Stamping process classification

Summary

I. Definition of Stamping Process

II. Classification of Stamping Processes

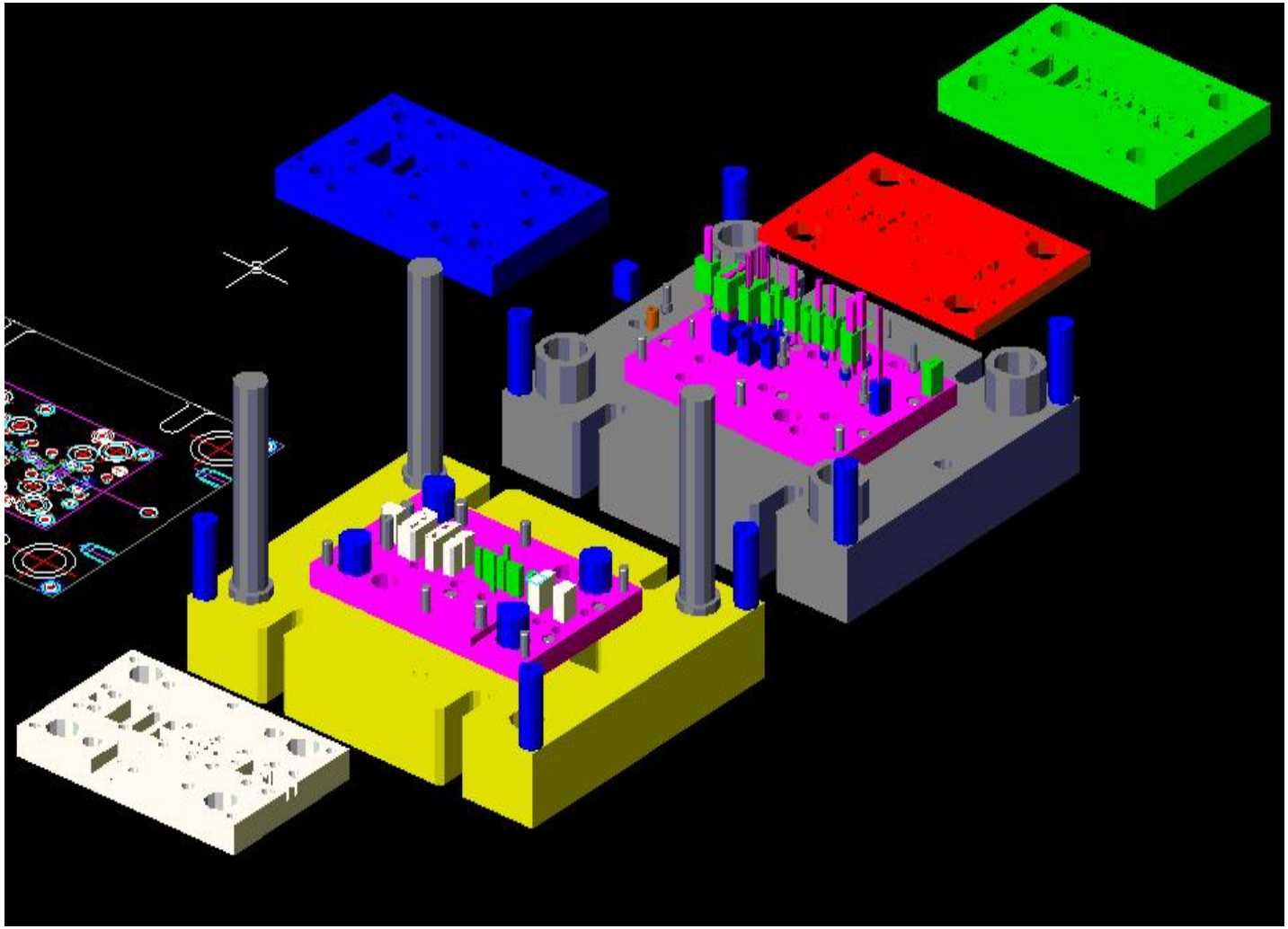
III. Typical Stamping Process Analysis

IV. Conclusion and Hopes

I. Definition of Stamping Process

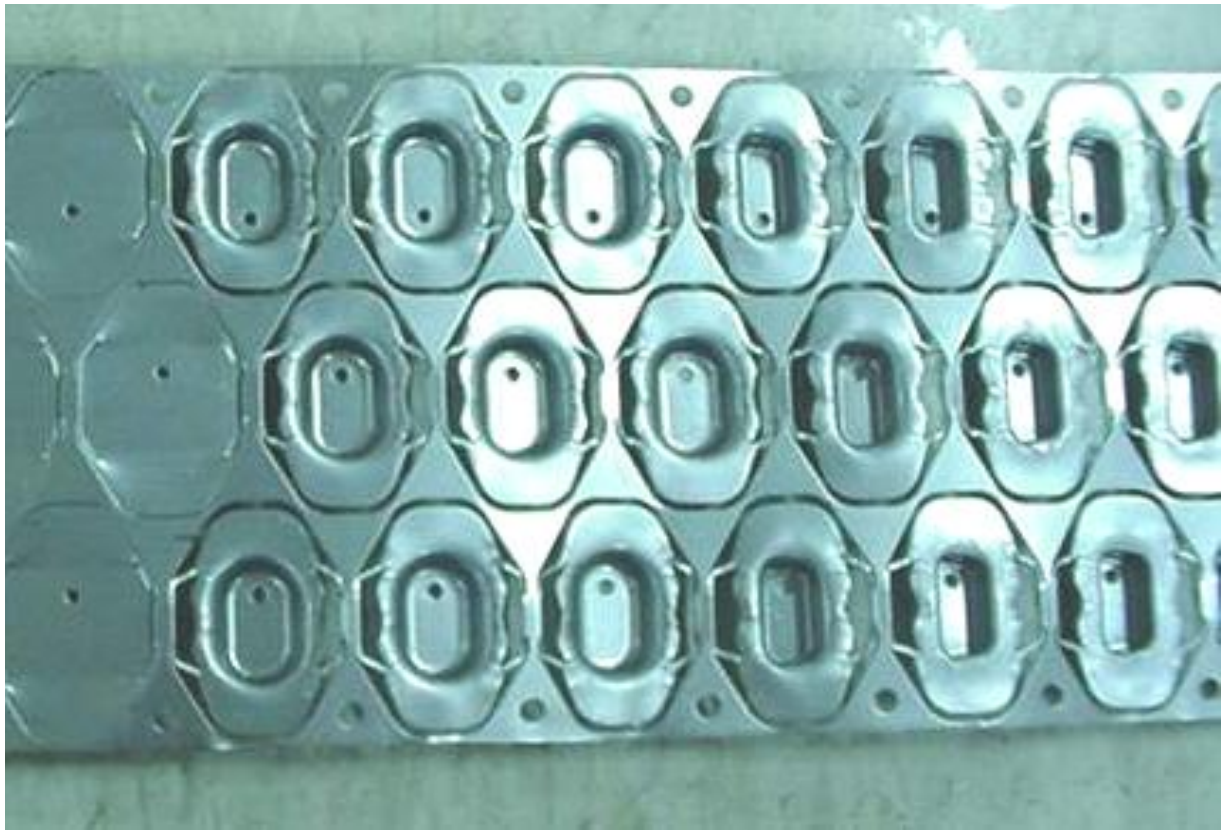
This is a manufacturing method that utilizes various pressure machines, with their sliders providing punching force, to perform various actions through molds, thereby causing plastic deformation of materials to achieve the purpose of making different parts.

Punch



Mold

material strip



II. Classification of Stamping Processes

1. Based on the deformation properties of the material, it can be roughly divided into two categories: separation (punching) and forming.

2. According to the different processing methods or stress-strain states of the deformation area, it can be further subdivided into several different processes.

II. Classification of Stamping Processes

Separation process:
Induces permanent shear deformation in the material.

2.1 Shearing

2.2 Blanking

2.3 Punching

2.4 Incision

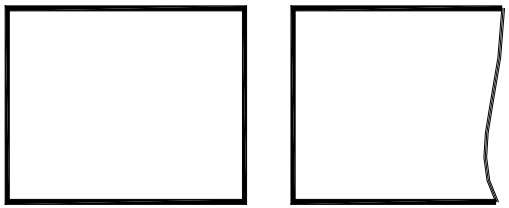
2.5 Cutting edge

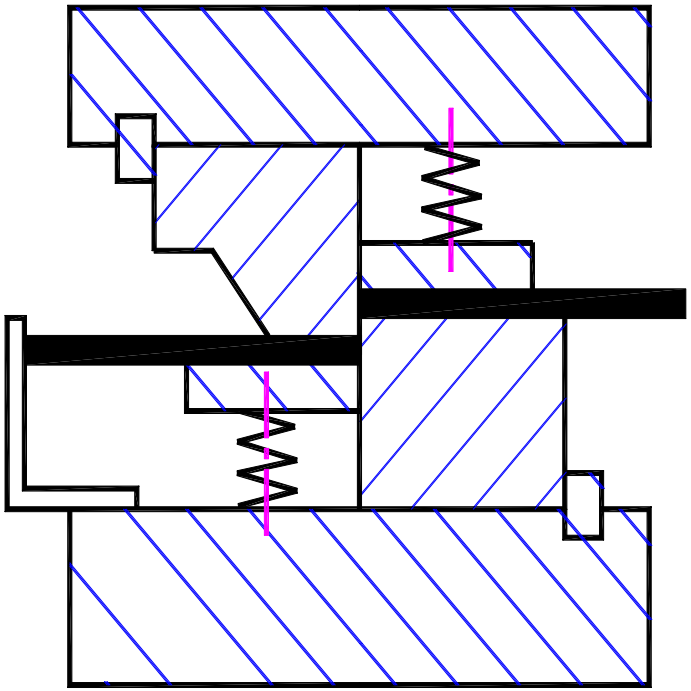
2.6 Sectioning

II. Classification of Stamping Processes

2.1 Cutting

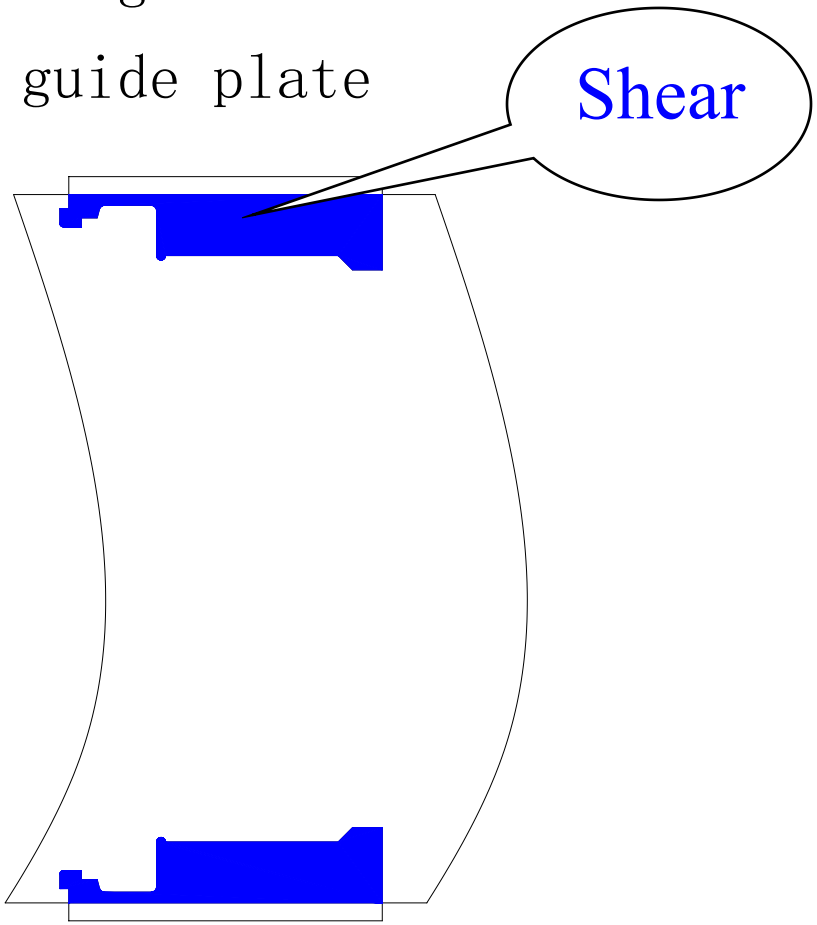
Cut the board with scissors or a die, leaving the cut line unclosed.





