacture of hand tools, blades etc.

### **COLD ROLLED STEEL SHEETS:**

Cold rolled steel sheets have a smooth deoxidized satin finish, which provide excellent base for paint, lacquer or enamel coating. Cold rolled sheets are produced by cold rolling the hot rolled steels to control the size and finish.

The thickness of such sheets is maintained to the greater accuracy. They are used in the manufacture of refrigerators, cooking ranges, panels, lockers, and electrical fixtures.

Cold rolled sheet and strips are available in six grades of hardness (fig....) as follows: -

#### A) HARD

Hard sheets and strips will not bend in either direction of the grain without cracks or fracture. Such steels are employed for flat blanks that require resistance to bending and wear.

#### B) THREE QUARTER HARD

Three quarter hard strips will bend to an angle of 60° from flat only across the grain.

#### C) HALF HARD

Half-hard steel strips will bend a sharp 90° angle across the grain.

#### D) QUARTER HARD

This commonly used steel will bend over flat (180°) across the grain and to a sharp right angle along the grain.

#### E) SOFT

Soft grades of steel will bend over flat (180°) both across and along the grain direction. This can be used for moderate forming and drawing operations.

#### F) DEAD SOFT

This steel is widely used for severe forming and drawing operation.

### **DEEP DRAWING STEEL SHEETS:**

Deep drawing steel is prime quality cold rolled steel having a very low carbon content. These sheets are thoroughly annealed, highly finished to deoxidized silver finish, and oiled. Deep drawing sheets are used for difficult drawing, spinning and forming operations such as automobile bodies, fenders, electrical fixtures and laboratory equipments.

### **SILICON STEEL:**

These are also called as electrical steel, silicon steel is extensively used for electrical laminations. Lighter gauges are suitable for transformer, reactors, relays, and other magnetic circuits.

### **STAINLESS STEEL:**

These steels cover a wide range of application. They can be used with few expectations for all application for which carbon steel are used where corrosion resistance is a requirement.

## NON-FERROUS METALS

### COPPER AND COPPER ALLOYS:

Due to good conductivity of heat and electricity as well as non-corrosiveness, copper and its alloys are widely used as stock material for stamping. Copper alloys and its composition:

Beryllium copper	Be 2%, Co 3%, Cu 97.7%
Red brass	Cu 25%, Zn 15%
Low brass	Cu 20% , Zn 20%
Cartridge brass	Cu 70% , Zn 30%
Yellow brass	Cu 65%, Zn 35%
Muntz metal	Cu 60%, Zn 40%
Phosphor bronze	
Zn 4%, Zn 4%, Sn 4%, Cu 27.65%, Pb 35%	

### 2.2.2.2) ALUMINIUM AND ITS ALLOYS:

Aluminium is one of the lightest metals. It resists the corrosive effect of most of the chemical and has high malleability combined with good thermal and electrical conductiveness. Aluminium is alloyed with silicon, iron, copper, manganese, chromium, nickel and zinc.

Some of the aluminium alloys are strain hardenable, whereas some are heat treatable. Aluminium and its alloys are widely employed in manufacture of aircraft, electrical equipment and utensils.

### MAGNESIUM AND ITS ALLOYS:

Magnesium is relatively silver white material. In its purest state, it does not possess sufficient strength for many commercial uses. Magnesium is alloyed with other metals like aluminium, manganese and zinc. Most of the forming and bending operations on manganese alloys are done at 200° C to 300° C. Other than once explained above, the alloys of zinc, tin and titanium are also used in stamping industry.

### RARER METALS:

Rarer metals like zirconium, tantalum, vanadium, tungsten and molybdenum and their alloys find their place as stock material in press working.

### PRECIOUS METALS:

Precious alloys like gold, silver. Platinum and palladium are for laboratory equipment and electrical industry.

### CLAD METALS:

Clad metal strip or sheet is a composite of a core or a backing layer and covering layer of a dissimilar material. The covering metal thickness is usually 10- 35% of the total composite thickness and it is bonded to the backing material by the use of adhesive, solder or by molecular bonding. Commonly used clad metals for steel are- Stainless steel nickel, copper, nickel and silver. For copper stainless steel and platinum. For brass gold silver platinum and palladium.

### PREPARATION OF STOCK:

Stampings can be manufactured from stock material of different forms.

### STOCK STRIP:

In steel mills, the metal is formed into large sheets by rolling and trimming. The sheets are cut into strips in a shearing machine. Gauges register the edges of the sheet for cutting the strips to correct width. The power shear can shear the sheet in any direction across the sheet or along the sheet or at an angle. The latest technique used in cutting the strip is by slitting. The sheet is fed through rotating cutter or knives and all strips are cut simultaneously. Power driven collars cause the sheet to advance. Unlike the shear, which can cut strips of length only equal to the width of the blade at a time, the slitting machine will cut continuously to any length of the sheet.

Small length of strips are hand fed into the tool by the press operator, whereas strips of longer length and lighter gauge are coiled into rolls and fed by automatic feeding mechanism.

### UNIT STOCK:

Quite frequently, it is not practicable to blank directly from a continuous strip or from a certain length of strip. This happens when the stock material is heavy or large in size. In such cases, unit stock is cut to slightly bigger size than the blank is fed into the tool, one per stroke of the press ram.

Scrap material left over from another tool may also be used as unit stock if there is sufficient margin all around.

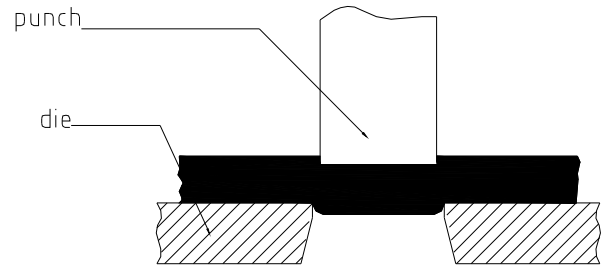


The name shearing stands for the method of cutting sheets or stock without forming chips. The material is stressed in a section, which lies parallel to the forces applied. The forces are applied either by means of shearing blades or punch and die.

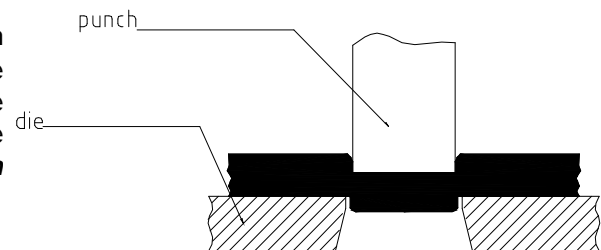
The forces necessary to bring rupture of the material depends primarily upon the shearing strength ( $t_{max}$ ) and the stressed section or the stressed area and secondly upon the shape, condition and position of the shear blades.

## CRITICAL STAGES OF SHEARING

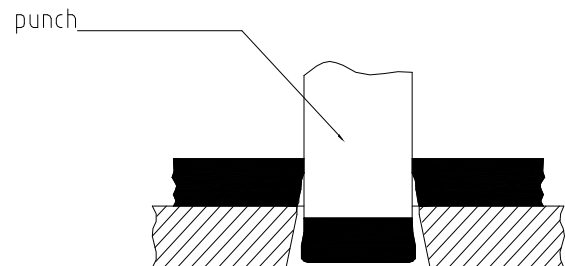
**STAGE 1:** The pressure applied by the punch on the stock material tends to deform it into the die opening when the elastic limit is exceeded and by further loading, a portion of the material will be forced into the die opening in the form of an embossed pad on the lower face of the material and will result in a corresponding depression on its upper face. This stage imparts a radius on the upper edge of the opening in the strip and on the lower edge of the punched out material (blank or slug). This is called the stage of *plastic deformation*.

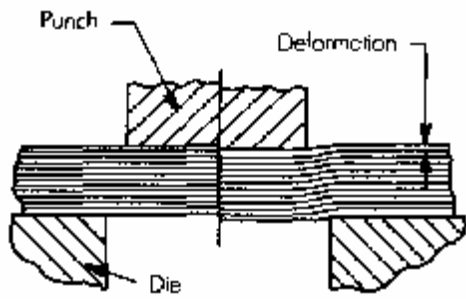


**STAGE 2:** As the load is further increased, the punch will penetrate the material to a certain depth and force an equally thick portion of metal into the die. This stage imparts a bright polished finish (cut band) on both the strip and the blank or slug. This is the *penetration stage*.

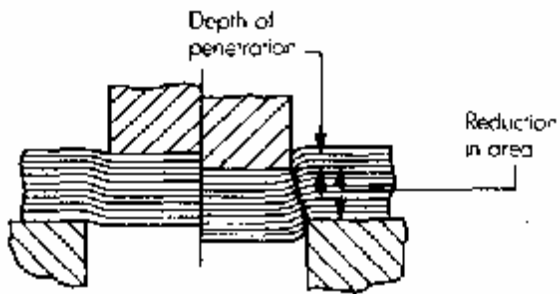


**STAGE 3:** In this stage, fractures will start from both upper and lower cutting edges. As the punch travels further, these fractures will extend towards each other and eventually meet, causing complete separation. This stage imparts a dull fractured edge. This is the *fracture stage*.

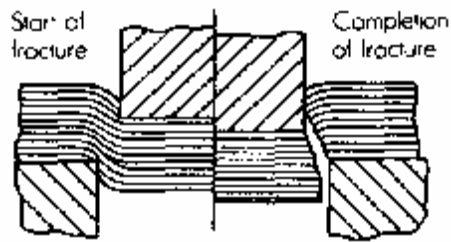




Plastic deformation



Penetration



Fracture

## CUTTING FORCE

Cutting force is the force which has to act on the on the stock material in order to cut out the blank or slug. This determines the capacity of the press to be used for particular tool. The first step in establishing the cutting force is to determine the cut length area. The area to be cut is found by multiplying the length of cut by stock thickness.

Formula for calculating the cutting force:

$$\text{Cutting force} = L \times S \times T_{\max}$$

L = Length of periphery to be cut in mm  
 S = Sheet thickness in mm  
 $T_{\max}$  = Shear strength in  $\text{N/mm}^2$ , (taken from table)  
 = 80% of tensile strength ( $\sigma_{\max}$ )

Resistance begins when the punch contacts the stock material. The load builds up rapidly during the plastic deformation stage and continues to increase while penetration is taking place. The accumulated load is suddenly released when fracture occurs. If proper cutting clearance condition exists between the punch and the die the fracture will occur when the cutting force equals the shear strength of the material. The curve levels off near the bottom. This last portion of the load curve represents the frictional resistance as the punch travels through the stock material and also the resistance of the blank passing through the die.

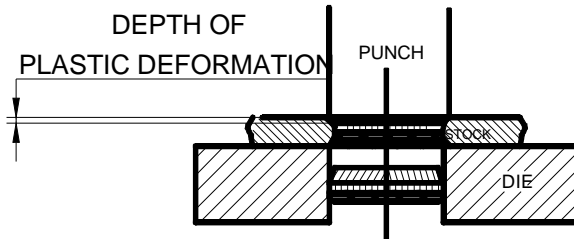
### FORMULA TO CALCULATE THE PRESS FORCE

$$\text{Press force} = \text{Cutting force} + \text{Stripping force}$$

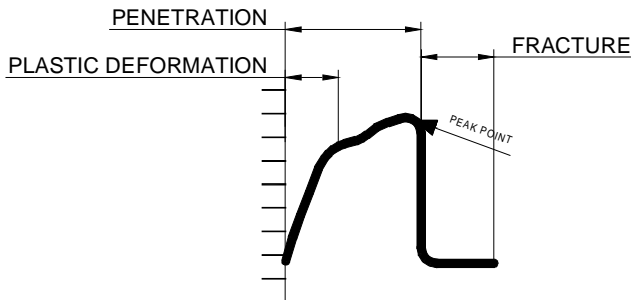
(Stripping force = 10%-20% of cutting force.)

The three critical stages of shearing action are related to cutting force.

The following table gives the shear strength ( $\tau_{\max} = 0.2$  for tensile strength  $\sigma_{\max}$ ) of several materials



The figure represents the typical load curve of cutting force of blanking or piercing punch.



MATERIAL	$\tau_{\max}$ in $\text{N/mm}^2$
Steel with 0.1% carbon	240-300
Steel with 0.2% carbon content (deep draw steel)	320-400
Steel with 0.3% carbon	360-420
Steel with 0.4% carbon	450-560
Steel with 0.6% carbon	550-700
Steel with 0.9% carbon	700-900
Silicon steel	450-550
Stainless steel	350-450
Copper	200-400
Brass	350-400
Bronze	360-450
German silver	300-320
Tin	30-40
Zinc	100-120
Lead	20-30
Aluminium 99% pure	20-120
Aluminium manganese alloy	150-320
Aluminium silicon alloy	120-250
Paper and card board	20-50
Hard board	70-90
Laminated paper	100-140
Laminated fabrics	90-120
Mica	50-20
Plywood	20-40
Leather	7
Soft rubber	7
Hard rubber	20-60
Celluloid	40-60
Laminated fabrics	90-120

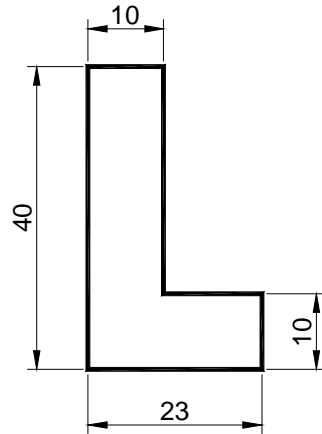


**Example:1.**

Calculate the press force required to produce the following component.

Sheet Thickness 2mm.

Material is brass



$$\begin{aligned} \text{Cutting force} &= l \times s \times T_{\max} \\ &= 126 \times 2 \times 400 \\ &= 100800 \text{ N} \\ &= 100.8 \text{ KN} \end{aligned}$$

$$\begin{aligned} \text{Press force} &= \text{Cutting force} + \text{stripping force} \\ &= 100800 + 20\% 100800 \\ &= 120960 \text{ N} \\ &= 120.960 \text{ KN.} \end{aligned}$$

**METHOD OF REDUCING THE CUTTING FORCE**

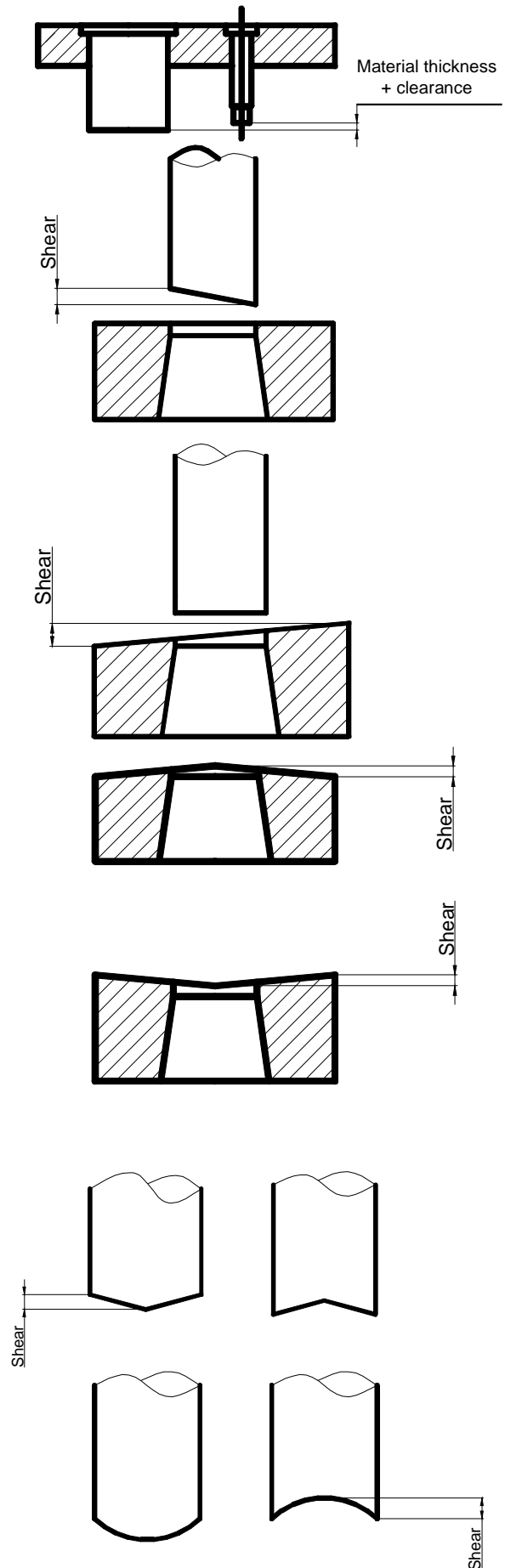
It sometimes becomes necessary to reduce cutting forces to prevent press over loading.

The method of reducing cutting forces is to step punch length. Punches or group of punches progressively become shorter by about one stock material thickness.

A second method is to grind the face of the punch or die to a small shear angle with the horizontal. This has the effect of reducing the contact area while shearing at one time. Providing shear also reduces the shock to the press and smoothens out the cutting operation. The shear angle chosen should provide a change in punch from 1 to 1.5-sheet thickness.

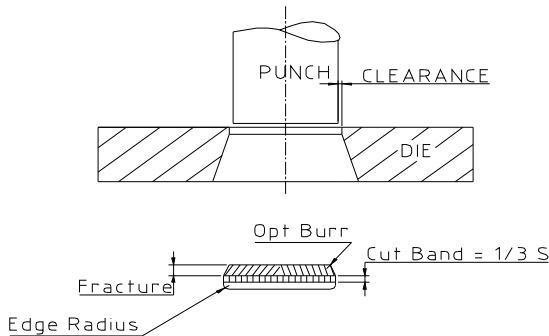
Various types of shear angle are shown in the figure. Double shear angle is preferred over single shear angle because it balances the cutting force acting on the punch. Double shear angle on punches should be concave to prevent the stretching of the material before it is cut. Shear angle may be applied either to the punch face or to the die face, depending on whether the operation is blanking or piercing because shear will distort the work material. The shear angle for blanking operation will be on the die member, while, as the piercing operation the shear angle will be given on the punch member.

**Stepping of punches**



## CUTTING CLEARANCE:

Cutting clearance is the gap between the side of the punch and the corresponding side of the die opening on one side of the edge, when the punch is entered into the die opening. Therefore the cutting clearance should always be thought and expressed as the amount of clearance per side.



## IMPORTANCE OF CUTTING CLEARANCE:

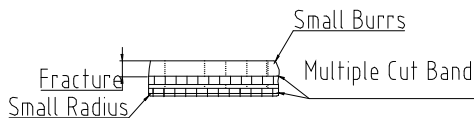
Proper cutting clearance is necessary to aid the life of the die and the quality of the piece part. Excessive cutting clearance results in objectionable piece part characteristics. In sufficient cutting clearance causes undue stress and wear on the cutting edges of the tool because of the greater punching effort required

## TYPICAL APPEARANCE CHARACTERISTICS

A visual examination of the press tool component will indicate the amount of clearance between them the excessive clearance, insufficient clearance and misalignment between the punch and the die.

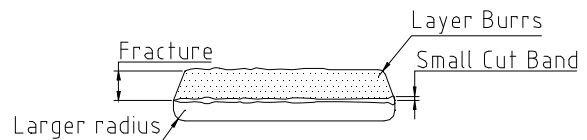
## OPTIMUM CUTTING CLEARANCE:

The figure shows the blank or slug made under optimum cutting conditions. The edge radius (die roll) is the result of initial plastic deformation, which occurred during the first stage of plastic shear action. Highly burnished cut band results from the second stage (penetration) of shear action. The width of the cut band is approximately  $\frac{1}{3}$  rd the thickness of stock material. The balance of the cut is the break, which results from the third stage (fracture) of the shearing action.



## EXCESSIVE CUTTING CLEARANCE:

The comparatively the large gap between the punch and the die cutting edges allows the stock material to react to the initial pressure on a manner approaching that of forming rather than cutting. Therefore the edge radius becomes larger. It does not blend smoothly. The cut band becomes smaller. The break shows greater irregularities due to above facts. These irregularities may effect cut band and the edge radius, and when the break occurs heavy burrs are noticeable all along the cut contour.

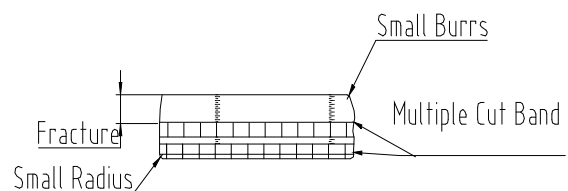


## INSUFFICIENT CUTTING CLEARANCE

When cutting clearance is slightly less the condition can be identified by greater width of the cut band. If the cutting clearance is further decreased, two or more cut bands will be produced.

Because of steeper angle between the punch and the die cut edges the resistance of the stock material to fracture is increased. The resulting accumulation of pressure may cause the initial fracture to originate at clearance rather than at the cut edges.

In case of excessive clearance the burr results from dragging of the material. While insufficient clearance compressive forces cause the burr.



## MISALIGNMENT BETWEEN PUNCH AND DIE

The cutting characteristics also indicate whether the punch and die openings are in accurate alignment. Because of misalignment clearance on one-side increases and other side decreases. The component will show corresponding differences in the cut band

### BURR SIDE:

The burr side is adjacent to the break. The burr side is so called because of a noticeable burr condition develops in this side. Burr should be practically non-existent if the cutting clearance between the punch and the die is correct and if the cutting edges are sharp.

The characteristics of the blank or slug and the punched opening are inversely identical. The burr side of the blank or slug is always towards the punch (die starts shearing) the burr side of the punched opening is always towards the die opening. (punch starts shearing).

### RELATIONSHIP OF PIECE PART SIZES TO PUNCH AND DIE SIZES:

When pierced or blanked piece parts are measured, the measurement is made at the cut band. The actual cutting of the blank or slug is done by cutting edge of the die opening. Therefore the die opening determines the size of the blank or slug. The actual cutting of the opening in the stock material is done by punch. Therefore the size of a punched opening is determined by the punch.

## DETERMINING THE CUTTING CLEARANCE:

The ideal clearance could be found by the following formula and depends on co-efficient of 'C'

*Clearance for 's' up to 3 mm*

$$= c \times s \times \frac{\sigma T_{max}}{10}$$

*For 's' above 3 mm clearance*

$$= (1.5 \times s) \times (s - 0.015) \times \frac{\sigma T_{max}}{10}$$

*Where 's' is the sheet thickness in mm*

*'C' is constant = 0.005 or 0.01 as the case may be.*

$$T_{max} = \text{Shear strength}$$

$$= 80\% \text{ UTS. It is expressed in N/mm}^2$$

If we take 'c' as 0.005 we get a clearance, which yields a better and cleanest work piece, but requires a higher cutting force and considerably more energy. If we take 'c' as 0.01, the cutting force energy as its minimum, but finish is bad. The usual practice however is to take 'c' as 0.01

## DETERMINATION OF PUNCH AND DIE SIZE:

### PIERCING:

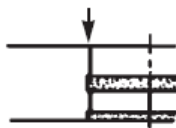
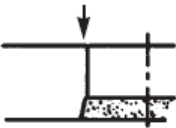
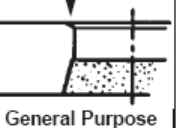
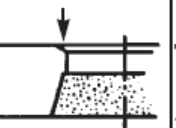
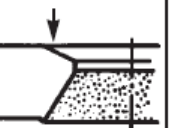
*Piercing punch = Pierced hole size*

*Die = Hole size + total clearance.*

### BLANKING:

*Blanking punch = Blank size - total clearance*

*Die = Blank size*

<p>BURR AND BURNISHED LENGTHS INCREASE AS CUTTING EDGES BREAK DOWN</p> <p><b>DURATION OF RUN:</b> LONGER RUNS AS CLEARANCES INCREASE</p>	<p><b>A</b> Burr: Tensile and Compressive Minimum Roll-Over</p>  <p>Double Shear</p>	<p><b>B</b> Burr: Tensile and Compressive Minimum Roll-Over</p>  <p>Secondary Shear</p>	<p><b>C</b> Burr: Tensile Moderate Roll-Over</p>  <p>General Purpose Hole</p>	<p><b>D</b> Burr: Tensile Large Roll-Over</p> 	<p><b>E</b> Burr: Tensile and Extrusion Very Large Roll-Over</p> 
	<b>EJECTOR PUNCHES REQUIRED</b>				
	<b>MATERIAL</b>	<b>TOTAL CLEARANCE IN PERCENT OF MATERIAL THICKNESS</b>			
ALUMINUM - HARD	1 - 2%	10 - 12%	18 - 20%	25 - 28%	40% Max.
- SOFT	1 - 2%	4 - 8%	12 - 16%	16 - 20%	34% Max.
BRASS - 1/2 HARD	1 - 2%	6 - 10%	12 - 16%	18 - 22%	48% Max.
- ANNEALED	1 - 3%	4 - 6%	12 - 16%	16 - 20%	42% Max.
BRONZE, PHOSPHOR	3 - 5%	7 - 10%	20 - 24%	25 - 27%	50% Max.
COPPER - 1/2 HARD	2 - 4%	6 - 10%	12 - 16%	18 - 22%	50% Max.
- ANNEALED	1 - 2%	4 - 8%	10 - 14%	16 - 18%	50% Max.
LEAD	3 - 5%	8 - 12%	13 - 15%	16 - 20%	44% Max.
MAGNESIUM	1 - 2%	3 - 5%	7 - 9%	10 - 14%	32% Max.
STAINLESS STEEL	2 - 4%	6 - 10%	18 - 22%	25 - 27%	46% Max.
STEEL, CRS (1020)	2 - 4%	10 - 14%	16 - 20%	23 - 25%	42% Max.
HIGH CARBON	5 - 10%	22 - 26%	28 - 32%	34 - 38%	50% Max.

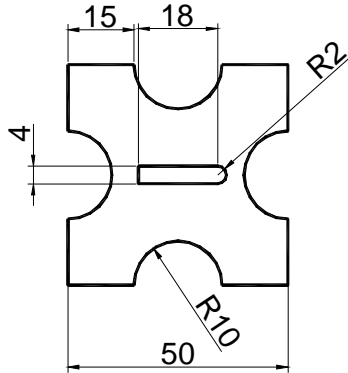
**PROBLEMS**

**Eg.1:** Calculate the clearance for punching a 2 mm sheet. Tmax is assumed to be 300 N/mm<sup>2</sup>

$$\begin{aligned} \text{Clearance} &= c \times s \times \sqrt{T_{\max}/10} \\ &= 0.01 \times 2 \times \sqrt{300/10} \\ &= 0.02 \times \sqrt{300/10} \\ &= 0.12 \text{ mm/ side} \end{aligned}$$

Therefore clearance on one side = 0.12mm

**Eg.2:** Determine the punch and die dimension for the component given below. Sheet thickness 0.5mm, stainless steel sheet, Tmax is 400 N/mm. C=0.01



$$\begin{aligned} \text{Clearance} &= C \times S \times \sqrt{T_{\max}/10} \\ &= 0.01 \times 0.5 \times \sqrt{400/10} \\ &= 0.03 \text{ mm/side} \end{aligned}$$

**BLANKING PUNCH:**

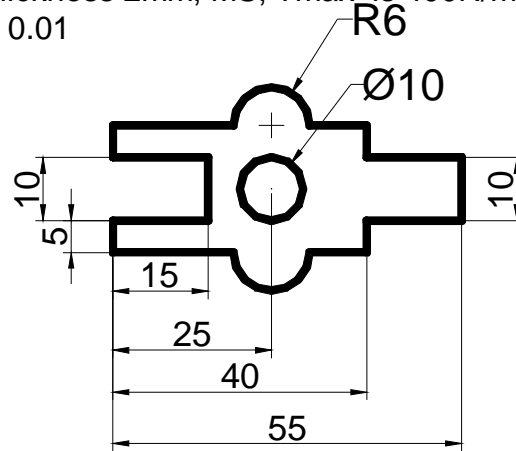
COMPONENT DIMENSION	CLEARANCE Add / Deduct	PUNCH / DIE Dimension
50	-0.06	49.94
15	-0.06	14.94
R10	+0.03	R10.03

Blanking die dimension is the same as the component dimensions.  
Piercing punch size is the size of the pierced opening

**PIERCING DIE:**

COMPONENT DIMENSION	CLEARANCE Add / Deduct.	PUNCH / DIE
R2	+0.03	R2.03
4	+0.06	4.06
18	+0.03	18.03

**Eg.3:** Determine the punch and die dimension for the component given below. Sheet thickness 2mm, MS, Tmax is 400N/mm. C = 0.01



$$\begin{aligned} \text{Clearance} &= C \times S \times \sqrt{T_{\max}/10} \\ &= 0.01 \times 2 \times \sqrt{400/10} \\ &= 0.13 \text{ mm/side} \end{aligned}$$

**BLANKING PUNCH:**

COMPONENT DIMENSIONS (PUNCH)	CLEARANCE Add / Deduct	PUNCH / DIE DIMENSIONS
5	-0.26	4.74
R5	-0.13	5.87
10	-0.26	9.74
10(SLOT)	+0.26	10.26
15	--	15
20	-0.26	19.74
25	-0.13	24.87
40	-0.26	39.74
55	-0.26	54.74

Blanking die dimension is same as the component dimensions.  
Piercing punch size is same as component size.

Piercing die size = component size + clearance

= 10.00 + 0.26

= 10.26mm



## GUIDE PLATE TOOL:

Guide plate tool is preferred when

- 1) Shape of component is simple.
- 2) The accuracy of the component is less.
- 3) Only fewer components are required.

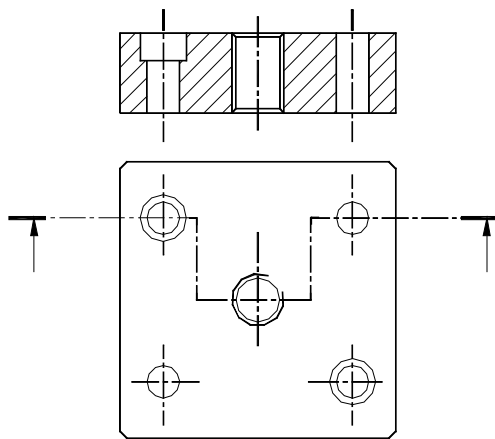
The guide plate tool consist of :

- 1) Top plate.
- 2) Bottom plate.
- 3) Punch holder.
- 4) Punch.
- 5) Die plate.
- 6) Thrust plate (back plate).
- 7) Shank.
- 8) Guide plate.
- 9) Stopper.
- 10) Dowel pin.
- 11) Screws.

## IMPORTANCE OF GUIDE PLATE TOOL ELEMENTS.

### TOP PLATE:

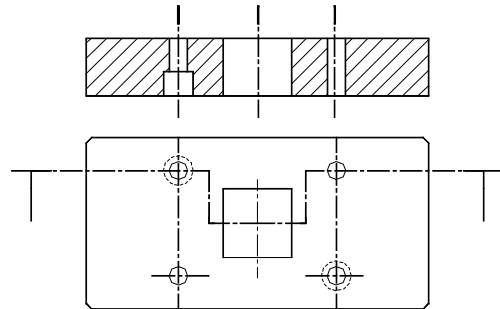
This plate is also known as top bolster or die head. Punch unit is rigidly and accurately held on this plate. Top plate should be thick enough to take the load of punch backpressure. It is made out of mild steel or cast iron.



TOP PLATE

### BOTTOM PLATE:

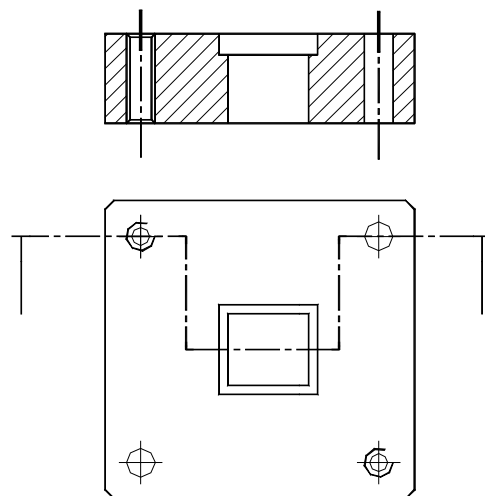
This plate is also known as bottom bolster or base plate or die shoe. Die unit is rigidly and accurately mounted on this plate. Bottom plate should be thick enough to take the load of the punching pressure or load. It is made out of mild steel or cast iron.



BOTTOM PLATE

### PUNCH HOLDER:

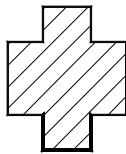
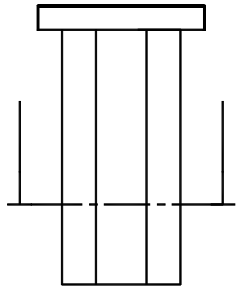
This plate is also called as punch plate. All the punches are accurately held in this plate. This plate should be thick enough to accommodate punch shoulder and keep the punches perpendicular. It is made out of mild steel. Punch plate is made out of single piece and a need base it is also made out of more than single piece.



PUNCH HOLDER

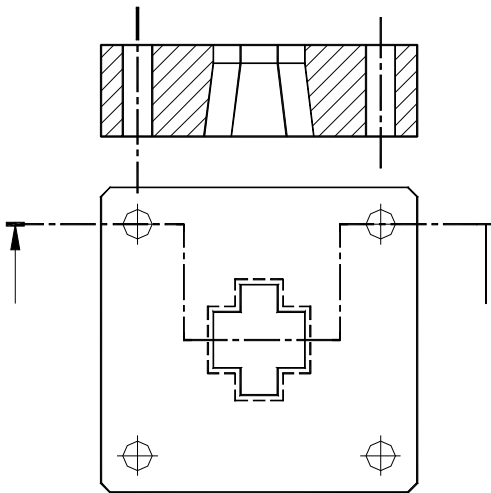
### PUNCH:

This is one of the most important element of the tool. It is the cutting element of the tool. Punch gives the hole size and the shape on the component. This is made out of high carbon high chromium steel Material. Punches are hardened and tempered to 58-60 HRC. The length of the punch in normal condition is kept up to 60mm. Opposite end of the cutting face is shouldered or tapered to mount on top unit.



### DIE PLATE:

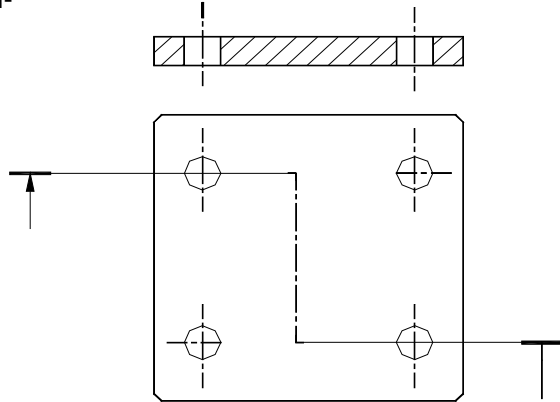
This is most on of the important element of the tool. This is mounted on bottom plate. Die plate is the cutting element of the tool which gives the blank size and shape. This is made out of high carbon high chromium steel material. It is hardened and tempered to 60-62 HRC. Die plate thickness is decided on the basis of stock material being cut.



DIE PLATE

### BACK PLATE:

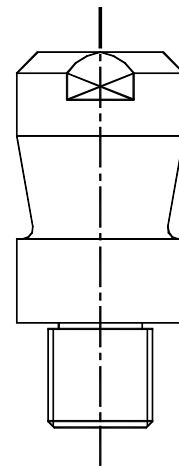
This plate is also known as thrust plate. This plate is mounted on top of the punch holder. It is made out of medium carbon steel. It is hardened and tempered to 45 to 48 HRC. Punch heads have direct contact with this plate, which will prevent the punch penetration into top plate during punching operation.



BACK PLATE

### SHANK:

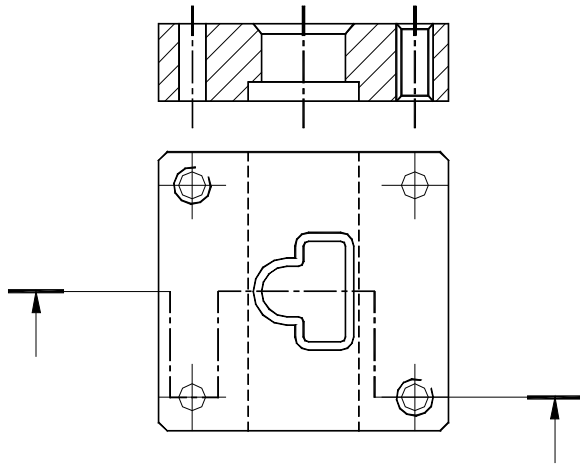
Shank is a tool element. This is fixed on the top plate. Shank is fixed in the press ram. This should be strong enough to take the total weight of the punch unit and stripping force. There are different types of shank standards. Selection of the shank is based on the need base. It is made out of mild steel. The location of the shank point is very important and different load acting on top plate is to be considered.



SHANK

## GUIDE PLATE:

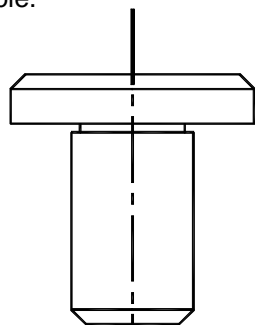
This plate is also called as stripper plate. In guide plate tool this element is known as guide plate. This plate helps in stripping operation. It not only strips the strip from the punch but the main function of this plate is to guide the punch accurately and maintains the alignment between punch and die. Hence the plate is made with the same care as die. It is mounted on die plate. It is made out of mild steel. In some cases this guide plate is also made out of tool steel. A channel is milled in the plate, which will guide the stock strip.



BOX STRIPPER

## STOPPER:

The stopper shown is a plain cylindrical pin. The pin is mounted in the die block. The function of the stopper is to arrest the movement of the strip when it is fed forward to one pitch length. Various type of stoppers are available.



STOPPER

## DOWEL PIN:

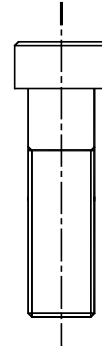
This is a cylindrical pin hardened and ground on center less grinder. This dowel is made to m6 tolerance. Dowel pins keep the alignment between the plates and prevent it from lateral movement.



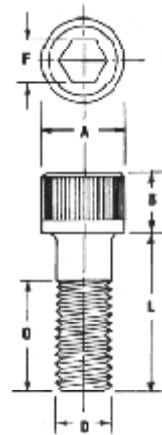
DOWELS

## SCREWS:

This is fastening element. Screws are used to hold the plates together. The sizes of the screws are selected on the basis of tool size

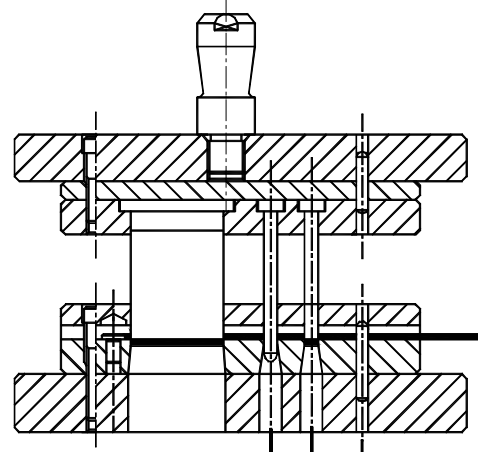


SCREWS



The guide plate tool consist of

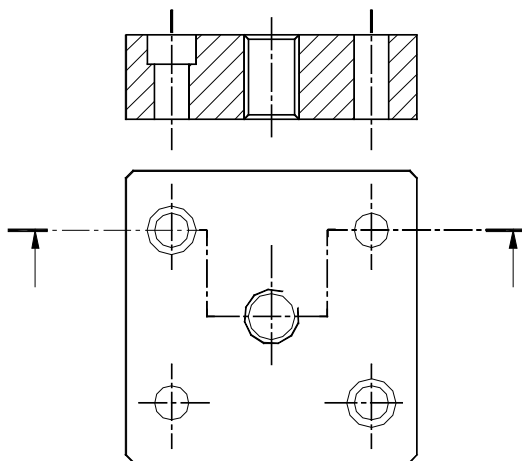
- 1) Top plate.
- 2) Bottom plate.
- 3) Punch holder.
- 4) Punch and die.
- 5) Back plate.
- 6) Shank.
- 7) Stripper cum guide plate.
- 8) Stopper.
- 9) Screws and dowels.



## IMPORTANCE OF GUIDE PLATE TOOL ELEMENTS

### TOP PLATE:

The punch, punch holder and back plate is mounted on the top plate. The tool shank that locates the whole tool centrally with the press ram is also screwed on the top plate. The top plate is made of mild steel or cast iron. This plate should be thick enough to prevent bending.



TOP PLATE

### BOTTOM PLATE:

This plate gives a cushioning effect to the die as well as provides enough room for the tool to be clamped to the press bed. There may be an opening in the back plate which allows the blank or slug to fall clear off the tool. They should meet the following requirement:

- 1) The opening should not weaken the support of the die.

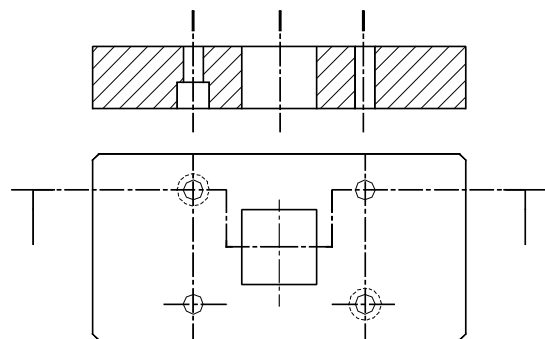
- 2) The blank should fall clear off the die without any obstruction.

- 3) The contour of the opening should be made simple as possible.

- 4) The openings in no case weaken the die plate.

- 5) Since the sharp edges of the blank dig into the side walls, extra relief should be provided in such cases by drilling the relief holes.

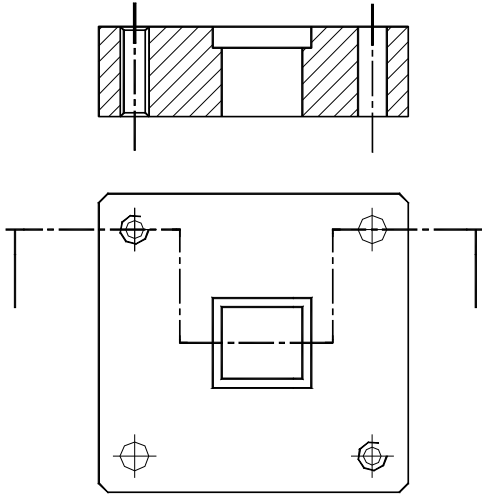
The base plate is also made of good quality mild steel or cast iron and should be thick enough to prevent deformation under pressure.



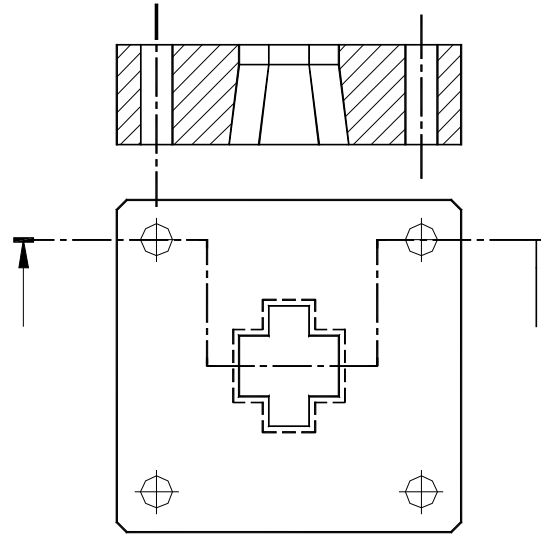
BOTTOM PLATE

### **PUNCH HOLDER:**

The punch holder is usually fixed in the with a light press fit in the punch holder. Some means to prevent the profiled punches from rotating should be provided in the punch holder (a key or a dowel)



PUNCH HOLDER



DIE PLATE

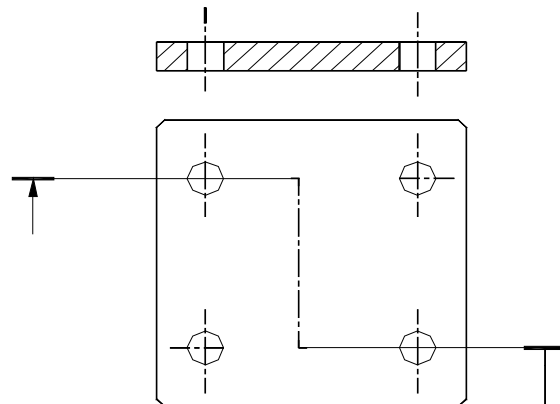
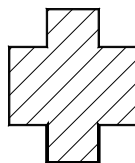
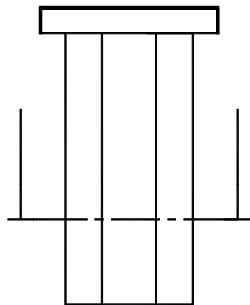
### **BACK PLATE:**

While performing the cutting operation the punch exerts an upward thrust. So the punch should be backed up by a hardened plate to prevent it from digging into the soft top plate.

The hardness is about 45-50 HRC

### **PUNCH AND DIE:**

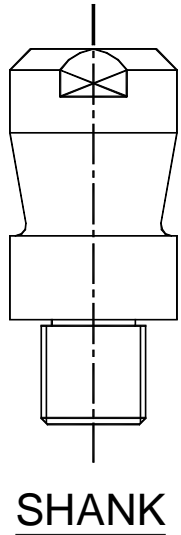
The basic elements of blanking tool are punch and die. They are made out of good quality alloy steels. They are hardened and tempered to 58 -62 HRC.



BACK PLATE

## SHANK:

The tool is located and clamped to the press ram by the shank. Diameter of the shank for a particular tool depends only on the diameter of the bore in the press ram on which it is intended to be mounted. Shanks are standardized to suit different press.

