

PRESS WORKING TERMINOLOGY

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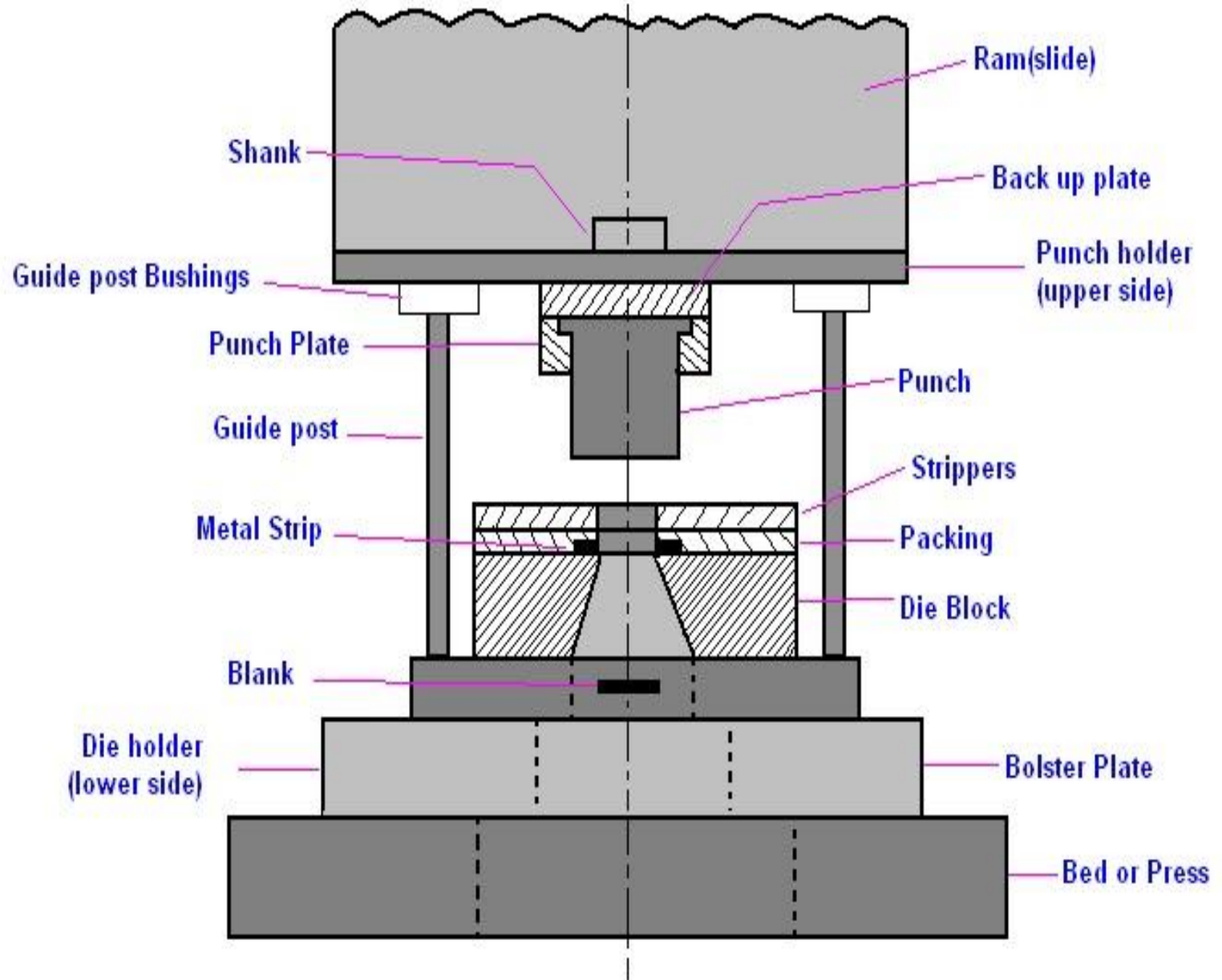
Press Working

- Press working may be defined as, a manufacturing process by which various components are made from sheet metal. This process is also termed as cold stamping. The machine used for press working is called a press.
- The main features of a press are:
- A frame which support a ram or a slide and a bed, a source of mechanism for operating the ram in line with and normal to the bed.
- The ram is equipped with suitable punch/punches and a die block is attached to the bed.
- A stamping is produced by the downward stroke of the ram when the punch moves towards and into the die block.
- The punch and die block assembly is generally termed as a “die set” or simple as the “die”

Press working operations

- The sheet metal operations done a press may be grouped into two categories.
- **1. Cutting operations**
- **2. Forming operations**
- In cutting operations the work piece is stressed by its ultimate strength. The stresses caused in the metal the applied forces will be shear stresses. The cutting operations include:
 - (a) Blanking (b) Punching (c) Notching (d) Perforating
 - (e) Trimming (f) Shaving (g) Slitting (h) Lancing
- In forming operations , the stresses are below the ultimate strength of the metal , in this operation , there is no cutting of the metal but only the contour of the work piece is changed to get the desired product.
- The forming operations include:
 - (a) Bending (b) Drawing (c) Squeezing

Press Working Terminology



Press Working Terminology

- A simple cutting die used for punching and blanking operation as shown:

1: Bed: The bed is the lower part of the press frame that serves as a table to which a Bolster plate is mounted.

2: Bolster Plate: This is a thick plate secured to the press bed , which is used for locating and supporting the die assembly. It is usually 5 to 12.5 cm thick.

3: Die Set: It is unit assembly which incorporates a lower and upper shoe, two or more guide parts and guide part bushings.

4: Die Block: It is a block or a plate which contains a die cavity

5: Lower Shoe: The lower shoe of the a die set is generally mounted on the bolster plate of a press. The die block is mounted on the lower shoe, also the guide post are mounted on it.

6: Punch : This is male component of a die assembly, which is directly or indirectly moved by and fastened to the press ram or slide.

7: Upper Shoe: This is the upper part of the die set which contains guide post bushings.

8: Punch Plate :The punch plate or punch retainer fits closely over the body of the punch and holds it in proper relative position.

9: Back up Plate: Back up plate or pressure plate is placed so that intensity of pressure does not become excessive on punch holder. The plate distributes the pressure over a wide area and the intensity of pressure on the punch holder is reduced to avoid crushing.

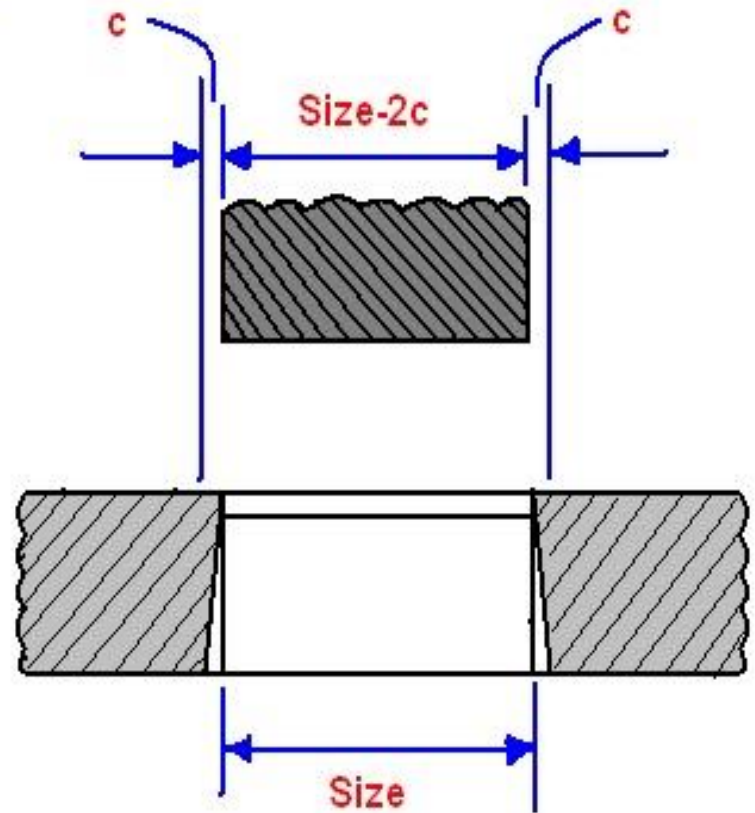
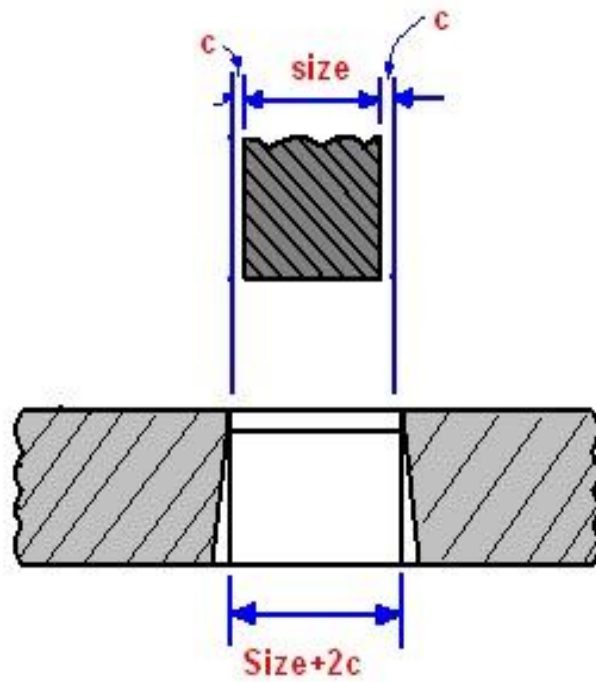
10: Stripper: It is a plate which is used to strip the metal strip from cutting a non-cutting Punch or die. It may also guide the sheet.

Terminology used in dies

1: Clearance

- The difference in dimensions between the mating members of a die set is called clearance. This clearance is applied in following manner:
- 1: when the hole has to be held to size i.e. the hole in the sheet metal is to be accurate (punching operation) , and slug is to be discarded. The punch is made to the size of the hole and the die opening size is obtained by adding clearance to the punch size.
- 2: In blanking operation , where the slug or blank is the desired part and has to be held to size, the die opening size equals the blank size and the punch size is obtained by subtract.

Clearance



- **2: Cutting Forces**

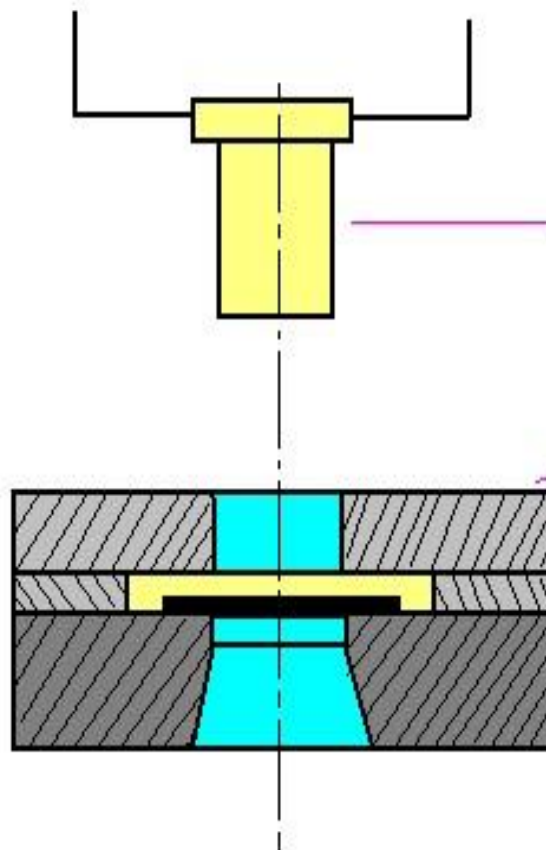
- In cutting operation, as the punch in its downward movement enters the material, it need not penetrate the thickness of the stock in the order to offset complete rupture of the part. The distance which the punch enters into the work material to cause rupture to take place is called penetrable and is usually given as the %age of the stock thickness
- The percent penetration depends on the material being cut and also on the stock thickness. When hard and strong material is being cut ,a very little penetration of the punch is necessary to cause feature. With soft material the penetration will be greater.

- **3: Strippers:**

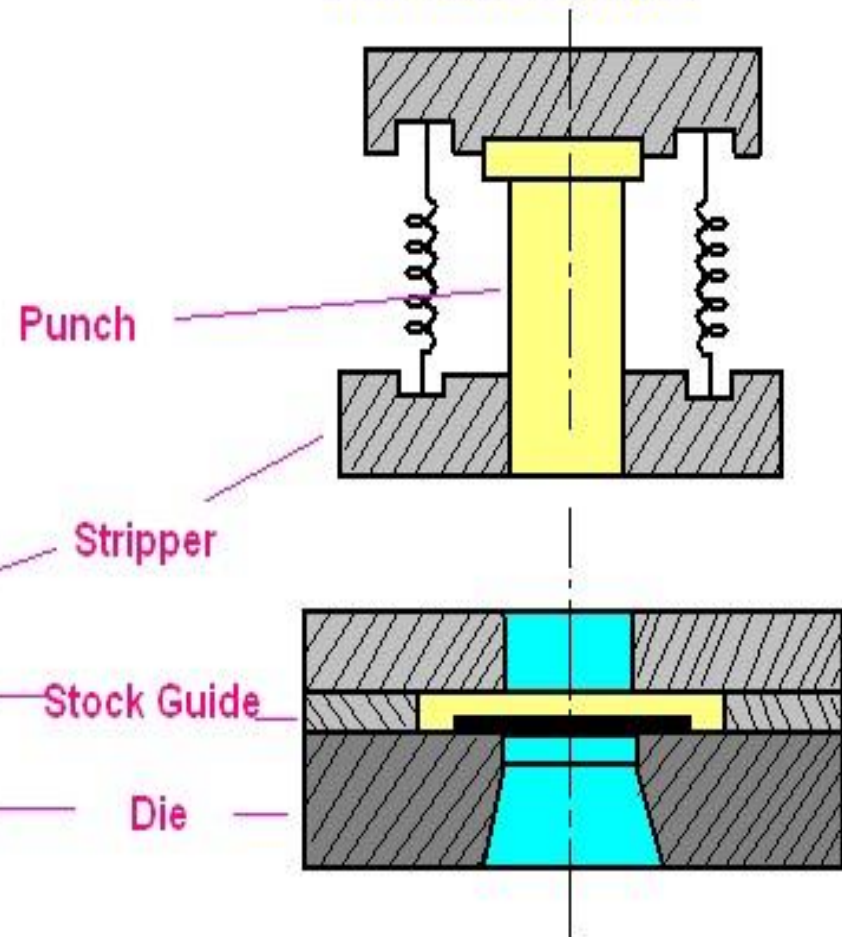
- After a blank has been cut by the punch on its downward stroke, the scrap strip has the tendency to expand. On the return stroke of the punch the scrap strip has the tendency to adhere to the punch and be lifted by it. This action interferes with the feeding of the stroke through the die and some device must be used to strip the scrap material from the punch as it clears up the die block. Such a device is called “stripper” or stripper plate.
- Stripper plate are of two types:
 - 1: fixed or stationary
 - 2: spring loaded or movable

Types of Strippers

(A): Fixed or Stationary Stripper



(B): Spring Loaded or Movable Stripper



- **(a): fixed or stationary strippers:**

- This stripper is attached at a fixed height over the die block. The height should be sufficient to permit the sheet metal to be fed freely between the upper die surface and the under surface of the stripper plate. The stripper plate thickness is determining by the formula:
$$T_s = 1/8(w/3 + 16t)$$
- Where w and t are width and thickness of the stock strip. The fixed stripper is also known as 'channel stripper'

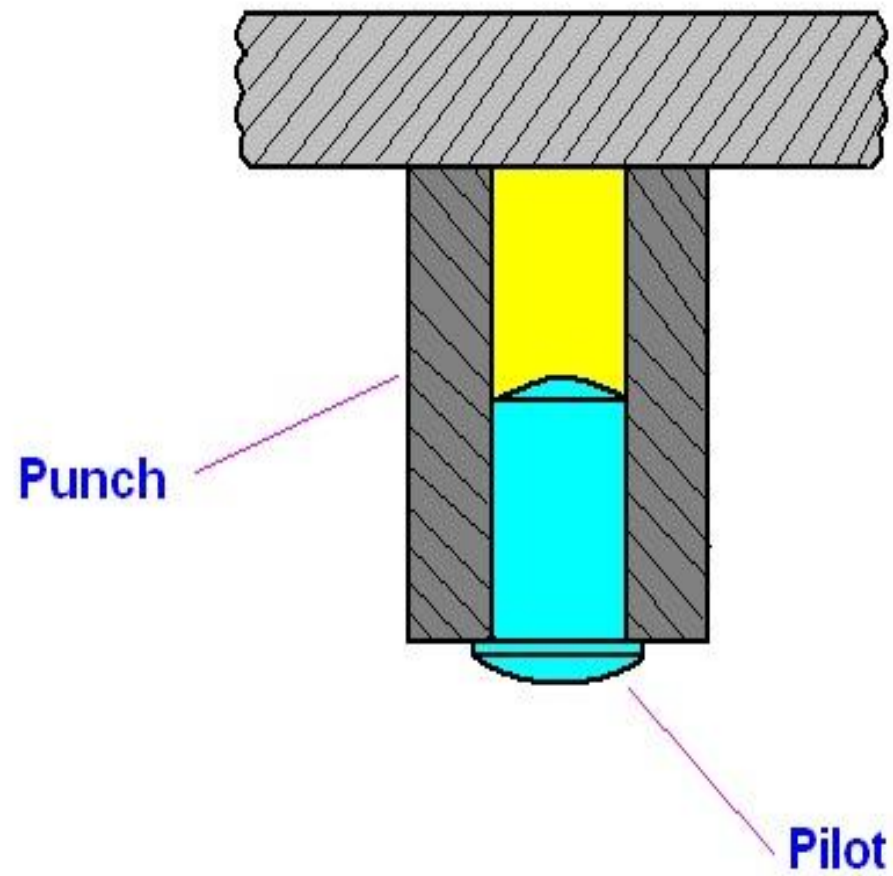
- **(b): Spring loaded Stripper:**

- This type is used on large blanking operations and also on very thin and highly ductile materials. As the punch travels downward for blanking operation the stripping force is determined with the help of following relation. $F_s = spt \text{ kn}$
- Where p and t are in mm and s is the stripping constant.

- **4:Pilots:-**

- Pilots are used in progressive dies. In the design of progressive dies, the first step is to establish the sequence of operations. In this sequence , the piercing operations are placed first. After the holes have been pierced , these holes are used for piloting the blanking punches so that the blank formed is truly concentric to the already punched hole. This piloting is achieved by means of pilots secured under the blanking punch. To be effective the pilot must be strong enough to align the stock without bending. Pilots are made of good grade of tool steel heat treated to maximum toughness and to a hardness of 56 to 60 Rockwell C.

-.:Pilot:-



- Types of pilots:

There are two types of pilots

- (a): Direct pilot:

- Pilots which are mounted on the face of a punch are called direct pilots. The pilot holder is generally a block of steel which can be fastened to the punch holder.

- (b) Indirect pilot:

- Such pilots are well guided through the hardened bushes in the stripper plate.

- **5: Stock Stop:**

- The strip of sheet metal is fed and guided through a slot in the stock guide or through a slot in the stripper plate after each blanking. The strip has to be advanced a correct distance, the device used to achieve this is called “ stock stop”

-

- **Dies and its Types:**

- **Die:**

- The die may be defined as the female part of a complete tool for producing work in a press. It is also referred to a complete tool consists of a pair of mating members for producing work in a press.

- **Types of dies:**

- The dies may be classified according to the type of press operation and according to the method of operation.

- **(A): According to type of press operation:**

- According to this criterion , the dies may be classified as cutting dies and forming dies.

- **1: Cutting Dies:**

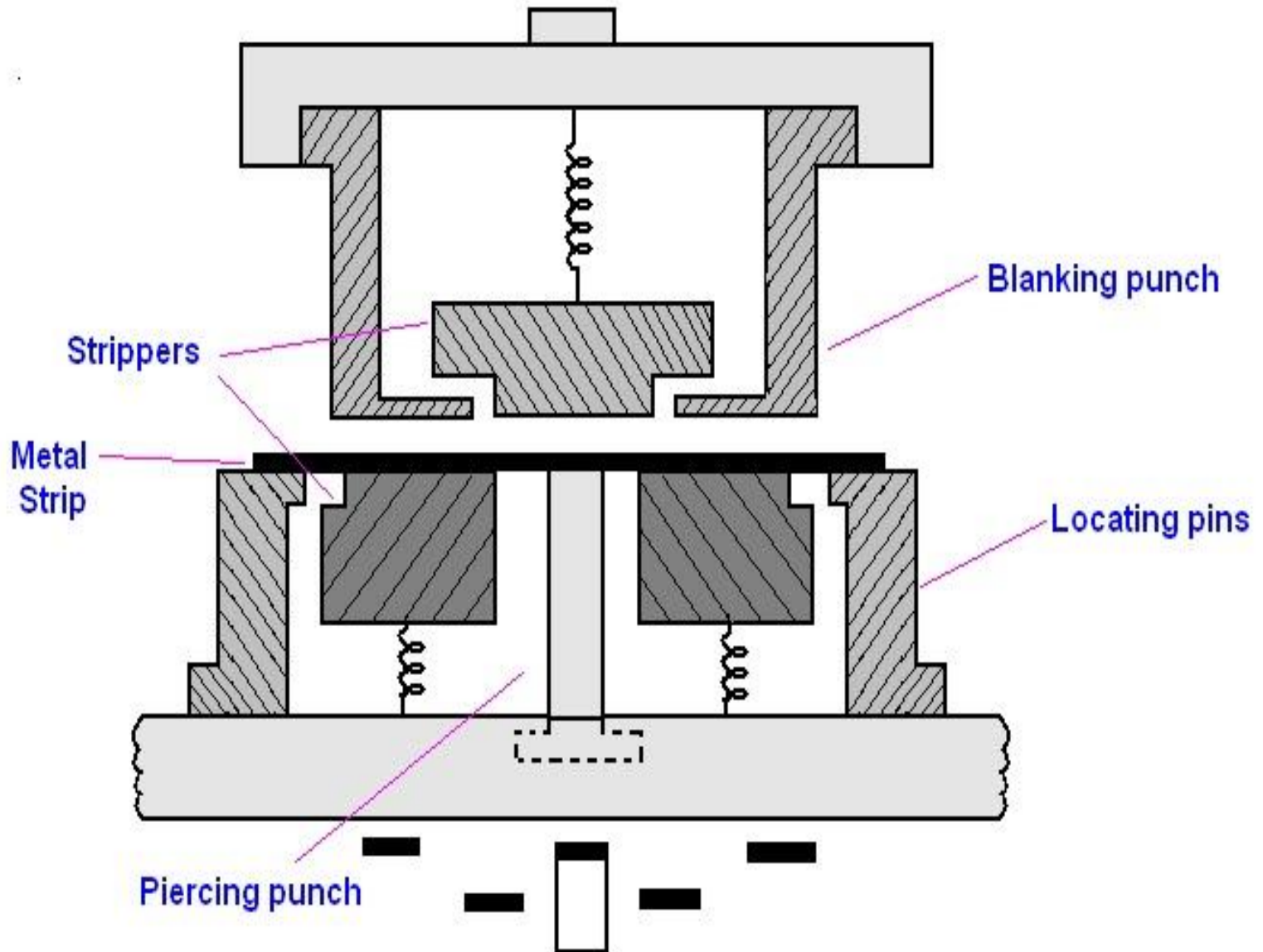
- These dies are used to cut the metal. They utilize the cutting or shearing action. The common cutting dies are : blanking dies , perforating dies , notching dies , trimming , shaving and nibbling dies.

- **2: Forming Dies:**

- These dies change the appearance of the blank without removing any stock. Theses dies include bending, drawing and squeezing dies etc.

- **(B) According to the method of operation:**
- According to this criterion, the dies may be classified as : single operation or simple dies , compound dies , combination dies , progressive dies , transfer dies and multiple dies.
- **1: Simple Dies:**
- Simple dies or single action dies perform single operation for each stroke of the press slide. The operation may be one of the operation listed under cutting or forming dies.
- **2: Compound Dies:**
- In these dies, two or more operations may be performed at one station. Such dies are considered as cutting tools since, only cutting operations are carried out. Figure shows a simple compound die in which a washer is made by one stroke of the press. The washer is produced by simulation blanking and piercing operations. Compound dies are more accurate and economical in production as compared to single operation dies.

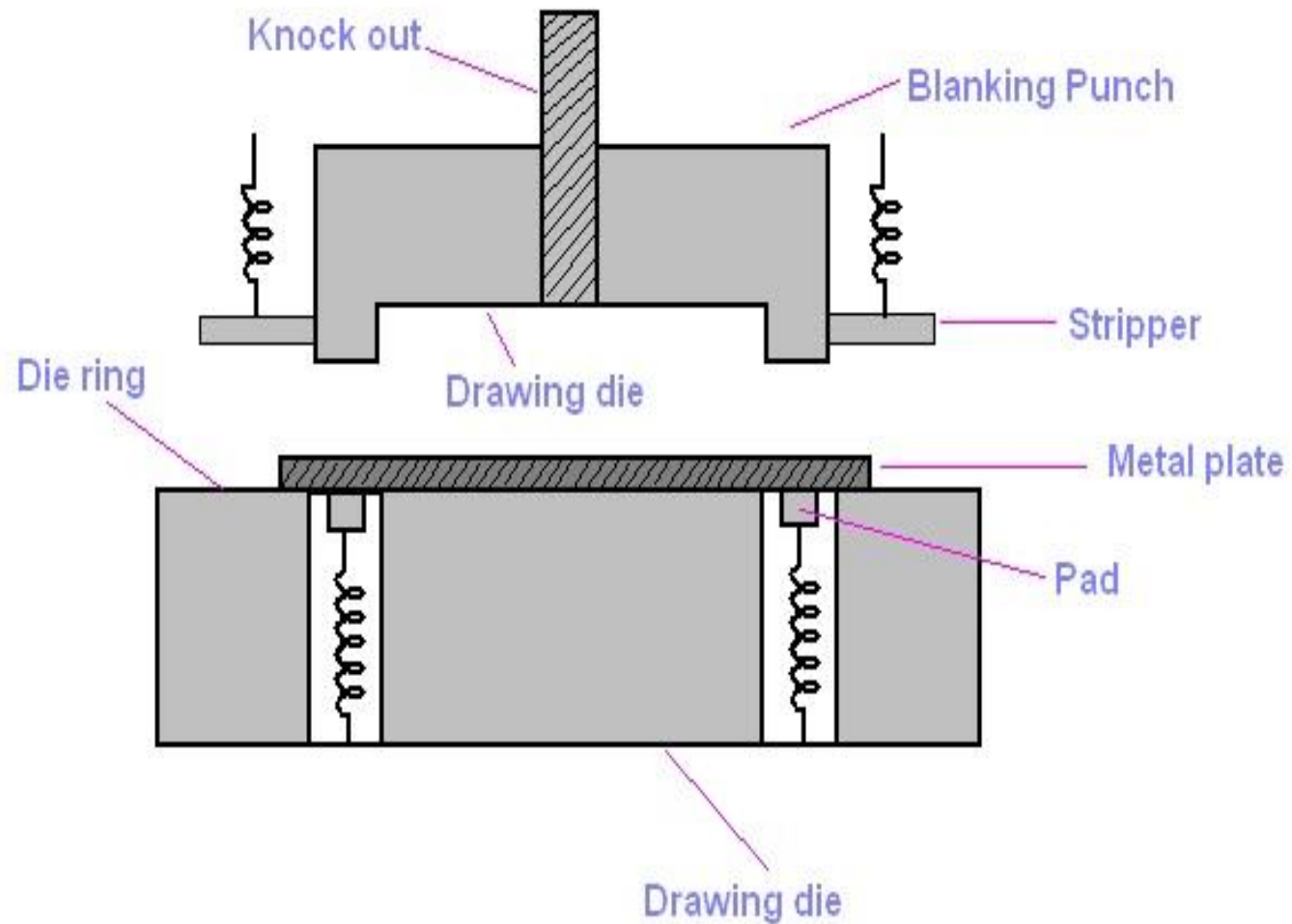
Compound Die



- **3: Combination Dies:**

- In this die also , more than one operation may be performed at one station. It is difficult from compound die in that in this die, a cutting operation is combined with a bending or drawing operation, due to that it is called combination die.

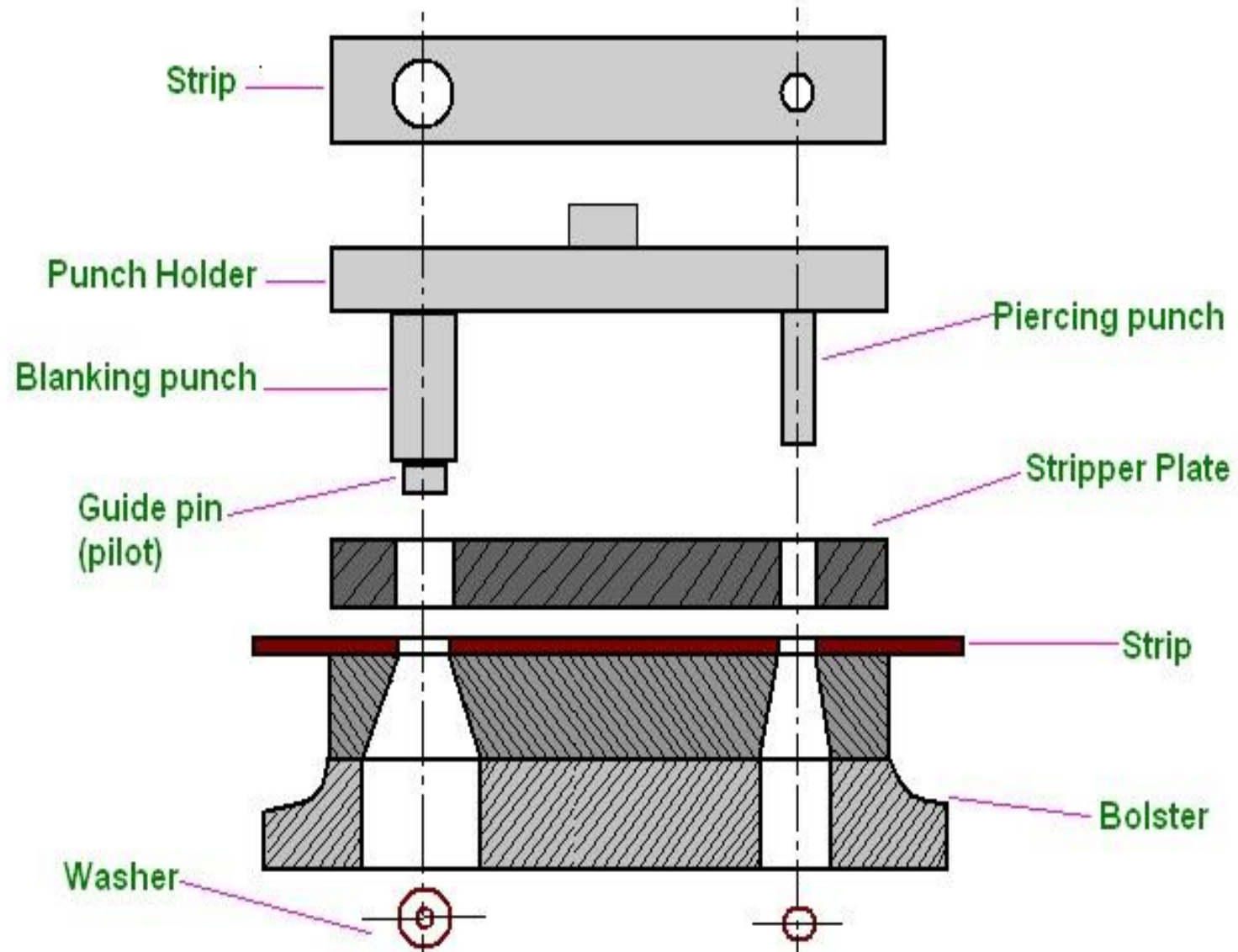
Combination Die



- **4: Progressive Dies:**

- A progressive or follow on die has a series of operations. At each station , an operation is performed on a work piece during a stroke of the press. Between stroke the piece in the metal strip is transferred to the next station. A finished work piece is made at each stroke of the press. While the piercing punch cuts a hole in the stroke , the blanking punch blanks out a portion of the metal in which a hole had been pierced at a previous station. Thus after the first stroke , when only a hole will be punched , each stroke of the press produces a finished washer.

Progressive Die



- **6: Transfer Dies:**

- Unlike the progressive dies where the stroke is fed progressively from one station to another. In transfer dies the already cut blanks are fed mechanically from one station to other station.

- **7: Multiple Dies:**

- Multiple or gang dies produce two or more work piece at each stroke of the press. A gang or number of simple dies and punches are ganged together to produced two or more parts at each stoke of the press.

THE END

Tooling of Metal Working

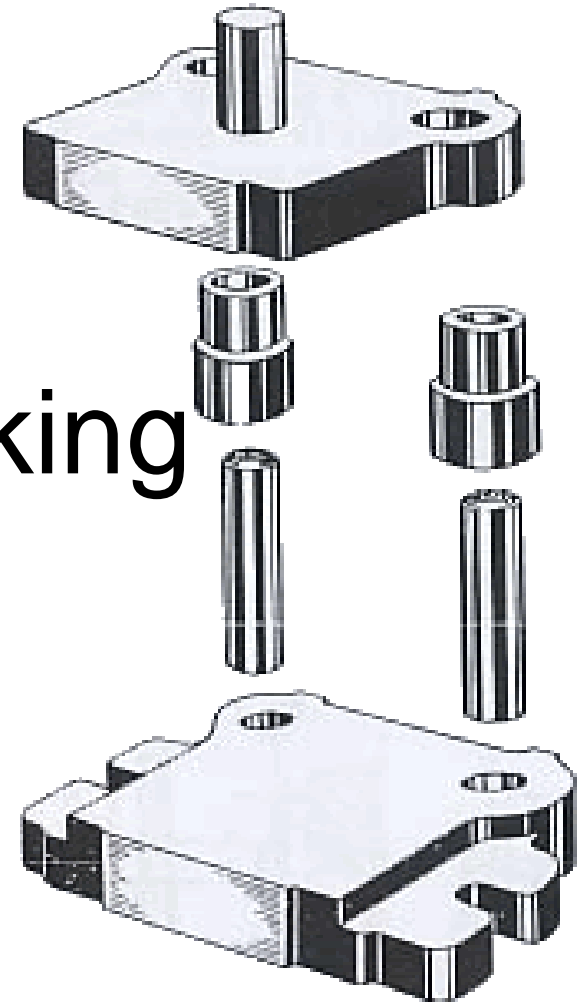
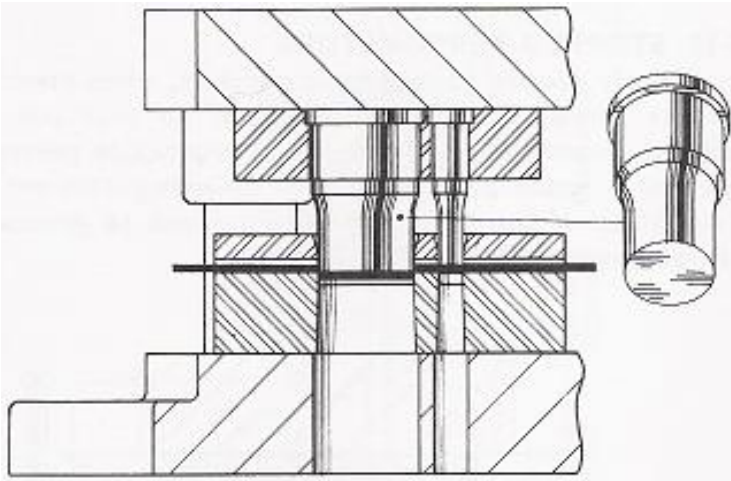
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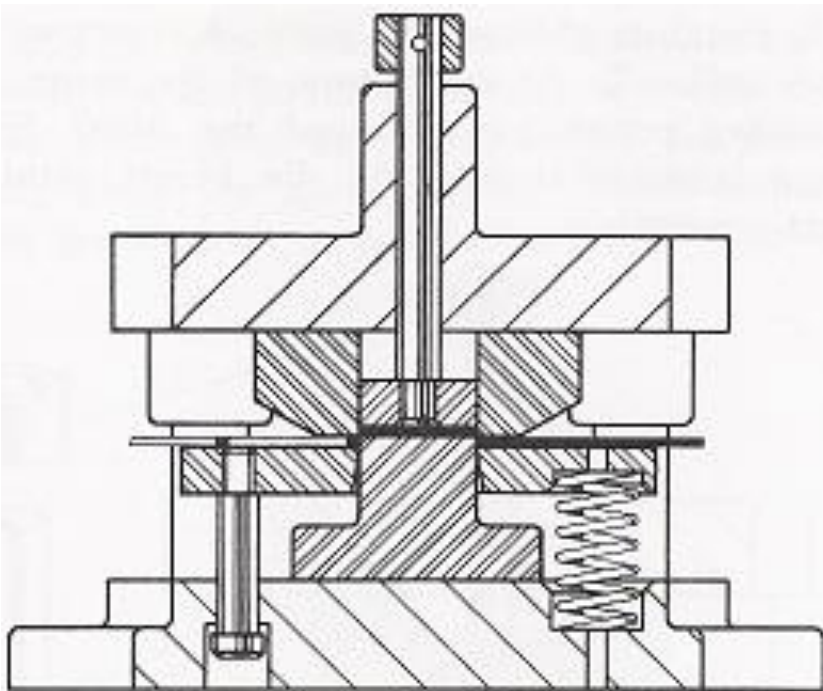
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Tooling for Metal Working

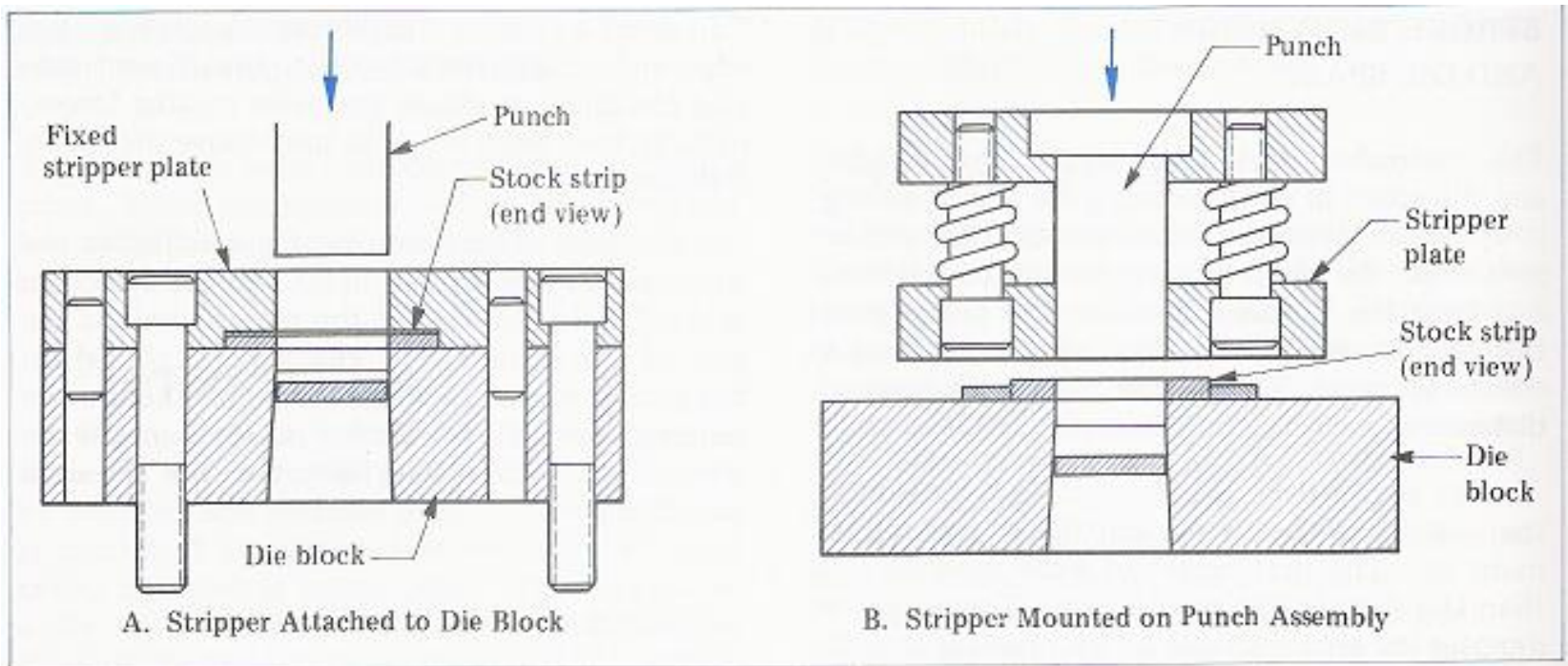


Contents

- Types of Die
 - Conventional
 - Inverted
 - Compound
 - Progressive
- Die Component
 - Punch
 - Die Block
 - Punch Plate
 - Pilot
 - Gage
 - Stripper
 - Die Set

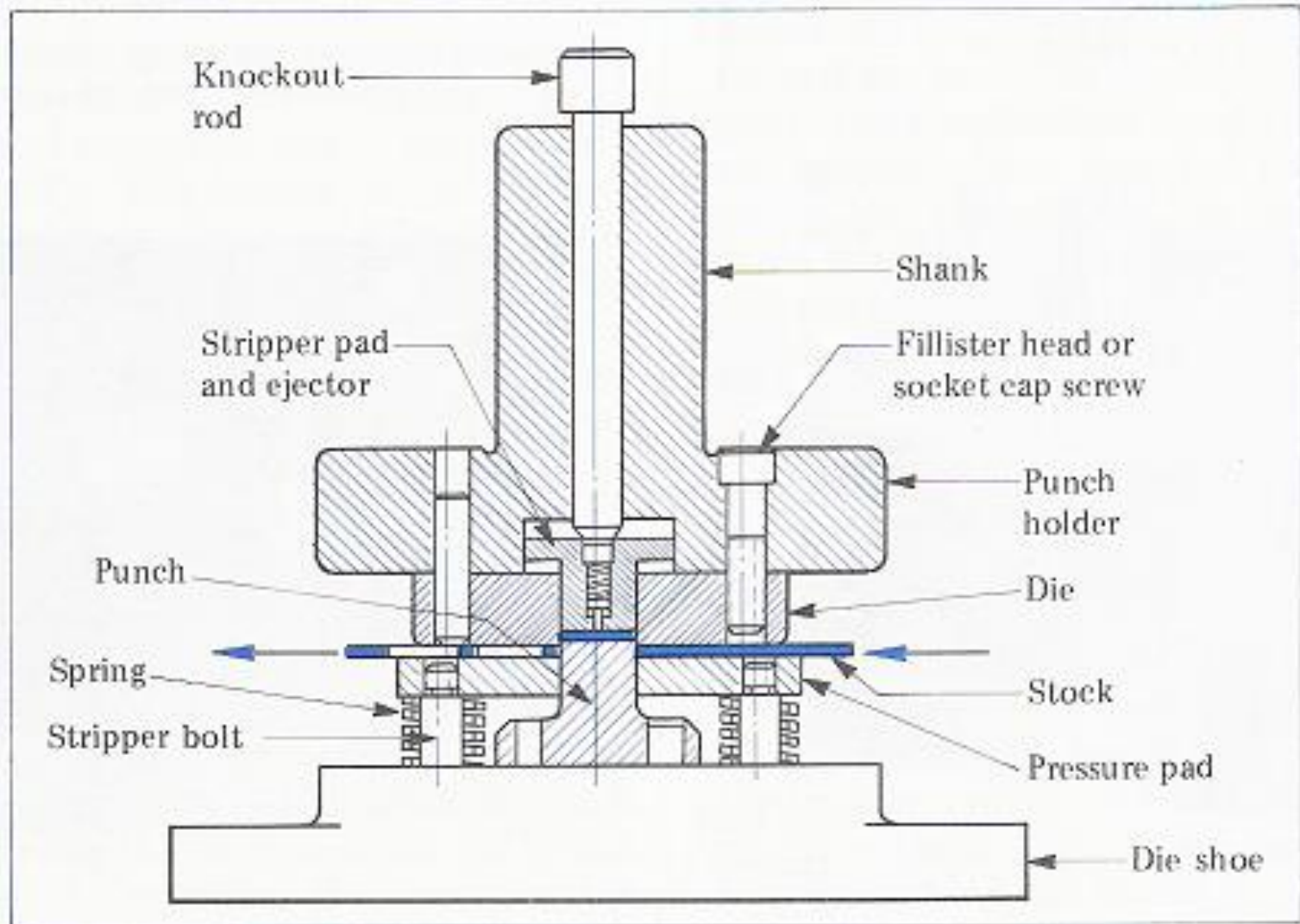
Types of Die

- Conventional
 - The punch fastened to the punch holder and aligned with the opening in the die block