II. Classification of Stamping Processes

Shearing: For example, the edge trimming station for many guide plate type molds in hardware.



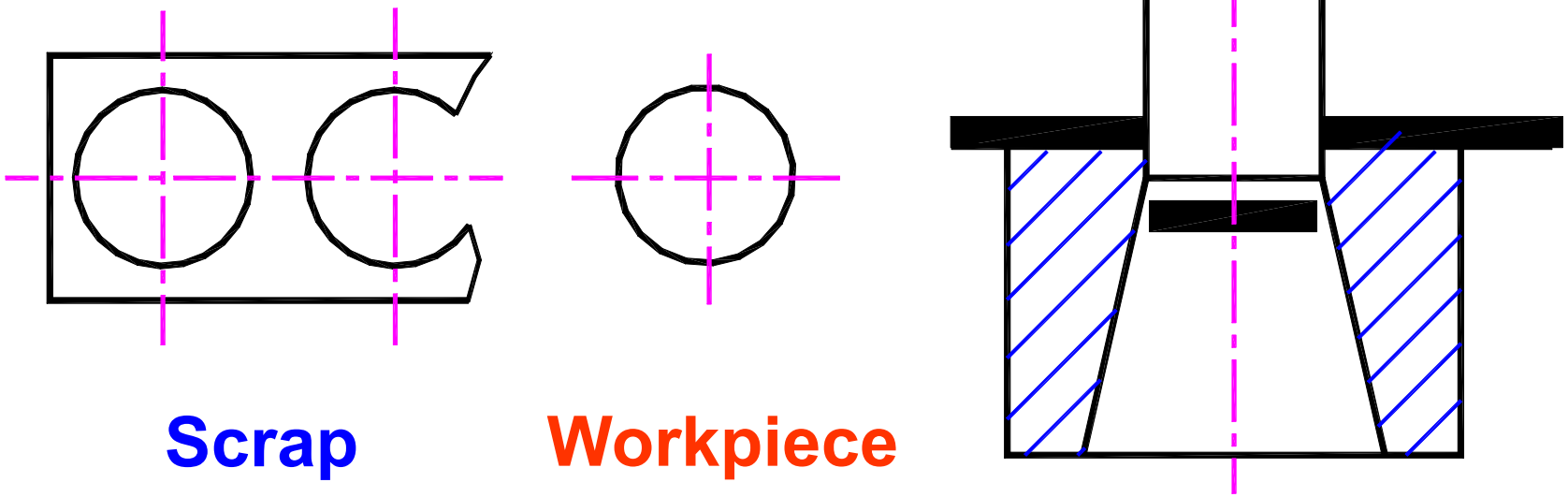
For example, 822-110N2

The cut line is not sealed.

II. Classification of Stamping Processes

2.2 Material dropping

The sheet metal is punched along the closed line using a die; the punched-off portion is the workpiece, and the remaining portion is scrap.

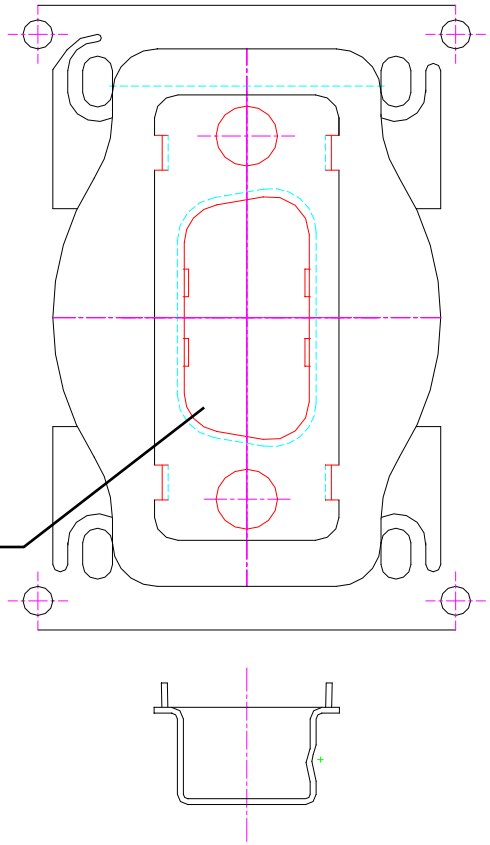


II. Classification of Stamping Processes

Blanking: Because metal parts are produced using progressive die manufacturing, blanking is generally done at the last stage of a single-piece product. The last product drawn is typically the blanking stage.

820-170n3

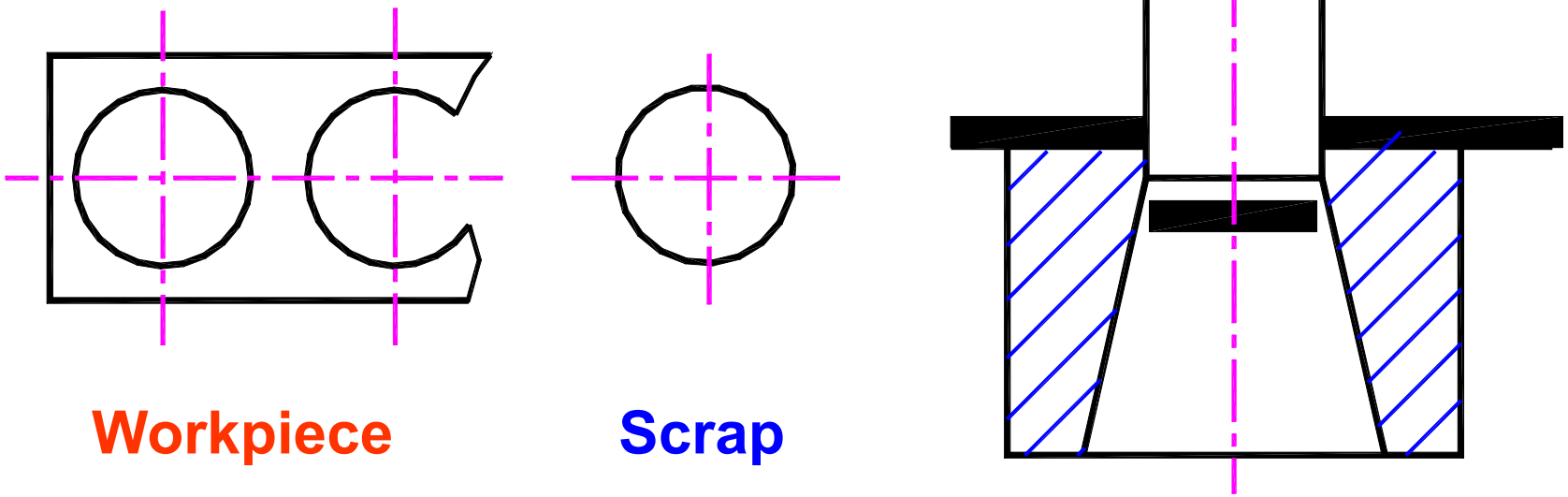
Product



II. Classification of Stamping Processes

2.3 Punching

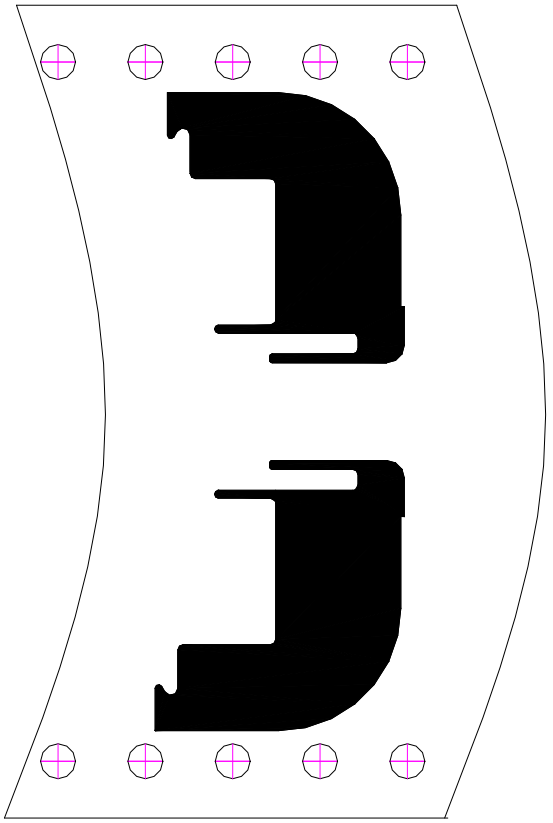
The sheet metal is punched along the closed line using a die; the punched-off portion is scrap, and the remaining portion is the workpiece.



II. Classification of Stamping Processes

Punching: The most common process in stamping

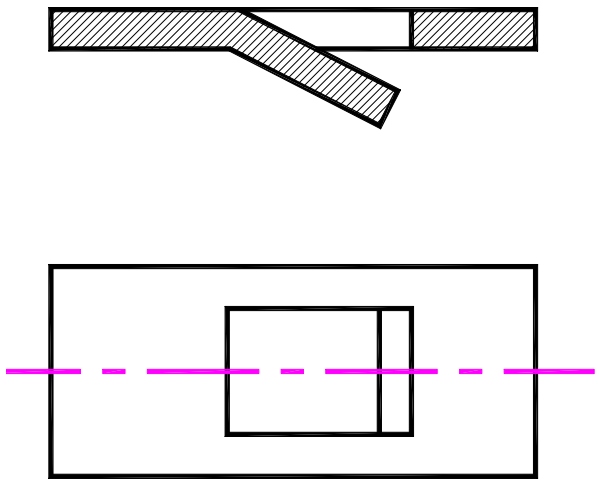
The part that was punched down (822-530) is scrap (black).

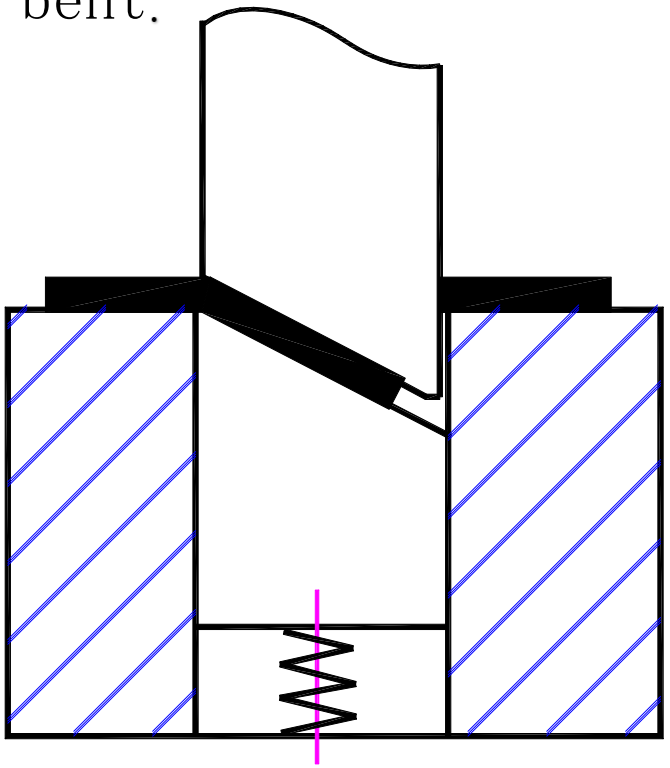


II. Classification of Stamping Processes

2.4 Incision

The sheet material is cut open from the blank, and the cut edge is bent.