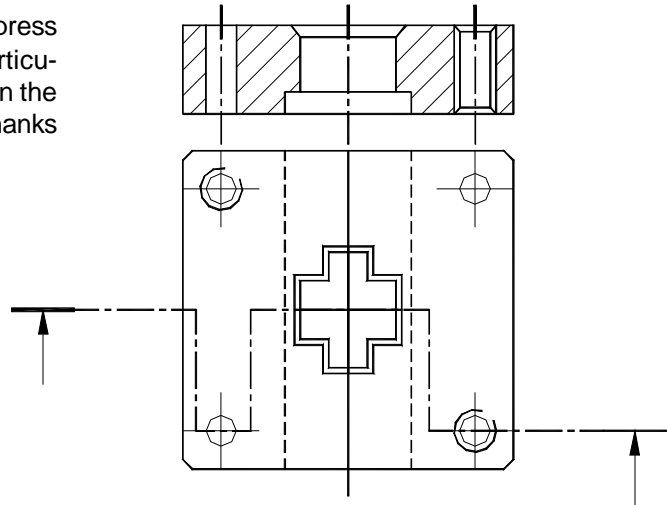


SHANK

## GUIDE PLATE:

While performing the cutting operation the punch penetrates the stock material and enters into the die. As a result of this blank or slug is pushed into the die. In completion of the cutting operation the punch withdraws from the die, but the stock strip clings tightly around the punch. The strip cannot be moved forward unless the strip is removed from the punch to facilitate the removal of the strip from the punch another plate is mounted on the top of the die with the help of screws and dowels. This plate does not allow the strip to go along with the punch so it is called the stripper.

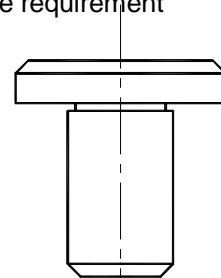
The stripper has another function too. The channel milled on bottom face of stripper ensures that the stock strip is guided and is fed in line with the die profile, thus maintaining the front and back scrap equal throughout. In guide plate tool it is the stripper, which aligns the punch with the die. Maintaining close sliding fit between the punch and the stripper opening as well as location in line with the die attains it. Whenever a stripper guides a punch into position it is called a guide plate. Guide plates usually made of mild steel. If higher production is anticipated, it is made of medium carbon steels and hardened to 45-50 HRC.



BOX STRIPPER

## STOPPER:

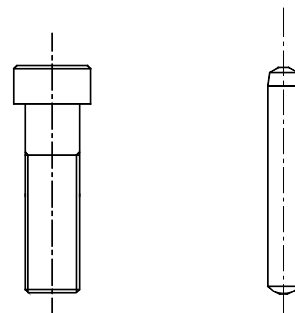
A stopper can be a plain cylindrical pin. The pin is mounted in the die block. The function of the stopper is to arrest the movement of the strip when it is fed forward to one pitch length. Stoppers are designed as per the requirement



STOPPER

## SCREWS AND DOWEL PIN:

The screws are used to hold the die parts together and the dowels are used to align the die parts to gather .



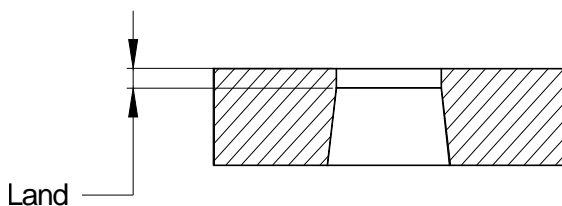
SCREWS AND DOWELS

## LAND AND ANGULAR RELIEF OR ANGULAR CLEARANCE:

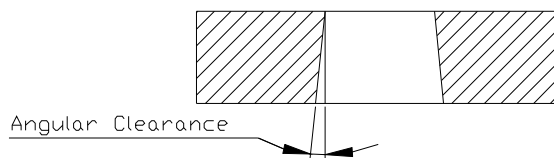
### LAND:

The inner walls of the die opening are not usually made straight through as the blanks or slugs tend to get jammed inside, which may result in undue stress build up. This may lead to the breakage of punch and die.

To avoid such a situation the die walls are kept straight only to a certain amount from the cutting edge. The straight wall is called "The Land." An amount of 3mm land for stock thickness upto 3mm and the thicker materials equal to their thickness has proved to be good practice.



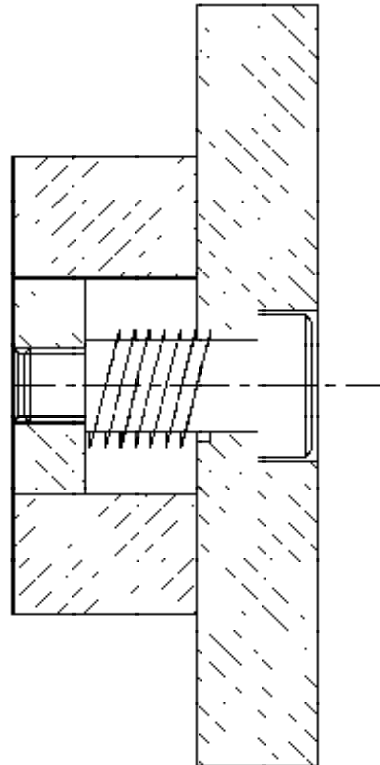
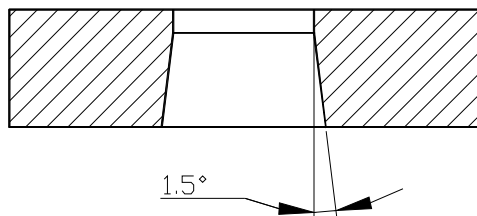
In special cases, the angular clearance extends from top to bottom of the die wall completely eliminating the land. Silicon steel and stainless steel stocks tend to bell mouth the die opening very rapidly unless the angular clearance begins at the cutting edge



Dies employing an ejector to clear the blanks will have straight walls without any angular clearance, as the blanks do not get accumulated in the die.

### ANGULAR CLEARANCE OR ANGULAR RELIEF:

The die wall below the land is relieved at an angle for the purpose of enabling the blanks or slugs to clear the die. Generally, soft materials require greater angular clearance than hard materials. Soft thicker materials above 3mm require more angular clearance. An angular clearance of  $1.5^\circ$  per side will meet the usual requirements



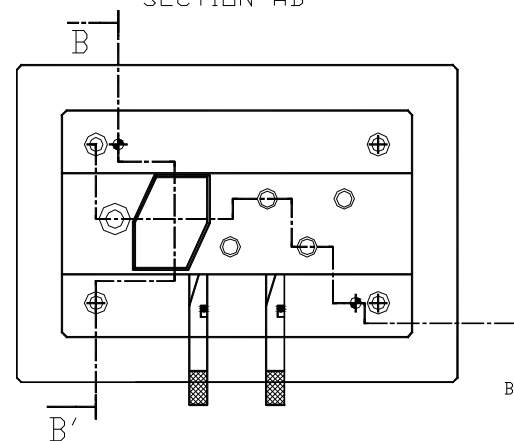
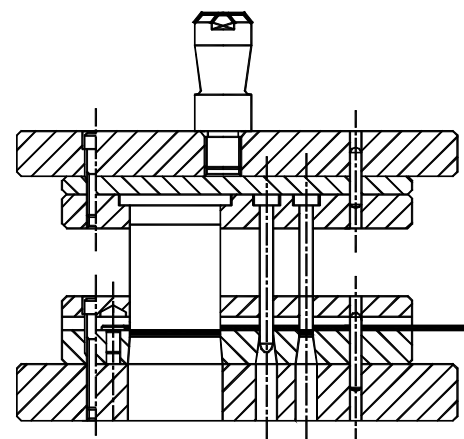
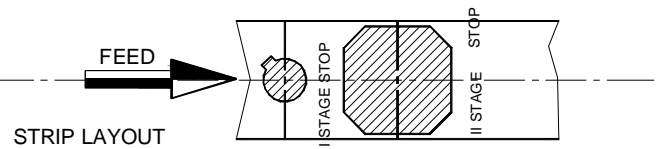
A simple blanking tool is designed only when the piece part has no internal details. An altogether different tool is designed if the piece part is to be produced by the combination of blanking and piercing operation. It can be done in the following way in the same tool. The piercing is performed in the first station. Then the stock strip is advanced to another station where blanking is carried out. The relative position with the previously pierced hole is maintained during the blanking operation. The tool is known as "progressive tool" because the processing progresses from station to station.

A simple design of blanking tool or piercing tool is made when the piece part has no internal details. When piece part is to be produced with internal details, then altogether a different tool is to be produced by combination of piercing and followed by blanking operation in one tool. The piercing operation is performed in the first stage. Stock strip is advanced equal to pitch and stopped against final stop. In this stage i.e. 2<sup>nd</sup> stage blanking operation is performed. Hence a piece part is produced with internal details of piercing operation.

When more internal details are to be produced in the piece part, same procedure is to be followed. In the first stage piercing operation is done. The strip is advanced equal to pitch stopping against the finger. In this stage piloting operation is performed. In the II stage piloting operation is carried out and with piloting some more internal detail can be performed. Hence internal details performed in the II stage is with relation to the pilot hole. Similarly strip can be advanced equal to pitch stopping against auxiliary stop. Once again in this stage piloting can be done and internal detail operation is performed. In this manner number of internal detailed operations can be performed in different stages. Finally the strip is stopped against the final stop and blanking operation is carried out. In this progressive die piece part is produced with internal details.

In guide plate progressive tool, piece part is produced following the above procedure. During the design of guide plate progressive tool, the limitations of this tool are to be understood and then the design is to be made.

The limitation is also same like guide plate tool. Piercing punches, pilots and blanking punch is purely guided by the guide plate. The accuracy is mainly depending on the accuracy of guide plate. Guide of tool elements like punches and pilots and alignment is governed by guide plate tool. Hence the following factors are to be kept in mind while deciding guide plate progressive tool.

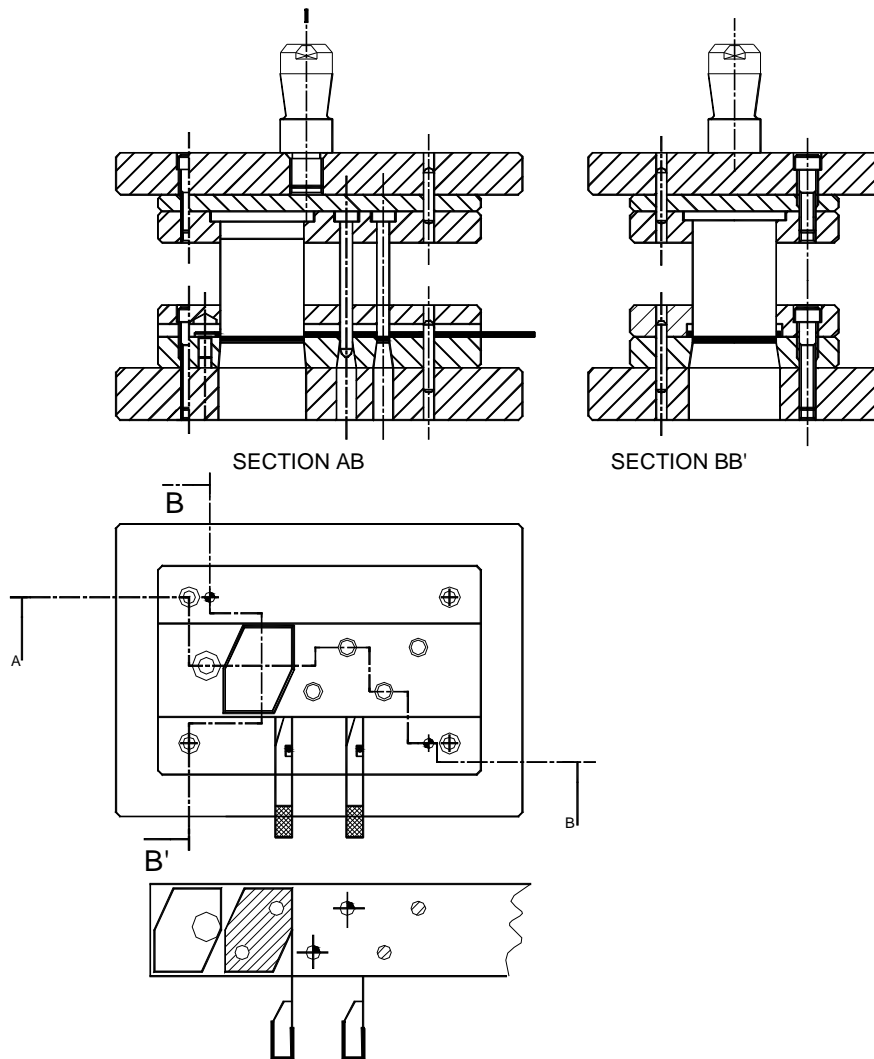




When the component profile is simple.

- When the accuracy of piece part is average (not very accurate)
- When production is less
- When number of stages are less

With the above limitations keeping in view, the decision is taken to make the guide plate progressive tool.



The die is constructed from the die drawing, the die drawing is made around the strip, and the strip represents the sequence of the logical, workable operations, which is to say, a sequence of ideas. If this sequence of operation has error, the error will be surely emerge in the try out press and so it behaves the designer to make certain, that his strip is cent percent sound. Other errors in the design can be corrected but the strip sequence is unworkable, the die is scrap

### **ECONOMY FACTOR:**

Stock material conservation being a decisive factor in press working, the designer should try out every possible means to attain this, without sacrificing the accuracy requirement of the piece part. Economy of any strip layout in percentage is found out by the following formula.

$$\text{Economy factor} = \frac{\text{Area of the blank} \times \text{number of rows} \times 100}{\text{Width of the strip} \times \text{pitch}}$$

*A minimum economy of 60% should be aimed at while laying a strip. The position of the blank in the strip decides the economy factor*

### **STRIP LAYOUT FOR BLANKING TOOLS:**

Blanking tools produce blanks entirely from the strip or the unit stock. None of the edges of the unit stock or the strip form the edge of the blank. Blanking is the most efficient and popular way of producing the intricate and closely tolerated blanks. Whatever profile and accuracy is built into the tool will be produced on the blank.

In the strip layout for blanking tool, blanks can be positioned in different ways in the strip. Choice of correct method depend upon the following factors:

- a) *Shape of the blank*
- b) *Production requirement.*
- c) *Grain directions*
- d) *Burr side*
- e) *Stock material.*

### **SHAPE OF THE BLANK:**

It is mainly the contour of the blank, which decides the way in which it is to be positioned in the strip. While some of the blanks could be economically produced by laying them at an angle. It may be economical to lay others for a double pass.

### **PRODUCTION REQUIREMENT:**

If lesser production is anticipated, more emphasis should be given on the material conservation without increasing the tool cost. A gang die may be suitable for mass production whereas the same economy can be achieved by double pass layout for comparatively small production requirement.

### **GRAIN DIRECTION:**

In the rolling mills, when the sheets are rolled the process orients the grains in rolling direction. Standard sizes of rolled strips and sheets will have the grain direction along its length. Bending the strip along the grain direction often results in crack and fracture. If the particular blank is to be bent at a later stage the strip layout should be such that the grain direction lies at right angles or angles more than 45° to the direction of the bend.

### **BURR SIDE:**

It is another decisive factor in laying the strip. In a blanking operation, burr is formed on the face of the blank, which comes towards the punch, whereas in piercing it appears on the faces that come directly in contact with the die. In some piece parts, the burr resulting from either blanking or piercing would be required on a particular face of the blank in relation to details of the blank contour. While deciding the strip layout the, care must be taken to see that such requirements are met.

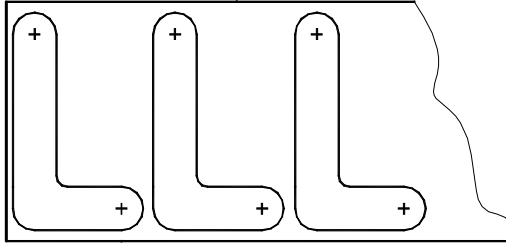
### **STOCK MATERIAL:**

A comparative study of material, conservation tool cost and labour cost is necessary while the strip layout is made. If the stock material is precious, every means to conserve the stock material should be employed. It should be studied whether the higher labour, cost incurred by the double pass layout would justify the cost of the stock material conserved.

Various methods of laying the strips are explained below:

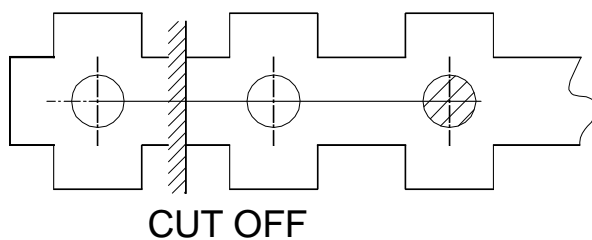
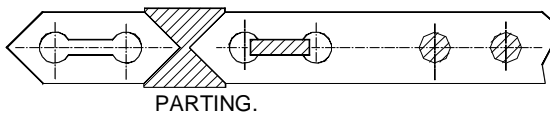
## SINGLE ROW ONE PASS LAYOUT.

This is the most popular way of laying out the strip. In case the blanks are arranged in a single row and strip is passed through the tool only once to the punch and blanks from it.



## BLANKS HAVING AT LEAST TWO STRAIGHT PARALLEL SIDES:

In such cases the strip width should be equal to the distance between those two parallel sides. The blanks are produced by a cut off operation or parting off operation. If the blank has got two sets of parallel sides a cutoff operation is sufficient to produce the blanks. But if the blank has got only one set of parallel sides, these sides become the sides of the stock strip and the other non parallel sides are produced by a parting operation.



## BLANKS HAVING IRREGULAR COUNTERS:

The following factors must be considered before determining the best method of positioning a blank in the strip.

1) **Contour:** If the blank has two parallel sides, determine whether it can be produced by cut off or parting off operation. The width between the parallel sides would become the width of the strip.

Three advantages are realized when a cut off or parting off tool is used.

- Minimum material wastage.
- Less tool cost.
- No scrap strip to handle which renders the production faster.

2) **Accuracy in strip width:** The sheared strips cannot be held to an accuracy closer than  $\pm 0.2$  mm. If the width dimensions between the parallel sides of the blank must be held to closer limits, discard the idea of using a cut off or parting tool.

3) **Accuracy of the blank:** If the blank dimensions are to be held to close limits, it should be produced in a blanking tool, regardless of the number of parallel sides it may contain.

4) **Flatness:** If a blank has got to be flat, design blanking tool because it will produce considerably flatter components than other tools.

## STRIP LAYOUTS FOR CUT OFF AND PARTING:

Both cut off and parting are press working operations of shearing the strip across its entire width, either in straight or curved lines.

The difference between cut off and the parting is that the cut off punch cuts with only one edge, thereby producing no scrap whereas a parting punch cuts with two opposite edges, thereby producing a scrap.

Figure shows how combining notching, trimming and piercing operations with cut off or parting operations can produce the blanks.

**Notching:** Notching is a cutting operation of cutting off small portions from the edge of a strip or a pre blank component.

**Trimming:** Just like notching, trimming is also an operation of cutting off material to alter the shape of the strip or blank. In notching, only a small area of material is cut off, whereas in trimming a larger area of material is removed. Trimming operations when applied for the excess material removal of drawn shells or forged components removes the material along the entire contour of the piece part.

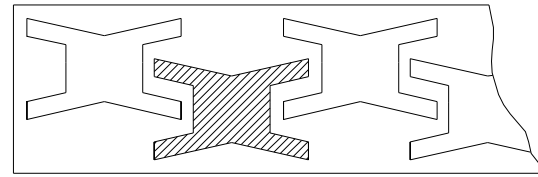
## DIFFERENT LAY OUTS:

There are two possible ways of laying out the strip: -

- 1) **Narrow run and**
- 2) **Wide run**

Wide run is generally more desirable due to the following reasons: -

- a) Shorter advance distance of the strip promotes easy feeding
- b) More blanks could be produced from a given length of the strip compared to narrow run. There fore a fewer number of strips are to be handled to produce a given number of blanks.
- c) Narrow run is used when the grain direction of the piece part has importance (example for bending bending perpendicular to grain direction is preferred)



Double row double pass

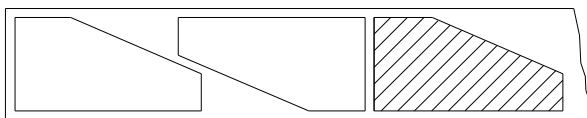
## SINGLE ROW TWO PASS METHOD:

To save stock material, often a strip layout demands the strip to be fed twice through the tool.

A two-pass tool requires minimum of two stops. The stop used for the first pass may have to be removed, or made to disappear from the working surface so as not to interfere with the second pass.

For double pass operations, the front and the back scrap as well as the Scrap Bridge should be wider than those for the single pass (about 50 to 100). As the two operations need nearly 20% more production time, this must be balanced against the saving in stock material.

Two pass layouts are justified only when the wastage is considerable and the stock material is costly.

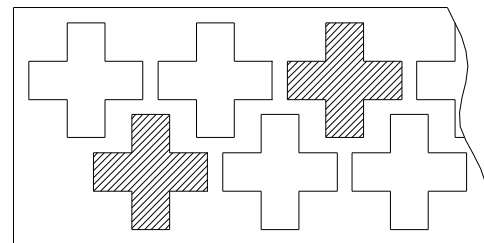


Single Row Two Pass.

## GANG DIES:

A gang die consists of two or more similar sets of tool members so as to produce two or more number of components during a single stroke of the press ram. A gang die eliminates the cumbersome process of double pass.

Gang die is the most economic means of mass production of stampings. The higher tool cost will be offset by the higher rate of production. But still gang dies are not recommended for very complex work.



Gang die

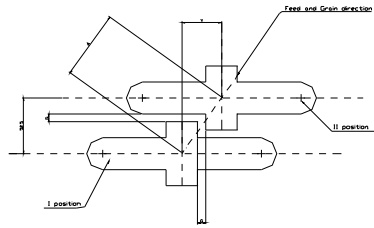
## DOUBLE ROW LAYOUTS:

Further economy is attained by positioning the blanks in the double rows. Especially circular blanks work out more economical if they are laid out in double rows. Strips for double row lay out will be wider and require the back and front scrap to be more than usual amount.

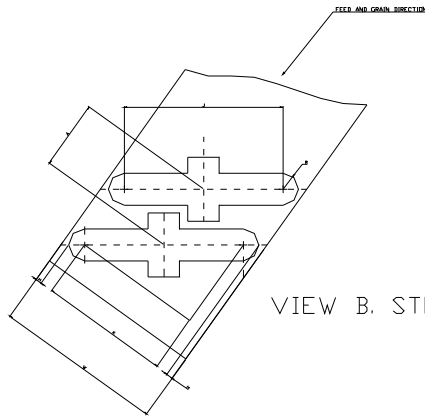
## ANGULAR LAY OUTS:

Some of the piece parts will be required to be laid out to an angular position to make the layout more economical.

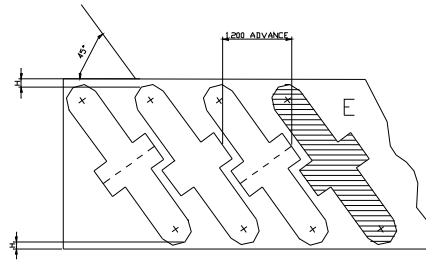
Illustration shows a comparative study of the economy of different strip layouts for a typical piece part.



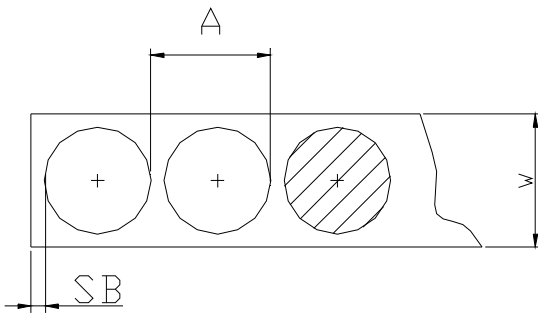
VIEW A. ANGLE & ADVANCE



VIEW B. STRIP WIDTH



**Example1:** Calculate the economy factor to punch the MS washer in single row feeding. Outer diameter 30 and inside diameter 18 mm. Thickness is =2mm. Scrap bridge width = 1.2 ' s



$$E = \frac{\text{Area of the blank} \times \text{number of rows} \times 100}{\text{Pitch} \times \text{strip width}}$$

$$\text{Pitch} = 30 + 2.4 = 32.4 \text{ mm}$$

$$\text{Strip width} = 30 + 2.4 + 2.4 = 34.8 \text{ mm}$$

$$\text{No of rows} = 1$$

$$\begin{aligned} \text{Area of the blank} &= \pi \times d^2/4 \\ &= \frac{3.142 \times 30 \times 30}{4} \\ &= 706.95 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \text{Therefore } E &= \frac{706.95 \times 100 \times 1}{32.5 \times 34.8} \\ &= \frac{70695}{1131} \\ &= 62.5066 \% \end{aligned}$$

**Example 2:** Calculate the economy to produce the same washer in double row feeding.

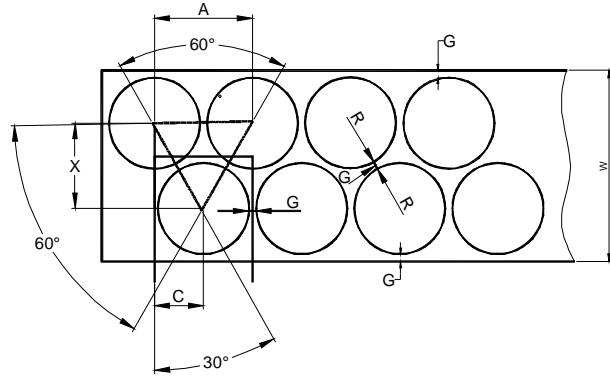
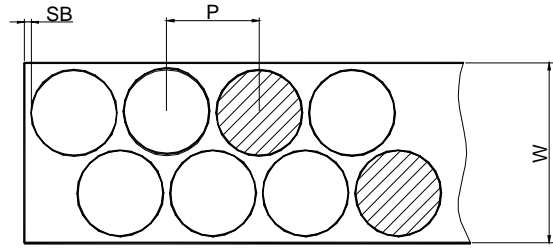
$$E = \frac{\text{Area of the blank} \times \text{number of rows} \times 100}{\text{Pitch} \times \text{strip width}}$$

Pitch = 32.4mm  
 Area of the blank = 706.105 mm<sup>2</sup>  
 Number of rows = 2

Centerline distance  
 between two washers =  $\cos 30^\circ \times \text{pitch}$   
 =  $0.866 \times 32.4$   
 = 28.05 mm

Therefore strip width =  $2.4 + 2.4 + 30 + 28.05$   
 = 62.85 mm

Now 'E' =  $\frac{706.105 \times 100 \times 2}{32.4 \times 62.85}$   
 = 69.35 %

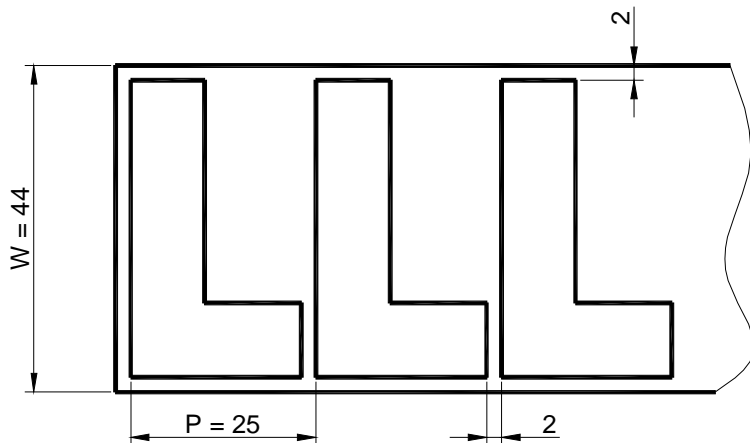
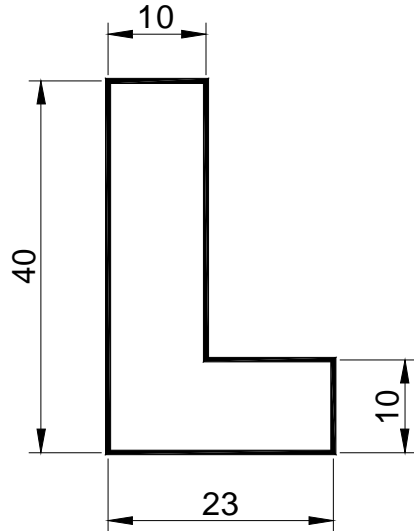


**Example 3:** Find the economy factor for four different pattern of the strip layout shown below:

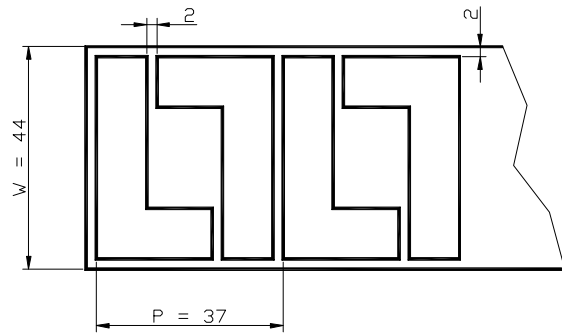
$E = \frac{\text{Area of the blank} \times \text{number of rows} \times 100}{\text{Pitch} \times \text{strip width}}$   
 Area of the blank =  $(40 \times 10) + (13 \times 10)$   
 = 400 + 130  
 = 530 mm<sup>2</sup>

3a) Pitch = component width + scrap bridge  
 = 23 + 2 = 25 mm

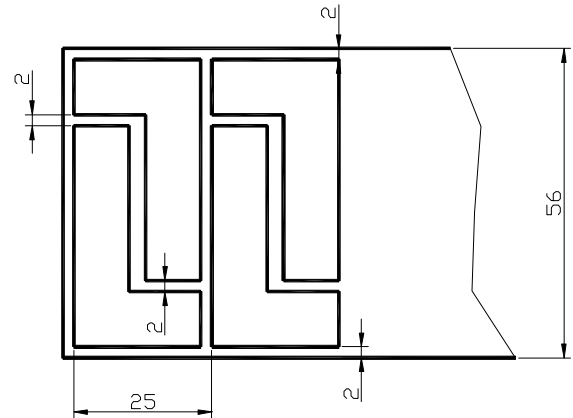
Strip width = 40 + 4 = 44 mm  
 There fore 'E' =  $\frac{530 \times 100 \times 1}{25 \times 44}$   
 = 48.18%



3b) Pitch =  $23 + 10 + 2 + 2 = 37\text{mm}$   
 Margin =  $2\text{mm}$   
 Strip width =  $40 + 4 = 44\text{ mm}$   
 There fore 'E' =  $\frac{530 \times 100 \times 2}{37 \times 44}$   
 =  $65.11\%$



3c) Pitch =  $23 + 2 = 25\text{mm}$   
 Strip width =  $40 + 10 + 2 + 2 + 2 = 56$   
 There fore 'E' =  $\frac{530 \times 100 \times 2}{25 \times 56}$   
 =  $75.71\%$



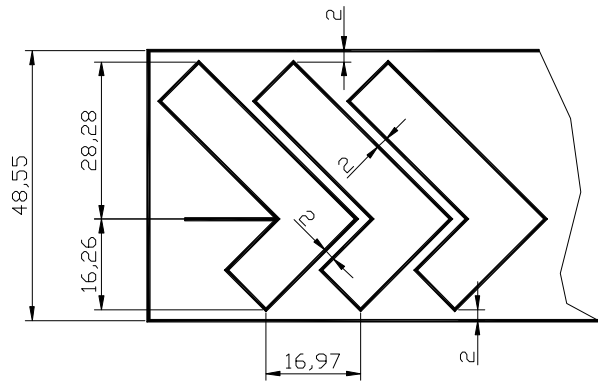
3d) Margin between two blanks =  $\sqrt{(2^2 + 2^2)} = 2.828\text{ mm}$   
 =  $\sqrt{(10^2 + 10^2)} = 14.142\text{mm}$

Therefore  $14.142 + 2.828 = 16.107\text{ mm}$   
 Margin at the sides =  $2\text{ mm/ side}$ .

1) Strip width =  $\sin 45^\circ = X / 23$   
 Therefore  $X = 23 \times 0.7071 = 16.26\text{mm}$ .

2)  $\sin 45^\circ = X / 40$   
 Therefore  $X = 40 \times 0.7071 = 28.284\text{ mm}$   
 Total width =  $28.224 + 16.26 + 2 + 2 = 48.54\text{ mm}$

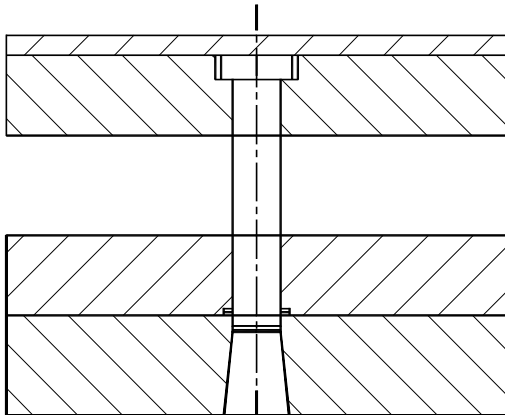
E =  $\frac{530 \times 100 \times 1}{16.107 \times 48.54}$   
 =  $64.34\%$



## PUNCHES:

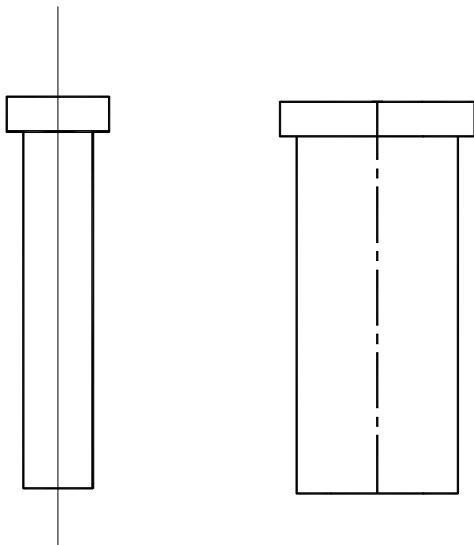
Punches are classified into three categories

1. *Cutting punches.*
2. *Non-cutting punches.*
3. *Hybrid punches.*



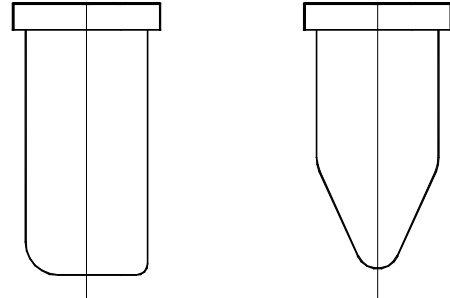
## CUTTING PUNCHES

Cutting punches do the operations like blanking, piercing, notching, trimming etc.



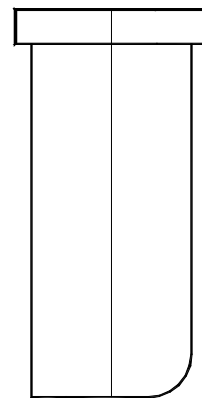
## NON-CUTTING PUNCHES

They do the operations like bending, forming, drawing etc.



## HYBRID PUNCHES.

Hybrid punches do both cutting and non-cutting operations like shear and form, punch, trim etc



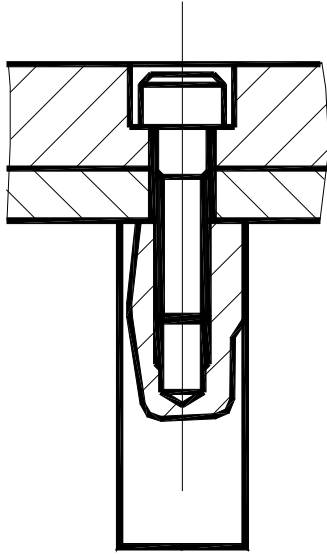
## PUNCH GROUPS

Punches can also be grouped to as segregated punches and integrated punches



## SEGREGATED PUNCHES

These punches are positioned and retained by means of self contained screws and dowels.

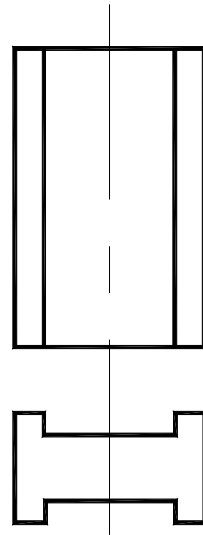
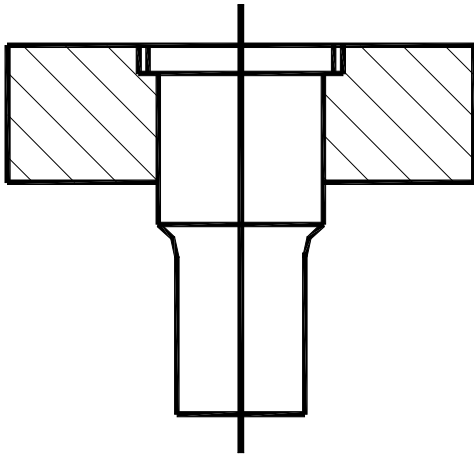


Advantages of plain punches are:

1. *Material saving.*
2. *Machining time saving.*
3. *Easy mounting.*
4. *Possibility of machining the profile straight through.*
5. *In case of large punches it can be splited.*

## INTEGRATED PUNCHES

This group of punches are located and positioned by punch holders.



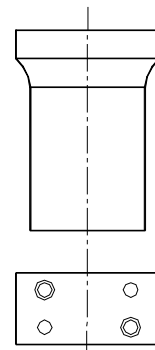
## PEDESTAL PUNCHES

The base area of the punch is larger. The cutting force is distributed to a larger area. These punches are recommended for heavy-duty work. In case of narrow pedestal punch angular fillets are used. These punches are also called as broad based punches.

## TYPES OF PUNCHES.

### PLAIN PUNCHES

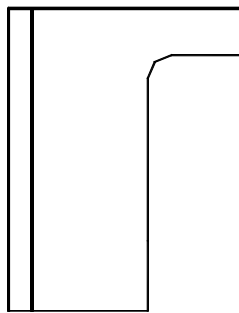
The sidewalls of the plain punches follow the cutting contour originating at the cutting edge and extending straight to the base surface. Plain punches are self mounting straight through punches.



## OFFSET PEDESTAL PUNCHES

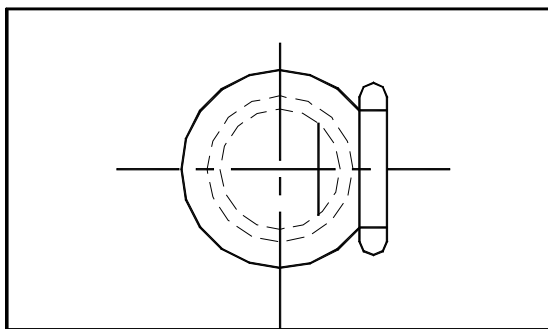
These pedestal punches have their base offset. The reason for offsetting the base are :

- n Space consideration for other components in the assembly
- n Machining and grinding accessibility. The distribution of cutting forces is non-uniform in these punches.
- n The disadvantages of these types of punches are the non uniform ditribution of forces



## KEYED PUNCH

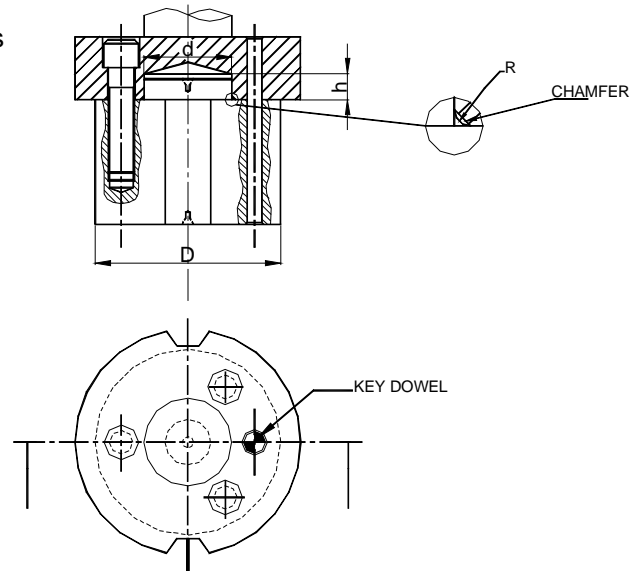
A key is provided for non-circular punches to prevent their rotation.



KEYED PUNCHES

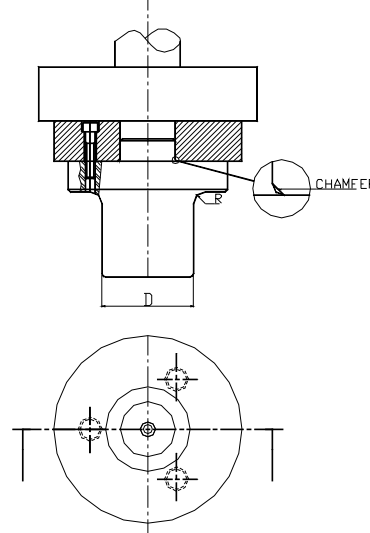
## BOSSED PUNCH

Punches are some times made with an integral positioning boss similar to that in the fig shown below . Boss diameter 'd' should be made a standard nominal dimension. Do not make d too small; generally it should be the largest diameter practical for the given set of circumstances. height h should be restricted. As a rule, a good proportion is  $h=d/2$ .

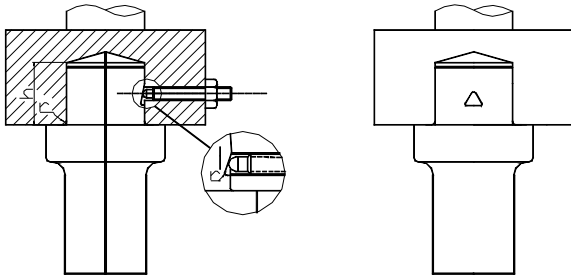


## FLANGED PUNCHES

Fig shown below depicts a flanged punch. It is essentially a pedestal punch which incorporates an integral posotioning boss. The extended base area may be necessary to provide space for attachment screws, or it may be required for stability. In most cases, both considerations probably influence the choice of this configuration. Except for the flange, this punch is the same as the preceeding punch.



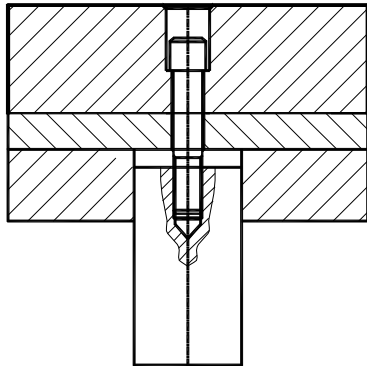
Another flanged-punch version is pictured in the fig shown below. Here, the boss is proportionately much larger.



**PUNCHES MOUNTED IN PUNCH HOLDERS**

**HEADLESS PUNCHES**

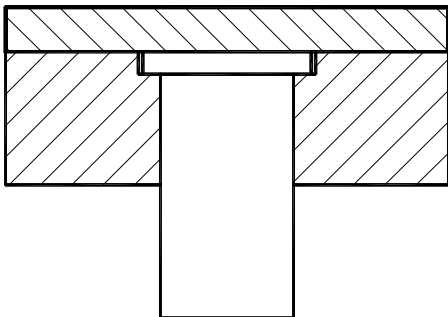
This is a plain punch except that it does not require dowels. The positioning of the punch is done by the opening provided in the punch plate. The punch is fastened to the top plate by means of screws.



HEADLESS PUNCHES

**STEP HEAD PUNCHES (SHOULDERED PUNCHES)**

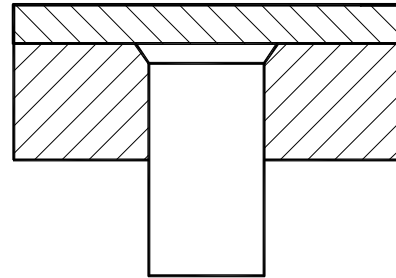
These types of punches are fitted in the punch plate without screws and dowels.



SHOULDERED PUNCH

**BEVELED HEAD PUNCHES**

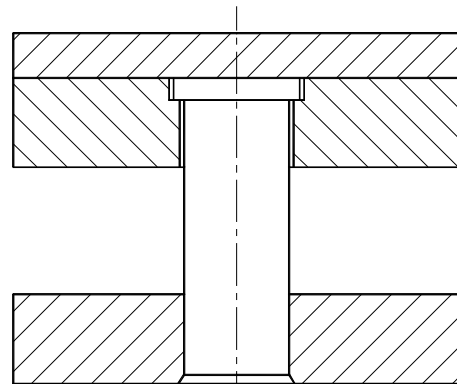
When the punch is made with angular seating is called beveled head punch. The bevel angle is usually between 30° and 45°. The beveled portion may be either machined or peened.



BEVELLED PUNCH

**FLOATING PUNCHES**

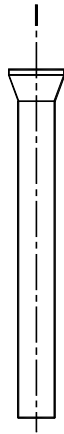
They are made loose in the punch holder and are guided in the stripper plate.



FLOATING PUNCHES

## PERFORATORS

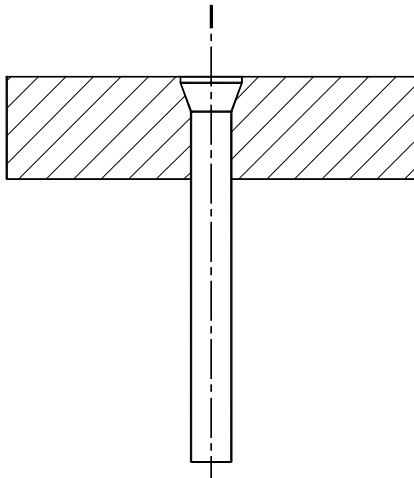
A punch of dia.2.5mm or below is called as perforator.



