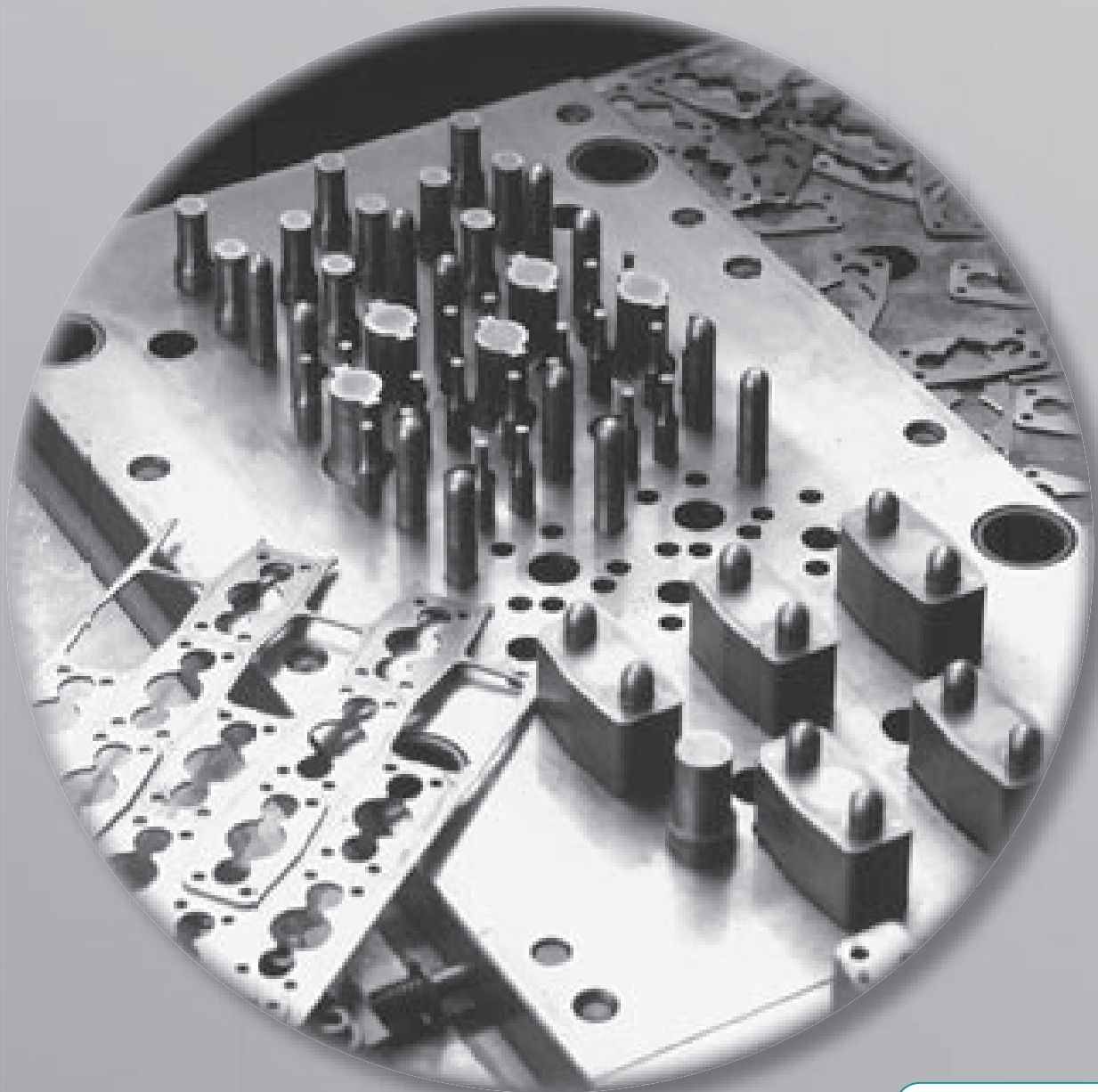


Stamping Basics

Fundamentals & Terminology



Stamping Basics

Fundamentals & Terminology



Introduction

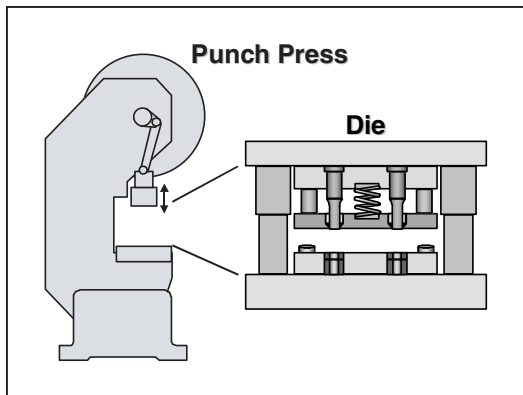
The Dayton Mission...