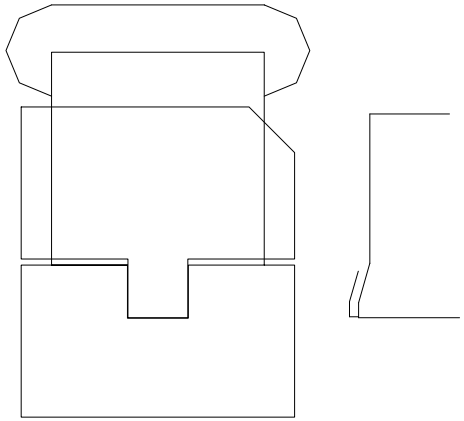




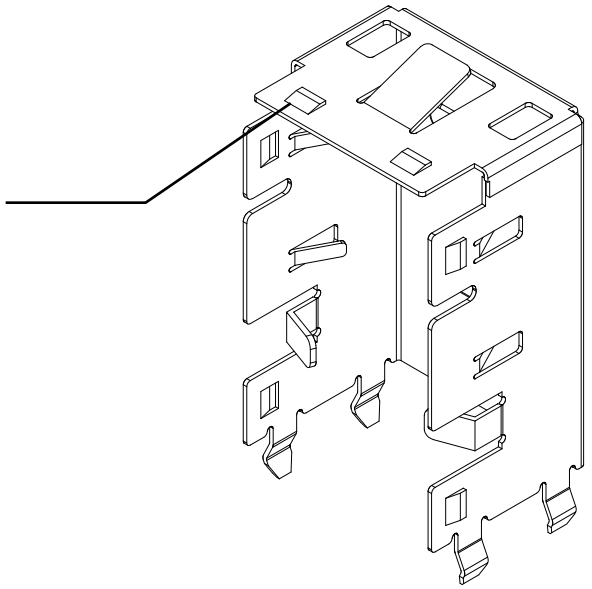
II. Classification of Stamping Processes

Cutting: Hardware parts often use a tearing method, in conjunction wi plastic parts.

824-180



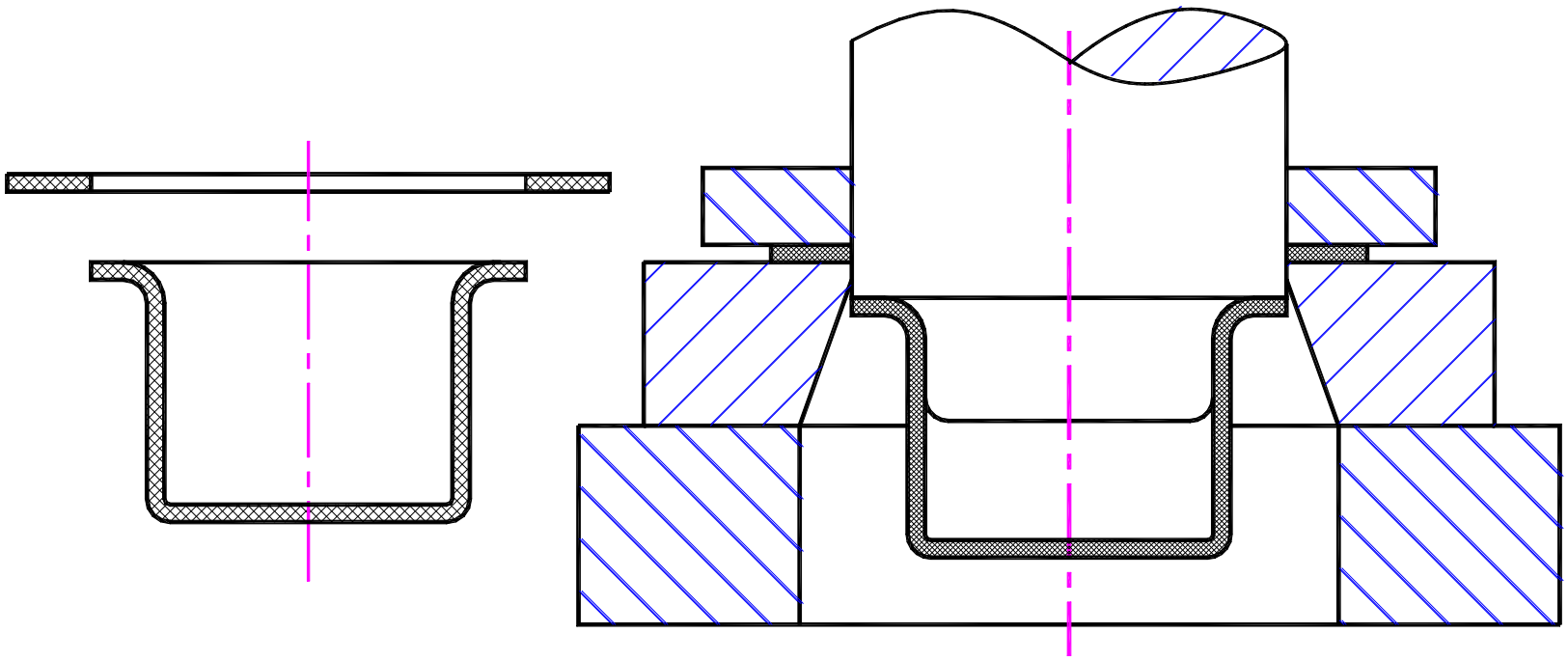
Incision location



II. Classification of Stamping Processes

2.5 Trimming

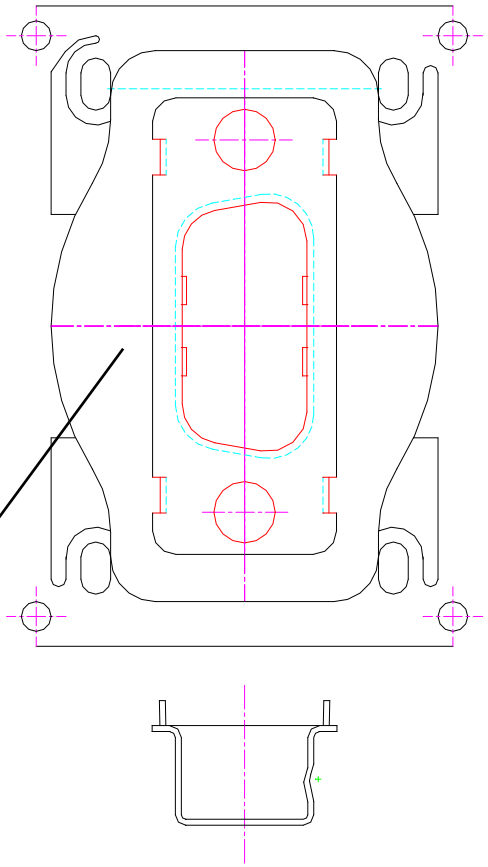
Cut off any excess material from the edges of the drawn or shaped semi-finished product.



II. Classification of Stamping Processes

Trimming: This refers to the trimming station, where trimming is generally required after the part is drawn.

820-170n3

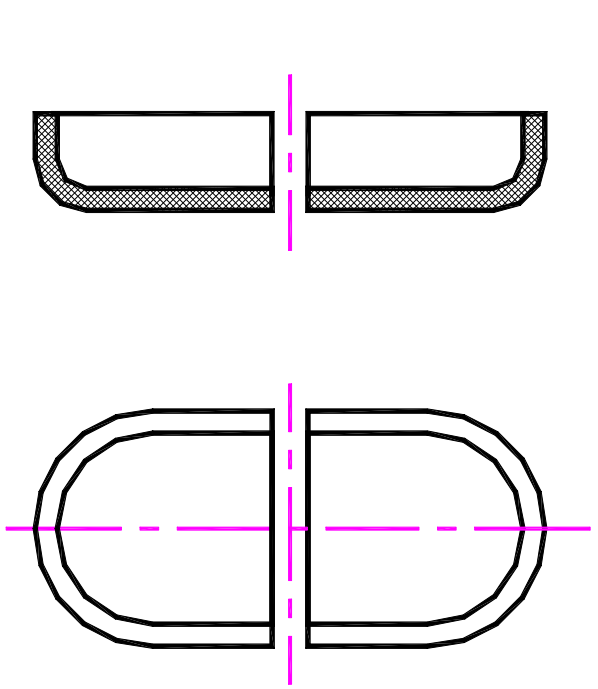


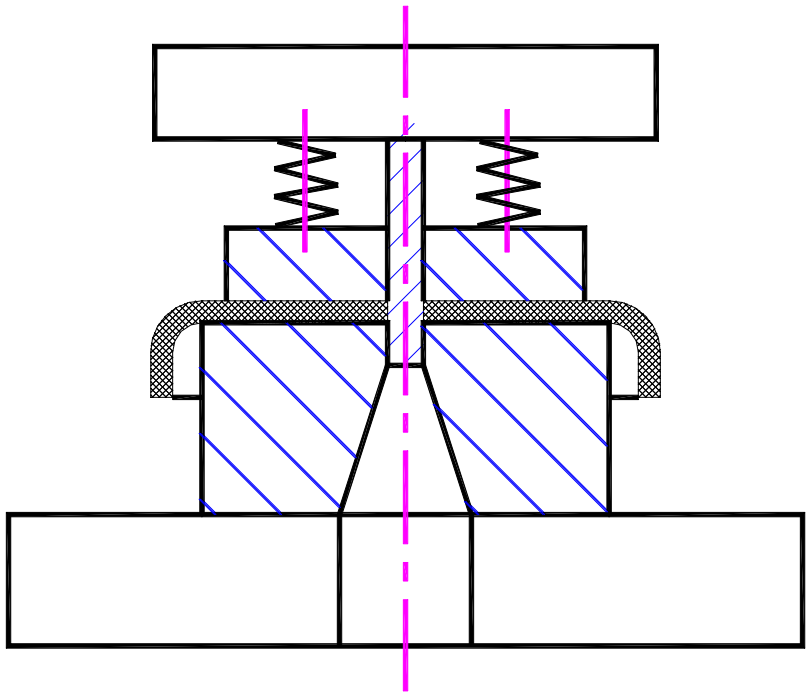
Excision of the lateral lap

II. Classification of Stamping Processes

2.6 Sectionin

The sheet material is cut open from the blank, and the cut edge is bent.





II. Classification of Stamping Processes

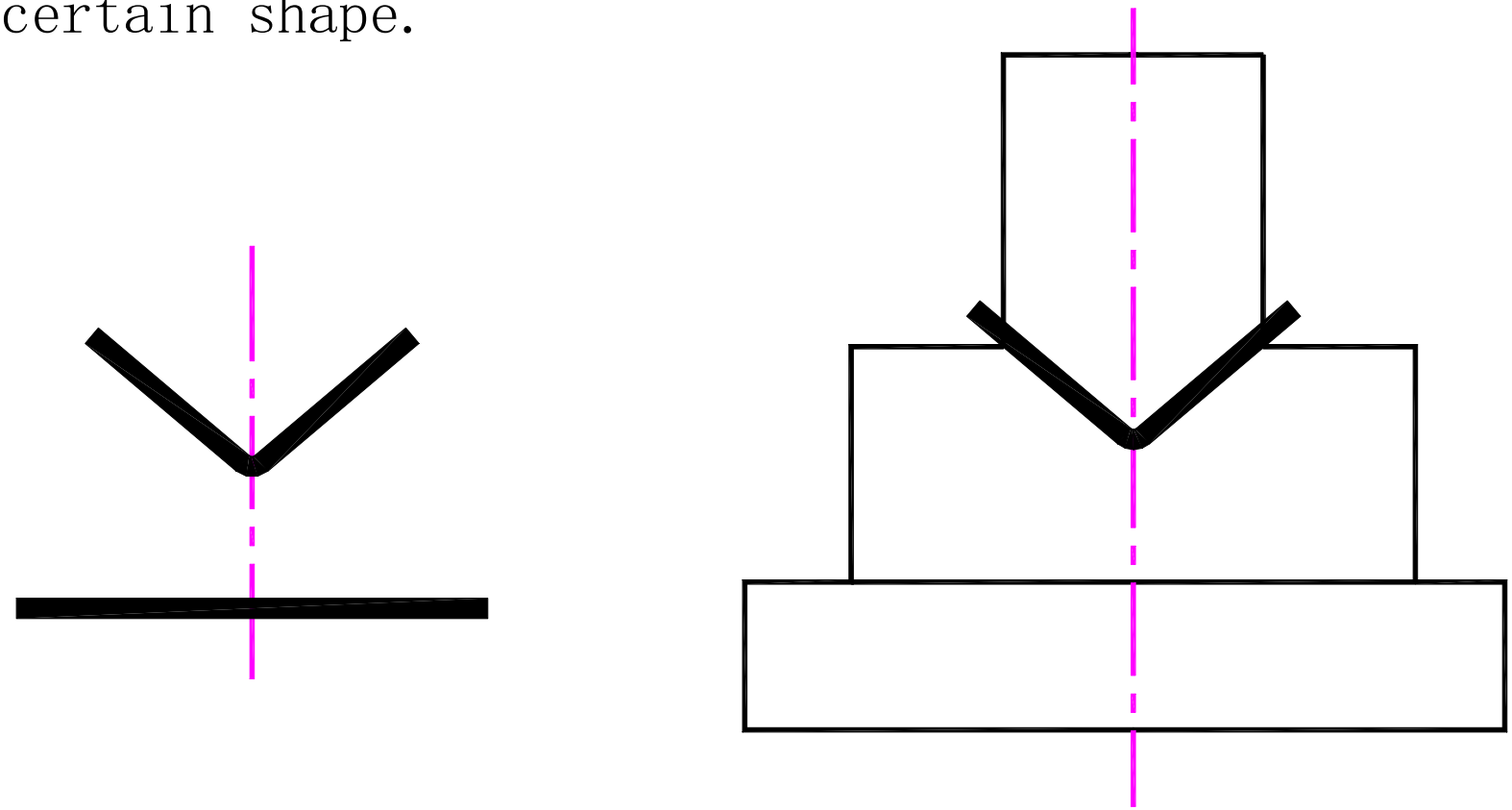
Forming process:
To induce plastic deformation in the material