PERFORATOR

## BEVEL HEAD PERFORATOR

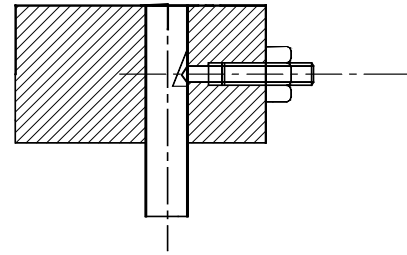
On these types of perforators beveled seating is machined or peened.



BEVEL HEAD PERFORATOR

## HEADLESS PERFORATORS

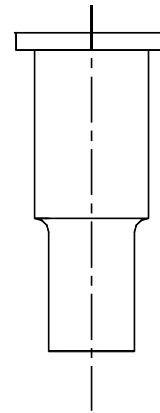
These punches do not have shoulders. A whistle notch is milled on the perforator. A screw from the side will fasten the perforator in position.



HEADLESS PERFORATOR WITH  
WHISTLE NOTCH

## STEP HEAD PERFORATOR

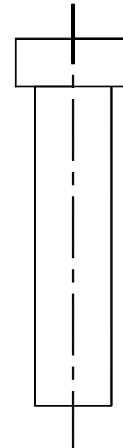
These are commonly used perforators. They have a stepped head shank and a point diameter.



STEPHEAD PERFORATOR

## STEP HEAD PERFORATOR SHANK LESS

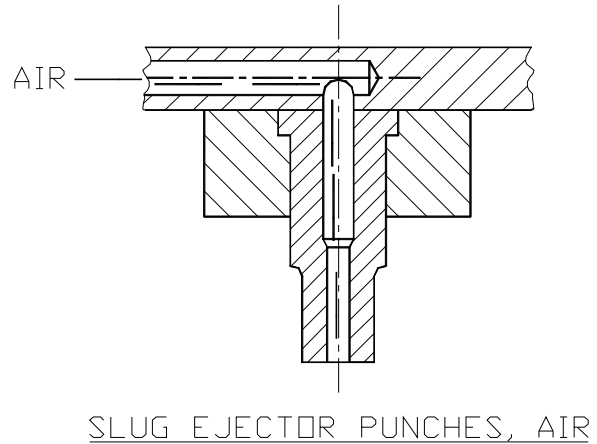
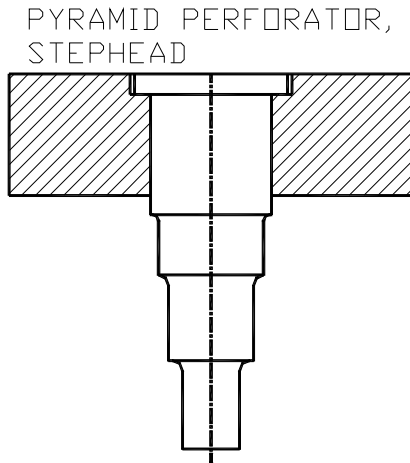
These are similar to the step head perforators except that the shank diameter is more by 0.025mm than the point diameter.



STEPHEAD PERFORATOR (SHANKLESS)

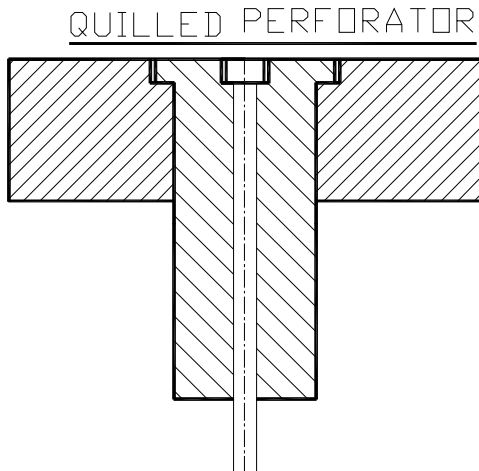
## PYRAMID PERFORATORS

This type of perforator is used when there is considerable disparity between the point diameter and the shank.



## QUILLED PERFORATORS

Slender punches are to be protected from buckling. Quills are provided to prevent buckling.



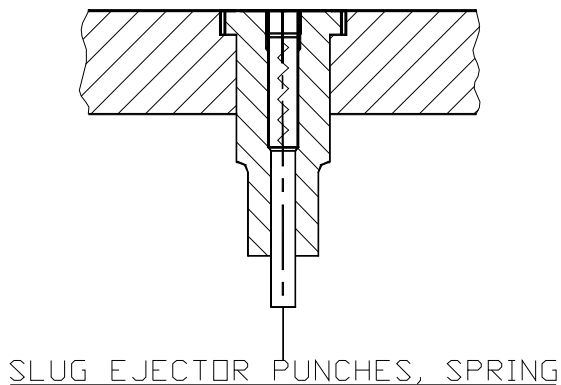
## KEYED PERFORATOR:

Wherever a perforator is having other than round profile, rotation of punch must be prevented. In such circumstances keyed perforator are used. they are many ways to prevent the rotation of perforators. They are:

- a. *By using rectangular key.*
- b. *By providing cylindrical pin.*
- c. *By seating a steel ball in a socket made in the perforator shank.*

## SLUG EJECTOR PERFORATOR

To prevent slug-pulling, air pressure or spring pins are used. These are known as slug ejector perforator.



## BUCKLING OF PUNCHES

### BUCKLING THEOREM:

Whenever a press tool is worked upon within the press, the punches mounted in that tool are subjected to compression stresses. But if due considerations of these stresses are over looked during designing of the tool, the thin punches within the tool may fail by buckling. Hence the maximum force, which a punch can withstand without buckling can be calculated by using the formula.

$$F_B = \frac{\pi^2 \times E \times I}{L_p^2}$$

$F_B$  = maximum force beyond which buckling occurs.

$E$  = Modulus of elasticity (for steel modulus of elasticity varies from 200 to 220 GN/m<sup>2</sup>)

$I$  = moment of inertia in mm<sup>4</sup>

$l_p$  = length of punch in mm

The ultimate condition is when

Buckling = cutting force required for operation = shear force on the punch.

### **Example: 1.**

Is it possible to punch 1mm brass sheet with a 5mm square punch.

$T_{\max} = 200 \text{ N/mm}^2$                       Length of the punch = 60mm

Shear force required to pierce the hole =  $l \times s \times T_{\max}$

$L$  = cut length in mm

$S$  = sheet thickness in mm

$T_{\max}$  = shear force in N/mm<sup>2</sup>

$$L = 5 \times 4 = 20\text{mm}$$

$$S = 1\text{mm}$$

$$T_{\max} = 320 \text{ N/mm}^2$$

$$\begin{aligned}\text{Shear force} &= 20 \times 1 \times 320 \\ &= 6400 \text{ N} \\ &= 6.4 \text{ KN.}\end{aligned}$$

$$\text{Buckling force} = \frac{\pi^2 \times E \times I}{L_p^2}$$

$$E = 210 \text{ GN /mm}^2$$

$$I = a^4/12 = 5^4/12 = 52.08 \text{ mm}^2$$

$$l_p = 60\text{mm}$$

$$\begin{aligned}\text{Buckling force} &= \frac{3.14^2 \times 210 \times 52.08 \times 10^{-12} \times 10^9}{0.06^2} \\ &= 2.99825 \times 10^5 \text{ N} \\ &= 29.9825 \text{ KN}\end{aligned}$$

As the punch can withstand a force of 29.9825 KN and the force coming on the punch is only 6.4 KN it is possible to use the punch.

**Example 2.**

Find the smallest diameter of the punch to pierce 2 mm mild steel sheet

Length of the punch = 60mm.  $E = 210 \text{ GN/m}^2$

Assume  $F_B = 800 \text{ N}$

$$F_B = \pi^2 \times E \times I$$

$$800 \times 10^{-9} = 3.14^2 \times \frac{L_p^2}{0.06^2} \times 210 \times I$$

$$800 \times 10^{-9} \times 0.06^2 = 3.14^2 \times 210 \times I$$

$$I = \frac{800 \times 10^{-9} \times 0.06^2}{3.14^2 \times 210}$$

$$= \frac{2.88 \times 10^{-9}}{2070.516}$$

$$= 1.38 \times 10^{-12} \text{ m}^4$$

$$I = \frac{\pi d^4}{64}$$

$$1.38 \times 10^{-12} = \frac{\pi d^4}{64}$$

$$d^4 = \frac{1.38 \times 10^{-12} \times 64}{3.142}$$

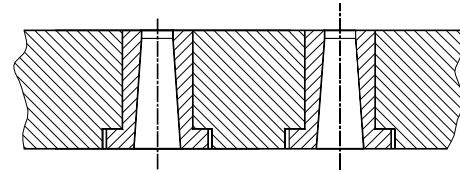
$$d^4 = 2.83 \times 10^{-11}$$

$$d = 2.3066 \text{ mm}$$

$$= 2.31 \text{ mm}$$

The following factors influence the design of the die block for any particular tool.

1. Piece part size
2. Stock thickness
3. Intricacy of piece part contour
4. Type of tool
5. Machinery available for manufacturing the tool.



Small tools used for producing accurate parts usually have a solid die made by spark erosion. Die blocks for medium sized simple shaped and less accurate piece parts are also made solid as the die openings can be easily machined and/or filed. Only for intricate piece part contours the die should be split to facilitate easy machining, hardening and grinding.

All the screw and dowel holes used to fasten and align the die block should be placed at sufficient distance from the cutting edge as well as from the outer edge of the die block.

### SOLID DIES:

Die blocks are made out of superior non-shrinking tool steels and hardened and tempered to 58 - 62 HRC. This is because of the critical nature of the dimensions involved, the extreme pressures and wear conditions the die is subjected to.

### DIE BUSHES:

Hardened die bushes inserted in mild steel retainer plates are commonly used in large piercing dies. Die bushes having profiled openings should be prevented from turning by suitable means.

In order to keep the manufacturing costs to the minimum, the die block should be made as small as possible without lowering its strength or life. Sufficient wall thickness should be provided at the weakest point between the die opening and the outer edge of the die block. This will be decided by the material used, the method of hardening, and the overall size of the die block, its thickness, the press force and the complexity of the contour of the die opening.

In general, the wall thickness can vary from one and a half die block thickness on small tools to twice the die block thickness on large tools.

The minimum thickness of the die block varies in accordance with the severity of the specific operation, the expected tool life and the properties of the material used in the manufacture.

The following table has been found quite satisfactory to enable an initial selection of proper die block thickness.

Stock material thickness in mm	For die block length upto 125mm	For die block length 125 to 200 mm	For die block length 200 to 400 mm
Upto 1mm	16	20	24
1 to 2mm	20	24	28
2 to 3mm	24	28	32
3 to 4mm	28	32	36
4 to 6mm	32	36	50
6mm and above	36	40	60



## SPLIT OR SECTIONAL DIE BLOCKS:

A sectional die block is one, which is made up of more than one section.

The following factors decide whether a die block should be solid or made up in the sections.

**1. Size of the die block:** Bigger the die block becomes more the advantage of sectional construction. Sectional construction reduces the cost of material, machining time and hardening failures.

**2. Size of die opening:** When the size of the die opening is too small to permit internal working the die block should be of sectional construction.

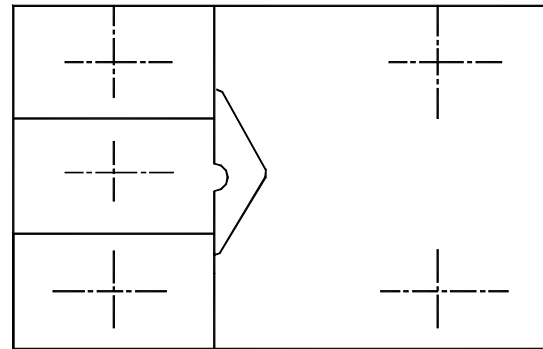
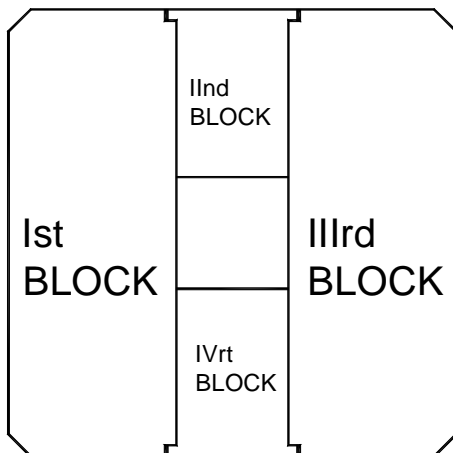
**3. Complexity of the die opening:** If the die opening is of a complicated nature, split dies will ease the manufacture. Also if the die opening consists of too many sharp corners, the die should be split to avoid cracks in the hardening.

**4. Perishability:** Sectional construction will simplify the manufacture and replacement of relatively perishable portions of the die block.

**5. Profile ground die opening:** When the contour of a precision die does not permit the conventional internal grinding methods, to grind the profile the die must be sectioned to facilitate profile grinding.

Effective fastening of the sectional die block is must, as they are subjected to tilting due to the downward thrust of the punch, as well as lateral displacement due to the lateral thrust created by the punching action.

When thin stock material are worked upon, the sections can be fastened with screws and dowels only. Wherever greater lateral thrusts are anticipated, the sections should be nested.



## NESTING IN DIE POCKETS:

Simplest nesting method is to fit the sections into a pocket that is milled directly in the die set. The die sections should fit tightly into the pocket but the assembly pressure should not be so great as to distort the die set. It should be noted that nesting does not eliminate the need for use of screws.

Liners, made out of hardened tool steel facilitate the easy and accurate assembly of sectional dies into the pocket.

Liners provide the following advantages:

1. Liners eliminate the possible shearing of the walls of pocket.

2. Liners expedite accurate assembly of the sections. Liners being the last fitted in the die assembly, permit adjustments to be made for these discrepancies in size and position of the pocket.

3. Liners facilitate easy dismantling of the die assembly. The liners are pushed out first, which let the sections free in the pocket. Therefore, knockout holes should be provided in the nest or pocket directly under the liners as shown.

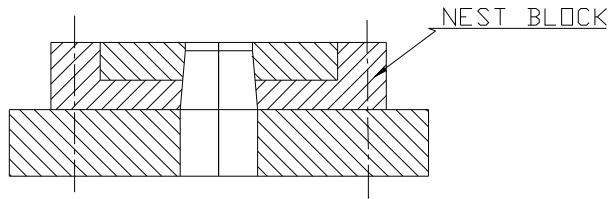
## NEST BLOCKS:

Separate nest blocks, even though costly, are preferred to pockets directly milled into the die set due to the following reasons:

1. Nest blocks do not weaken the die set as the pockets do

2. Easy to handle and can be case hardened for heavy work

3. For the regrinding of the die, only the nest block has to be dismantled without disturbing the assembly of the die sections in it Figure shows die sections mounted in different styles of nest blocks.

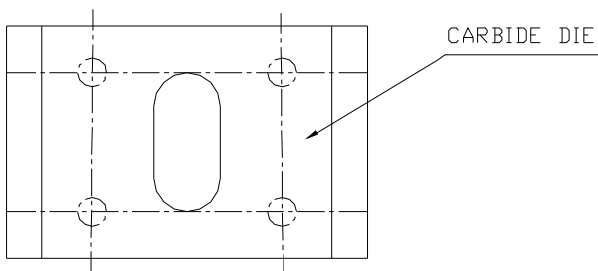


### **CARBIDE DIES:**

Tungsten carbide is used as a die material for blanking, piercing, trimming, forming, drawing and swaging operations. They are used where the production rates are high and the parts have closer tolerances. Carbide dies are widely used to produce electrical laminations at lower cost per piece compared with steel dies.

Since tungsten carbide is fabricated by powder metallurgy techniques, there are limitations to sizes that can be produced as a single piece. Round hole draw dies have been produced up to about 500mm in diameter.

No upper limit has been established for the thickness of material, which can be punched with carbide. Any limit will depend upon the type of stock and the ratio of punch diameter to stock thickness.



### **DESIGN PRINCIPLES:**

The principles of design of most carbide dies are similar to those of steel dies of high precision. Draw radii or approach angles, punch and die clearance and relief are similar to those for steel dies.

### **SUPPORTING CARBIDE INSERTS:**

When a carbide die insert is subjected to high impact loads and internal bursting pressures, it must be supported externally by pressing or shrinking the carbide ring into a hardened steel case.

# Press Tool Technology

Strippers.

Stoppers.

Gauge

Pilots

Side cutters

Ejectors

Fasteners and Dowels

Shank and Shank location

Presses

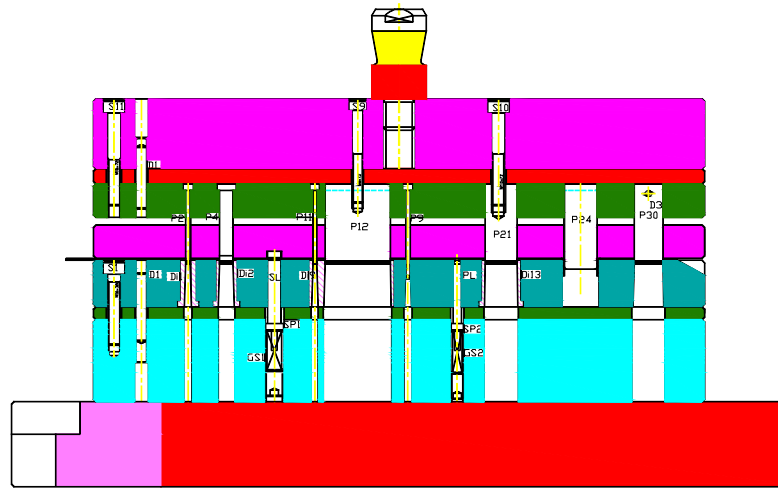
Die set

Type of Press Tools

Compound Tool

Progressive Tool

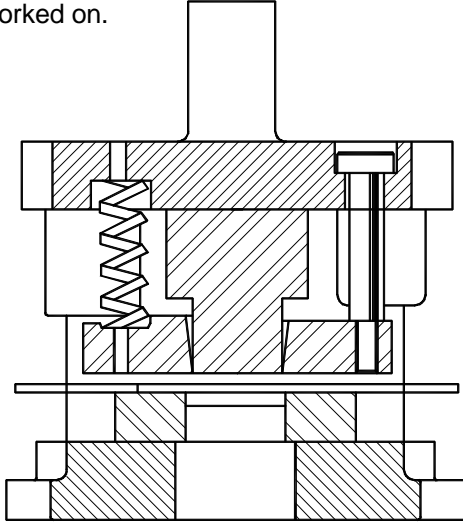
Progressive Tool & Compound Tools



(An ISO 9001:2000 Certified Training Institution)

Volume 2

The main function of a stripper is to strip the stock material off the punches after each stroke. In addition the stripper may act as a guide for the punches, as well as hold the strip flat and tight while the strip is being worked on.



### STRIPPER CATEGORIES AND TYPES:

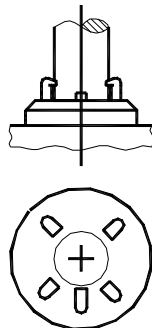
Strippers can be classified into two groups, fixed strippers and traveling strippers. Fixed strippers are simple and easier to make than traveling strippers. Fewer components are required in the construction of fixed strippers when compared to the equivalent traveling strippers. Therefore fixed strippers are economically desirable as far as die construction cost are concerned. Mechanically a fixed stripper is solid (positive) in performance. This is an advantage where strong stripping force is necessary. But in some situations a fixed stripper may be impractical.

E.g.:

1. When it is necessary to clamp the strip in addition to its stripping function
2. When it is necessary to keep the punches engaged in the stripper during the entire press cycle
3. A traveling stripper permits the operator to observe the work while the tool is operating.

### HOOK PIN STRIPPER:

Hook pins are made from cold drawn steel rod. The function is shown in figure.



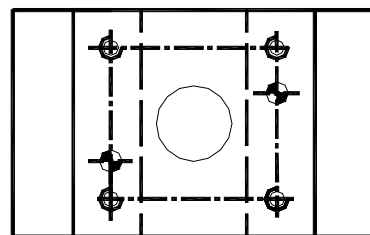
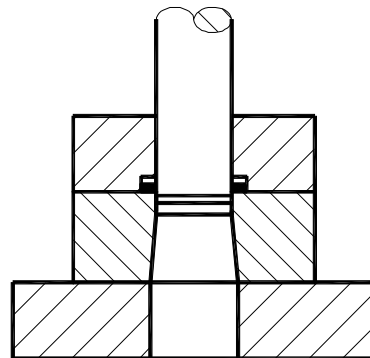
### BOX STRIPPER:

A box pin stripper is shown in figure. The overall dimensions E and D are made the same as the die block, die shoe and stripper can be machined together.

The back edge of the tunnel acts as the back gauge and must be located accordingly ( $B + S =$  Back scrap). Tunnel width X is then made equal to  $W + F$  ( $W =$  stock width and  $F =$  desired horizontal feeding clearance). Tunnel height H is made equal to  $S + G$  ( $S =$  material thickness,  $G =$  vertical feeding clearance).

As a principle hard materials will have more clearance than soft materials. If the clearance is too large it will lead to stripping distortion. Suitable lead angle L must be provided at the tunnel entrance. The angle facilitates starting the stock strip into the tunnel and is very necessary for practical operation.

Strippers are generally left soft. However when required the back gauge should be hardened.



## TUNNEL DIMENSION:

The tunnel width  $X$  can be determined as  $X = W + F$

$W$  = stock strip width at maximum tolerance

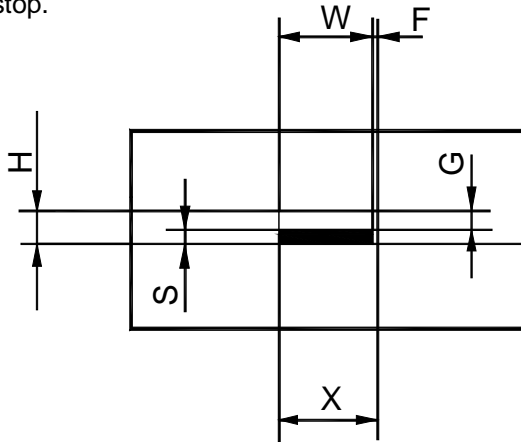
$F$  = desirable horizontal feeding clearance

For the average progressive die, assuming there are no other specific requirements, clearance  $F$  may be 0.3 mm per 100 mm tunnel length

Tunnel height  $H = S + G$ ,

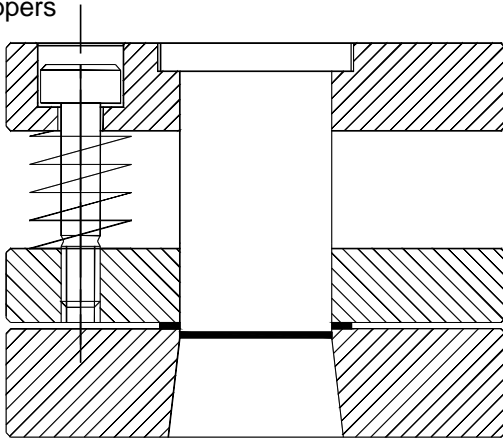
$G$  is the required vertical feeding clearance.  $G$  cannot be specified in a general way.

$G$  may be  $= 0.5s$  for flat work cutting dies with short tunnel length, or it may be several times larger than  $S$ . Special attention should be taken in case of a die which incorporates forming operation, or where there is a fixed stop.



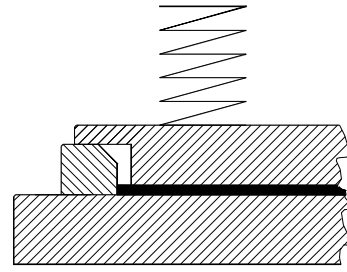
## SPRING STRIPPERS:

A spring stripper is a pressure pad stripper. They are used when it is necessary or desirable to hold the stock material flat (or very nearly flat), or to provide better visibility and access when the tool is mounted in the press. Inverted dies have stationary punches and therefore require traveling pressure pad strippers. Pressure pad strippers are also used for push back applications. There are two main types of spring strippers



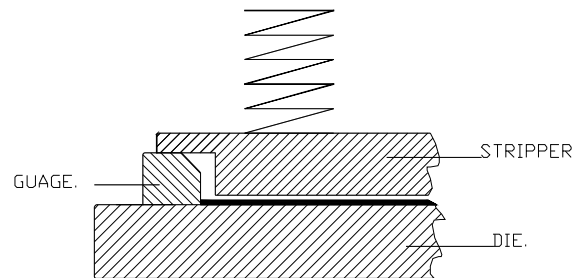
## CLAMPING SPRING STRIPPERS:

They are true pressure pads. They bear against the stock material, applying pressure to it. The material is clamped between stripper and die. Clearance must be large enough to assure clamping.



## NON CLAMPING SPRING STRIPPERS:

These kinds of strippers are used when the material is not to be clamped. There will be clearance between the stock strip and the stripper. For obtaining good flatness, clearance within 0.05 - 0.4 is recommended. The pilot registers the stock strip. In most cases, spring strippers are an effective device for producing good flat piece parts. A spring stripper can prevent distortion, but will not prevent dishing from blanking pressure. The prevention of dishing would require a pressure pad within the die opening to hold the material flat during the cutting process.



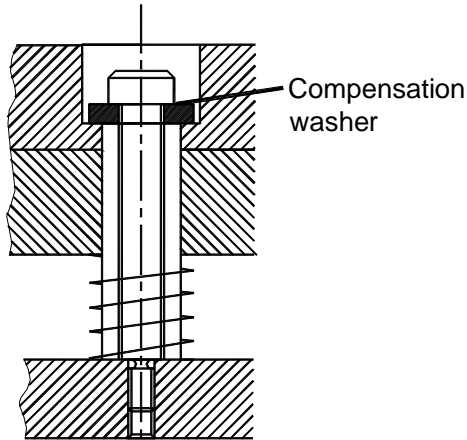
## PILOTING THROUGH SPRING STRIPPERS:

It is often necessary to employ pilots in conjunction with spring strippers. If the stripper is a clamping stripper, it cannot be used to strip the pilot completely. This is because the pilot should register the stock strip before the strip contacts the material. To strip the material from the pilot, the guide rails are used. If the pilots however are too far away from the hooking action of the guide rail legs, the stock material may pull up, bowing the strip. Even if the stock material does not pull out of the rail confinement, there will be bowing action. It can cause excessive pilot wear, seriously deteriorate the quality of the pierced opening and adversely affect the ultimate flatness of the pierce part. When the pilot position is too far away a non-clamping stripper is applied, so that the stripper strips the stock strip also from the pilot.

In some instances a clamping stripper must be incorporated in a die in spite of favorable pilot location. In this case shedder pins may be provided.

### COMPENSATING WASHER:

When cutting punches are sharpened they become shorter. In many applications, the springs are compressed a little more and are not always desirable. A practical method to eliminate this is to install a cylindrical washer as shown in figure. Each time the punches are sharpened, the washer is reduced for the amount.



### SPRING AROUND STRIPPER BOLTS:

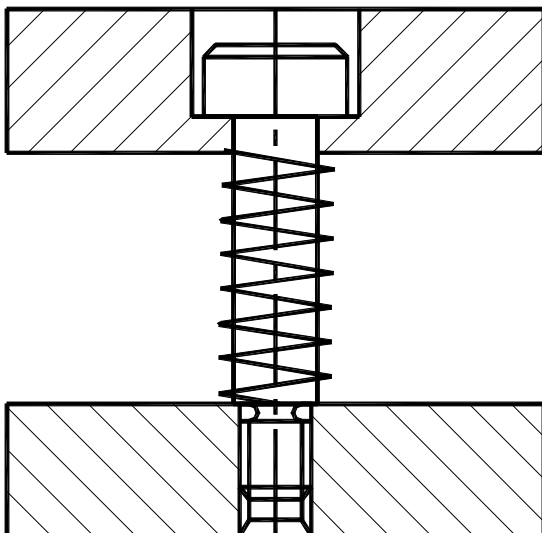
Such a construction is shown in figure. This construction has desirable features and undesirable features.

#### Desirable features are

1. The bolt retains the stripper at centre of spring pressure.
2. The bolt acts to confine the spring in location. So that double spring pocket can be eliminated.

#### Undesirable feature

1. The assembly needs considerable vertical space of ten more than available.

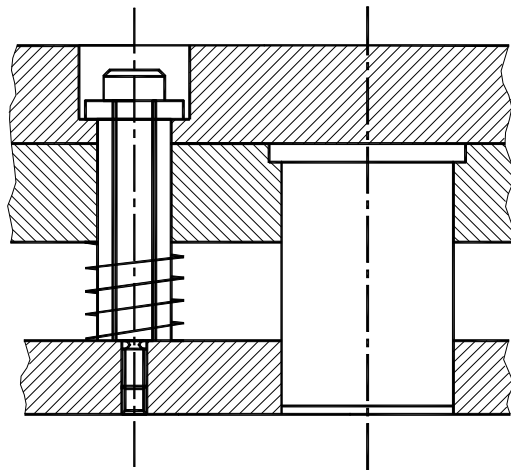
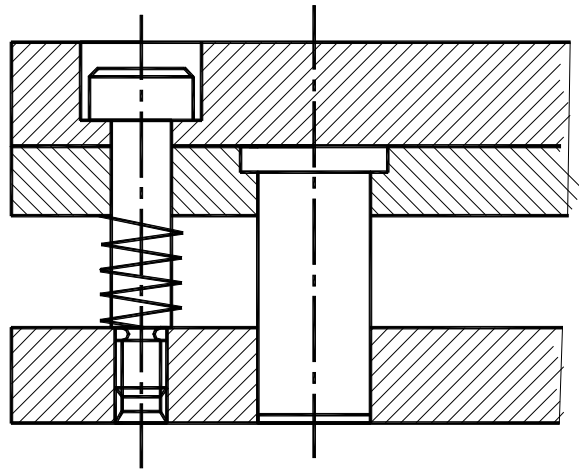


### STRIPPER BOLT SUSPENSION:

Bolt hole B is drilled larger than shoulder diameter A. (clearance hole is provided). When the die is fully closed and the stripper bolt is at its maximum travel position distance E must be sufficient to assure adequate punch grinding life. (E is about 6 mm).

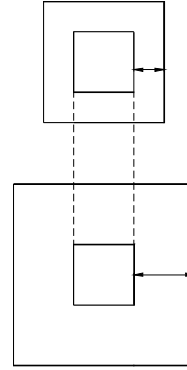
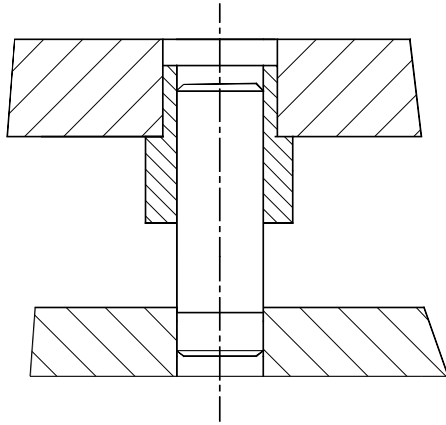
Normally, a space G should exist between the end of the stripper bolt and the face of the stripper (G = 0.5 mm).

To ensure stripping a spring stripper should over travel a distance S, when the stripper is at its extended position. The over travel is between 0.1 for very light work to 1.5 for heavy work. In any case each time the punch is sharpened, the over travel increases. This should be corrected from time to time by inserting a compensator under stripper bolt head as shown in figure. The stripper bolt is made out of mild steel for light work and from tool steel for heavy work.



### GUIDED STRIPPERS:

Two typical stripper guide pins arrangements are shown in figure. The drawings are self-explanatory.



### STRIPPING FORCE:

Stripping force for most operations range from 10 to 20% of the cutting force.

If the die has more than one punch the stripping force for that die is the sum of stripping forces required for each punch.

### STRIPPING FORCE FOR THE BLANKING AND PIERCING:

The following factors affect stripping force.

1. Stock material: Materials, which have high friction, value and materials, which tend to cling, are more difficult to strip.
2. Surface conditions of sidewalls: A punch, which has smooth finish on its side, walls strips more easily than a punch, which is not as smooth.
3. Distance between punches: More effort is required to strip punches that are close together.
4. Area of the stock material to be stripped: Figure shows two piece parts one larger than other.

The thickness and the type of the stock material are identical. The pierced opening is the same size in both parts. The cutting is the same for both the parts. But the larger piece part requires the greater stripping effort.

The larger area of the stock material surrounding the punch is stronger and causes the material to cling more tightly to the punches.

## STOPPERS:

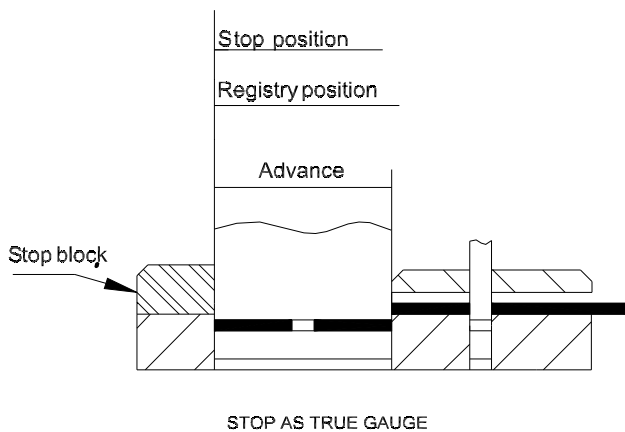
After each and every stroke of the press, the strip has to be feed forward for one pitch length. This can be accomplished by means of stopper. The function of a stopper is to arrest the movement of the strip when it is fed forward to one pitch length.

## BASIC STOP PRINCIPLES:

It is essential that two basic definitions be associated with the fundamental principles of stops.

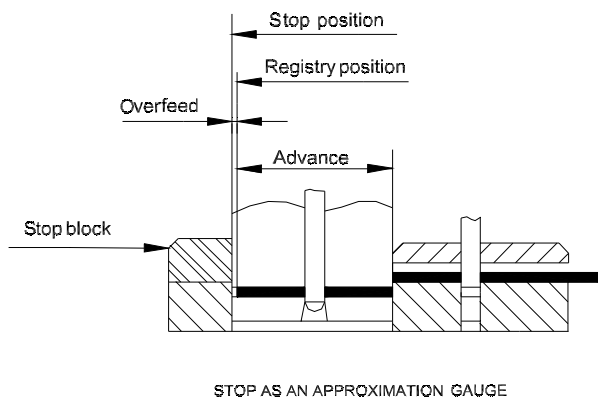
## STOP POSITION:

This is the location of the actual stopping position surface against which the stock strip is halted.



## REGISTRY POSITION:

This is the exact location in which the stock strip must be established in order that the work will be dimensionally correct. The registry position may or may not be the same as the stop position.



The work is located by the stop and is registered by pilots.

The relationship between the stop position and registry position depends upon the function of the stop. If a stop acts as a true gauge the stop position and the registry position are one and the same. If a stop functions as an approximation gauge, the stop position does not coincide with the registry position. It can be said generally that if a stock strip is piloted, it is necessary for the stop to act only as an approximation gauge, allowing the strip to be overfed. If a stock strip is not piloted the stop then functions as a true gauge.

## STOP CATEGORIES:

All stops may be classified as belonging to one of the following categories:

1. Primary
2. Secondary
3. Final

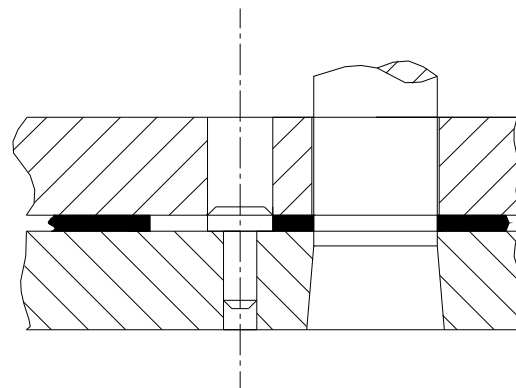
A primary stop is the first stop and a final stop is the last stop in the die. The stops in between are secondary stops. Primary stops acts as true gauges, registering the stock strip. When installing them locate the stopping position to coincide with registry position. Secondary stops serve normally as approximation gauges. Therefore allow for overfeeding when installing them. Final stop may or may not register the stock strip. When mounting them locate the stopping position as required.

## STOP TYPES:

Quite a number of different stop types are in common use - for example, solid stops, pin stops, finger stops, pivoted auto stops etc. in addition there are many variation of each type. This diversity exists because of the wide variety of applications to which stops must be adopted.

## SOLID STOPS:

It is simply a hardened steel block securely mounted at the required location.

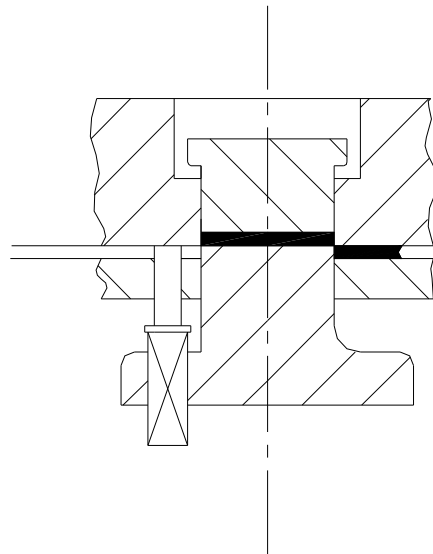
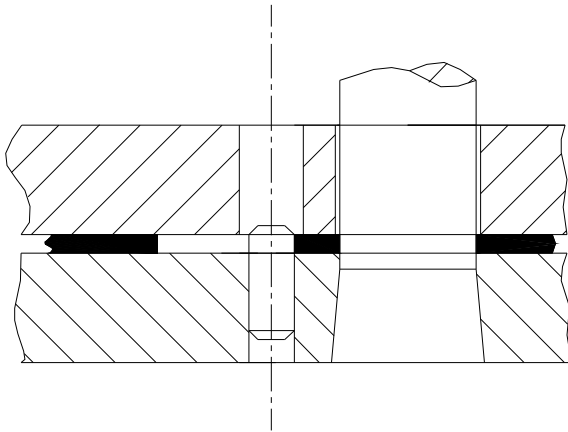




### PLAIN PIN STOP:

The stop is the plain cylindrical pin. The stop pin is mounted in a die block. The pin is a light drive fit on the mounting hole. The mounting hole is generally made to suit a standard pin size (dowel size). A clearance hole for the pin should be provided in the die shoe for three reasons.

1. To permit adjusting the height of the stop pin without removing the die block from the die shoe.
2. To allow the stop pin to be removed in order to sharpen the die with the die block fastened to the die shoe.
3. To allow the pin to be driven down in the event of a misfeed, thus reducing the chance of damage to the die.



DISAPPEARING PIN STOP

### FINGER STOPS:

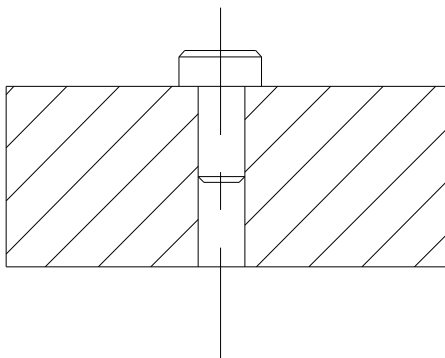
Some typical finger stops shown in figure.

#### OPERATION:

The stop is actuated manually. It is pushed inward until the stop shoulders contacts the front edge of the stripper. This distance is the travel as indicated in the illustration. When the stop is in close position, the nose of the stop extends into the stock channel, obstructing the stock strip. The stop is held in closed position and the leading end of the stock strip is fed against the stop. Then the operator trips the press and releases the stop. The spring returns the stop to its open position where it remains until a new stock strip is fed into the die. In the stopper shown in the figure after the stroke the operator has to release the stopper manually

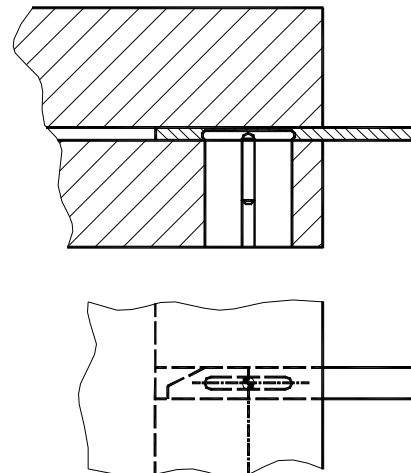
### HEADED PIN STOP:

It frequently occurs that a stop must be located close to the die opening. In such cases the use of a plain pin stop is prohibited because the proximity of the mounting hole to the die opening will make the die weak. For such an applications a headed pin stop may be employed. The mounting hole can be located at the safe distance from the die opening.



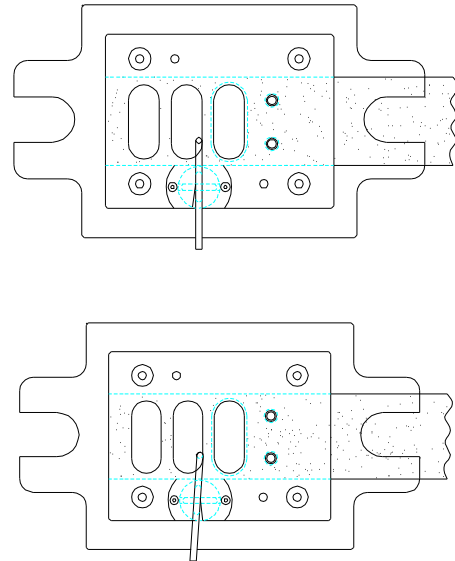
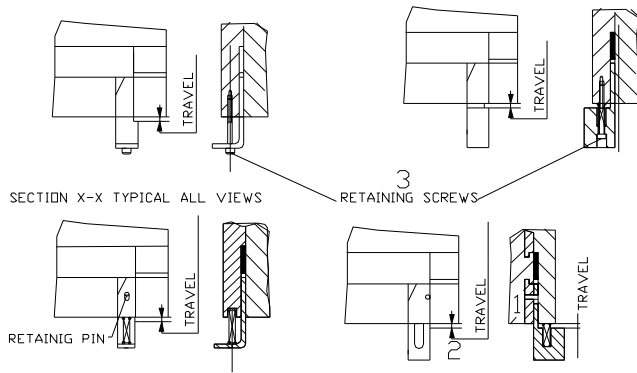
### DISAPPEARING PIN STOP:

It is a spring pin located at the required stopping position. Disappearing stops offer one important advantage over other pin stops is that they do not require clearance in apposing die members.



## PUSHER STOPS:

These stops are special types of finger stop. They serve a dual purpose as both stops and pushers - the spring forces inward where it obstructs the stock strip channel. In operation the leading end of the stock strip is fed against the pusher stop. After the press cycle, the stop is manually pulled outward, permitting the strip to advance to the next stop. When released, the stop in effect becomes a pusher



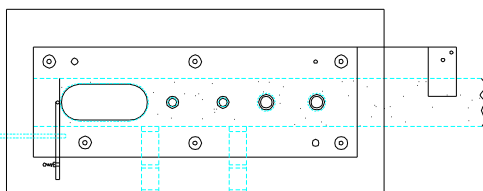
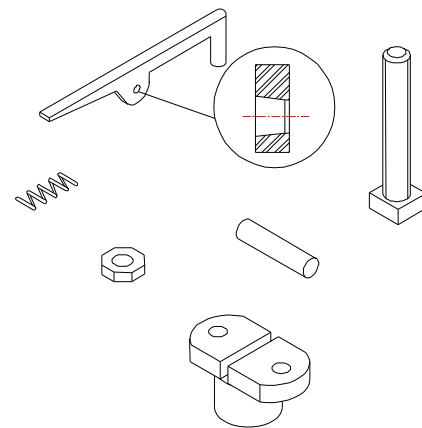
## TRIGGER STOPPERS:

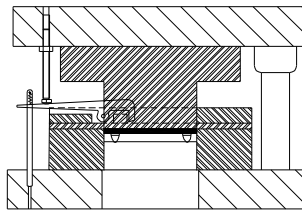
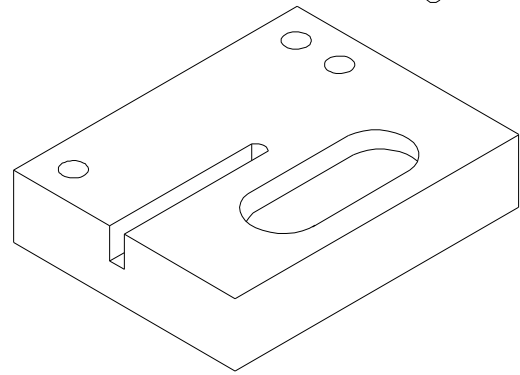
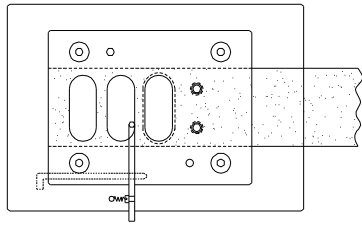
The previously explained stoppers maintain slow rate of production. For the fast productions mostly trigger stoppers are used. They are also called as automatic stoppers. They are of two types.

1. Front acting &
2. Side acting

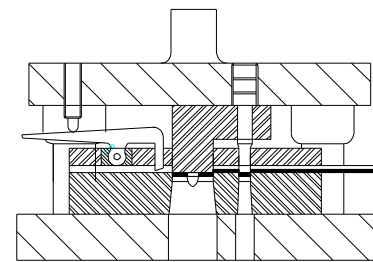
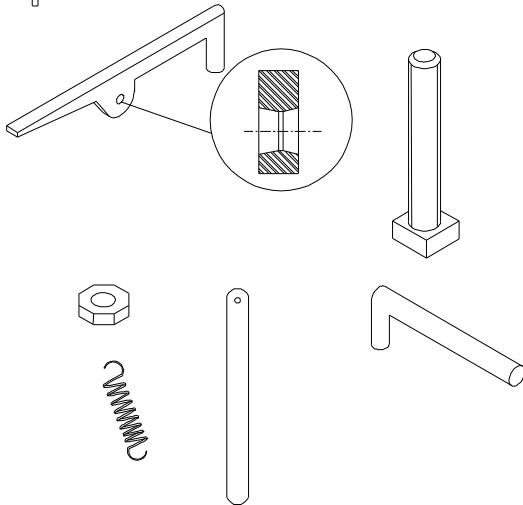
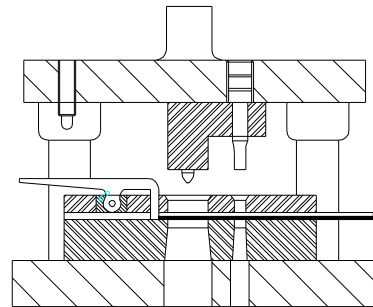
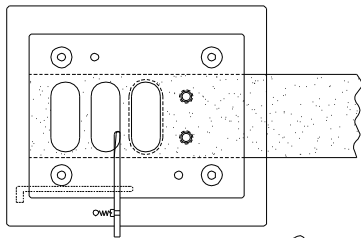
In general, the working mechanism is same in both but one is mounted in the front end of the tool and other one at the side of the tool.