It is the mission of Dayton Progress Corporation to continue furnishing our customers with the highest quality information, metal stamping tools and precision components. Our over half century of surpassing delivery performance of the competition is our commitment to the future.

Program Objectives

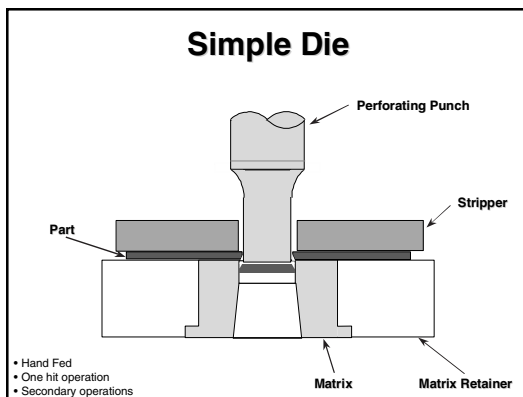
- Describe Common Types of Die Construction.
- Compare Stripper Design Options.
- Analyze Common Die Operations.

This report defines basic stamping terminology and illustrates basic stamping functions. We explore the common types of die construction, compare stripper design options, and analyze common die operations.



Punch Press

Perforation is generally the most severe operation performed in a die. That's because the punch press applies forces ranging from a few tons to more than 1000 tons. Proper press alignment is essential. While die set has some effect on alignment during operation, it cannot offset poor press alignment.

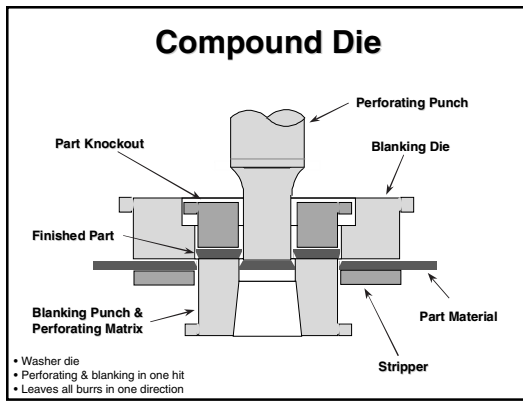


Simple Die

A simple die typically perforates holes in a part or blanks out the part using punches in conjunction with mated lower die components (matrixes). Simple dies also commonly produce basic forms as well as perform notching and lancing operations.

Simple dies require a press operator to load and unload parts and part material before and after each press cycle.

- Hand Fed
- One Hit operation
- Secondary operations



Compound Die

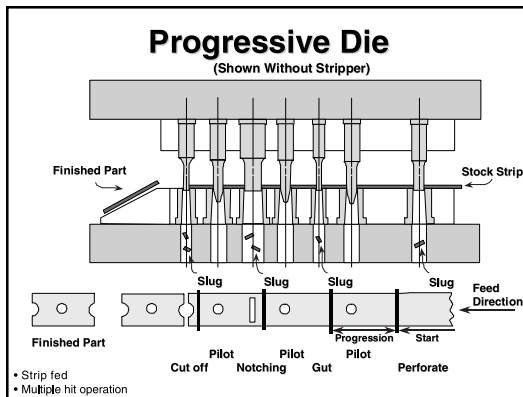
A compound die blanks and perforates a part at the same time in the same station. In most cases this operation perforates a hole or holes down, while the part blanks up. This allows slugs from those holes to fall through the die. This method leaves the part in the die, requiring some means of part removal.

Compound dies commonly run as single-hit dies. They can run continuously with a feeder, provided you can remove the part in a timely manner. Open Back Inclinable (OBI) presses - in the inclined position along with an air blow-off - aid in part removal.