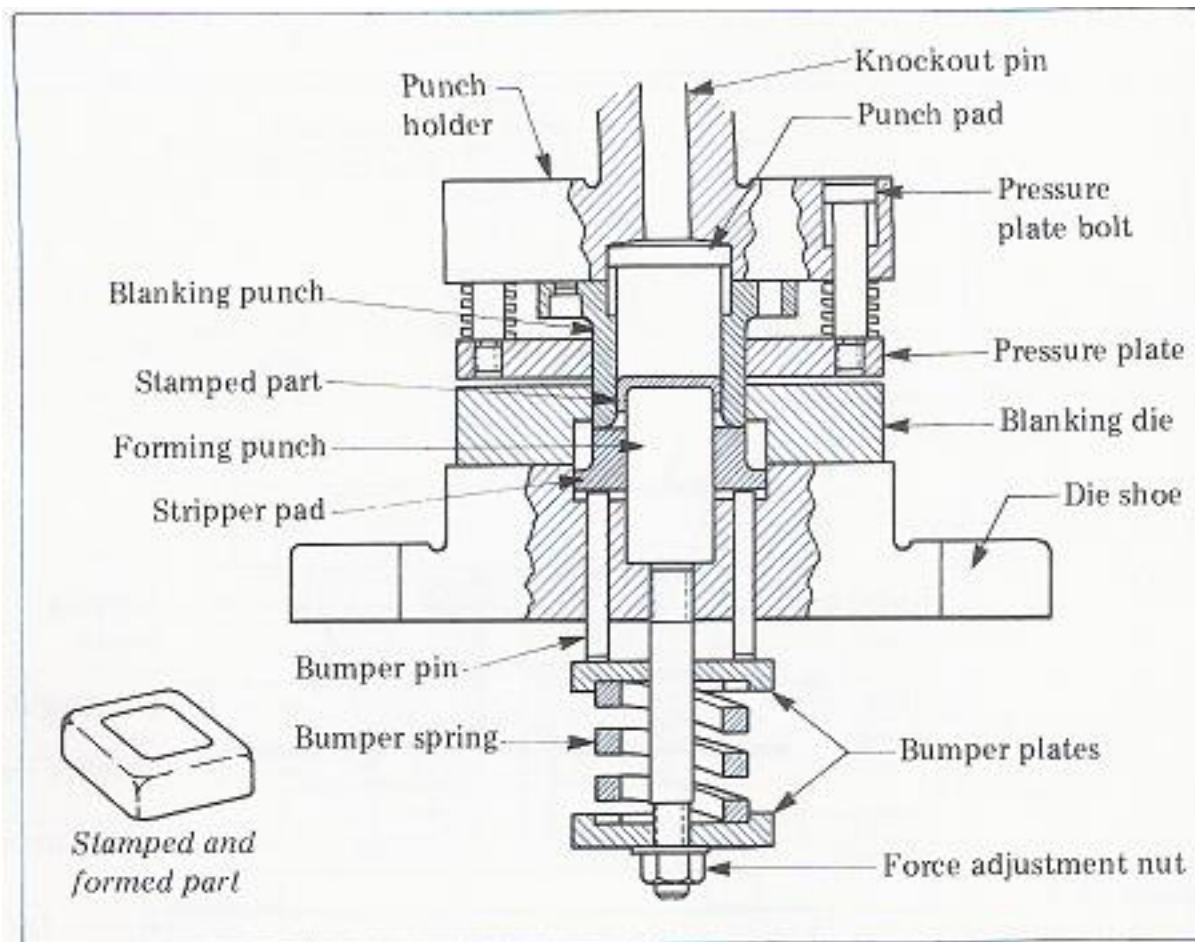
Single action with fixed and spring stripper

Single action with knockout



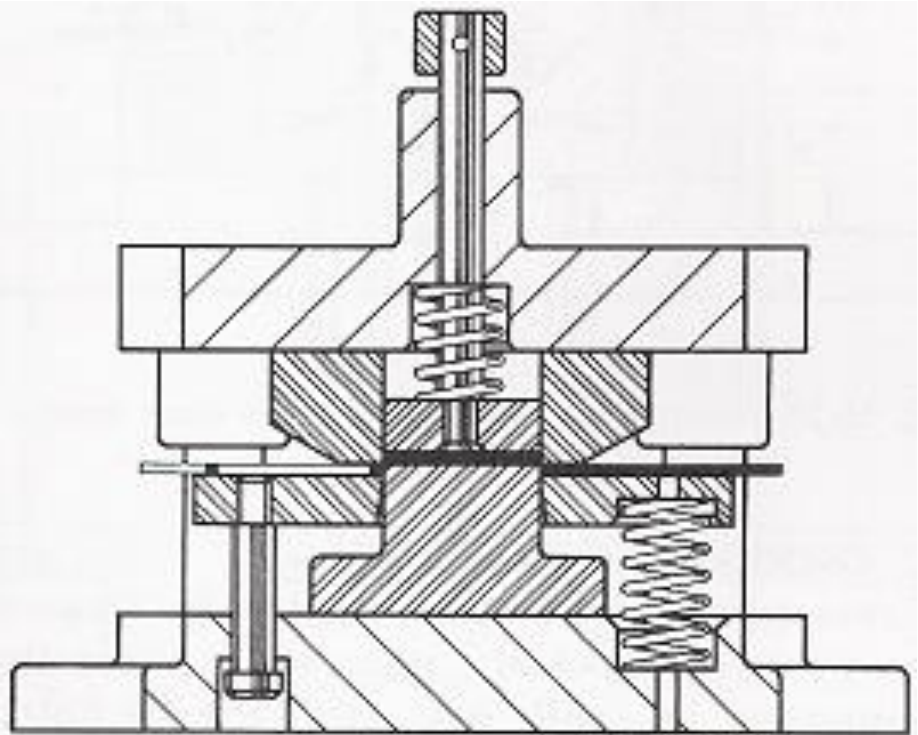
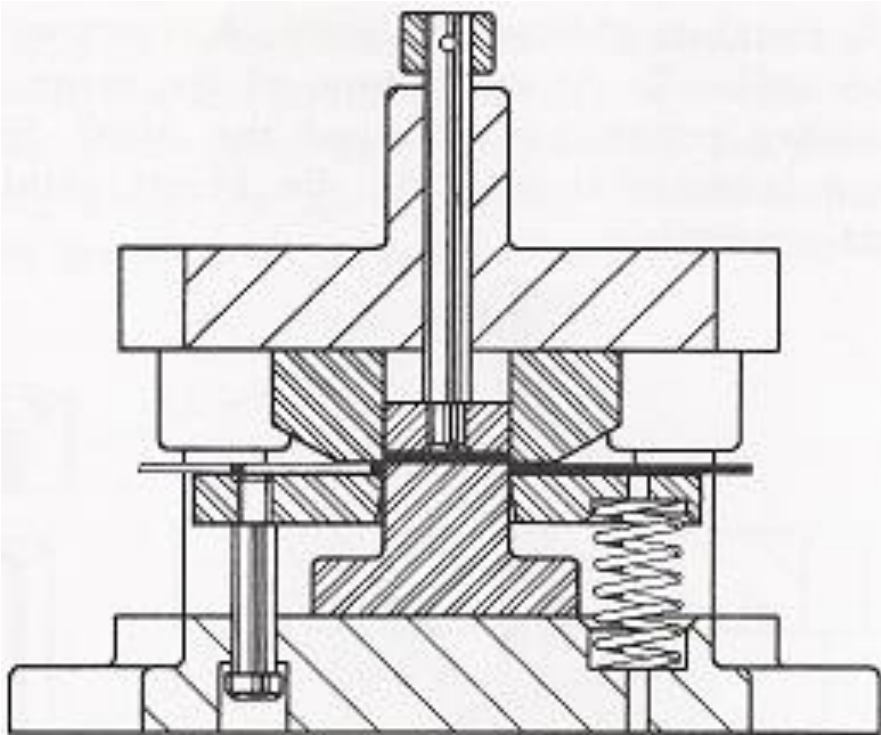
Double Action

- A die in which pressure is first applied to a blank through the blank holder and is then applied to the punch



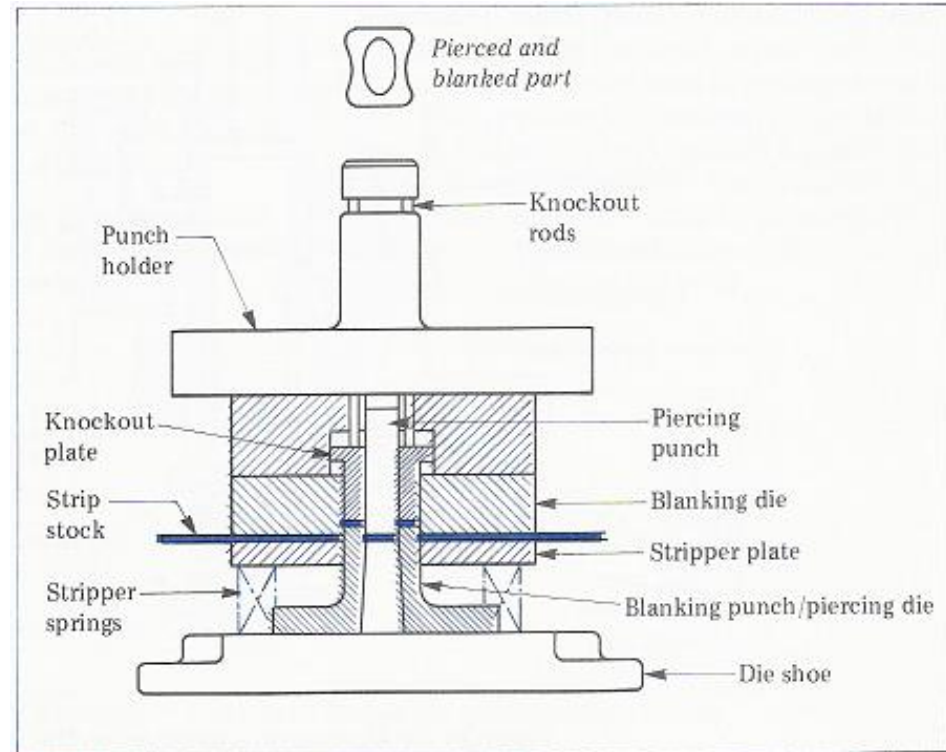
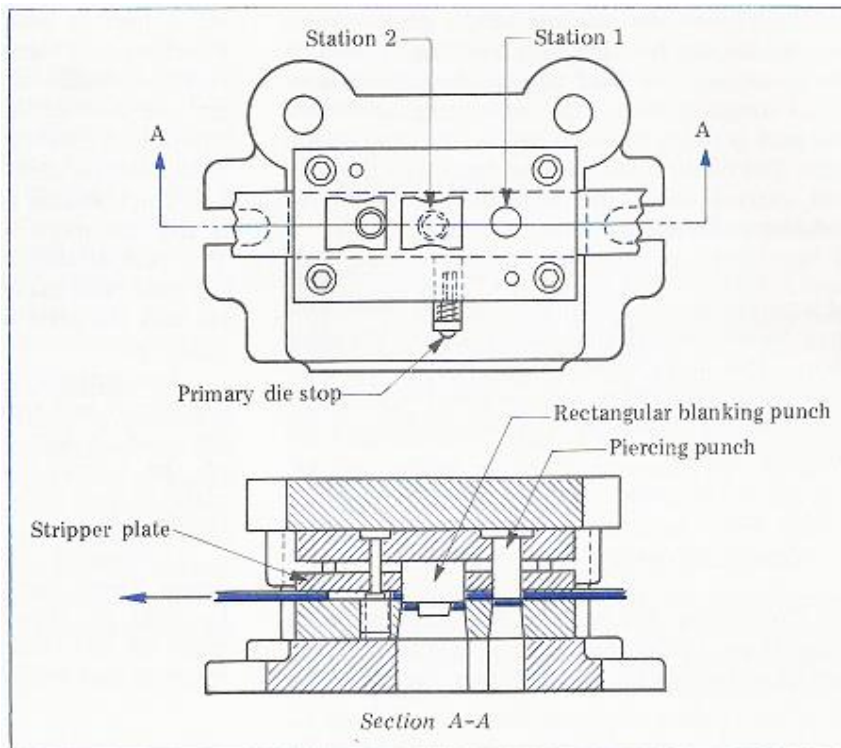
Types of Die

- Inverted
 - The die block fastened to the punch holder and the punch fastened to the die shoe



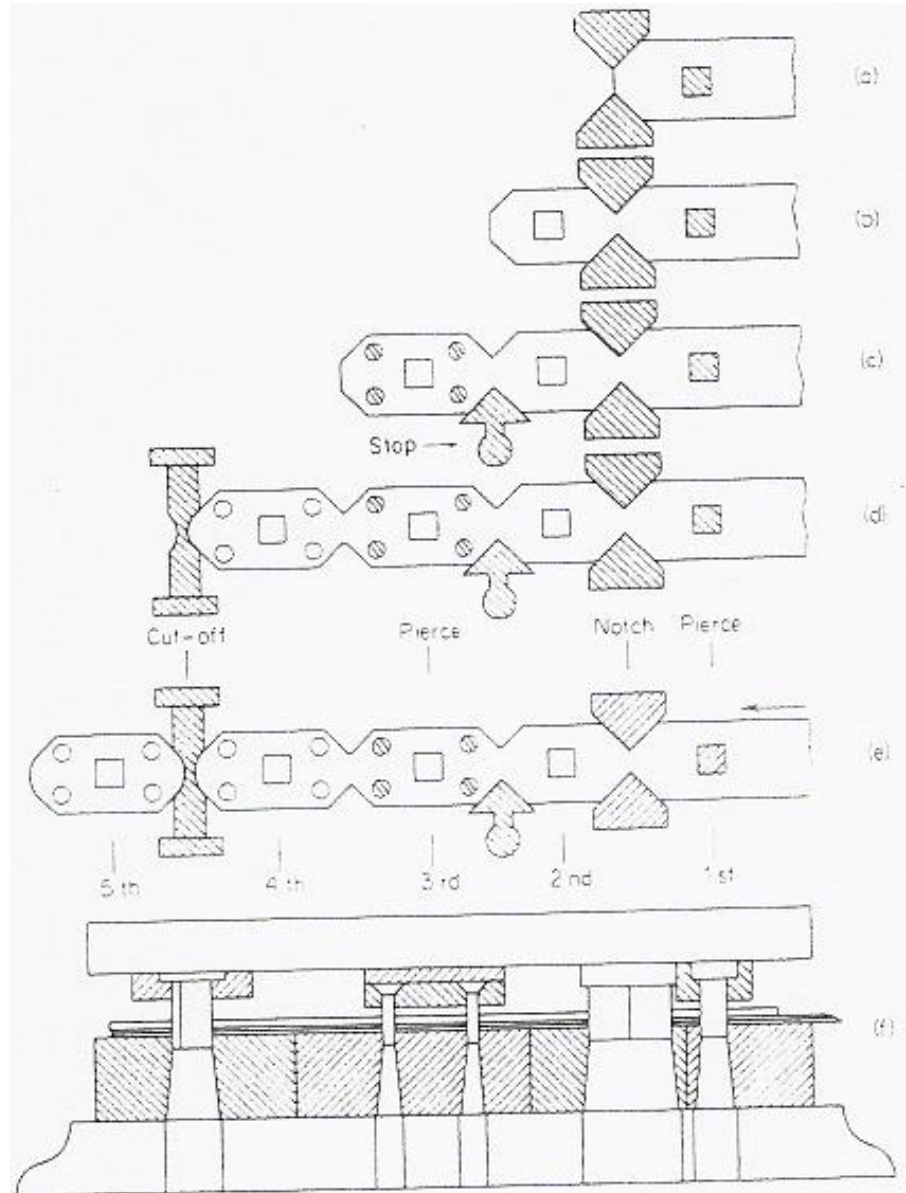
Types of Die

- Compound
 - Combined the principles of conventional and inserted dies in one station



Types of Die

- Progressive
 - Two or more station
 - Produce a workpiece which is pierced and blanked in one station and in one operation
 - Each station performs an operation on the workpiece, or provides an idler station
 - Workpiece is completed when the last operation has been completed



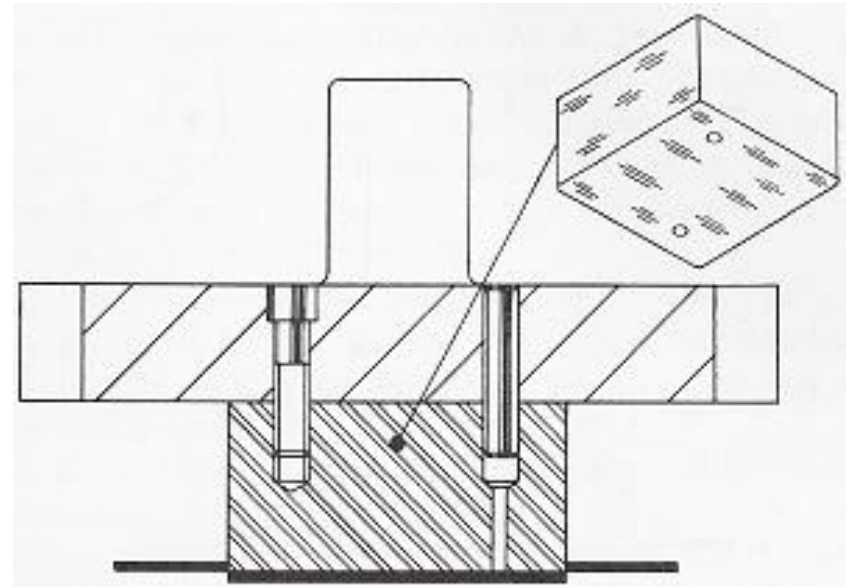
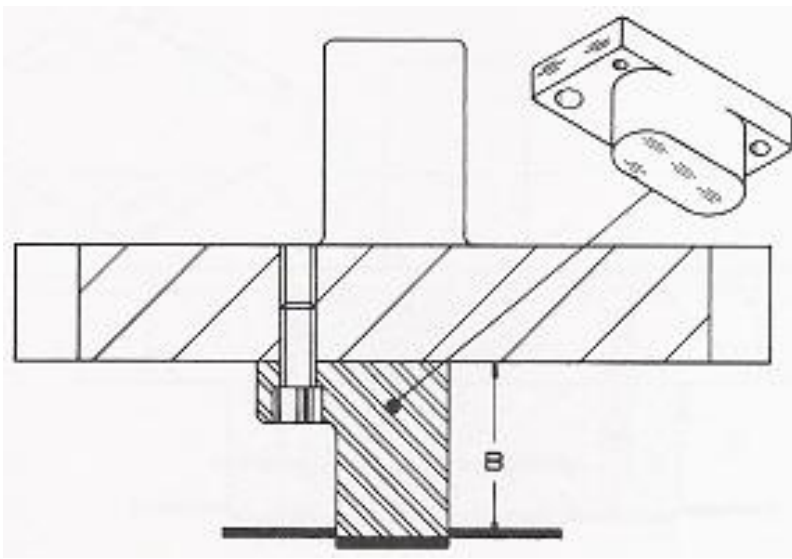
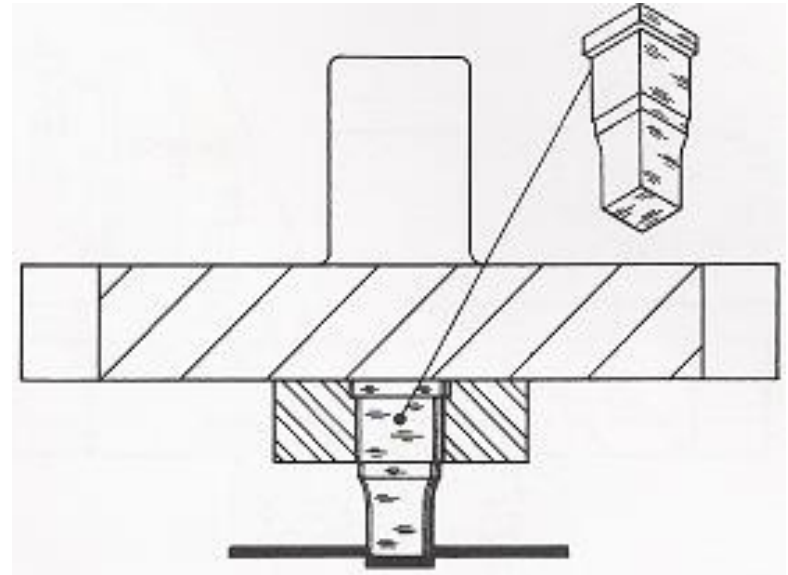
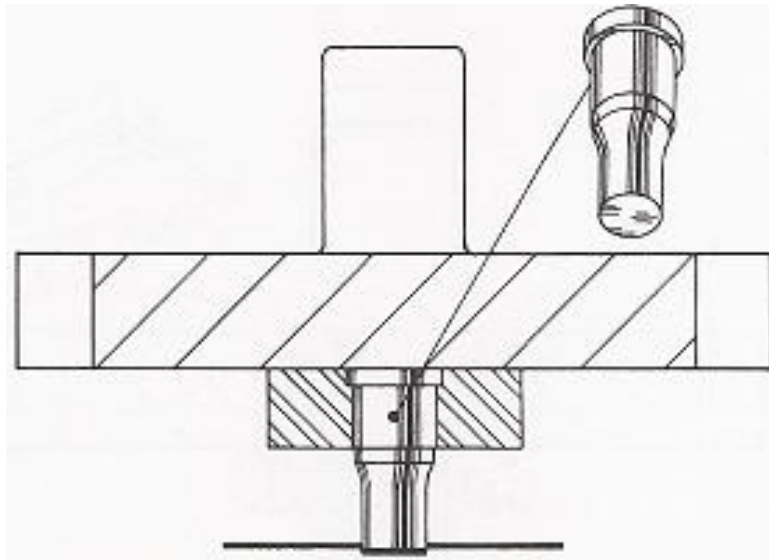
Die Component

- Punch
- Die Block
- Punch Plate
- Pilot
- Gage
- Stripper
- Die Set

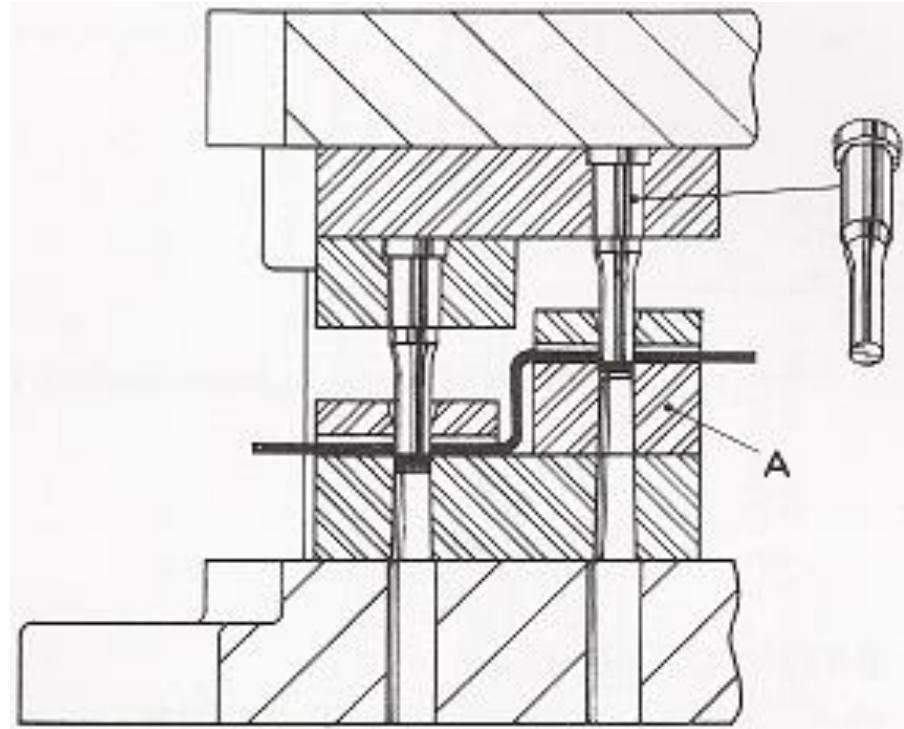
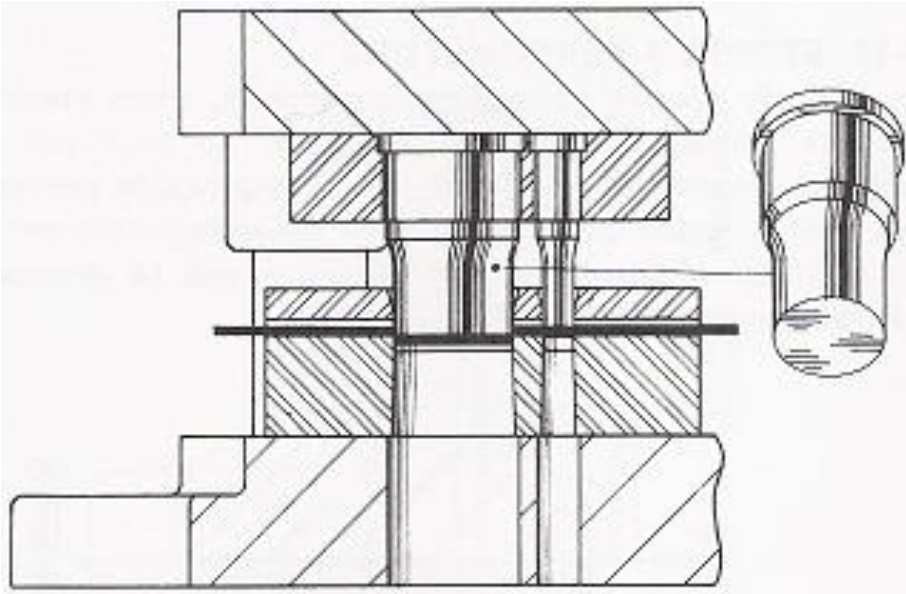
Punch

- Do not reflect
- Withstand stripping forces
- Do not rotate
- Types
 - Blanking Punch
 - Piercing Punch
 - Bending Punch
 - Drawing Punch

Blanking Punch

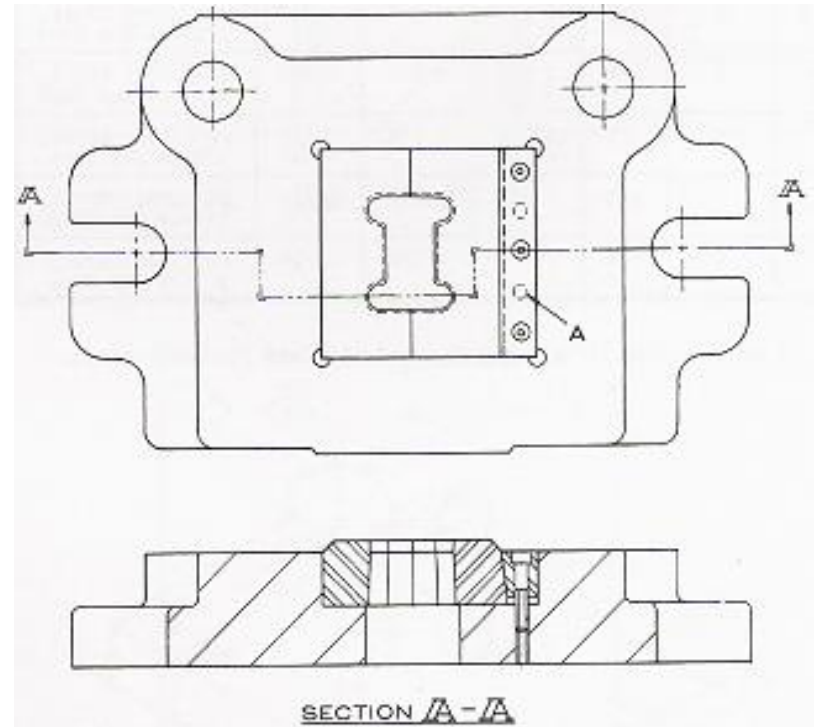
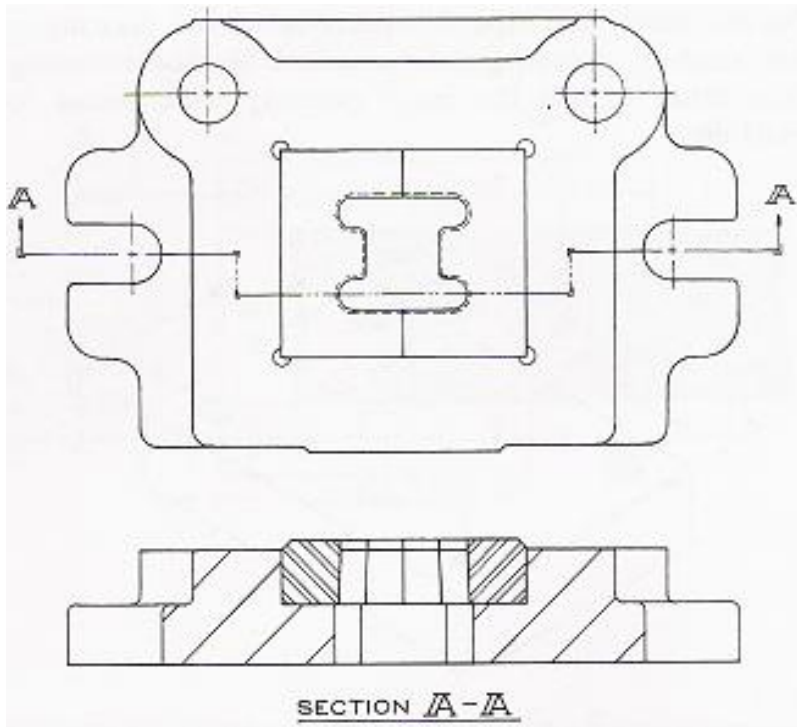


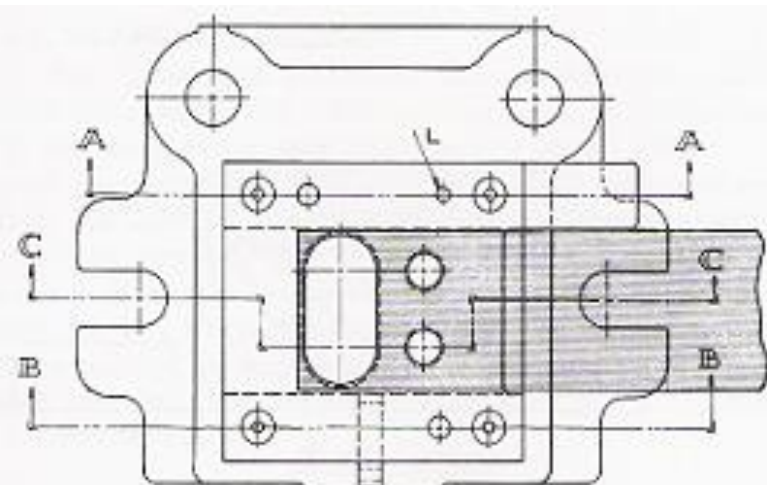
Piercing Punch



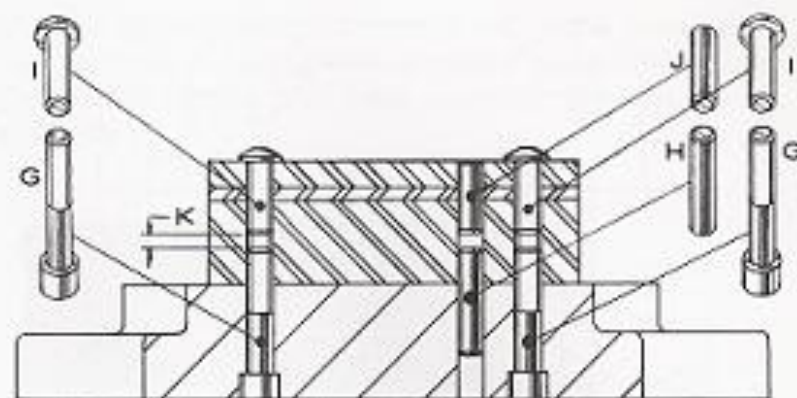
Die Block

- A block, often made of heat treated steel, into which desired impressions are machined or sunk and from which closed-die forgings or sheet metal stampings are produced using hammers or presses. In sheet metal forming, the female die is used in conjunction with a male punch.

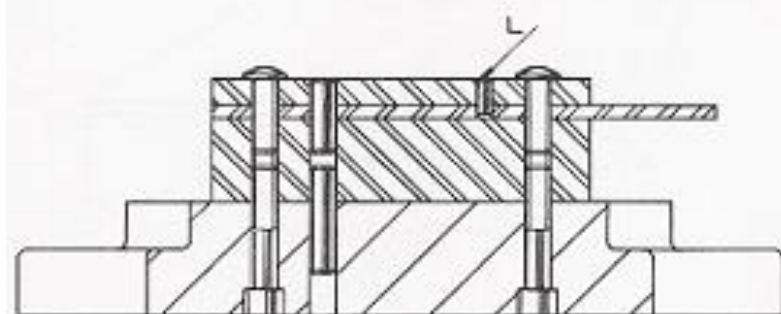




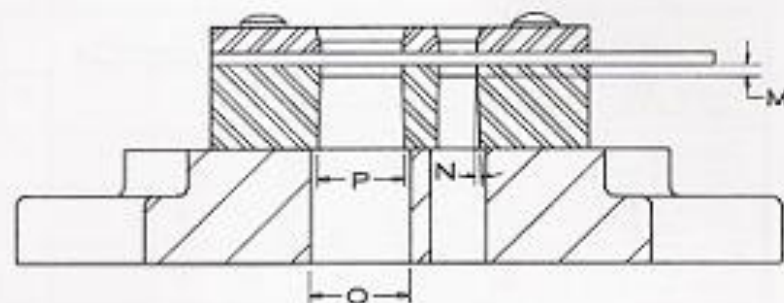
Complete Die Member



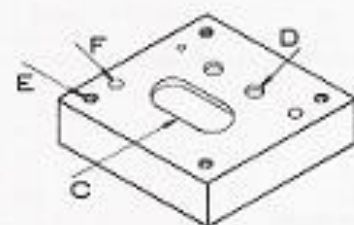
SECTION B-B



SECTION A-A



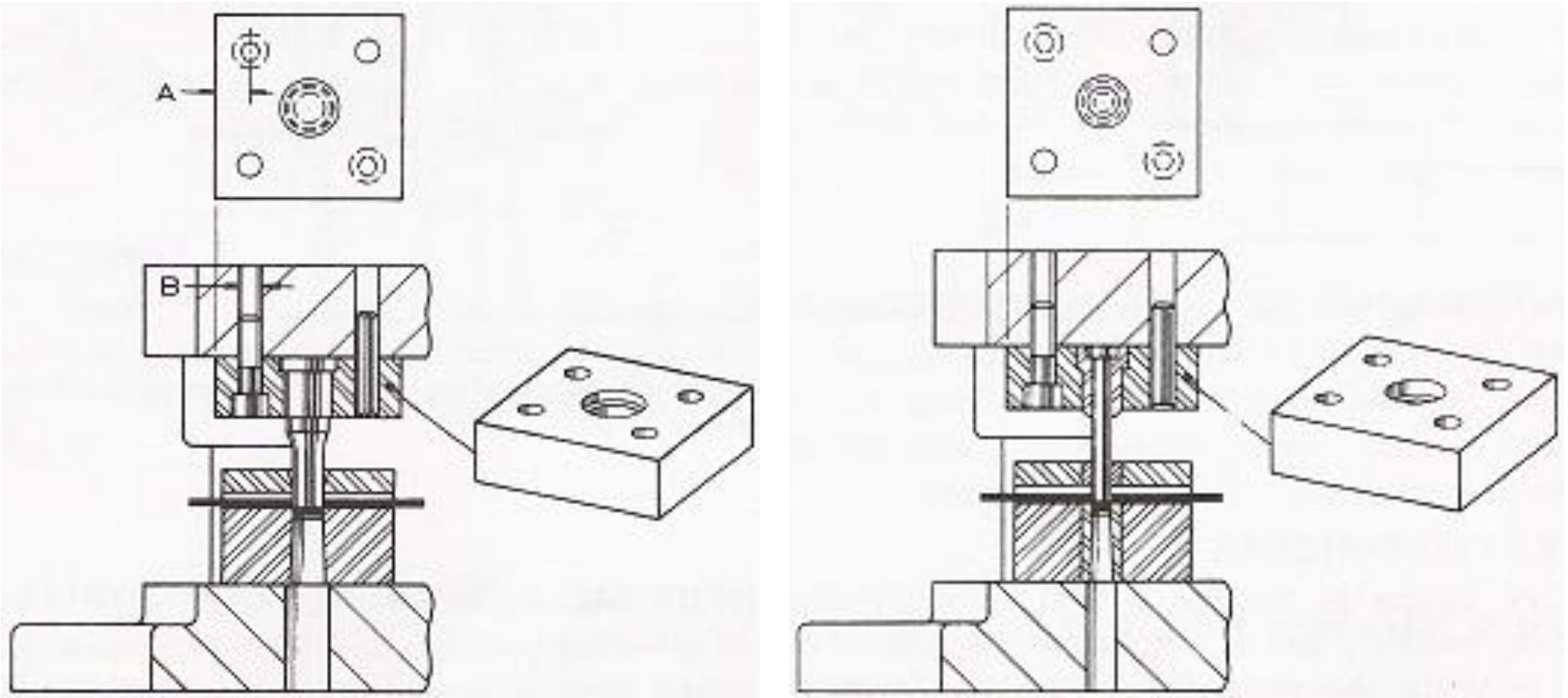
SECTION C-C



Die Block

STRIP THICKNESS	ANGULAR RILEEP N
0 to 1/16	1/4°
1/16 to 3/16	1/2°
3/16 to 5/16	3/4°
Over 5/16	1°

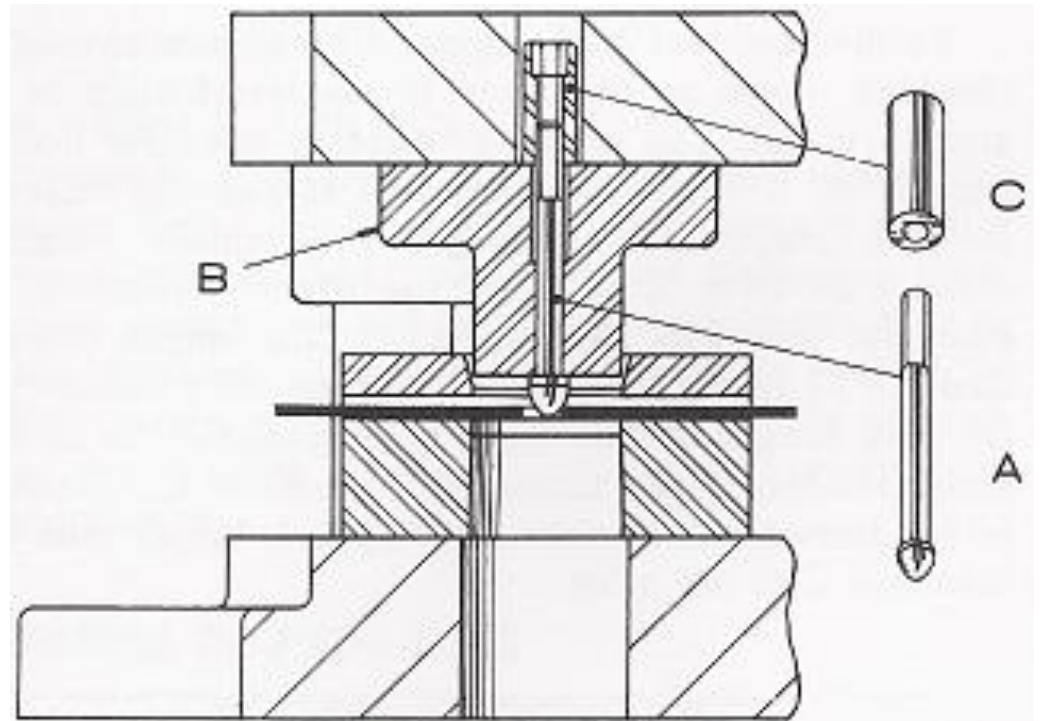
Punch Plate



- Punch plate hold and support piercing, notching, blanking, drawing and cut off punches

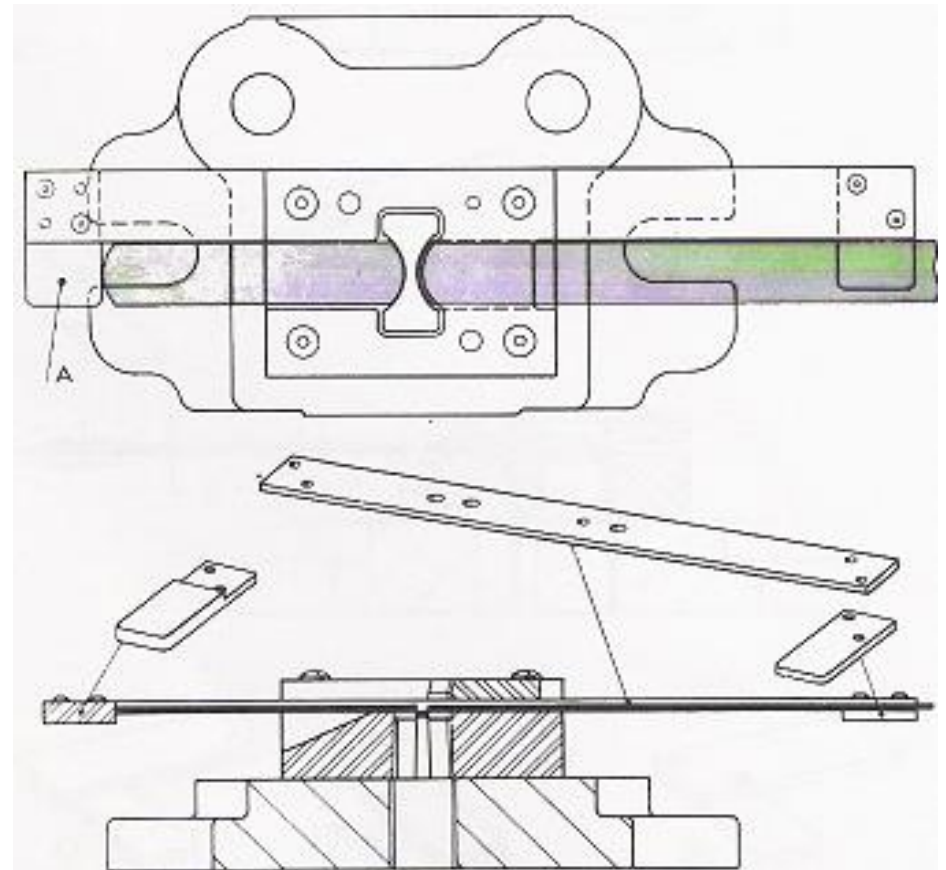
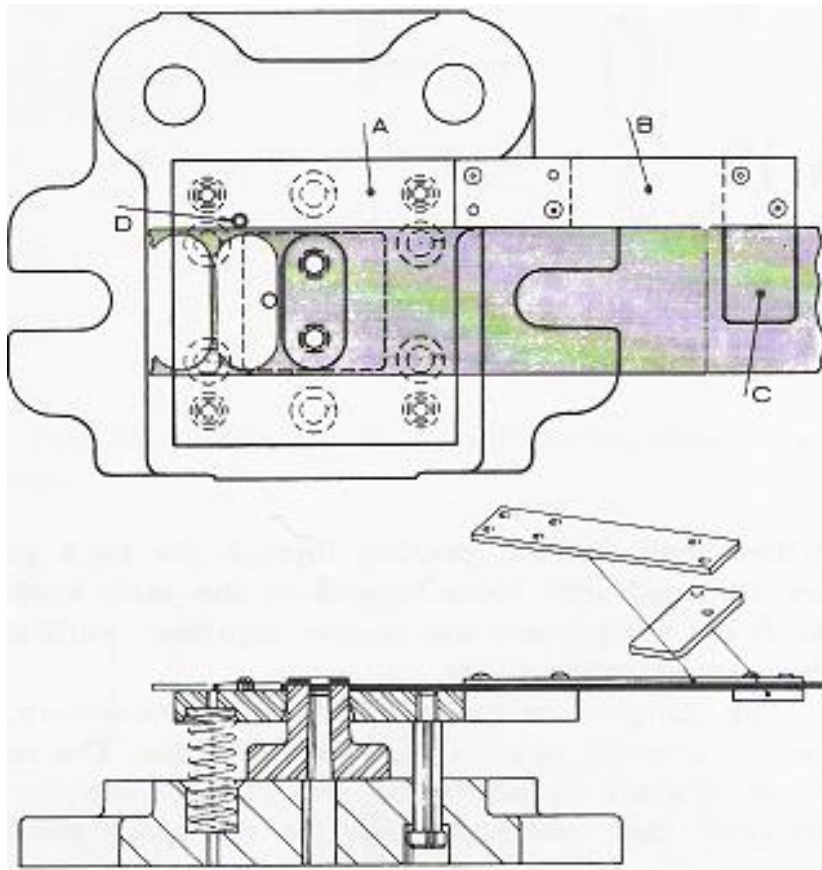
Pilot

- A pin or projection provided for locating work in a die from a previously punched hole. Also called locating pin, pilot pin, etc.



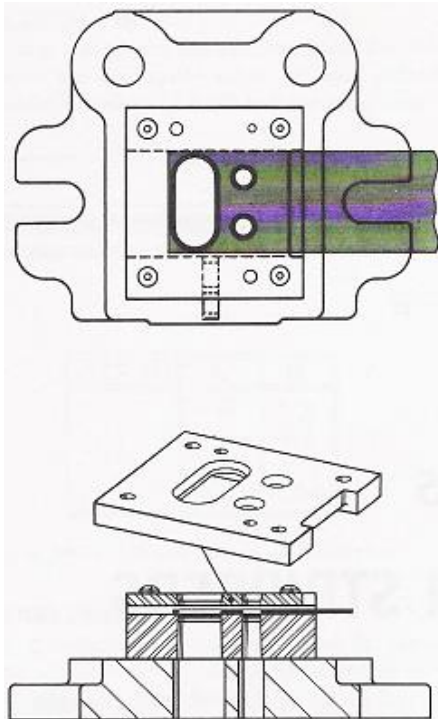
Gage

- A device used to position work in a die accurately.