The lever shaped trigger stop fits freely in the slot milled in the guide plate. One sidewall of the slot is provided with a taper angle, which gives the necessary movement to the trigger. An inclined set spring at the other end of the trigger holds the trigger in position. When the strip is pressed against tip face of a trigger the trigger moves backwards and stops against non-tapered wall of the slot thus allowing the strip to advance. The advancement is equal to one margin width. When the tool is tripped, a knocker bar, which is fixed to the top assembly of the tool, comes down and hits the free end of the trigger so that it clears the strip thickness and jumps back to its old position and falls on the strip so that the strip can be fed forward.



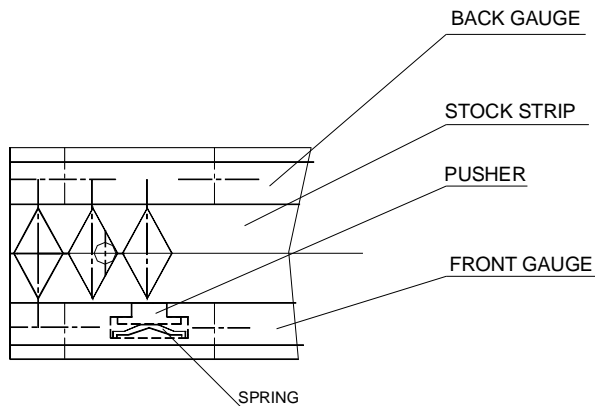


Side acting automatic stops



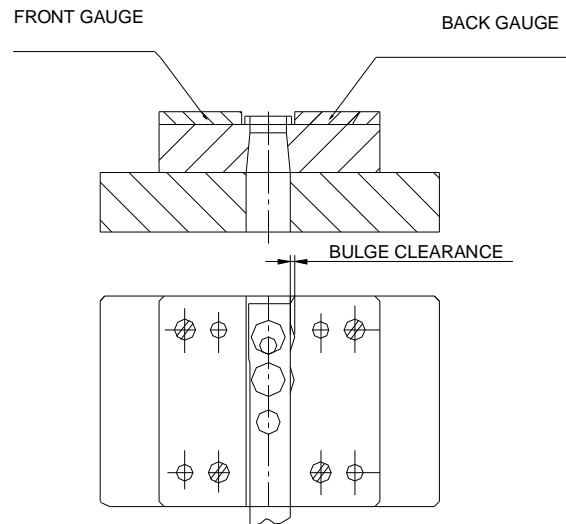
## GAUGES (STRIP GUIDE):

In most of the press tools, the stock material is fed into the tool in the form of long strips. For the efficient functioning of the tool, the strip should be guided longitudinally during its travel through the tool. This is achieved by employing gauges. If unit stocks are utilized for the manufacture of blanks pin gauges nest them in required position. Gauges used in secondary operation tools locate the pre-blanked or pre-formed component in relation to the operation to be carried out.



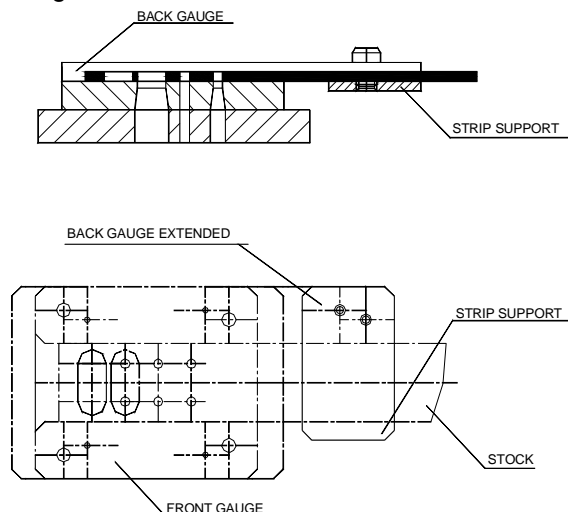
## BULGE CLEARANCE:

Thick and soft stock materials tend to bulge side-wise as soon as blanking operation is performed. This makes it quite difficult to feed as well as to gauge the strip further unless a bulge clearance is provided in such stations. Bulge clearance is provided usually in the back gauge only.



## BACK GAUGE AND FRONT GAUGE:

In a press tool whenever the stock material is fed in the form of strip it is fed in between the back gauge and the front gauge. Back gauge is the one, which is on the far side of the press operator, and the front gauge is on the near side. While feeding the strip the operator always keeps the strip pressed against the back gauge. Back gauge is the actual gauging member and the function of the front gauge is only to provide an approximate gauging. The required dimensional relations are maintained from the back gauge to the die opening.



## SIZE OF BACK GAUGE AND FRONT GAUGE:

The gauges should be thick enough to avoid binding of the strip between the stripper and the die block. The recommended thickness of 3 mm for sheets upto 1.5 mm and strip thickness + 1.5 mm for heavier (more than 1.5 mm) strip is found to be satisfactory if automatic stops are employed in the tool. Special care should be taken while deciding this thickness if a tool incorporates a fixed stopper and also if the tool performs the forming operations. Extra thick gauges if used with solid strippers tend to break fragile punches in the process of stripping.

The space between the back gauge and the front spacer is made to strip width plus 0.5 mm if roll feed is used and strip thickness plus 1 mm for hand feeding.

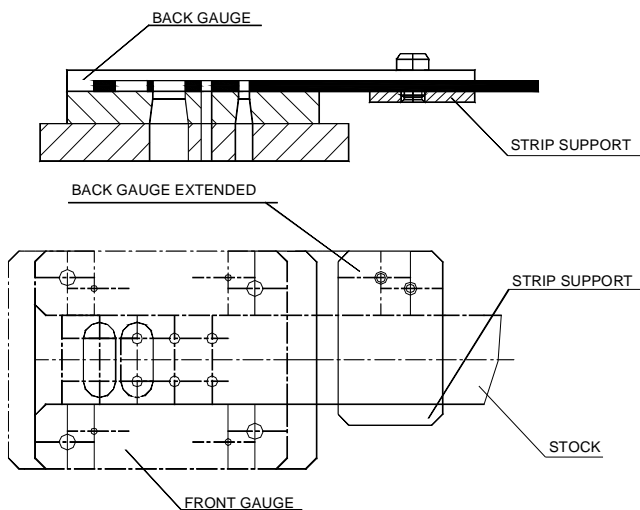
For low production requirements gauges are commonly made from cold rolled steel. They are also made from tool steel and hardened fully or hardened inserts are fixed to the soft gauges where production requirements are high.

## EXTENDED BACK GAUGE:

For easier gauging usually the back gauge is extended beyond the die on the feeding side. An amount equal to two and half times the strip width for hand feeding and equal to the strip width for roll feeding is sufficient.

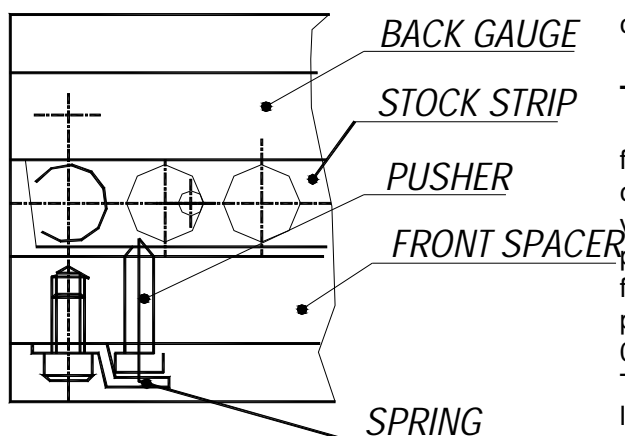
## STRIP SUPPORT:

While hand feeding the strip, to reduce fatigue to the operator a strip support should be provided especially while feeding the flexible strips. The strip support should be made wider and brought closer to the die block to provide better support and guidance. Roll feed does not require strip support.



## PUSHERS:

Means are often provided to keep the strip firm against the back gauge during its travel through the tool. Spring-loaded pushers are often employed to achieve this. Figure shows various constructions of pushers for medium and heavy-duty operations.



## NESTING GAUGES:

Nest gauges are used in secondary operation tools or whenever unit stock is fed into the tool.

There are three conditions to be met with, in order to achieve the best result.

**1. Accuracy:** The fit between the piece part and the gauge should be perfect and consistent throughout the life of the tool. For gauging purpose, it is not necessary for the nest to fit entire contour of the piece part. All that is required is to provide sufficient number of locating points, strategically located in relation to the piece part contour. The number of locating points required for a certain nest depends upon the size and the shape of the piece part. A minimum of 3 points for circular and triangular shapes and four points for other shapes are required.

**2. Easy and quick loading and unloading:** Nest gauges should facilitate fast and easy loading and unloading of the components. The main factors, which decide this, are good visibility and accessibility to the nest. Adequate lead angle should be provided around the nesting profile for easy loading.

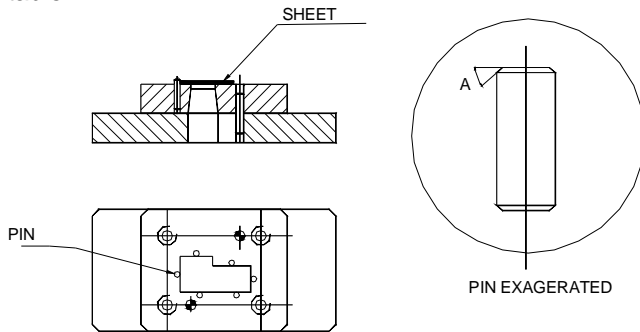
Unloading is always more difficult than loading and should be given a thorough consideration before deciding upon the means to be employed. For low production tools, simple pick-off slots machined in the nest would be sufficient to allow the operator to manually pick the piece out of the nest. Ejection of piece parts out of the nest by means of lever operated ejectors is another solution. Thin piece parts could be expelled from the nest by means of compressed air jets. Pneumatic or hydraulic devices also could ease the unloading in mass production tools.

**3. Fool proofing:** Any possibility of the piece part being loaded in the incorrect manner by the operator should be prevented by the nest. Foolproof pins could easily accomplish this as shown in figure.

## TYPES OF NEST GAUGES:

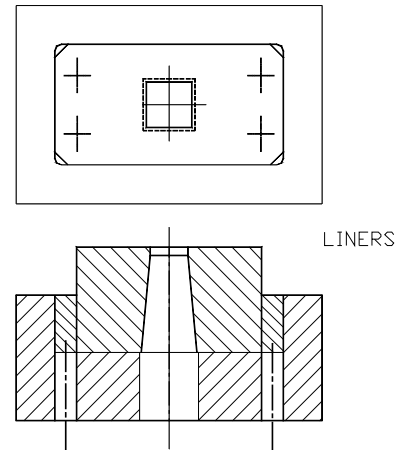
**1. Pin type nest gauges:** The simplest form of nest gauges comprises of plain or headed cylindrical pins arranged in such a way as to provide enough number of locating points for the piece part. These hardened and ground pins are press-fitted into the die block. The arrangement of the pins should be such that a total clearance of at least 0.03-mm results between them and the piece part. The upper end of the pins must be beveled for easy loading and unloading. The opposing member should have relief holes drilled into it to receive these pins. Figures show various constructions with nest pins.

In inverted tools, the nest pins are fitted into the travelling stripper and the relief holes are to be drilled in the die block, the opposing member. If these holes happen to appear in the near vicinity of the die opening the die will be weakened. In such cases the nest pins should be of the spring-loaded type and made to disappear below the face of the stripper, upon contact with the die block. It is obvious that disappearing nest pins are less accurate and should be used only if inevitable.



## NESTING IN DIE SET:

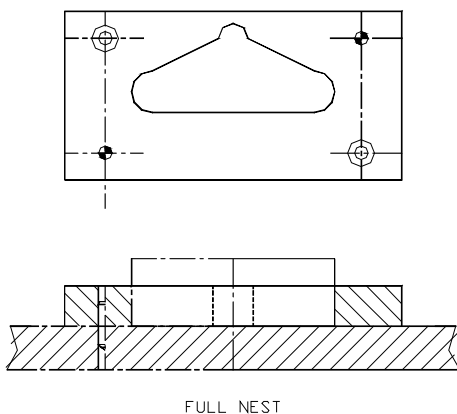
Simplest nesting method is to fit the section into a pocket that is milled directly in the die set. The die section should be fit tightly into the pocket but the assembly pressure should not be so great as to distort the die set. It should be noted that nesting does not eliminate the need for the use of screws.



## Plate type nest gauge:

Plate type nest is a plate into which an opening is machined to receive the piece part. As mentioned already the opening need not fit the entire contour of the piece part. Plate type nests could of sectional construction for easiness in machining and hardening. Plate type nest gauges should be perfectly screwed and dowelled in position.

As a general rule, all gauging elements should be made out of tool steels and hardened to 48 to 52 HRC.



Pocket milled in the dieset

Liners, made out of hardened tool steel facilitate easy and accurate assembly of sectional dies into the pocket.

a. Liners eliminate the possible shearing of the walls of pocket.

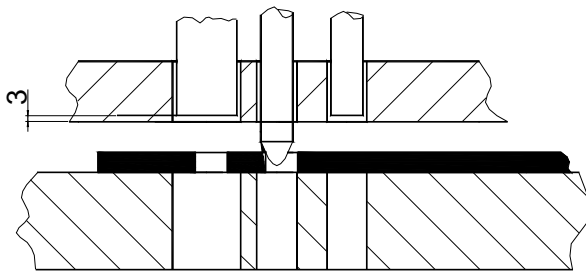
b. liners expedite accurate assembly of the sections. Liners being the last to be fitted in the die assembly permit adjustments to be made for the discrepancies in size and position of the pocket.

c. Liners facilitate easy dismantling of the die assembly. The liners are pushed out first which let the section free in the pocket. Therefore, Knockout holes should be provided in the nest or pocket directly under the liners as shown.

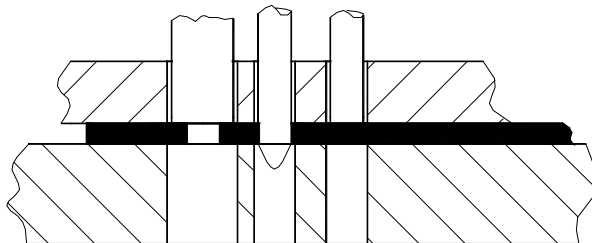
## PURPOSE OF PILOTS:

The pilot positions the stock strip in relation with the die opening. This is termed as registering the stock strip in the required position. Usually the stock strip is over fed than the actual pitch length. The maximum over feeding of the strip is about 0.1mm. When the press is tripped the pilot comes down and engages the pre-pierced hole, thus dragging the strip back into the registry position.

When the stock strip is fed by mechanical means pilot action is the same principle. However, the direction in which the feed is qualified is normally reversed. Instead of being overfed the stock is underfed.



*registry starting- spring stripper is descending along with punches*



*strip registered and clamped punches about to penetrate.*

## PILOT SIZE:

The accuracy with which the work can be registered depends upon the proper location and the diameter of the pilot.

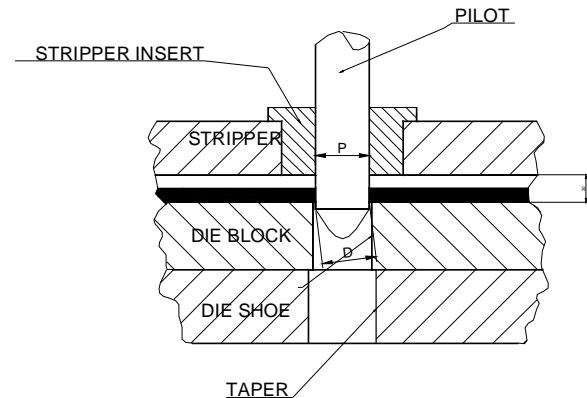
The following will indicate the pilot diameter:

For an average work,  $\varnothing$  of pilot =  $\varnothing$  of hole to be piloted - 0.05 to 0.1 mm

For close work,  $\varnothing$  of pilot =  $\varnothing$  of hole to be piloted - 0.03 to 0.05 mm

For accurate work,  $\varnothing$  of pilot =  $\varnothing$  of hole to be piloted - 0.01 to 0.02 mm

However, the thick stock materials and the stock materials like aluminum and copper need often-bigger tolerances between the pilot and the pierced hole.

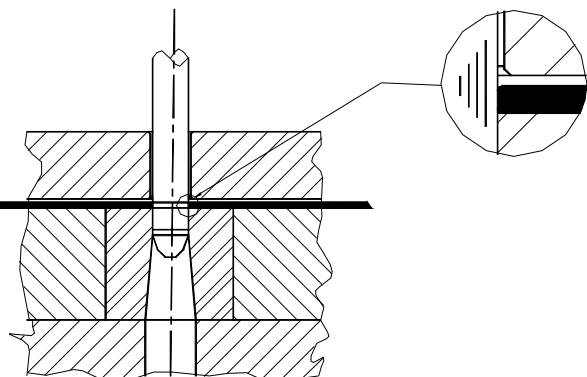


## PILOT LENGTH:

Registering the strip must be complete before the cutting punches come and engage the strip. Therefore the pilots must be longer than the punches. If the pilots are too short, they cannot perform their function. This creates serious consequences ranging from spoiled work to damaged pilots. Care must be taken while setting the stroke of a press so those pilots clear the stock strip without obstructing the future feeding of the strip. In any case the piloting length should extend beyond the punch face equal to one sheet thickness.

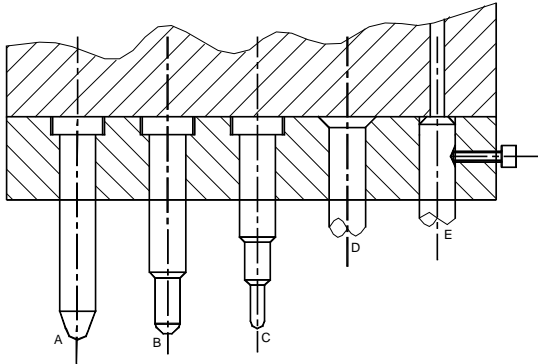
## PILOT OPENING IN THE DIE:

The opening for the pilot in the die should not be too large. If so, the stock strip may tend to draw into the opening. In case of thin material the pilot may not displace the material into registry position but may instead draw the material on one side. Therefore it is advisable to have the opening diameter as pilot diameter + double clearance. Weaker pilots are guided in the stripper.



### PILOT OPENING IN DIE SHOE:

Through hole is provided in the die shoe for the pilots so that, slugs produced during misfeed are cleared. It also helps in clearing the accumulated burrs dislodged from the pierced hole.



- A- STEP HEAD SHANK LESS
- B- STEP HEAD SHANK TYPE
- C- STEP HEAD PYRAMID TYPE
- D- BEVELED HEAD
- E- HEAD LESS. WHISTLE NOTCHED

### PILOT NOSE PROFILE:

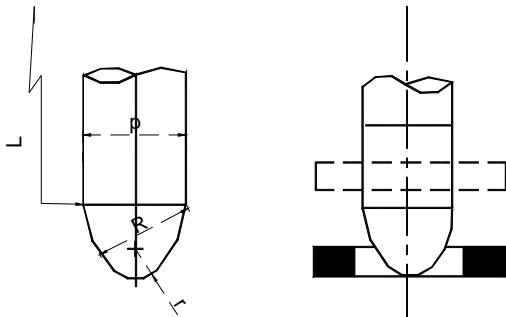
The main functions of the pilot nose profile are to allow smooth riding of the pilot into the stock strip. The most commonly used nose profiles are described below:

#### BULLET NOSE:

The most common pilot nose profile is bullet nose. The bullet shape is formed by radius R which is equal to piloting diameter. For piloting in holes less than 6 mm the length of radius R can be increased to reduce the lateral force during piloting. Bullet nose is strong simple to make and smooth in action.

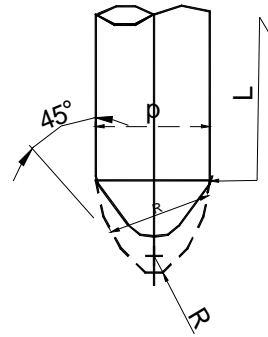
The other three commonly used pilot nose profiles are:

1. 45° conical stub nose
2. 30° conical stub nose
3. 15° angular long nose.



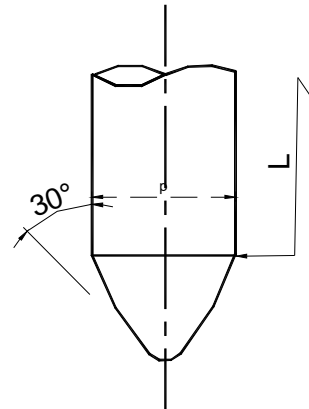
### 45° CONICAL STUB NOSE PILOT

The profile is used when a shorter nose profile is desired. 45° cone increases the relative lateral forces hence not recommended for delicate pilots used for piloting thin soft materials.



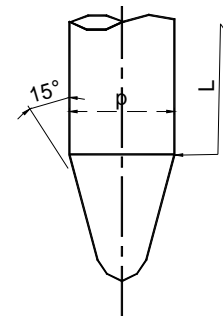
### 30° CONICAL STUB NOSE PILOTS:

This is same as the above pilot except the nose angle is 30°. This is a compromise between the 45° stub nose pilot and the conventional bullet nose



### 15° ANGULAR NOSE:

This small angle provides good mechanical advantages. They are used for small pilots and for thin materials.



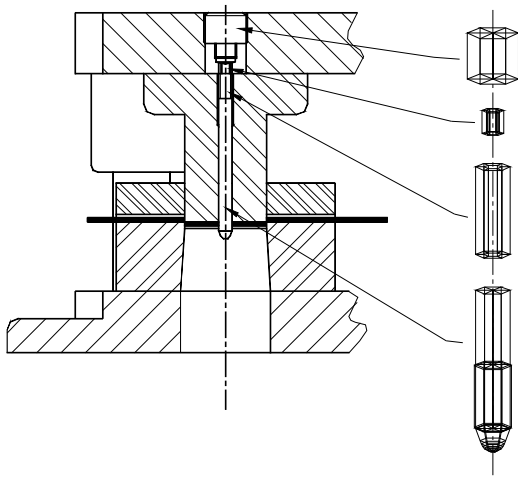


## TYPES OF PILOTS:

### RETRACTABLE PILOTS:

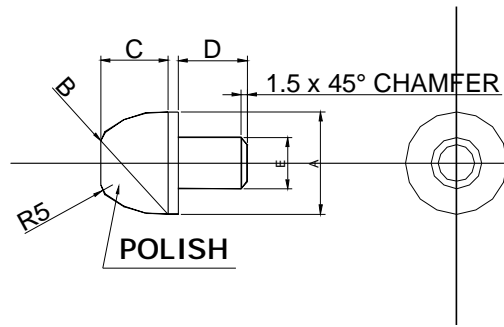
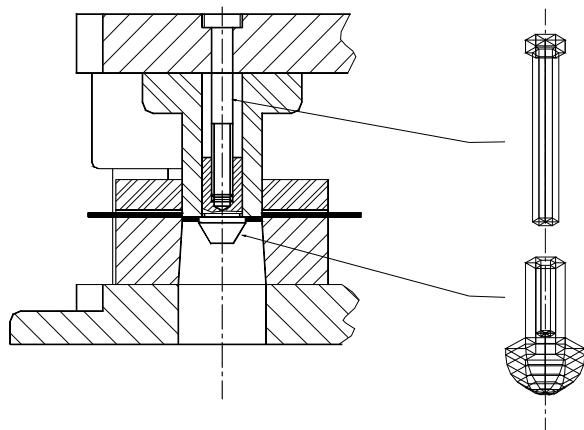
In many occasions especially during hand feeding, misfeeding occurs due to over shooting of the stock strip over the stoppers. This creates the problem when a tool is having pilots in it. Pilots may break or buckle obstructing smooth functioning of the tool. To overcome this difficulty, retractable pilots are incorporated in the tool.

Generally retractable pilots are spring loaded in such a way that they will be lifted upwards when they come in contact with unpierced area during press descend. Care should be taken while selecting spring so that spring allows more telescopic movement to the pilot.



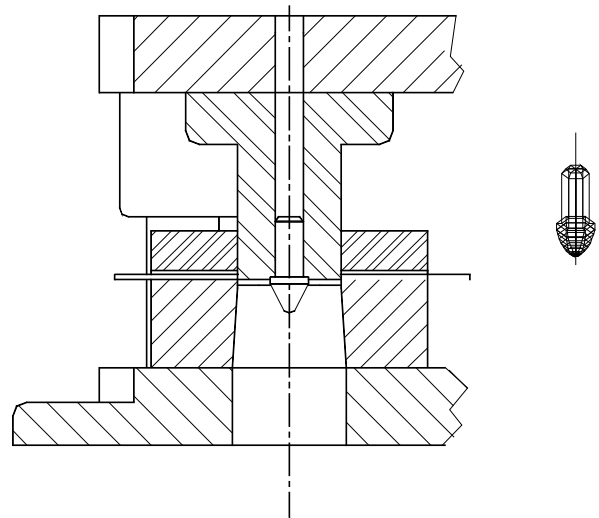
### REMOVABLE TYPE PILOTS:

Pilots break very often due to misfeeding of the stock strip. This will be a real handicap aspect when it comes to fast production loss due to pilot breakage. Much consideration must be given for changing quickly the broken pilots, preventing greater time loss during production. Removable type of pilots can overcome this difficulty. These pilots inserted through the top bolster into the punch holder and fastened with a back up screw as shown in figure.



### PILOT IN PUNCHES:

Pilot mounted in punches is called punch pilots. Piloting size should extend beyond the punch face a distance of at least stock thickness, but minimum dimensions of 1.5 mm. When pilots are mounted in blanking punches there is a tendency of pulling the blanks by the punch. When the blanking punch retracts spring-loaded pins are provided to prevent this pulling of blanks.



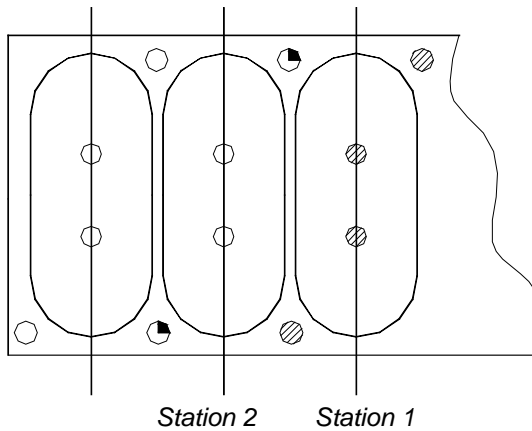
### METHODS OF PILOTING:

There are two methods of piloting in progressive dies.

1. Direct piloting: Direct piloting consists of piloting in holes pierced in that area of the strip, which will become the blank.

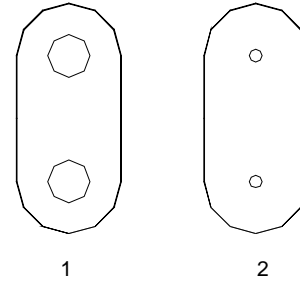
2. Indirect piloting: Indirect piloting consists of piercing holes in the scrap area of the strip and locating by these holes at subsequent operations. Direct piloting is the preferred method, but certain blank conditions require indirect pilot.

PILOT IN HOLES IN SCRAP, BLANK OUT PARTS  
PIERCE 2 HOLES IN PART & 2 HOLES IN SCRAP.

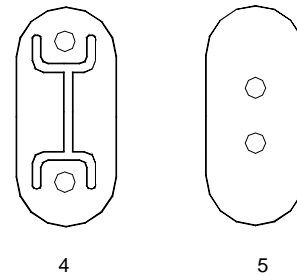
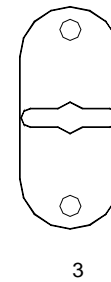
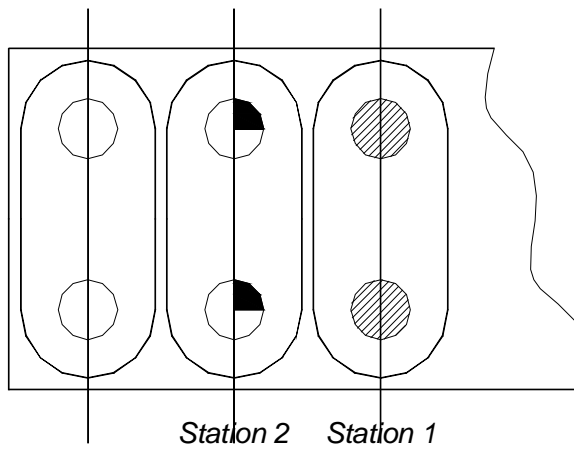


6. Blanks without holes - piloting is done in the scrap area whenever the blank does not contain holes

7. Projection in hole - whenever the hole in the blank contains weak projections which could be bent down by the pilot, indirect piloting should be selected.



PILOT IN HOLES, BLANK OUT PARTS.  
PIERCE 2 HOLES



### PART CONDITIONS:

There are seven conditions that require indirect piloting.

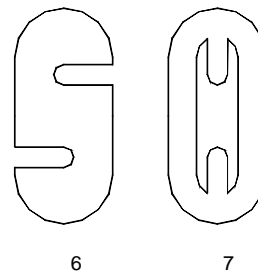
1. Close tolerance on holes - pilots can enlarge holes by pulling a heavy strip in position.

2. Holes too small - frail pilots can break or deflect in operation.

3. Holes too close to the edges of the blank - distortion can occur on the blank because of enlargement of holes.

4. Holes in weak area - piloting in projection tabs is impractical because they may deflect before the strip is pulled to position.

5. Holes spaced too closely - piloting closely spaced holes does not provide an accurate relationship between holes and outside edges of the blank.



## SIDE CUTTERS

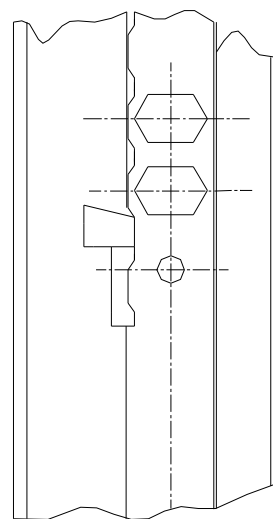
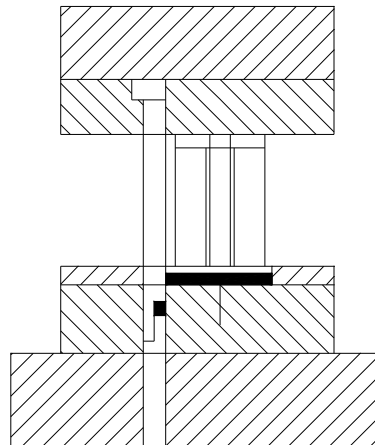
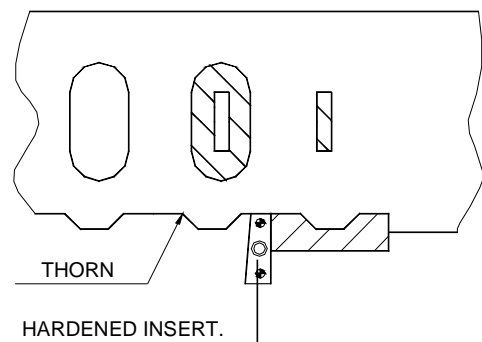
Side cutter is an accurate method of stopping arrangement used mainly for thinner strips where it is difficult to accommodate the other types of stoppers.

A side cutter is a trimming punch, which trim the side of the stock material, providing a shoulder. This shoulder is stopped against a hardened insert, provided in the spacer. In small tools the spacer may be the fully hardened to avoid the insert. The width of the side cutter is equal to the pitch. The allowance for side cutting depends on the type and thickness of the stock material. Tables give the allowances for side cutting for different materials.

No	Material	S	C
1	Steel	0.2 – 0.4	2.5
	Brass	0.2 – 0.6	1.5
	Bronze	1.0 – 1.5	2.5
		1.5	$1.5 \times s$
2	Copper	0.2 – 0.5	3
	Zinc	0.5 – 1	2
	Aluminum	1 – 1.5	2.5
3	Leather paper	0.4	5
	Fibers	0.4 – 1	4
	Card board	1	$3 \times s$

The size of the side cutter will be more then the pitch by 0.05 - 0.1 for the purpose of registry of the strip with the pilot. But in the case of tools without pilot, the side cutter is made equal to the pitch. The stop position and the registry position will be the same.

Due to the unbalanced cutting force acting on the side cutters, the side cutters are provided with heels. The under cuts provided on side cutter eliminates the difficulties of feeding due to thorn formation. Thorns are small projections, which occurs on the side of the strips due to the punch wear out. In side cutting there is the tendency of the slugs being coming up with the punch, causing difficulties in further punching. Slug pushers are used to avoid this. A standard side cutter shape is shown in the figure.



### THE ADVANTAGES OF SIDE CUTTERS:

1. It is the safer method than stop pins.
2. Avoids the danger of the deformation of margins of thinner strips by the stop pins, when pressed against it.
3. Preferred for small punching where it could be difficult to employ other types of stops.
4. It is economical and avoids complications in tools where the number of stages is more.
5. Pilots can be avoided for punching components with moderate accuracy.

The side cutter is installed in the first position of the tool. This eliminates the extra stops and simplifies both construction and operation of the tool. Usually the side cutter is located along the front edge of stock strip, because of the fact that the strips are usually meant to gauge against the back gauge of the tool.

Two side cutters, one on each side are used where the number of stages are more or if the pitch is less.

In conventional drop through type blanking tools, the punch forces the blank into the die. The blank will be retained in the die cavity till the subsequent blanks push it past the land. Then it falls down through the opening in the die shoe and subsequently through the opening in the press bed.

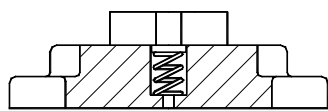
Shedders and ejectors are used when it is not possible to remove the blanks in the conventional methods due to the following reasons.

1. Size of the blank does not allow it conveniently pass through the opening in the press bed.
2. Contour of the blank is such that it tends to stick and get distorted during its travel through the die cavity.
3. Opening in the press bed is fitted with the die cushion, which will interfere with the piece part disposal.
4. Close tolerance specified for the flatness of the blank.
5. Tools of inverted nature.

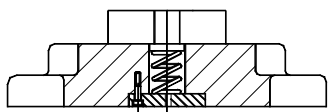
## EJECTORS:

In the conventional tools die is the lower member of the tool. (Being clamped to the die shoe). If the expulsion of the blank is achieved by forcing it upwards, the action is known as "ejection". The element of the tool, which ejects the blank, is called an "ejector".

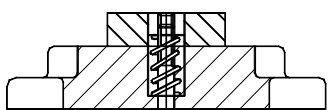
Ejectors may be actuated by compression springs, rubber, pneumatic devices or hydraulic devices. Ejectors if used with spring strippers always return the blank into the strip due to the simultaneous stripping and ejecting action. In some progressive tools, the blanking station is provided with an ejector to return the blank into the strip to be carried forward to the next station for further operations, known as cut and carry method.



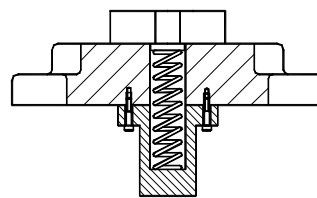
A



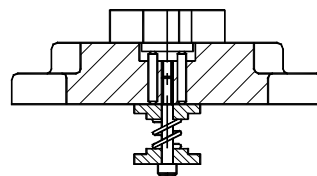
B



C



D



E

## SHEDDERS:

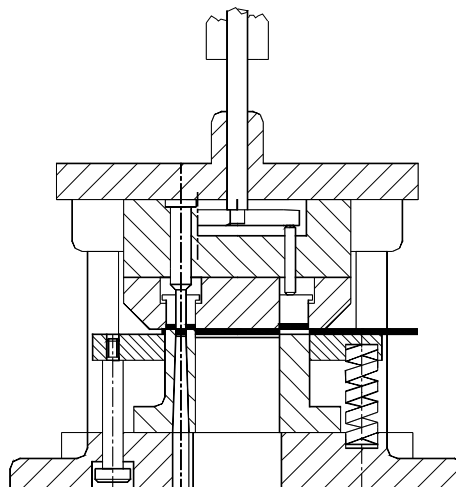
Another way to accomplish the expulsion of the blanks from the die cavity is by making use of the knockout mechanism on the press. For this purpose, the tool should be of the inverted design.

In inverted tools, die becomes the upper member of the tool, being clamped to the press ram. The expulsion of the blanks is achieved by forcing them downwards. This action is generally known as "shedding" and the element of the tool, which sheds the blanks, is known as the "shedder".

## POSITIVE SHEDDERS:

Shedders operated by the knockout mechanism on the press are called "positive shedders".

The knockout arrangement of the press is usually of a bump type knockout bar, mounted through slot across the press ram. The knockout bar is free to move up and down within the slot, as well as it could ride up and down together with the ram. Figure depicts the operation of a positive shedder.



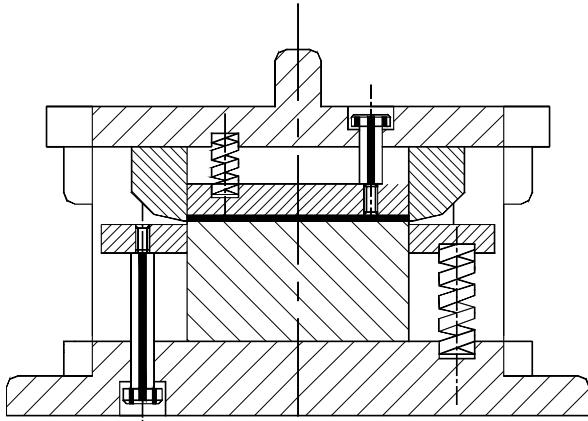
## COMPRESSION SHEDDERS:

Shedders backed up by compression springs, hard rubber or disc springs are called compression shedders. Such shedders always tend to return the blank into the strip if employed with compression type travelling strippers.

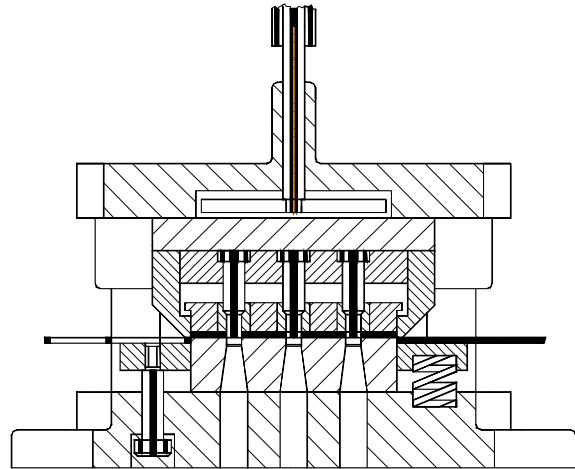
Compression shedders could be used to great advantage to produce flatter and neatly sheared blanks. They are also used if the blanks are too large to allow the incorporation of an efficient positive knockout system.

Therefore, regardless of conditions of the stock, the installation of shedding pins must be considered to be absolutely necessary. Shedding pins will be more effective if applied to one side of the shedder face rather in centre.

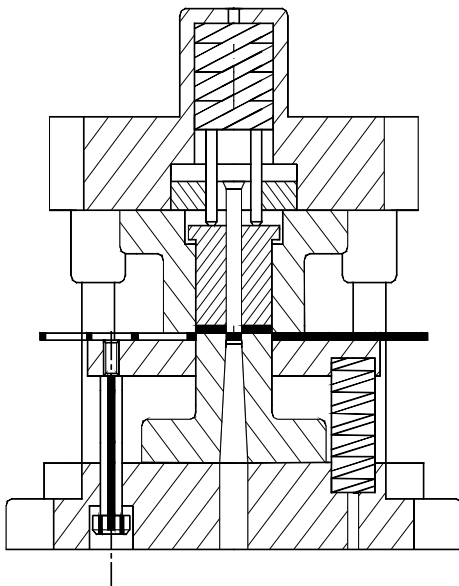
All ejection and knockout elements are to be case hardened to 48 - 52 HRC. Depending on the severity of operation.



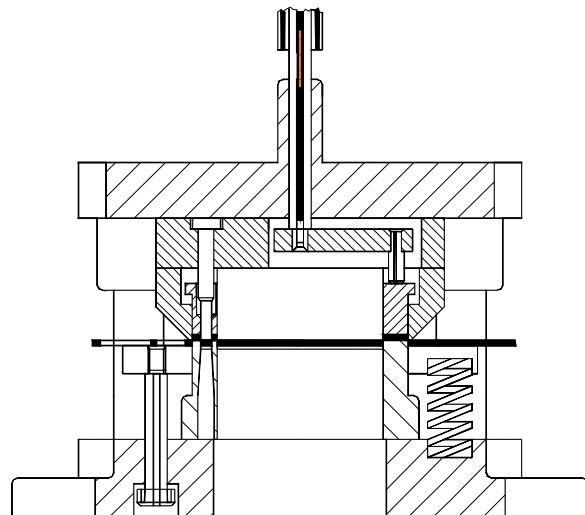
Typical knock out used in large dies.



Pins (A) guide and transmit force to the knockout block



Typical small knock out of the spring operated varieties.



Spider knockout plate in this die has been flame cut

## SHEDDING PINS:

The stock material is usually coated with a rust preventive solution. It is obvious that any liquid or oil deposit left on the stock material will cause the blanks to stick to face of the shedder. Spring-loaded shedding pins are employed to overcome this problem. Even absolutely clean and dry stock material tends to adhere to the shedder face, due to the atmospheric pressure.

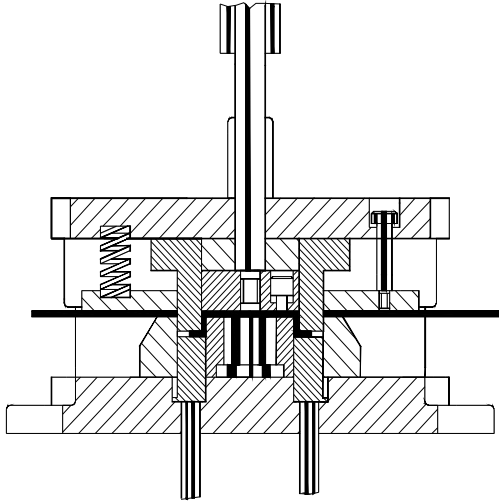
## KNOCKOUTS:

Positive knockouts are classified into two groups.

1. Direct knockouts
2. Indirect knockouts.

### **DIRECT KNOCKOUTS:**

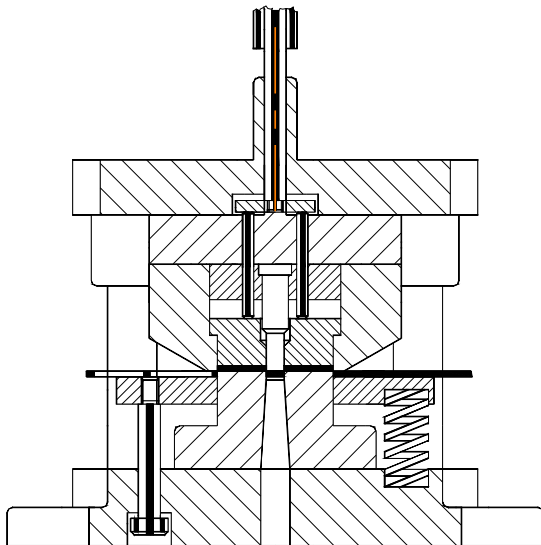
In a knockout system if the knockout rod is directly in contact with the shedder the system is known as direct knockout shedder.



### **INDIRECT KNOCKOUTS:**

As the passage of the knockout rod is through the shank, any punch which comes in line with or near to the centre line of the shank will obstruct the knockout rod from coming in direct contact with the shedder. In such cases an indirect knockout system should be employed.

In addition to the shedder and the knockout rod, it consists of a knockout plate and transfer pins as shown in figure. The location and number of transfer pins depend on the size and shape of the blank.



## DOWELS:

Dowels hold parts in perfect related alignment by absorbing side pressures and lateral thrusts. Also they facilitate quick disassembly of parts and reassembly in their exact former relationship.

Dowels are precise with accuracy both in dimensions and in their physical characteristics. They are made of alloy steels and heat-treated (case hardened). Dowels are available readily in a range of sizes from 1.5 to 20 mm in various lengths.

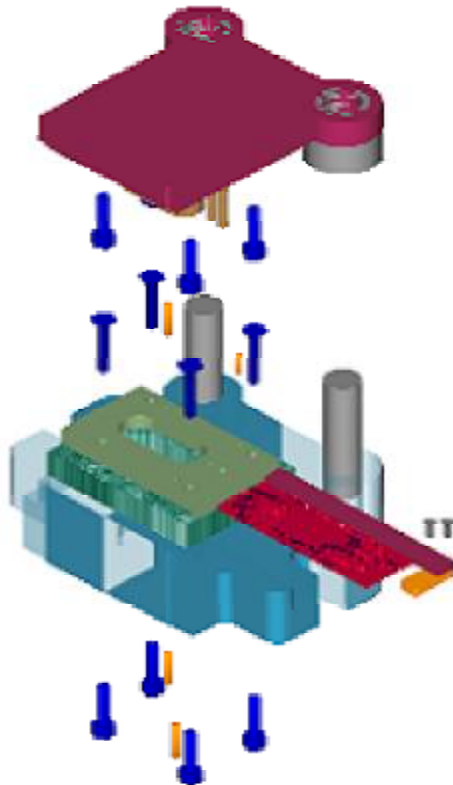
The dowels are made in IT 6 grade and are finish ground. The fit between dowel hole and dowel pin is H7/m6. The surface finish is maintained in 4 - 6 microns. This extremely smooth finish reduces the possibility of seizing when driven into their respective holes.