Advantages of a compound die include:

- Minimal space in the press
- All burrs in one direction
- Superior accuracy between holes and trim edges
- More economical to build than a progressive die

A disadvantage of a compound blank die is its limited space that tends to leave die components thin and weak. This concentrates the load and shock on punches and matrixes, resulting in tooling failures.



Progressive Die

Progressive dies provide an effective way to convert raw coil stock into a finished product with minimal handling. As material feeds from station to station in the die, it progressively works into a completed part.

Progressive dies usually run from right to left. The part material feeds one progression for each press cycle. Early stations typically perforate holes that serve as pilots to locate the stock strip in later stations.

There are many variations of progressive die designs. The design shown here illustrates some common operations and terminology associated with progressive dies.

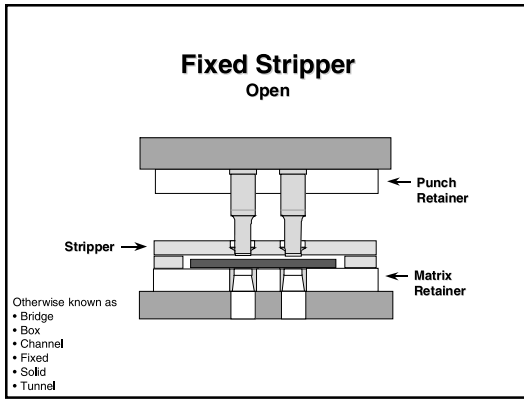
Stamping Terminology Stripper Designs

- Fixed
- Urethane
- Spring

Stripper Designs

Stamping dies require some means of stripping the part from the end of the punch at withdrawal. Common types of strippers for accomplishing this include Fixed, Urethane and Spring.

Stripping force varies based on part material type and thickness as well as punch-to-matrix clearance. This force ranges from nearly zero to as much as 25% of the force required to perforate the initial hole. Most applications do not exceed 10% of the perforating force.

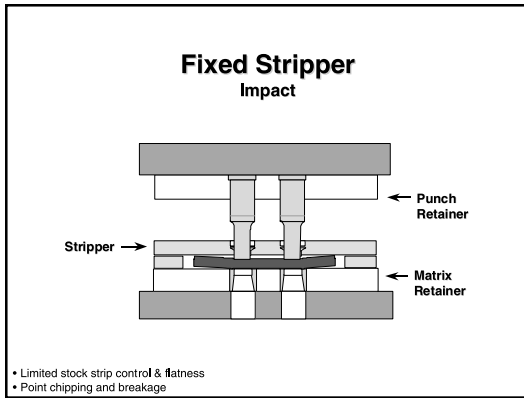


Fixed Stripper

Fixed strippers go by many names:

- Box
- Channel
- Solid
- Bridge
- Positive
- Tunnel

A fixed stripper is a steel plate with a clearance slot that allows the part material to pass under it. This plate mounts to the die retainer in a fixed position. Clearance holes cut through the stripper plate let the punches extend through without interference. At withdrawal the part material hits the stripper, preventing it from lifting as punches retract. The part material strips from the end of the punch.

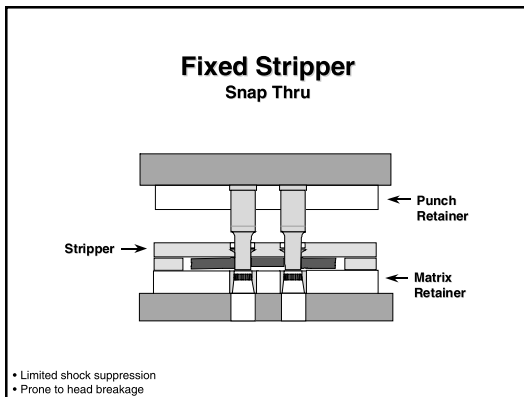


Fixed strippers have several drawbacks. They do not hold the stock strip flat and are unable to absorb impact and snap-thru shock. The result is poor part flatness and premature punch failure.