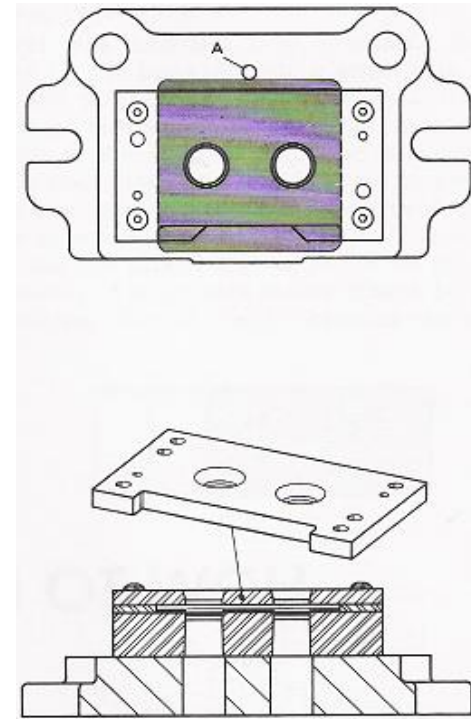


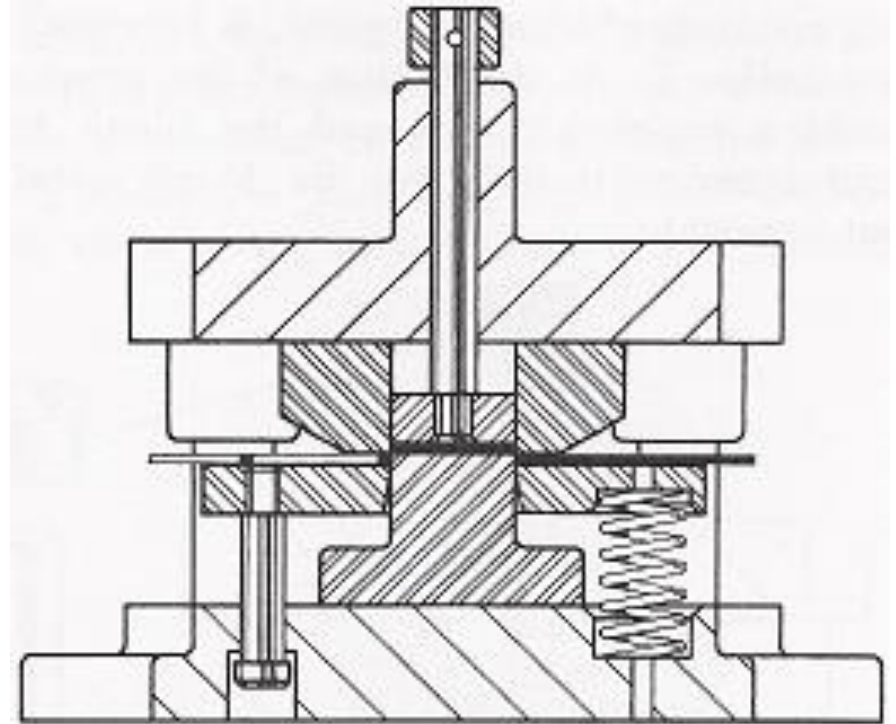
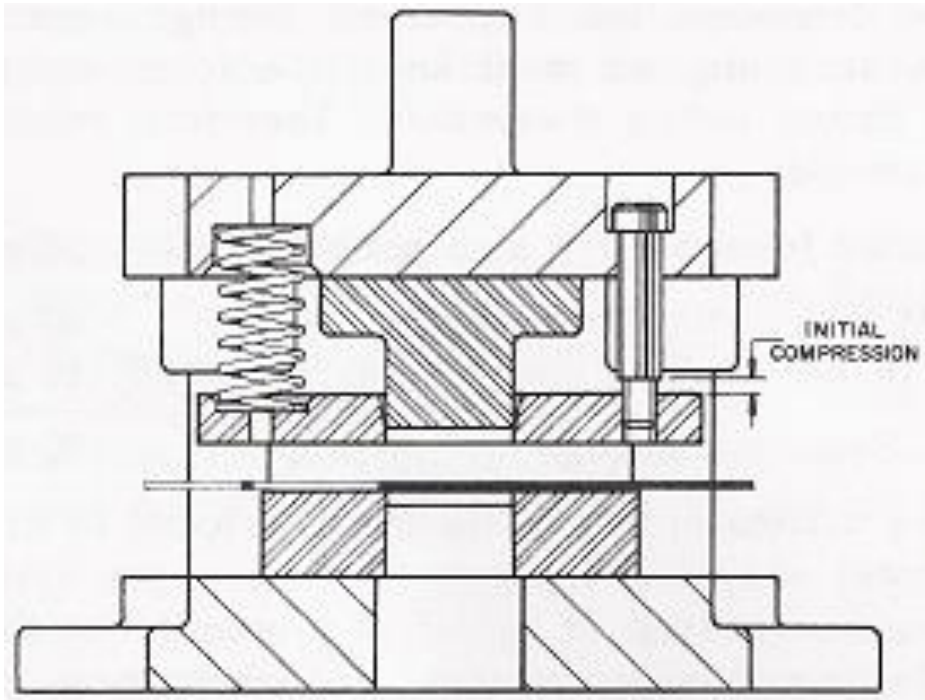
Stripper

- A plate designed to remove, or strip, sheet metal stock from the punching members during the withdrawal cycle. Strippers are also used to guide small precision punches in close-tolerance dies, to guide scrap away from dies, and to assist in the cutting action. Strippers are made in two types: fixed and movable.



fixed stripper





movable stripper (spring)

Die Set

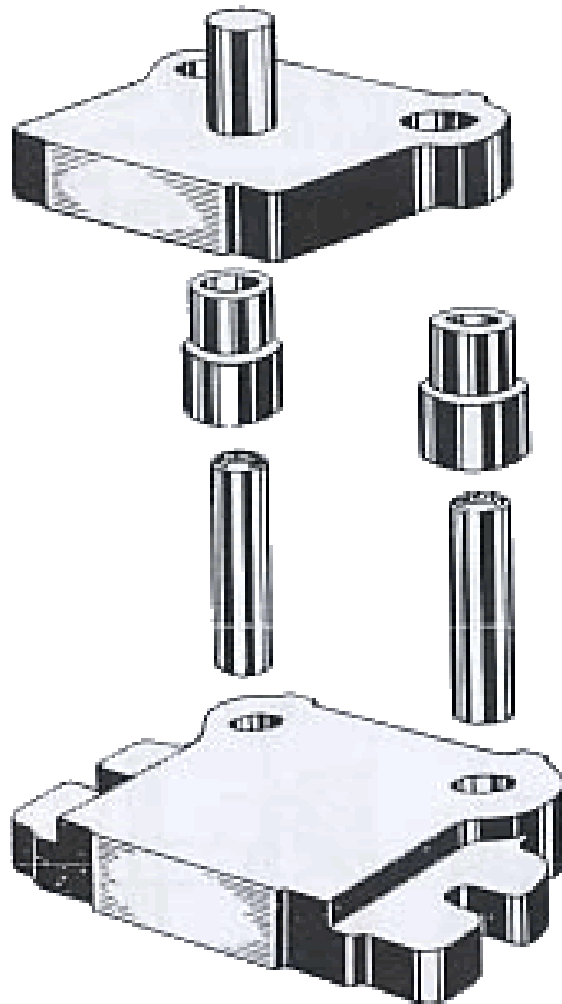
What is die set?

- The assembly of the upper and lower die shoes (punch and die holders), which usually includes the guide pins and guide pin bushings.
- This assembly, which takes many forms, shapes, and sizes, is frequently purchased as a commercial available unit.
- Standard die set

Die Set Material

- Typical material used in die set:
 - Semi-steel (7% of steel – cast iron)
 - Die holder may be broken in two because of the weakening effect
 - All steel
 - Steel die set are thoroughly stress-relieved by manufacturers before final machining
 - Welding anything to a die must be avoided
 - Combination steel
 - in which the punch holder is semi-steel and die holder is all steel.

Basic Components in Die Sets



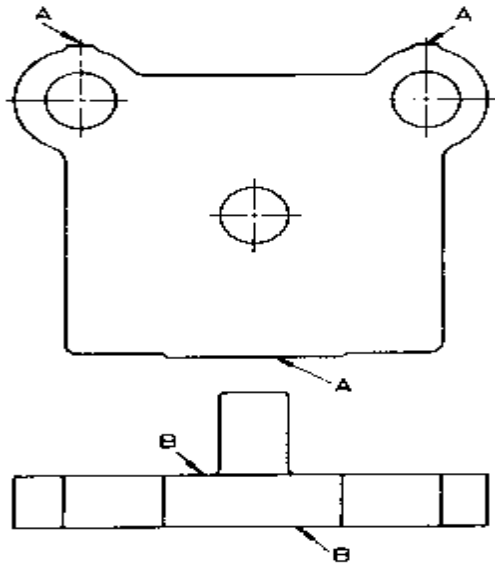
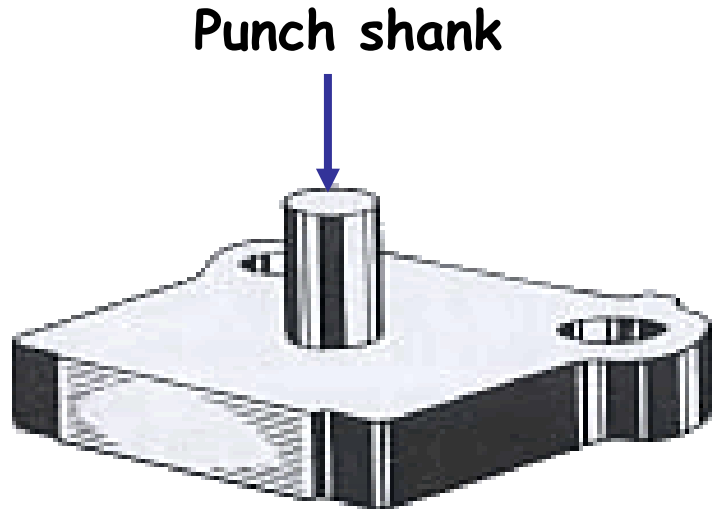
Punch holder

Guide bushings

Guide posts

Die holder

Punch holder



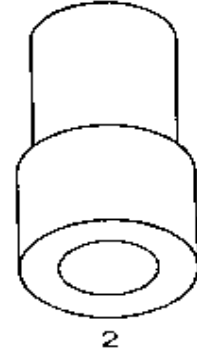
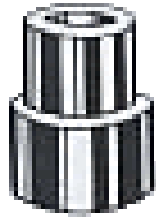
- Upper working member of die set.
- Employed by the die maker for squaring and locating punch components of the die.
- Upper surface bears against the underside of the press arm.
- Punch component are fastened to the lower surface.
- Punch shank clamped securely in the press ram and it drives the punch portion of the die, raising and lowering it for performing cutting and other operations.

Punch holder

Punch shank

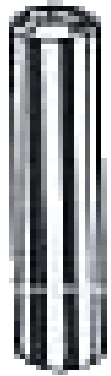
- Shank may be attached to, or made as an integral part of, the punch holder.
- They are available in integral cast, welded, or inserted (screw in).
 - Cast-iron: cast integrally
 - Steel: electrically welded and then machined
- Align the center of the die with centerline of the press.
- An example of the latter type is shown in figure.

Guide bushing



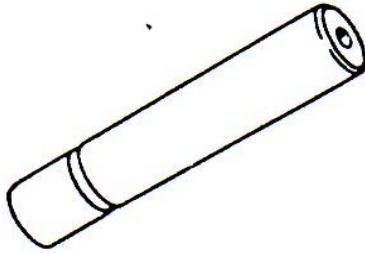
- Engage guide posts for aligning the punch holder with the die holder
- Two types
 1. Plain bushing
 2. Shoulder bushing
- **Plain bushing**
 - Simple sleeves pressed into the punch holder.
- **Shoulder bushing**
 - Turned down at one end and they are pressed into the punch holder against the shoulder thus formed.
 - They are recommended for all dies which perform cutting operations.
- If bushings are sized for a press fit, the pin hole should be made oversize by approximately the amount press fit interference to allow for normal hole closure.
- A better method that provides ease of replacement is to make the bushing hole in the shoe a close slip fit and to retain the bushing with several toe clamps.

Guide posts

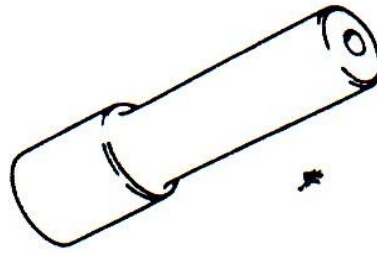


- Are precision-ground pins which are press-fitted into accurately bored holes in the die holder.
- They engage guide bushings to align punch and die components with a high degree of closeness and accuracy.

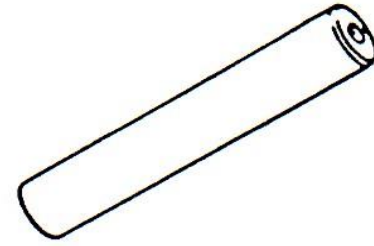
Guide posts



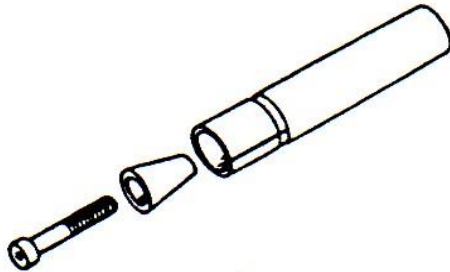
(A)



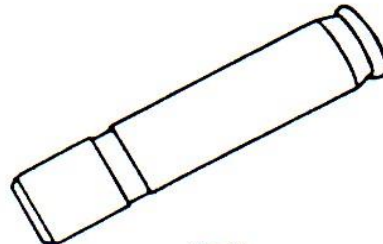
(B)



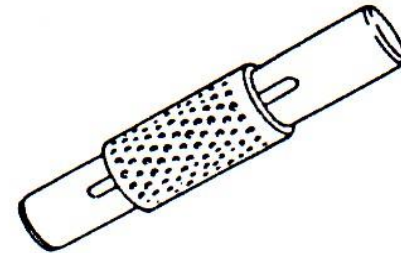
(C)



(D)



(E)



(F)

a. Regular

b. Shoulder

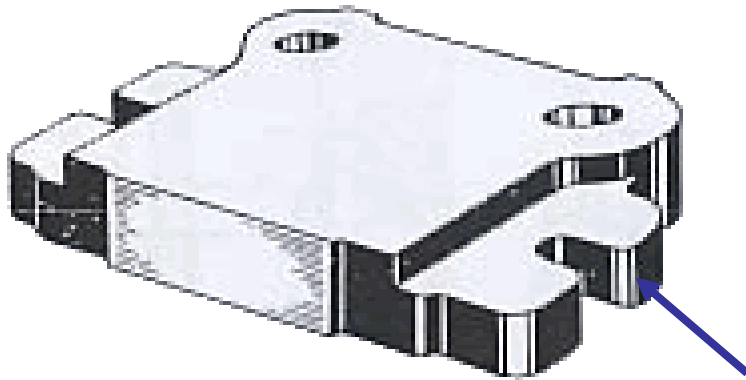
c. Commercial

d. Removable

e. Quick fit

f. Ball bearing

Die Holder

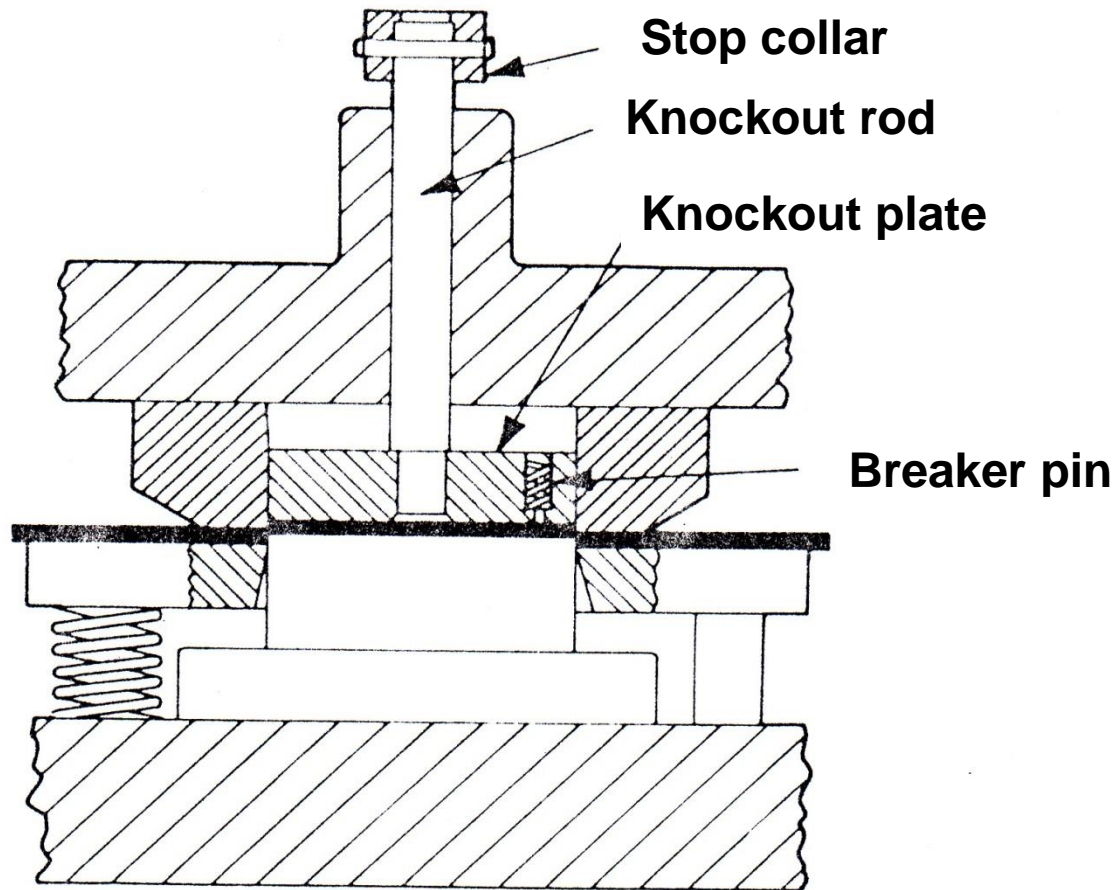


- Lower working member of the die set.
- To hold the die.
- Its shape corresponds with that of the punch holder except that it is provided with clamping flanges punch holder having slots for bolting the die holder to the bolster plate of the press.

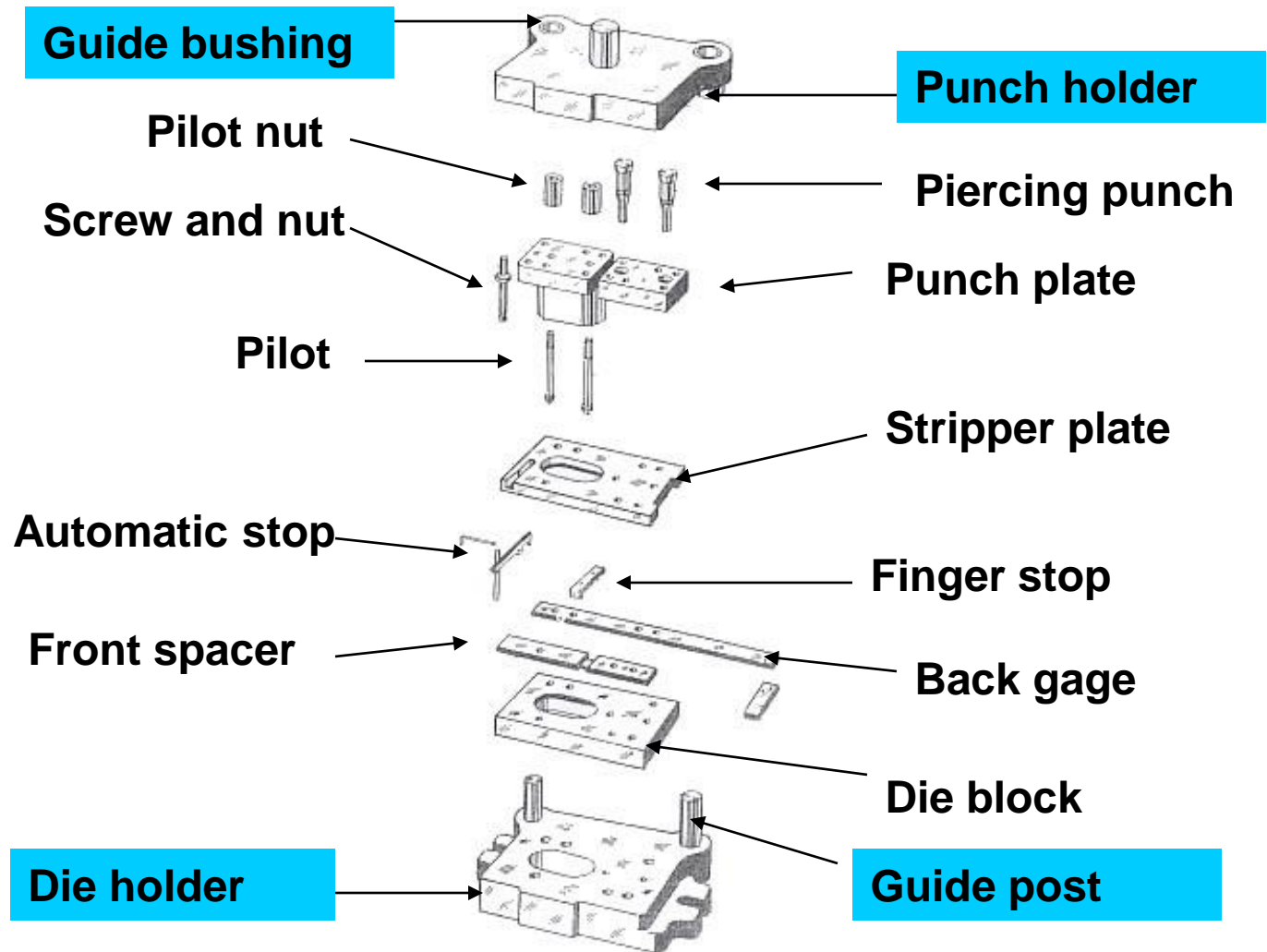
Other components

- Stripper
 - Fixed type
 - Movable type (with pressure from air, nitrogen, or springs)
- Knockouts
 - Usually push or lift parts from die cavities.
 - A knockout rod forces the knockout plate to strip the part from the die.
- Stops
 - Used only for starting stock through a progressive die.

Other components

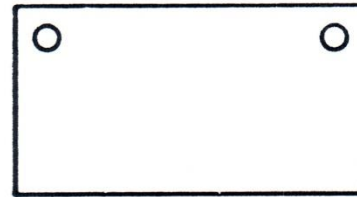


Example: Die for Blanking

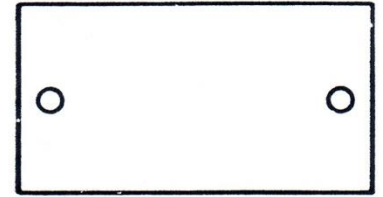


Post arrangement

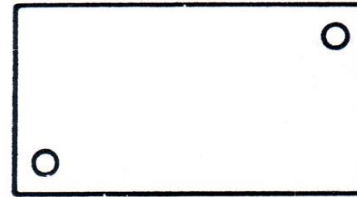
- A. Back (2) - post
- B. Center (2) - post
- C. Diagonal (2) - post
- D. Rectangular (4) - post
- E. Front-back (2) - post
- F. Three (3) - post



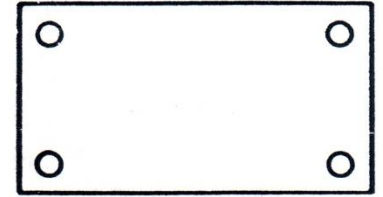
A



B

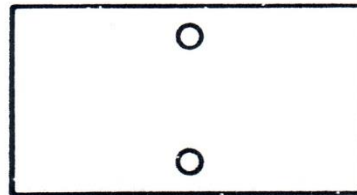


C

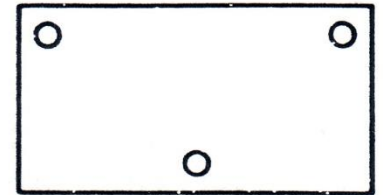


D

SPECIAL



E



F

How to select a die set?

1. Make or manufacturer
2. Type
3. Size
4. Material
5. Thickness of punch holder
6. Thickness of die holder
7. Shank diameter
8. Type and length of bushings
9. Lengths of guide posts

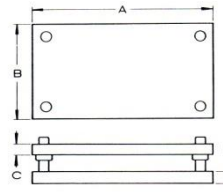
Selecting

**Consider dimensions from front to
post and side to side**

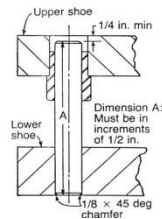


Die-set area or usable area

Thickness of the die holder and punch holder

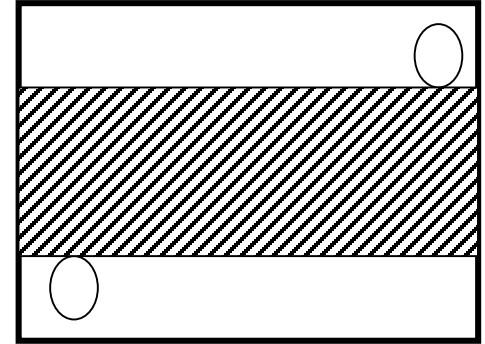
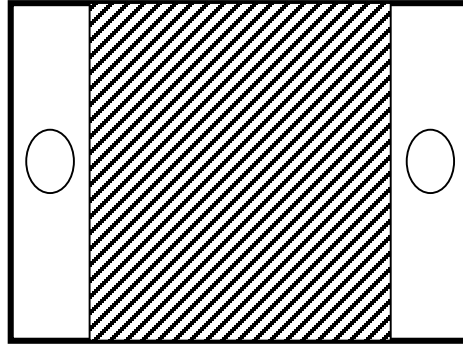
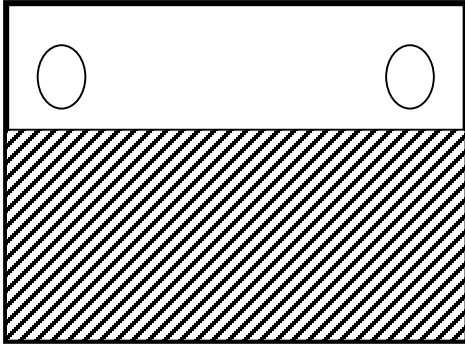


Length of the guide post and bushing

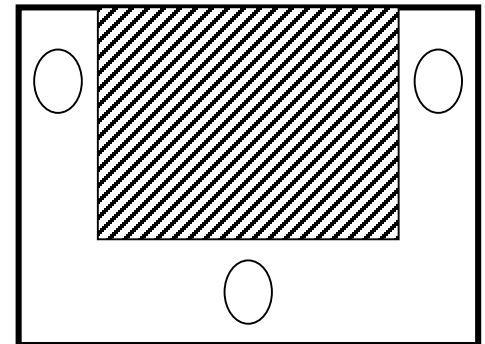
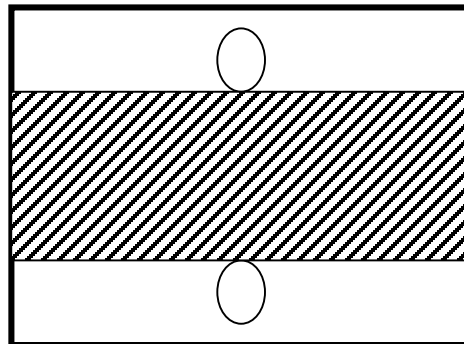
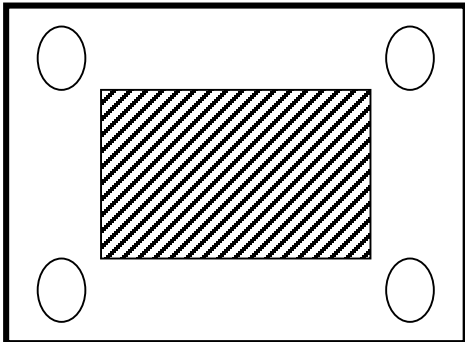


Select die set from catalog

Working area



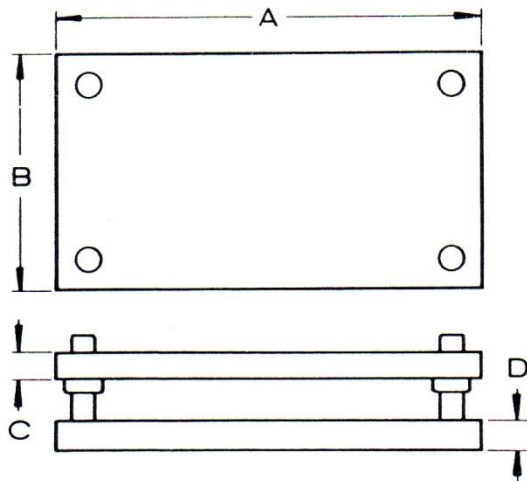
Working area



Thickness of Die Holder & Punch Holder

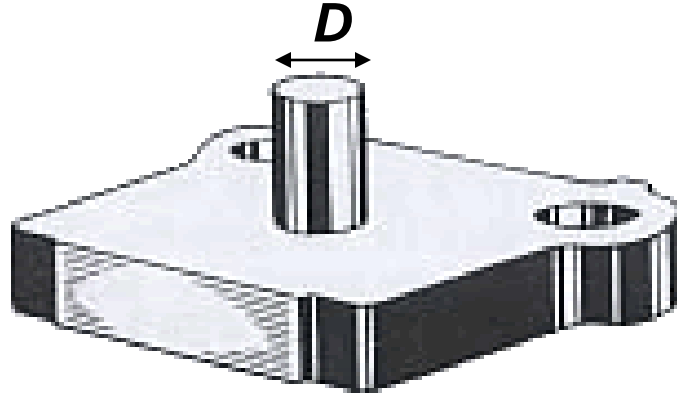
- Die holder is made thicker than punch holder to compensate for the weakening effect of slug and blank holes which much machined through it.
- For different size of dies, the thickness for die holder and punch holder are different.
- Common proportions
 - ~ Small and medium-size dies
 - ✓ Punch holder thickness – 1 $\frac{1}{4}$ inches
 - ✓ Die holder thickness – 1 $\frac{1}{2}$ inches

Recommended Thickness



DIE SPACE		PUNCH HOLDER THICKNESS	DIE HOLDER THICKNESS
A	B	C	D
15	10	1 ¼	1 ½
30	20	1 ¾	2
45	30	2	2 ¼
60	40	2 ½	3
75	50	3	3 ½
90	60	3 ½	4
105	70	4	4 ½
120	80	4 ½	5
135	90	5	5 ½
150	100	5 ½	6

Shank diameter



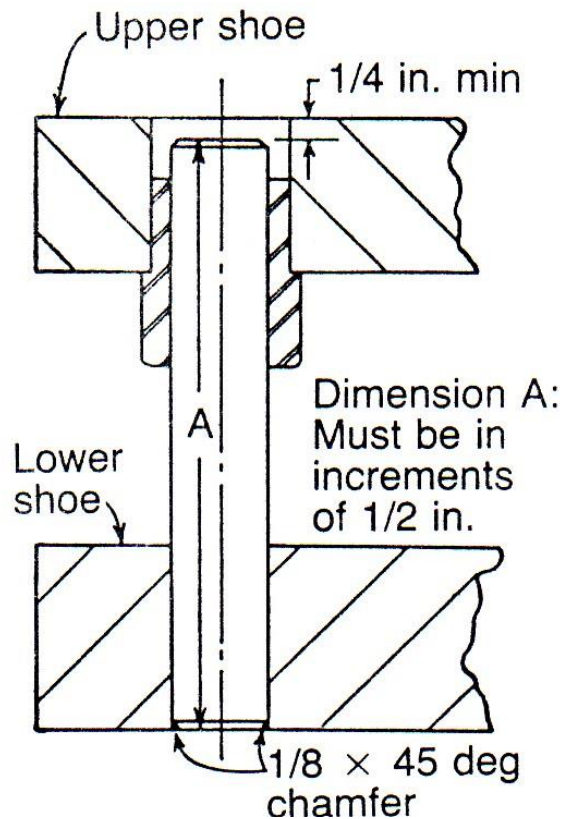
- Shank diameter depends upon the press selected.
- It is usually determined from a company standards book and it should be checked carefully for accuracy.
- After the diameter is known, the length can be found listed in a die-set catalog.

Length of guide post

Six types:

- Small guide posts are usually hardened and centerless ground, particularly for the commercial die-set grades
- Larger diameter posts are ground between centers after hardening
- Posts may be relieved at what will be the die set surface. This relief is usually applied to precision posts
- A non-sticking post end may be incorporated. This provides for quick and easy assembly and disassembly.
- Shoulder guide posts are employed in conjunction with shoulder guide-post bushings. The large shoulder is the same diameter as the press-fit portion of the guide bushings.
- Removable guide posts can be easily removed from the die for sharpening. They are employed for large dies and for dies having more than two posts.
- For secondary-operation dies, guide posts should have sufficient length so that they never leave their bushings in operation.

Length of guide posts



- Diameter depend on the size of the die set.
- Must not extend beyond the top surface of the punch holder when the die in closed position to avoid striking the press ram.
- Guide posts are specified at least $\frac{1}{4}$ inch shorter than the shut height of the die as listed on the drawing.

Length of guide bush

- The longer the bushing -- more accurate the alignment of punch and die members
- The length selected will depend upon the accuracy requirements of the die.
- This is important in cutting operations, especially for thin stock when clearances between cutting edges are small.
- Lengths for plain bushings:
 1. Regular
 2. Long
- Shoulder bushings are furnished in three lengths:
 1. Regular
 2. Long
 3. Extra long

Design of Press Working Tools

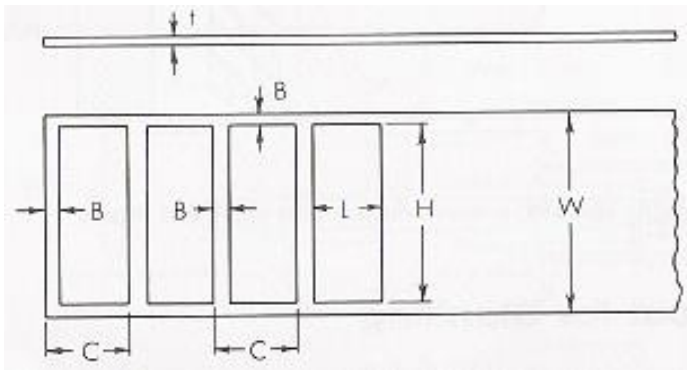
C. NANDA KUMAR

ASSISTANT PROFESSOR

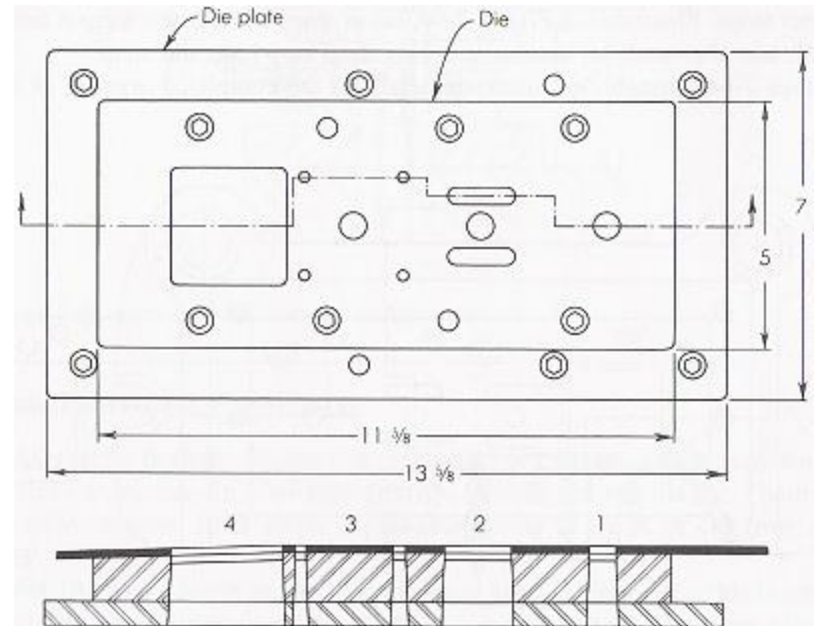
DEPT. OF PRODUCTION TECHNOLOGY

MIT CAMPUS

ANNA UNIVERSITY CHENNSI



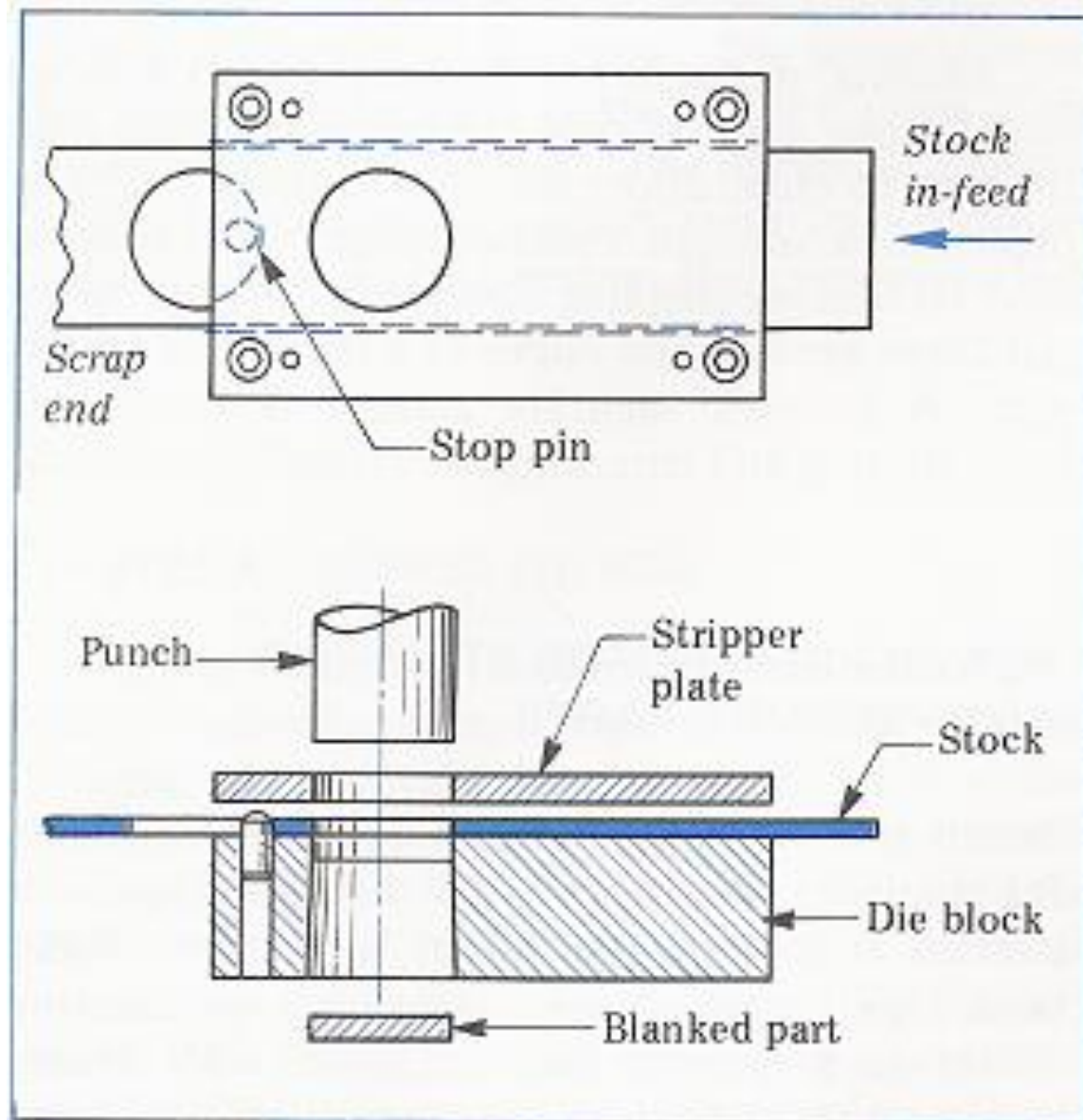
Design of Press Working Tools



Contents

- Blanking Die
- Strip Layout
- Forming Die
- Bending Die
- Drawing Die
- Progressive Die

Blanking Die



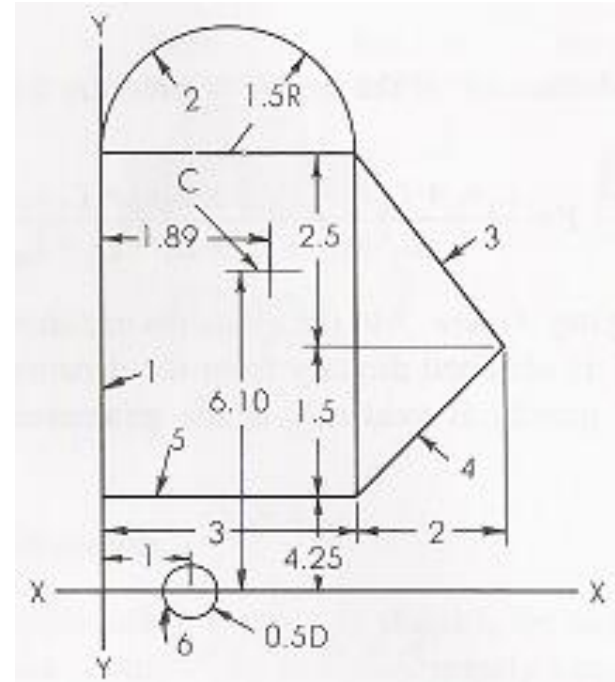
Center of Pressure

- Draw outline
- Draw X-X and Y-Y axis
- Divide cutting edge into line elements
- Find length of each elements
- Find center of gravity of each element
- Find distance (x) of center gravity of each element from axis Y-Y
- Find distance (y) of center gravity of each element from axis X-X
- Calculate the distance X of the center of pressure from axis Y-Y by

$$X = \frac{L_i x_i}{L_i}$$

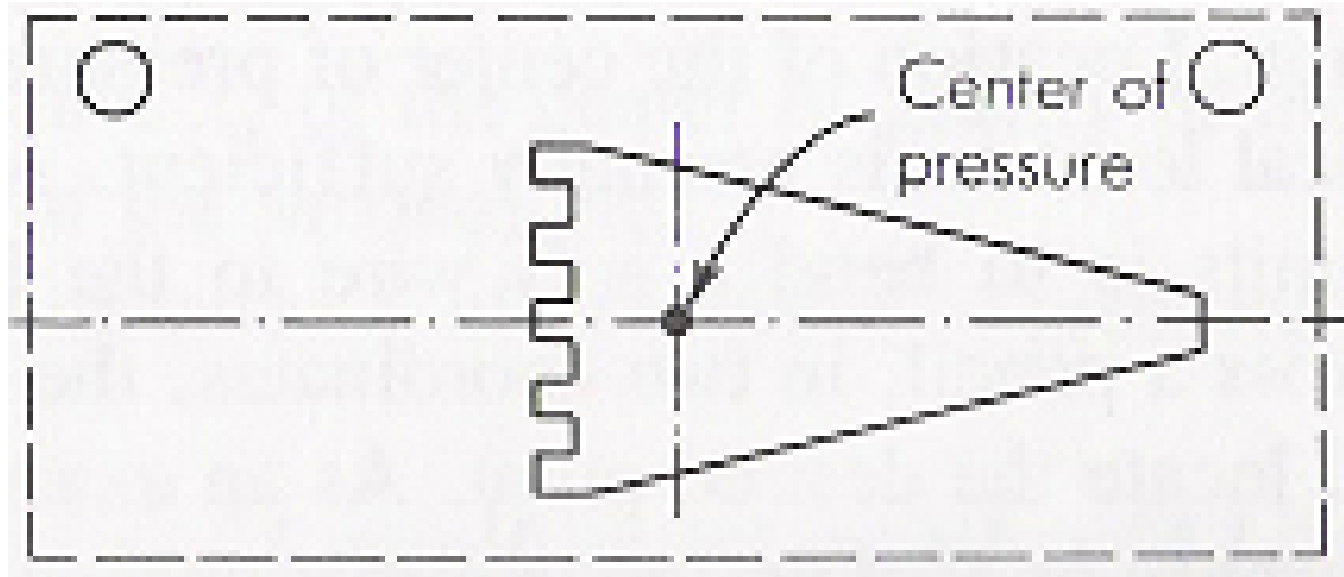
- Calculate the distance Y of the center of pressure from axis X-X by

$$Y = \frac{L_i y_i}{L_i}$$



Center of Pressure

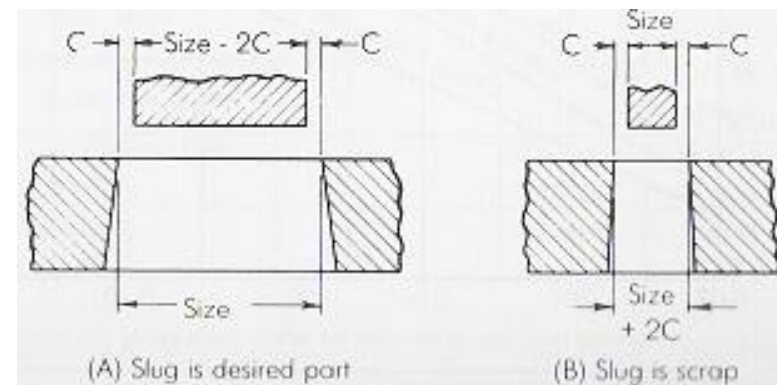
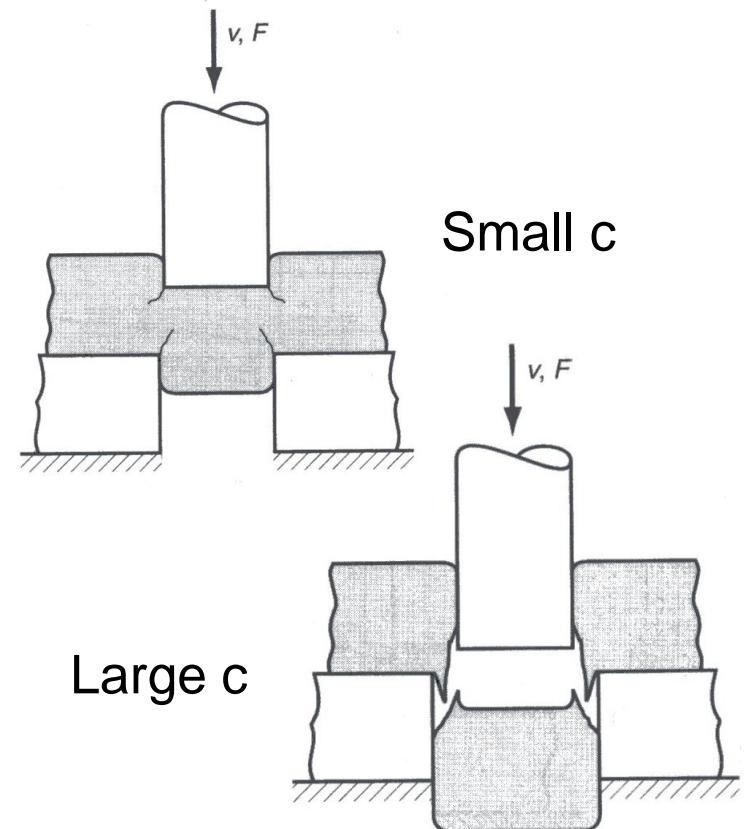
- Effect of center of pressure location on tool design