There are two types of dowels in common use. They are

- 1.Solid dowels used in through and through hole applications
- 2.Removable type dowels. These types are used where blind hole applications exists.

Shape of the dowel is shown in the sketch.

The dowels are driven inside the reamed holes or in a jig ground holes. The hole sizes are maintained to H7 tolerance.



*Exploded view of die showing number of fasteners used.*



## SCREWS:

Various types of fasteners are used in tooling construction. The main function of a fastener is to hold or clamp two or more tool elements together in position.

The fasteners are divided into two types.

- 1)Threaded fasteners
- 2)Non-threaded fasteners.

## THREADED FASTENERS:

In this group all types of screws and bolts are included. But only those used in tool making are discussed here.

## SOCKET HEAD SCREWS:

These are generally used to fasten the plate elements of a press tool like punch holder assembly to the die top and die - stripper assembly to the die - shoe.



**COUNTER SUNK SCREWS:**

These are used to fasten elements like nest gauges, spacers, plate stoppers etc.

**CHEESE HEAD SCREWS:**

These are used to fasten sheet metal elements like spring holders, leaf springs etc.

**COUNTER SUNK SCREWS:**

These are used to fasten elements like nest gauges, spacers, plate stoppers etc.

**SET SCREW (Grub screw):**

These are used to fasten parts, which are to be confined within a hole, like spring's etc.

**EYE BOLTS:**

Eyebolts are used for lifting heavy die sets or mould housing. It is also called as carrier bolts.

**NON - THREADED FASTENERS:**

This group includes the elements like rivets and cotter pins.

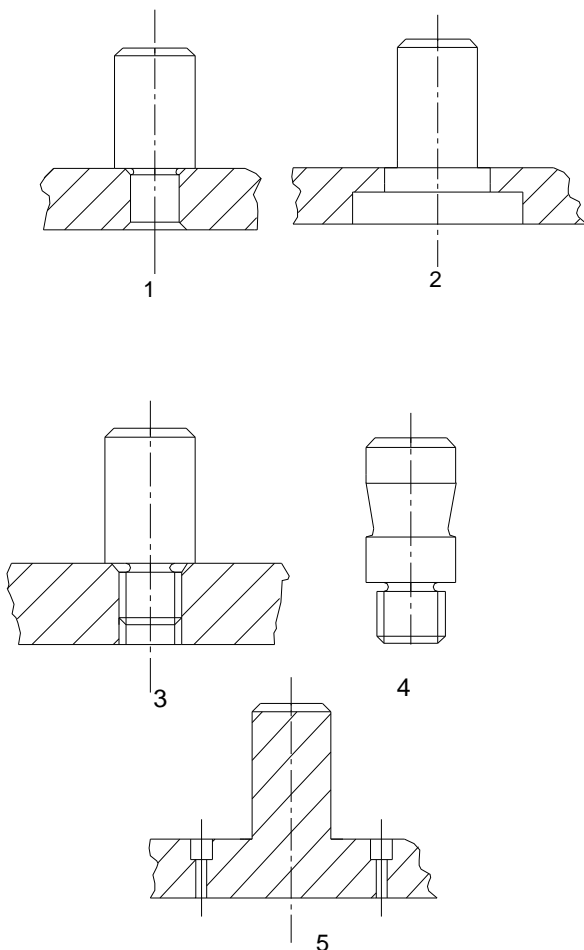


## SHANK:

A shank is an element of a press tool. The shank is mounted on the tool and acts as a connecting link from press tool to the press. The diameter of the shank fits the bore within the press ram. The shank diameter is standardised in relation with the press ram bore, which is varying from press to press depending on the capacity of the press.

There are four ways in which the shank is mounted to the tool top. They are as follows:

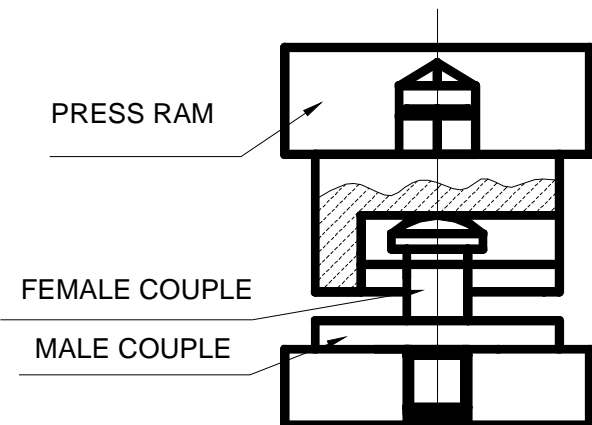
- 1) By riveting
- 2) By press fitting
- 3) By means of a thread
- 4) By making as integral part of top plate.
- 5) By making flange fastening.



However threaded types are used commonly. The shank should contain a spanner flat milled, to facilitate its fastening to tool top.

## SELF ALIGNING TYPE SHANK:

This is a special type of shank, which permits quick loading, and unloading of a press tool on a press. This type of shank differs very much in design when compared with other regular shanks. A Tee coupling mechanism is made in two sections. The one half, which is mounted on a tool, is a male member, whereas the other half, which is fixed to the press ram, is a female member. They are usually case carburised and hardened. The working mechanism is explained in the sketch.

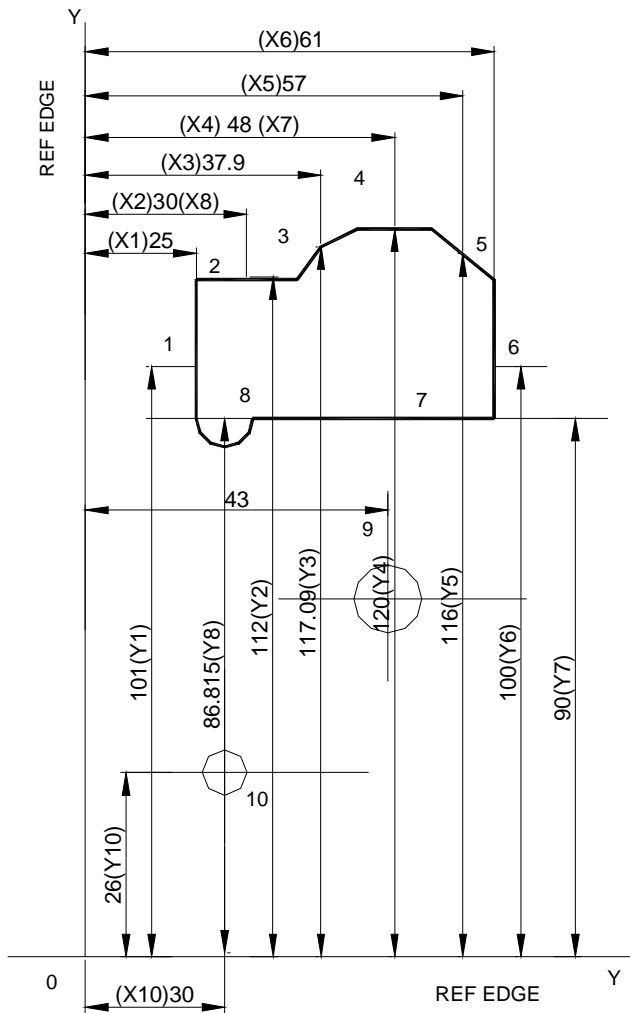


## LOCATION OF SHANK ON A TOOL:

The balancing of the cutting punches is one of the most important aspects to be considered during the punching operation. Unbalanced force distribution on the tool top may cause undue wear on the punch and die as well as on the pillars.

The resultant force of all the cutting forces, acting on many different punches should pass through the shank centre. The position of the resultant force of all the partial cutting forces can be found applying the following methods.

1. By calculations
2. By polygon system (Graphical).



By calculation: The resultant force should be found for both X and Y-axis by applying the following formula.

$$X = \frac{(L1 \times X1) + (L2 \times X2) + (L3 \times X3)}{L1 + L2 + L3}$$

$$Y = \frac{(L1 \times Y1) + (L2 \times Y2) + (L3 \times Y3)}{L1 + L2 + L3}$$

**Calculate the shank point for the die layout shown in the sketch.**

	L	X Distance	Product		L	Y Distance	Product
1.	203	25	550	1.	203	101	2020
2.	103	30	300	2.	103	112	1120
3.	12.563	37.90	476.02	3.	12.563	117.09	1470.72
4.	103	48	480	4.	103	120	1200
5.	11.313	57	644.67	5.	11.313	116	1131.96
6.	203	61	1342	6.	203	101	2020
7.	263	48	1248	7.	263	90	2340
8.	15.713	30	471.30	8.	15.713	86.815	163.86
9.	25.1363	43	1080.84	9.	2.1363	48	1206.52
10.	15.713	30	471.30	10.	15.713	26	408.46
**	170.42		7064.13	**	170.42		14,865.52

\*\* (indicates) = Total.

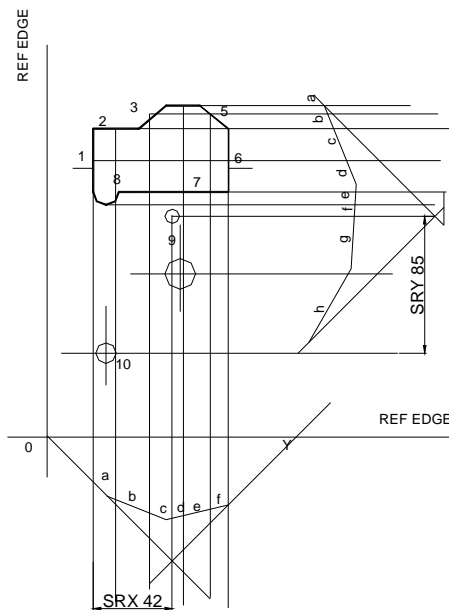
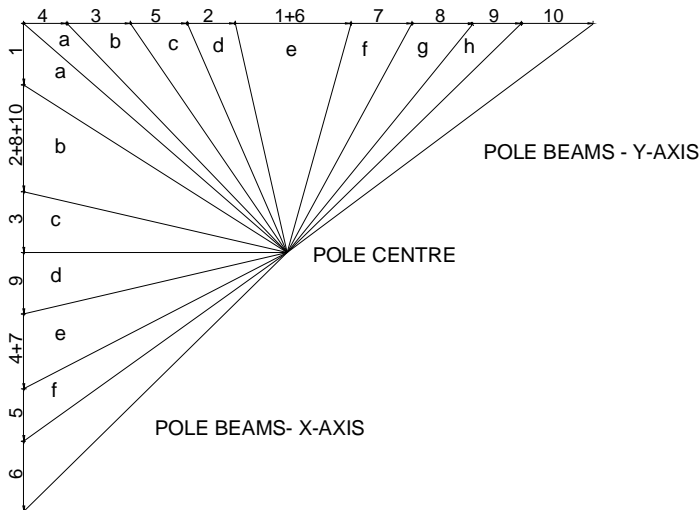
$$\text{Therefore } X = \frac{7064.13}{170.42} = 41.45 \text{ mm}$$

$$\text{and } Y = \frac{14865.52}{170.42} = 87.20 \text{ mm}$$

## Polygon system:

To find the line of the action of resultant then follow the reference below.

1. Draw the forces to scale in a straight line.
2. Draw the arrow heads at the ending points of each force as shown.
3. Draw two more lines at 45° angle from the starting and finishing points of the total length of the forces so as to form an equilateral triangle and call the intersecting point as pole.
4. Draw the lines from each arrow head joining the pole point and call them as pole beams.
5. Draw the forces to scale at the given distance.
6. Draw the lines parallel to the pole beams, cutting force line graphically.
7. The line of action of the resultant goes through that point where those two pole beams intersect.



## GLOSSARY OF PRESS TERMS:

### CAPACITY OF A PRESS:

The rated capacity of a press is the force in MN, which the slide will safely exert near the bottom of the slide.

### PRESS BED:

The stationary and usually the horizontal part of a press that serves as a table to which a bolster plates or lower die assembly is mounted.

### PRESS SLIDES:

The common name for the reciprocating member of a press guided in the press frame and to which the punch or upper die member is fastened. On a hydraulic press it is called the platen.

### PLUNGER SLIDE:

The inner slide of a double action press upon which the punch is mounted.

### BLANK HOLDER SLIDE:

The outer slide of the double action press usually operated by toggles or cams.

### BOLSTER PLATE:

A plate secured to the press bed for locating and supporting the tool.

### PITMAN:

Connecting rods to convey power and motion from the main shaft to the press slide.

### CLUTCH:

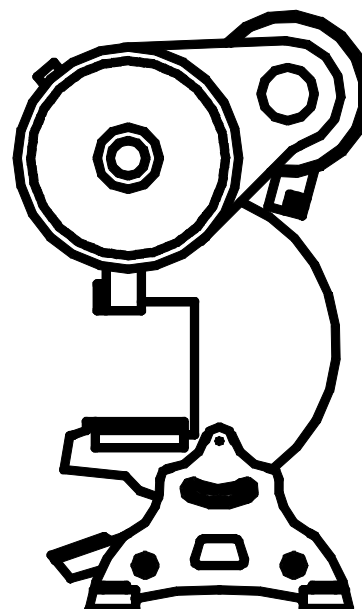
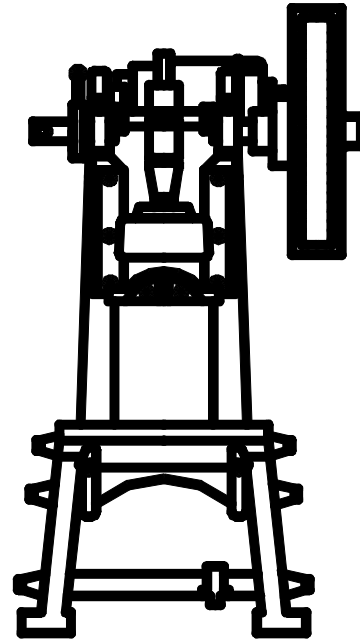
A coupling used to connect or disconnect a driving machine member such as the flywheel to or from a driven machine member such as the main shaft.

### STROKE:

A stroke of a press is the reciprocating motion of the press slide. It is the distance between terminal points of motion.

### STROKES PER MINUTE:

This is specified as the continuous running speed. It is not the number of single trippings of a press and does not measure the available production per minute except when a press is run continuously.



## SHUT HEIGHT:

It is the distance from the top of the bed to the bottom of the slide with the stroke down and the adjustment up.

## DIE SPACE:

Die space is the area available for mounting tools in the press.

## CLASSIFICATION OF PRESSES:

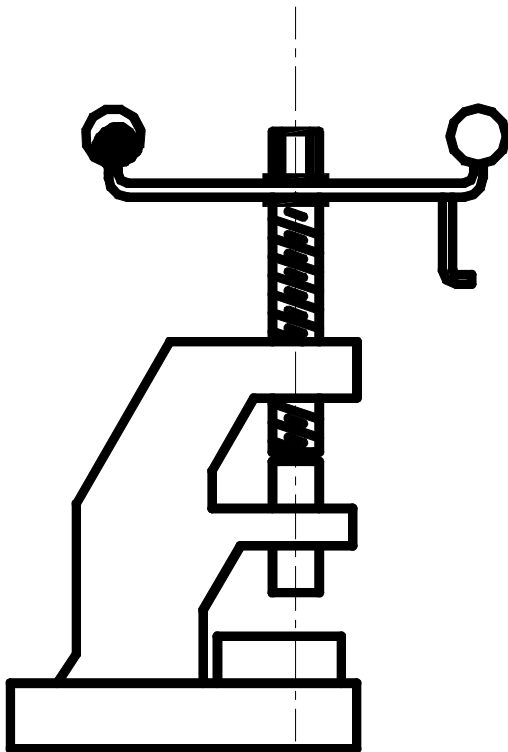
Presses are classified by one or a combination of some of the following characteristics, which include source of power, method of actuation of slides, number of slides incorporated, frame type, bed type and their intended use.

## SOURCES OF POWER:

The source of power for presses is either manual, mechanical, hydraulic or pneumatic.

## MANUAL:

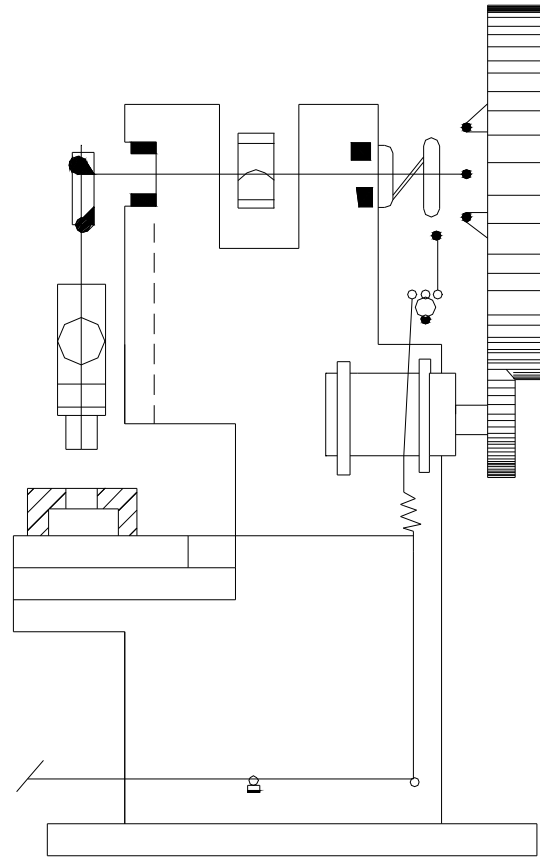
These presses are hand or foot powered through levers, screws or gears. Fly presses, arbor presses and toggle joint presses come under this category.



## MECHANICAL:

There are three major types of mechanical drives.

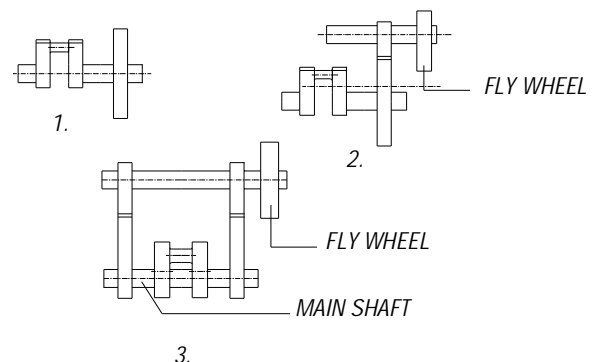
- 1) Non geared or fly wheel type.
- 2) Single reduction gear type.
- 3) Multiple reduction gear type.



In all three types a flywheel stores energy. The source of power is an electric motor.

The flywheel type drive transmits the energy of the flywheel to the main shaft of the press. Thus these presses are generally applicable to light shearing operations or light high-speed application. The single reduction gear drive transmits the energy of the flywheel to the main shaft through one gear reduction and is recommended for heavier shearing operations or shallow drawing.

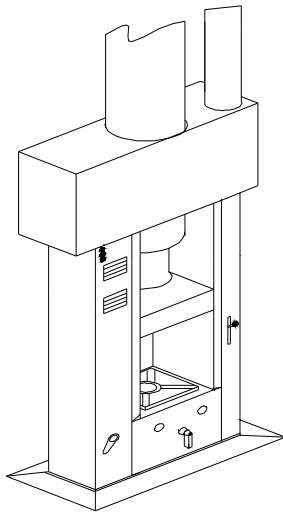
The multiple gear drive transmits the energy of the flywheel to the main shaft through two or more gear reductions. These reductions reduce the strokes per minute of the slide without reducing the flywheel speed.



Most presses have their drive mechanism on the top. The slide is pushed down to perform the operation. The under drive type has the mechanism under the bed with connecting linkage in the uprights to pull the slide downward. The mechanisms of the large under drive presses are below the floor level, thus requiring minimum space above the floor level.

### HYDRAULIC PRESSES:

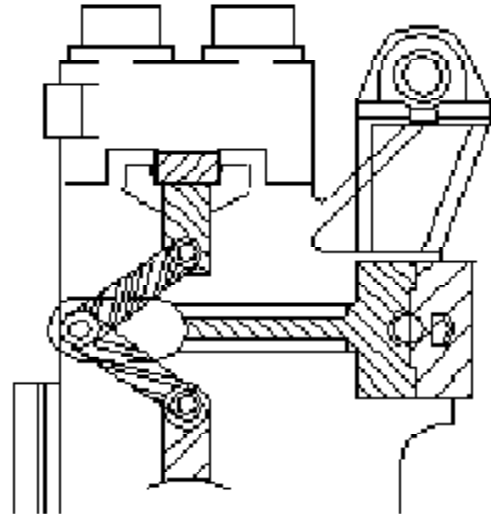
In these types of presses oil pressure in a cylinder with a closed end reacting against a piston moves the slide. A pump supplies the pressure to the cylinder. Constant pressure and speed can be maintained throughout the entire stroke. A few large presses use an accumulator to supply the energy.



Knuckle joint presses exert high tonnage's only at the bottom of the stroke. This type incorporates a crank or eccentric main shaft, which moves a joint consisting of two levers that oscillate to and from dead center and results in short powerful movement of the slide with slow travel near the bottom of the stroke.

Toggle press blank holder slides are actuated by a crank or eccentric working through a series of levers moving together through two or more dead center positions.

In hydraulic and pneumatic presses the levers are actuated by hydraulic and pneumatic cylinders respectively



### PNEUMATIC PRESSES:

Such presses are operated by pneumatic power. pneumatic cylinders provide the necessary forces.

### NUMBER OF SLIDES:

With respect to the action upon the material the presses are classified as single action, double action and triple action.

A single action press has only one slide. These presses are employed for operations such as blanking, piercing, bending, shallow drawing, forming etc.

A double action press has two slides arranged one within the other and moving independently of each other. The outer one serves as a blank holder and the inner one carries the punch.

A triple action press has three slides, two of which are located above and one within the bed. Such presses are used for complicated deep drawing operations.

### METHOD OF ACTUATION OF SLIDES:

The crankshaft is not commonly used for actuating slides. For comparatively short strokes the throw is obtained by means of a full eccentric machined on the shaft. Crankshafts are used for longer strokes.

### PRESS FRAMES:

Press frames are broadly classified into two general types, gap frames or C frame and straight side.

### GAP FRAME:

The housings of a gap frame press are cut back below the gibs to form the shape of letter C. this permits the feeding of wide strips from the side. They have a solid back or an open back to permit feeding from front to back or ejection of finished parts through back. The frames are in a fixed vertical position or in fixed inclined position or a frame that can be inclined. The inclined position allowed the parts to fall out by gravity.

### STRAIGHT SIDE:

The slide of the press travels downward between two straight sides or housings. These presses are used for heavy work.

## **CLUTCHES AND BRAKES:**

Timing and control of the intermittent reciprocating movement of the slide in a mechanical power press are provided by a clutch. The clutch is placed between the fly wheel and drive mechanism. The flywheel rotates continuously and engagement of the clutch causes the drive shaft to rotate and start the slide on its working stroke. As soon as the stroke is completed the clutch is automatically disengaged.

The clutches are divided into three main groups.

1. Positive clutches in which the driven and driving members of the clutch are intertouched in engagement.
2. Friction clutches.
3. Eddy current clutches.

Because of the inertia the press components will slide or rotate after the clutch has been disengaged. The brake stops the slide after the clutch is disengaged.

## **PRESS SELECTION:**

Depending upon the operational requirements the press is to be selected.

## **CUTTING OPERATIONS:**

Majority of the work can be done on short stroke mechanical presses.

## **BENDING:**

Straight side up frame or inclined single action press with a stroke to suit the operation can be selected. Hydraulic presses and press brakes are also suitable.

## **FORMING:**

Upto 75 to 100 mm-deep forming operations can be done on mechanical presses. Forming with die cushion is more accurate on mechanical presses, because the depth of the form is regulated by the throw of the crank.

## **DRAWING:**

Drawing can be done in presses used for blanking operation if the stroke is suitable and the press is equipped with die cushion. But the operating speed should be slower. Long stroke hydraulic presses are recommended for deep drawing, redrawing and ironing operations.

## **STROKE ADJUSTMENT IN PRESSES:**

The method of adjusting the stroke in a crank press is explained below.

The overhanging end of the crankshaft carries eccentric bushing and bronze bushing. The latter enters the cavity of the head of the pitman. The eccentric bushing has blind holes drilled over its circumference. The bushing can be turned around the shafts. Turning the bushing changes the eccentricity of the crank and consequently the slide stroke. Spontaneous turning of

bushing is prevented by lock clutch whose projections engage depressions in the bushing. The front end of the crankshaft is threaded to receive the nut whose shoulder connects it with the lock clutch. When unscrewed the nut shoulder will draw the lock clutch away from its place and thereby disengage clutch and bushing. After this the bush is free for adjustment by turning it through the required angle. Clutch is connected with shaft by key.

The maximum slide stroke is equal to the run of the eccentricities of bush and the shaft. The stroke is minimized by setting the eccentricity of the bushing opposite to the eccentricity of the shaft. The distance from the bed to the lower plane of the slide is adjusted by the screw screwed into the shank of pitman and resting against the spherical bearing. The adjusted screw is fixed in position by slide block.

## **DIE CUSHIONS:**

When a single action press is used for drawing operations the manner in which pressure is applied to the blank holder to control the flow of the metal is important. The application of the pressure to the blank holder is one of the features of the double action press. Single action presses lack this feature and therefore require supplementary blank holding equipment.

Tools are sometimes built with a blank holder using compression springs or PUR springs. The pressure exerted by the compression springs increases, as they are depressed. In order to obtain a small increase in pressure during the stroke, extremely long compression springs are required. On shallow draws the pressure increases due to the compression of springs usually does not affect the quality of the work piece. On deep draws the increase in the blank holder pressure and the decrease of flange area under the blank holder result in the increase in the blank holding pressure. This will lead to the tighter gripping of blank and the draw force required to pull the blank into the die will exceed the strength of the material. This will result in the fracture of the drawn component.

The most common type of pressure control mediums for single control mediums for single action press and drawing operation are the pneumatic and hydropneumatic diecushions.

## **PNEUMATIC DIE CUSHIONS**

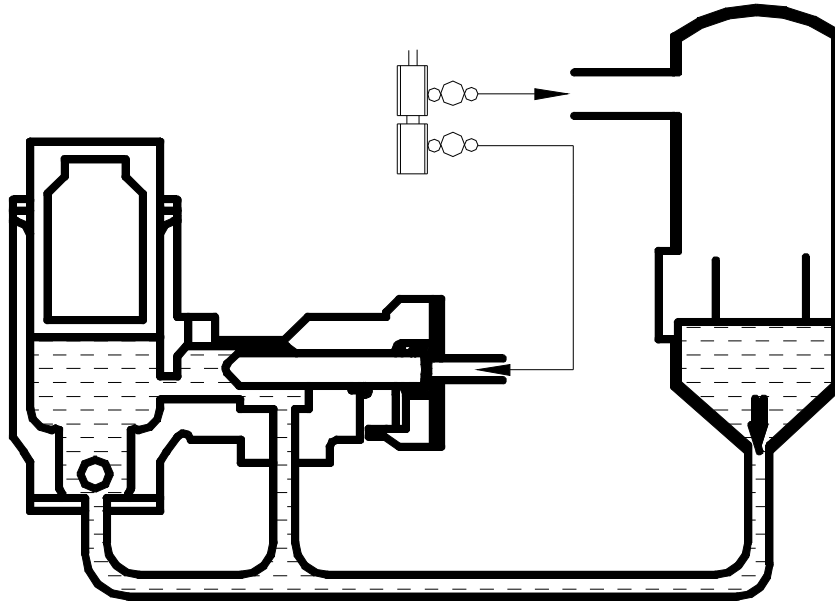
These types of die cushions are recommended when air pressure is not more than  $7 \times 10^5$  Pa is required. A pneumatic design normally uses one pitman and cylinder. However two or more cushions may be placed on top of one another if a higher capacity cushion is required in a limited bed area where vertical space is available. A multiple pneumatic die cushion is preferable over a hydropneumatic die cushion because of speed restriction of latter.

Die cushions are used in double setting presses to keep the bottom of the blank flat or to hold it to shape to prevent distortion or slippage while drawing.

**HYDROPNEUMATIC DIE CUSHION:**

These die cushions are used where the capacity required is more than that can be obtained with  $7 \times 10^5$  Pa air pressure on the pneumatic cushion. But they are slower acting than the pneumatic cushions. The principle of oil to air intensifier is used.

rect amount of stock unwound in form of loop. The press feeding mechanism draws stock from this loop. Unpowered loops require external power source. They are equipped with an automatic or manual brake to stop the reel after sufficient coil has been uncoiled



**STRIP FEED ARRANGMENT:**

For simple dies the strip feeding is done manually. But when the production rate is very high automatic feeding is employed. This also helps the steel mills to prepare strips in large coils.

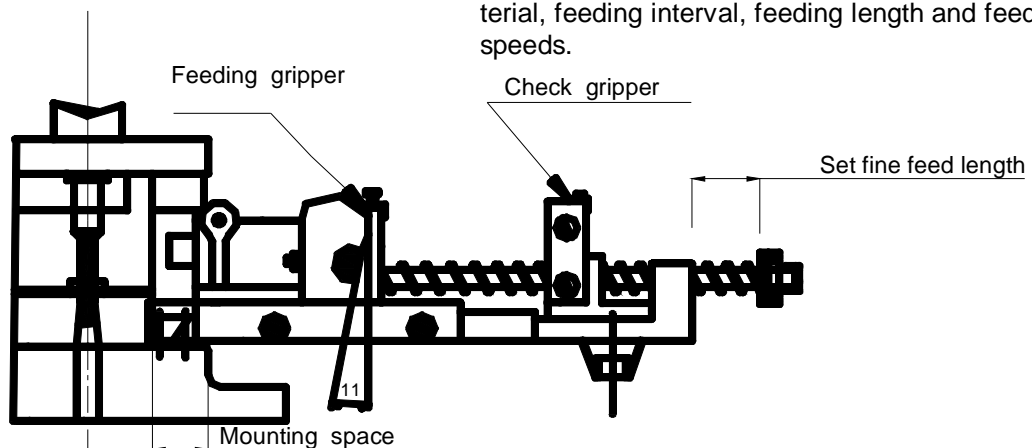
**STRIP STRAIGHTENING ARRANGMENT:**

The function of this device is to remove wrinkles and curvature after uncoiling. This is an intermediate step between uncoiling and feeding into press. The mechanism consist of a series of roll that bend the stock back and forth past its elastic limit for economic purpose straightening rolls are combined with feed rolls or coil cradle.

**COIL UNWINDING EQUIPMENT:**

The basic equipment used for this are the reel and coiled cradles. Power driven reels have mechanism which switch off the power to be drive when enough coil is uncoiled. Thus the reel always keeps the cor

After uncoiling and straightening the stock is fed into the press. Different types of strip feeding equipment are available. Their factors depend upon factors such as width, thickness and surface condition of the material, feeding interval, feeding length and feeding speeds.





### **BASIC FEED TYPES:**

There are two basic types of feed used with coil and strip stock, namely slide feed and roll feed.

The mechanical principle by which it operates varies, ratchet and pawl arrangement, system of dogs and pins or barrel type indexing cam.

### **MECHANICAL SLIDE FEED:**

The basic principle of the mechanical slide feed is the use of feed block actuated between the A positive strip that advances the material to exact distance required at each stroke. They have high accuracy and are suitable for use with coil stock. When strip stock is used it is necessary to feed the strip ends into the press manually.

When the stock is to be fed with the slide feed, stock guides should be used to overcome any tendency of the stock to buckle.

A slide feed is powered by the crankshaft of the press. The rotation of the crankshaft is transmitted to the feed through an eccentric mounted on crank shaft.

### **PNEUMATIC FEED:**

The working principle is shown in the figure. The pneumatic system grips the stock and takes it forward and then returns it to start position.

### **HITCH FEED:**

They resemble mechanical slide feed and the stock is pushed forward by gripper plate. The feed is operated by a cam mounted on the punch holder. The propelling force is generated by one or more springs that are compressed by the action of the cam as the punch holder descends. The springs feed the stock into the die on the up stroke of the press. Hitch feed can be used to feed the stock in any direction and can be used on presses that do not have any accessible crankshaft.

### **ROLL FEED:**

A roll feed consists of a pair of rolls that can turn in only one direction. They exert force on the stock by means of springs. They are rotated by means of press crankshaft. As they rotate they push the stock forward that is the function of angle of rotation. Rolls feed are suitable for use with extremely thin material. Polished surfaces of the stock will also not be spoiled. Roll feed eliminates manual feeding of end sections when the strip is processed. Double roll feeds are used when a sizable scrap skeleton remains after the press operation.

### **DIAL FEED:**

Dial feed is a rotating table. It may be built into the press bed, or it may be fixed to the press bolster or it may be a separate piece of equipment. Its function is to position one or more dies under a punch or punches mounted on the press slide. Dial feed may be powered with press crankshaft or independently.

After all tool details have been designed, a die set of the proper size and style is selected from a manufacturer's catalogue and drawn in position. Between five and ten percent of total design time is spent in selecting and drawing the views of the die set. This allowance may be increased considerably if the designer does not thoroughly understand the principles underlying die set selection and representation.

Die sets are manufactured in a bewildering variety of sizes and shapes and it is the purpose of this section to acquaint you with the various styles as well as to indicate proper methods of selection and placement.

Advantages realized when tool components are retained in a properly selected die set are: Members are kept in proper alignment during the cutting process even though some looseness may exist in the press ram. Thus, uniform clearances are maintained around the cutting edges for producing blanks free of burrs.

1. Tool life is increased.
2. Tools can be installed in the press in the minimum amount of time because they are self-contained units.
3. Storage is facilitated. There is no possibility of loss of loose parts.
4. Properly designed tools can be sharpened without removal of cutting members.

Standard die sets range from 3 by 3 inches to 45 by 60 inches. Bottom plate and top plate thicknesses range from 1 to 3 ½ inches, by quarter inches.

## ACCURACY:

Die sets are manufactured to two standards of accuracy precision and commercial. Top plate and bottom plate tolerances are same for both. The difference between them occurs in the closeness of fit between bushings and guide pillars. For precision sets, tolerances between bushings and guide pillars are maintained from 0.0002 to a maximum of 0.0004 inches. This tolerance assures extremely accurate alignment between punches and corresponding holes in die blocks. For this reason precision die sets should be specified for all tools which perform cutting operations.

Commercial die sets are given more liberal clearances between bushings and guide pillars. These range from 0.0004 to 0.0009 inches. Commercial die sets should be specified only for tools which perform bending, forming or other non-cutting operations. Selection of the material from the die sets are to be made will depend upon the strength requirements.

There are three choices:

1. Semi-steel
2. All steel
3. Combination-in which the top plate is semi-steel and bottom plate is all steel.

## SEMI-STEEL:

In manufacturers' catalogs the material of the die set is listed as either steel or semi-steel. Semi-steel contains only about 7% of steel in its composition and is considered to be cast-iron. Semi-steel die sets are cast to shape and then machined. Some manufacturers may cast top plate and bottom plate of meehanite which may be considered a high-grade cast iron.

## STEEL DIE-SETS:

When a large hole is to be machined through the die set for blank removal, it is considered good practice to specify a steel die holder if placed over a large hole in the bolster plate, which is done occasionally even in the best press shops. It happens too frequently that a cast iron die holder is actually broken in two because of the weakening effect of a large hole in conjunction with insufficient support under pressure.

Steel die sets are thoroughly stress relieved by manufacturers before final machining or grinding. Stress relieving removes any stresses introduced in the material in rolling at the mill and other stress added during rough machining. If such residual stresses are not removed, they are gradually released with consequent distortion and dimensional change, which can ruin a precision die.

Obviously, it behooves the designer not to incorporate anything in the design which can introduce stresses in the die set while the die is being built. Welding anything to a die set must be provided. Rough machining of deep pockets should be done by the die set manufacturer before the stress relieving operation and a print showing necessary machining operations should accompany the purchase order. To illustrate the importance of stress relieving in the manufacture of die sets with deep milled pockets and through holes, here is a representative order of operations actually employed for a larger die holder.

1. flame-cut holes
2. stress relieve
3. surface grind
4. rough machine pockets
5. stress relieve
6. surface grind
7. finish-machine

## SELECTING THE DIE SET:

Ten elements of die-set information must be decided before a die set can be ordered:

1. Make or manufacture
2. Type
3. Size
4. Material
5. Thickness of the die holder
6. Thickness of punch holder
7. Type and lengths of bushings
8. Lengths of guide posts
9. Shank diameter
10. Grade of precision

In selecting a die set from a catalog, first consider the dimensions from front to posts and from side to side. This is the die set area or usable space, to which die details can be fastened. Next in importance is the thickness of the die holder and of the punch holders.

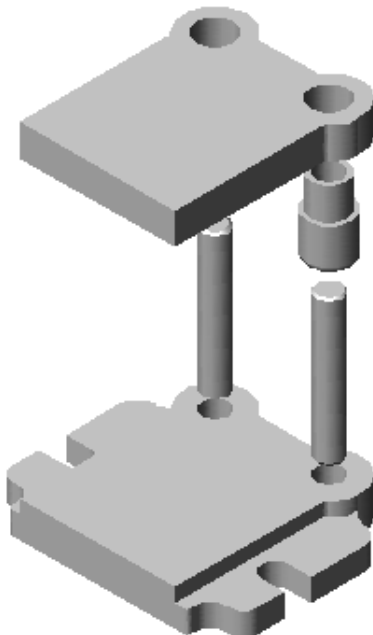
## DIE SET COMPONENTS:

These are

- A. Top plate
- B. Guide bushings
- C. Guide pillar
- D. Bottom plate

When the die set is assembled, the lower ends of the guide pillar are pressed securely into the die bushings and the turned down portions of the guide bushings are pressed into the top plate. The bushings engage the guide pillars with a close sliding fit to provide accurate alignment.

The illustration typifies small and medium size die sets made of both cast iron and steel, although different manufacturers may incorporate slight variations.



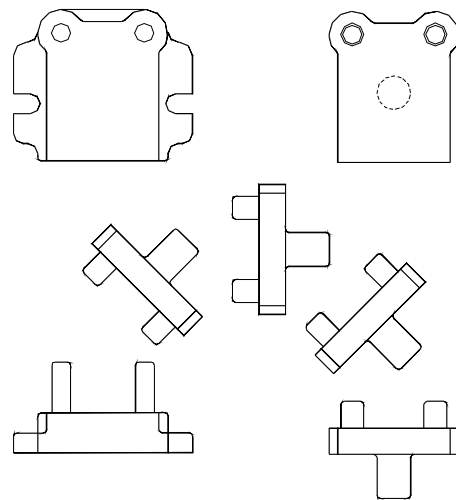
## TOP PLATE:

The upper working member of the die set is called the top plate. The name is easy to remember because of its relationship with punches, which are normally applied above the strip and fastened to the underside of the top plate. Surfaces 'A' are finished. They are employed by the die maker for squaring and locating punch components of the die. Surfaces 'B' are also finished surfaces. The upper one bears against the underside of the press ram. Punch components are fastened to the lower finished surface.

## INVERTING THE TOP PLATE:

On the die drawing the top plate is shown inverted or turned over. At the upper portion of the illustration the bottom plate is shown at the left and the top plate at the right, exactly as they appear on the drawing. At the bottom is shown how the top plate is removed from the guide pillars and inverted to an upside down position for drawing.

At the upper right view the punch shank is represented by a dotted circle and the bushings by concentric solid circles. The top plate is drawn inverted in this manner because this is the position in which it is placed on the die maker's bench for assembly of the punches. Also, punches can be drawn with solid object lines which makes the drawing easier to draw and read.



## PUNCH SHANK:

The punch shank projects above the top plate and it aligns the centre of the die with centerline of press. In operation, the shank is clamped securely in the press ram and it drives the punch portion of the die, raising and lowering it for cutting and other operations.

For semi-steel die sets, the punch shank is cast integrally with the body of the top plate and it is then machined. For steel die sets, it is electrically welded to the top plate and then machined.

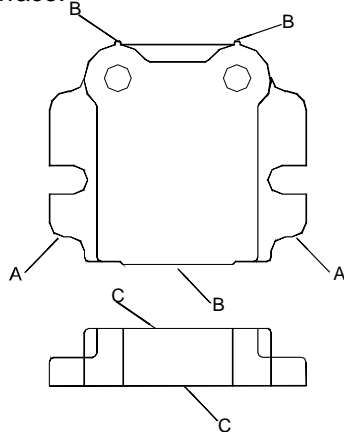
Punch shanks may also be ordered separately. These are turned down at one end and threaded for engagement in a large tapped hole in the top plate. Punch shank diameter depends upon the press selected. It is usually determined from a company standards book and it should be checked carefully for accuracy. After the diameter is known, the length can be found listed in a die set catalog. The round A at the top of the punch shank and the fillet B at the bottom where it joins the top plate or given a 1/8 inch radius on the drawing. Larger die sets are not ordinarily provided with a punch shank, or the shank is employed only for centering the die and not for driving. Instead, such die sets are clamped or bolted into the under side of the ram because of the considerable weight of large top plate and punch members. The relatively small punch shank would not be a safe method of driving.

To supplement their holding power of the shank, socket cap screws are often inserted upward through the top plate to engage hole tapped in the press ram. Where this practice is followed the designer specifies and dimensions the mounting holes to match the hole pattern in the ram, and he must make certain that they clear punch components. Dimensions for mounting holes are ordinarily taken from a company standards book.

## BOTTOM PLATE:

The bottom plate is the lower working member of the die sets. Its shape corresponds with that of the top plate except that it is provided with clamping flanges A having slots for bolting the bottom plate to the bolster plate of the press.

Machined surfaces B are employed for squaring and locating die components. Surfaces C are also finished. The lower one rests on the bolster plate, and the die block and other components are fastened on the upper surface.



Usually, the bottom plate is made thicker than the top plate to compensate for the weakening effect of slug and blank holes which must be machined through it. Common proportions for small and medium size dies are:

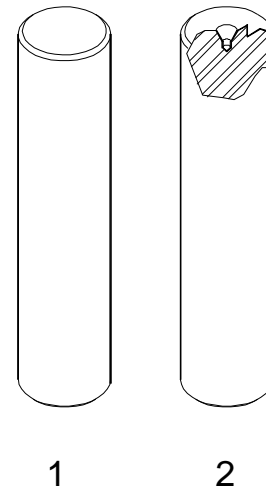
Top plate thickness-11/4inches.

Bottom plate thickness-11/2inches.

## GUIDE PILLAR:

Guide pillars are precision-ground pins which are press fitted into accurately bored holes in the bottom plate. They engage guide bushings to align punch and die components with a high degree of closeness and accuracy. Illustrated are 6 types:

1. Small guide pillars are usually hardened and center less ground, particularly for the commercial die set grades.
2. Larger diameter pillar are usually ground between centers after hardening.
3. Pillar may be relieved at what will be the die set surface. This relief is usually applied to precision pillars.
4. A non sticking pillar end may be incorporated. This provides for quick and easy assembly and disassembly.
5. Shoulder guide pillars are employed in conjunction with shoulder guide pillar bushings. The large shoulder is the same diameter as the press fit portion of the guide bushings. In the manufacture of special die sets the top plate and bottom plate are clamped together and holes are bored through both for engagement of bushings and guide pillars.
6. Removable guide pillar can be easily removed from the die set for sharpening. They are employed for large dies and for dies having more than two pillars



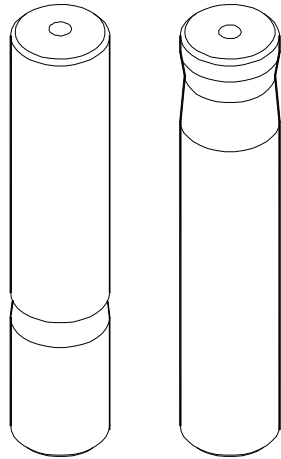
## REMOVABLE GUIDE PILLARS:

Often guide pillars must be removed for die sharpening, especially in large dies and in dies having more than two pillars of the back pillar style. We will look at three types:

1. The first kinds of removable guide pillars have an axial hole machined through them and are tapered at one end to engage a taper pin A. The pillar end is slotted. By driving the taper pin, the pillar is expanded against the wall of the hole in the bottom plate. To remove the pillars, a long rod called a drip is inserted from the top and the taper pin is pressed out.

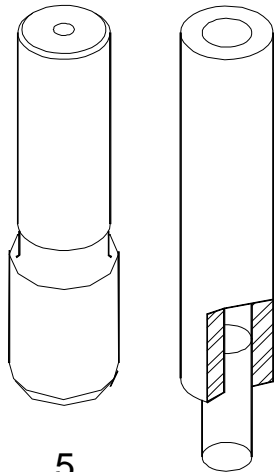
2. In the second type of removable guide pillar, the taper pin B is advanced for locking the pillar by means of a socket cap screw C.

3. The third removable pillar has a taper at the lower end to engage a sleeve for bushings, which is pressed into the bottom plate. A socket cap screw engages in a retaining cap to clamp the pillar to the bushing. Removal of the socket cap screw allows the pillar to be lifted up and removed.