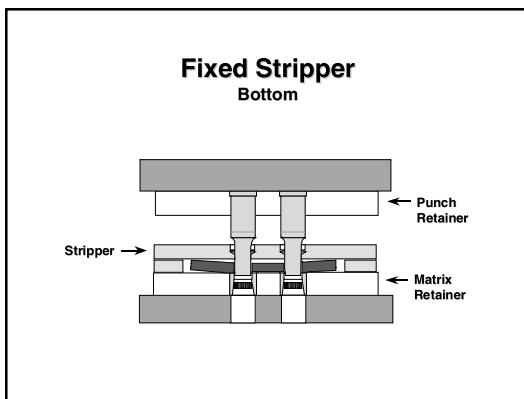
We generally do not recommend fixed strippers for high-volume or high-precision jobs. A typical clearance under the stripper is 1½ times the material thickness - 1/16” to 1/8” is common clearance on the sides of the stock strip.

Clearance under a fixed stripper is commonly 1½ times the part material. This allows for variations in part material thickness and for stock strip deformation.

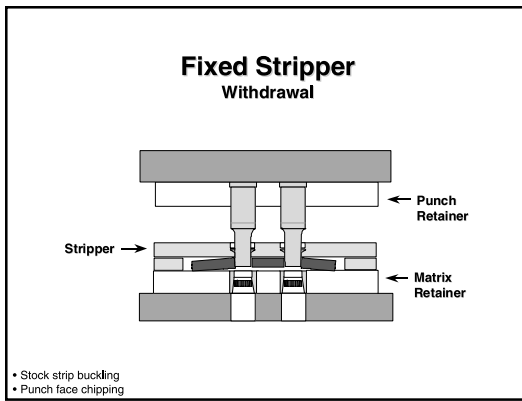
This deformation allowance under the punch point results in punch point chipping. That deformation can also cause lateral movement of both part and punches, resulting in punch point breakage and poor part quality.



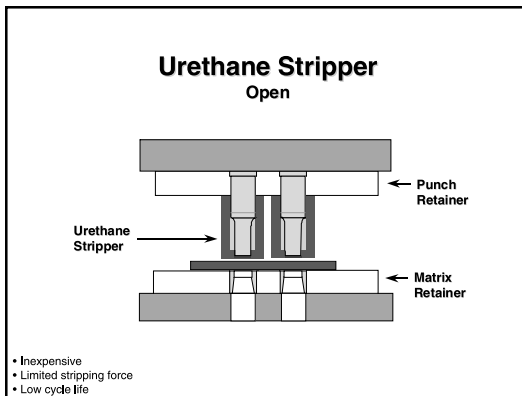
At snap-thru there is a sudden unloading of pressure on the punches and part material. This generates shock, which can lead to punch head breakage.



Note the buckling of the part material throughout the press cycle, as seen in. This can lead to dimensional and functional problems in the finished part.



The buckling effect binds the part on the ends of the punches, which increases stripping pressure and potentially chips the punch face.



Urethane Stripper

Urethane strippers are inexpensive and simple to use. They slide over the end of a punch with a slight press fit, which prevents the stripper from falling into the die during operation.

Through use, urethane strippers fatigue and become loose on the punches. You must continually monitor them to prevent them from falling into and damaging the die. Some urethane strippers are molded with a head designed to fit a standard urethane retainer. This greatly enhances urethane stripper life and reliability.

Urethane stripper performance - especially during the bottom and withdrawal steps of the punch cycle - prompts special consideration before use.

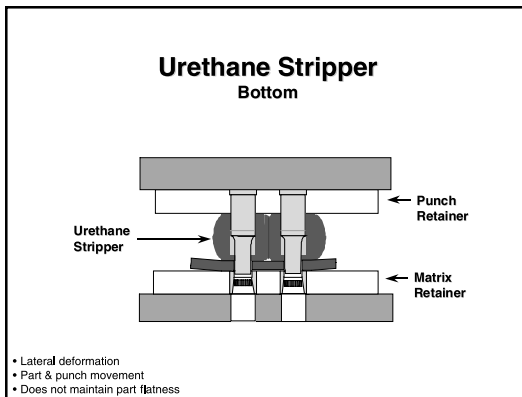
1. Urethane does not compress. Under load urethane deforms. If the volume displacement necessary for this deformation exceeds the available space in the tool, the urethane stripper likely creates space by moving or breaking tooling components.