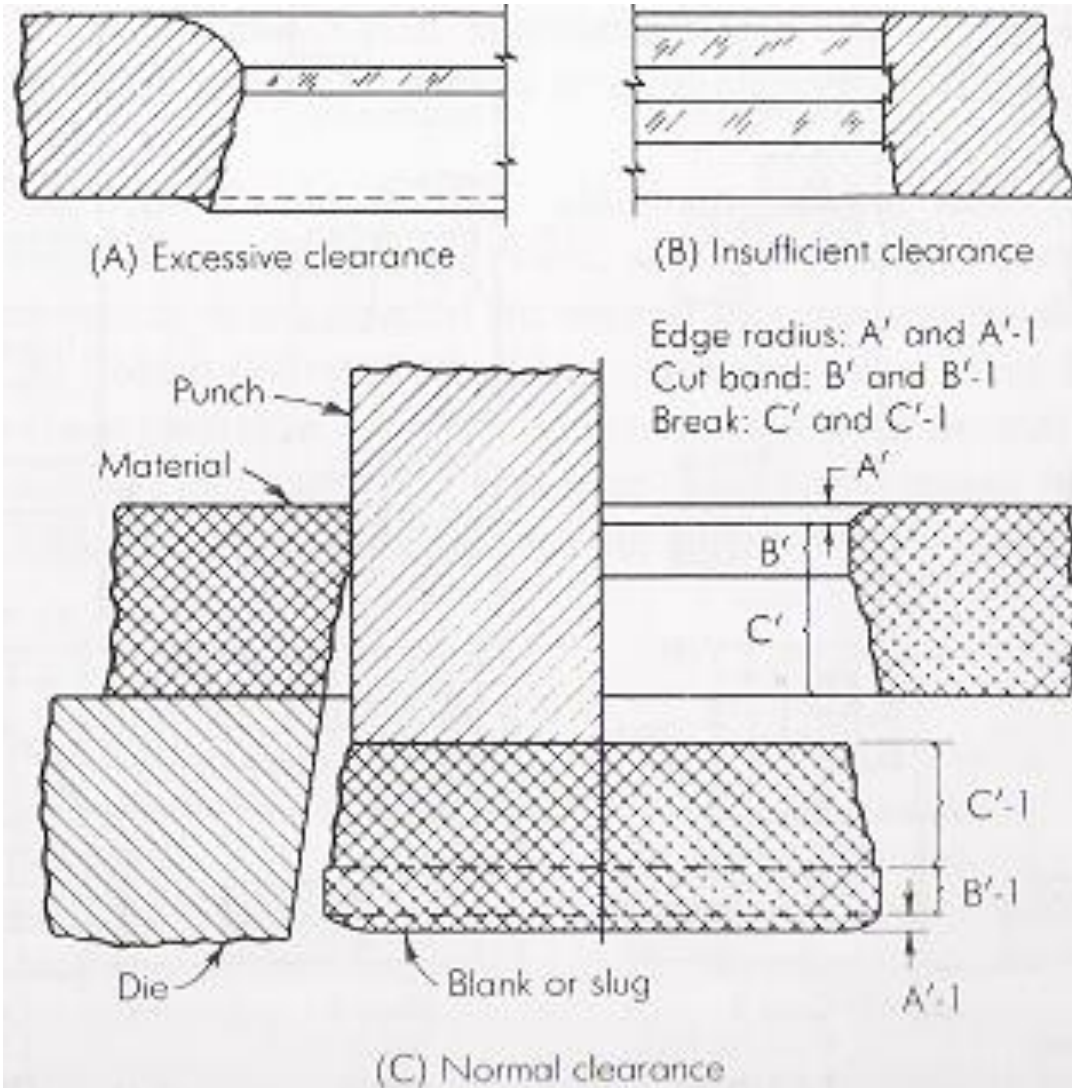
Clearance

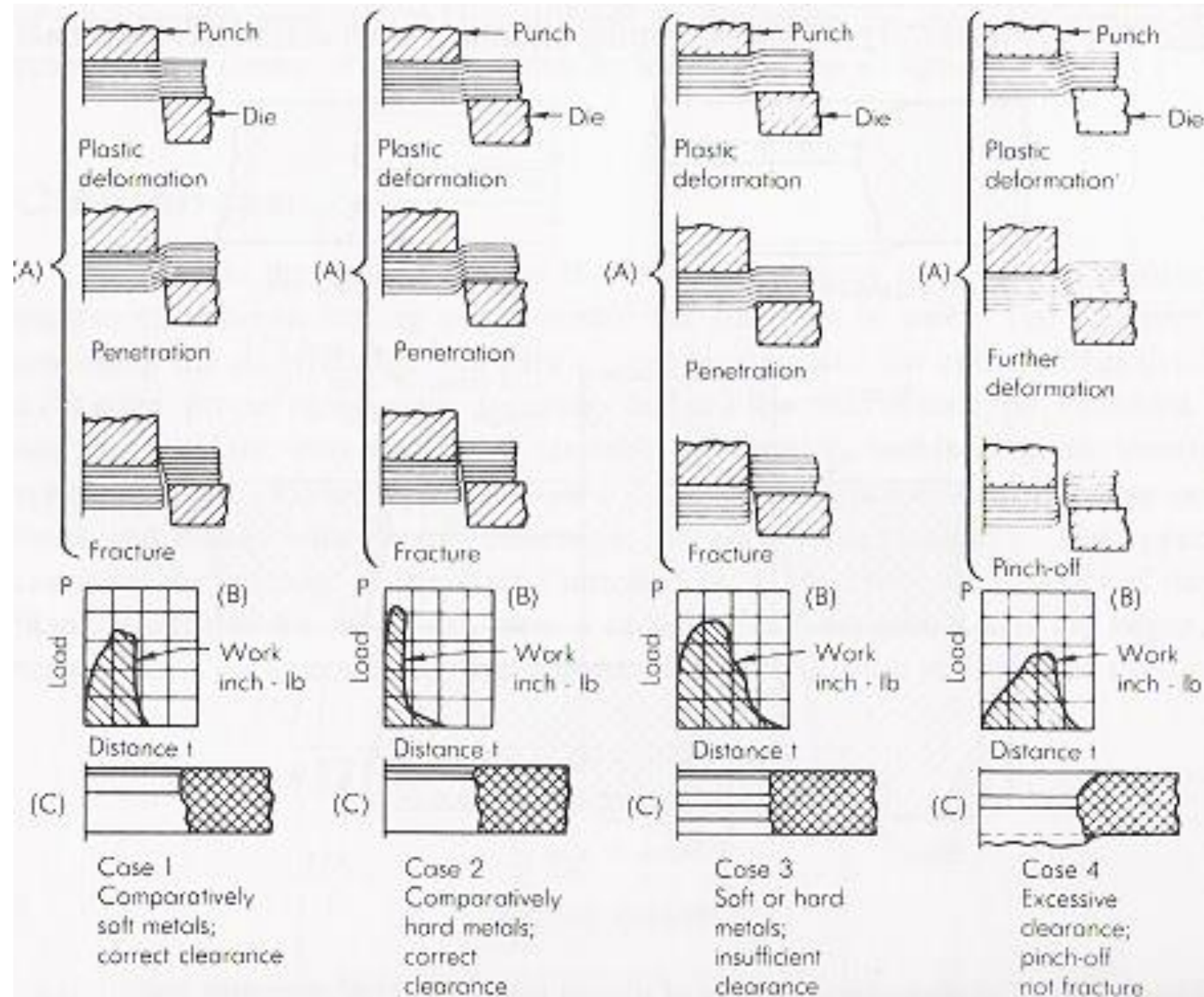
- Clearance (c):
 - Distance between punch and die
 - Clearances range from 4 to 8 % of the sheet metal thickness t
 - If c is too small, the fracture lines tend to pass each other, causing less than optimal fracture and excessive cutting forces
 - A large c causes an oversized burr
 - Recommended clearance can be calculate using:

$$c = at, \text{ where}$$
 $c = \text{clearance,}$
 $a = \text{allowance (determined according to type of metal) and}$
 $t = \text{stock thickness}$



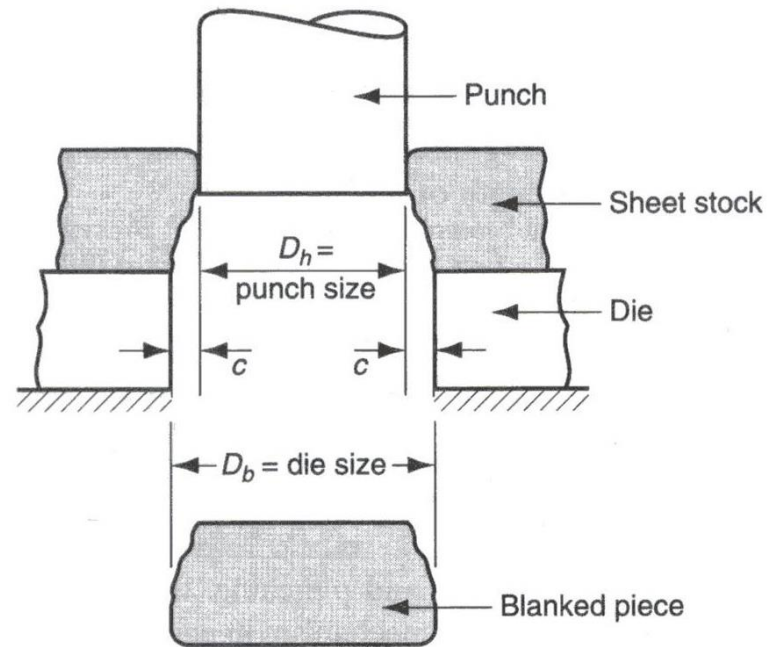
Excessive vs. Insufficient vs. Normal Clearance



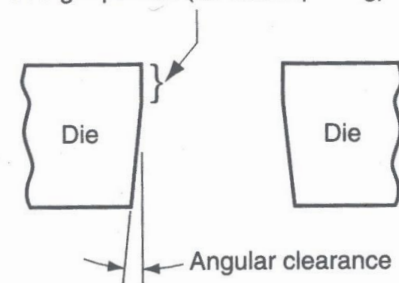


Punch and Die Sizes

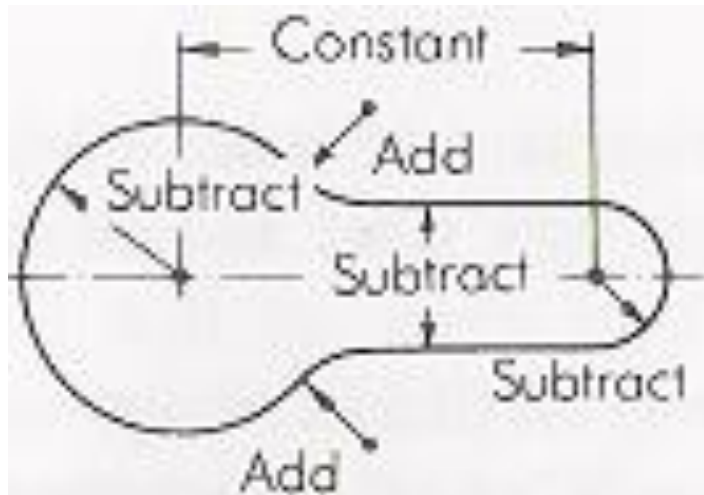
- Clearance values can be used to determine punch and die sizes for blanking and punching operations
- The punch and die sizes for a round Blank of diameter D_b
Blanking punch diameter = $D_b - 2c$
Blanking die diameter = D_b
- The punch and die sizes for a round Hole of diameter D_h
Hole punch diameter = D_h
Hole die diameter = $D_h + 2c$
- For the slug or blank to drop through the die, the die opening must have an angular clearance of 0.25° to 1.5°



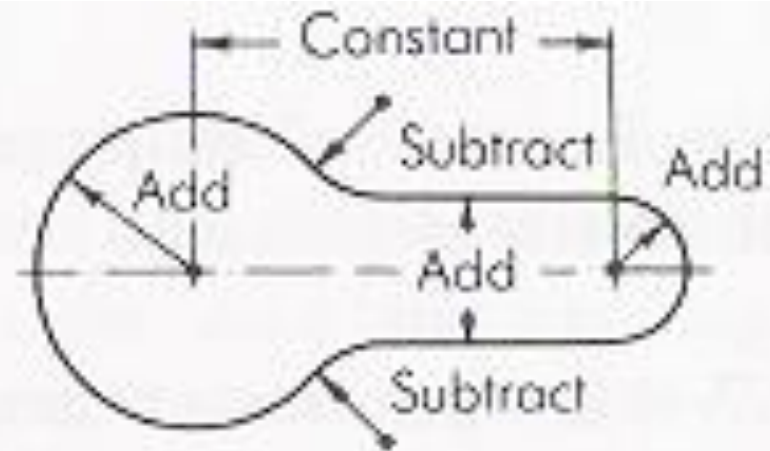
Straight portion (for resharpening)



Punch and Die Sizes – hole of irregular shape



(A) Clearance applied to punch



(B) Clearance applied to die

Cutting Forces

- Cutting force determines the size (tonnage) of the press needed

$$F = S t L$$

where

S = shear strength of the sheet metal (MPa or PSI);

t = stock thickness and

L = length of the cut edge.

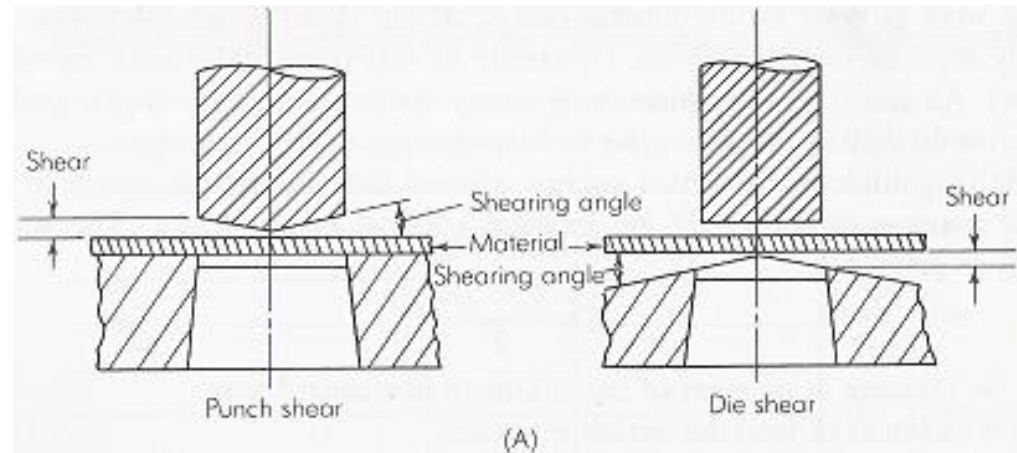
- In blanking and punching operations, **L** is the perimeter length of the blank or the hole being cut. The minor effect of clearance on the value of **L** can be neglected
- If the shear strength is unknown:

$$F = 0.7 TS t L$$

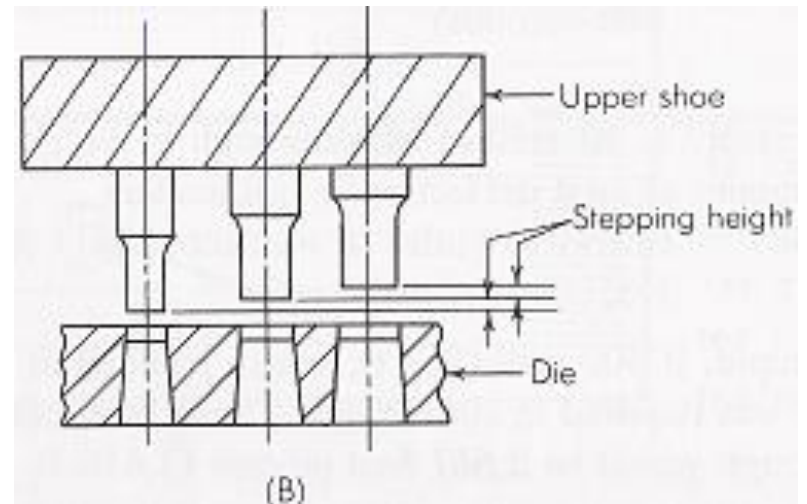
where **TS** is the ultimate tensile strength (MPa)

Reducing cutting force

- Adding shear to die or punch

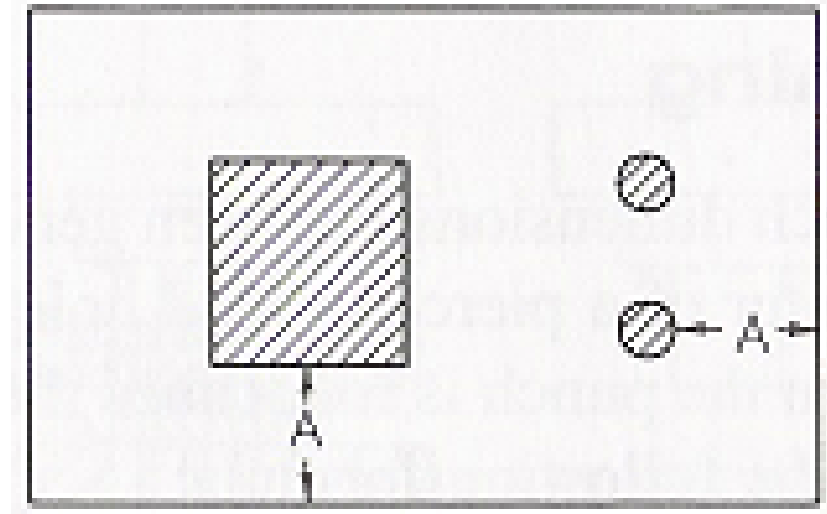


- Stepping punches

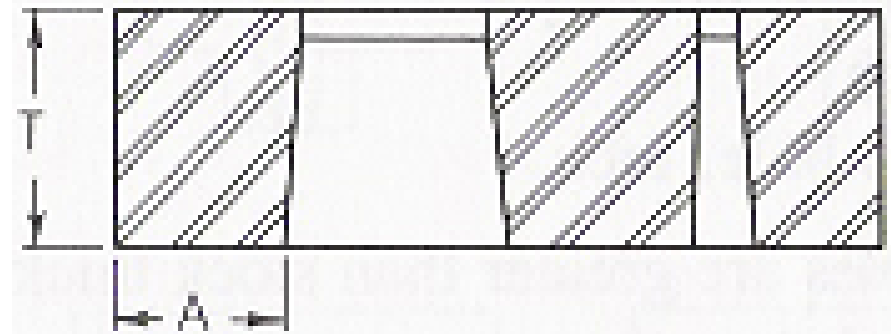


Die Block

- Distance **A** must not be less than 1.5 to 2 times die thickness



- Die block thickness, **T** governed by the strength necessary to resist the cutting force



Punch

- Punch diameter $\frac{4S_s t}{S_c d} = 1$

- Punch length
$$L = \frac{\pi d}{8} \frac{E}{S_s} \frac{d^{1/2}}{t}$$

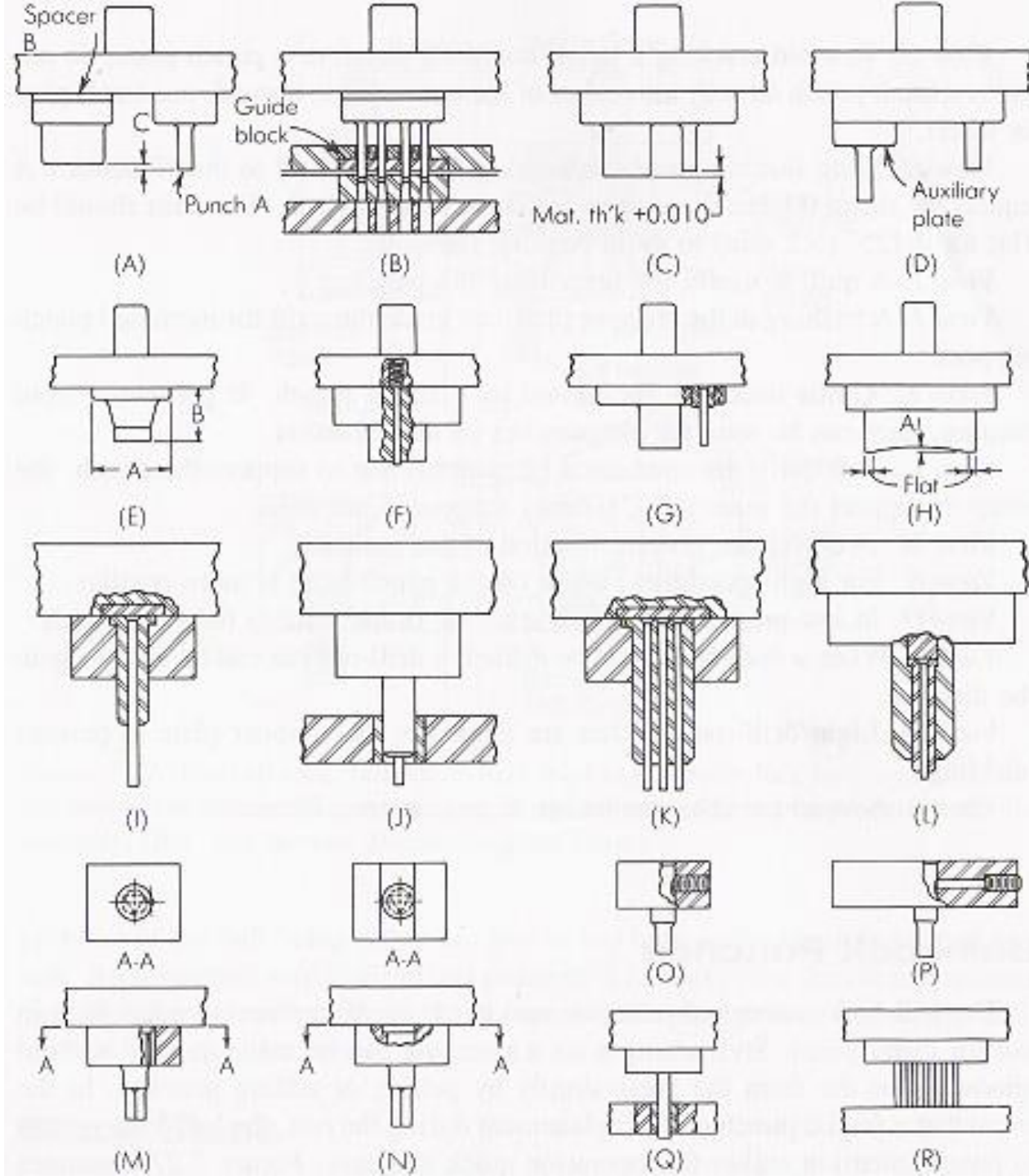
S_c = compressive stress, psi

S_s = shear stress, psi

t = stock thickness, inch

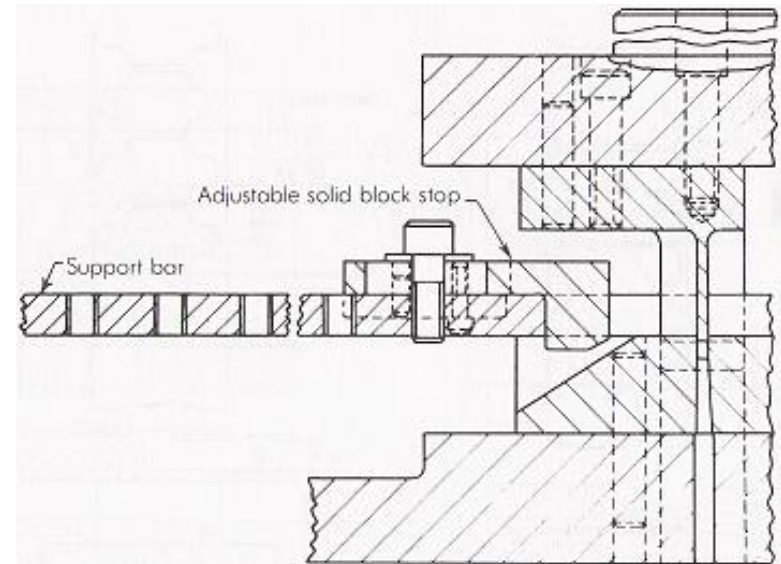
d = diameter of hole punch, inch

Method of Punch support

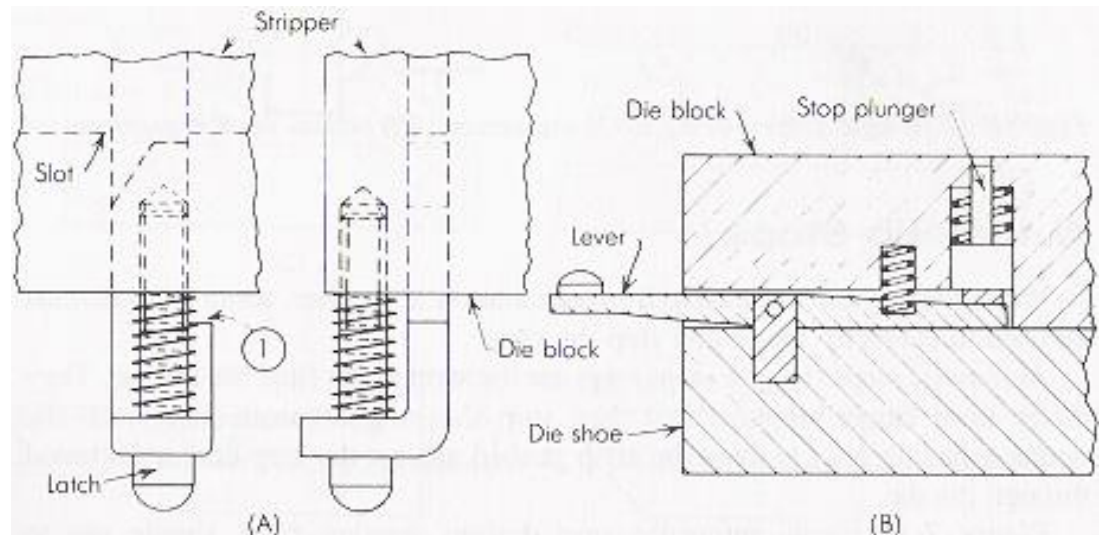


Stock Stops

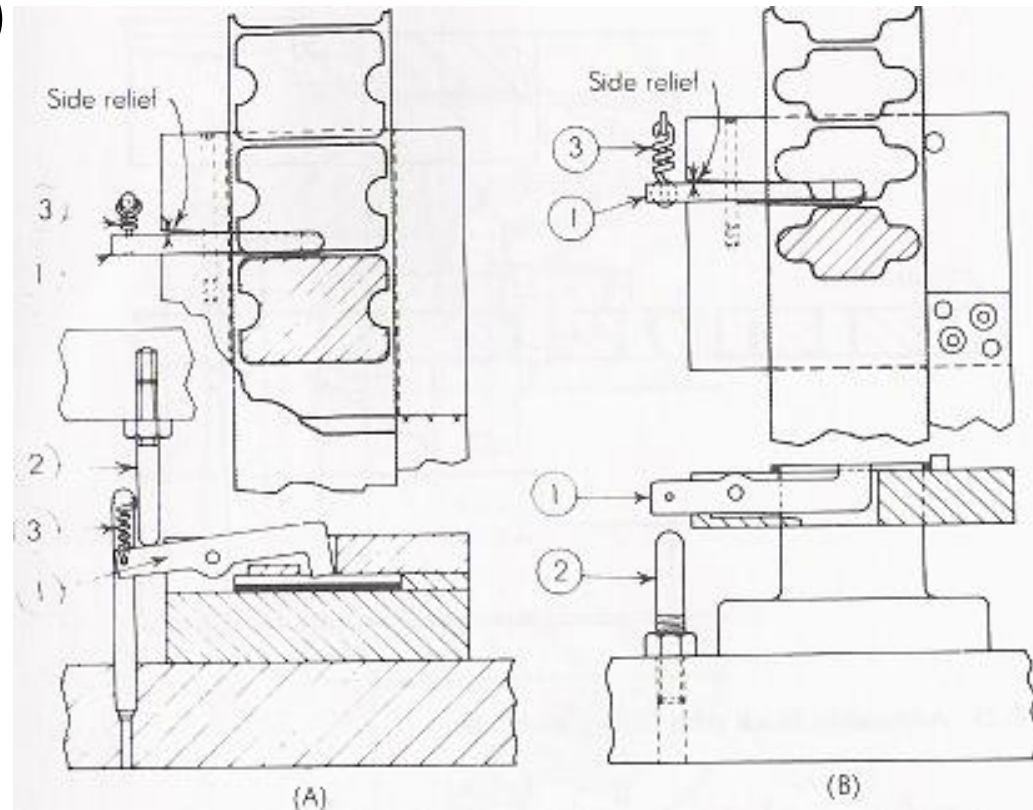
- Adjustable block stop



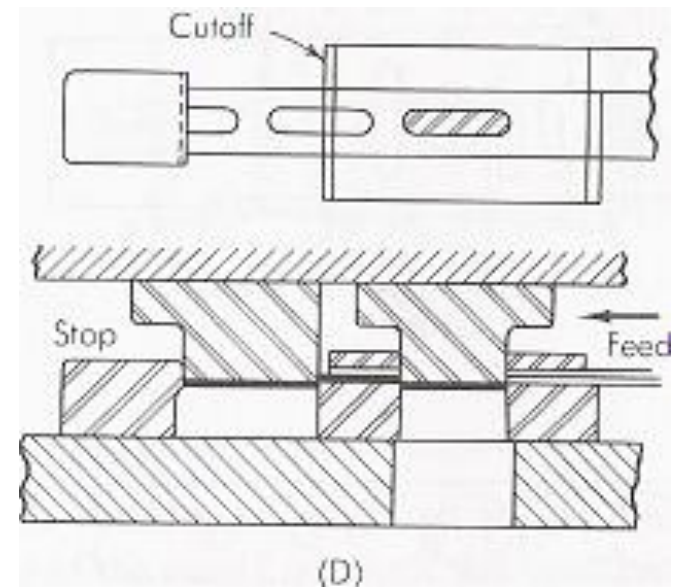
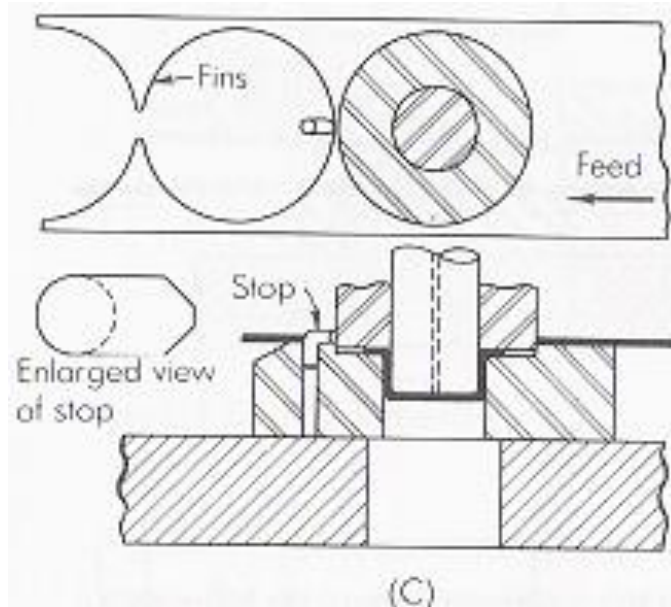
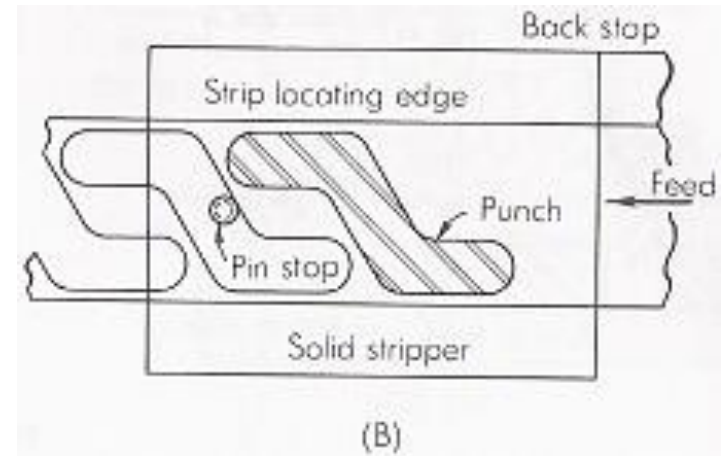
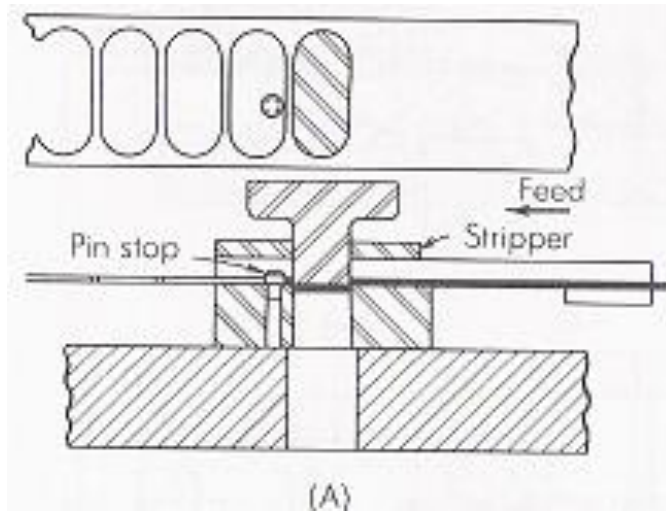
- Starting stops

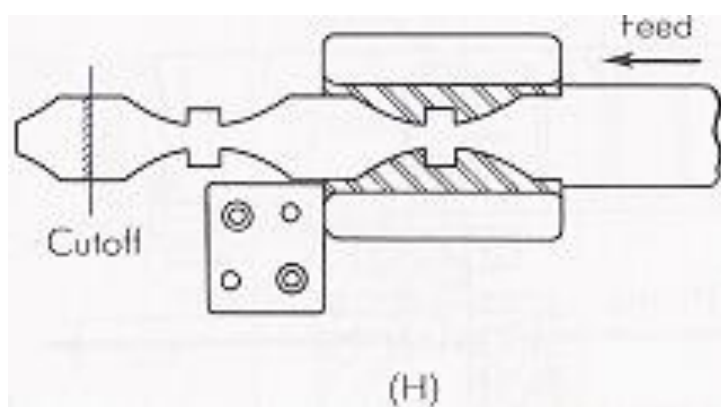
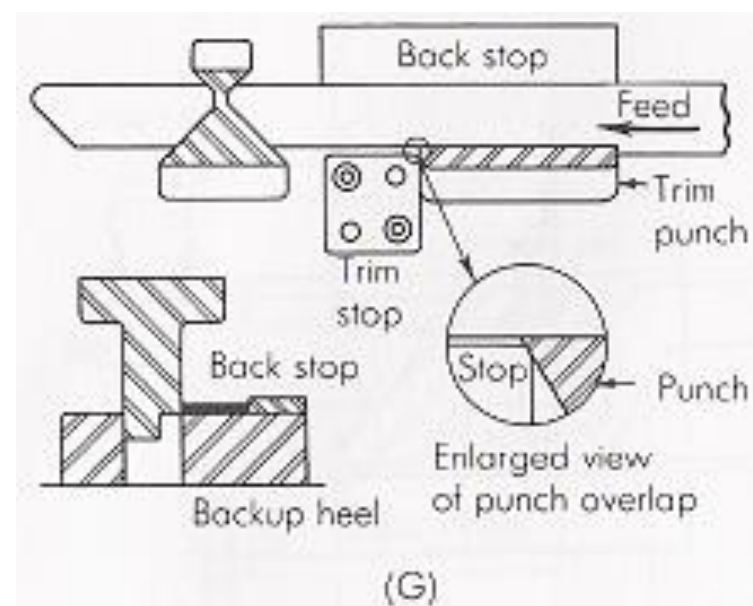
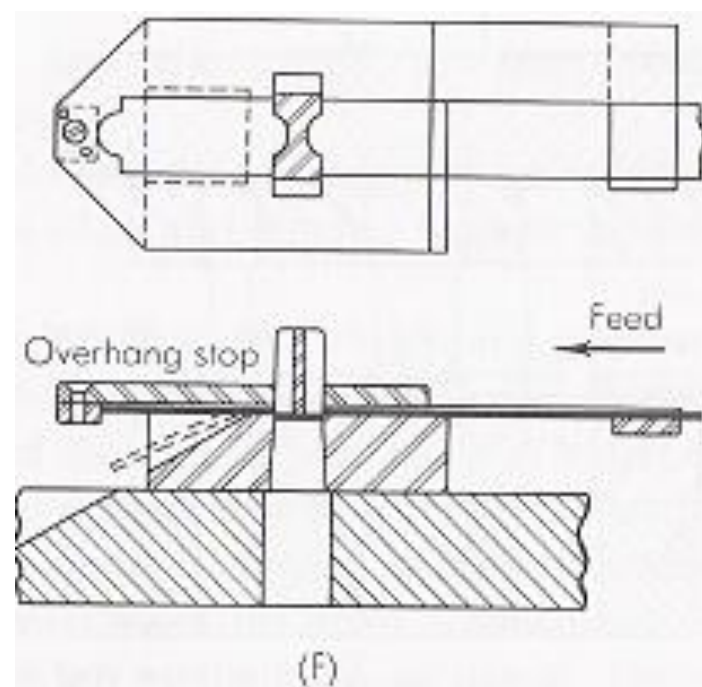
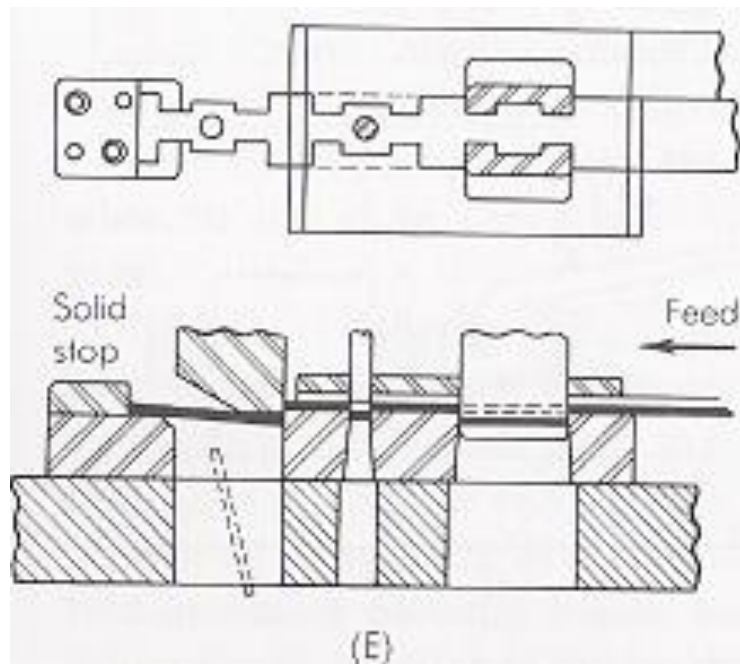


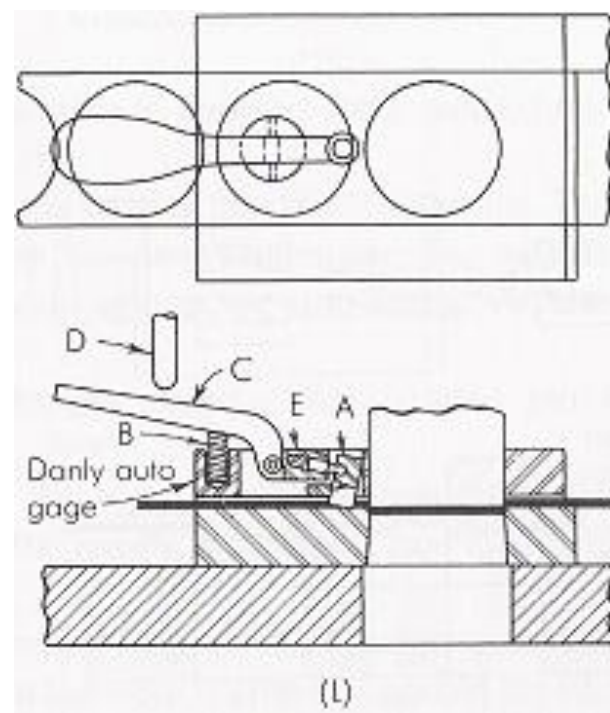
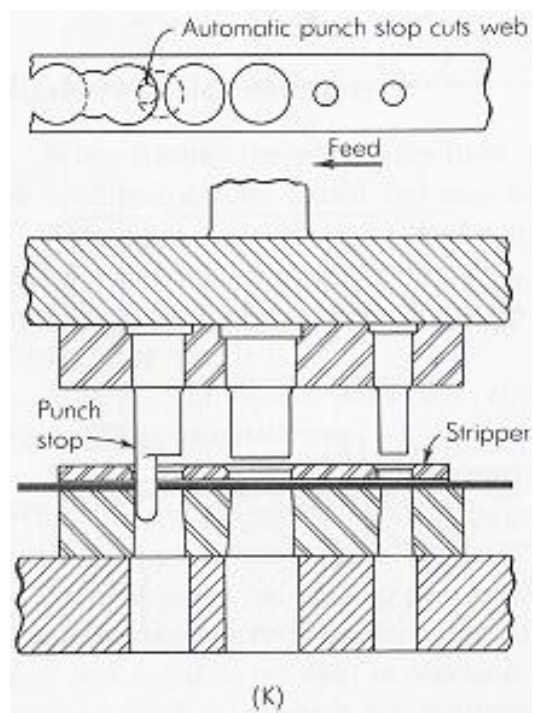
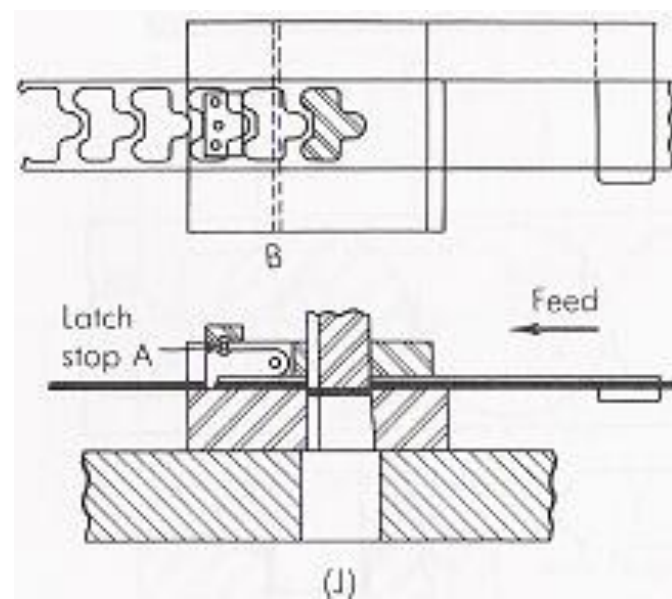
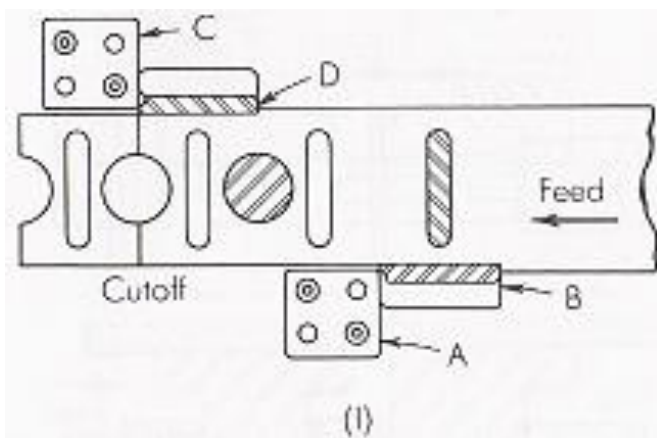
- Trigger stop: (A) top stop engagement; (B) bottom stock engagement

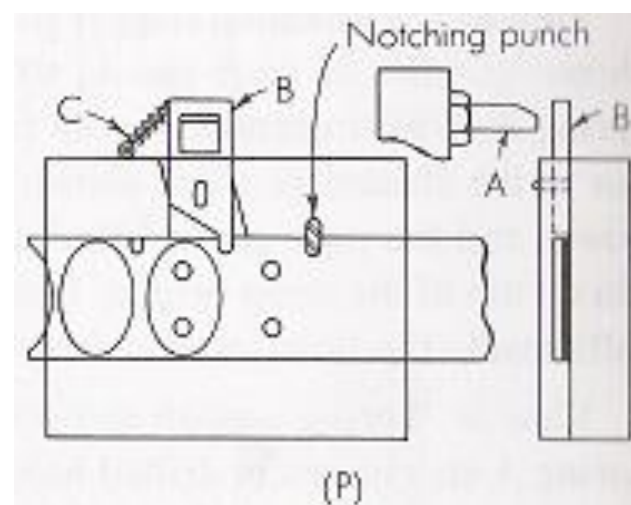
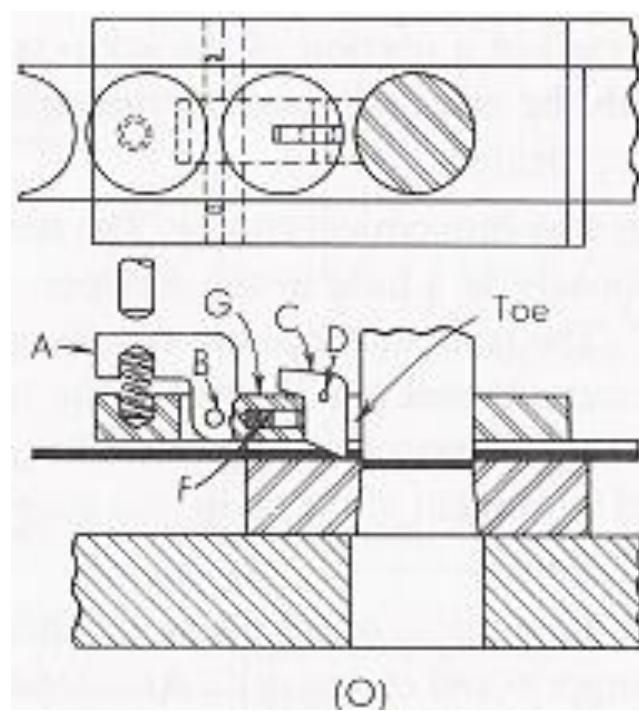
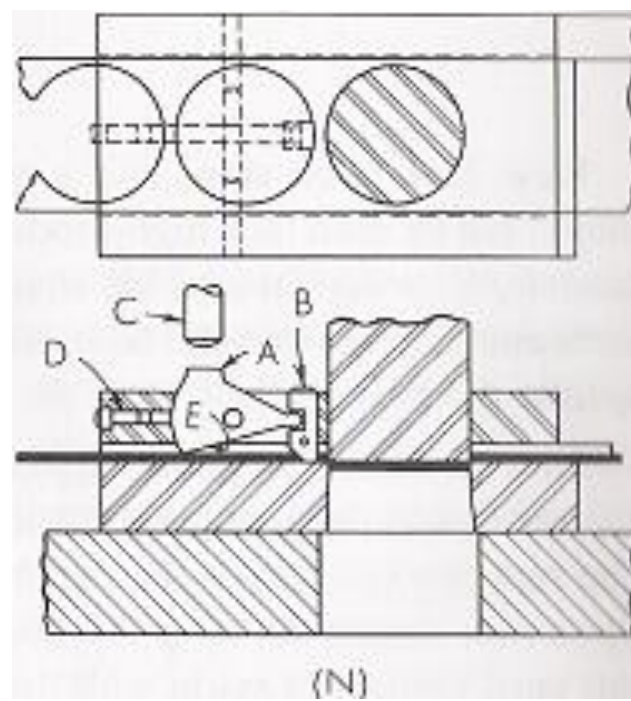
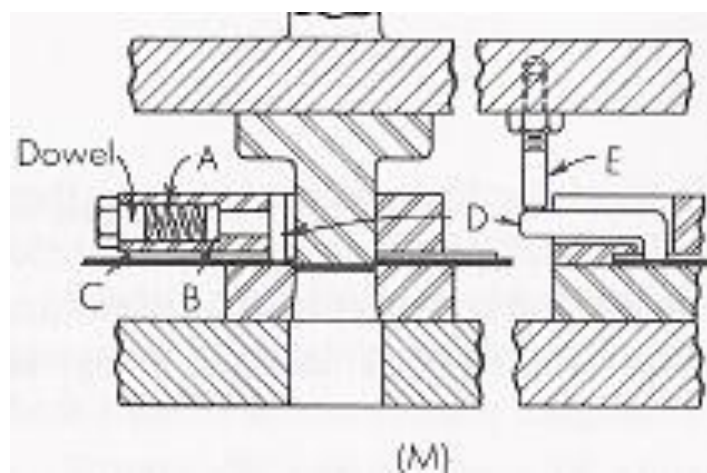