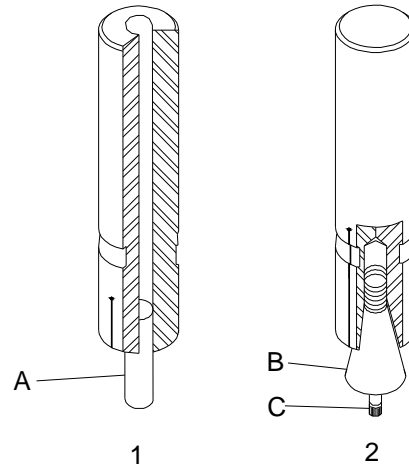
3

4



5

6



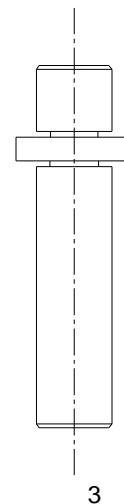
1

2

Guide pillars for precision die sets are hard chromium plated to provide a high degree of resistance to wear. Also, the addition of chromium surface reduces friction by more than 50%.

For secondary operation dies, guide pillars should have sufficient length so that they never leave their bushings in operation. This is a safety feature to prevent possible crushing of fingers accidentally introduced between pillars and bushings as the die operated.

Guide pillars are specified at least  $\frac{1}{4}$  inch shorter than the shut height of the die as listed on the drawing, (the shut height being the bottom of the bottom plate to the top surface of the top plate, excluding the shank, and measured when the top plate is in the lowest working position). This provides a grinding allowance to assure that the top of the pillars will not strike the under side of the press ram when the upper die is lowered as punches are sharpened.



3

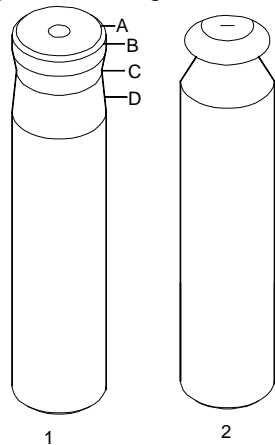
## NON-STICKING GUIDE PILLARS:

Sticking or jamming in initial stages of engagement of top plate and bottom plate has long been a problem because of the close fits maintained. Sticking occurs until the bushings have engaged the pillars sufficiently for complete alignment. Die must be assembled and disassembled to great number of times in their manufacture, try out and in sharpening.

Illustrated at 1 is popular, as well as a commercially available, pillars that features the following characteristics:

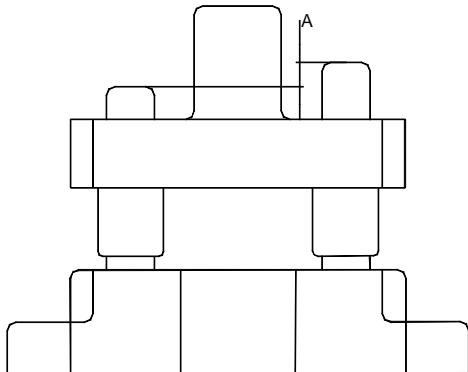
- A. A ground taper guides the bushing over the pillar.
- B. A narrow land of the same diameter as the pillars centers the bushings. The land is narrow enough to allow rocking of the bushing over it
- C. This clearance area represents the sticking range. Because metal has been removed, sticking cannot occur.
- D. This is a ground lead which guides the bushing to engagement with the full diameter of the pillars.

Shown at 2 is a pillar that features a radius at the leading edge to align the bushing.



## OFFSET PILLAR ENDS:

In another method of assembly employed by a commercial supplier one if the guide pillar is made longer than the other. The top plate engages the long pillar first and it is thus aligned before engagement of the other pillar occurs. Dimension A is usually made 1/2 inch.



## GUIDE BUSHINGS:

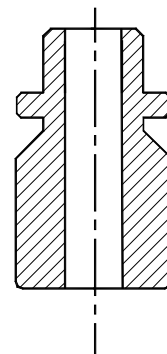
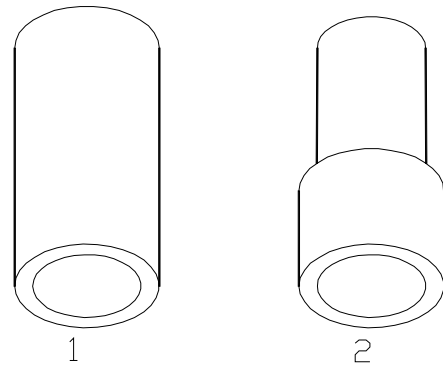
Accurately ground sleeves, or guide bushings, engage guide pillars for aligning the top plate with the bottom plate. Most bushings are made of tool steel although they are also available in bronze. There are two types:

1. Plain bushings are simple sleeves, pressed into the top plate.
2. Shoulder bushings are turned down at one end and they are pressed into the top plate against the shoulder thus formed. They are recommended for all dies which perform cutting operations.

Length of guide bushings vary, depending upon the manufacturer. In general, we may recognize two different lengths for plain bushings, - regular and long. shoulder bushings are furnished in three lengths- regular, long, and extra long. The length selected will depend upon the accuracy requirement of the tool. the longer the bushing, the more accurate will be the alignment of the punch and die members. this is particularly important in cutting operations, especially, for thin stock when clearances between cutting edges are small.

Pillars and bushings are assembled by shrink fitting into holes bored in the top plate and the bottom plate. The pillars and bushings are subjected to deep freezing, thereby reducing their diameters. They are then inserted in the top plate and bottom plate and upon warming to room temperature, they expand to provide a tight fit between components.

Each guide bushing is provided with a fitting for lubrication. Helical grooves are machined in inside surface for retention and distribution of lubricant.



Pillars and bushings are assembled by shrink fitting into holes bored in the top plate and the bottom plate. The pillars and bushings are subjected to deep freezing, thereby reducing their diameters. They are then inserted in the top plate and bottom plate and upon warming to room temperature, they expand to provide a tight fit between components.

Each guide bushing is provided with a fitting for lubrication. Helical grooves are machined in inside surface for retention and distribution of lubricant.

### SELF OILING GUIDE BUSHINGS:

Shown is a guide bushing made of porous powdered alloy steel. Internal pockets are cored in the walls, and these are filled with at manufacture. In use, the oil meters through the porous wall by capillary action. Stored lubrication is sufficient for the life of the bushing.

### DEMOUNTABLE GUIDE BUSHINGS:

These are shoulder bushings provided with clamps that engage and annular groove machined in the bushing wall or shoulder. Socket cap screws are threaded into the top plate to effect clamping. The turned down portion of the bushing is not a press fit into the top plate. Instead, it is ground to an accurate sliding fit for ease in disassembly.

These bushings are available in both steel or bronze and they are provided with either two clamps or three clamps, depending on size. Demountable guide bushings are specified for long runs, when it is anticipated that bushings and posts will require replacement.

### BOSS BUSHINGS:

Demountable bosses may be employed as guide bushings in large die sets. They are used for heavy duty work when long runs are expected. The bosses are turned down for location in holes in the die sets and they are fastened with socket cap screws for easy replacement. There are three types of boss bushings:

1. Flange mounted - the greater portion of the surface is within the die set.
2. Demountable- employed as bearing and also as guide pillar supports
3. Long bearing- these have a bearing surface extending below the mounting flange and supported by ribs.

### BALL-BEARING DIE SETS:

Some die sets are provided with ball bearings instead of guide bushings. Guide pillars are pressed into the top plate and they engage linear ball bearings, which in turn are guided in hardened sleeves. The bearings are pre loaded to remove looseness or side play. Lubrication is by cup grease applied at set up and this is usually sufficient for the entire run. Ball bearings take more room than conventional guiding methods and they reduce die space a small extent.

### DIRECTION OF FEED:

Direction of feed of strip will influence selection of die sets. strip may be fed through a press in any of three directions:

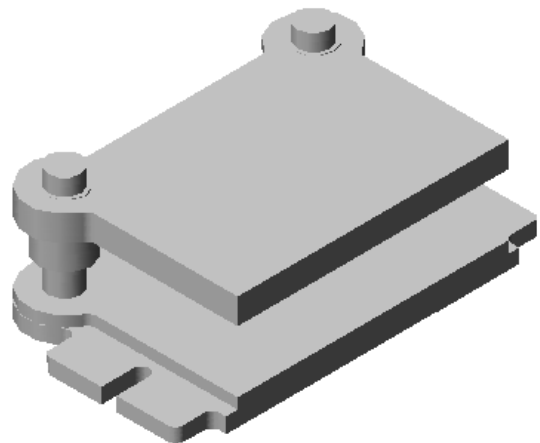
1. *Front to back*. This method may be employed for long runs when the strip is fed automatically.
2. *Right to left*: This is the most commonly used feeding direction. It is used when the strip is advanced by right hand.
3. *Left to right*: This is used occasionally when strip is feed automatic.

### PILLAR ARRANGEMENT:

Guide pillars are position in six ways  
Two pillars may be positioned in different ways

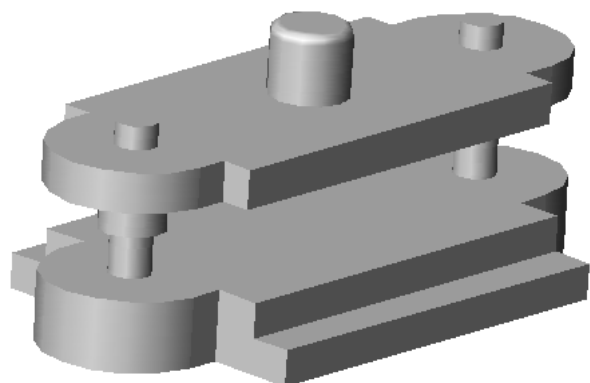
#### Rear pillar die set

Rear pillar die set used for bending tools, secondary tools operation.



#### Centre pillar die set

Centre pillar die set is used for round or rectangular working area

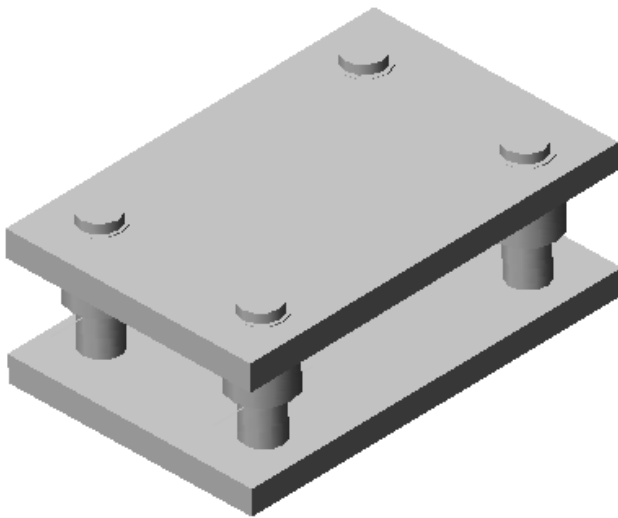


### Diagonal pillar die set

Diagonal pillar die set is used for progressive tools with rectangular working area.

### Four pillar die set

Four pillar die set is used for heavier press working operation.



### NON STANDARD DIE SETS

These die sets are made for a particular design when standard die sets are not suitable or not available. These are usually made of mild steel with case hardened pillars and bushes.

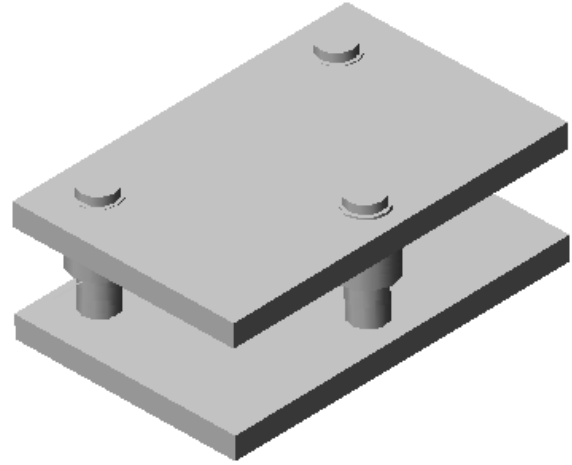
### STYLES:

Back pillar die sets are made in five different styles or shapes:

1. This style is most common. It is used for small medium size die sets ranging from 3 X 3 inches to about 16 X 18 in both semi-steel and steel.
2. Large, semi-steel die sets ranging from 22 ½ X 6 inch to 25 X 14 inches have sides wider than the distance over the pillars.
3. The larger ranges of steel die sets are made square or rectangular in shape.
4. Many tools have relatively small punch members which occupy little top plate room. For such tools die sets with v-shaped punch holders provide a better proportioned design as well as greater visibility for loading and unloading work.
5. For round punch members a round die set may be used.

### THREE PILLAR DIE SETS:

The addition of a front pillar to a back pillar die set provides increased stability for unbalanced cuts and when greater precision is required. These are incorporated only in square or rectangular steel sets. For hand feeding, the extra pillar is applied at the front, left corner as at A. when the feed is automatic it is centered as at B.



### FOOL PROOFING :

Center pillar and diagonal pillar die set are provided with different diameter pillars, dimensions A and B. Thus, the top plate cannot be reversed on the bottom plate. This is an important precaution for symmetrical tools.

### FLOATING-ADAPTER DIE SETS:

In blanking and piercing thin stock and for shaving and broaching operations very little clearance can be allowed between the punch and die members. The slightest lateral movement would cause nicked or dulled cutting edges. The floating adapter shank A is clamped in the ram of the press in the regular way. However, by using this adapter the ram can only impart an up and down motion to the top plate. Any inaccuracy or wear in the slide of the press will not be transmitted as stresses on the die set guide bushings and guide pillars. The top plate therefore is actuated independently of the press slide. Long shoulder bushings should be used with these die sets because, in operation the guide pillar must always be guided within them.

### LARGE DIE SETS - SEMI-STEEL:

Large semi steel die sets are available in the back pillar A, center pillar B, diagonal pillar C, or four pillar D styles. All are provided with clamping flanges for shoulder bushings unless otherwise specified.



### LONG, NARROW DIE SETS:

This type of die set is used to retain tools for cutting, bending and forming of long, narrow parts. They are back pillar sets, and they are available with either two or three guide pillars. Two pillar are specified for sets ranging from 12 to 72 inches in length and three pillars for sets ranging from 84 to 240 inches in length.own at B are available in diameters ranging from 4 to 48 inches.

### ROUND DIE SET :

These die sets are selected for retaining round dies such as drawing tools, trimming tools, and the like. There are two style: back pillar style as shown at A and center pillar style as shown at B are available in diameters ranging from 4 to 48 inches.

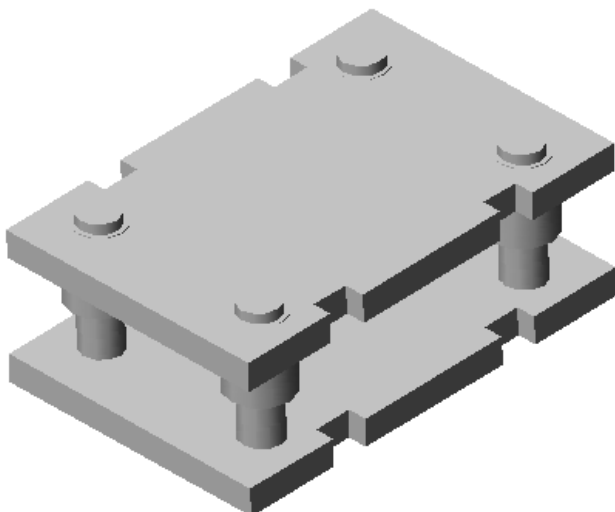
### CENTER PILLAR DIE SET :

These die sets are ordinarily employed for secondary operation work such as piercing, coining, and the like. Parts are loaded from the front. The die sets are available in semi steel and steel in the style illustrated in fig. Components may be supplied in combination, with a steel bottom plate used in conjunction with a semi steel top plate as at C.

Another important application for center pillar die sets is the performing of secondary operations on work pieces having a right and a left hand. Parts of one hand may be conveniently loaded from one side. When the other hand is to be run, th die set is turned around 180° in the press for ease in loading.

### LARGE DIE SET - STEEL:

Large steel die set are made of plate. They have ground surfaces and they are square or rectangular in shape. Two-pillar sets are given one of three pillar arrangements. At A is shown the back pillar, at B the center pillar, and at C the diagonal pillar style. Sizes are not limited. That is, they may be specified to any length, width, and thickness of top plate and bottom plate.



### RECOMMENDED THICKNESSES:

The bottom plate and top plate of a large die set must be given sufficient thickness. Die set catalogs recommend specific thickness in relation to side-to- side and front -to-back dimensions and these recommendations should be followed. When plates are too thin in relation to their width and length, they will warp causing misalignment of punch and die numbers and binding of guide pillars in guide bushings. Conversely, when plates are too thick the overall die cost increases.

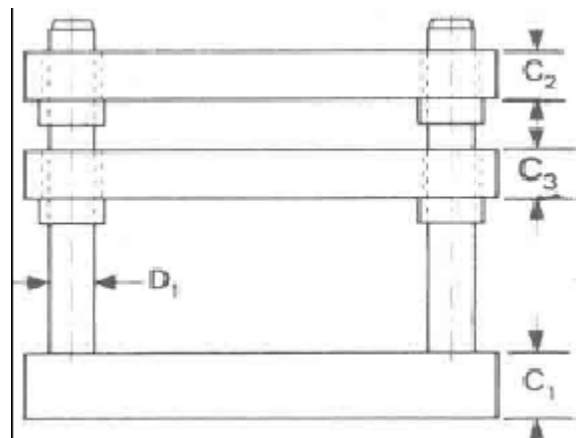
This table provides a useful guide to the specification of top plate and bottom plate thickness. Observe that there are two considerations, die-space dimensions A&B ,and the force in tons required to perform the work that is to be done by the tool. Select the values for C and D opposite whichever is greater.

Eg:- If the die set area for a particular die measures 30 by 20 inches and the force in tons is less than 30, the values of 1 ¾ inches for C and 2 inches for D would be selected. however, if the force in tons were 60, we would use the values opposite pressure in tons of 50 to 70, and the value for C would be 2 ½ inches and for D 3 inches.

### SPECIAL DIE SETS:

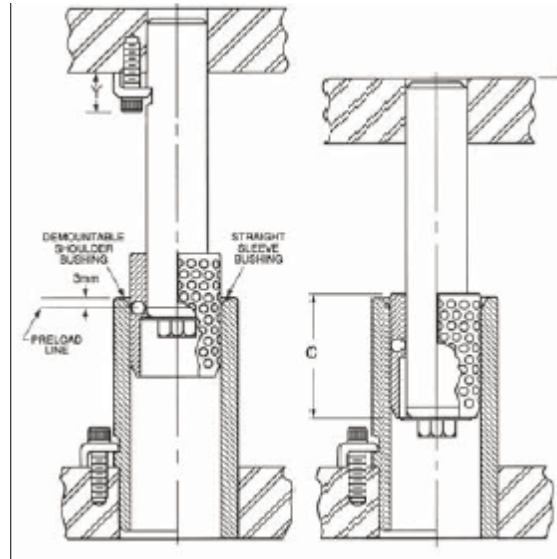
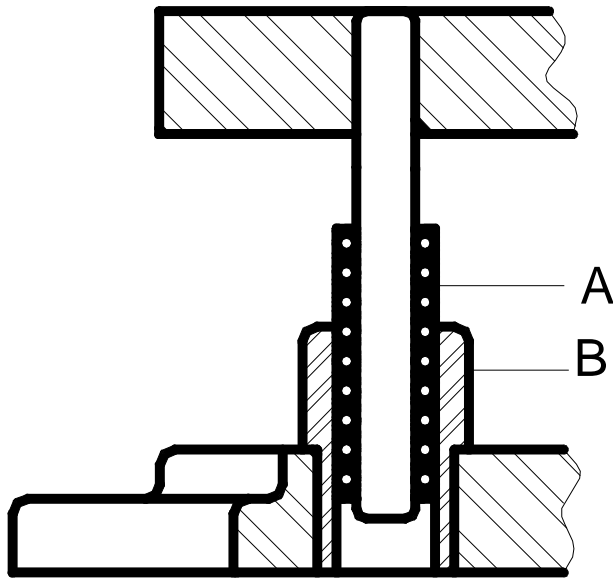
Despite the large number of styles and sizes of standard die sets available, it is occasionally necessary to design a special die set for a specific job. This occurs particularly for parts which are exceptionally large or which contain severe offsets. Provide adequate strength by applying ribs or gussets at highly stressed sections. Specific rules can not be given because of the variety of conditions encountered.

Special die sets are designed by the die designer and a print is sent to a die set manufacturer where the die set is actually built.



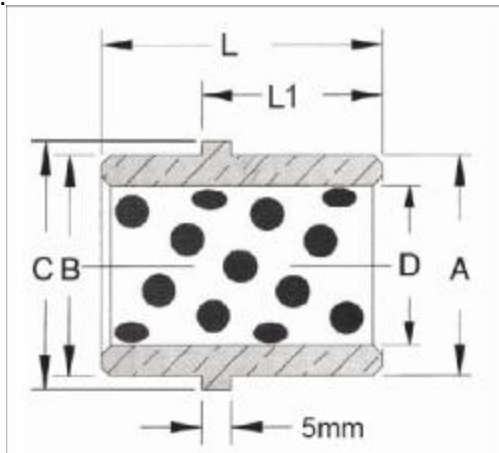
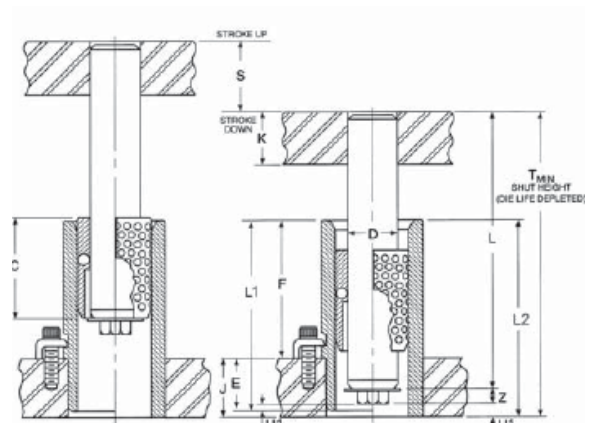
### BALL-BEARING DIE SETS:

Some die sets are provided with ball bearings instead of guide bushings. Guide pillars are pressed into the top plate and they engage linear ball bearings, which in turn are guided in hardened sleeves. the bearings are pre loaded to remove looseness or side play. Lubrication is by cup grease applied at set up and this is usually sufficient for the entire run. Ball bearings take more room than conventional guiding methods and they reduce die space a small extend.



### Self-Lubricating Ejector Bushings

These self-lubricating bushings contain graphite plugs which are impregnated with oil. When the bushing reach 80-90°F as a result of friction between the bushing and guide post, oil is drawn from the plug,thus lubricating the wear surface. A dark smear pattern is created on the wear surface as the oil and graphite are imbedded into the bronze or steel grain. This provides the lubrication necessary for continuous performance of the tool.



In previous sections of this book, you have learned the elements that go into building a complete tool. In addition, you have learned how to design a tool, that is, how to arrange those elements - the die block, punches, stops, gauges, die set and all the others into a functioning tool. Also the preparation of tool drawing was explained in detail so your comprehension would be thorough one.

The next step is to learn about the types of dies, the function, and how they operate. There are twenty types of tools and each is distinct and different from all the other types. However, as you study the descriptions to follow, observe how the elements that you learned previously are applied and re applied with suitable modifications to adopt them for each particular job to be performed.

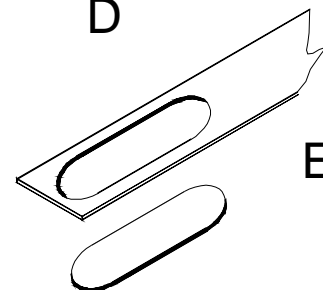
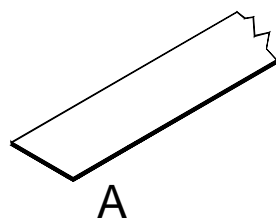
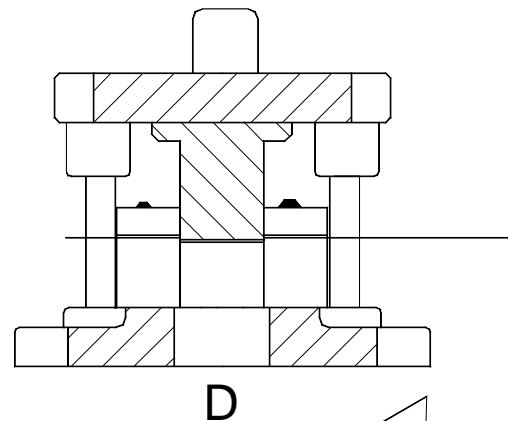
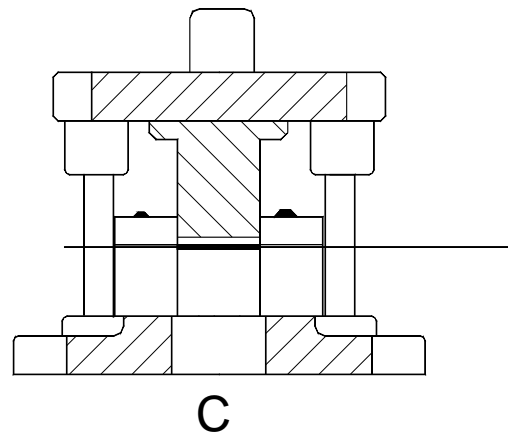
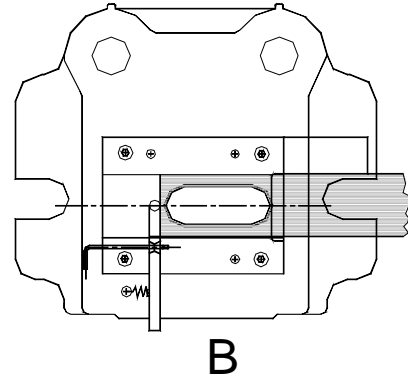
### BLANKING TOOLS:

A blanking tool produces a blank by cutting the entire periphery in one simultaneous operation. Three advantages are realized when a part is blanked.

1. Accuracy. The edges of the blanked parts are accurate in relation to each other.
2. Appearance. The burnished edge of each blank extends around its entire periphery on the same side.
3. Flatness. The blanked parts are flat because of the even compression of material between punches and die cutting edges.

The insert at A shows a material ready to be run through a blanking tool. At B is shown top view of the tool with punches removed. The section view at C shows the tool in open position with the upper punch raised to allow advance of the strip against the automatic stop. At D the tool is shown closed with a blank pushed out of the strip.

Blanking tools may produce plain blanks as shown in the inset E, but more frequently holes are pierced at one station and the part is then blanked out at the secondary station. Such tools are called "pierce and blank tools" and they have been described fully in preceding sections of the book.



## PIERCING TOOLS

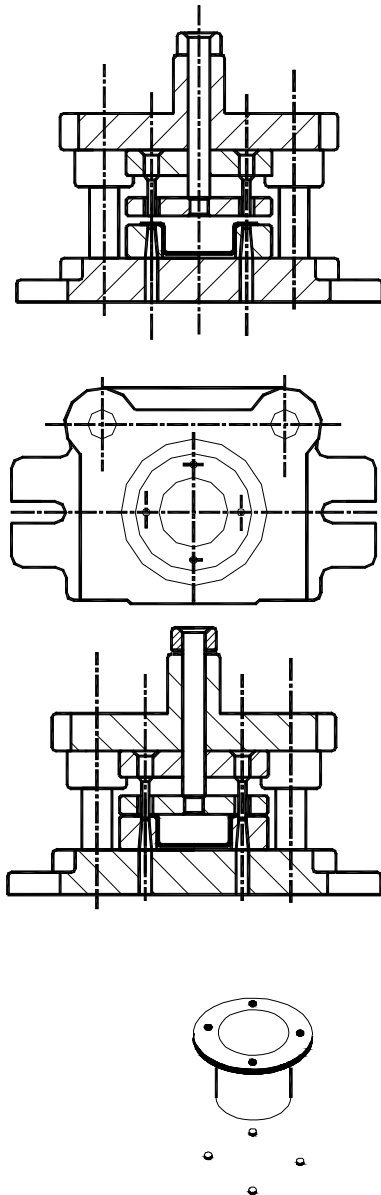
Piercing dies pierce holes in stampings. There are two principle reasons for piercing holes in a separate operation instead of combining piercing with other operations:

1. When a subsequent bending, forming, or drawing operation would distort the previously pierced hole or holes.

2. When the edge of the pierced hole is too close to the edge of the blank for adequate strength in the die section. This occurs in compound and combination tools in which piercing and blanking are done simultaneously.

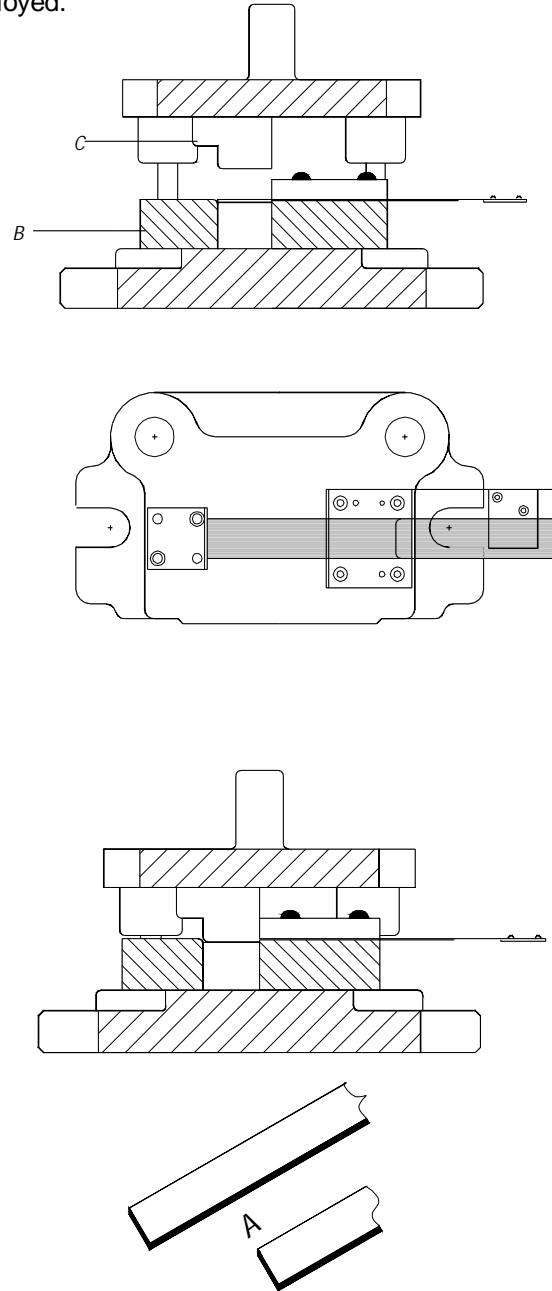
In the inset at A is shown a flanged shell requiring four holes in the flange. If the holes were pierced before the drawing operation they would become distorted because of the blank holder pressure applied to the flange in the drawing process.

The shell is located in an accurately ground hole in the die block. Piercing punches are retained in the punch holder fastened to the top plate, and a knock-out effects stripping after the holes have been pierced.



## CUTOFF TOOLS:

The basic operation of a cutoff tool consists in severing strips into short lengths to produce blanks. The line of cut may be straight or curve, and holes and notches or both may be applied in previous operations. The cutoff tools are used for producing blanks having straight, parallel sides because they are less expensive to build than blanking tools. In operation, the material strip A is registered against stop block B. Decent of the upper tool causes the cut off punch C to separate the blank from the strip. Stop block B also guides the punch while cutting occurs to prevent deflection and excessive wear on guideposts and bushings. A conventional solid stripper is employed.



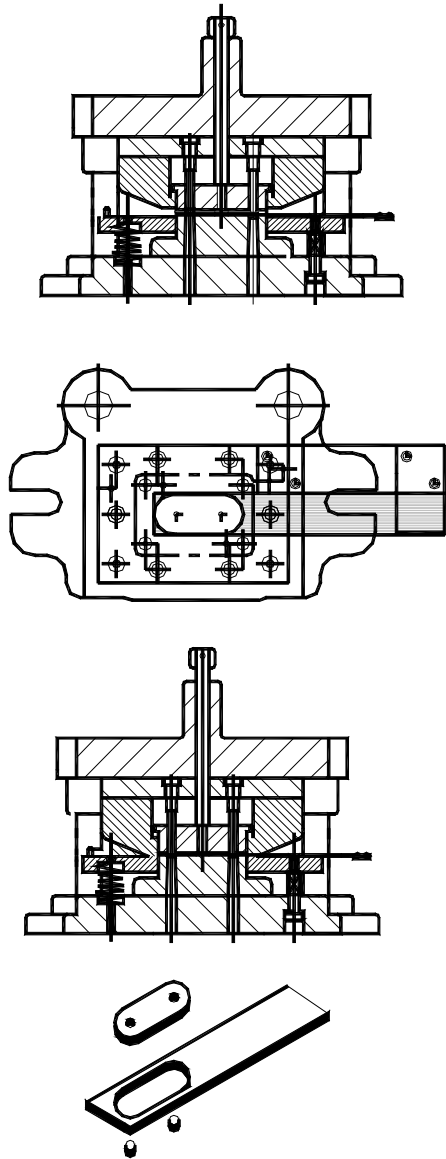
## COMPOUND TOOLS:

In a compound tool, holes are pierced at the same station as the part is blanked, instead of at a previous station as is done in the pierce and blank tool. The result is greater accuracy in the blank. Whatever accuracy is "built in" the tool will be duplicated in every blank produced by it. Compound tools are inverted tools. The blanking punch A is located on the tool holder of the die set instead of being fastened

The tool block B is fastened to the punch holder and it is backed up by a spacer C which retains piercing punches. A positive knockout removes the blank from within the die cavity near the top of the press stroke. A spring stripper removes the material strip from around the blanking punch.

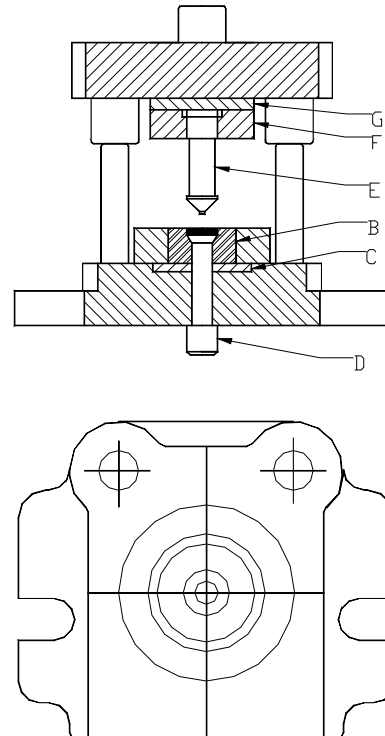
Although most compound tools are designed for producing accurate, flat blanks, they are occasionally used for producing blanks that are too large for production in more than one station. Since all operations are performed at the same station, compound tools are very compact and a smaller die set can be applied.

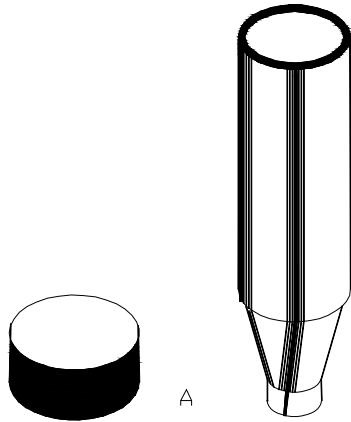
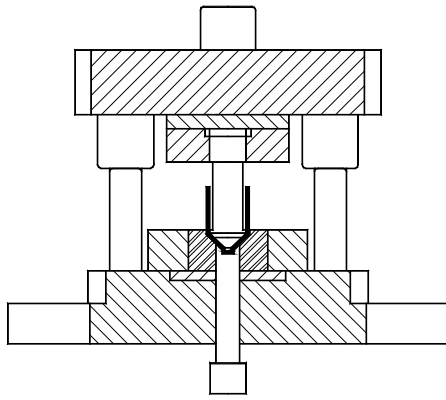
COMPOUND DIE



## EXTRUDING TOOLS:

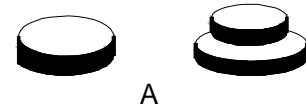
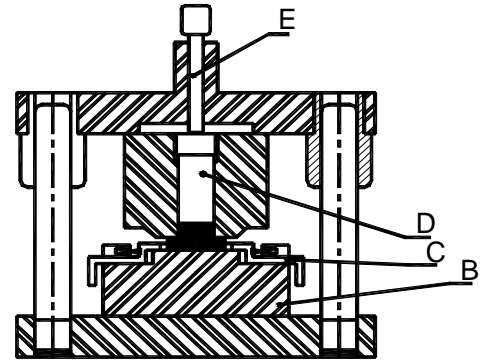
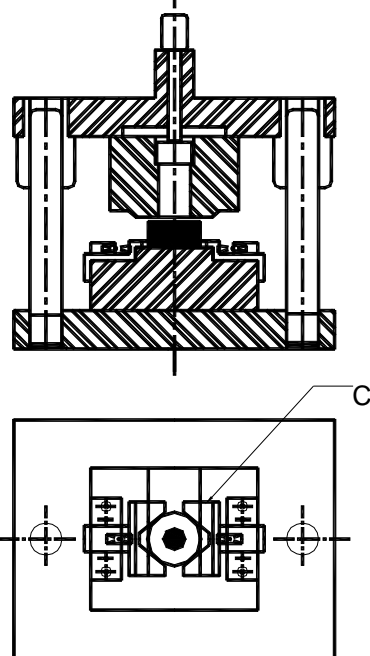
The function of all the tools discussed so far is to perform work on the sheet material - to cut sheet materials into blanks, to perform further operations upon the blanks, or to perform the operations on the workpiece bent, formed or drawn from the blanks. We come now to interesting classes of tools that perform secondary operations on small thick blanks called slugs. In this dies the slugs are severely deformed to make parts having no resemblance to the slug from which they were made. The first class is called extruding tools. In this type of tool each slug is partly confined in a cavity and extremely high pressure is applied by a punch to cause the material in the slug to extrude or squirt out, much like tooth paste is extruded when the tube is squeezed. In the illustration the slug A is to be extruded into a thin wall shell having a conical closed end. The slug is placed in die block B, backed up by a hardened plate C the bottom of the cavity in the die block is formed by the end of the knockout rod D. when the press ram descends extruding punch E first squeezes the material in the slug until it assumes the shape of the die cavity and of the working end of the extruding punch. Continued descent causes the material to extrude upward between the walls of the punch and die wall of the cavity. The amount of clearance too determines the thickness of the wall of the extruded shell. The extruding punch is retained in punch plate F. and because of high pressure involved; it is backed up by backing plate G.





### COLD FORMING TOOLS:

Cold forming tools produce work pieces by applying pressure to blanks, squeezing and displacing the material until it assumes the shape of the punch and die. In the illustration at A, a slug is to be formed into a flanged part in the cold forming die. It is placed on the punch B located within spring loaded V gages C. Descent of the upper die causes the material under the upper die block to be displaced outward to form the flange. As the flange increases in diameter, the gauges are pushed back as shown. When the die goes up, the part is carried upward within it and it is ejected near the top of the stroke by knockout plunger D actuated by knock out rod E.

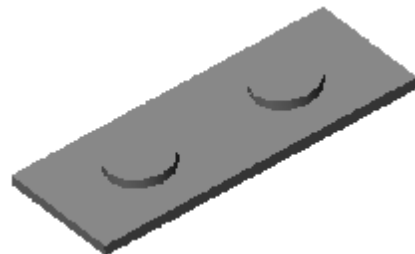
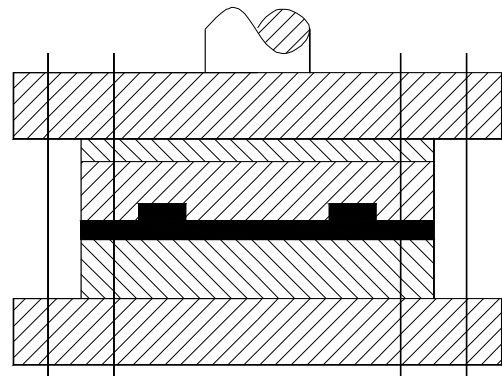


### COINING:

Coining is the operation of pressing material in a die so that it flows into space in the detail of the die face. Coining differs from embossing. In coining the metal flows, whereas in embossing the metal does not change in thickness to a great extent.

Coining operations are generally performed cold. Coining has two major advantages.

- 1) Ornate detail can be produced with excellent surface finish.
- 2) Tolerances can be held to very closer values.



## BROACHING TOOLS:

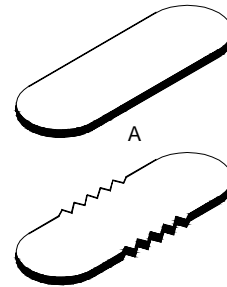
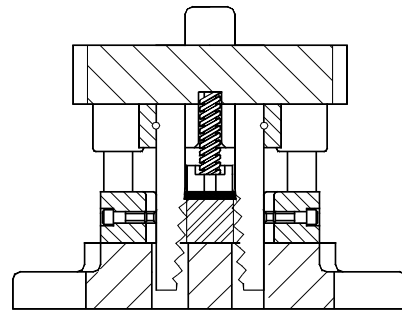
Broaching may be considered to be a series of shaving operation performed one after the other by the same tool. A broach is provided with a number of teeth, each of which cuts a chip as the broach traverses the surfaces to be finished. Internal broaches finish holes; surface or slab broaches finish outside surfaces.

Two conditions make broaching necessary:

1. Blanks are too thick for shaving. A considerable metal must be removed from the edge of the thick blanks; a series of shaving tools would be required to produce smooth finish. It would then be more economical to use a broaching tool.

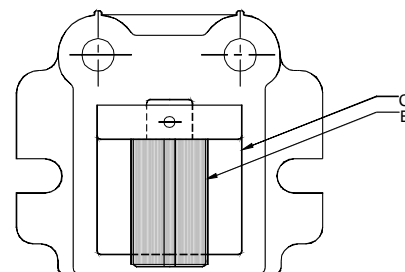
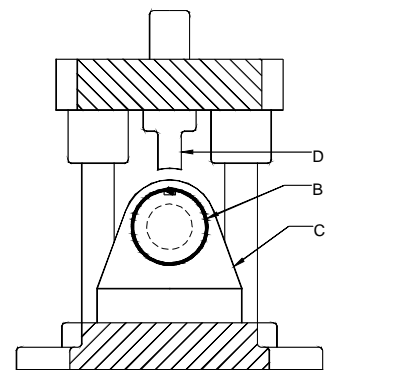
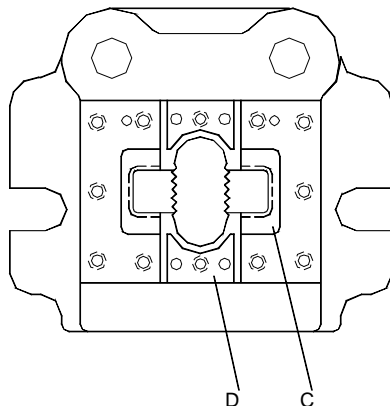
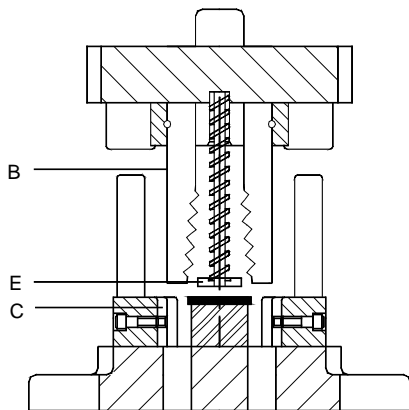
2. When considerable metal must be removed. This occurs when ridges or other shapes are required in the edge of the blank such shapes directly because the cutting edge would be weak and subjected to breakage.

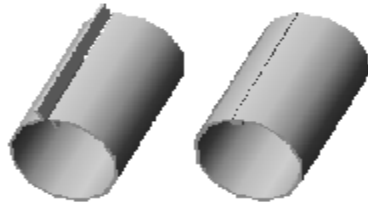
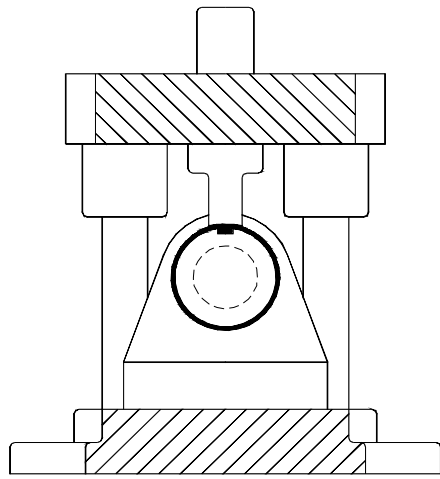
In the illustration, a blank at A must have small pointed serrations machined in the sides. The die is provided with two broaches B supported during the cutting process by hardened backing blocks C. The blank is located in the nest D. Pressure pad E, backed up by heavy springs, clamps the blank securely before the cutting begins. The first three or four of the broach are made undersize and they ordinarily do no cutting except if an oversize blank is introduced into the die. The last three or four teeth are sizing teeth. Intermediate teeth are called working teeth and they take the successive chips to machine the serration.