2. Because urethane does not provide a rigid flat surface, it cannot hold the stock strip or part flat.

3. Urethane strippers prevent air from venting in around the punch point or through the side vent hole of ejector punches, which can cause slug-pulling problems.

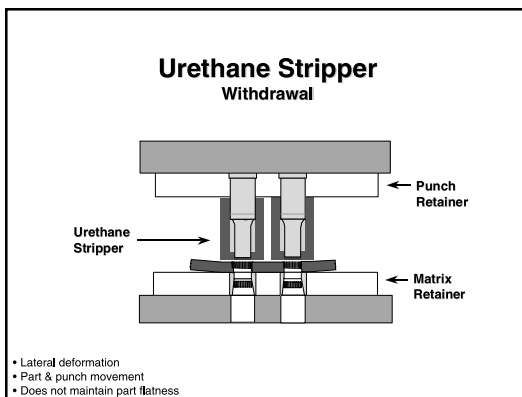
Deformation and movement of the urethane strippers can move the stock strip or part laterally, creating punch-to-matrix alignment problems.

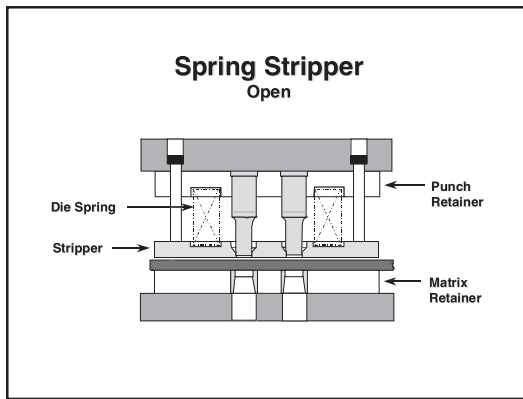
A urethane stripper strips the part off the ends of the punches as it returns to its original shape. Due to the urethane's pliable nature, the part material may distort during the perforating and stripping process.



Some urethane strippers have a steel washer attached to the end to minimize part distortion. Exercise caution when using this type of urethane stripper on shaped punches or applications where large amounts of pre-load are required. Catastrophic punch failure can occur if the punch face catches the steel face prior to hitting the part material.

The optimum urethane stripper should have a combination of two different grades of urethane: a high hardness grade of urethane for the face and a medium hardness grade for the body. This helps maintain part flatness without sacrificing durability and elasticity.



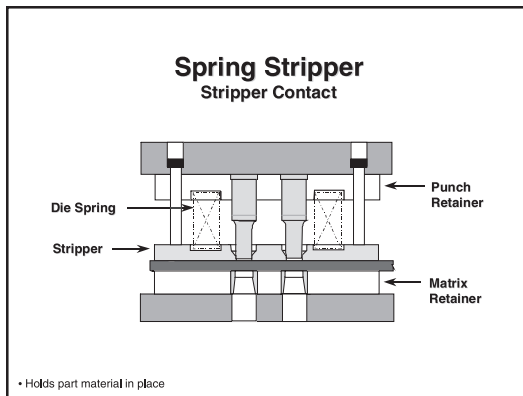


Spring Stripper

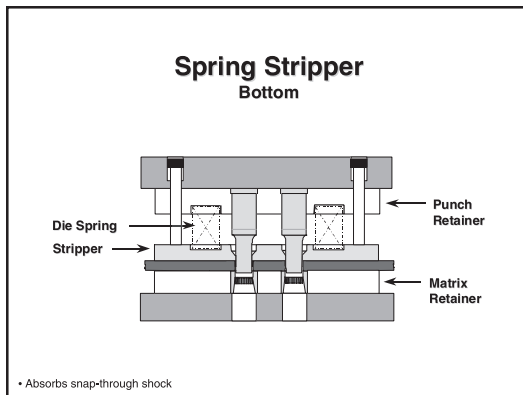
Spring strippers offer superior performance.

Their main advantage is that as the die closes, they hold the stock strip or part flat and in place during perforating. A spring stripper prevents the part material from lifting or hanging up on the punches at withdrawal.