Automatic Stops

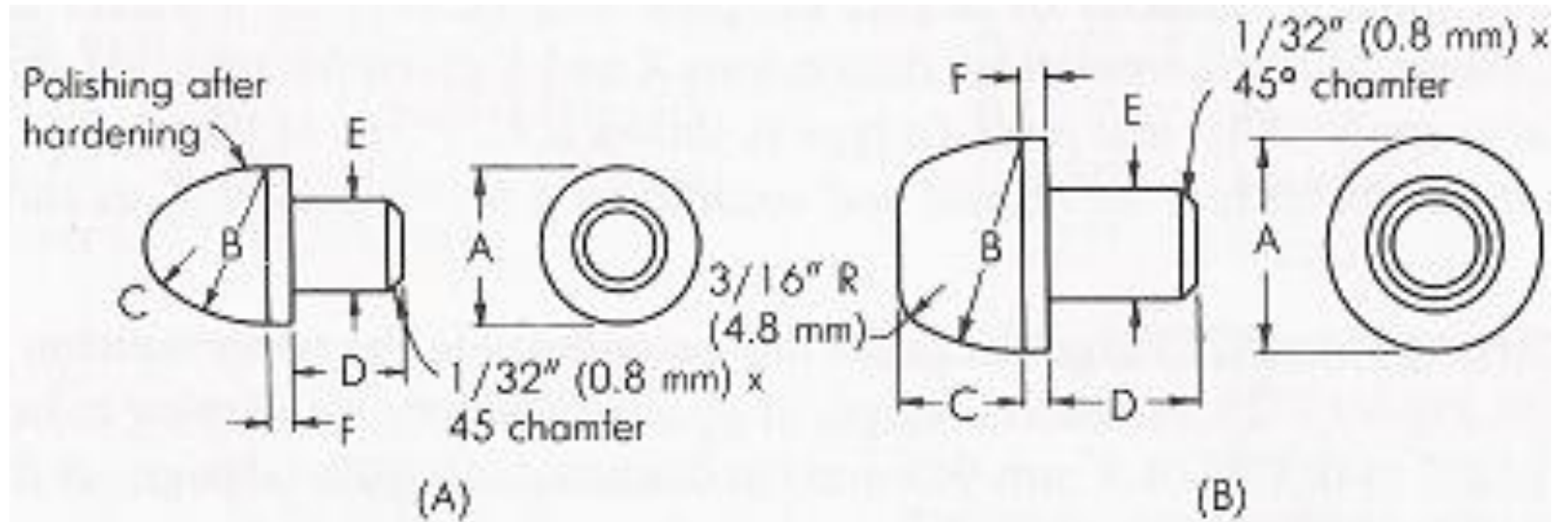




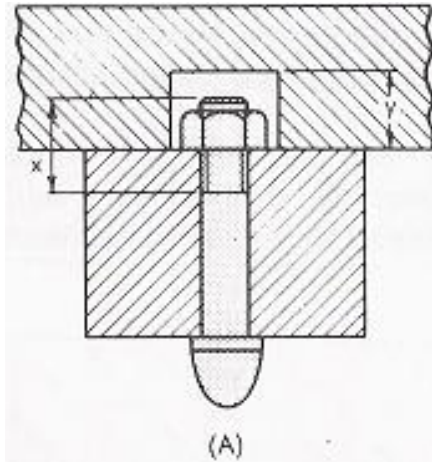




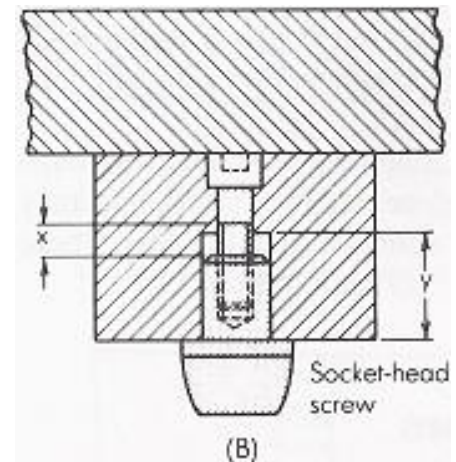
Pilots



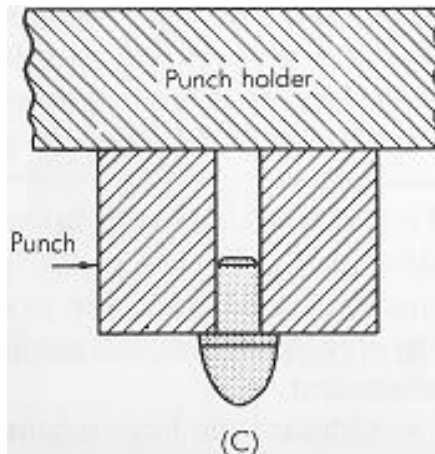
Pilots



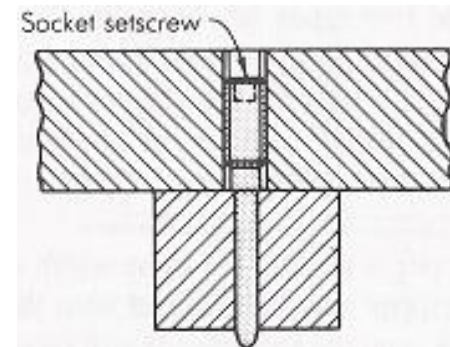
Threaded shank



Screw-retained

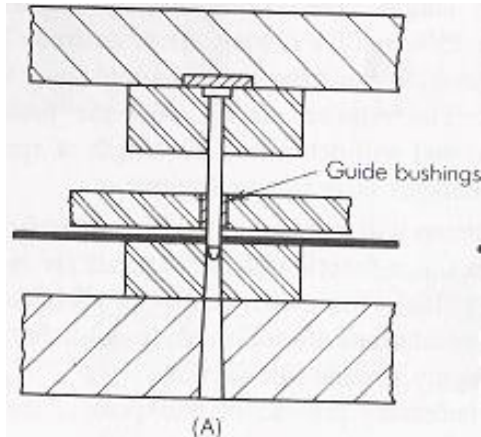


Press-fit

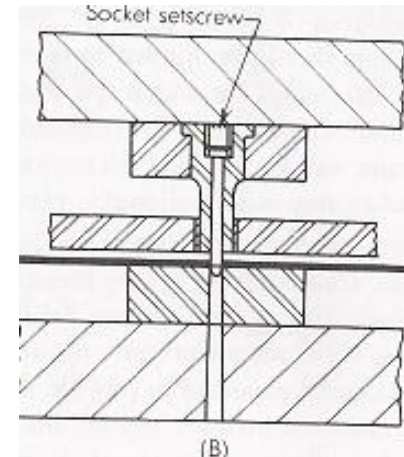


Socket setscrew

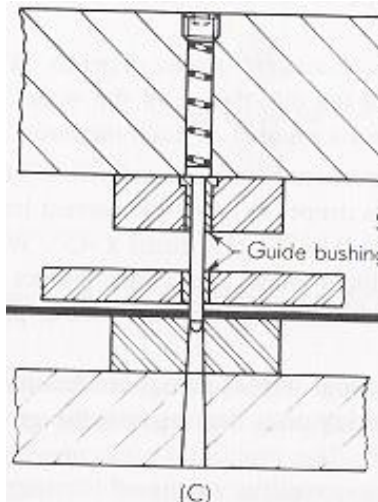
Indirect Pilots



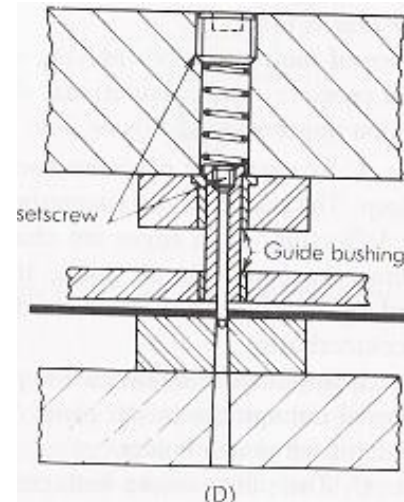
headed



quilled



Spring-backed

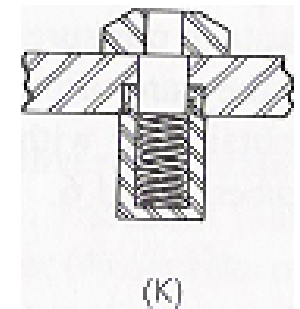
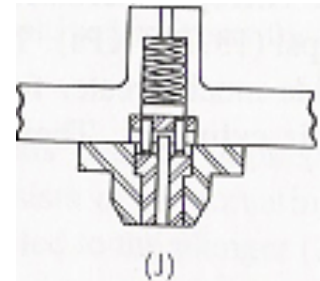
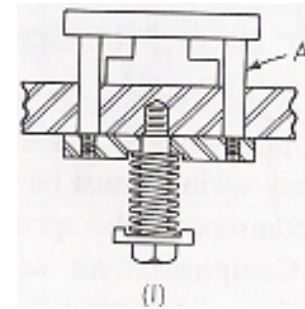
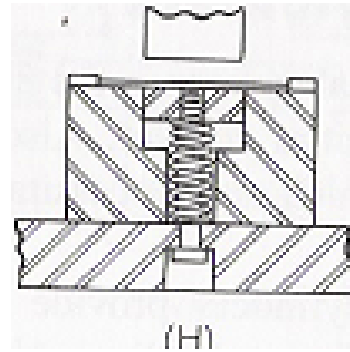
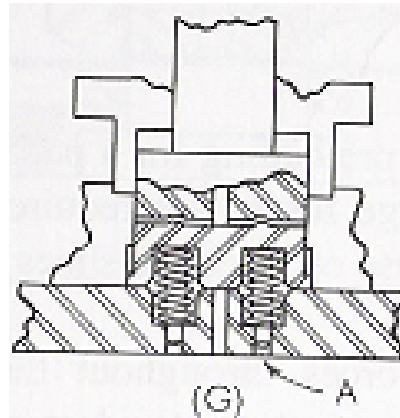
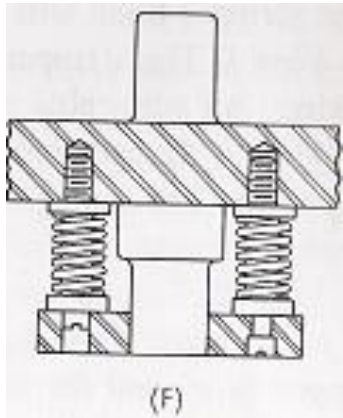
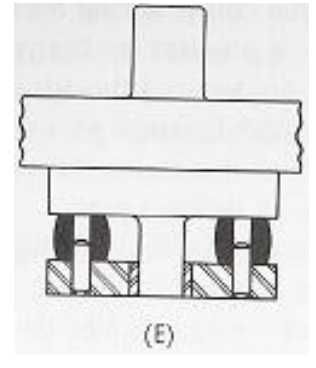
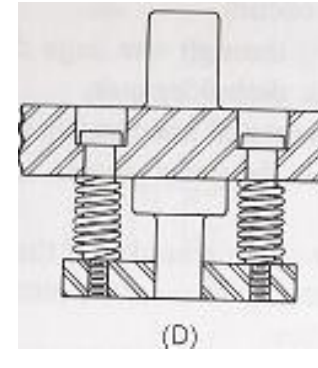
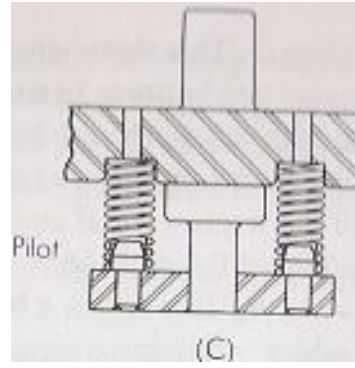
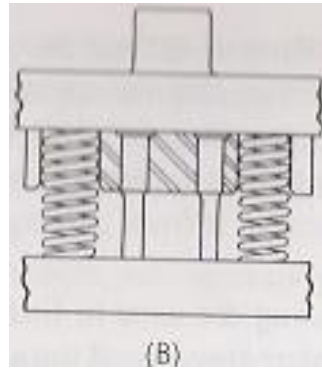
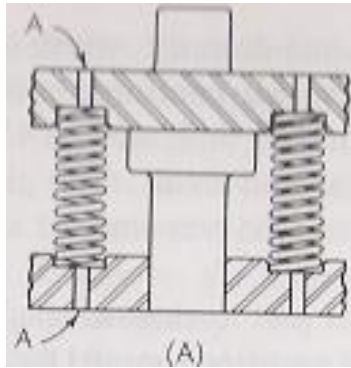


Spring-loaded quilled

Strippers

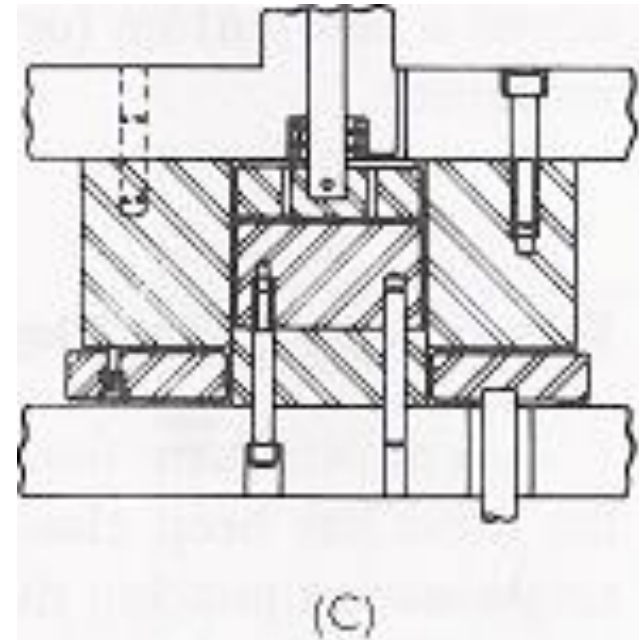
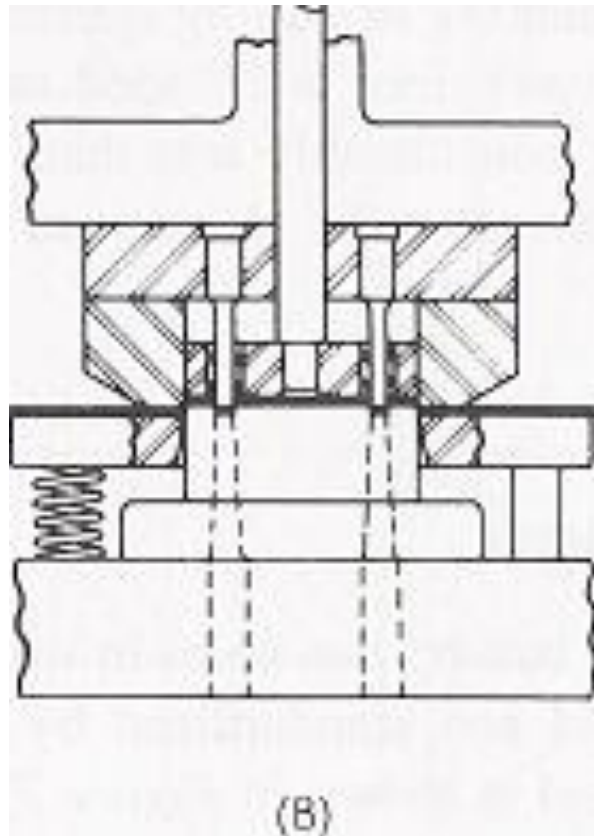
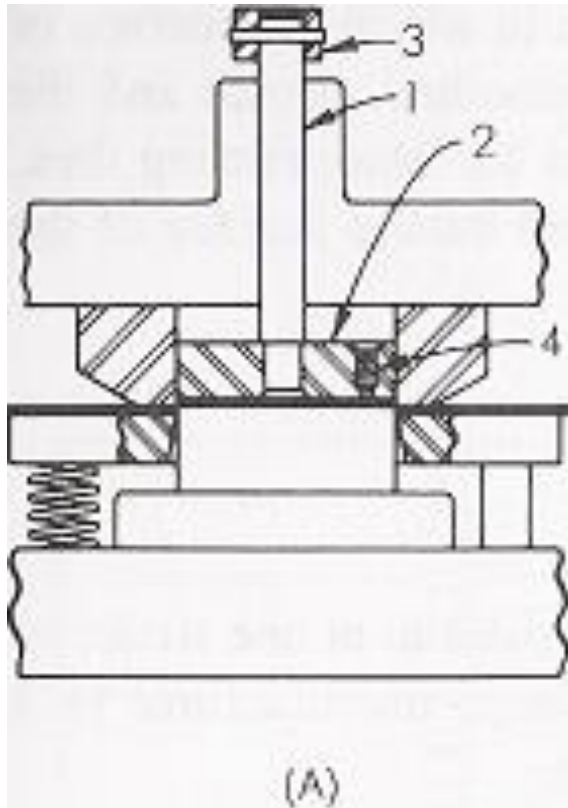
- Use to strip the workpiece from a cutting or non cutting punch or die.
- Two type of stripper: fixed and spring operated
- The size of stripper is same as die block
- Thickness of stripper must be sufficient to withstand the force required to strip the stock from the punch

Strippers

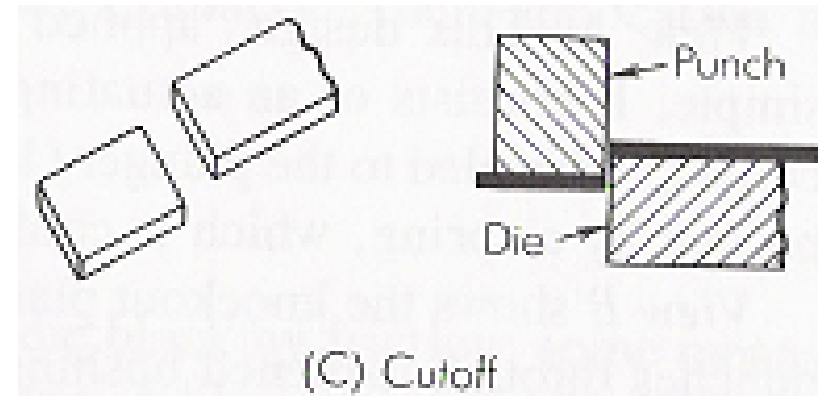
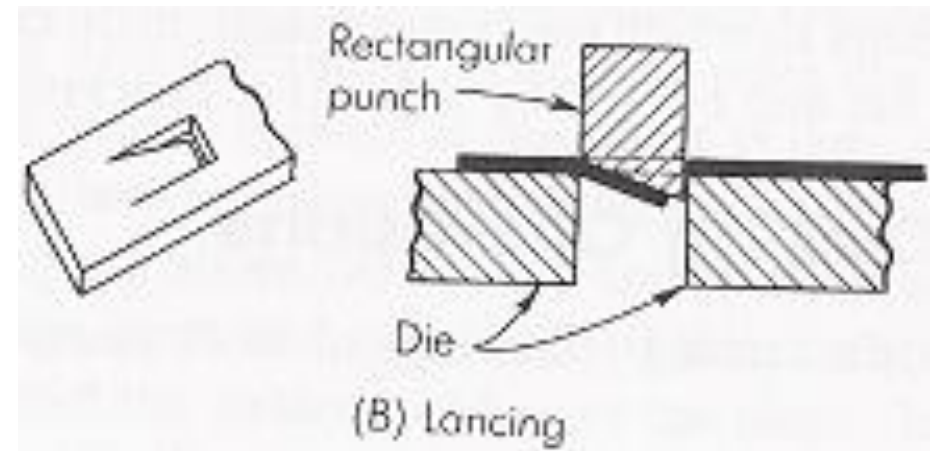
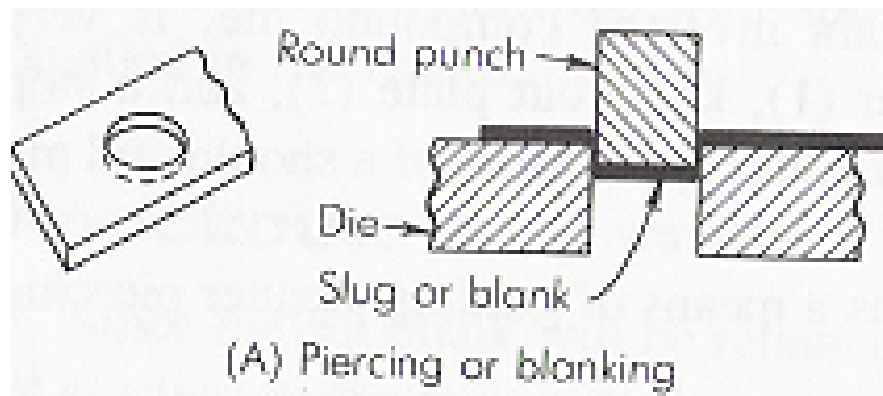


Knockouts

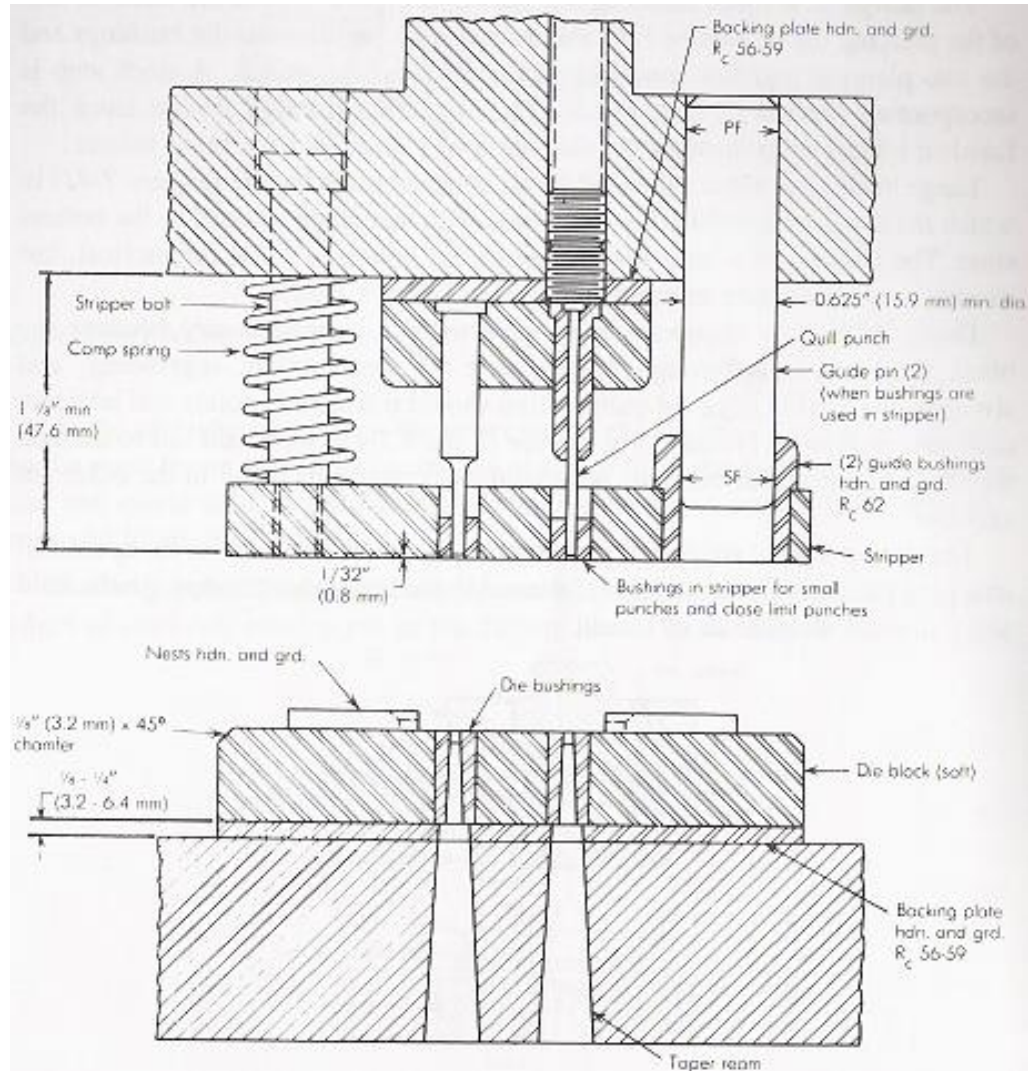
- Use to eject/remove the cut blank



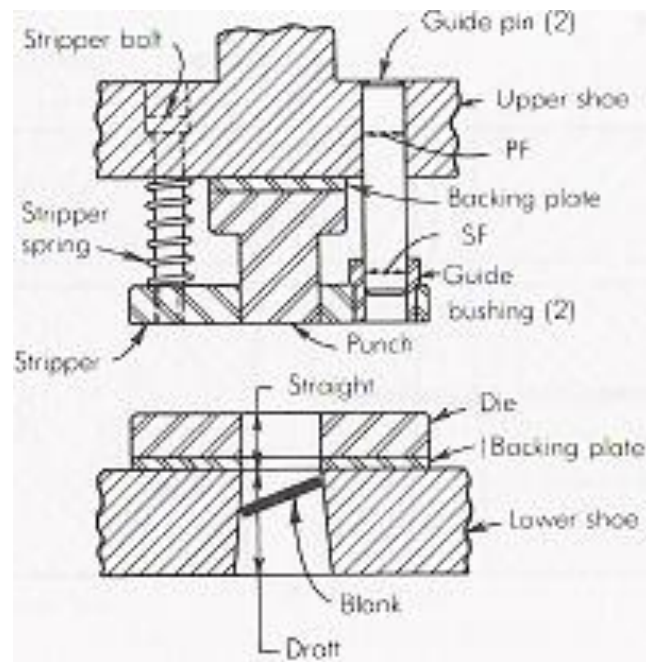
Piercing Die Design



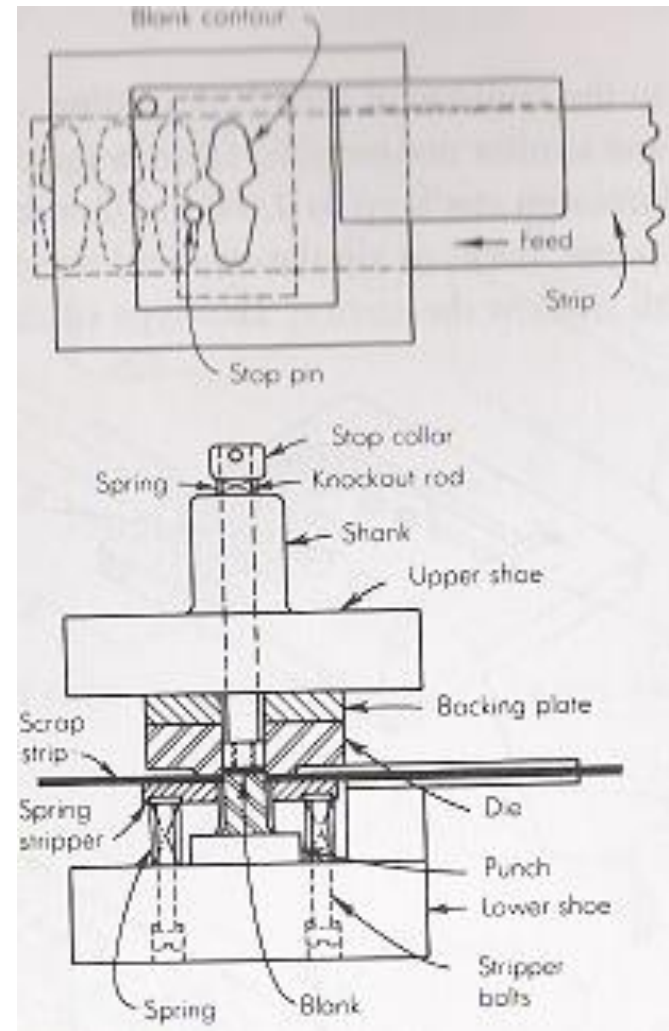
Typical single-station die for piercing holes



Blanking Die (Normal vs. Inverted)

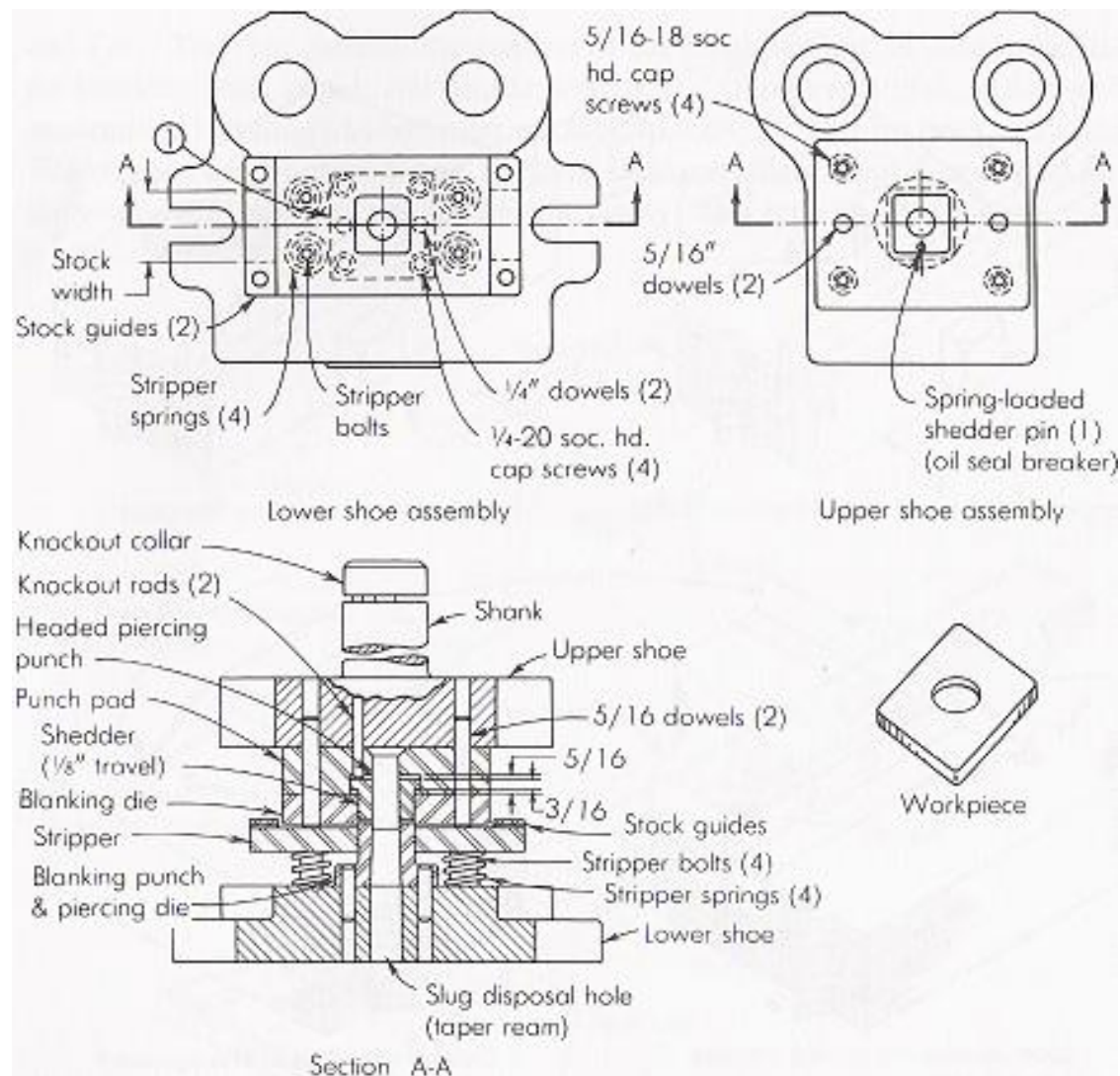


Normal

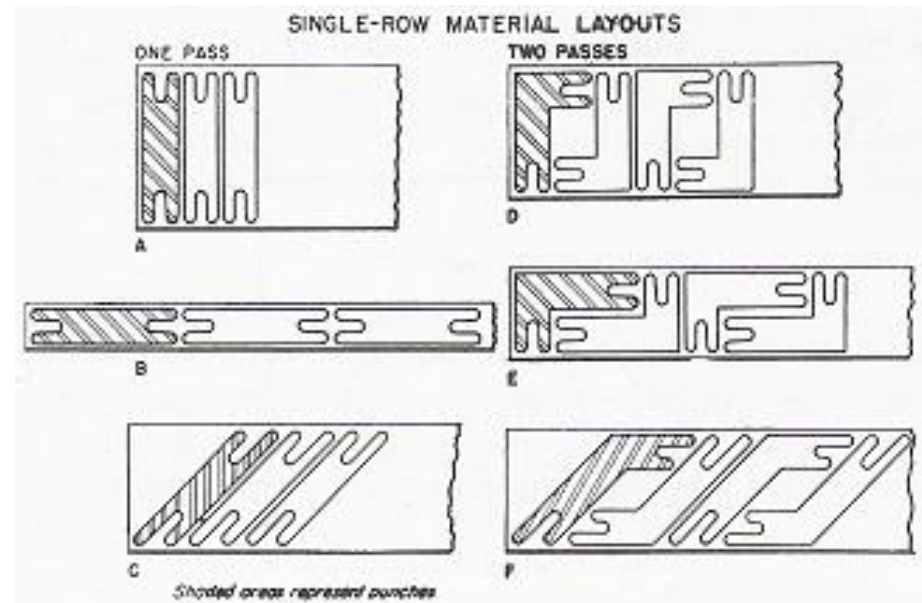
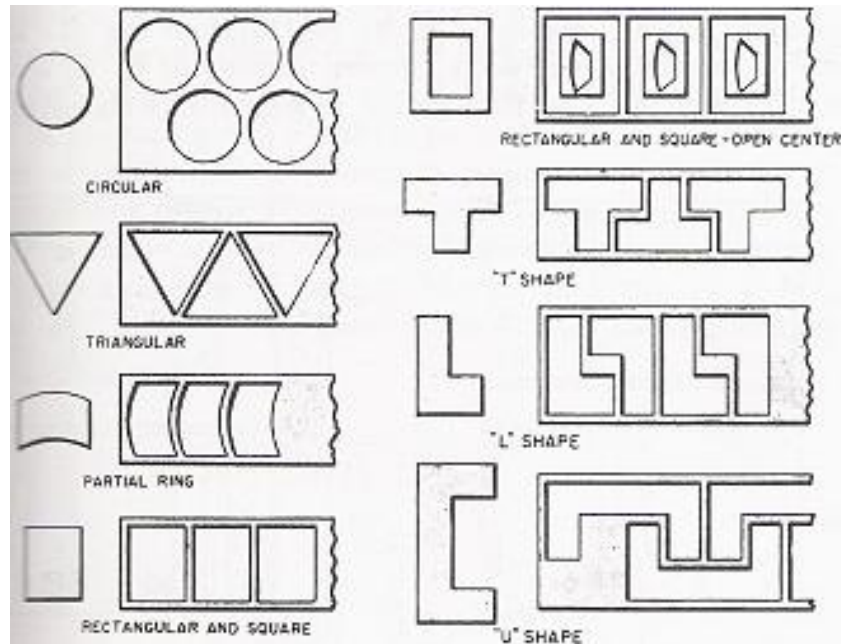


Inverted

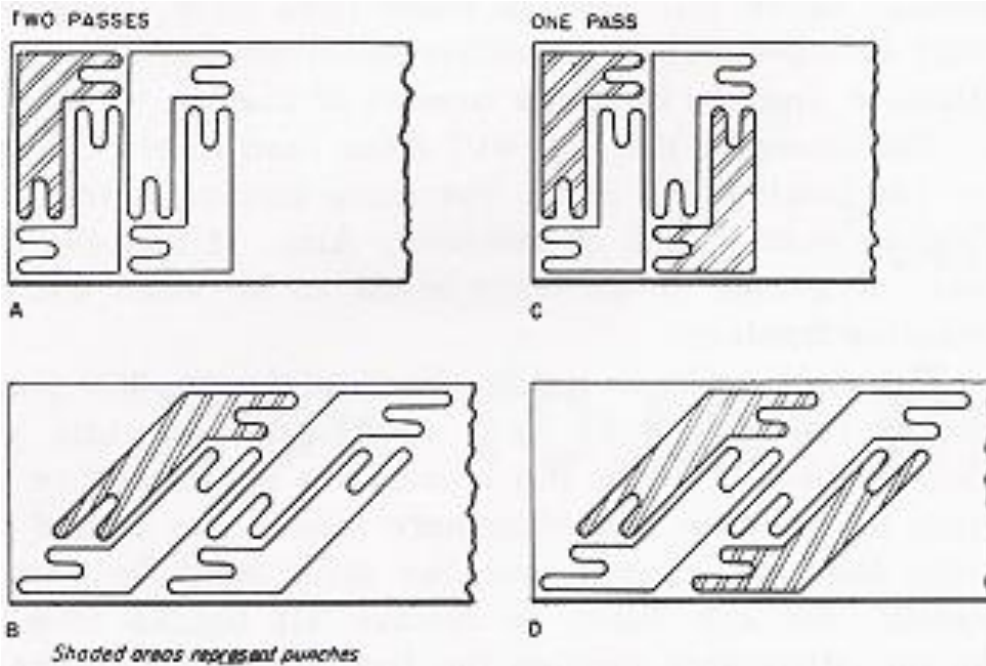
Compound Die Design (for Blanking Operation)



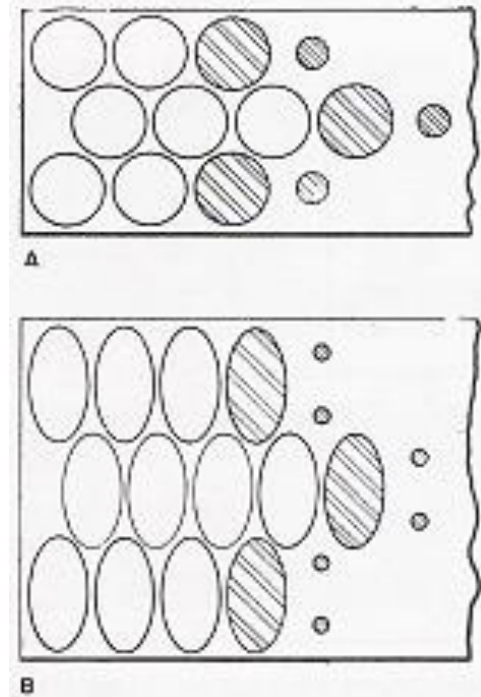
Basic Shape & Position of Blank



- Basic Blank Shape
- Various position of blank

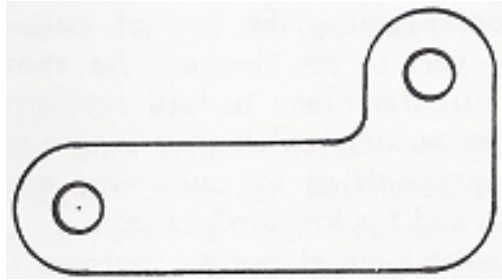


- One and two pass of double row blank layout

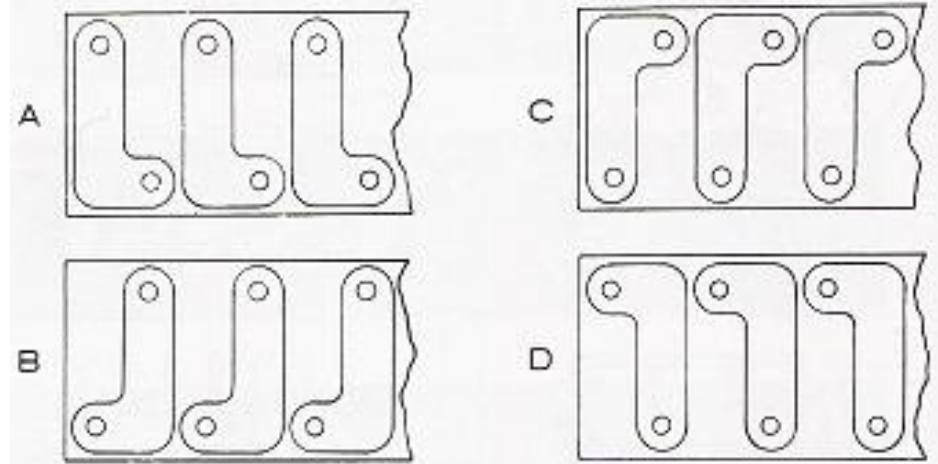


- Triple row blank layout

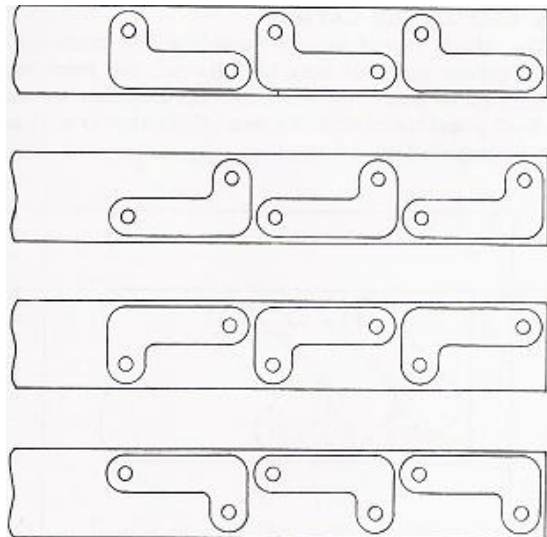
Example – Blank Layout



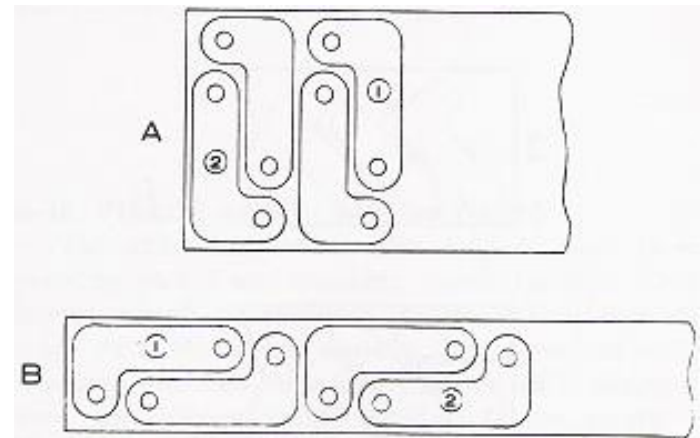
- Part layout



- Part positioned for wide run

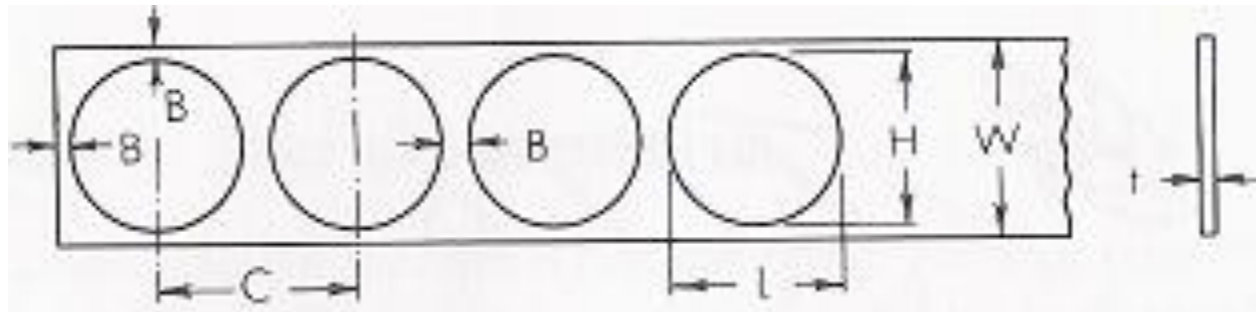


- Part positioned for narrow run



- Double row layout

Strip Layout for Blanking



t = the stock thickness

B = space between part and edge of strip

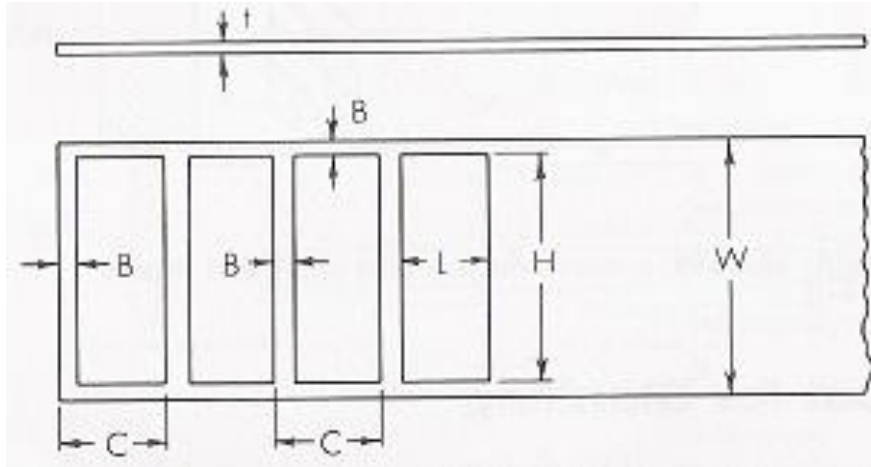
C = distance from center point on one part to the corresponding on the next part