2.7 Bending
2.8 Rolling
2.9 Twisting
2.10 Deep drawing (drawing)
2.11 Thinning and deep drawing
2.12 Bulging
2.13 Flanging

II. Classification of Stamping Processes

2.7 Bending

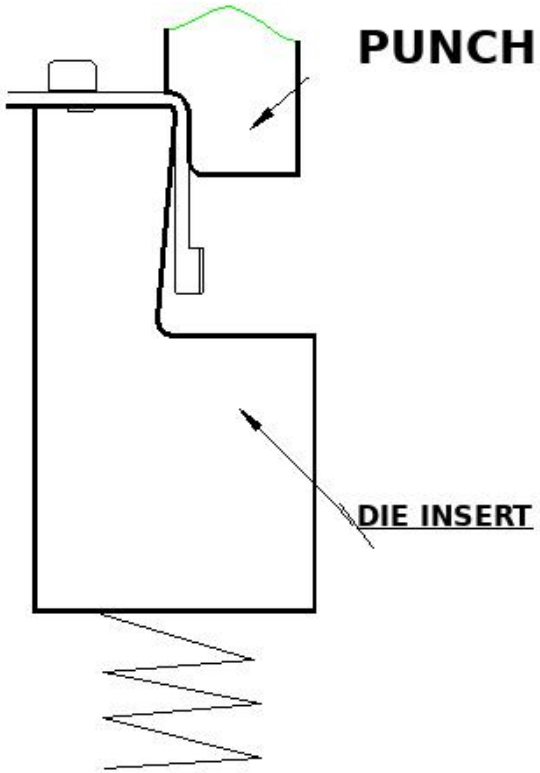
Use a mold to bend the material into a certain shape.



II. Classification of Stamping Processes

Bending: A common process in stamping parts, widely used in hardware components.

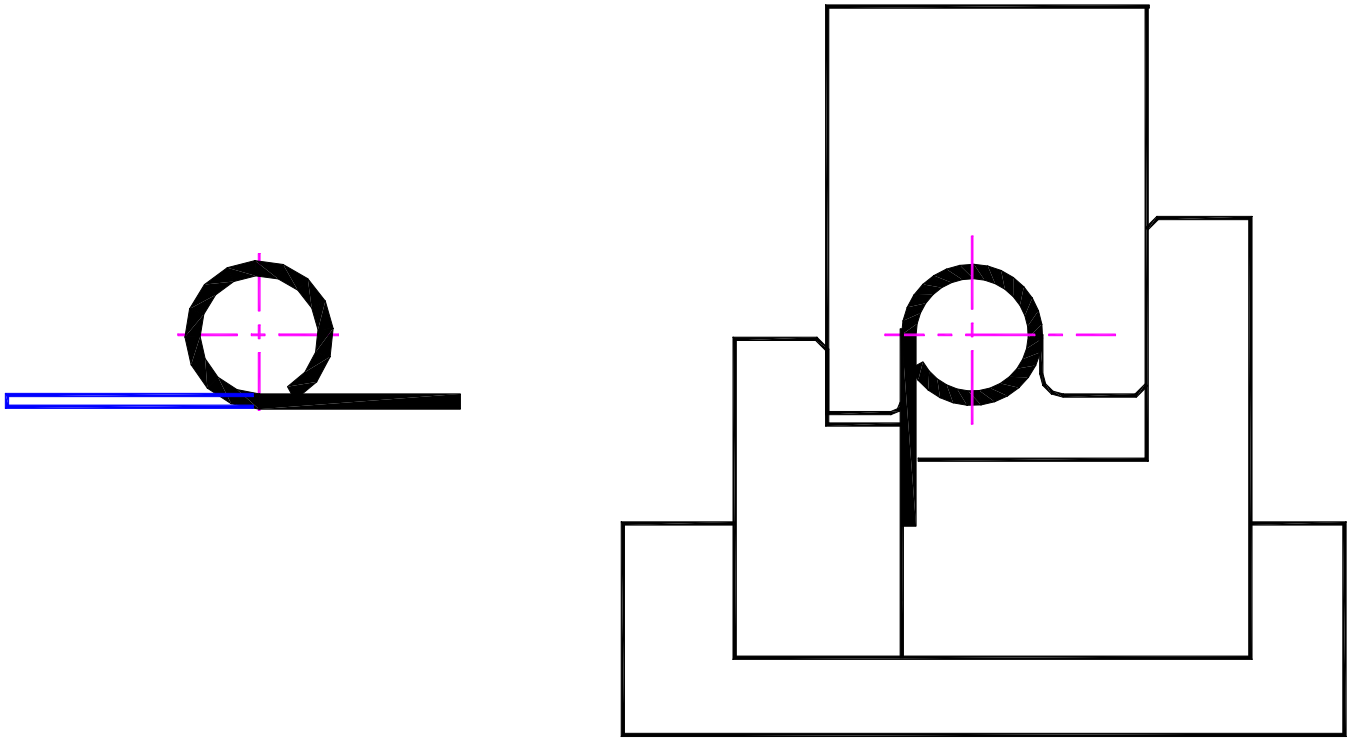
824-147 Single-sided bending



II. Classification of Stamping Processes

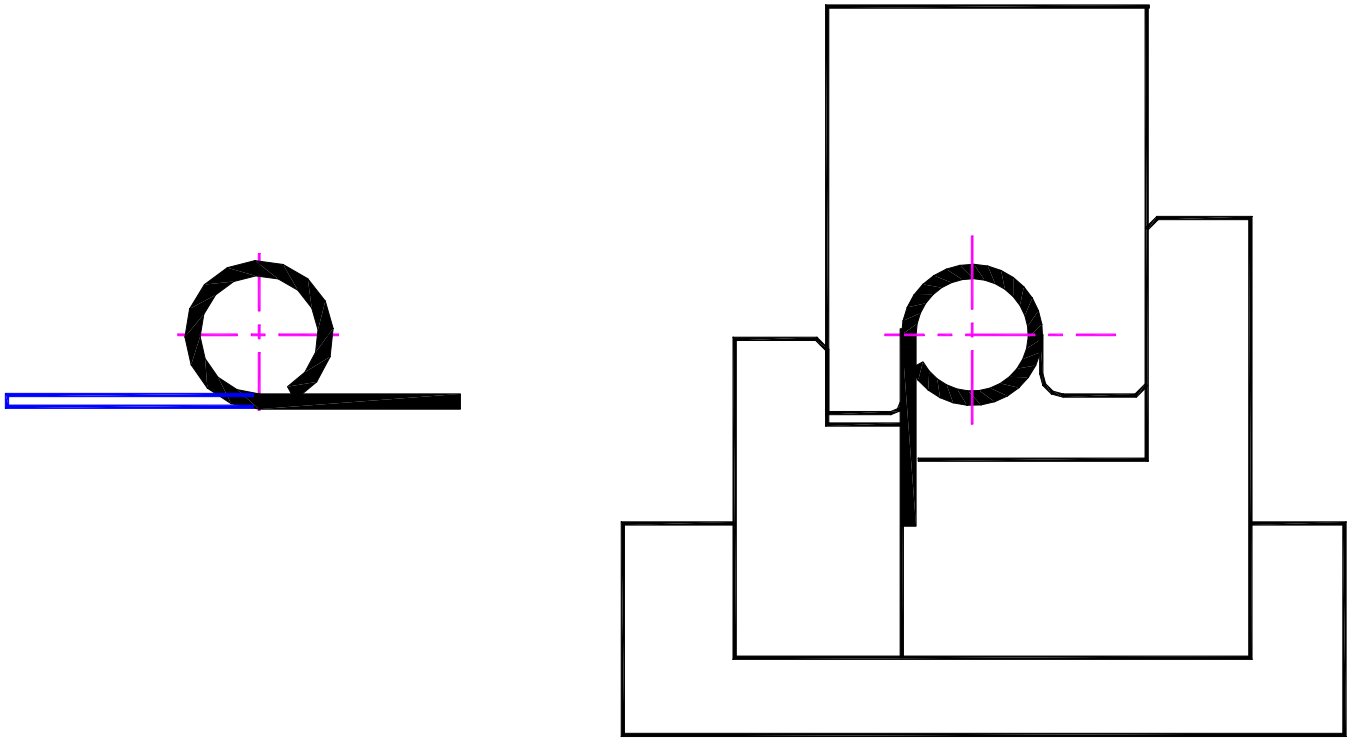
2.8 Rolling

Roll the ends of the sheet metal into a circle



II. Classification of Stamping Processes

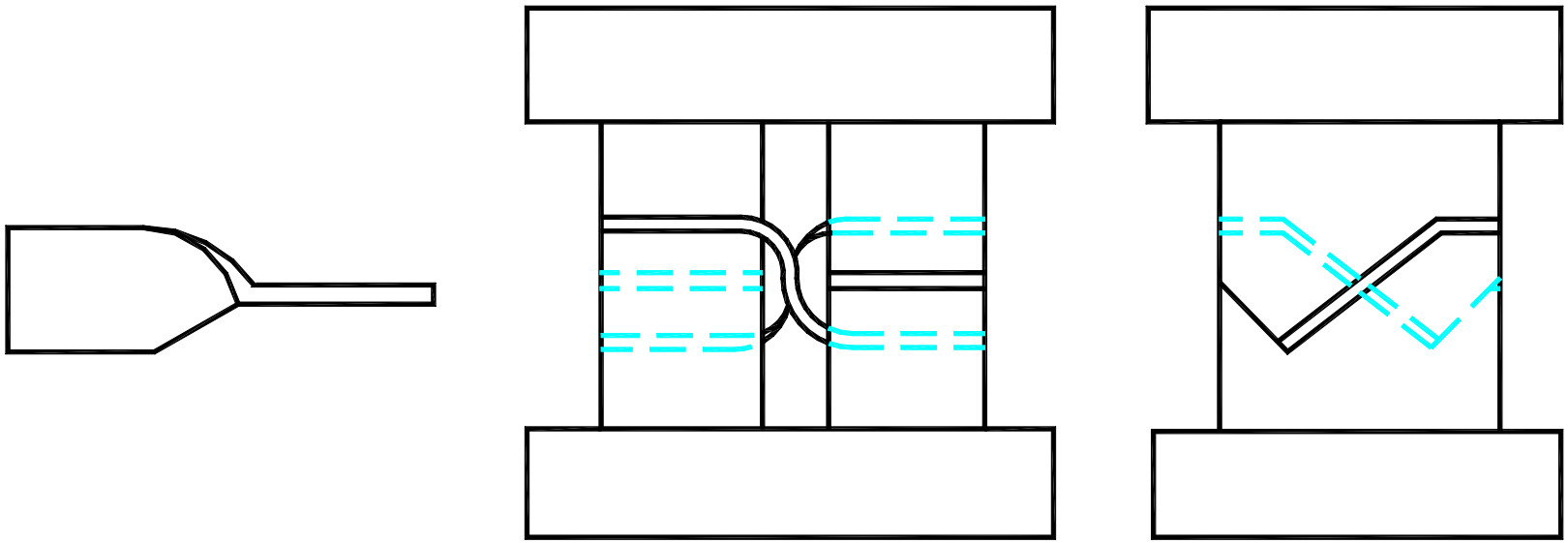
Rolling: Special forming method, such as 820-436