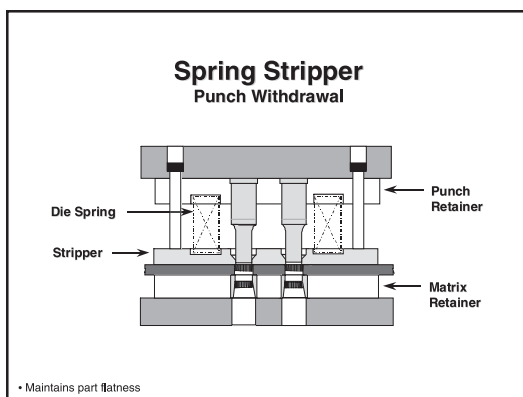
Because the stripper lifts away from the part material after each stroke, you can visually monitor die performance.



A spring stripper hangs below the ends of the perforating punches. As one of the first components to contact the part material, it holds the part in a fixed position throughout the cycle of the press.

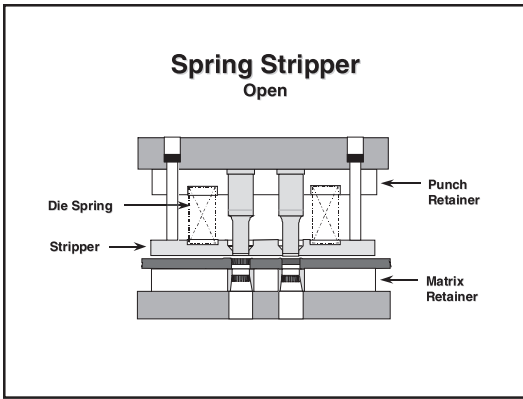


A spring stripper absorbs shock at snap-thru and eliminates shock at withdrawal that would otherwise damage the tooling and possibly the press.

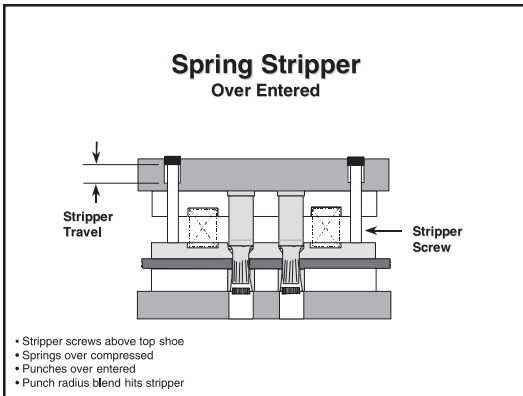


The main purpose of a stripper is to pull material from the ends of the punches. This function occurs at the withdrawal phase of the perforating process.

Stripping force varies based on part material type and thickness as well as punch-to-matrix clearance. This force can range from nearly zero to as much as 25% of the force required to perforate the initial hole. Most applications do not exceed 10% of the perforating force.



Continuous pressure throughout the working portion of each press cycle provides superior performance in tool reliability, part quality and press life.

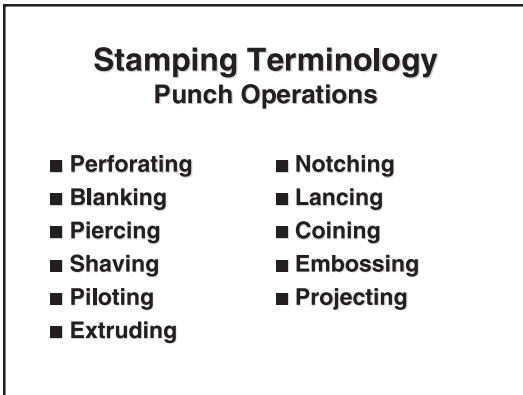


Over-entry or closing a die below its recommended shut height can have catastrophic consequences.

Excessive stripper travel can:

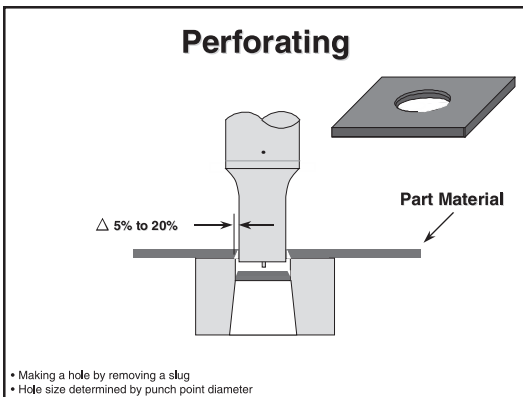
1. Drive stripper screws into parallels or the press ram, potentially breaking the screws or bending the stripper.
2. Compress die springs beyond design limits, causing premature failure.
3. Cause stripper interference with the radius blend on the punches, resulting in broken punch points and heads.