## HORN TOOLS:

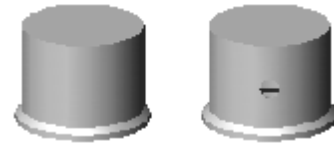
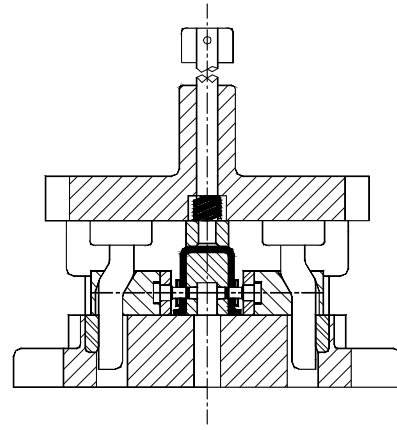
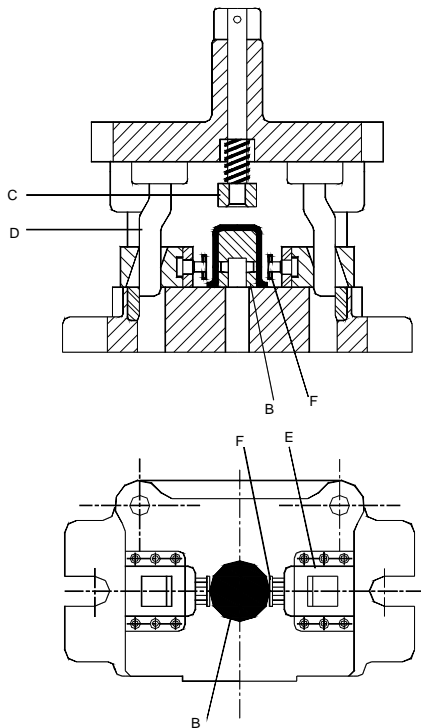
A horn tool is provided with a projecting post called a horn. Bent, formed, for drawn work pieces are applied over the horn for performing secondary operations. The illustration in a blank has been reverse bent in a previous operation and the ends are to be hooked together and seamed in a horn tool. The horn D is retained in a holder C fastened to the bottom plate. When the ram descends, seaming punch D strikes the workpiece to form the seam. Many other operation such as piercing, staking, and the like are also performed





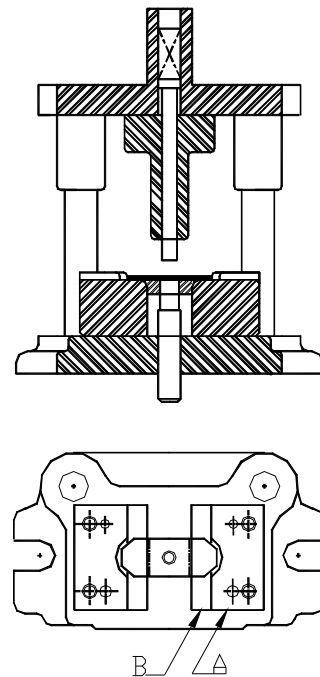
### SIDE CAM TOOLS:

Side cams transform vertical motions on the press ram into horizontal or angular motion and they make possible many indigenous operations. In the illustration A, a flanged shell requires two holes pierced in its side. The shell is placed over die block B of the tool. Descend if the upper tool causes pressure pad C to seat the shell firmly on the block. Further descend causes side cam D to move the punch - carrying slides E for piercing the holes. Spring strippers strip the shell from around the piercing punches, as they are withdrawn.

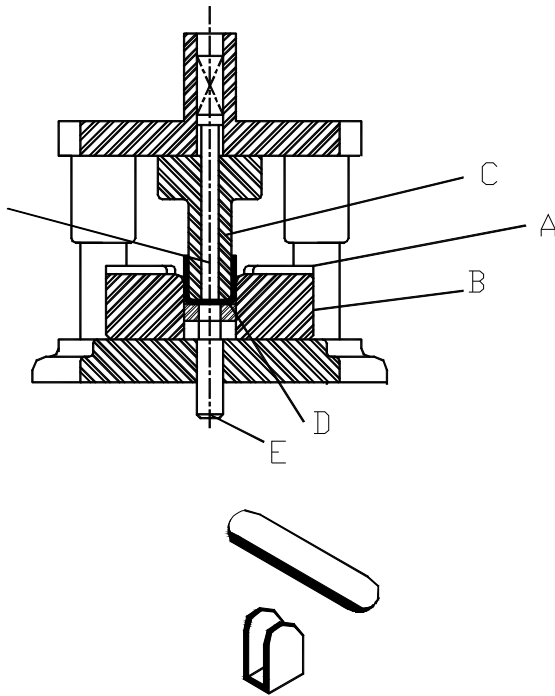


### BENDING TOOLS:

A bending tool deforms portions of flat blanks to some angular position. The line of bend is straight along its entire length, as differentiated from a forming tool, which produces work pieces having a curved line of bend. In the illustration a flat blank is to be given a double bend to form a U shape. The blank is inserted in gauges A fastened on bending blocks B. The bending blocks, in turn are fastened to the bottom plate. Upon the descend of the upper tool, the bending punch C grips the blank between its lower face and pressure pad D. Pins E extend to the pressure attachments of the press. Shedder F strips the workpiece from the punch.



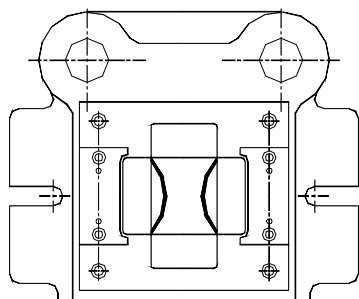
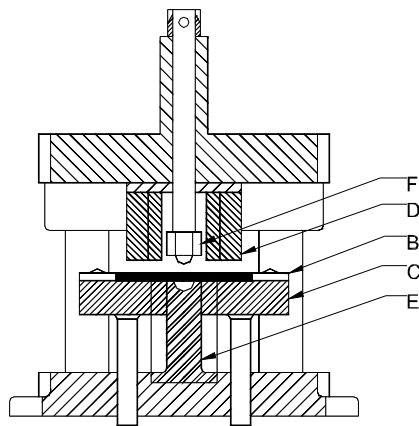
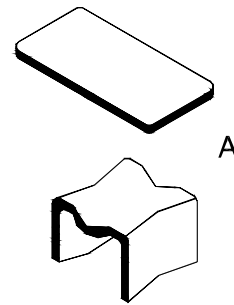
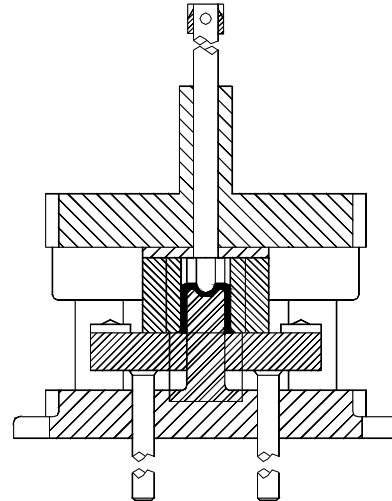




### FORMING TOOLS:

The operation of forming is similar to bending except that line of bend is curved instead of straight and plastic deformation in the material is more severe. In the illustration the flat blank at A is to be formed into a part having a curved contour. The blank is positioned in nest B composed of two plates mounted on pressure pad C. When the ram descends, the blank is gripped between the bottoms of forming blocks D and surface of pressure pad C. Further descends causes the sides of the blank to be formed to the curved shape of forming blocks D and forming punch E.

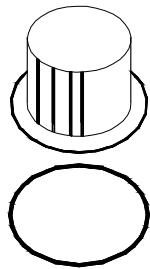
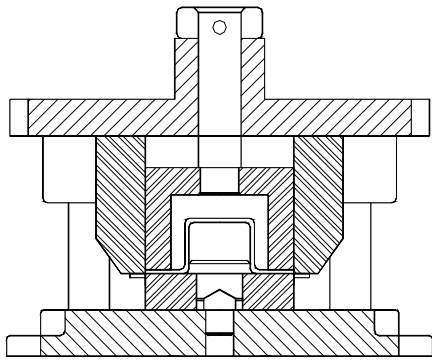
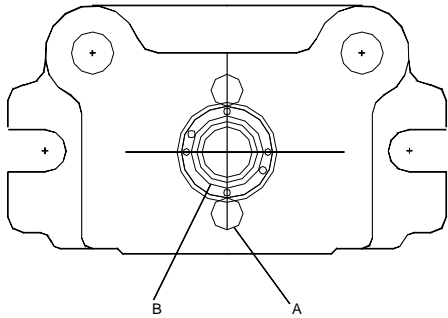
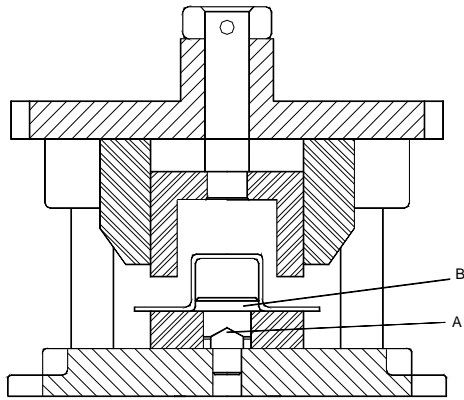
At the bottom of the stock, knockout block F applies the final form. It bottoms against a hardened spacer fastened to punch holder thus "setting" the form. When it ascends, the part is carried up within the form blocks D. Near the top of the stroke it is ejected by knock out F.



### TRIMMING DIES:

Trimming tools cut away portions of formed or drawn work pieces that have become wavy and irregular. This condition occurs because of an even flow of metal during forming operations. Trimming removes this unwanted portion to produce square edges and accurate contours.

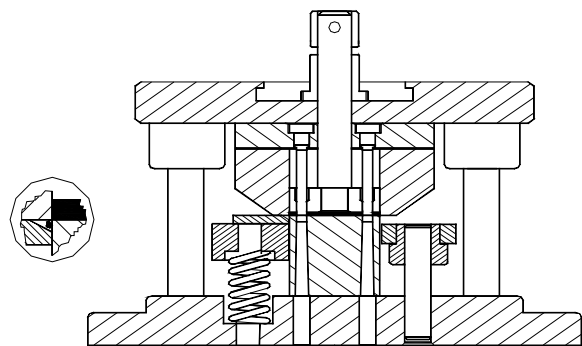
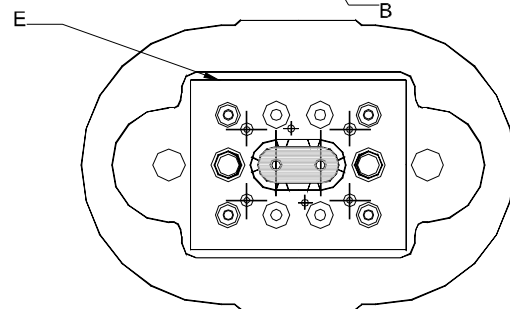
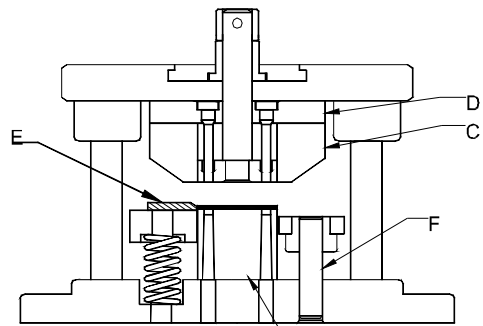
The illustration at A shows a flanged shell after the drawing operation. A trimming tool is required to trim the irregular edge of the flange. The shell is placed over a locating plug B and descent of the upper die causes the scrap ring to be cut from the flange. After trimming, the shell is carried up in the upper die and a positive knockout ejects it near the top of the stroke. The scrap rings are forced down around the lower trimming punch until they are split into two by scrap cutters C applied at the front and back of the die. The scrap pieces fall to the sides, away from the operation of the press.



### SHAVING TOOLS:

Shaving is the operation of removing small amount of metal from around the cut surface of the blank or hole. In order to improve the surface. A properly shaved blank has a straight, smooth edge and it is held to a very accurate side. Many instruments, business machine, and other parts are shaved to provide better functioning and longer wear.

In the illustration, a blank A is to be shaved, both along outside edges of the walls of the two holes. The shaving tool for this workpiece consist an inverted shaving punch B fastened to the bottom plate, and the shaving die block C fastened to the top plate. A spacer D backs up the die block and it retains the shaving punches for the holes. The blank is located in the nest E beveled to provide clearance for the third chip. The nest is mounted on the spring strip- per plate guided on two guide pins F the shaved blank is carried up, held in the die block with considerable pressure, and it is ejected near the top of the stroke by positive knockout. Shaving dies are ordinarily held in the floating adapter die sets for better alignment. This is necessary because less clearance is applied between punches and die blocks.

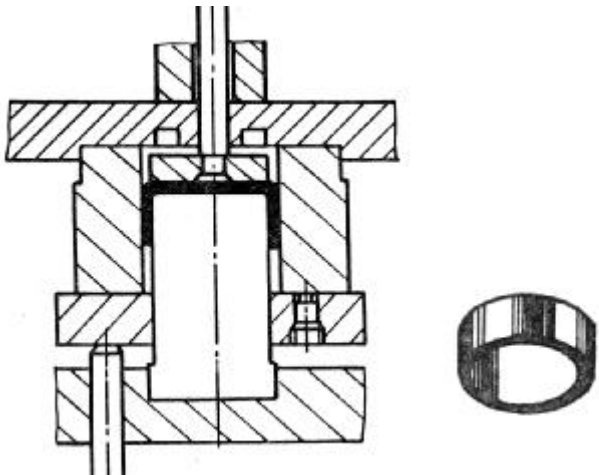


## DRAWING TOOLS:

The operation of drawing is similar to forming, although there is more severe plastic deformation in the material. The difference between the two occurs in the extent of closure of the form. Consider a drawn cup such as a metal ringing up. The material extends all around the sides and therefore the part is said to have been drawn. In a formed part the material does not extend completely around to surround a space, even though the formed contour may be quite intricate.

In the illustration at A over a flat disc is to be drawn into a cup. The blank is placed on pressure pad B of the drawing tool and it is located by four spring loaded pins C. descends of the upper die causes the blank to be grip securely between the surface of the pressure pad B and the lower surface of draw ring D. Further descend of the ram causes the blank to be drawn over punch E until it has assumed a cup shape shown in closed view at the right. Pressure pins F extends to the pressure attachment of the press.

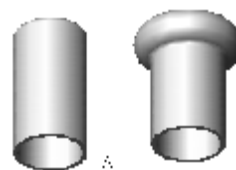
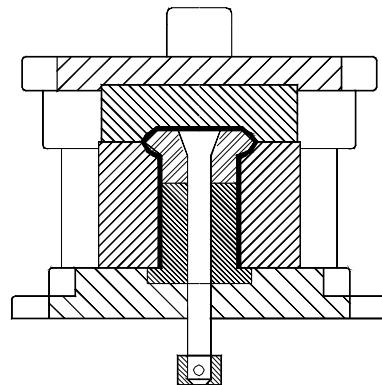
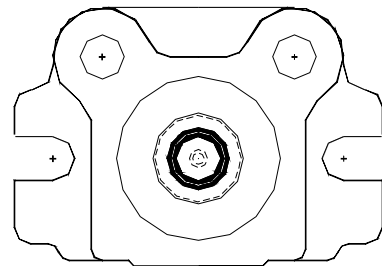
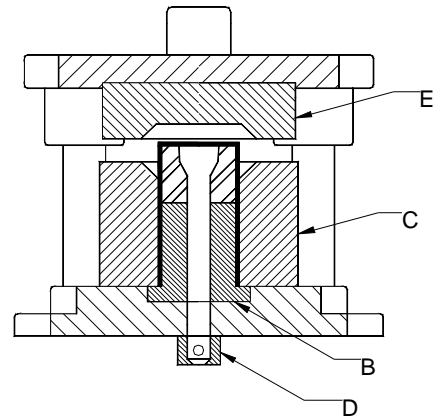
The amount of pressure must be adjusted carefully. Excessive pressure would cause the bottom of the punch to be punched out. Insufficient pressure would allow wrinkles to form. With the proper amount of pressure, a smooth, wrinkle-free cup is produced. Drawing is extensively used for producing stampings ranging from tiny cups and ferrules to large shells for vessels, ships, aircraft's, and missiles producing.



## BULGING TOOLS:

A bulging tool expands a portion of a drawn shell causing it to bulge. There are two types: fluid dies and rubber dies. Fluid dies employ water or oil as the expanding medium and a ram applies pressure to the medium. In rubber dies, a pad or block of rubber under pressure moves the walls of the workpiece to the desired position. This is possible because rubber is virtually incompressible although it can be made to change its shape, the volume remains the same.

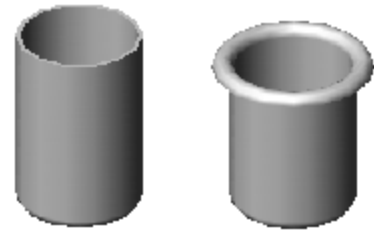
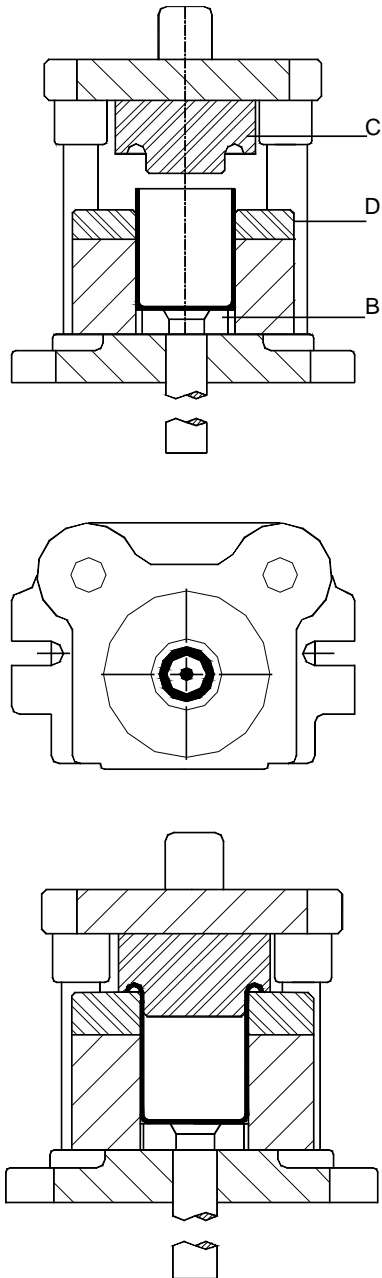
In the illustration at A, a drawn shell is to be bulged at its closed end. The shell is placed over punch B of the bulging tool and its lower end is confined in lower die C. the upper end of punch B is a rubber ring within which is applied a spreader rod D. this rod is conical at it upper end and it helps the rubber to flow outward to the desired shape. When the press ram descends, the upper die applies a force to the shell bottom and since the rubber cannot compress, it is forced outward bulging the walls of the shell. When the ram goes up, the rubber returns to its original shape and bulged shell can be removed from the tool. After bulging a shell is shorter than it was previously.



## CURLING TOOLS:

A curling tool forms the material at the edge of a work piece into a circular shape or hollow ring. Flat blanks may be curled; a common application is a hinge formed of two plates, each of which is curled at one side for the engagement of the hinge pin. More often, curling is applied to edges of the open ends of the cups and shells to provide stiffness and smooth, rounded edges. Most pans used for cooking and baking foods are curled.

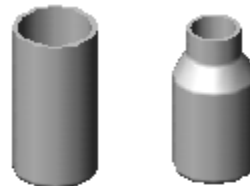
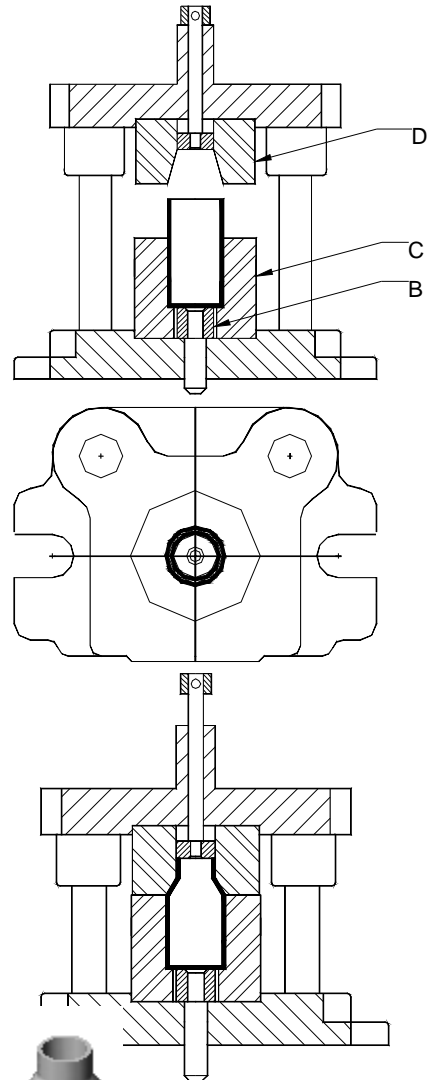
In the illustration, a drawn shell shown at A is to be curled. The shell is placed in the curling tool where it rests on knockout pad B. descent of the upper causes the knockout pad to push down until it bottoms on the bottom plate. Further descent causes curling punch C to curl the edge of the shell. Near the bottom of the stroke, the lip of the material contacts an angular surface machined in curling ring D to complete the curl. When the punch goes up, the knockout raises the shell for easy removal.



A

## SWAGING TOOLS:

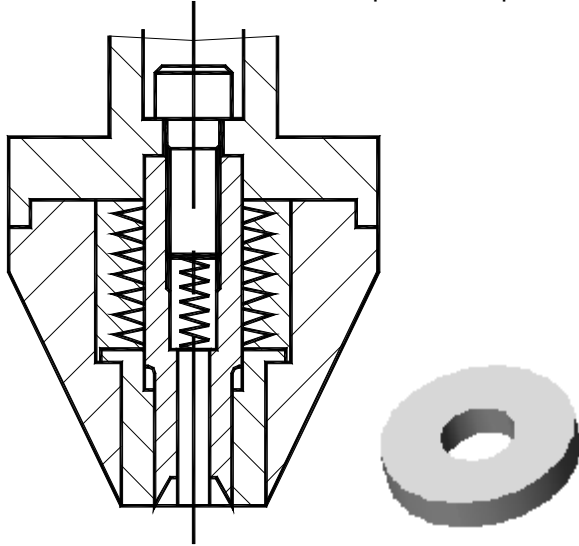
The operation of swaging, sometimes called necking, is exactly the opposite of bulging. When a workpiece is swaged a portion is reduced in size and this causes the part to become longer than before it was swaged. In this illustration at A, a shell is to be swaged at its open end. It is inserted in the swaging die where it rests on knock out pad B. and its lower end is surrounded by the walls of block C. When the ram descends swaging die reduces a portion of the diameter of the shell and this becomes longer.



A

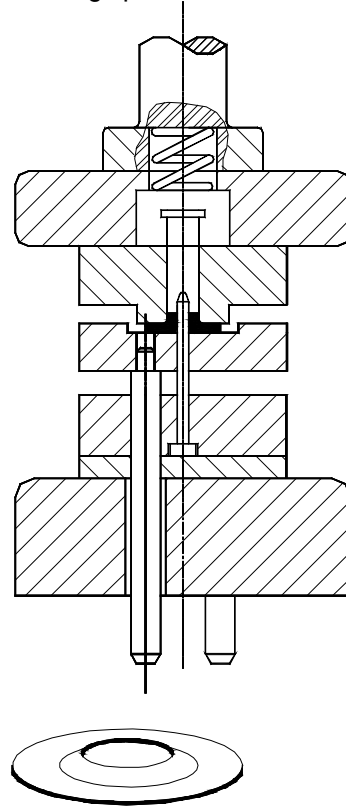
### DINKING TOOL:

To cut paper, leather, cloth, rubber and other soft materials a dinking tool is used. The cutting edges penetrate the material and cut it (like knives). The dinking punch digs into the base plate. The base plate is made of wood, fiber, or hard rubber. The dinking tool can be used to cut the inner and outer shapes of component.



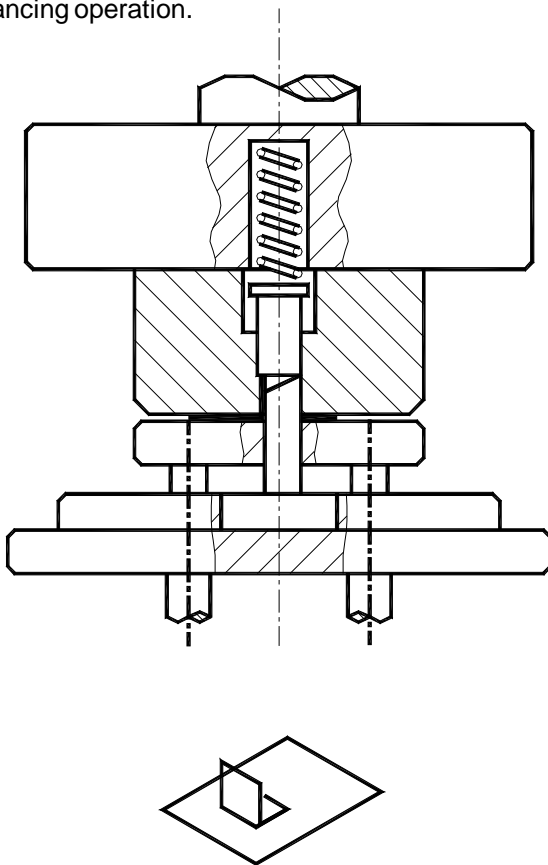
### FLARING TOOL (LUGGING TOOL):

The process of forming an outward flange on parts is called flaring operation.



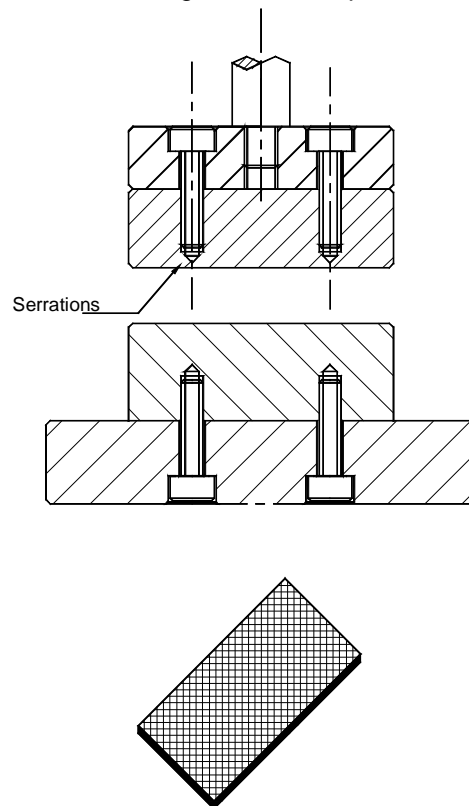
### LANCING TOOL:

This is a continuous bending and cutting operation along a line in the work material. No metal is cut free during the lancing operation.



### PLANISHING TOOL:

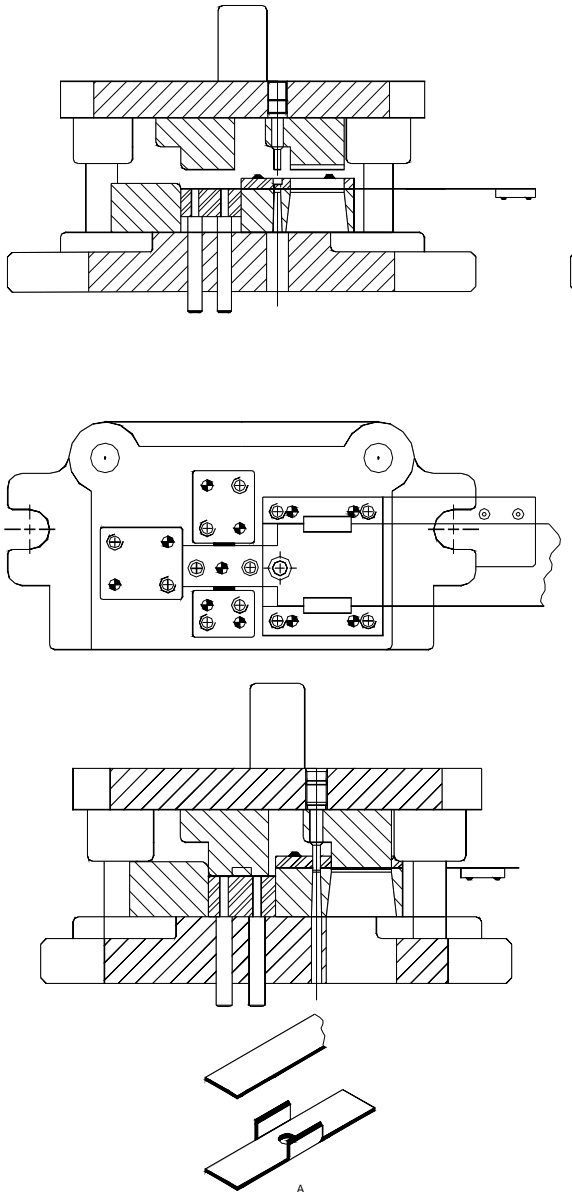
Planishing tool is used to straighten blanked components. Very fine serration points penetrate all over the surface of the component in order to release stress and straighten the component.



## PROGRESSIVE TOOLS:

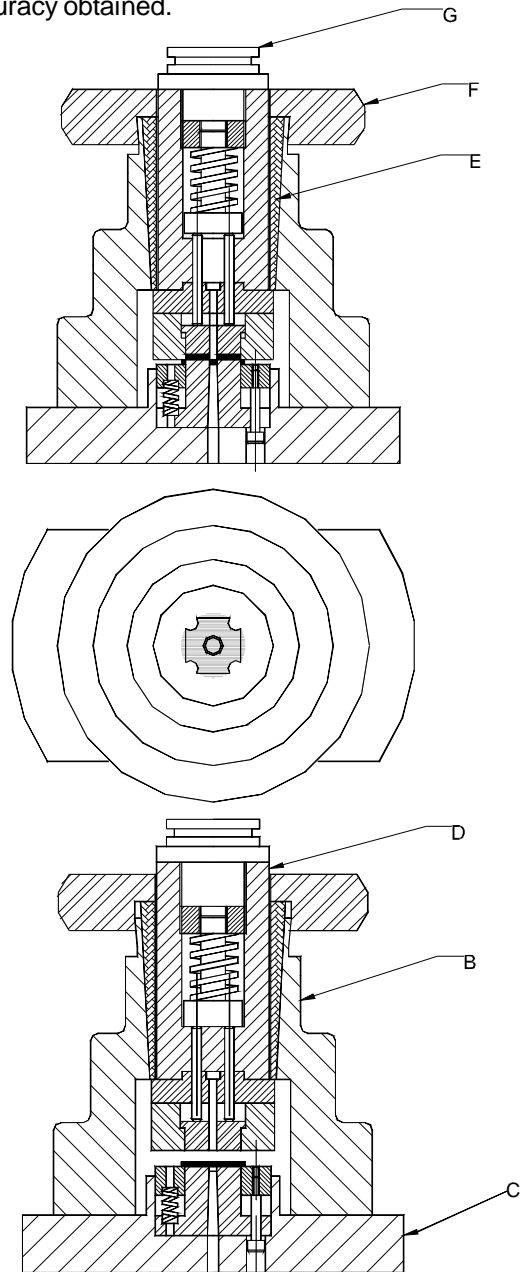
In a progressive tool the strip is moved in stages from station to station. Different operations are performed on it and at each station except at idle ones applied to provide room for components. A complete work piece is removed from the strip at the final station. All the operations described previously may be performed in progressive tools. For example, a single die of this type may do piercing at the first station, trimming at the second station, bending at third, forming at the fourth etc. a progressive tool may thus be considered as a series of different tools placed side by side with the strip passing through each successively. This analogy has some merit although it does not give a true picture of the extremely close inter relationship between the various stations.

In the illustration at A, pierced, trimmed and bent part is to be produced complete in a simple progressive tool. At the first station strip is notched and pierced and at the second station the blank is cut-off and bent. You should easily recognize all of the elements in this tool- the die block, piercing punch, trimming punch, knockout, stop block, and all the others.



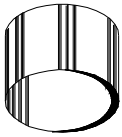
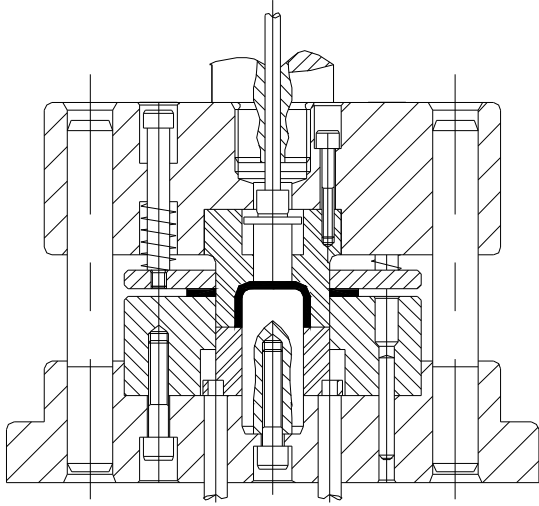
## SUB-PRESS TOOLS.

Sub-press tools blank and form very small watch, clock and instrument parts. An example would be the small instrument cam shown at A. The tool components are retained in a sub press which is, as its name implies, actually a small press operated in a larger one. The sub press is composed of base C, barrel B and plunger Die set along, tapered Babbitt bearing E provided with longitudinal key slots which guides the plunger and prevents the rotation. Tightening spanner nut against bearing E causes it to close around plunger D, to remove all looseness. The top portion of the plunger D is engaged by an actuator G threaded into a central tapped hole. The slot of the actuator is engaged loosely by a yoke fastened to the press ram. Thus the press ram does not guide the sub press in any way. It simply applies the up and down motion. Sub press tools are usually of the compound type because of the considerable accuracy obtained.



**COMBINATION TOOL:**

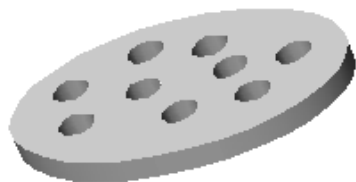
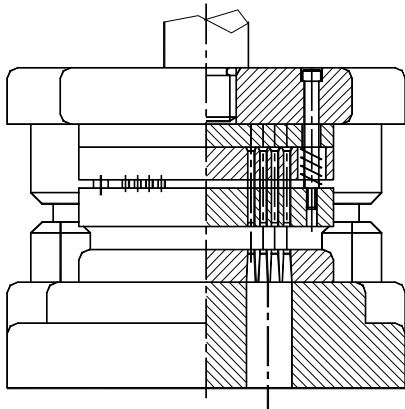
In combination tool two or more operations such as forming, drawing, extruding, embossing may be combined with each other or with various cutting operations such as blanking, piercing, broaching etc.



COMBINATION TOOL

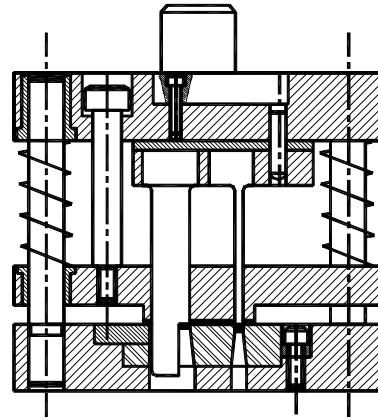
**PERFORATING TOOL:**

If more no. of holes are pierced, it is called perforating tool. The process of piercing a series of holes in a given blank or workpiece is known as perforating.



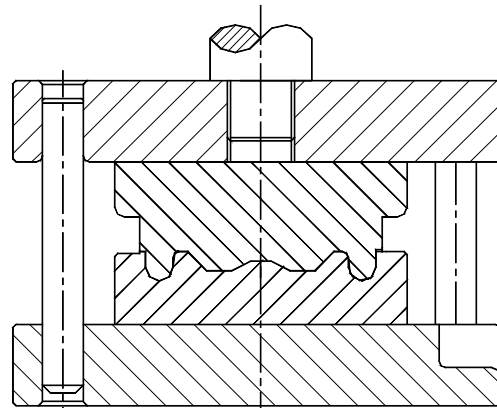
**NOTCHING TOOL:**

This operation removes a small amount of material from the edges of the strip or a blank. Notching serves to shape the outer contours of the work piece in a progressive tool or to remove excess metal before a drawing or forming operation in a progressive tool.



**EMBOSSING:**

Embossing is the shallow forming operation in which the work piece material is stretched over a male die and made to conform to a male die surface by a mating female die surface. The finished product will have depressed detail on the other.

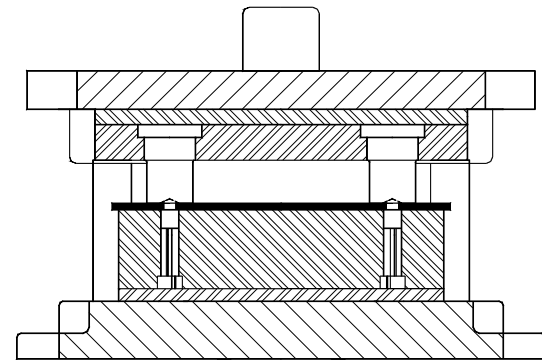
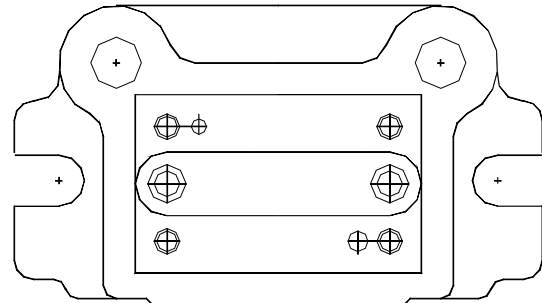
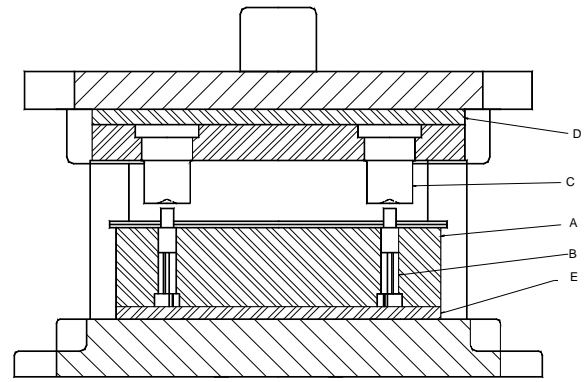
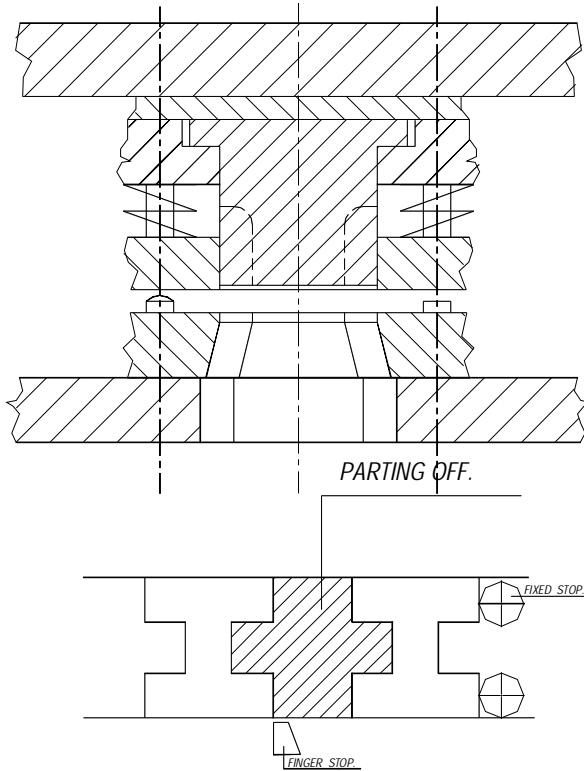


EMBOSSING TOOL.



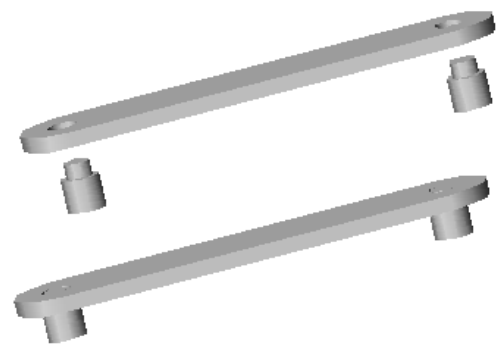
### PARTING OFF TOOL:

The parting off operation separates the work material along a straight line or angle or an irregular in double line cut. The piece removed by the punch is scrap.



### ASSEMBLY TOOLS:

Assembly tools assemble two or more parts together by press fitting, riveting, stacking or other means. Components are assembled very quickly and relationship between parts can be maintained closely. In the left a link and two studs are shown that are to be riveted together in an assembly tool. The studs are positioned in die block A and they seat on plungers B. The link is then positioned over the studs, the turned down ends of the studs engaging in holes in the link. Descend of the press ram causes riveting punches C to deform the ends of studs into the shape of rivet heads. A hardened plate D backs up the punches to prevent the heads from sinking into the relatively soft material of the die set. Another hardened plate E backs up the plungers.





## COMPOUND DIES:

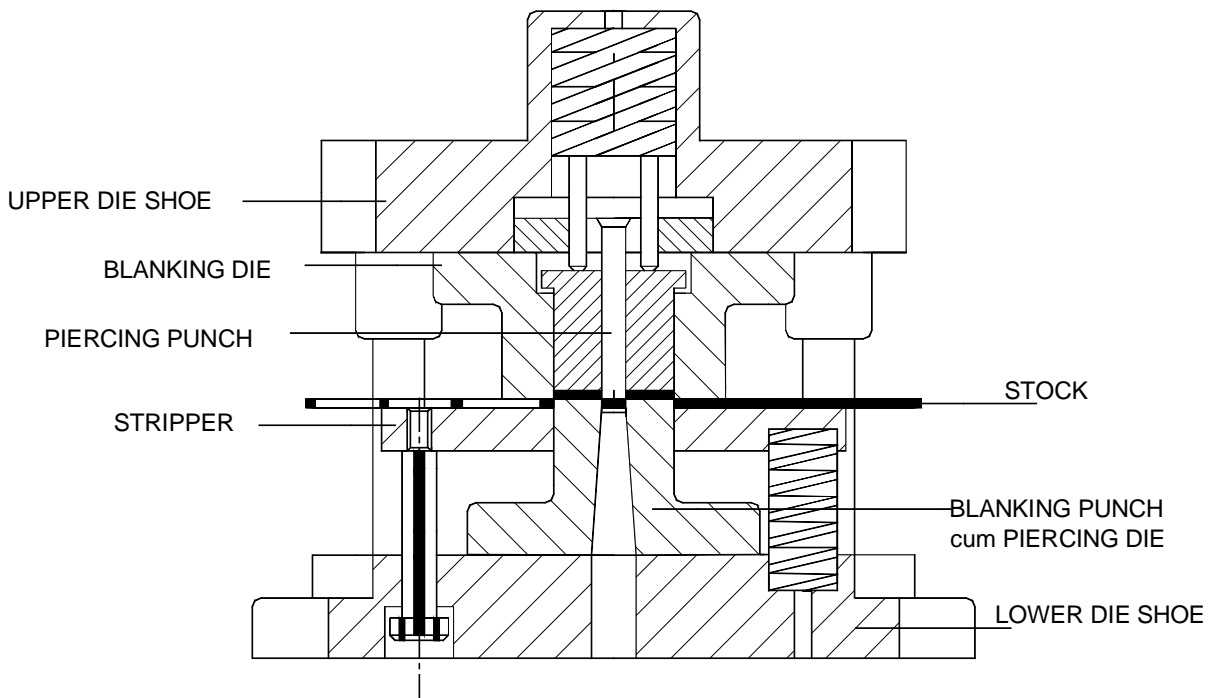
A common characteristic of compound-die design is the inverted construction, with the blanking die on the upper die shoe and the blanking punch on the lower die shoe. This construction commonly calls for the pierced slugs to pass through the lower die shoe.

## BLANK-AND-PIERCE DIES:

Compound dies are particularly useful for producing pierced blanks to close dimensional and flatness tolerances. Generally, the sheet material is lifted off the blanking punch by a spring-actuated stripper, which may be provided with guides to feed the material and a stop to position it for the next stroke. The blank tends to remain in the die, from which it is removed by a spring stripper or by a positive knockout. A positive knockout is most satisfactory when blanking relatively hard or heavy materials that remain flat without the use of a hold down or pressure pad. A combination spring-actuated blank holder and knockout is used for blanking thin and springy materials when flatness and accuracy are required. It also is used when a press has no positive-knockout attachment, or when the blank is too large to eject properly. Ejection of the blank from the die by spring or positive knockouts makes angular die clearance unnecessary, assuring constant blank size through the entire life of the die.

A typical example of a compound (blanking and piercing) die is shown in fig. During the cutting cycle, the stock is held flat between the faces of the stock stripper and the blanking die. The blanking die makes contact with the stock slightly before the piercing punch, which pierces the hole in the center of the piece after it is blanked out of the strip. As the piece is blanked out, the strip is carried below the cutting edge of the blanking punch brought back slightly above the punch level by the lower stripper. A compound die for blanking and piercing, a clutch disk. The clutch disk is made of 1.83 mm. half-hard cold-rolled sheet steel. The blank is produced from a 254 mm. wide strip, and a 165 mm. diameter hole is pierced in the center. Subsequent operations in other dies pierce 12 small holes in the disk and bend up the ears on the five tongues. In this two-section compound die, the blank is cut from the strip and forced downward into the die by the punch.

The piercing punch (D1) is a solid block and fits a counterbore in the die shoe. The blanking die (D2) also is fitted in the counterbore in the die shoe. A pressure pad (D3), located between the die sections, is supported and operated by four pressure pins. Two stripper plates are operated in connection with the punch, one (D4) being located on the outside of the outer cutting edge, and the other (D5) on the inside of the inner cutting edge.