II. Classification of Stamping Processes

2.9 Distortion

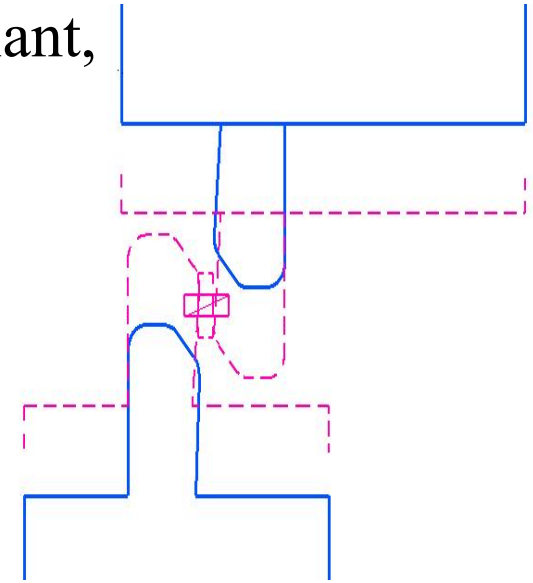
Twist one part of the flat blank relative to another part at an angle.



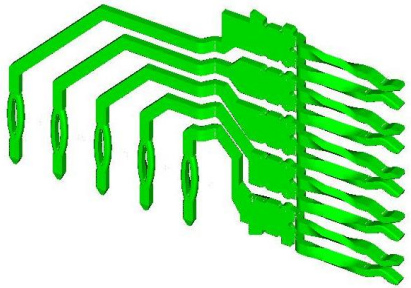
II. Classification of Stamping Processes

Twisting: An uncommon forming process, such as:

NWInG Product Business Unit, Baoyuan Plant, NB2 Manufacturing Division: Terminal Bidirectional Rotation



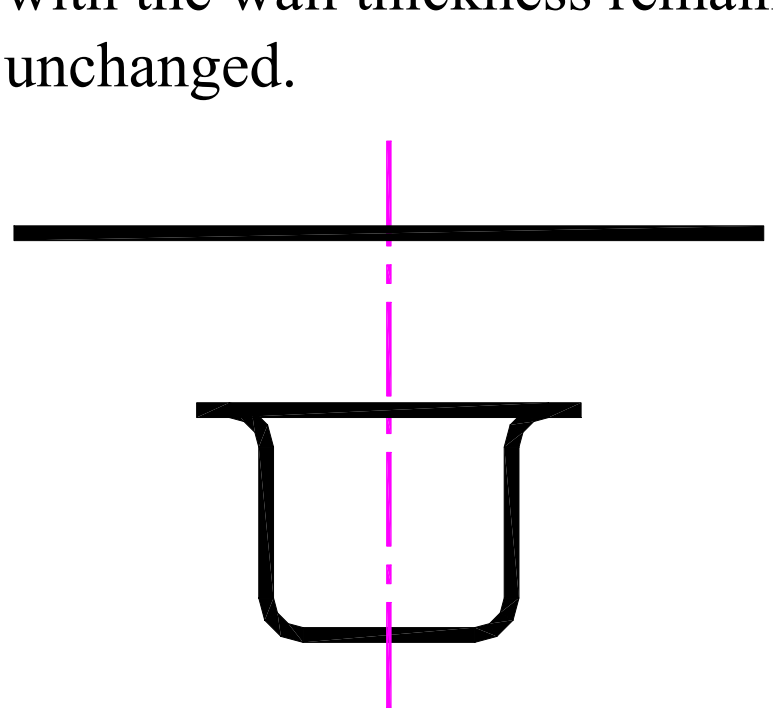
1.Contact

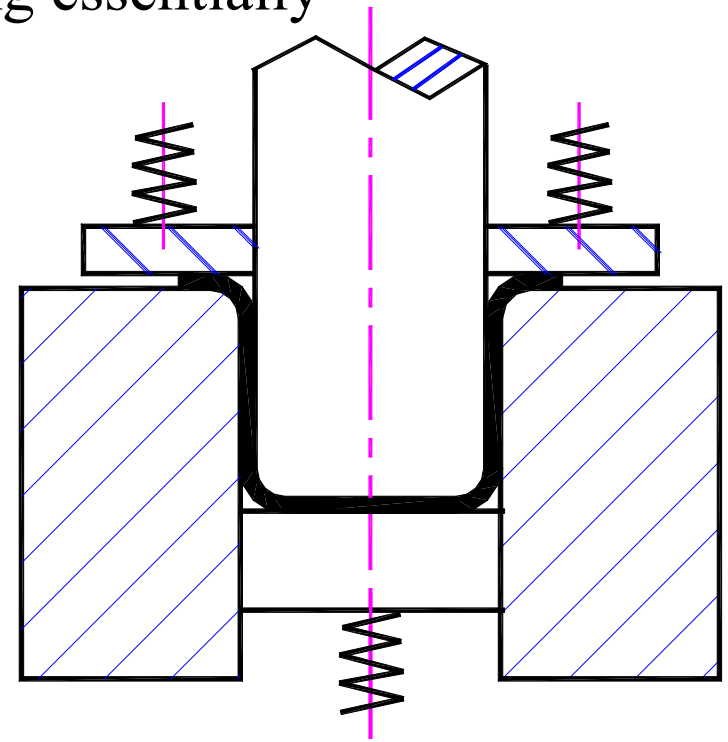


II. Classification of Stamping Processes

2.10 Deep drawing (or drawing)

The sheet metal is pressed into hollow workpieces, with the wall thickness remaining essentially unchanged.

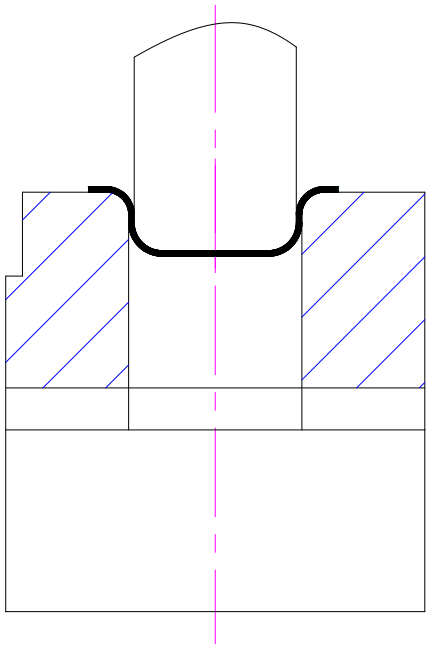




II. Classification of Stamping Processes

Deep drawing (drawing): A unique forming process for hardware parts. Hardware parts often have multiple sets of drawing dies.

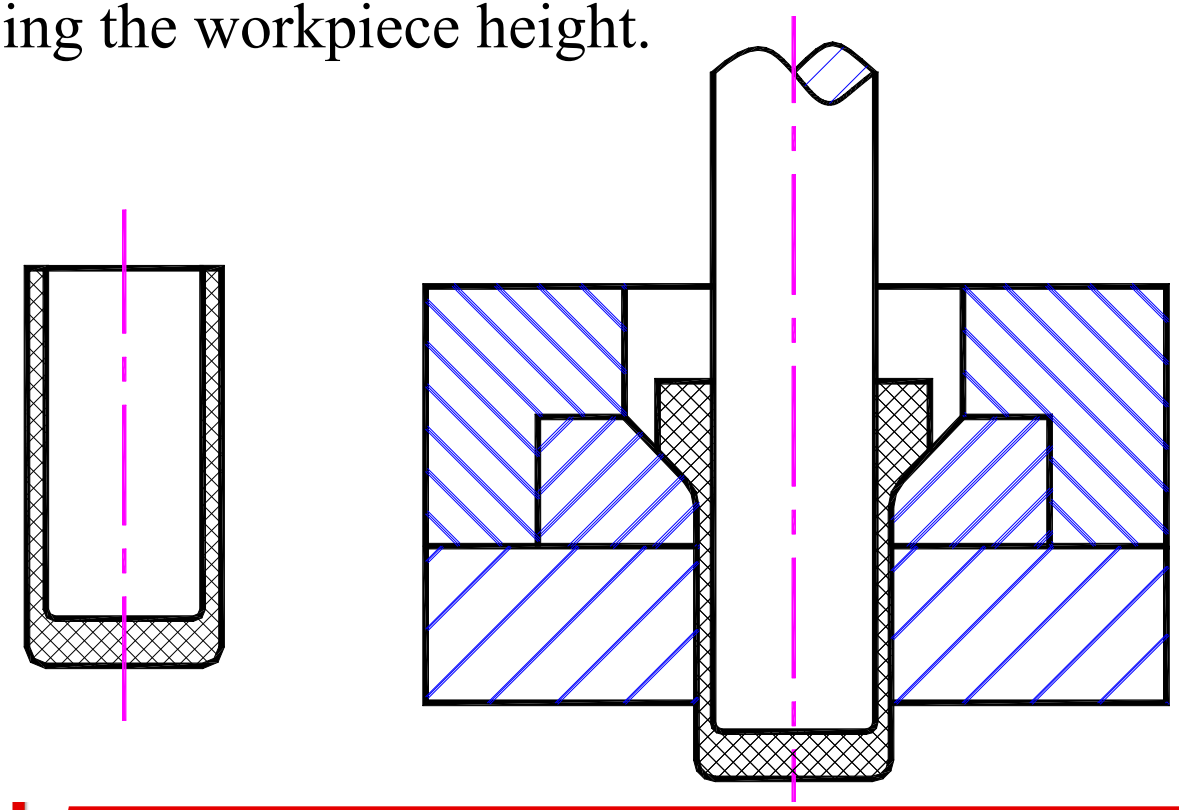
820-170n4



II. Classification of Stamping Processes

2.11 Thinning and Deep Drawing

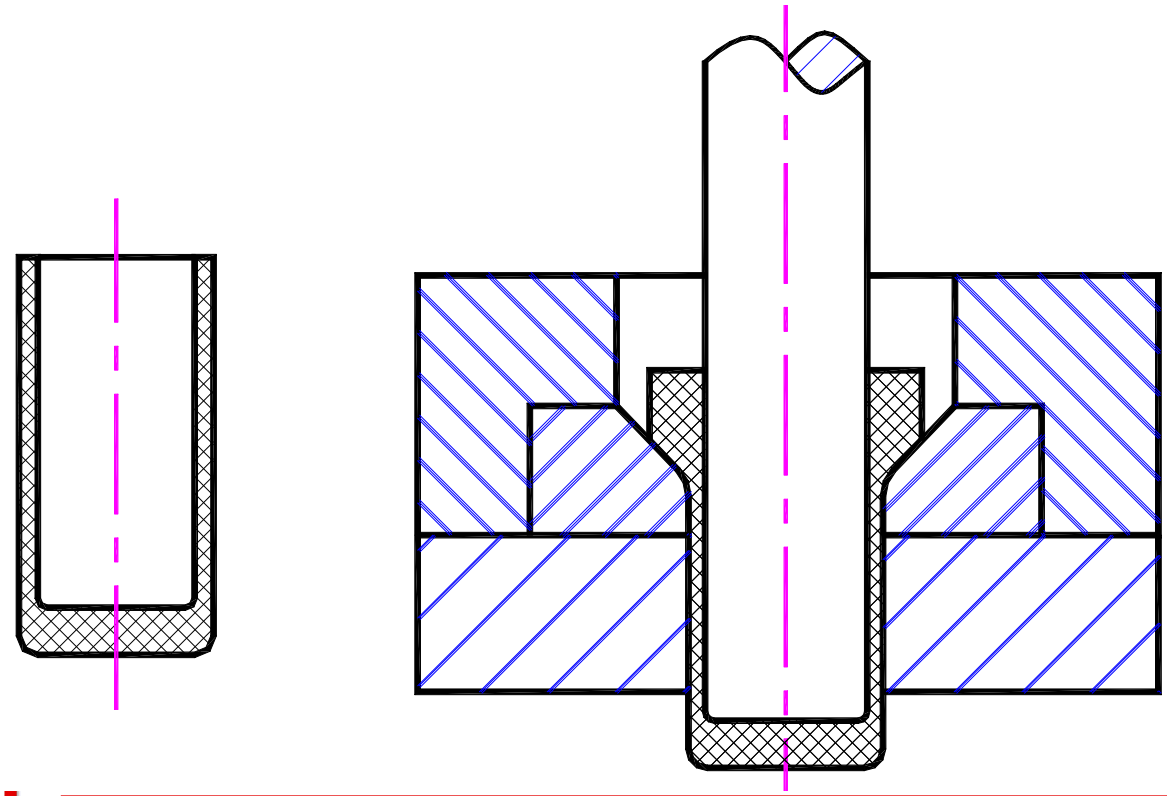
Workpieces with thick bottoms and thin walls can be obtained by reducing the diameter and wall thickness and increasing the workpiece height.