Punch over-entry also causes excessive galling and wear on the punch points.



Stamping Terminology - Punch Operation

Punches perform many functions. Some of the more common operations are shown at left.



Perforating

Perforating makes a hole by removing a slug. When perforating in a stamping operation, a punch shears and breaks a slug out of the intended part material. The punch pushes the slug into a die hole (matrix). The matrix hole is larger than the punch point. A constant punch-to-matrix clearance is maintained around the entire punch point.

Perforating Pressure Formula

$$P = T \times L \times S$$

T = Thickness of Part Material

L = Length of Shear (Pi x Dia = Circumference)

S = Shear Strength of Part Material

P = Perforating Force

Example

T = .062"

L = .5" Diameter (3.14159 x .5 = 1.5708)

S = 38,500

P = .062 x 1.5708 x 38,500

P = 3,749.5 Lbs.

* Don't forget to include stripper pressure when calculating total tonnage of the die.

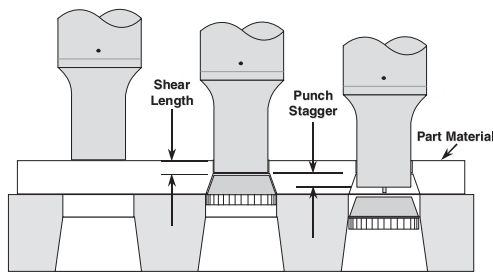
To calculate tonnage requirements for perforating, multiply the part material thickness times the length of the cut, or perimeter of the hole, times the material shear strength (see Figure 18). Determine the perimeter of a round hole by multiplying pi times the hole diameter.

Shear and tensile strengths for most materials are not the same.

- Aluminum shear strength is approximately 50% of its tensile strength
- Cold-roll steel shear strength is approximately 80% of its tensile strength
- Stainless steel shear strength is approximately 90% of its tensile strength

It is important to include the stripper pressure when calculating die tonnage requirements. Stripper pressure should be at least 8% of the perforating force. Some die manufacturers require stripper pressure as high as 25% of the perforating pressure.

Punch Stagger



- Shear, also known as burnish
- Punch stagger = shear length +.000 -.010
- Reduces overall load and snap-thru shock

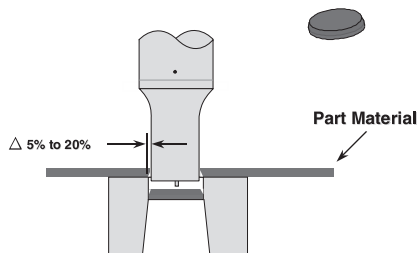
Punch Stagger

Stagger punch lengths to minimize impact and snap-thru shock. You can split punch lengths into two or three groups, reducing impact and snap-thru shock by half or third.

Common practice is to stagger the different groups of punches by an amount equaling stock thickness. Although this reduces the initial shock, it does not reduce the total shock. Each punch, or group of punches, is exposed to both impact and snap-thru shock.

Making stagger equal to or slightly less than burnish length in the hole being perforated greatly reduces impact and snap-thru shock. This amount of stagger allows the next group of punches to contact the material before the first group snaps through. The snap-thru energy from the first group of punches is absorbed and used to drive the next group of punches through the part material.

Blanking



- Saving the slug
- Slug size determined by matrix inside diameter

Using burnish length instead of material thickness as the amount of stagger is extremely important in high-speed stamping applications. It reduces punch entry to minimize punch wear and slug pulling. Because the punches withdraw from the stock strip sooner, you also gain more feed time.

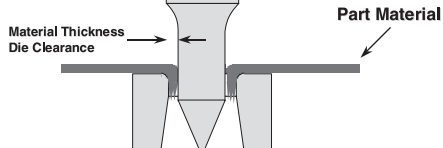
Blanking

Blanking cuts the periphery of a stamped part in one operation. This operation is similar to perforating except the slug is saved as the finished product.