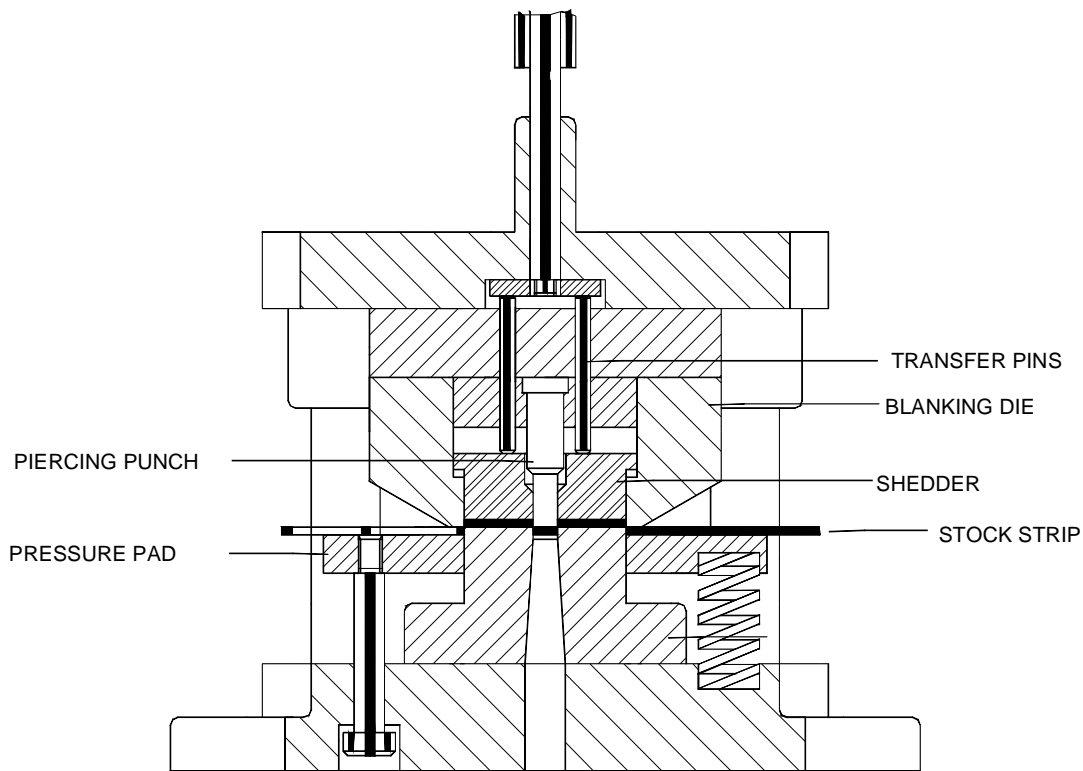


Helical springs furnish stripping pressure for the plates. The construction of this compound tool is substantially the reverse of that shown in fig. Because the blanking die and piercing punch are supported by the lower die shoe.

A compound die for making a pierced blank for a washer is shown in fig. One press stroke punches the center hole and blanks the piece from 0.38 mm cold-rolled-steel strip. The piercing punch is attached to the upper die shoe. And the blanking punch is attached to the lower die shoe. (The piercing punch contacts the material slightly ahead of the blanking die). The part is stripped from both the blanking die and piercing punch by a positive knockout. The blanked strip is lifted off the blanking punch by a spring-loaded pressure pad.

In the blanking and piercing die shown in fig. the blanking die is made in three pieces whose cutting edges form the outside shape of the part. The part is blanked from 1.27 mm cold-rolled-steel strip. A blanking punch mounted on the lower die shoe mates with a sectionalized blanking die mounted on the upper shoe. Piercing punches mounted in the upper shoe pierce two small in the part as it is being blanked from the strip. A stripper plate removes the work from the blanking punch, and a shedder pin strips the blank from the small punches.

Three washers and a slug are produced at a single stroke of the press by the die shown in fig.



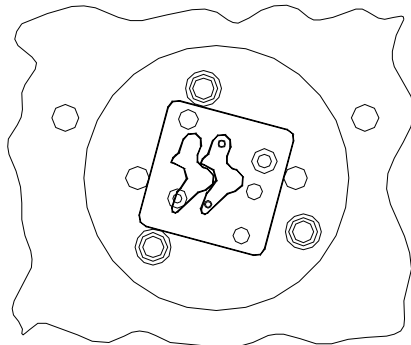
Helical springs furnish stripping pressure for the plates. The construction of this compound tool is substantially the reverse of that shown in fig. Because the blanking die and piercing punch are supported by the lower die shoe.

A compound die for making a pierced blank for a washer is shown in fig. One press stroke punches the center hole and blanks the piece from 0.38 mm cold-rolled-steel strip. The piercing punch is attached to the upper die shoe. And the blanking punch is attached to the lower die shoe. (The piercing punch contacts the material slightly ahead of the blanking die). The part is stripped from both the blanking die and piercing punch by a positive knockout. The blanked strip is lifted off the blanking punch by a spring-loaded pressure pad.

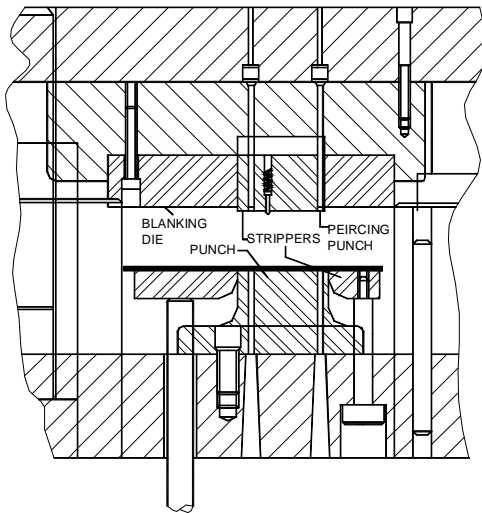
Three concentric punches are attached to the upper shoe, and the concentric sleeve dies are attached to the special combination die block and lower shoe. Two concentric ejector sleeves fit between the punches and two concentric strippers for the blanking dies, one between the dies and one outside the outer die. The outermost of the three upper punches functions as a blanking die, cutting on its ID only. It is seated firmly in a groove in a punch holder and held in the place with a screw-on ring. The intermediate blanking punch and the solid center piercing punch are integral and are screwed to the bottom of the punch holder. The ejector sleeve and knockout assembly slide freely between the punches,

and gravity holds the ejectors down when the die is open. The knockout ejects the two washers when the press ram reaches the top of its stroke. The spring is intended to balance the weight of the ejector knockout so the washers will not drop out accidentally.

The strippers, which hold the stock and remove both the pierced stock and the intermediate washer, are actuated by a die cushion through pressure pins. The solid slug falls through the center die. All punches and die edges are sharp except the OD of the outside punch. This die cuts cardboard washers from 1.59 mm and 3.18 mm stock but also could cut thin metal. A progressive die could be used to make these washers and automatically sort them.



Plan of die

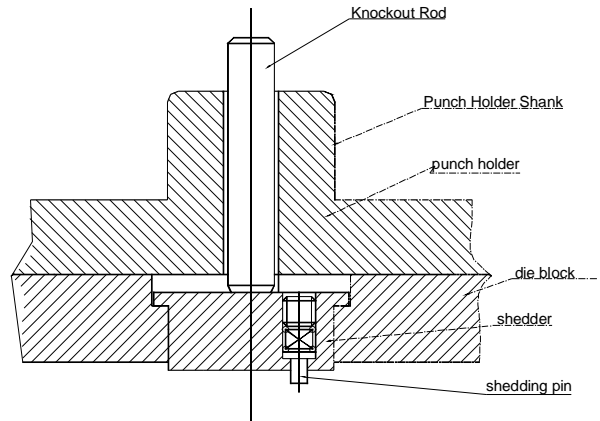


## SHEDDERS AND KNOCKOUTS

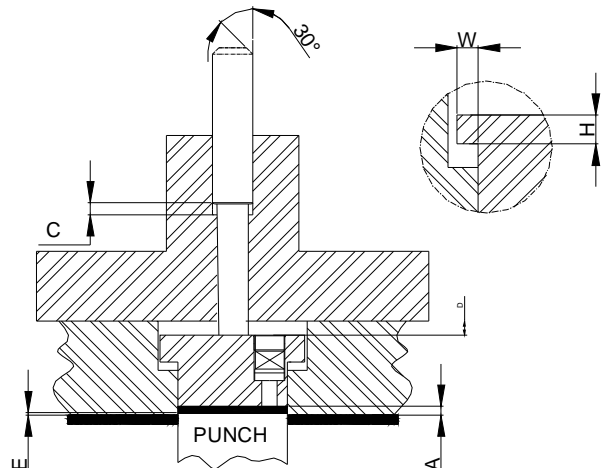
### Positive Shedders

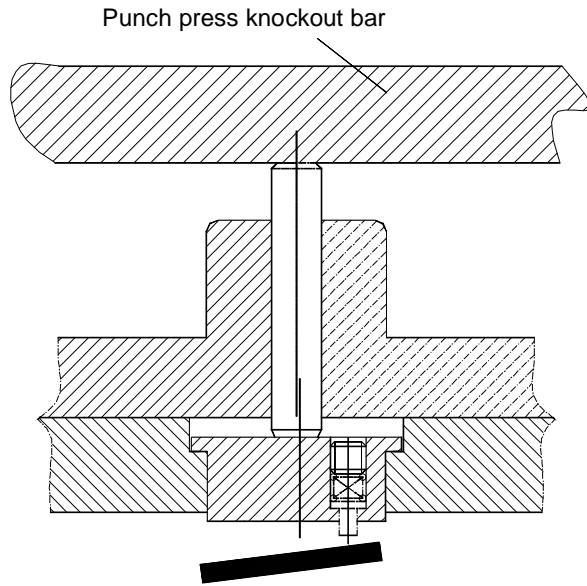
A positive shedder can be described as one, which is not actuated by springs or other compression media. Figures A,B,C-illustrates a very basic positive shedder actuated by means of a simple knockout rod. The shedder and knockout rod assembly shown is functionally typical for inverted type dies. This shedder is a flanged shedder. The flanges are, an integral part of the shedder, act as keepers, retaining the shedder within the die cavity.

In fig (A). the assembly is shown, as it would appear with the punch holder removed from the die shoe this is the condition when the assembly is being checked for proper relationship between the die block, shedder and knockout. The shedder flanges are resting on the die opening edge. The shoulder on the knockout rod is seated against the bottom of its counterbore. In this condition, the shedder should be beyond the die face.



Figure(B) depicts the shedder relationship at the bottom of the press stroke (die closed). The punch entry distance is shown at E. the stock material thickness is T. The shedder is forced upward into the die opening a distance  $A = E + T$ . with conditions as shown, gap D should normally be a minimum of  $2 \frac{1}{2} T$  or 3.0 mm, whichever is greater. Gap D is an important safety factor: in the event of either shedding-pin or knockout malfunction, gap D should permit the accumulation of at least two extra piece parts within the die cavity. This gives the operator an opportunity to notice the malfunction and stop the press. It is obvious that an accumulation of doubles can have serious consequences including damage to the die and/or punch press as well as possible injuries to persons in the vicinity.



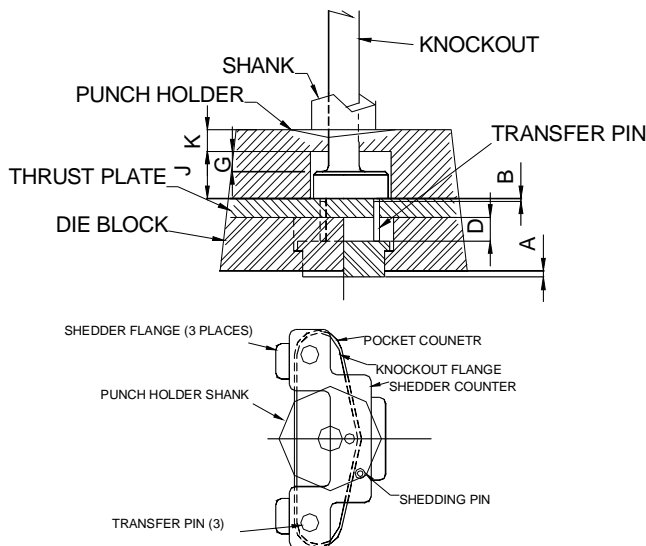


Always provide a slight fillet radius at F. do not make this corner sharp; a fillet radius as small as 0.5 mm is far superior to a sharp corner.

The top end of the knockout is chamfered. A 30° chamfer, as shown, is generally optimum. It will eliminate peening and spalling while providing maximum end area for contact against the punch press knockout bar.

Immediately following the condition shown here, the knockout rod and the shedder drop free to the condition shown in fig (A).

Do not underestimate the significance of the relationships shown; they are vitally important to successfully shedder functions. Note also the function of the shedding pin, and remember that the shedding pin in this and similar applications is mandatory. The importance of an adequately functional shedding pin cannot be overemphasized; an inadequate one is too often the primary cause of a wrecked die.



The assembly in fig (D) is somewhat more sophisticated. This is necessary because of the nature of the shedder contour. Since it is essential for knockout force to be evenly distributed with respect to shedder contour, the knockout- shedder assembly must be designed specifically for each application. This, of course leads to considerable variation in construction. It does not, however, change the basic principles associated with positive-shedder assemblies. In principle, the relationship described for figs (A to C) are essential for positive shedder applications the requirements for dimensions A and B in fig (D) are same as for A and B in fig (A). Gap can be derived, by association, from fig(B). In fig(D),

$$D = E + T + A + 2 \frac{1}{2} T \text{ min}$$

Where E= punch entry distance

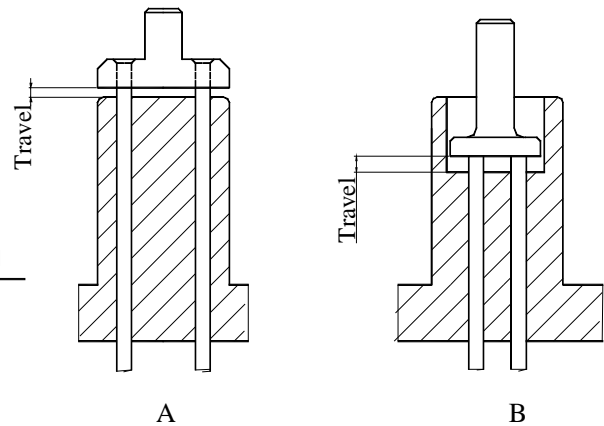
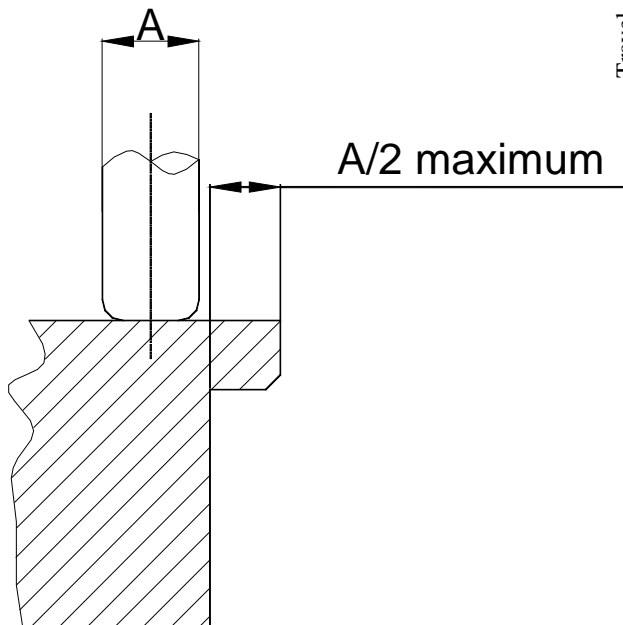
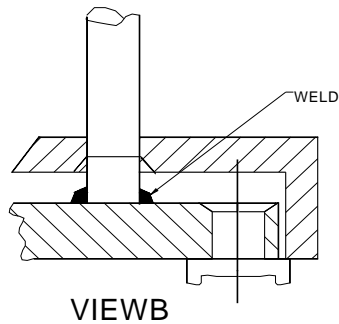
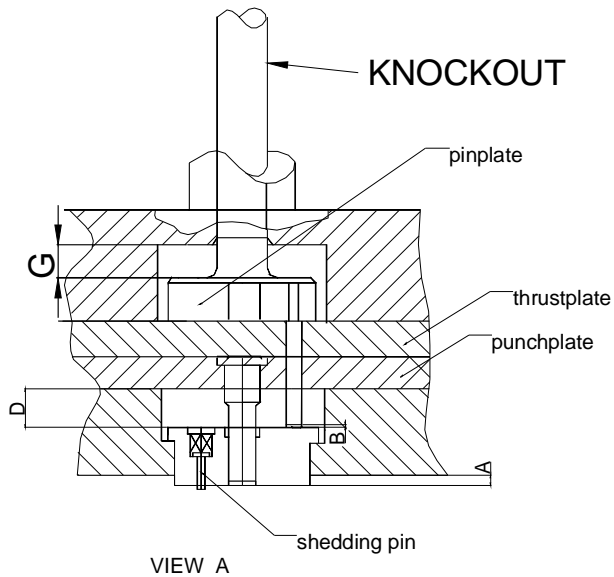
T= stock material thickness.

Space G must not be less than D. to facilitate die making, G should be made 0.8mm or more larger than D however, when determining the required pocket depth J, always check and be certain that dimension K will be adequate. Do this before machining the pocket.

Shedder contours determine the location of shedder flanges. Locate the flanges to facilitate grinding and /or machining. Flange location should be balanced out around the periphery of the shedder. The no. Of transfer pins required, as well as the location, must be appropriate for the specific shedder. The transfer pins must distribute the knockout force evenly through the shedder. Avoid unbalanced condition. Be especially careful in cases where shedders have areas of cross section which are comparatively delicate.

Among the many possible knockout variations are those in fig(E). Here the transfer pin is assembled by peening then into s thin plate. In view A, the peen plate and knockout rod are also fitted together and secured by peening. This method is practical for any light duty, where the knockout forces evenly distributed and very well balanced in relation to the shedder contour. The complete upper die assembly is shown here in order to emphasize the existence of the normal shedder knockout relationships even though the die different construction. The knockout assembly shown in view B is much stronger here, knockout rod is welded to the pin plate. This knockout would be capable of withstanding more severe service. A generalized restriction to transfer-pin location is indicated in fig.(F). Do not permit more than one-half of the pin diameters A to bear against the flanged portion of the shedder. Whenever practical, have the entire pin diameter located behind the body of the shedder.

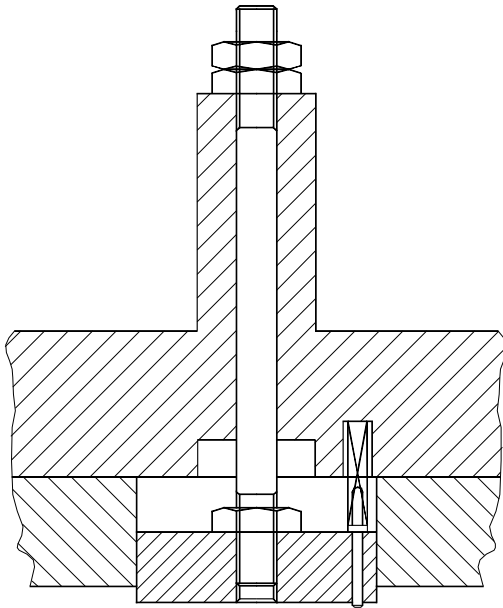
On occasion, laminated construction may be used to advantage. The shedder in fig(G) is for a compound pierce and blank die. The flange is a separate ring, secured to the shedder body by screws.



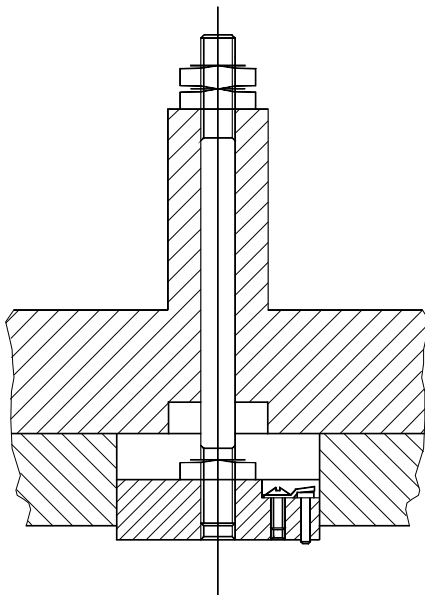
The size and contour of this particular shedder make laminated construction feasible. Its size permits installation of screws, which are adequate in size, sufficient in number, and strategically disposed. Its contour is such that the straight-through machining permitted as a result of lamination is a definite asset. However, in spite of its advantages, this construction should not be used indiscriminately. It can at times be tempting enough to encourage gambling upon its adequacy, but keep in mind positive shedders are subject to severe impact conditions, and employ laminated construction only where it is practicable.

The knockout constructions in fig.(H) are variations of transfer-pin knockouts. They are not heavy-duty knockouts but are limited to applications where the span of the transfer pins can be contained within the punch-holder shank. They are desirable from the die cost standpoint and are practicable for many applications. The knockout in view A is more economical to make. In addition to the cost advantage, it permits a wider span for the transfer for the transfer-pins. However, in some punch presses, the cavity in the ram may not be deep enough to accept the top bridge. This condition worsens in proportion to the knockout travel. Such an objection, of course, does not apply to the knockout in view B. for applications, which require a long knockout travel; the long slender pins may be too susceptible to bending if considerable knockout force is required.

Keeper lugs (flanges) are not required on the shedder, which appears in fig.(I). The knockout -rod 1 is peened into assembly with the shedder 5. A collar ring 2 is assembled to the knockout-rod by means of a cross pin 3. The collar acts as a stop, limiting the protrusion distance A of the shedder. The collar impacts against the top of the shank and subjects the cross pin to considerable force, which is suddenly applied. Therefore, the cross pin should be made of drill rod and left soft. Do not attempt to use a standard dowel pin for this or any similar application.



In the case illustrated, the shedding pin installation differs from those previously shown. This type of installation is not feasible in round shedders unless some means of preventing shedder rotation is provided. A much stronger shedder assembly is pictured in fig.(J). Here the knockout shaft is engaged (threaded) in the shedder and secured by a lock nut. Two locknuts are jam-tightened on the shaft, stopping the shedder travel as required. Wrench flats should be provided on the knockout shaft to aid in positioning and tightening the lock nuts, especially the lower lock nut. The shedding pin 1 shown here is actuated by a flat spring 2.



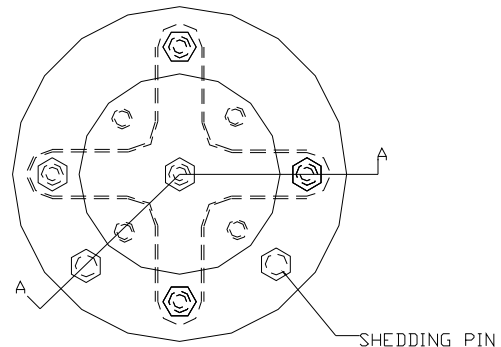
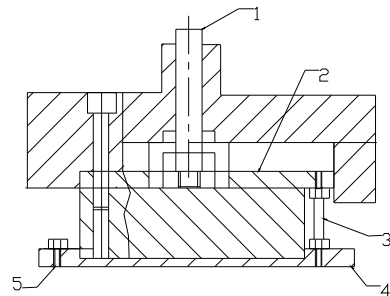
By definition, the arrangement in fig.(K) is a stripper. Its function is to strip either the workpiece or the stock material scrap (whichever the application requires) from the punch. It is included here because the construction and action exactly parallel those of a positive shedder. Thus the allowances and relationships given earlier for positive shedders apply, as equivalents, to positive knock-off strippers.

A spider-type bridge plate 2 is shown. The spider operates within a suitably contoured recess, which is milled in the punch holder. In this case, the transfer pin is threaded studs. The studs are secured with lock nuts to maintain the required spacing between the stripper plate 4 and the spider.

Spiders, which are often used in conjunction with large shedders and strippers, permit a long span between the transfer-pin centers. In addition, the contoured recesses permit punches (or other components) to be mounted directly to punch holders. Before milling the recess, check and be certain that the security of the shank will not be endangered.

One or more shedding pins are required for this kind of stripper. In the case illustrated, standard commercially available spring pins 5 are employed. They are the type which is installed in tapped holes and secured with lock nuts, as shown.

A knockout arrangement for large work is represented in fig.(L) where it is applied to a positive knock-off stripper. It would apply to large shedders, as well. The mechanical relationships are the same as for the center-poised knockout-shedder arrangements previously described. Center distance M between the knockout rods must be made to suit the specific punch press in which the die will be operated.



Spiders, which are often used in conjunction with large shedders and strippers, permit a long span between the transfer-pin centers. In addition, the contoured recesses permit punches (or other components) to be mounted directly to punch holders. Before milling the recess, check and be certain that the security of the shank will not be endangered.

One or more shedding pins are required for this kind of stripper. In the case illustrated, standard commercially available spring pins 5 are employed. They are the type which is installed in tapped holes and secured with lock nuts, as shown.

A knockout arrangement for large work is represented in fig.(L) where it is applied to a positive knock-off stripper. It would apply to large shedders, as well. The mechanical relationships are the same as for the center-poised knockout-shedder arrangements previously described. Center distance M between the knockout rods must be made to suit the specific punch press in which the die will be operated.

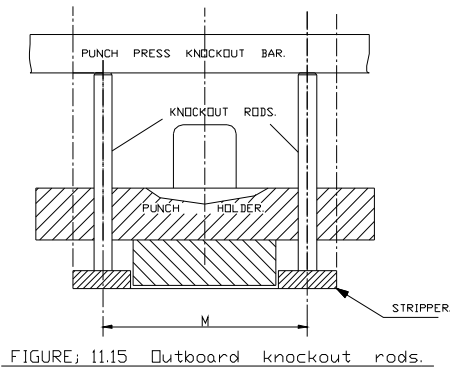


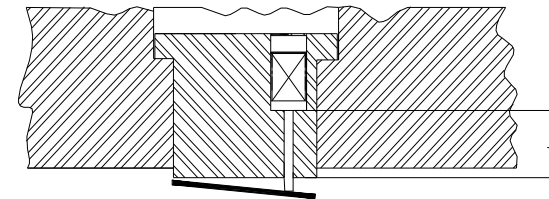
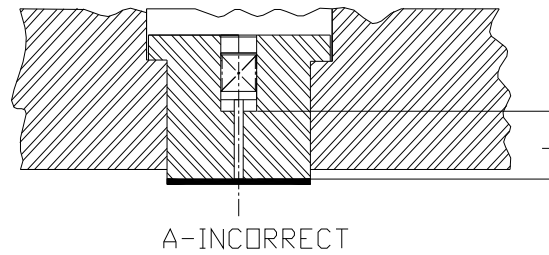
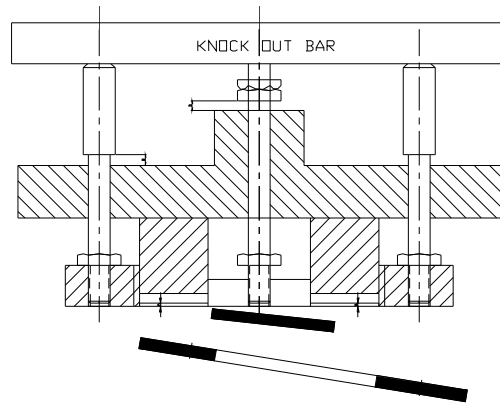
FIGURE 11.15 Outboard knockout rods.

Shankless punch holders are often used for large dies. In other instances, the shanks are used only to position the die centrally in the press.

In these situations the punch holders are normally screw-attached to the ram. Also some presses may be equipped with special adapters. All of these factors must be taken into consideration when determining specific knockout constructions.

As with many other aspects of die making, variations of shedder-stripper-knockout constructions can be virtually endless. However, the basic relations principles may, by associations, be generally applied on all positive constructions of this type. The combination arrangements shown in fig.(M) serve to emphasize the fact. The illustrated arrangement cannot be considered a common application, and yet in spite of this, the A and B relationships shown here are the same as those shown earlier in fig (N), view A:

1. The shedding pin is located at the center of the shedder. Because of this, there is no leverage advantage for the shedding pin. This error can result in failure of the shedding pin to displace the blank from the face of the shedder. The final result could be just as disastrous as if the shedding had been omitted entirely.
2. Length L is too short. It does not provide grinding life on the shedder. This would not apply, of course, to situations where grinding life is not required.

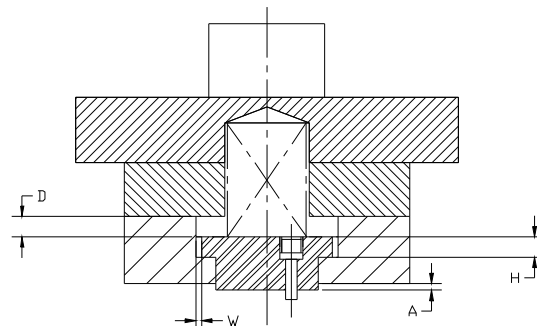


B-CORRECT

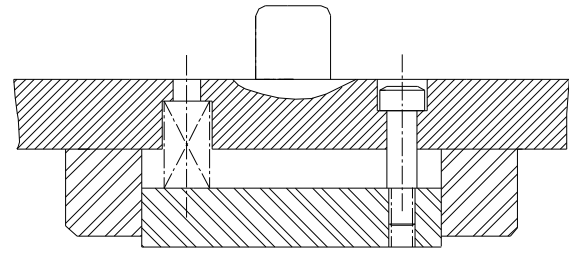
In view B, the shedding pin is correctly installed. It is located off-center, which permits it to lever the blank away from the shedder face as shown. Also, length L will permit the shedder face to be ground away, as required, in the course of die maintenance.

### SPRING SHEDDERS

The basic spring-actuated shedder appears in fig(O). It is a flanged shedder. Flanged proportions are indicated at H and W. These should be  $H=2W$  min. Space D should be treated the same as for a positive shedder.



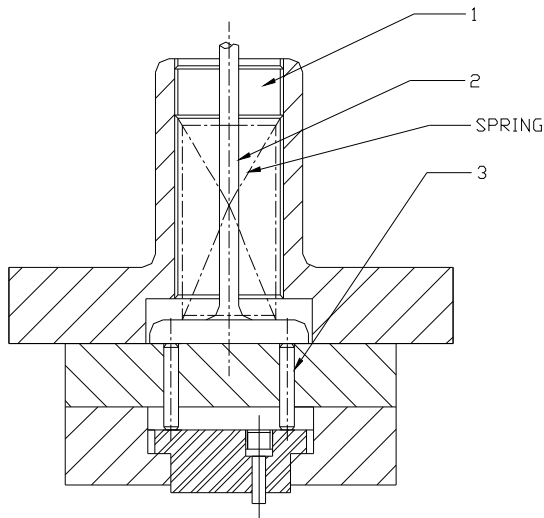
Protrusion distance A will vary according to the specific application. Range A will be from zero (flush) to approximately 0.8mm., as dictated by the specific requirements of the specific application. If it is intended to push the blank back into the stock strip, protrusion A should range from zero for light gage stock to 0.127 mm. For heavier stock. For light gage material, two or more shedding pins should be installed in the shedder. They should be symmetrically located. The springs which actuate the shedding pins should not too strong. If they are, or if the shedding pin locations are not balanced, the blank may be pushed through the stock strip. For heavier material, shedding pins may not be necessary. However, holes should be provided in the shedder anyhow, to permit the installation of shedding pins if this should prove necessary.



For applications where the shedder is not intended to be a pushback shedder, protrusion A may be 0.8 mm., if desired to facilitate die making. In the case of heavy, crude work, this may be increased, if desired to, 1.5mm., which should be ample to facilitate die making even on crude work. For shedders, which are pushback shedders, only one shedding pin is usually required. Installation is generally the same as for a positive shedder.

In fig.(P), the shedder actuating spring is contained within the punch holder shank. The spring applies pressure to the plunger 2, and transfer pins 3 transmit the spring pressure to the shedder 4. The plunger flange is slip fit in the spring pocket. The tail, or shank, of the plunger is a slip fit in the hole in the screw plug 1. This stabilizes the spring action, eliminating cocking or tilting forces on the shedder and transfer pins. Stripper bolts are a practical means of suspending larger shedder in the manner typified in fig.(Q) Construction practices for such shedders are identical for spring strippers. Remember to associate the spring and stripper-bolt locations to provide balance, in order to prevent deflection of the shedder plate. Keep in mind that the most common errors in this type of construction are:

1. Poor stripper-bolt-to-spring association.
2. Stripper bolts, which are too small for the application.





## PROGRESSIVE BLANKING AND PIERCING TOOLS

A simple blanking tool is designed only when the piece part has no internal details. An altogether different tool is designed if the piece part is to be produced by the combination of blanking and piercing operation. It can be done in the following way in the same tool. The piercing is performed in the first station. Then the stock strip is advanced to another station where blanking is carried out. The relative position with the previously pierced hole is maintained during the blanking operation. The tool is known as "progressive tool" because the processing progresses from station to station. Before designing the tool the piece part drawing should be studied carefully. This is to plan the operations to be carried out in different stations. Then the drawing of the stock strip is planned. The drawing will be similar to the stock strip, as it will appear after it has gone through all the stations till a finished part is removed from it. This layout is known as the "strip layout". It must be fully dimensioned and should carry all informations necessary to start the design of the tool.

### The informations are

1. Feed direction.
2. The amount of pitch by which the strip should advance after each stroke of the press.
3. Position of stoppers.
4. Width of the strip.
5. Scrap bridge dimensions.

Fifty to seventy percent of the cost of stamping is on the material. The method employed in laying out the strip influences the economic success or failure of any pressing operations. The strip layouts should be such that the maximum area of the strip is utilized for the production of stamping. In the tool shown the finished piece part is produced when the strip passes through three stations. The strip is stopped at the first station by the auxiliary stopper (finger stopper). During the first stroke of the press ram two holes are pierced by piercing punch.

The strip is then advanced to the next station. To do this the first finger stopper is withdrawn and the second finger stopper is engaged. Now the pierced hole comes in line with the two pilots. The pilots are longer than the piercing punches. Their nose is conical shape with a radius at the tip. During the next stroke of the press ram the pilots enter into the previously pierced holes and locate the strip (second station). In the first station the piecing punches again pierce two holes in the strip. Again the strip is advanced and brought to stop against the final stop. During the third stroke of the press ram the pilots enter the pre pierced holes and locate the strip. In the first station the two piercing punches produce two holes. In the third station the component is blanked and the piece part is obtained. This part will conform to the piece part drawing.

Once the first blank is removed from the strip, the strip is lifted to clear fixed stopper, the strip is fed till it again stops against the newly formed edge of the opening in the strip created by the removal of the first blank. Only when a new strip is introduced into the tool the auxiliary stoppers are used again.

## PROGRESSIVE DIE DESIGN:

A progressive die performs a series of fundamental sheet-metal operations at two or more stations during each press stroke in order to develop a workpiece as the strip stock moves through the die. Each working station performs one or more distinct die operations, but the strip must move from the first station through each succeeding station to produce a complete part one or more idle stations may be incorporated in the die to locate the strip, facilitate interstation strip travel, provide maximum-size die sections, or simply their construction.

The linear travel of the strip stock at each press stroke is called the "progression", "advance", or "pitch" and is equal to the interstation distance.

The unwanted parts of the strip are cut out as it advances through the die, and one or more ribbons or tabs are left connected to each partially completed part to carry it through the stations of the die. The operations performed in a progressive die could be done in individual dies as separate operations but would require individual feeding and positioning. In a progressive die the part remains connected to the stock strip which is fed through the die with automatic feeds and positioned by pilots with speed and accuracy.

When parts are made from individual blanks moved from die to die by mechanical fingers in a single press, the dies are known as transfer dies.

## Selection of progressive dies:

Whenever the total production requirements for a given stamping are high, a progressive die should be considered. The savings in total handling costs by progressive fabrication compared with a series of single operations may be great enough to justify the cost of progressive die.

The present application of computer aided die design, together with the general use of wire burn EDM for making die sections, has greatly simplified the designing and construction of progressive dies.

The quality of stampings made on progressive dies is often higher than that produced on individual dies. There is less chance for off-gage conditions due to part locating problems. The human factor has less influence on part quality. Often the

savings in labor costs together with the more consistent quality progressive die stampings have been the deciding factors in justifying the greater material cost of coil stock over producing automotive stampings from offal in recovery dies.

**The fabrication of parts with a progressive die should be considered when:**

1. Stock material is not so thin that it cannot be piloted.
2. Coil handling equipment, stock straighteners, and feeders are available or can be justified.
3. The overall size of the die, which is determined by part size, number of stations, and strip length, is not too large for available presses.
4. The total press tonnage capacity required is available.
5. The press is level and in good condition. Problems with worn gearing, loose gibbing, and worn bearings can result in alignment problems that can damage precision tooling.
6. Quality and part consistency requirements are high.
7. Quick die change and flexible manufacturing requirements exist.

**STRIP DEVELOPMENT FOR PROGRESSIVE DIES:**

The individual operations performed in a progressive die are usually simple, but when they are combined in several stations, the most practical and economical strip design for optimum operation of the die requires careful analysis. The sequence of operations on a strip and the details of each operation must be carefully developed to ensure that the design will produce good parts without production or maintenance problems. The following strip development sequence is applicable to both manual and computer aided design.

A tentative sequence of operations should be established and the following items considered as the final sequence of operations is developed:

**Step 1. Analyze the part**

- a. What is the material and thickness?
- b. What hole dimensions - size and location- are critical?
- c. What surfaces are critical?
- d. What forms are required?
- e. Where can carriers be attached?
- f. Is direction of material grain important?

**Step 2. Analyze the tooling required.**

- a. What production is required per month, per year, total?
- b. What presses are available? It is important to know bolster area, shut-height, feed height, strokes per minute, air cushion, etc.
- c. What safety conditions must be met?

**Step 3. Make dummy drawings.**

A part dummy drawing shows the finished part and all positions in which the part will be formed in order to achieve the final form. Provide for proper metal movement for drawing or forming operations.

**a. Tips for dummy drawings:**

1. Show the complete part.
2. Show all positions necessary to form part in and elevation views.
3. Show over-bend positions if they are critical.
4. Show all necessary views to achieve clarity.
5. Show work lines and set-up lines.
6. Provide vertical and horizontal center lines for measuring when assembling the strip layout.
7. Show the strip carriers, if known, before strip layout is assembled.
8. Trace dummy from part print, if part print is dimensionally accurate (less time and lesser errors)
9. Use design aids:
  - a. Wax for sample parts and carriers.
  - b. Rubber skins.
  - c. Plastic skins.
  - d. Models
10. Check accuracy.

**Step 4. Make strip layout. A strip layout for a progressive die is a series of part dummy drawings marked up to indicate the die operation to be performed on each station of the die. How to construct a strip layout:**

- a. Determine the proper progression for the part.
- b. Tape on a drawing board a series of prints of the plan view of the part in die position using the horizontal center line for alignment.
- c. Apply clear tapes over prints in order to hold prints together after removal from the drawing board.
- d. Mark all die operations on each station that will be performed in the die. (Use red color pencil for cutting operations and blue or green for forming operations)
- e. Mark operations directly on prints or use overlay-sheet for preliminary layout, but mark directly on the prints for final layout to prevent something being missed during die design.

**Step 5. Discuss proposed process with another person to check for errors. Use a checklist when analyzing the preliminary strip layout.**

- a. What stations can be eliminated by combining with another station?
- b. Are good die steel conditions maintained?
- c. Does movement of part between stations require a stretch web?
- d. Are idle stations provided to permit "breathing" of strip, if stretch is not feasible?
- e. Provide for pitch notch(s), if possible, to maintain proper progression.
- f. Avoid sight stop for first hit, if possible.
- g. If possible, pierce in first station and pilot in second station to establish pitch control.
- h. Provide adequate pilots for all subsequent stations.
- i. Is there room for stock lifters to permit free flow of strip during feed?
- j. Are close tolerance holes pierced after forming to eliminate development of hole location?

k. Use an overlay sheet to run a simulated strip through the die to check each operation and to spot any loose pieces of scrap which might be left on the die.

**Step 6. Draw plan views by tracing proper part positions for each station from the strip layout.**

**Step 7. Draw the plan of the punch over the plan of the die to permit tracing as much as possible and to reduce scaling errors.**

**Step 8. Make views and notes to communicate properly to the die maker (Remember to assume is to blunder).**

**Step 9. Problem areas to watch:**

- a. Part lifters.
- b. Part gages.
- c. Part control-pilots, etc.
- d. Pad travels.
- e. Scrap ejection.
- f. Part ejection.
- g. Poor die steel conditions.
- h. Will the die fit the press?
- i. Will the die fit production requirements?

**Step 10. Receive preliminary design approval.**

**Step 11. Finish design layout.**

### Providing for carrier strip distortion:

The strip development for drawing in progressive dies must allow for movement of metal without affecting the positioning of the part in each successive station. Fig. shows various types of cutouts and typical distortions to the carrier strips as the cup shaped parts are formed and then blanked out of the strip. Piercing and lancing of the strip around periphery of the part, leaving one or two tabs connected to the carrier strip is commonly used method. The semi-circular lancing as shown at B is used for shallow draws. The use of this type of relief for deeper draws places an extra strain on the metal on the tab and may cause it to tear. The carrier strip is distorted to provide stock for the draw. A popular cut-out for fairly deep draws is shown at C. this double-lanced relief suspends the blank on narrow ribbons, and distortion takes place in the carrier strip. Two sets of single rounded lanced relief of slightly different diameters are placed diametrically opposite to each other to produce the ribbon suspension. The hour-glass cutout in D is an economical method of making the blank for shallow draws. The connection to the carrier strip is wide, and a deep draw would cause considerable distortion. An hour-glass cutout for deep draws is shown in E, which provides a narrow tab connecting the carrier strip to blank. The cupping operations narrow the width of the strip as the metal is drawn into the cup shape.

The hour-glass cutout made in two sections by piercing two separate angular shape cutouts and lancing or notching the material between them in a second section. The cutouts shown at F and G provide an expansion type carrier ribbon that tends to straighten out when the draw is performed. These cutouts are made in two stations to allow for stronger die construction. Satisfactory multiple layouts may be designed using most of the reliefs by using a longitudinal lance or slitting station to divide the wide strip into narrower strip as the stock advances. The I-shaped relief cutout in H is a modified hour-glass cutout used for relatively wide strip from which rectangular or oblong shapes are produced. Straight slots or lances across the stock are sometimes used on very shallow draws or where the forming is in the center portion of the blank. On the deeper draws, this type of relief tends to tear out the carrier strips or cause excessive distortion in the blank and is not recommended.



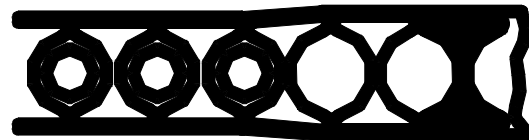
(B)



(C)



(D)



(E)



(F)



(G)

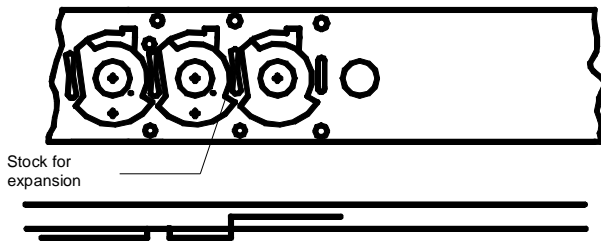


(H)

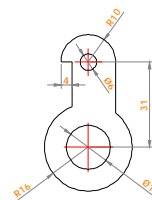
## Good general practices:

The following are good progressive die design practices.

- 1) Pierced piloting holes and pitch notches in the first station. Other holes may also be pierced that will not be affected by the subsequent non-cutting operations.
- 2) Use idle stations to avoid crowding punches and die blocks together. Idle stations also permit the use of larger die blocks and punch retainers. An added advantage is that future engineering changes can be incorporated at low cost.
- 3) Use solid spring-loaded stock guide rails rather than spool lifters where possible.
- 4) Plan the forming or drawing operations either in an upward or downward direction, which ever will assure the best die design and strip movement.
- 5) The shape of the finished part may dictate that the cut off operation should precede the last non-cutting operation.
- 6) Locate cutting and forming areas to provide uniform loading of the press slide. If this is not practical, and the press is large enough to permit the die to be off-set, determine the required offset and have instruction to the die setup placed on the die.
- 7) Design the strip so that the scrap and part can be ejected without interference. The best way to eject the apart is to cut it off and drop it through the lower die shoe.

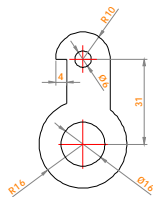


COMPONENT DRAWING



Material : Copper  
 Sheet thickness : 2mm  
 Shear strength : 20kg/mm<sup>2</sup>

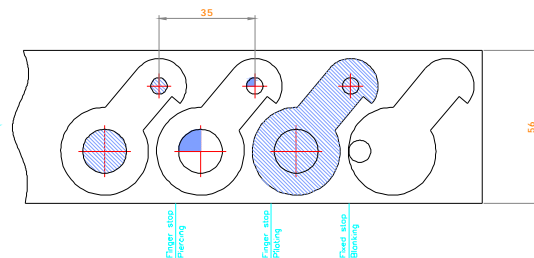
COMPONENT DRAWING



STRIP LAYOUT

Material : Copper  
 Sheet thickness : 2mm  
 Shear strength : 20kg/mm<sup>2</sup>

Feed direction →



E.F : 63.5%



## ADVANTAGES

1. Piece parts produced from compound tools are very accurate and identical because all operations are carried out in a single station. This is possible because the accuracy of the piece does not depend on the accuracy of the advance of the strip or the accuracy of the layout of the stations as in the case of progressive tools.

2. Scrap stocks from the other tools can be employed to produce piece parts in a compound tool. But progressive tools always need stock strip sheared to size

3. In a compound tool burrs resulting from the piercing and blanking are on the same side of the piece part. Piece part produced on a progressive tool will have burr on both sides.

4. Cost of manufacturing a compound tool is normally lesser than that of a progressive tool for the same component. This is because of the smaller size of the tool and the easier manufacturing methods required.

## DISADVANTAGES

If the pierced holes are too near to the outer edge of the piece part, the blanking punch of the compound tool, which accommodates the piercing dies, will become very weak. This is a major disadvantage because the punch may break either during manufacture or during the course of the tool life. When the piece parts are having pierced holes are too near to their outer edges progressive tools are preferred.

**NETTUR TECHNICAL TRAINING FOUNDATION**

Peenya Industrial Area, 23/24, II Phase, Bangalore - 560 058

Phone : 080 – 28397218, Fax : 080 - 28397196; Email : [kv@nttf.co.in](mailto:kv@nttf.co.in) ; Web:[www.nttftrg.com](http://www.nttftrg.com)