II. Classification of Stamping Processes

Thinning deep drawing: A special deep drawing method that results in a smooth wall surface and uniform wall thickness down to 0.01mm.

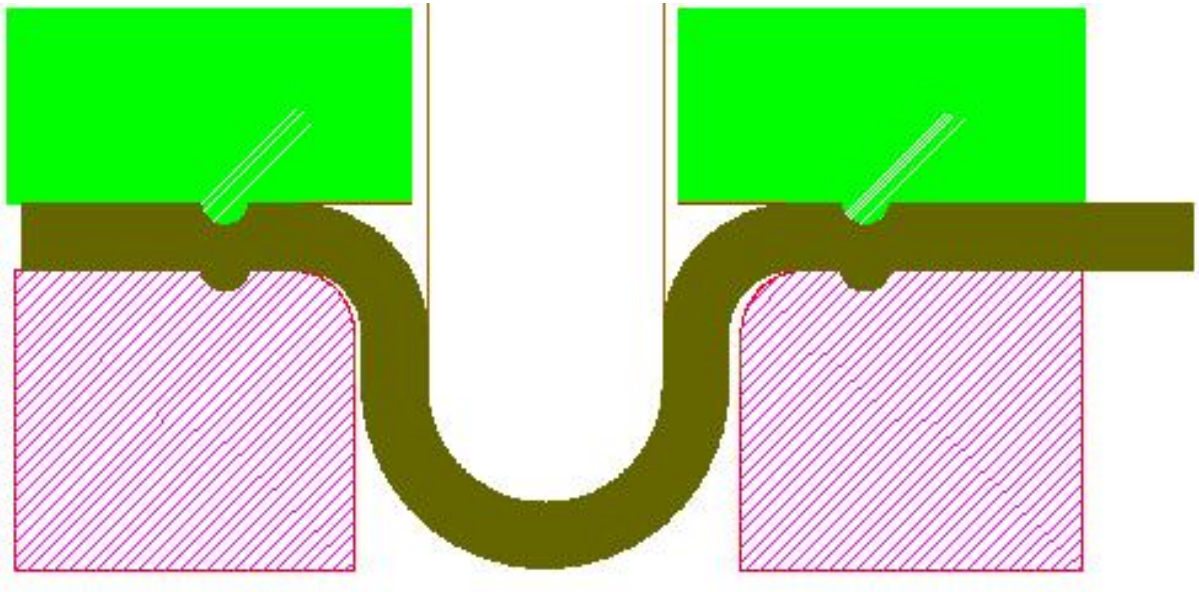
824-087



II. Classification of Stamping Processes

2.12 Bulging

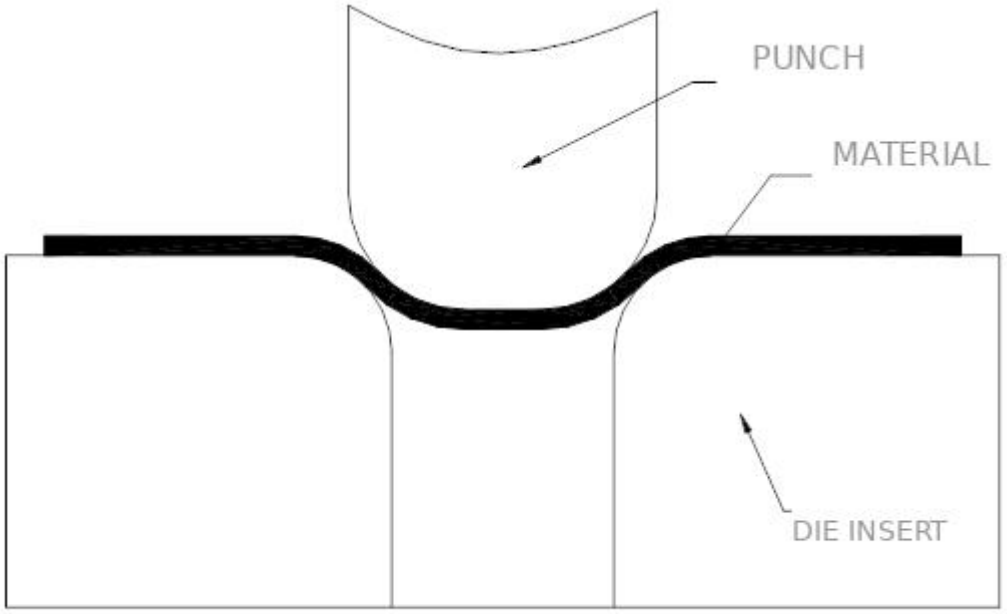
Using molds to force the sheet metal to thin out and increase its surface area in order to obtain the desired geometric shape.



II. Classification of Stamping Processes

Bulging: A common forming process for hardware parts

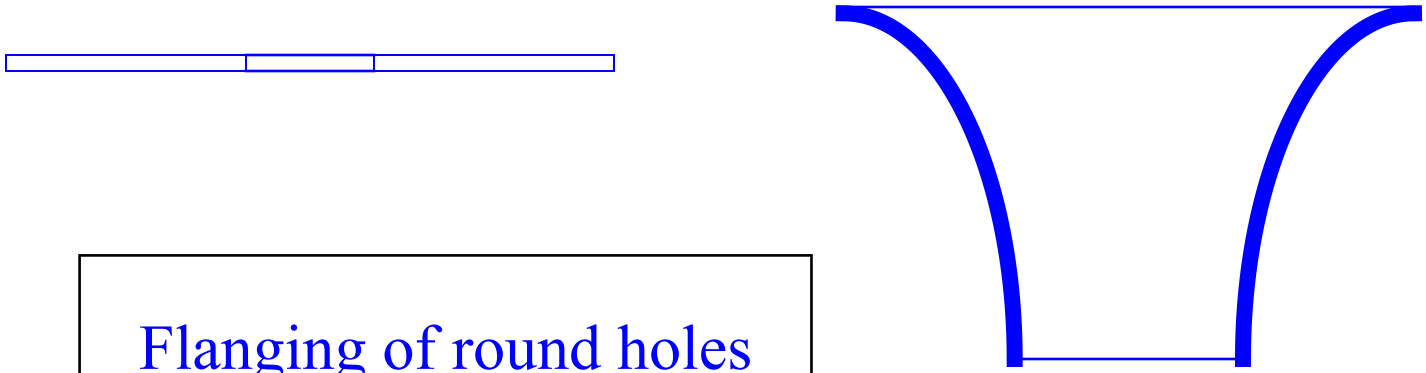
822-653



II. Classification of Stamping Processes

2.13 Flanging

A processing method that uses a mold to turn the outer edge of a hole on a sheet of material into a vertical edge.

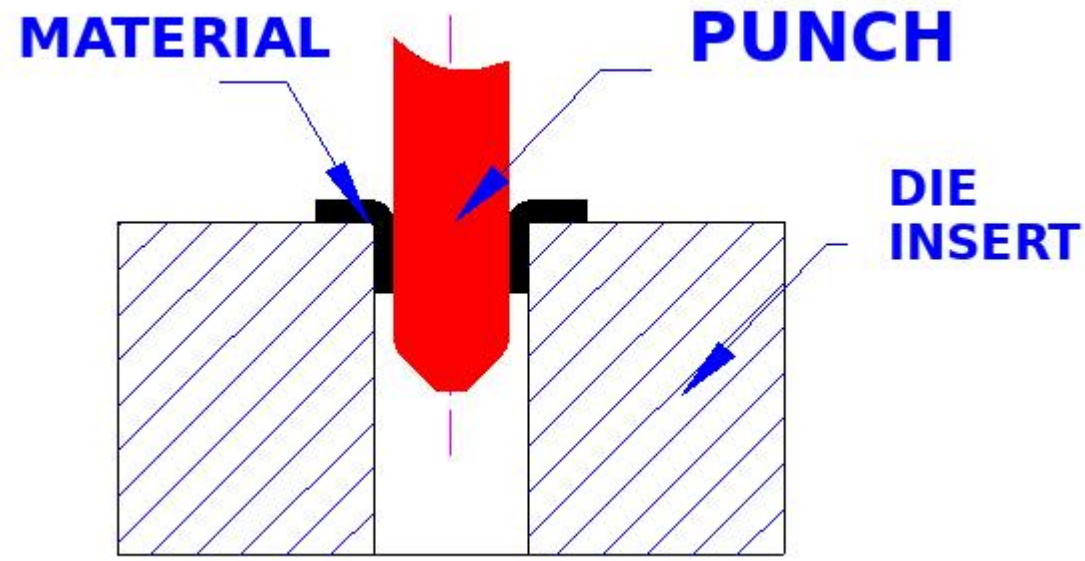


Flanging of round holes

II. Classification of Stamping Processes

Flanging: A common method for forming the bottom hole of tapped metal products.

822-077n1



III. Typical Stamping Process Analysis

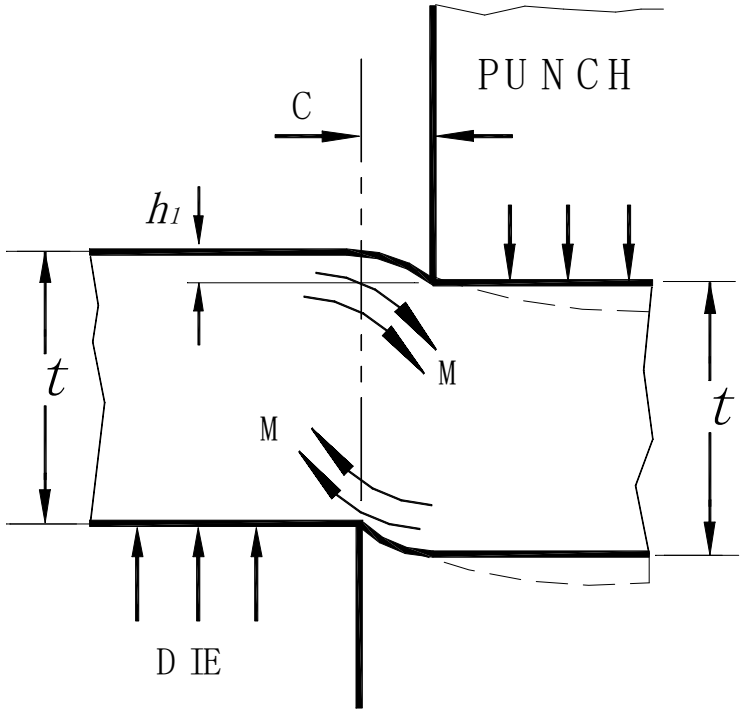
3.1 Punching

1. Blanking Process:

The separation action dur
blanking is completed
instantaneously, generall
going through the followi
three stages.