L = length of the part

H = part width

W = width of stock strip

Scrap Allowance



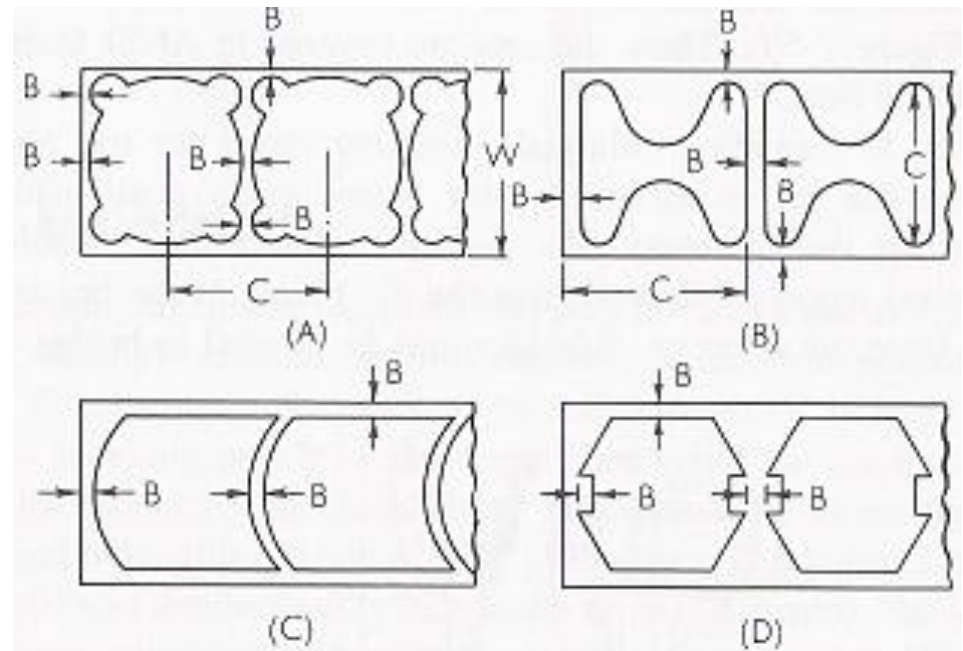
t = the stock thickness

$B = 1.25t$ when C is less than 2.5"

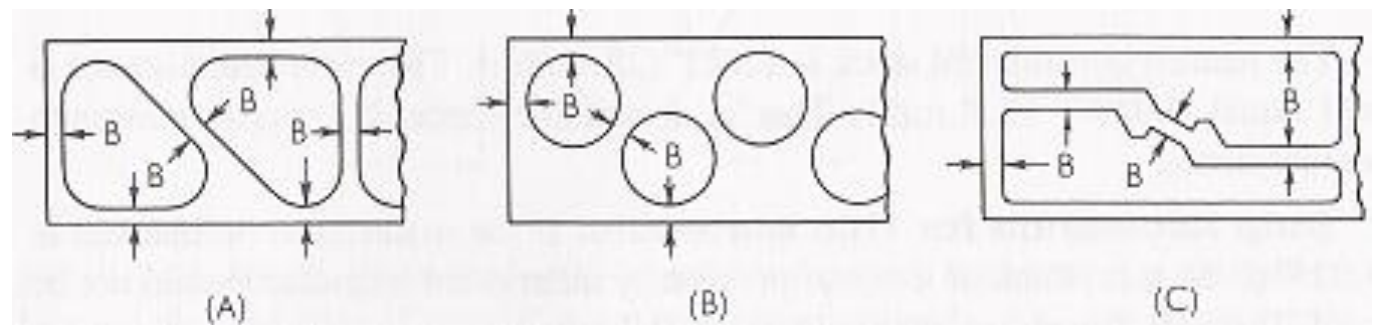
$B = 1.5t$ when C is 2.5' or longer

$C = L + B$

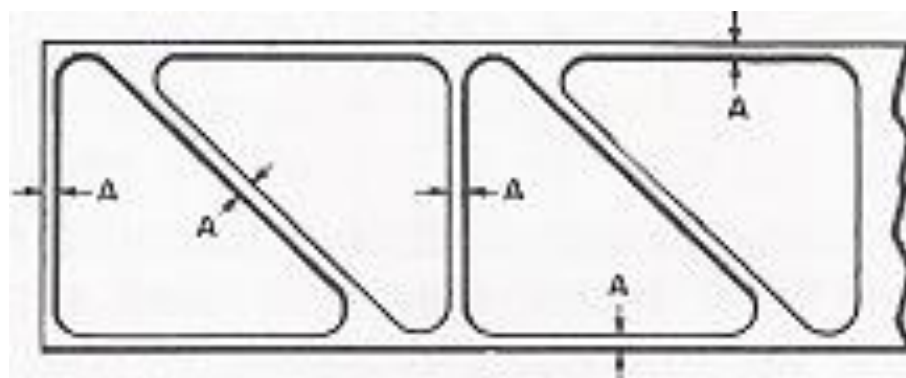
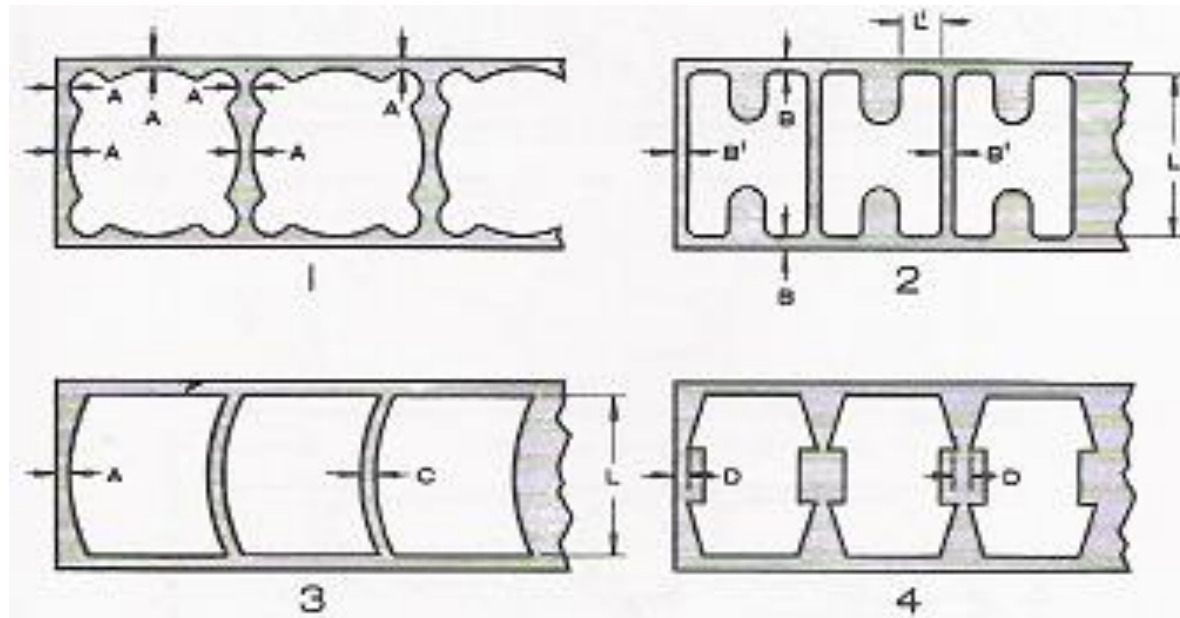
- Allowance for one-pass layouts



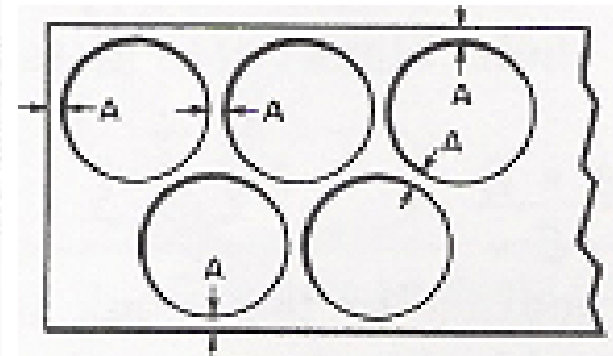
- Allowance for two-pass layouts



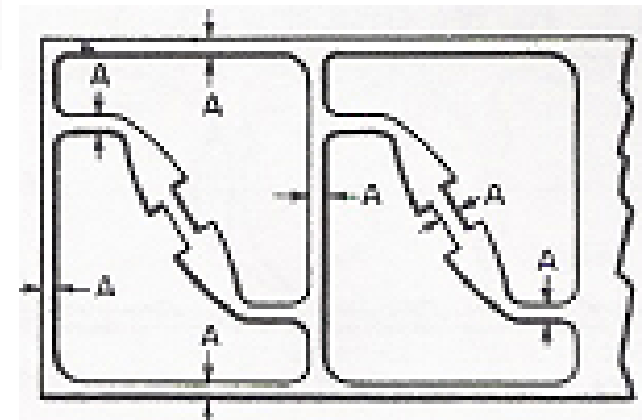
Strip Allowances



A Single-row layout intended for two passes through die: $A = 1\frac{1}{2} T$

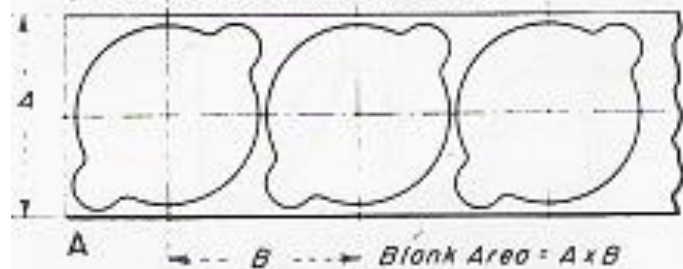


B Double-row layout of blanks with curved outlines: $A = 1\frac{1}{4} T$

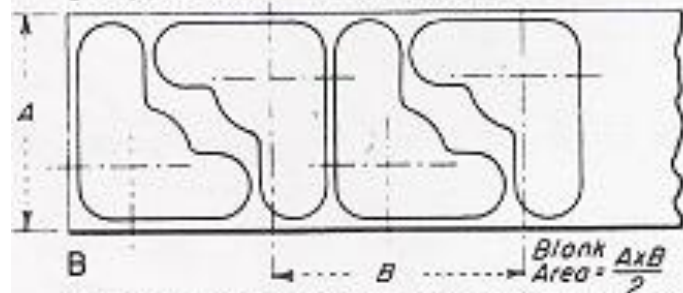


C Double-row layout of parts with straight and curved outlines: $A = 1\frac{1}{4} T$

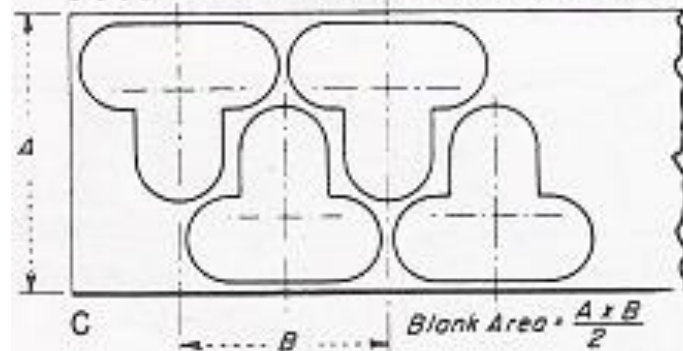
SINGLE ROW - ONE PASS



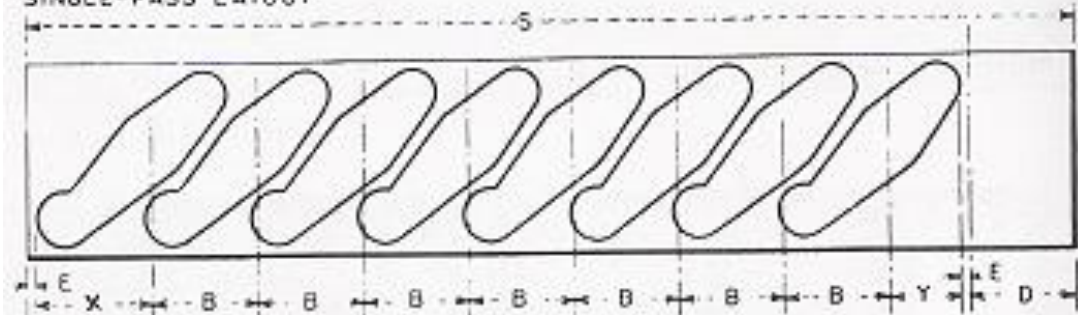
SINGLE ROW - TWO PASSES



DOUBLE ROW - ONE OR TWO PASSES

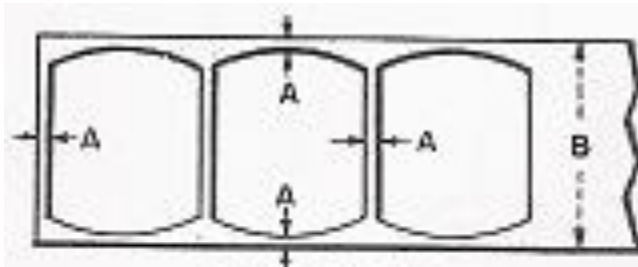


SINGLE-PASS LAYOUT



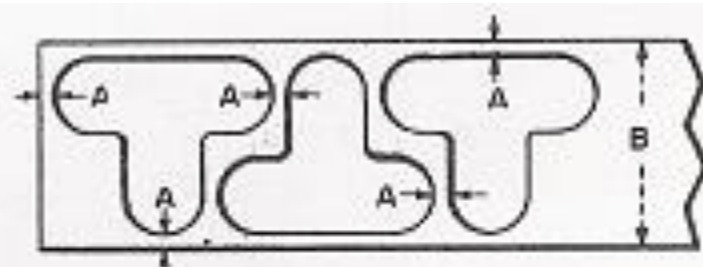
TWO-PASS LAYOUT





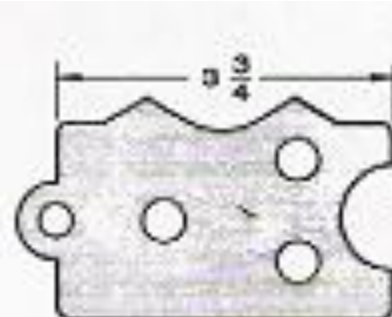
ONE-PASS LAYOUT

Strip Width B	Space A
0 to 3 in.....	$1/32$ in.
3 to 6 in.....	$1/16$ in.
6 to 12 in.....	$3/32$ in.
Over 12 in.....	$1/8$ in.

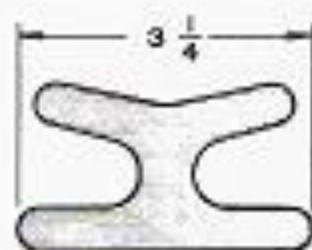
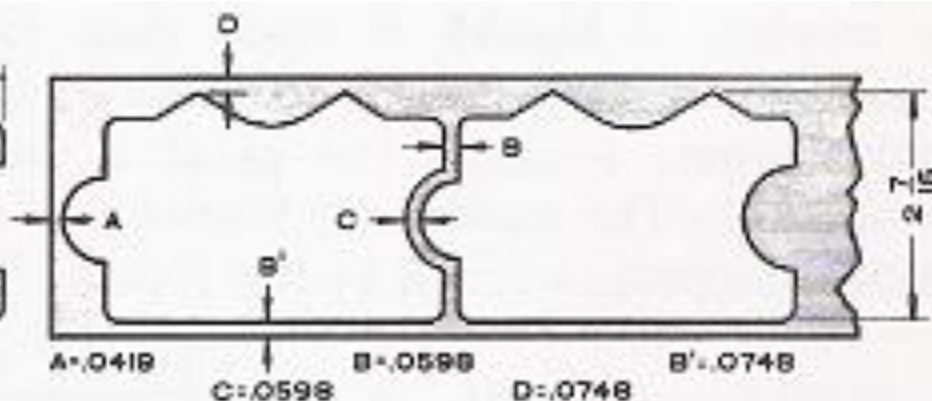


DOUBLE-PASS LAYOUT

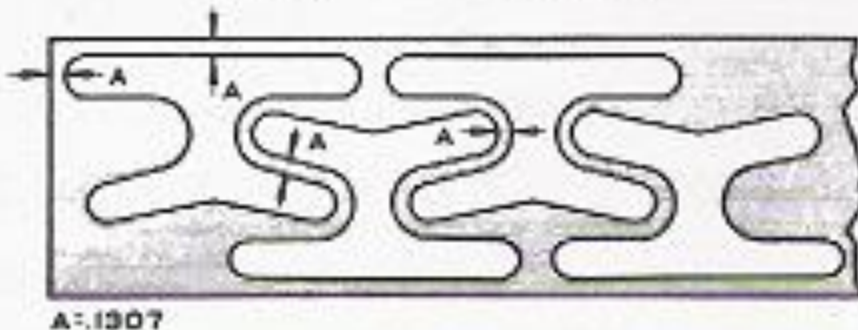
Strip Width B	Space A
0 to 3 in.....	$1/16$ in.
3 to 6 in.....	$3/32$ in.
6 to 12 in.....	$1/8$ in.
Over 12 in.....	$5/32$ in.



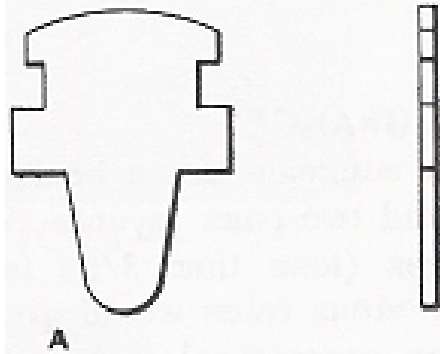
NO. 18 GA. (0598)



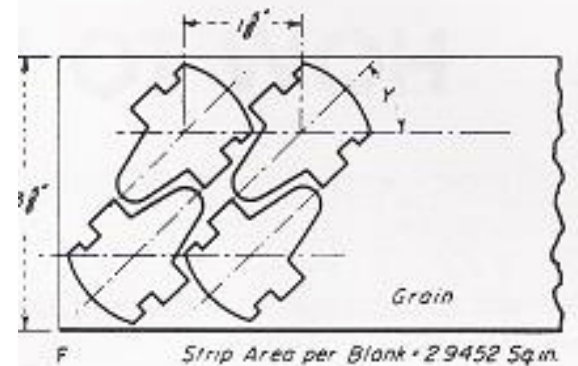
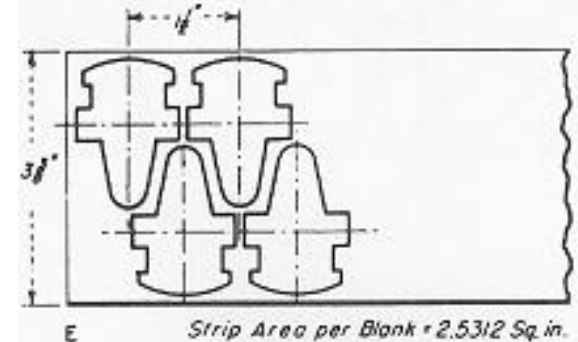
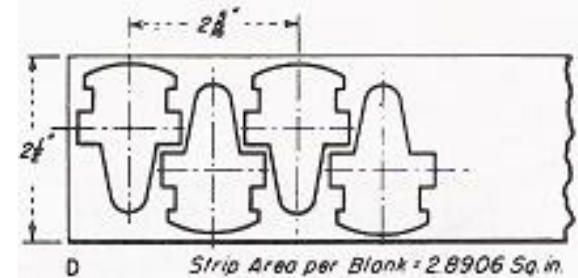
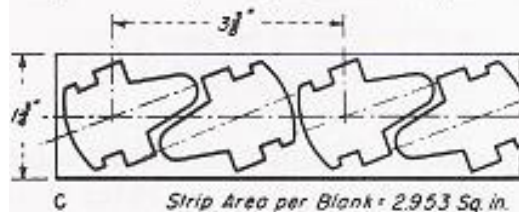
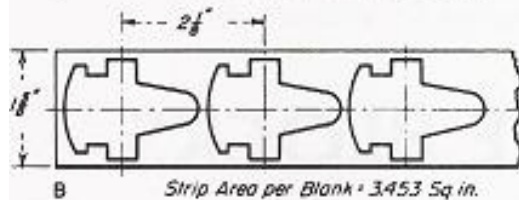
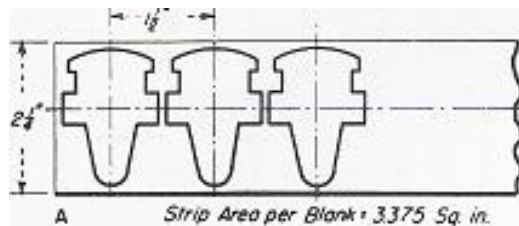
NO. 12 GA. (1307)



Example – Allowance Layout

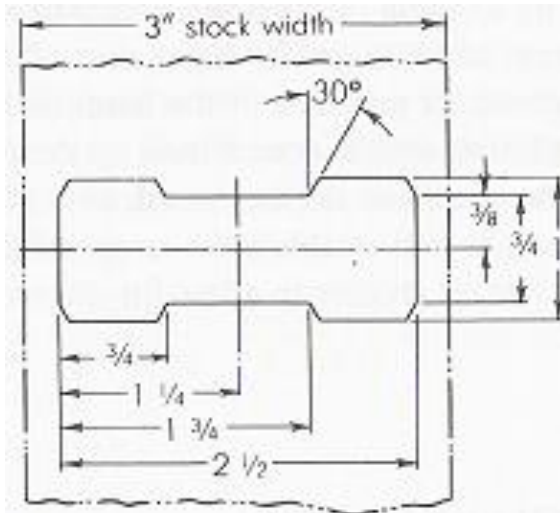


Part

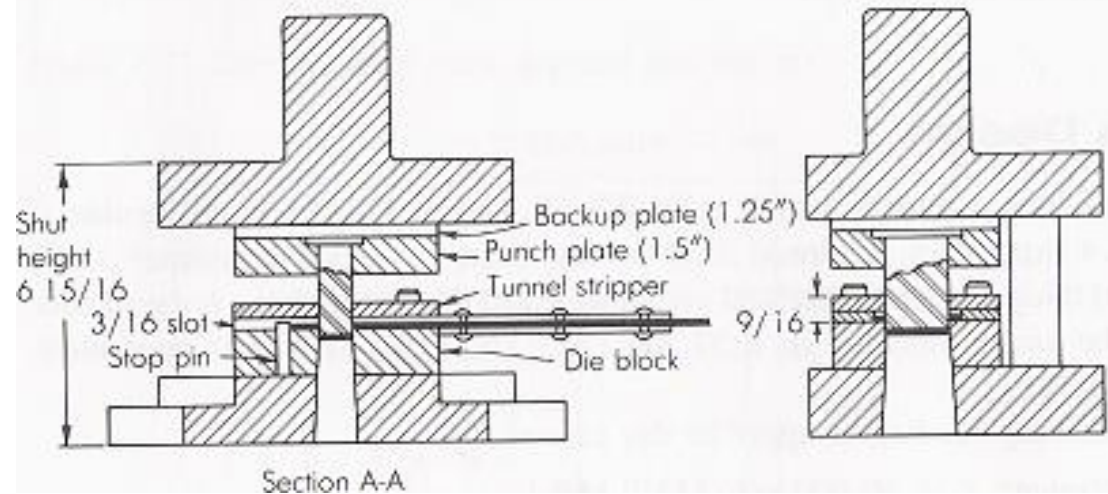
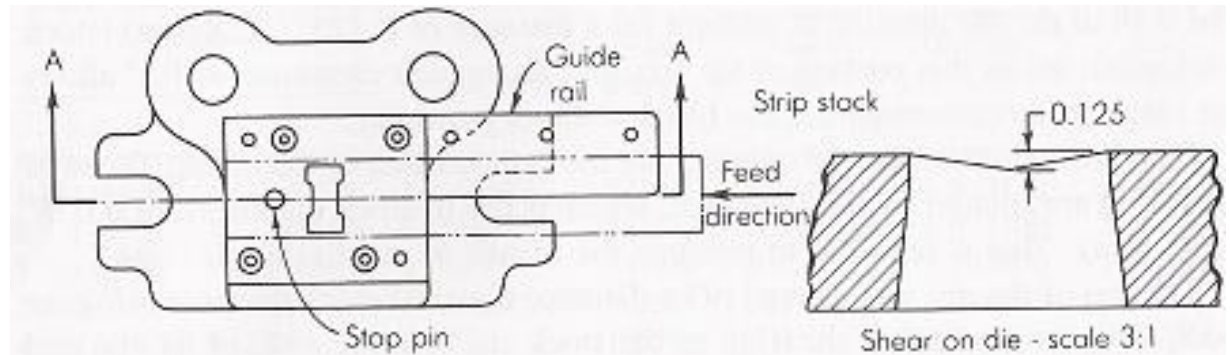


Blank Positioning

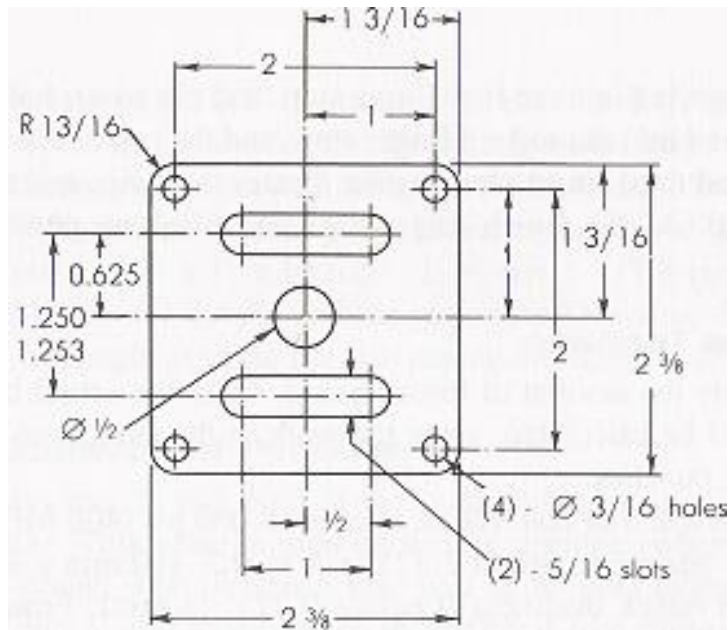
Example - Blanking



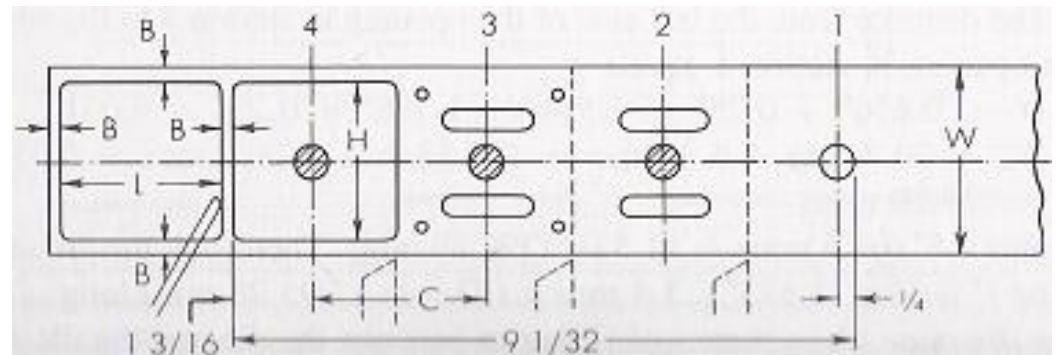
.125" thick SAE 1020 steel to be blanked from 3" stock



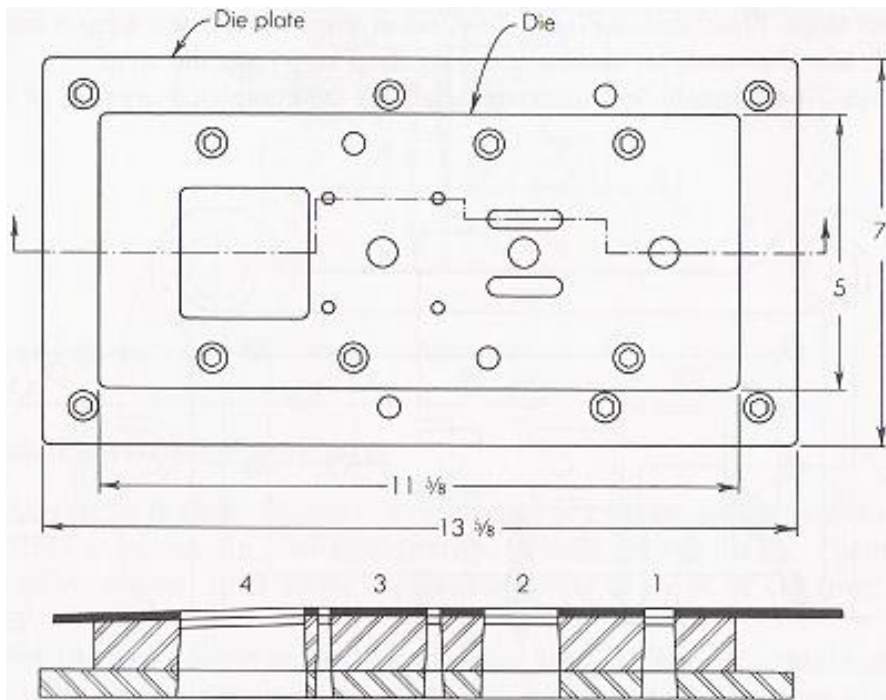
Example – Progressive Blanking Die



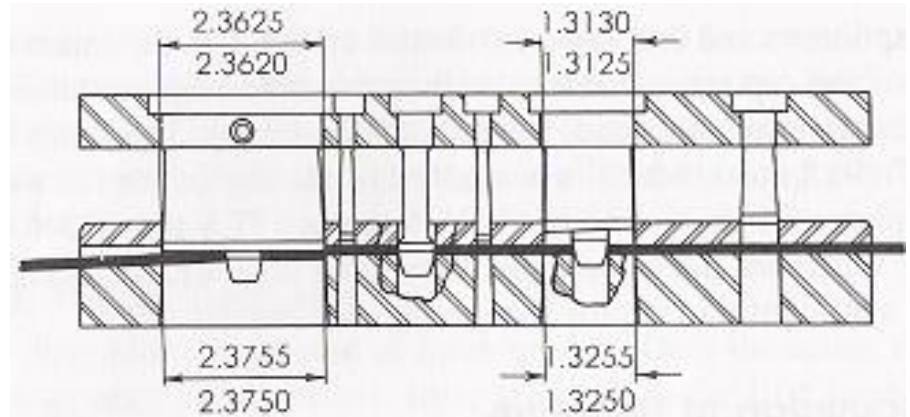
Linkage case cover to be blank



Progressive strip development

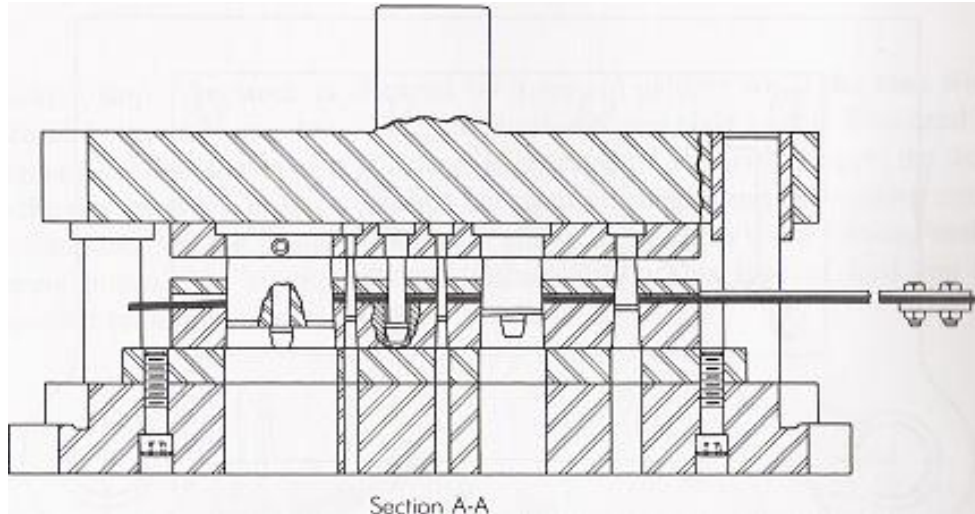


Fitting the die and die plate

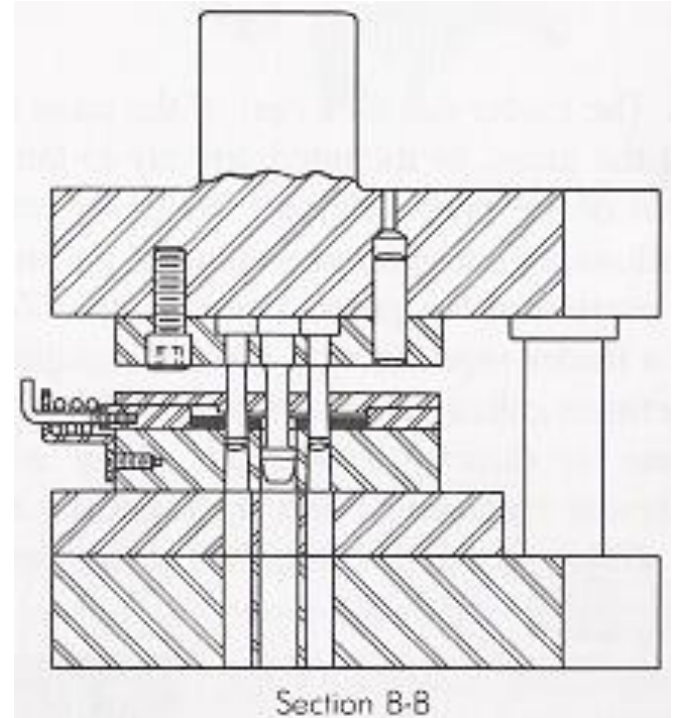
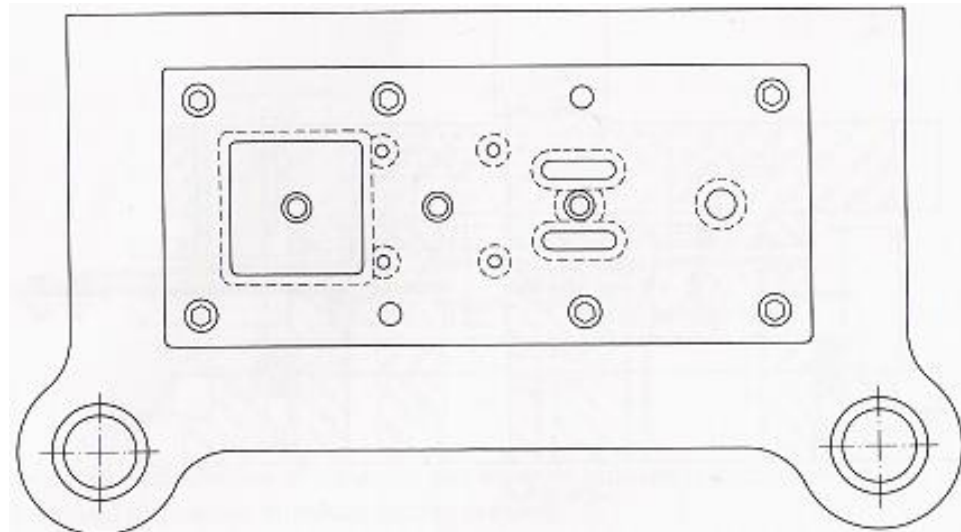


Clearance and shear on punches and die, and stepped arrangement of punches

Front, side and bottom view of complete progressive die

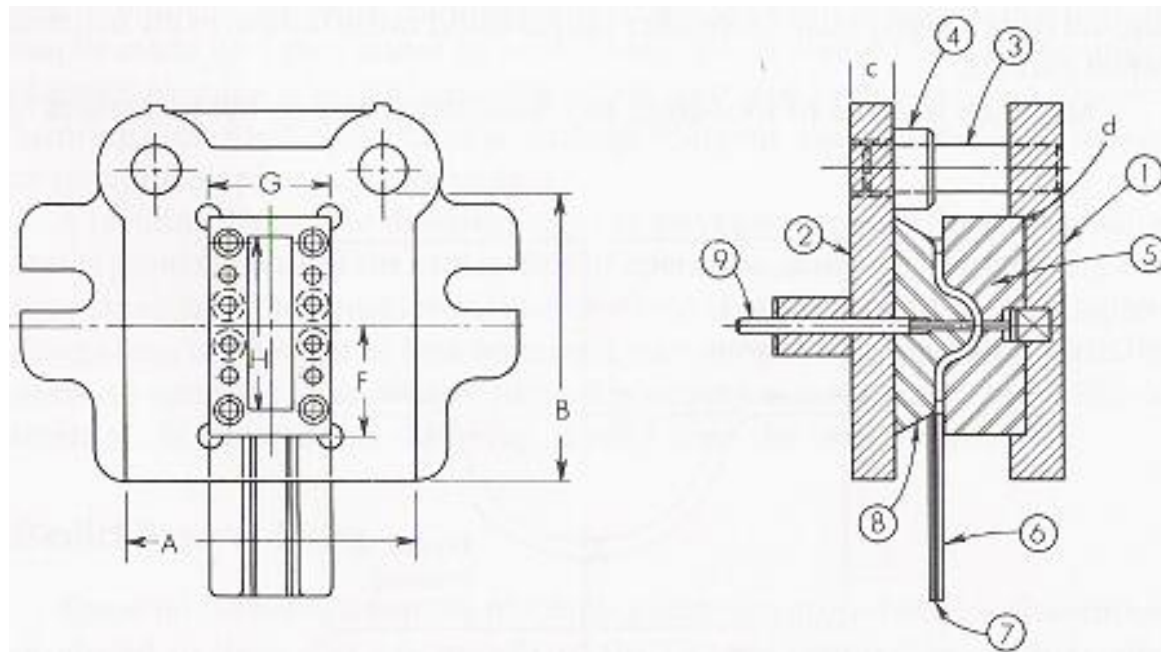
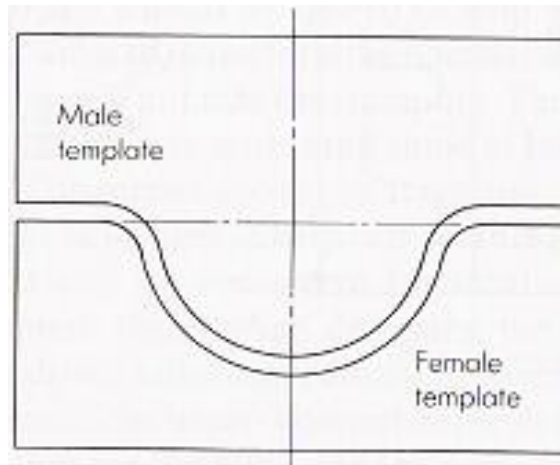


Section A-A

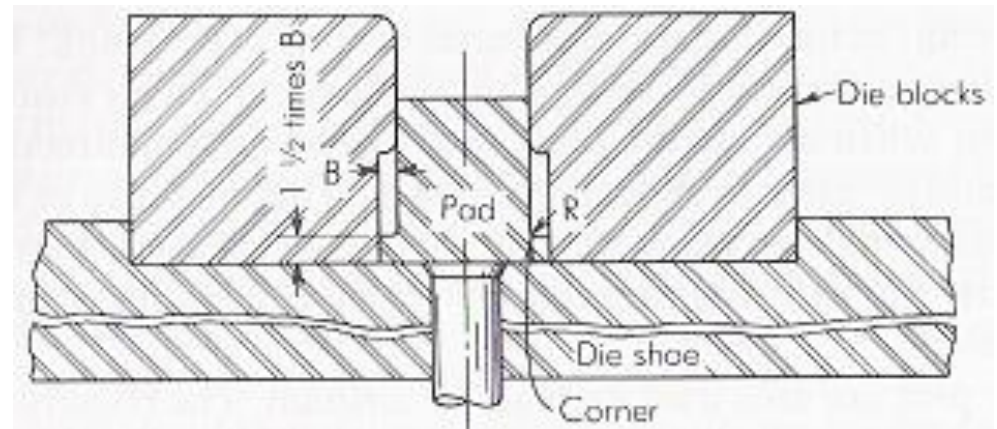
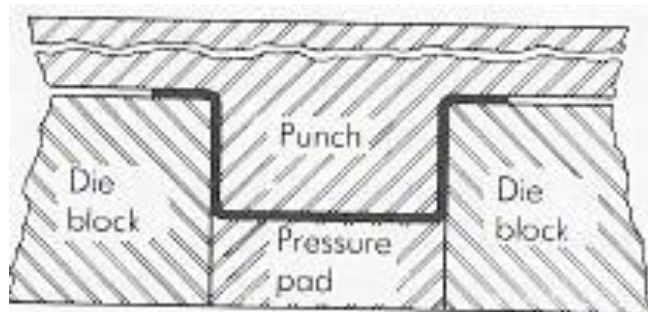
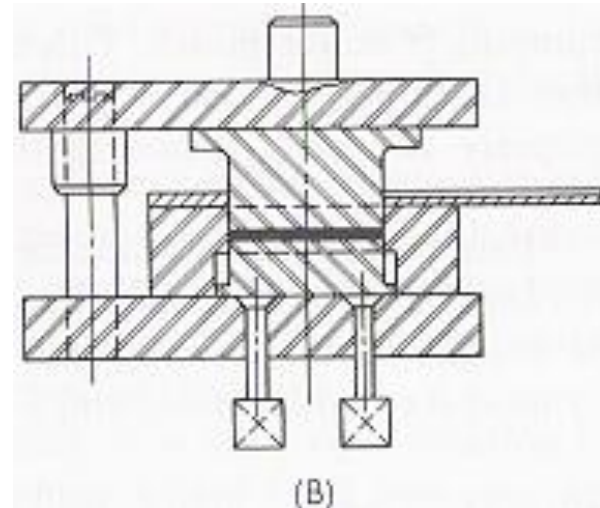
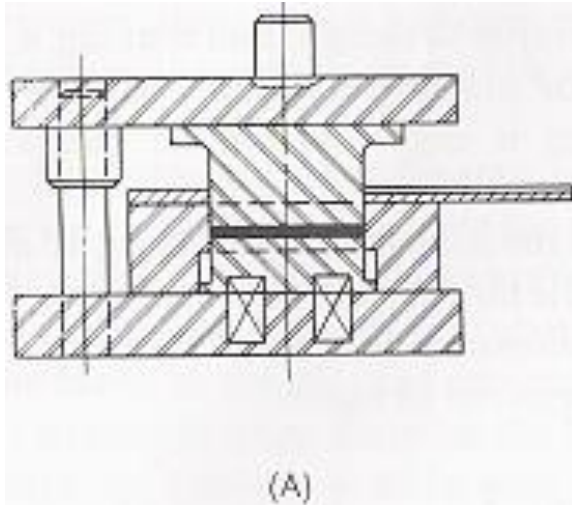


Section B-B

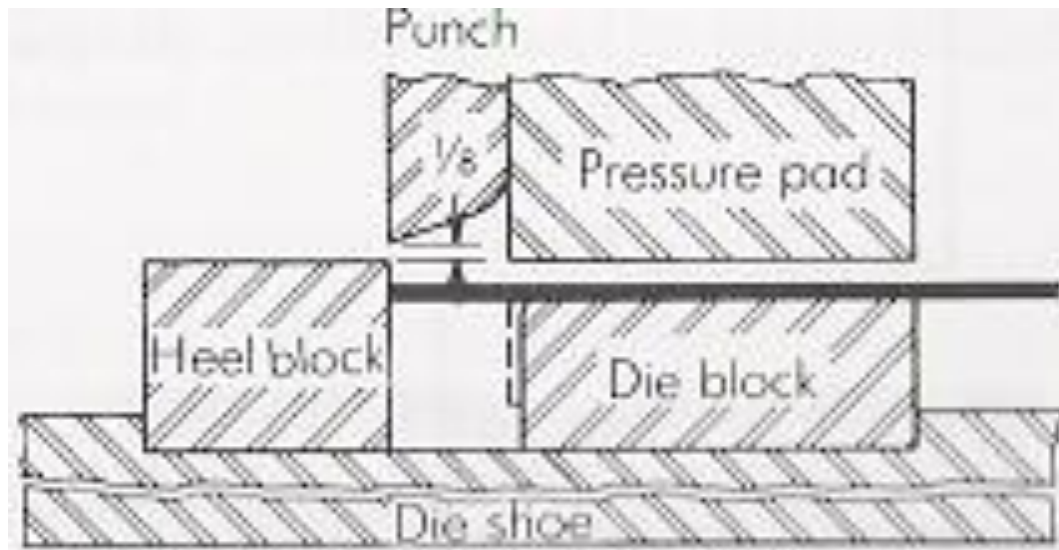
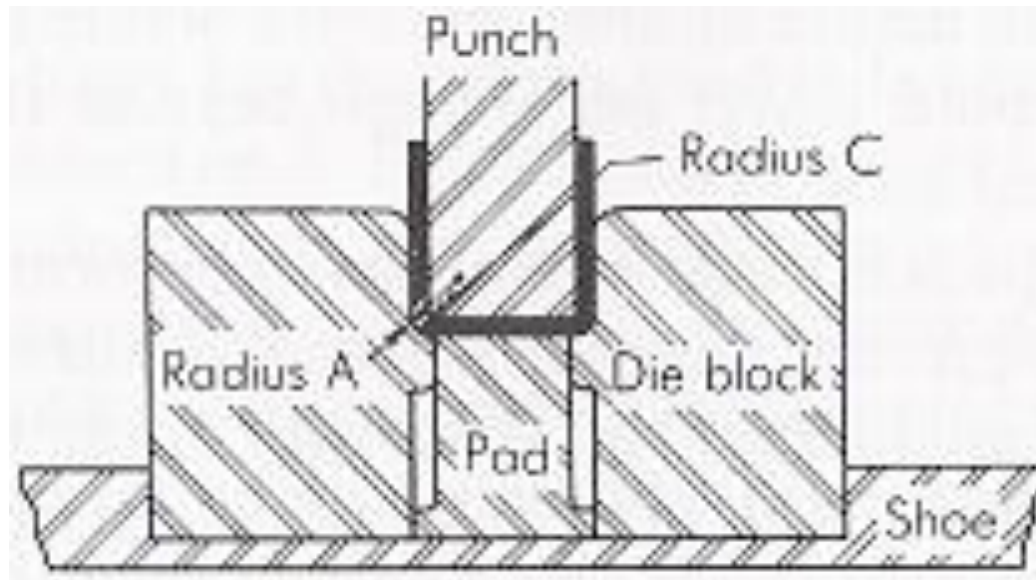
Forming Dies