A: First Stage: Elastic
Deformation Stage

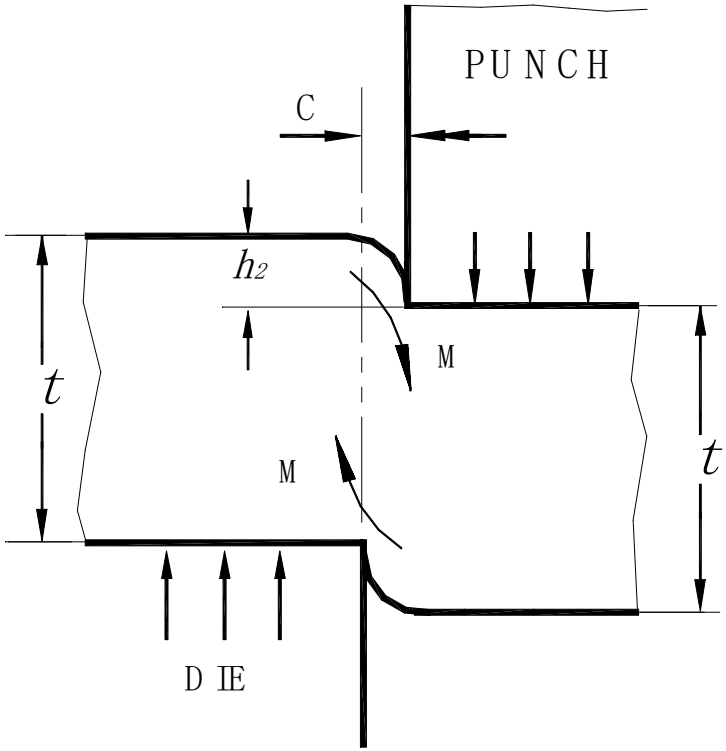
Due to bending, the mater
bends downwards by a heig
The larger the gap, the
larger h becomes, and the
larger the final collapsed
angle.



III. Typical Stamping Process Analysis

B: Second Stage: Elastic-Plastic Deformation Stage

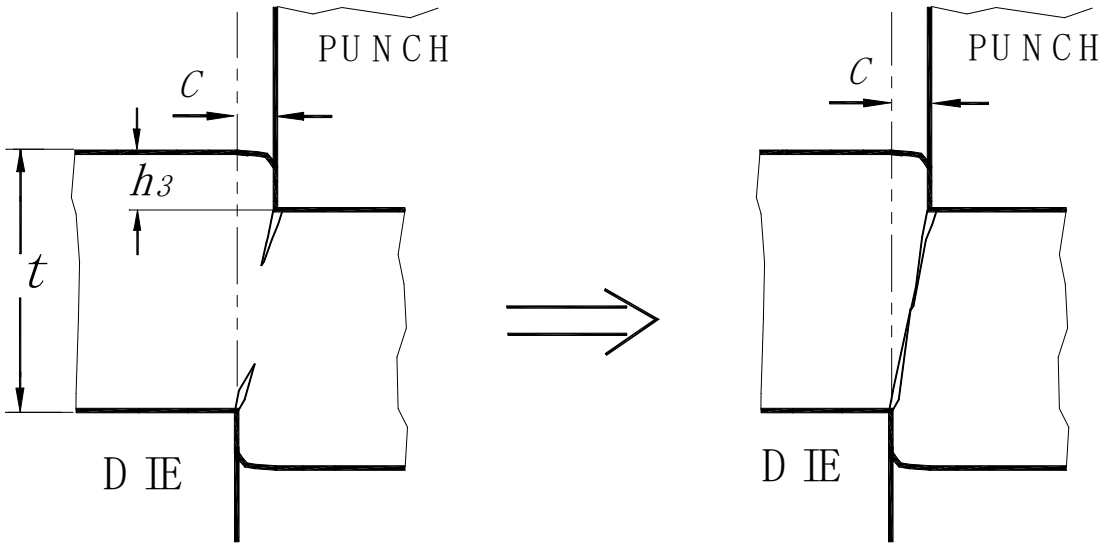
During this stage, a brig band forms. When the gap large, the bending moment large, and the internal s of the material immediate reaches its limit value, resulting in fracture. Therefore, the bright ban minimal. When the gap is it is pure shear, and the bright band is large.



III. Typical Stamping Process Analysis

C: Third stage: Fracture stage

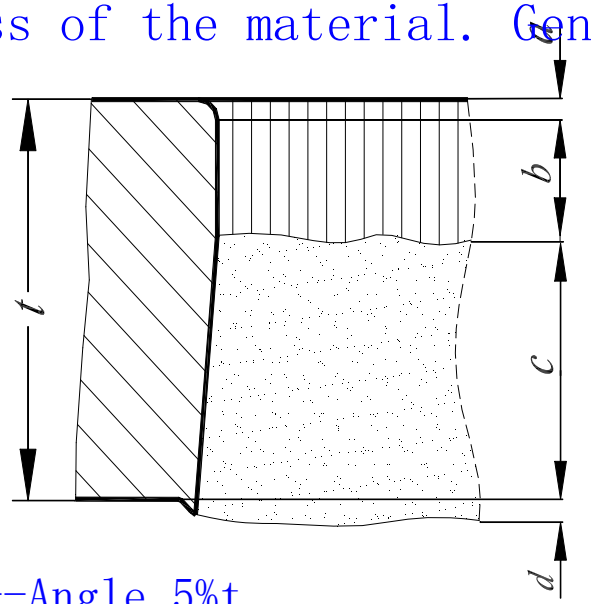
Cracks appear on the sides of the punch, die, and cutting edge, grow and merge, thus causing fracture. When the gap is too small, the upper and lower cracks do not overlap, resulting in two bright bands, i.e., secondary punching.

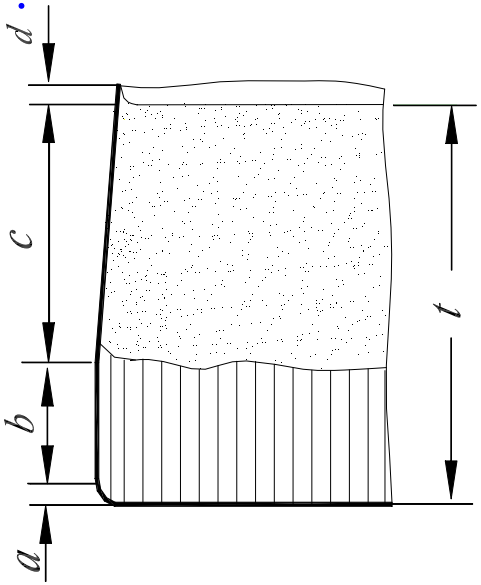


III. Typical Stamping Process Analysis

2. Shape of the blanking fracture surface

The proportions of the collapsed corner, bright band, fracture surface, and burr height are related to the clearance, the sharpness of the cutting edge, and the hardness of the material. Generally:





a ------Angle 5%t

b ------Bright band (1/3~1/2)t

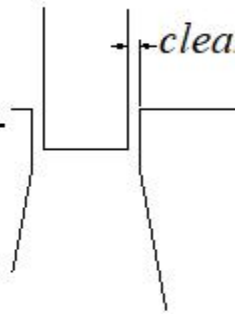
c ------Fracture surface (1/2~2/3)t

d ------Burst (5~10)%t

III. Typical Stamping Process Analysis

3. Blanking Clearance

Single-side punch/die clearance; expression: **Clears=%t**



Design: choose 4–6%t.

Key factors for selecting clearance:

1. Hardness ↑ → CLEAR ↑;
2. Thickness t;
3. Hold-down / stripper;
4. Tool life;
5. Die steel: V3 ↑; SKD11 ↓
6. Accuracy ↑ → CLEAR ↓;
7. Complex shape → CLEAR ↑;
8. Tol. req. ↑ → CLEAR ↓;
9. Lubrication ↑ → CLEAR ↓;

Clearance	Fracture quality	Dim. accuracy	Residual stress	Die life	Machining difficulty
Small	Good	High	Lower	Poor	Difficult
Medium	Fair	Medium	Low	Medium	Normal
Large	Poor	Low	Higher	Good	Easy

III. Typical Stamping Process Analysis

4. Punching Process Considerations:

a. Simple shape;

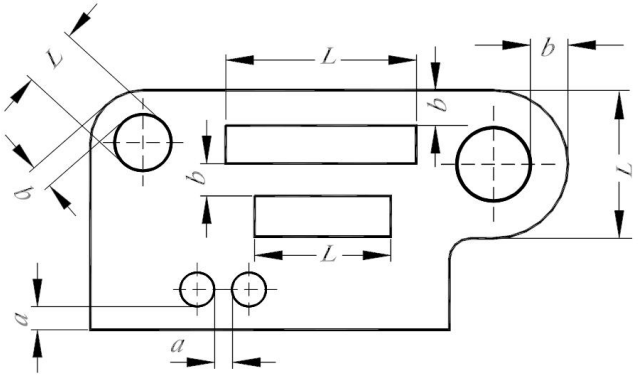
b. Avoid sharp corners; the transition radius R is related to the material thickness;

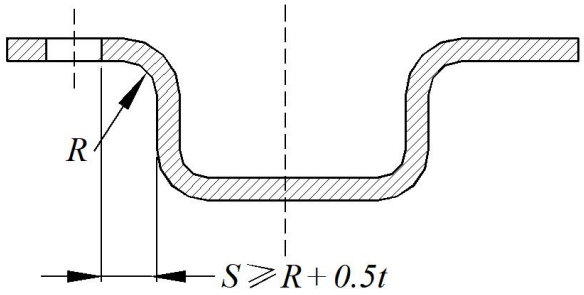
c. The overhang should not be too long, otherwise the cutting edge will be too weak, and even with step-by-step cutting, insufficient blank pressure will cause the material to flip;

d. The minimum punching diameter is related to the hole shape, material thickness, and material, as well as whether the die structure has a guide and whether it has a guide sleeve;

e. The distance between the hole edge and the hole should not be too small, mainly considering the strength of the cutting edge and the blank pressure;

f. After bending and drawing, the distance between the hole edge and the straight wall should be S>R+0.5t.





III. Typical Stamping Process Analysis

5. Punching Force

Total Punching Force = Punching Force + Stripping Force + Pushing Force + Ejection Force

Where: Punching Force = 1.3L * t * K

L ------ Punching edge circumference

t ------ Material thickness

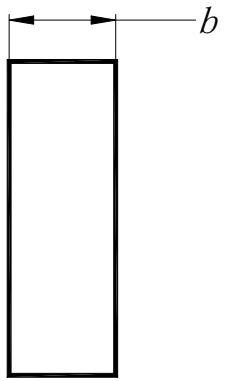
K----- Material shear strength

1.3---- Safety factor

III. Typical Stamping Process Analysis

3.2 Bending

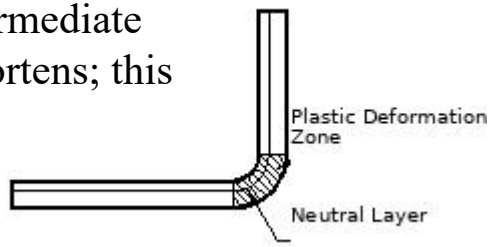
1. Bending Process: Flat materials undergo plastic deformation under external force. Bending processes can transform these materials into various complex three-dimensional shapes.
2. Characteristics of the Bending Process:
a. Bending involves localized plastic deformation at the bending radius (R).
b. The neutral layer shifts inward; the smaller the radius (R), the greater the inward shift.
c. The material length in the deformation zone increases, while the thickness decreases.
d. The bending line is always a straight line.
3. Classification of Bending Processes:
a. Narrow Plate Bending: $b < 3t$, the bending area after bending is fan-shaped.
b. Wide Plate Bending: $b > 3t$, the bending area after bending remains rectangular.