Forming Dies with Pressure Pad

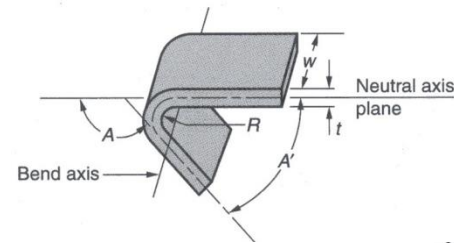


Radii consideration for form die

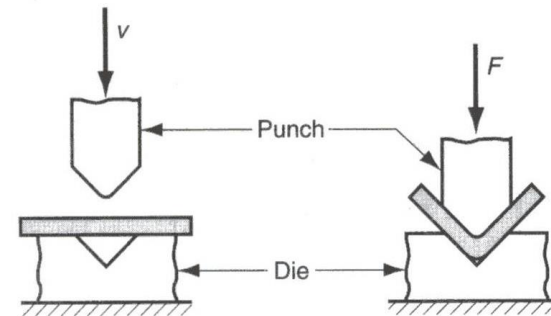
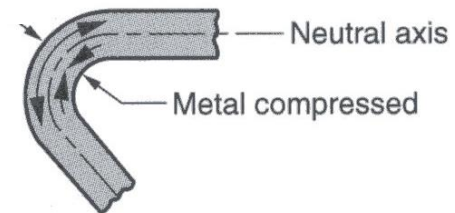


Bending Operation

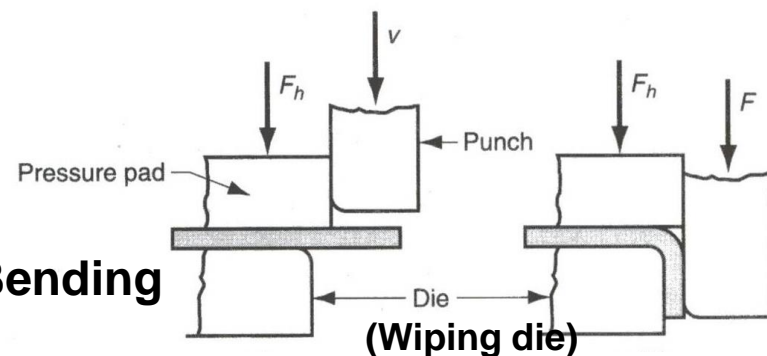
- Bending in sheet-metal work is defined as straining of the metal around a straight axis
- The metal on the inside of the neutral plane is compressed, while the metal on the outside is stretched
- The metal is plastically deformed so that the bend takes a permanent shape
- Produces little or no change in thickness
- Bending Methods:
 1. V-bending: Sheet metal is bent between a V-shaped punch and die
 2. Edge bending: Involves cantilever loading of the sheet metal. A pressure pad holds the base of the part against the die (wiping die) while the punch forces the part to yield and bend over the edge of the die (die angle 90° or less)



stretched



V-bending



Edge-Bending

(Wiping die)

Analysis of Bending

- Bending Force:

The maximum bending force can be estimated by means of the following equation:

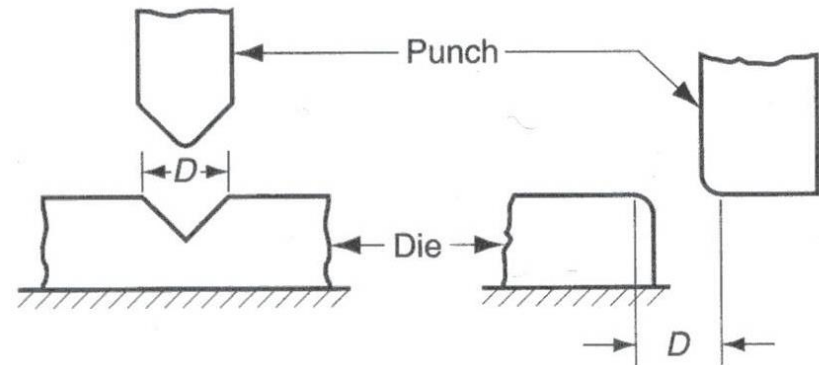
$$F = \frac{K_{bf} TS wt^2}{D}$$

where

F = bending force (N) ; **TS** = tensile strength of the sheet metal (MPa); **w** = width of the part in the direction of bend axis; **t** = stock thickness; and **D** = die opening dimension as defined in the figure

K_{bf} = 1.33 for V-bending

K_{bf} = 0.33 for Edge-bending



Analysis of Bending

- Bend Allowance - length of a neutral axis

$$\check{BA} = 2\pi \frac{A}{360} (R + K_{ba} t)$$

A = Bend Angle

R = Bend Radius

t = Stock Thickness

K_{ba} = A Factor to Estimate Stretch

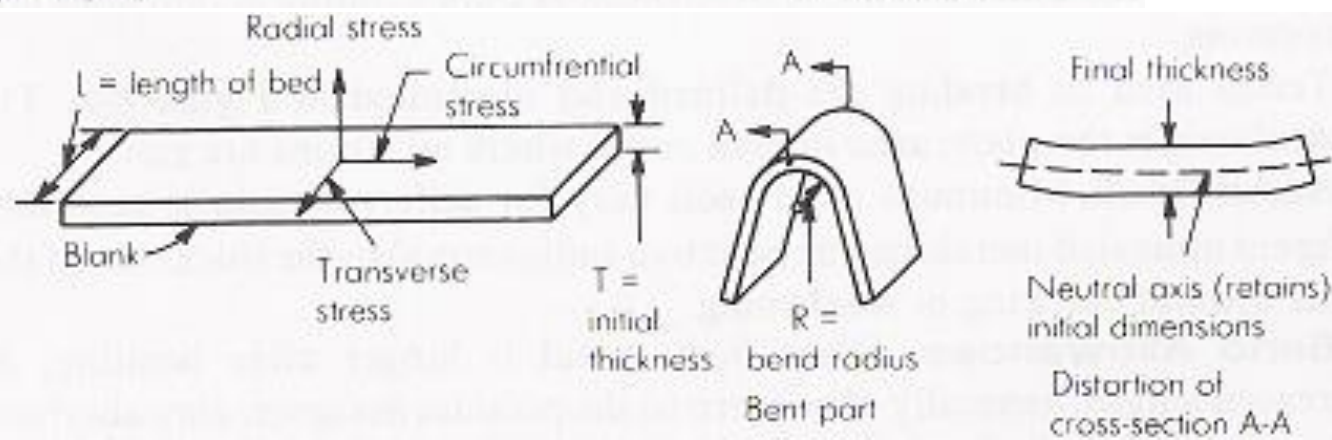
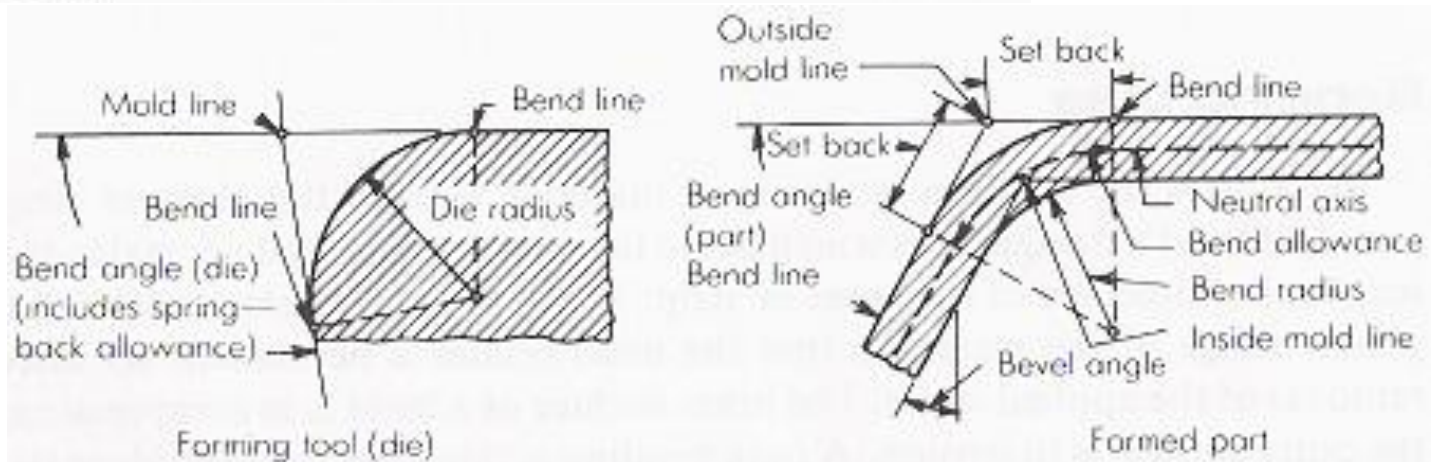
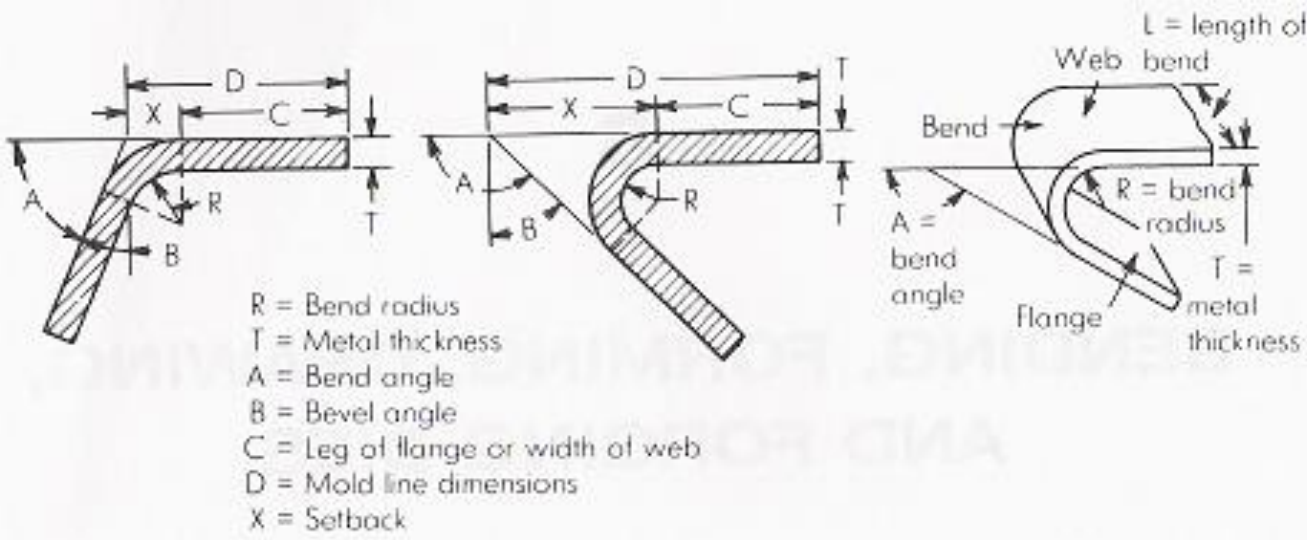
$K_{ab}=0.33$ if $R<2t$ and $K_{ab}=0.5$ if $R\geq 2t$



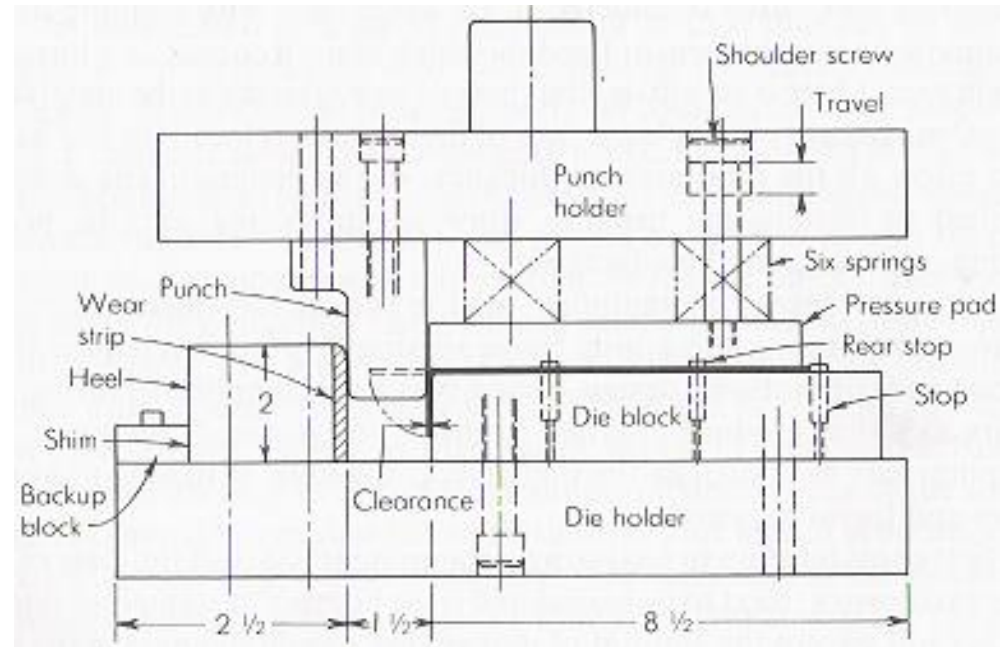
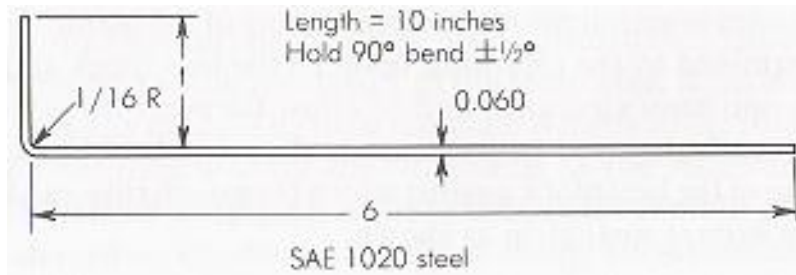
- Springback $SB = \frac{A' - A_b}{A_b}$

A' = included angle of the sheet metal part

A_b = included angle of the bending tool



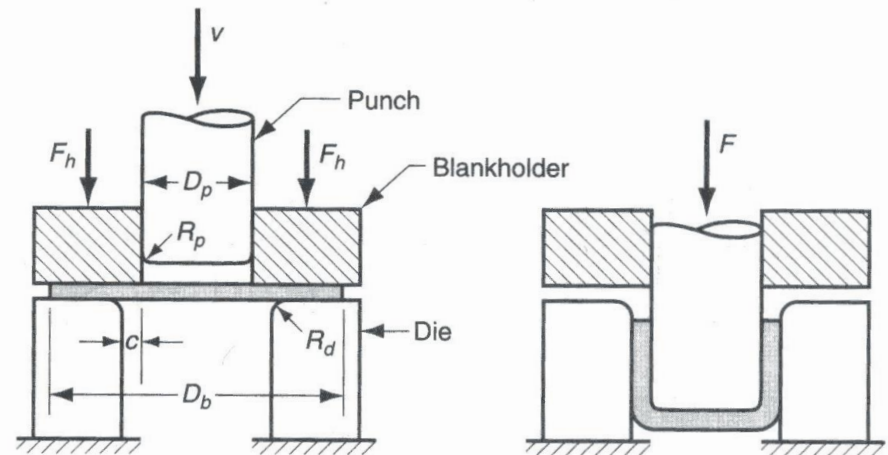
Bending Die



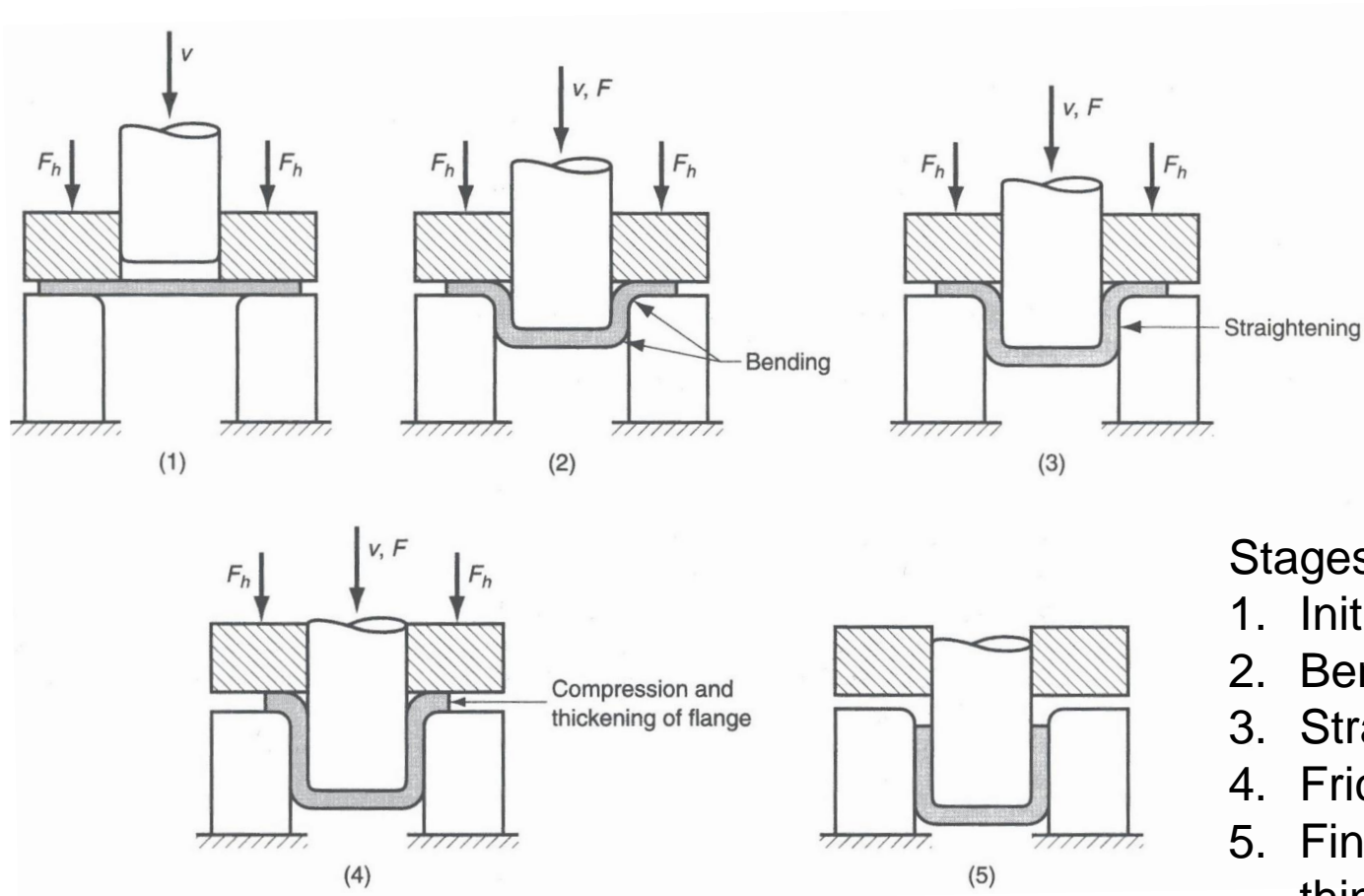
Drawing

- Sheet metal forming operation used to make cup-shaped, box-shaped or other complex-curved, hollow-shaped parts
- It is performed by placing a piece of sheet metal over a die cavity and then pushing the metal into the opening with a punch
- Common parts include beverage cans, ammunition shells, sinks, cooking pots and auto body parts
- The die and punch must have corner radii to avoid hole-punching
- Clearance c in drawing is about 10% greater than stock thickness

$$c = 1.1 t$$



Stages in Drawing Process



Stages:

1. Initial contact
2. Bending
3. Straightening
4. Friction and compression
5. Final cup shape and thinning of cup walls

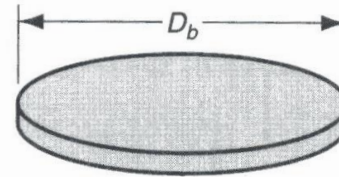
Note: Upto 25% thinning occurs in a successful drawing operation

Analysis of Drawing

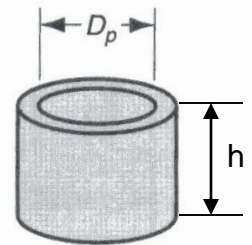
- Blank size determination:
Assuming no change in thickness,

$$\frac{\pi D_b^2}{4} = \frac{\pi D_c^2}{4} + \pi D_c h_{\max}$$

$$h_{\max} = \frac{1}{4} \left(\frac{D_b^2}{D_c} - D_c \right)$$



$$D_p \approx D_c$$



- Measures of Drawing (Severity of deep drawing)

- Drawing Ratio $DR = \frac{D_b}{D_p}$

For most materials $DR \leq 2$

- Thickness to diameter ratio:

To avoid wrinkling $\frac{t}{D_b} > 0.01$

- Drawing Force:

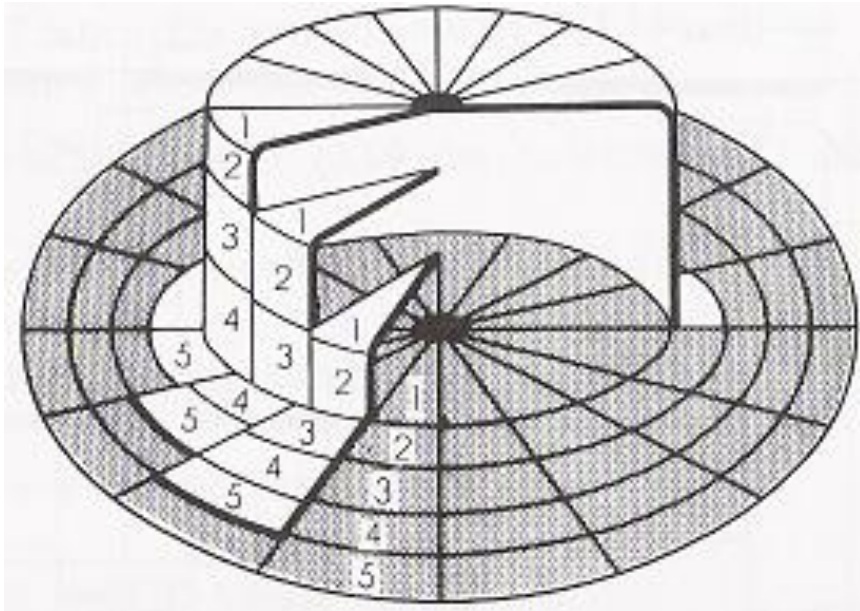
$$F = \pi D_p t (TS) \left(\frac{D_b}{D_p} - 0.7 \right)$$

where F is the drawing force; t is the blank thickness; TS is the tensile strength

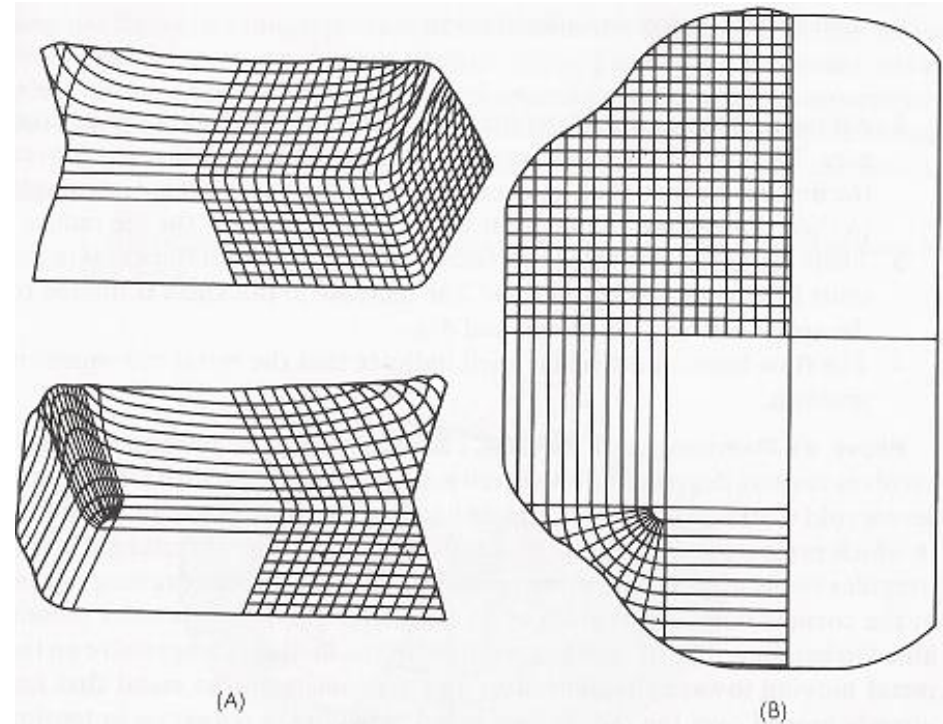
- Holding force:

$$F_H \leq 1/3 F$$

Cylindrical and Rectangular Draws

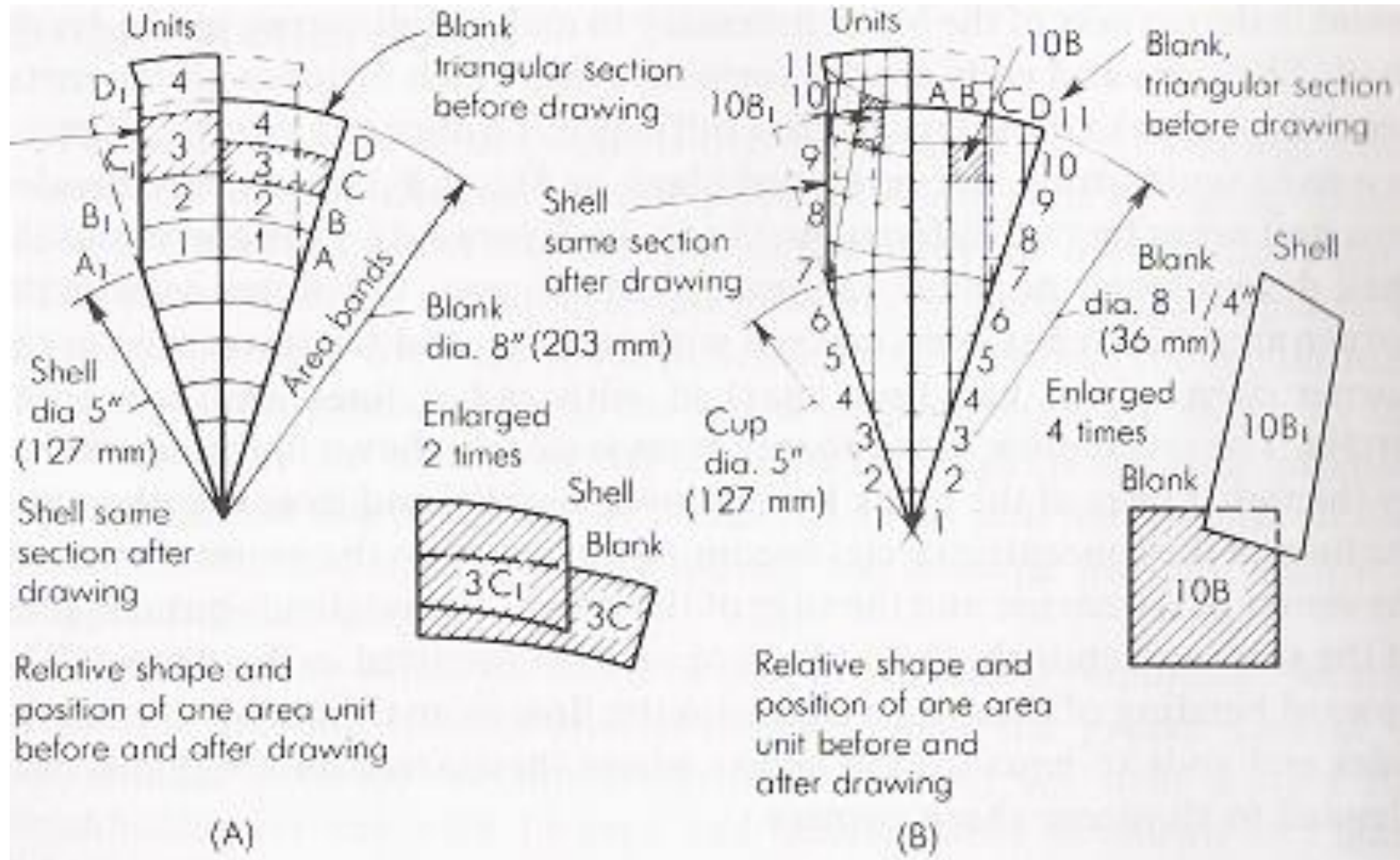


- Metal flow in cylindrical draw



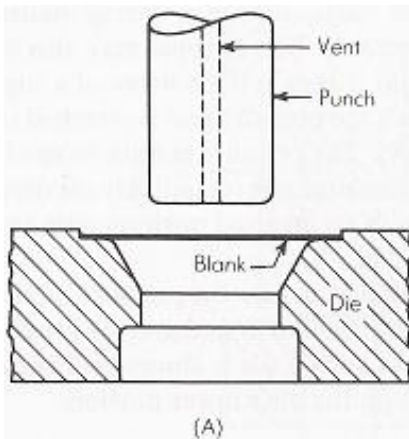
- Metal flow in rectangular draws

Before and after draw

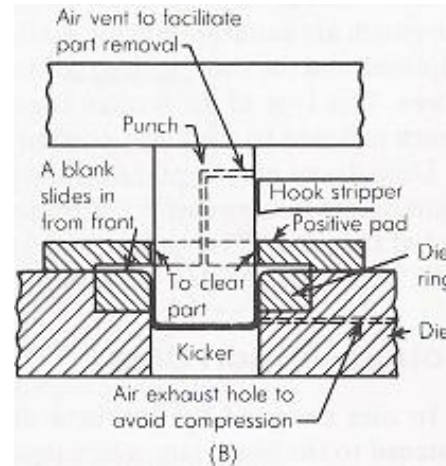


- Two method of marking blanks to illustrate size, shape and position of the units area, before and after drawing

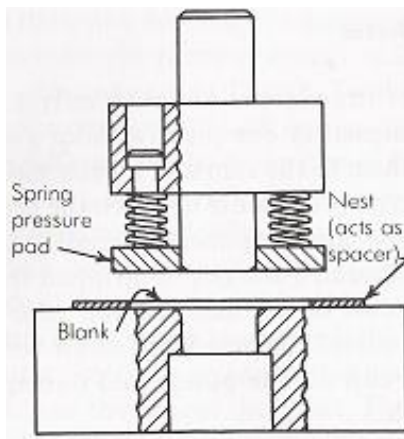
Single Action Die



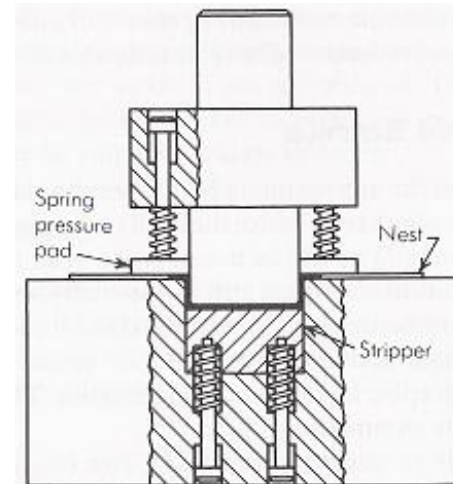
Simple Die



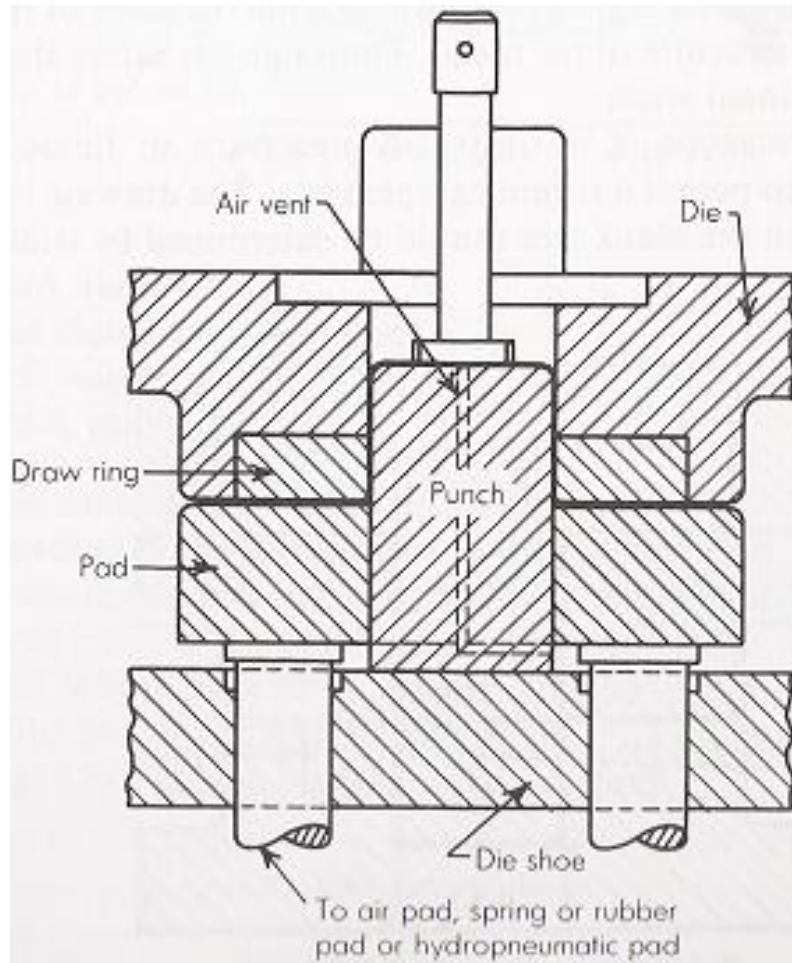
Simple draw Die



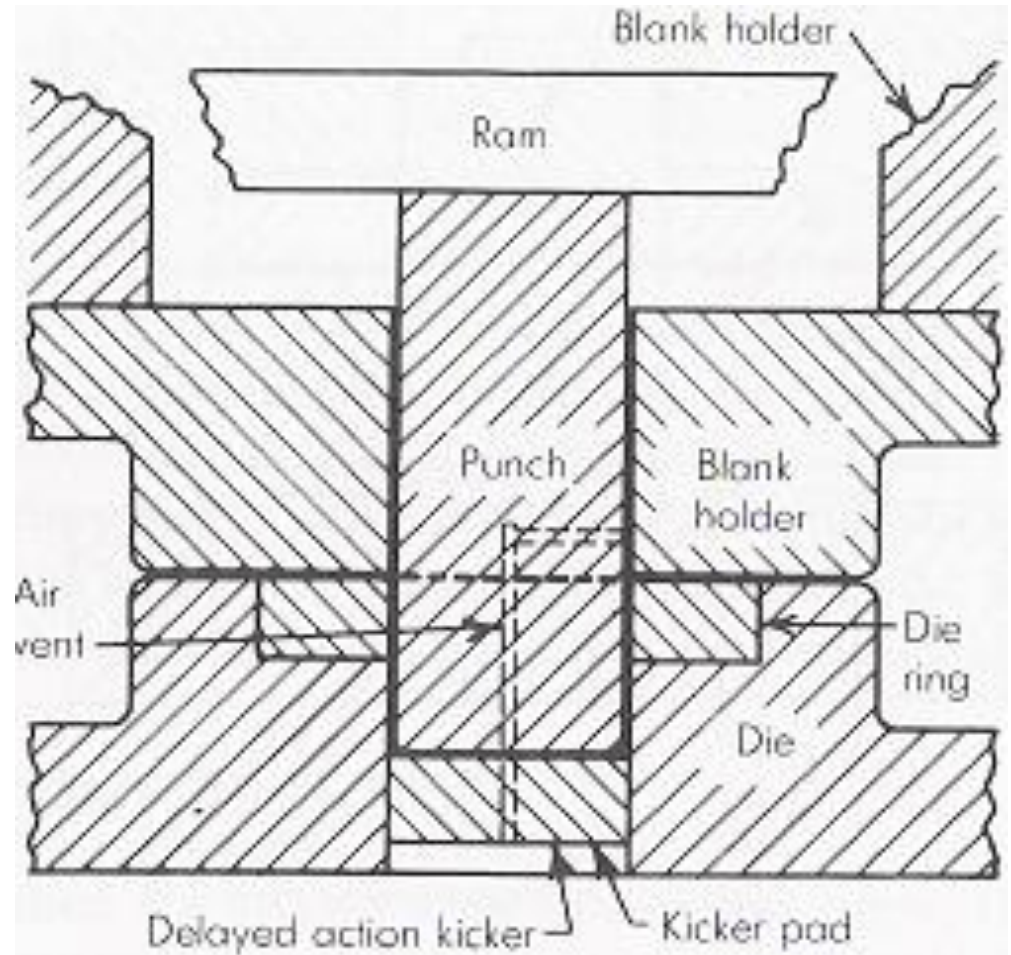
Draw die with spring



Draw die with spring pressure pad and stripper

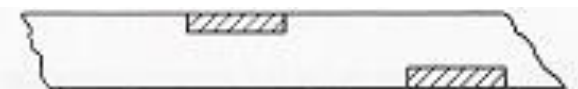
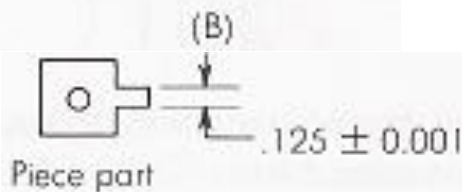
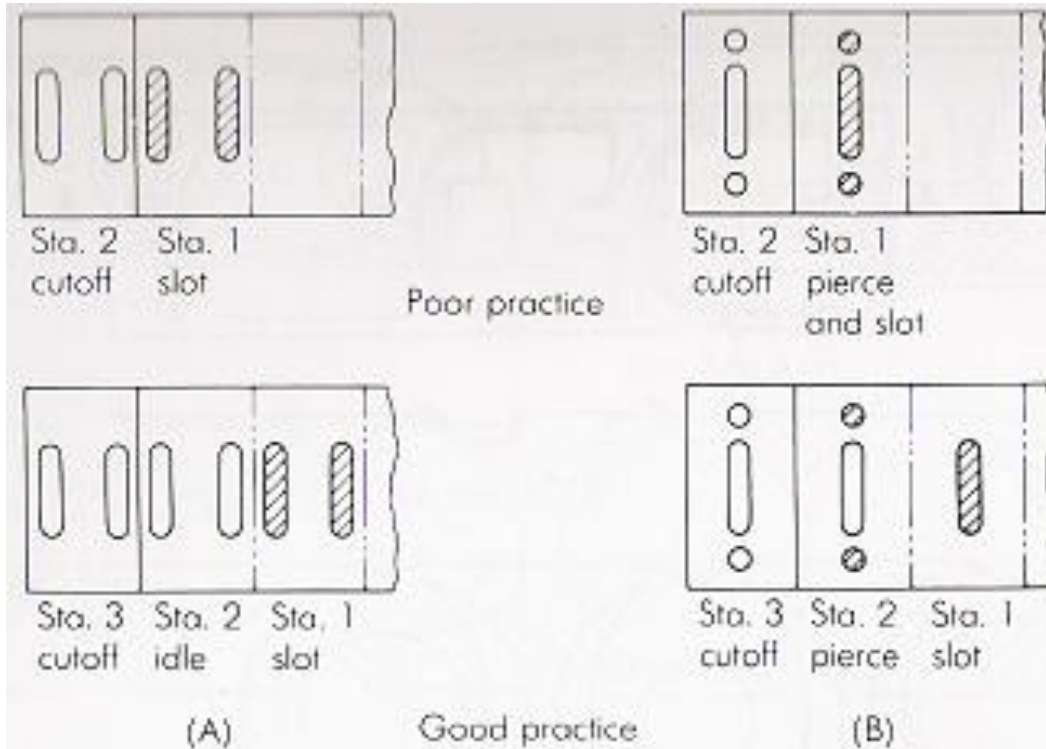


- Single action inverted draw dies

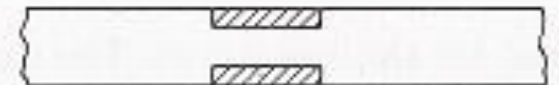


- Double action cylindrical draw die

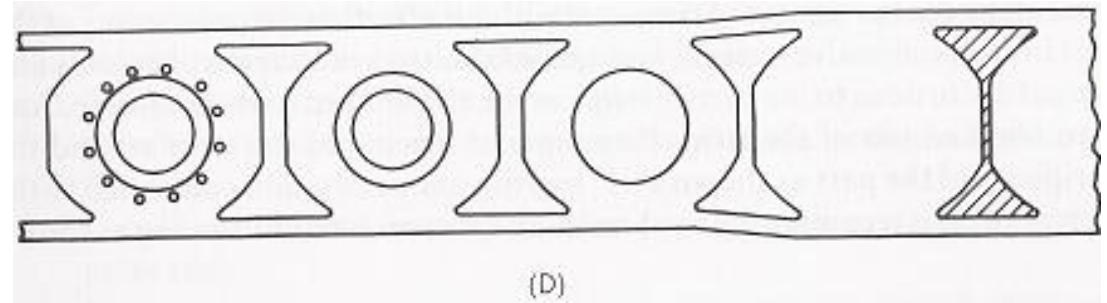
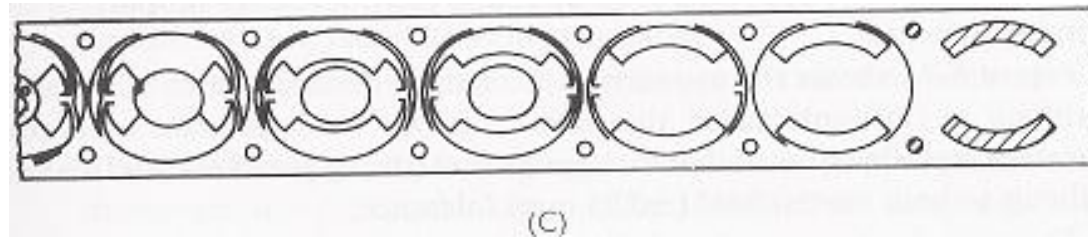
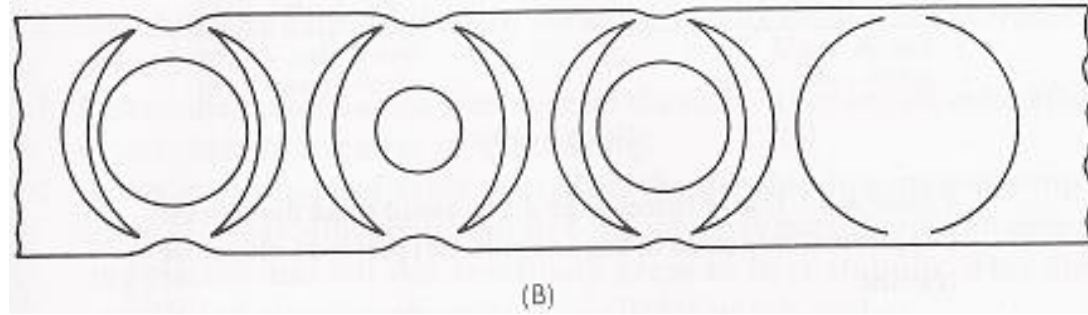
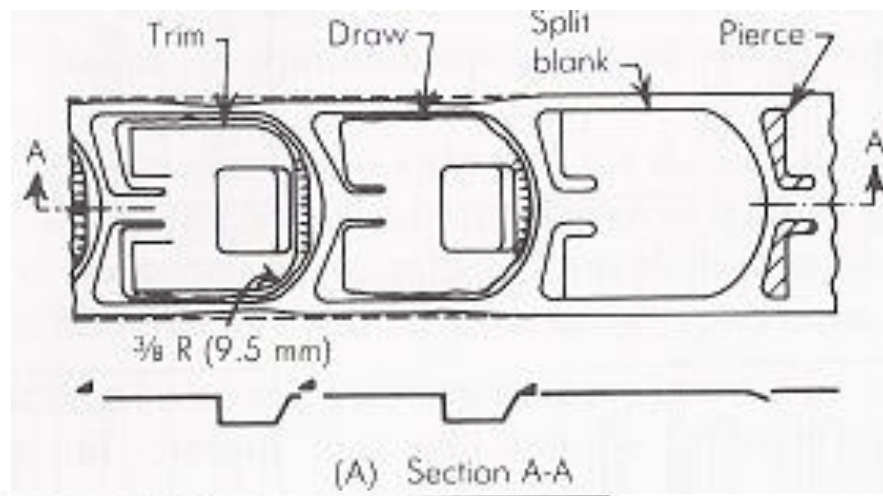
Design of Progressive Die

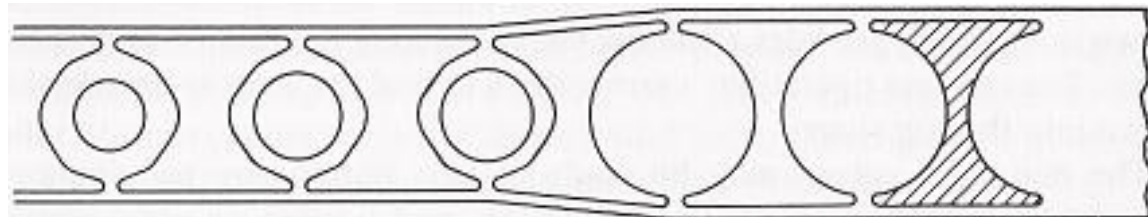


Poor practice because of two-station cutting



Good practice because the dimension is controlled in one station

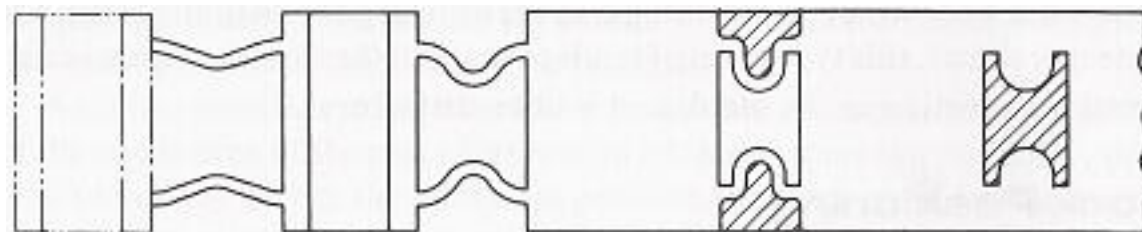




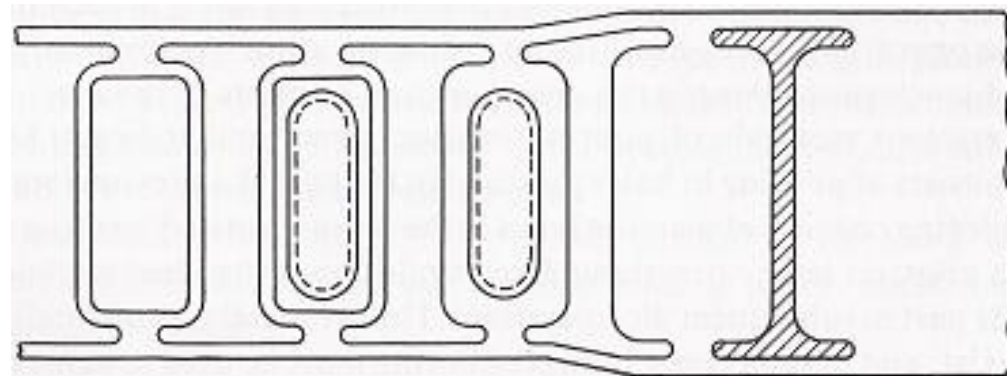
(E)



(F)

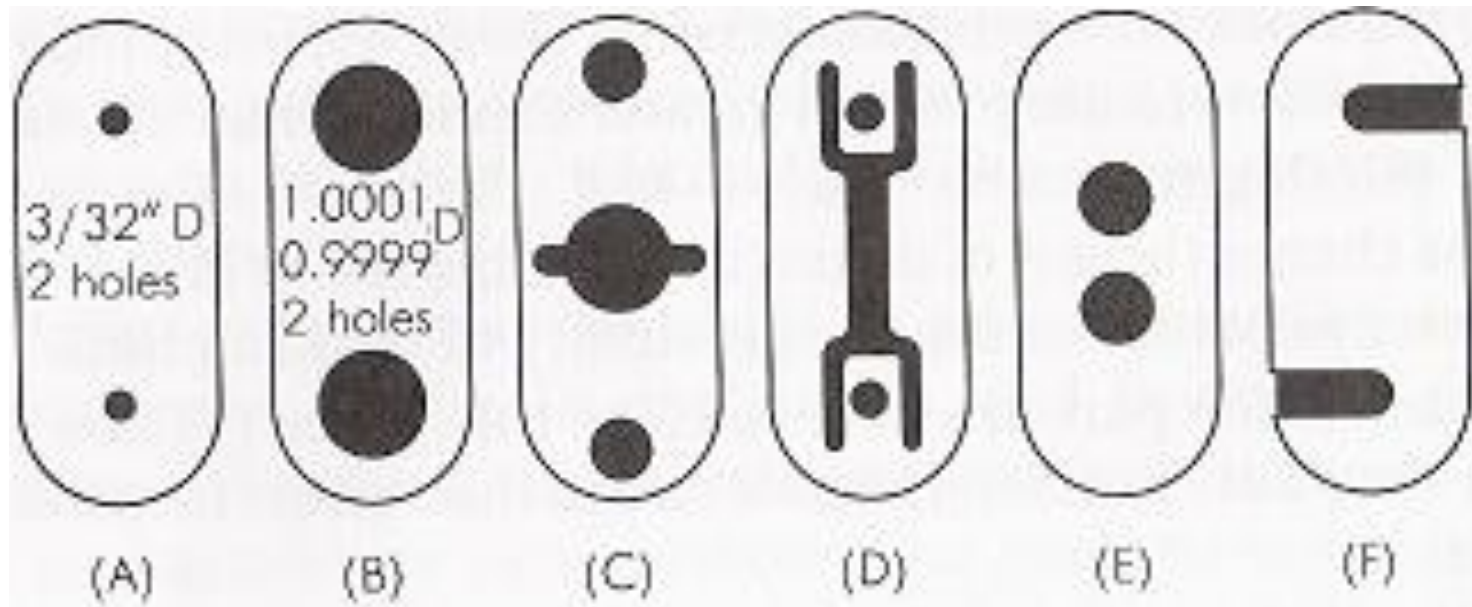


(G)



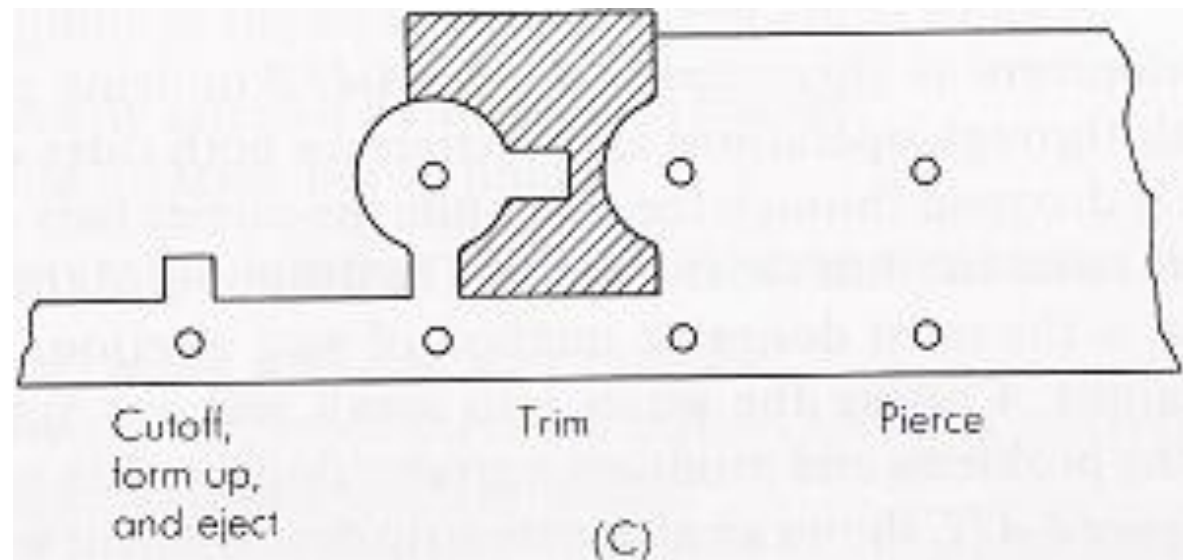
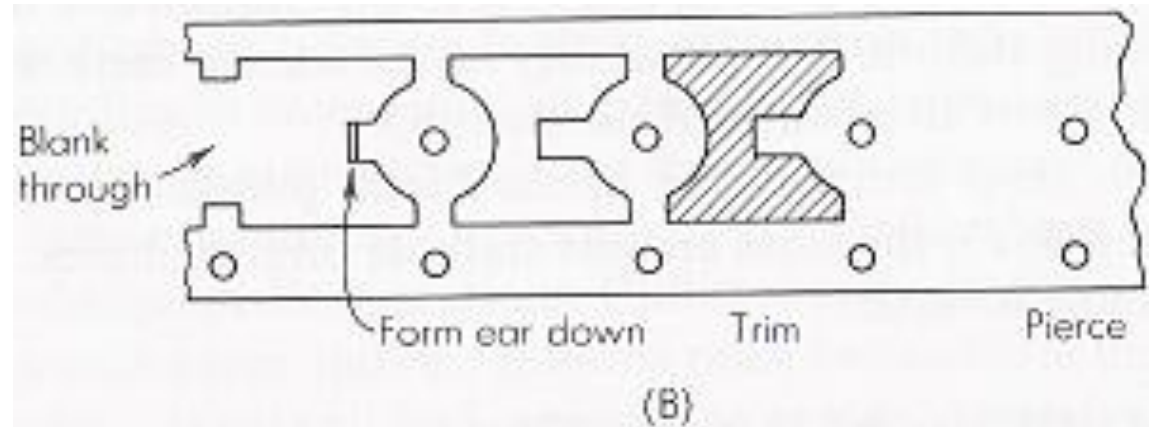
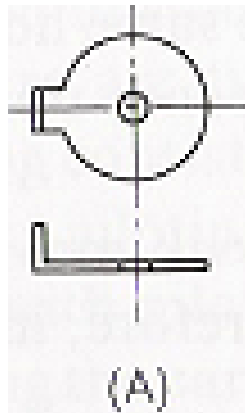
(H)

Stock Positioning



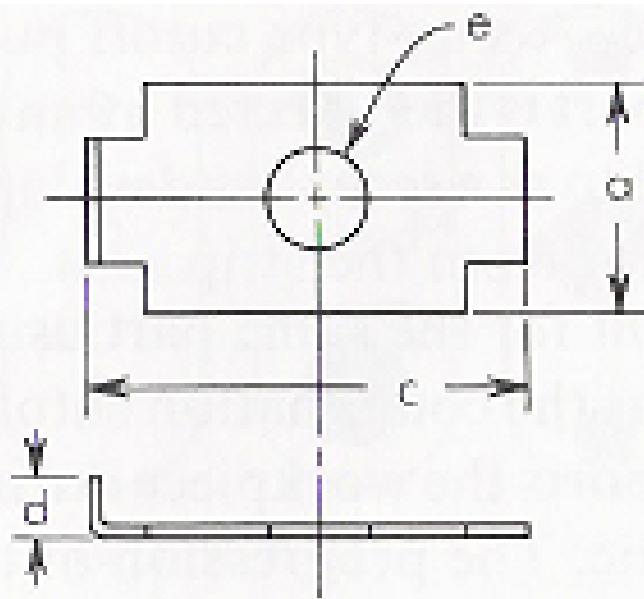
- A. Small holes
- B. Close tolerance holes
- C. Holes too near edge
- D. Hole fragile areas of the part
- E. Holes too close together
- F. Slots in parts

Alternate strip development for a workpiece

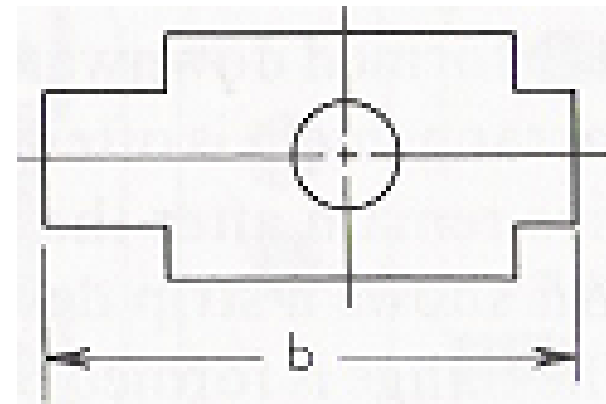


Which is better B or C?

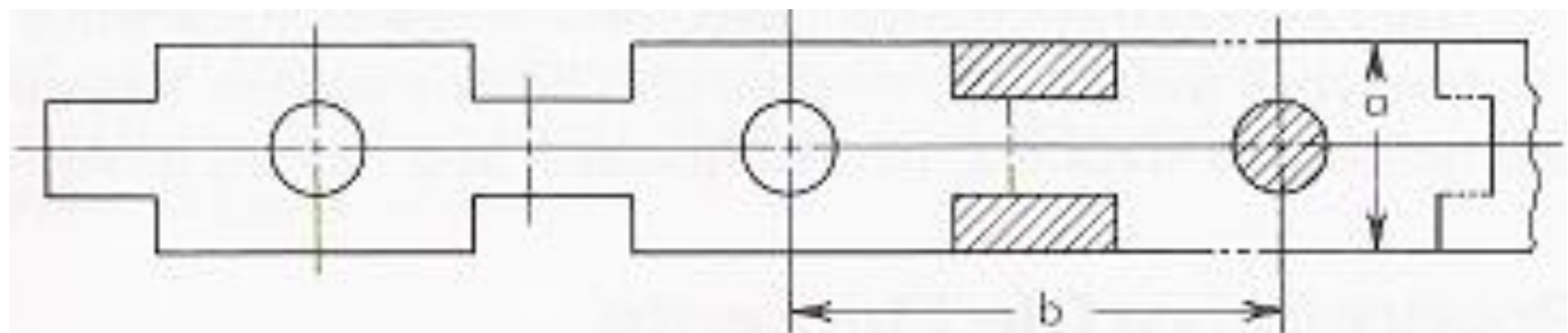
Example – Progressive Die



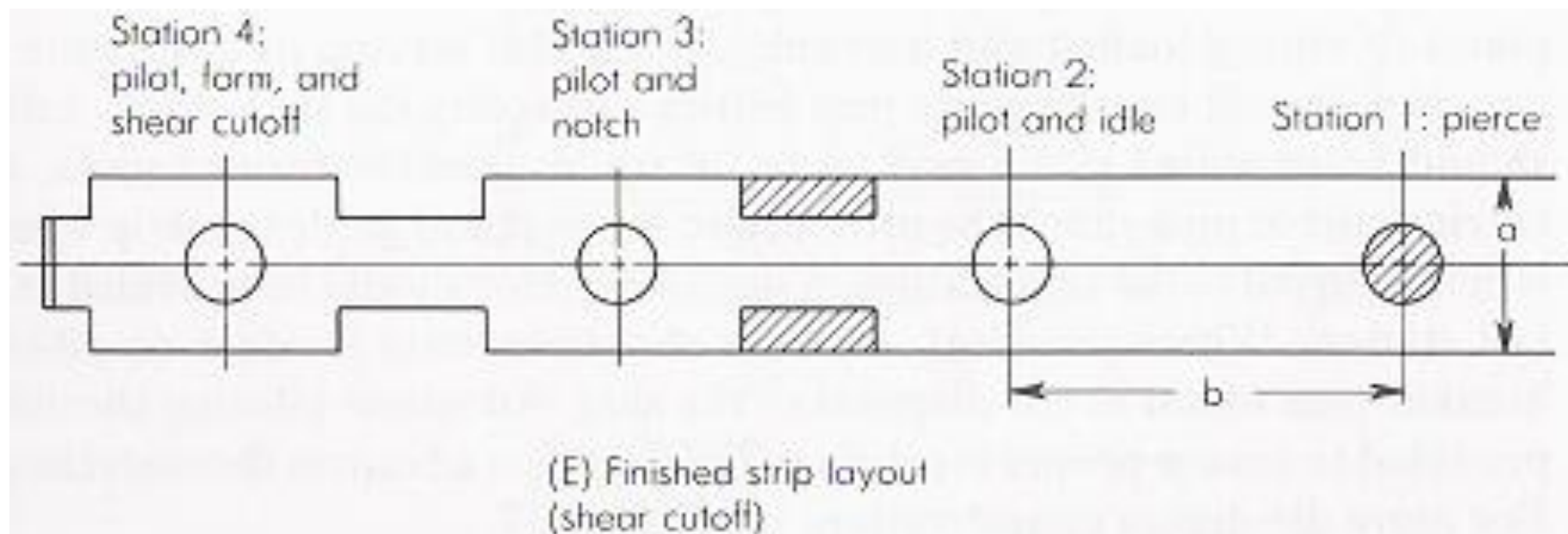
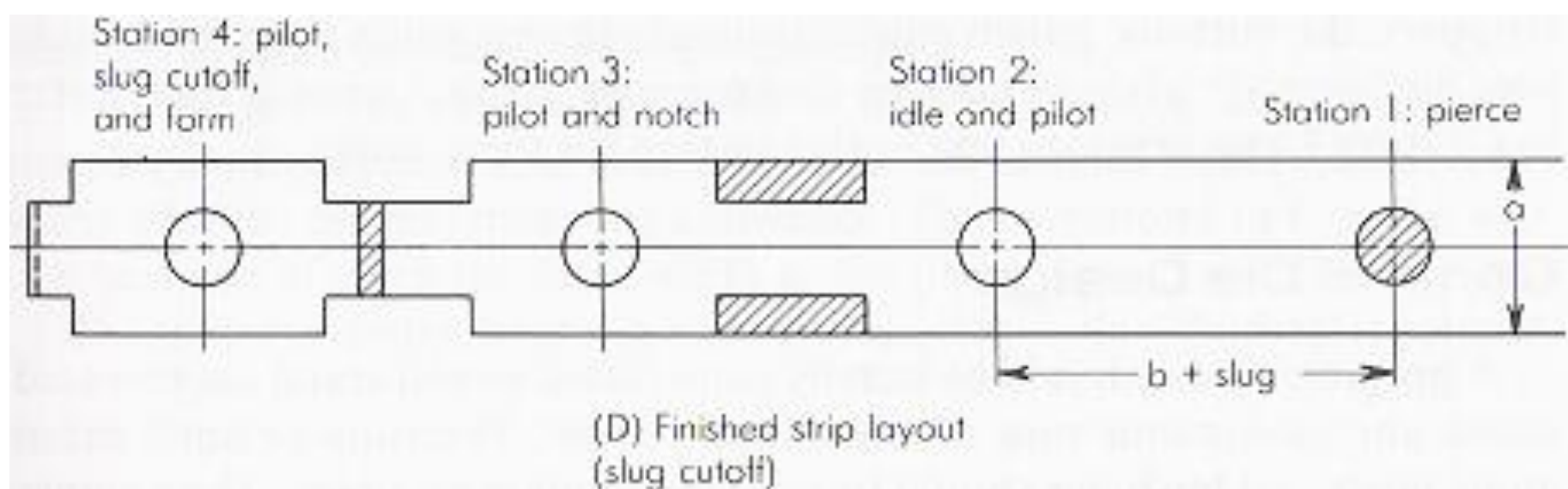
(A) Workpiece



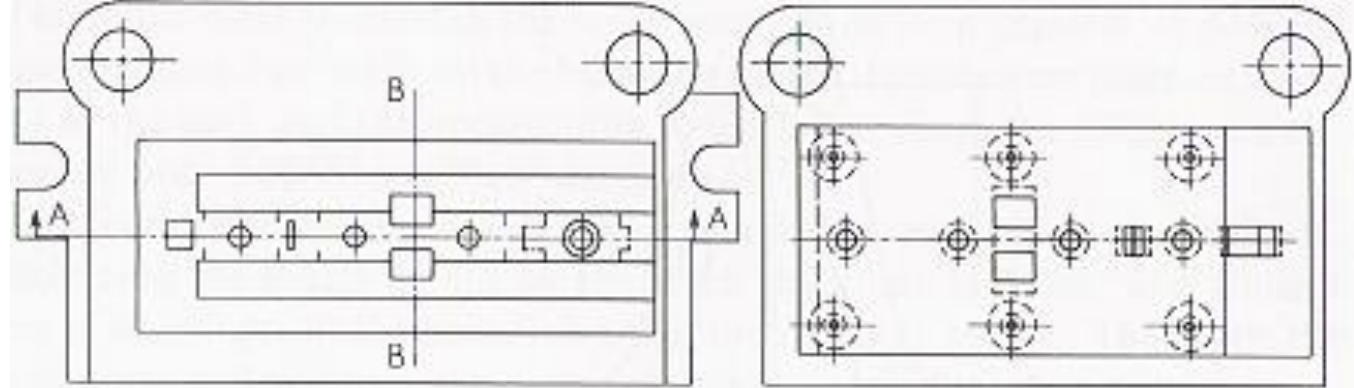
(B) Developed blank



(C) Rough strip layout

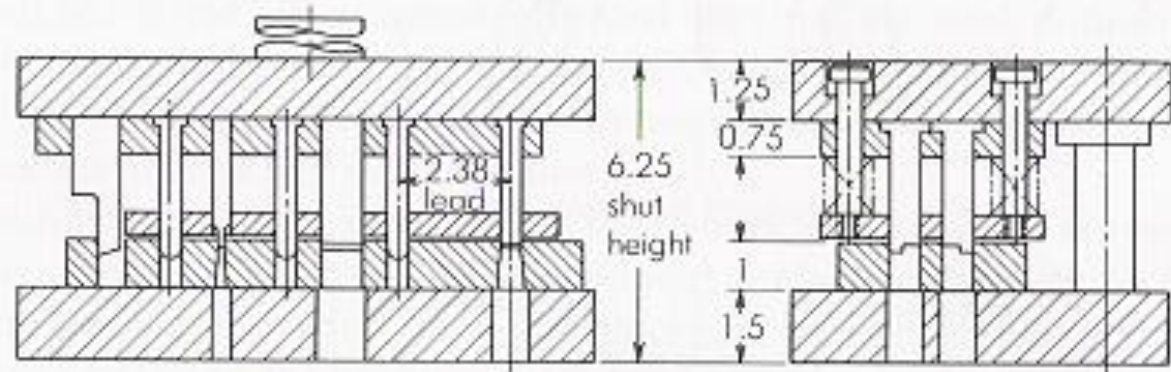


Complete Progressive Die



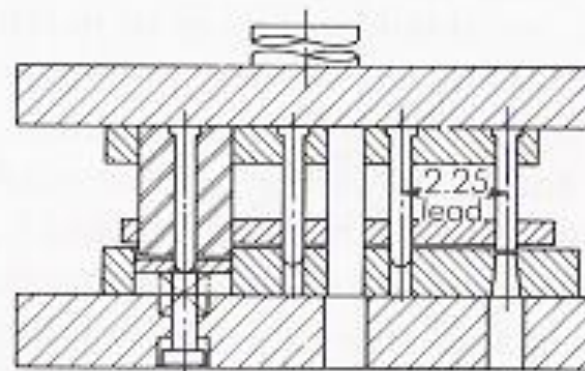
Plan view of die

Plan view punch (inverted)



Section A-A

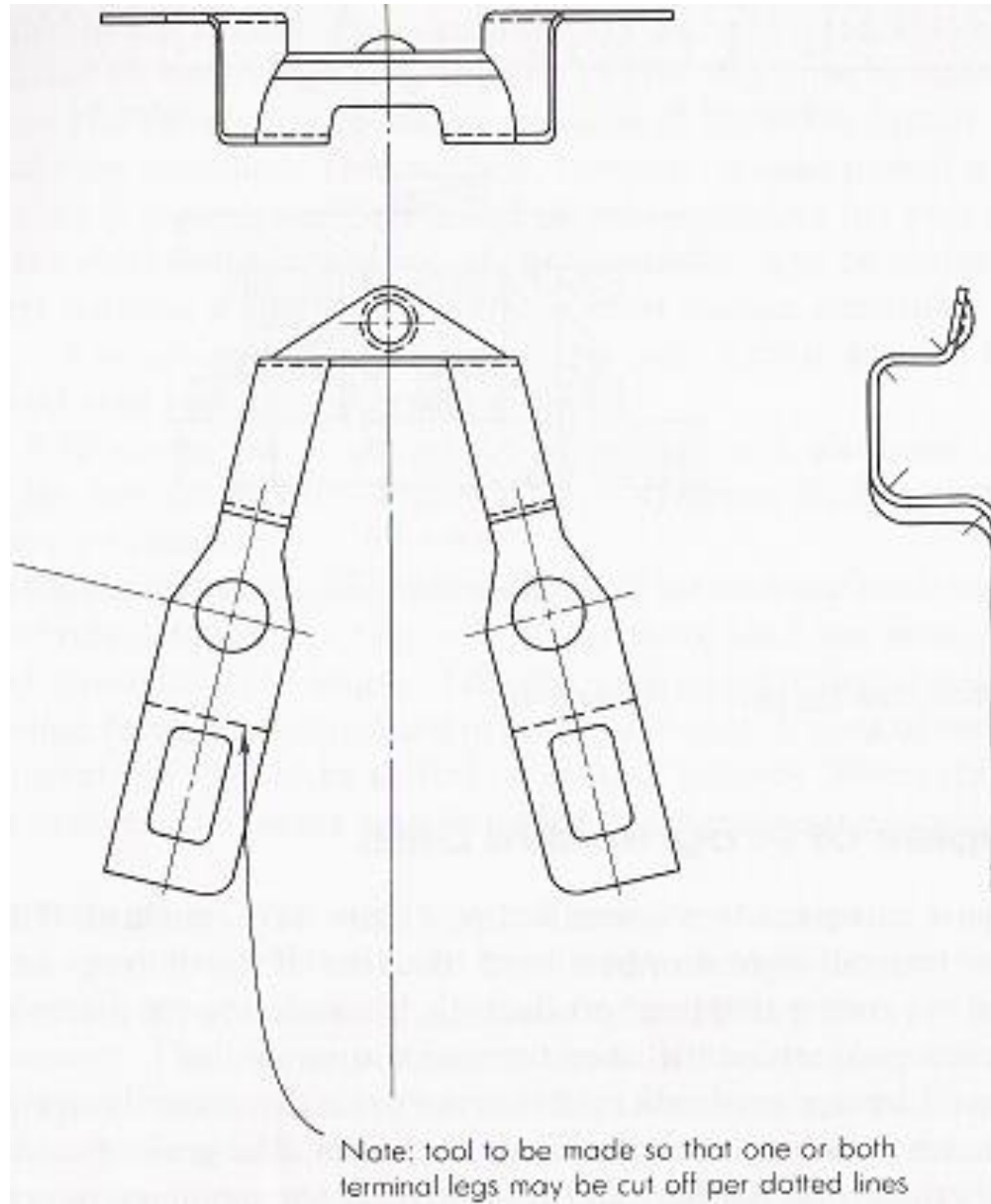
Section B-B

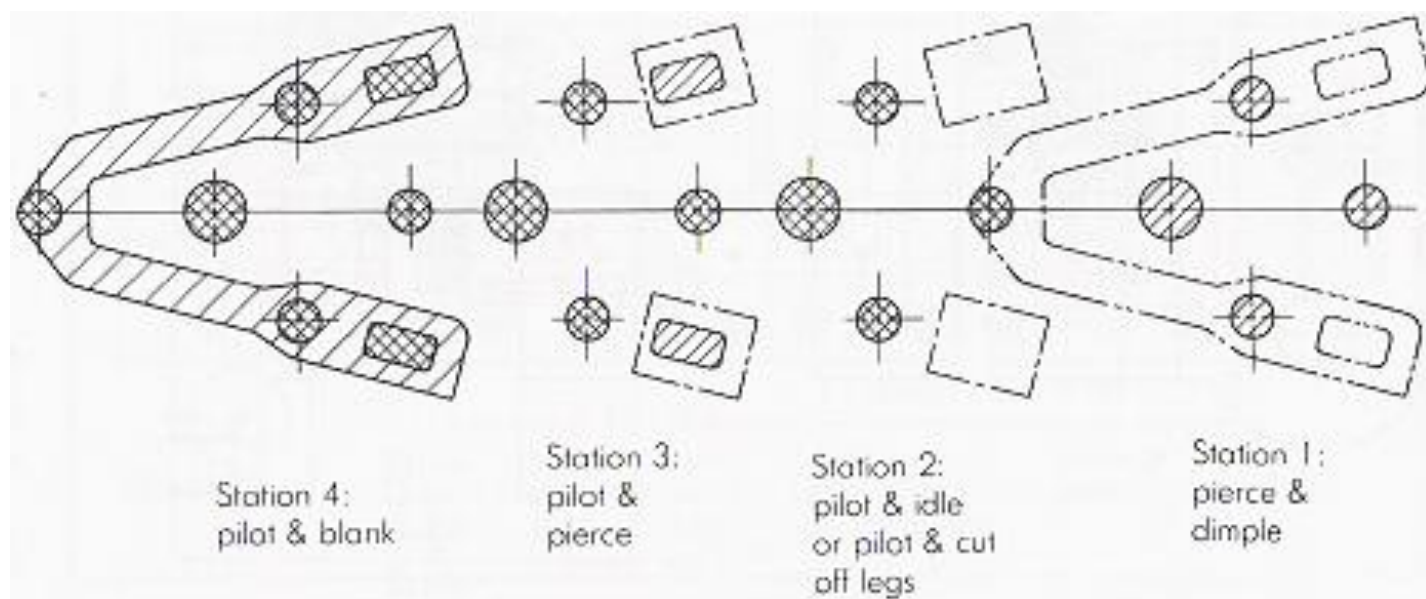
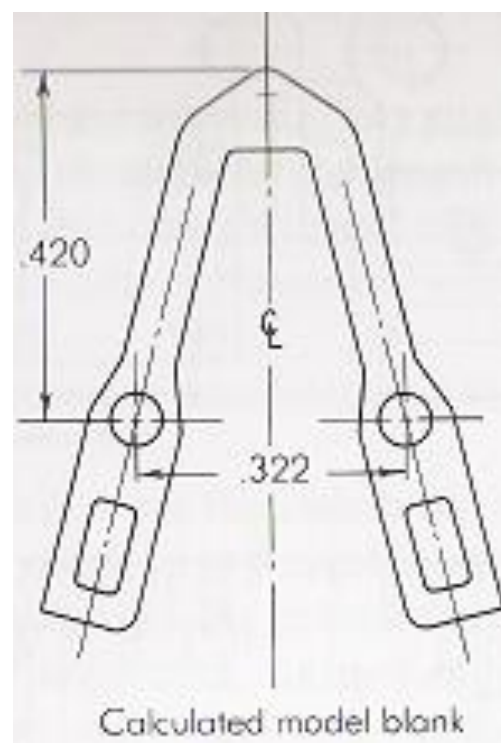


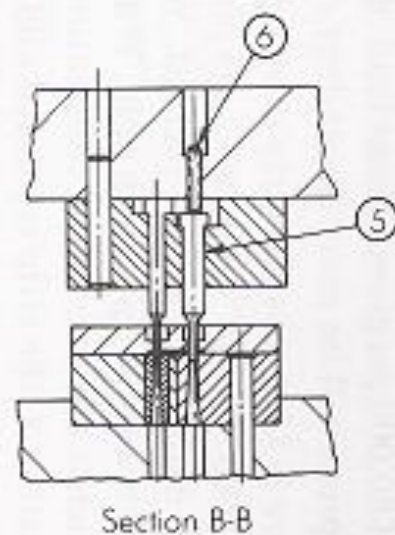
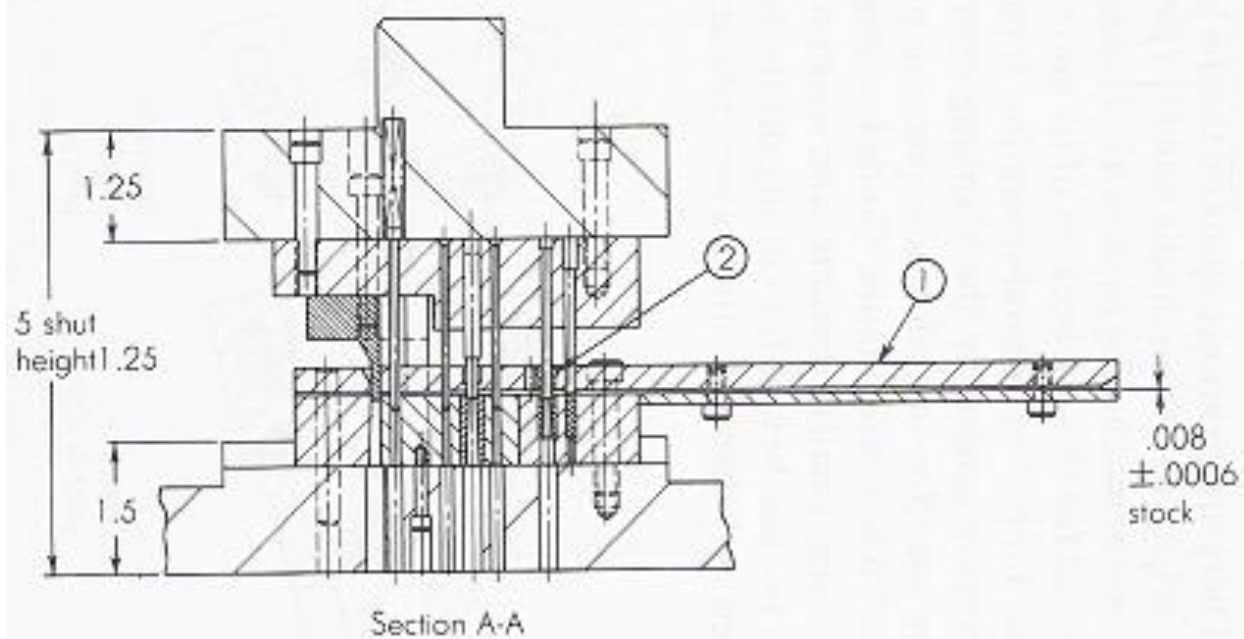
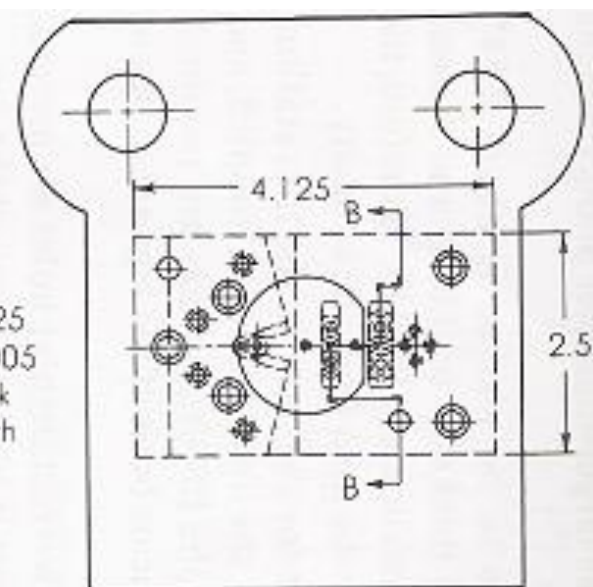
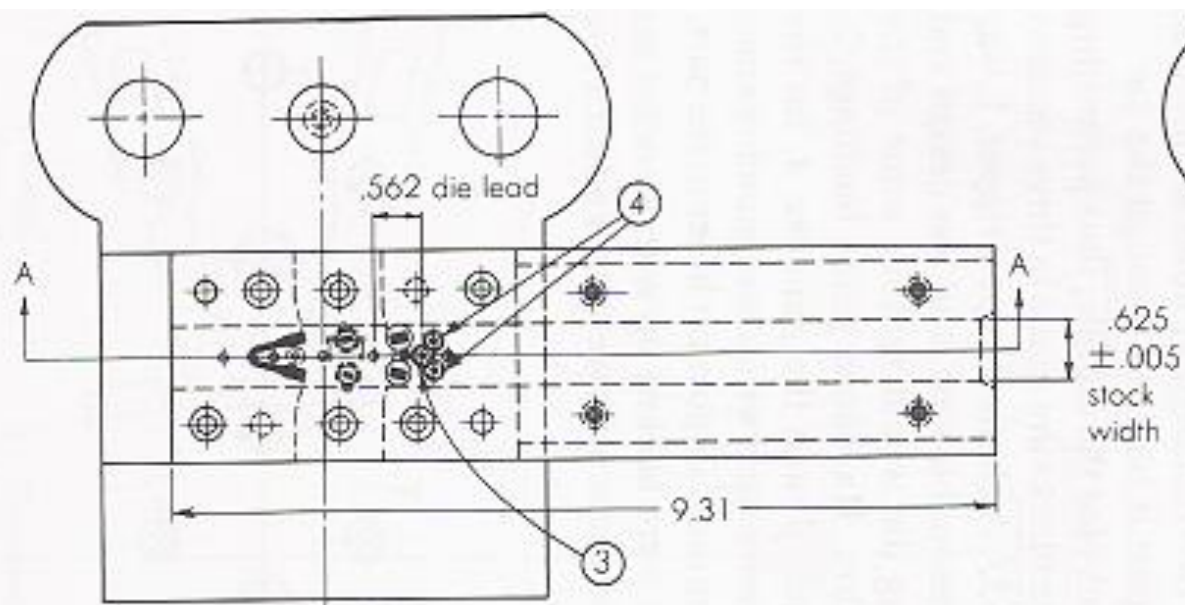
Section A-A

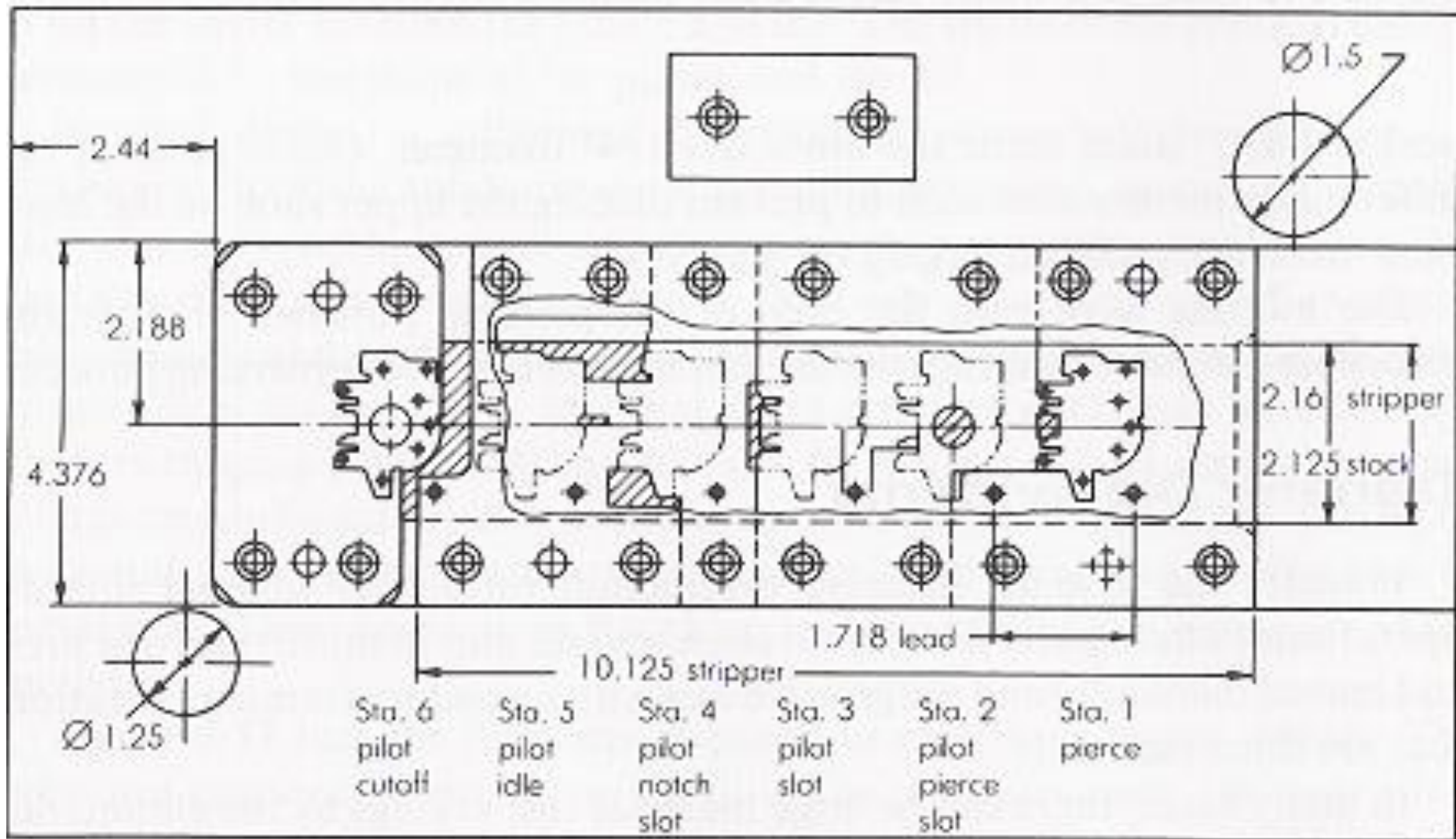
Shear type cutoff

Example – Progressive Die

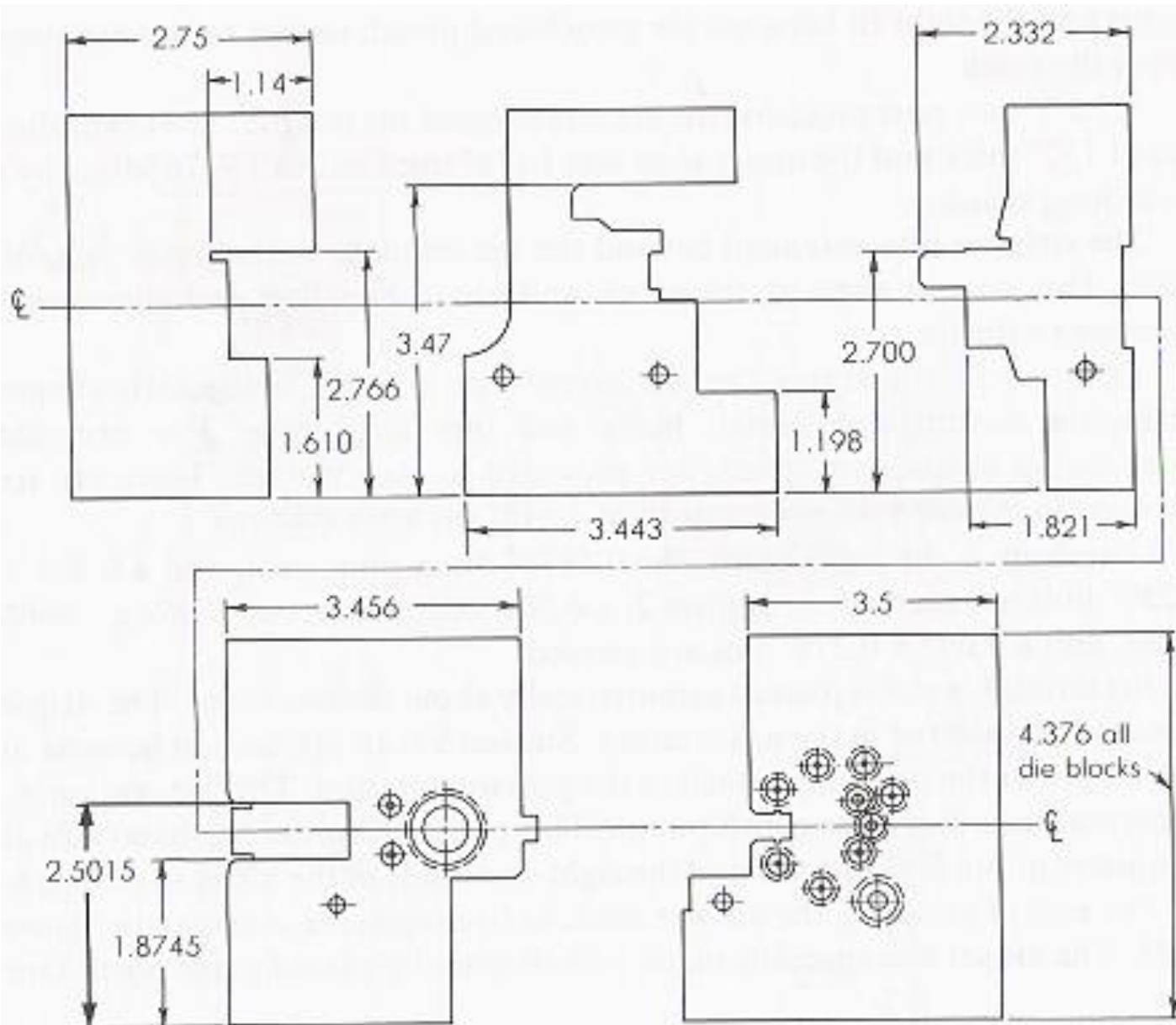








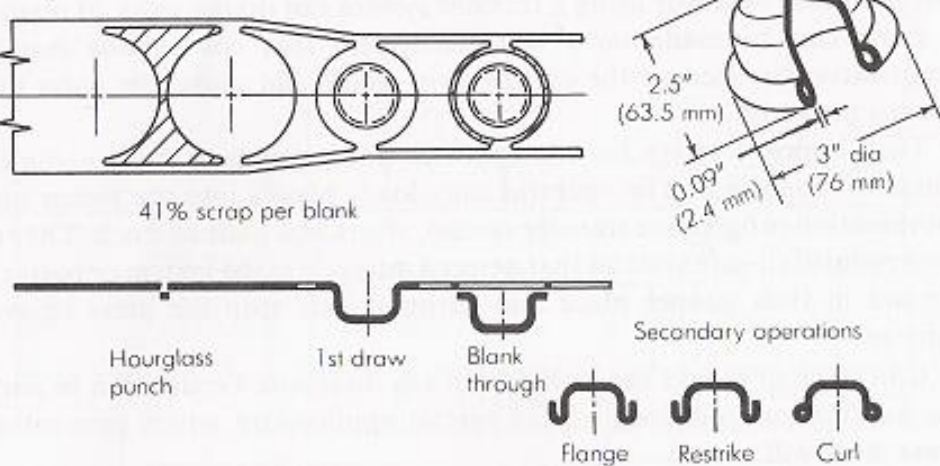
- Die layout for a small. Irregularly-shaped stamping having eight small holes and one large hole



- Detail of die block

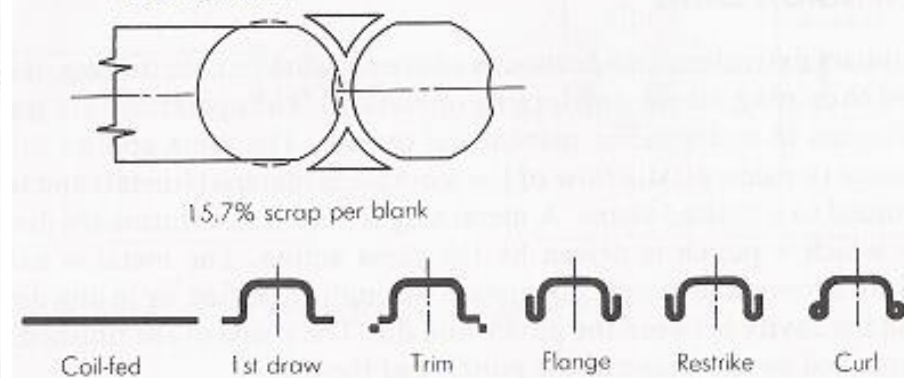
Progressive vs. Transfer Dies

Progressive operation



- Progressive Operation

Transfer operation



- Transfer operation

Which is Better ?