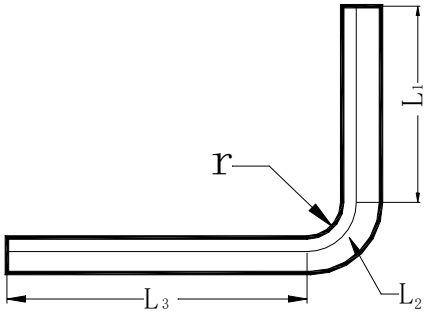
III. Typical Stamping Process Analysis

4. Deformation Mechanism During Bending

During bending, deformation only occurs in the rounded corners, while the straight edges do not undergo plastic deformation. Within the deformation area, the inner material is compressed and shortens, while the outer material is stretched and lengthens. Due to the continuity of the materials, there must exist an intermediate layer between the inner and outer materials that neither lengthens nor shortens; this layer is the bending neutral layer.



r/t	0.1	0.2	0.25	0.3	0.4	0.5	0.8
x	0.23	0.28	0.30	0.31	0.32	0.33	0.34
r/t	1.0	1.5	2.0	3.0	4.0	5.0	6.5
x	0.35	0.37	0.40	0.43	0.45	0.48	0.5



III. Typical Stamping Process Analysis

6. Bending Processability

a. Minimum Bending Radius: During bending, the outer radius (R) is under tensile stress. When the tensile stress exceeds the material strength, cracks will occur. The smaller the inner radius (R) during bending, the greater the tensile stress on the outer radius (R). Therefore, the minimum inner radius (R) that prevents the material from cracking is called the minimum bending radius (r_min).

The minimum bending radius depends on the mechanical properties of the raw material. Different materials and different states of the material will result in different r_min values. Additionally, when the bending direction is perpendicular to the rolling grain direction, r_min can be smaller; otherwise, it will be larger, expressed as %t.

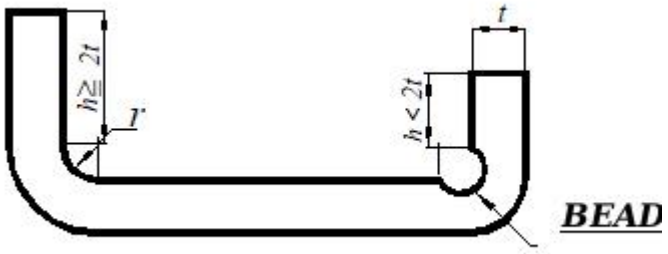
Generally, for C5191, r_min is 1t when the bending line is parallel to the rolling grain, and 3t when the bending line is perpendicular to the rolling grain.

For C2680, r_min is 0.5t when the bending line is parallel to the rolling grain, and 1.2t when the bending line is perpendicular to the rolling grain.

For SPCC, r_min is 0.4t when the bending line is parallel to the rolling grain, and 0.8t when the bending line is perpendicular to the rolling grain.

III. Typical Stamping Process Analysis

b. Bending height of the component wall: Generally, h>2t, otherwise it cannot be bent to the correct position. When h<2t, a coin can be added for bending, or the component can be bent first and then cut off (which is difficult to achieve in progressive dies).

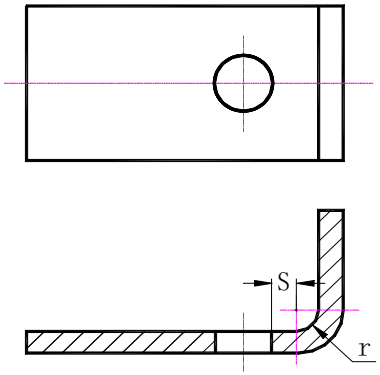


c. Hole edge distance

To avoid hole deformation, generally

when t < 2mm, s > t

when t > 2mm, s > 2t



III. Typical Stamping Process Analysis

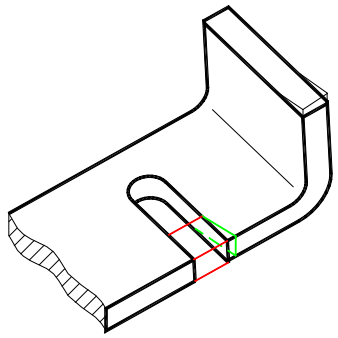
d. When there is a notch near the bending area, the cut will deform during bending. In this case, bend first, then make the cut.

7. Springback after Bending

Springback: The phenomenon where material returns to its flat state in the opposite direction of bending after the applied bending force is removed is called springback. This includes angular springback and springback of the bending radius (R).

$\Delta\alpha = \alpha1 - \alpha2$

α1-----Die angle α2-----Angle of the bent part after springback

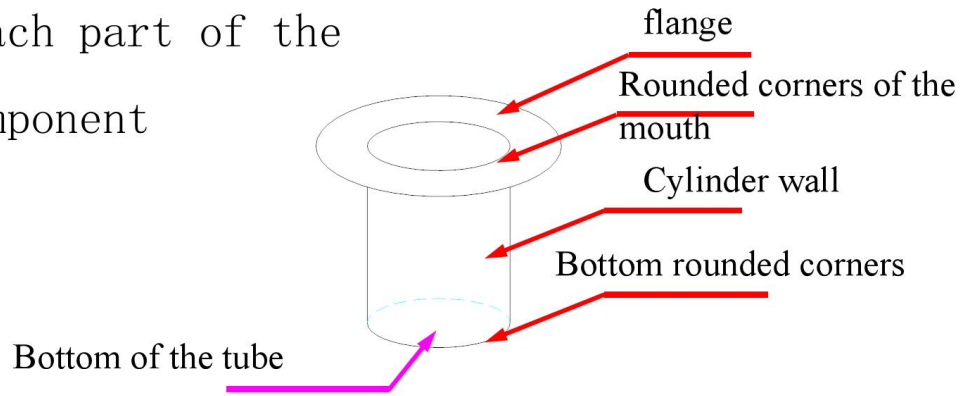


Influencing factors: Overcoming springback:

a. Material mechanical properties; a. Selecting suitable materials;
b. Relative bending radius r/t; b. Correcting bending;
c. Bending gap; c. Compensating for bending;
d. Variable bending angle; d. Reducing bending gap;
e. Bending correction force; e. Reducing bending radius;
f. Double bending;
g. Coin bending, etc.

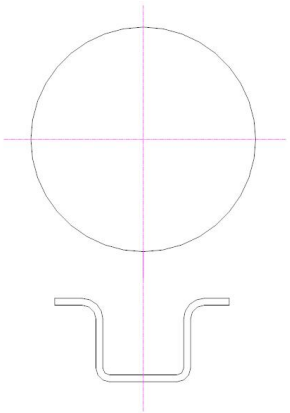
III. Typical Stamping Process Analysis

3. Names of each part of the extraction component



4. The Essence of Drawing Processing

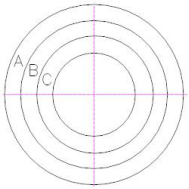
Drawing processing involves causing flat sheet material to flow into a three-dimensional shape in space; it is not about thinning the bottom material into a shape.



III. Typical Stamping Process Analysis

5. Major Defects During Drawing

Wrinkling: During drawing, the material on the outer circle flows inward, and the radius becomes smaller and smaller, causing the materials to squeeze against each other, thus causing wrinkles to form in the flange material.



Note: A, B, and C are sectors of equal width.

Tensile cracking: a. Cracks at the punch radius: As the flange flows inward, the material compresses against each other, generating resistance. When this resistance exceeds the material strength, cracks will appear at the most critical section (punch radius).

Solutions: Select materials with good plasticity, reduce blank holder force, increase die radius, etc.;

b. Cracks at the die radius: When the material wrinkles and thickens, it cannot flow into the drawing gap because the material thickness is greater than the drawing gap, thus causing the material to fracture.

Solutions: Increase the drawing gap or control wrinkling.

III. Typical Stamping Process Analysis

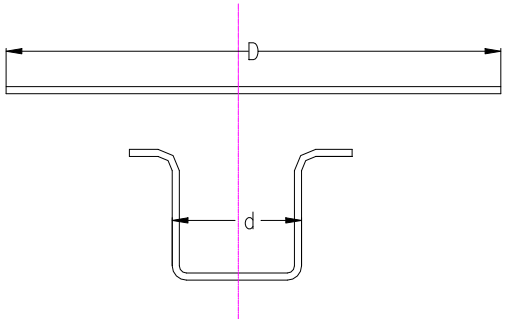
6. Drawing Limit Value – Drawing Coefficient

Drawing Coefficient: The ratio of the diameter of the drawing punch to the diameter of the drawing blank.

$m = d/D$

The minimum drawing coefficient that prevents breakage during drawing is the drawing limit value.

$m_{min} = d_{min}/D$



Generally, for the first drawing of SPCC, m min is 0.6.

Factors affecting the drawing coefficient:

a. Mechanical properties of the material

b. Relative material thickness t/D

c. Number of drawing passes: Due to work hardening, the drawing coefficient gradually increases.

d. Drawing method: Whether or not blank holder is used.

e. Corner radius of the punch and die

f. Surface finish, lubrication conditions, and drawing gap of the punch and die drawing parts

g. Drawing speed, etc.

In short, any factor that helps control tearing will help reduce the drawing coefficient.

III. Typical Stamping Process Analysis

7. Calculation of Cylindrical Part Drawing Process

a. Determination of Trimming Allowance: Because lugs will appear on the edge of the part after drawing, it is necessary to trim the edge.

The trimming allowance is generally taken as 1.0 mm.

b. Blank Calculation - Equal Area Method

Blank area = $\pi(D/2)^2$ = Cylindrical area A

Therefore, blank diameter $D = 4A/\pi$

c. Calculation of Drawing Coefficient and Number of Drawings

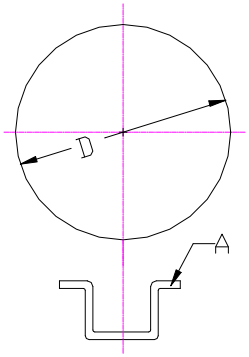
mtotal = Cylindrical diameter d / Blank diameter D

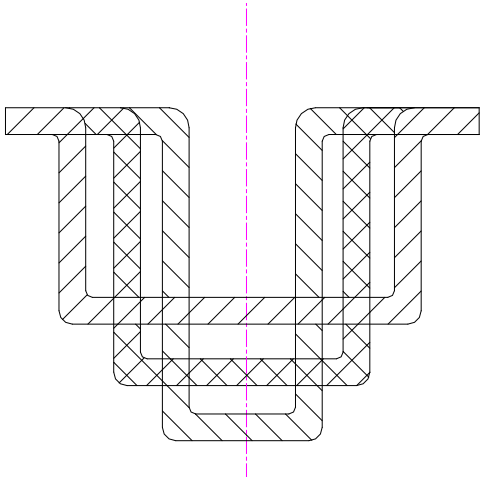
Drawing coefficient m = Diameter of each drawing punch / Diameter of the upper drawing punch

=dn/dn-1

Where mtotal = m1*m2*m3*…… *mn = (m)n

Number of drawings n = log mmtotal



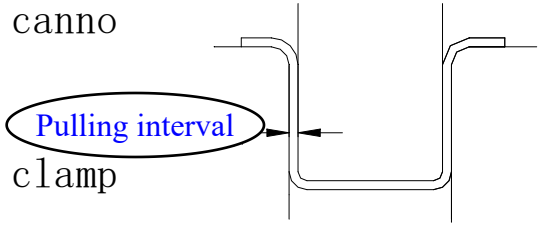


III. Typical Stamping Process Analysis

d. Determination of Drawing Gap

a. When the drawing gap is too small, the material canno easily flow into the mold cavity, and is prone to tearing.

b. When the drawing gap is too large, the material clamp is poor, and the material is prone to wrinkling.



Generally: The gap for the first draw is 1.1t, the gap for the last draw is t, and the gaps for the intermediate draws decrease arithmetically from 1.1t to 1.0t.

e. R-angle values for the drawing punch and die:

Generally, the R-angle of the first drawing die is (8~12)t, and for the subsequent draws, R_dn = (0.6~0.8)r_dn-1. For the last draw, the R-angle of the die = the R-value of the product.

For each draw, the R_{punch}n = (0.6~1)r_dn.

f. Determination of drawing height:

Once the diameter and R-value of the punch and die are determined, the drawing height of each draw is calculated backward from the product area using the equal area method.

IV. Conclusion and Hopes

The stamping process has its own inherent rules. Mastering these rules to guide production can effectively improve the accuracy of mold maintenance. However, we must not be bound by theory. Our goal is to use theory to innovate and continuously improve our stamping processing capabilities!

I hope we can all strive together!

THE END

THANKS!