Note that the burr is up when blanking down. This burr is in the opposite direction of all other holes or notches within the part. The only exception to this condition is when the part is blanked out in the upward direction as in a compound blank die.

Calculating tonnage requirements for blanking operations is the same as for perforating operations.

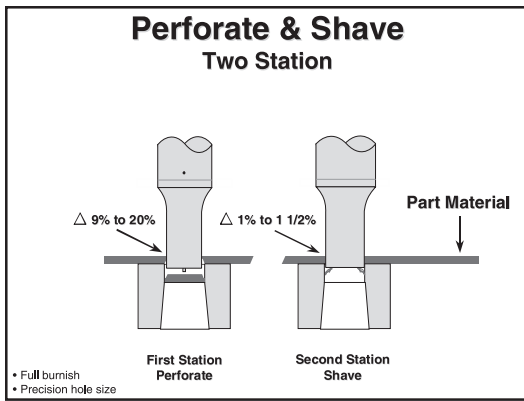
Piercing



- Tearing a hole
- No slug removed

Piercing makes a hole without removing a slug. A sharp or pointed punch tears open a hole, leaving a ragged edge that has been formed down.

A food grater is a good example of what pierced holes look like in a finished product.



Perforate and Shave

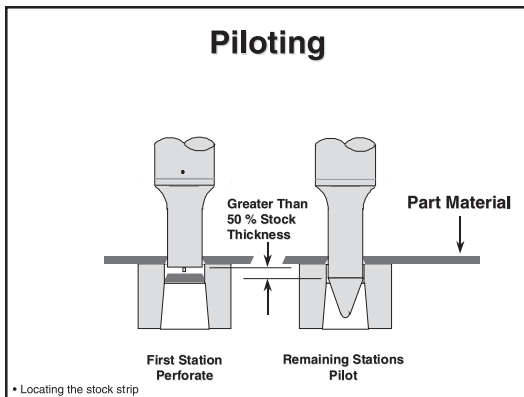
Shaving achieves a high percentage of burnish or shear in a hole. Shaving occurs in a two-station operation.

The first station resembles most perforating operations using optimum engineered die clearance. This optimizes tool life while minimizing work hardening of the part material.

The second station cuts the hole to size using tight die clearance.

Determining punch and matrix sizes starts in the shave station. The shave punch point size equals the desired finished hole size. The shave station matrix hole has 1% to 1½% of the material thickness clearance per side (2% to 3% of the material thickness total clearance). Too much clearance in a shave station results in a shear and rebreaking of the hole.

Once you know the shave station component dimensions, you can determine the perforating station component sizes. The perforating matrix equals or is slightly larger than the shave station matrix size. Perforating clearance is as much as possible without generating an excessive burr. This clearance is achieved by reducing the punch point size.

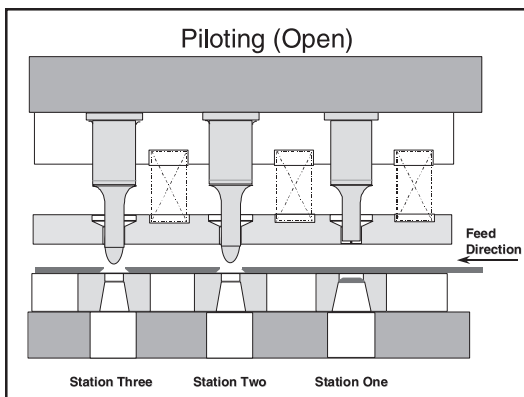


Piloting

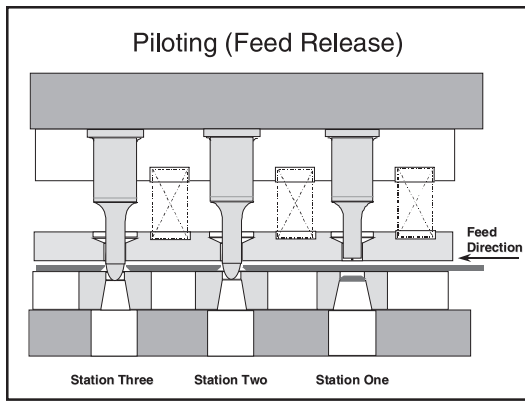
Pilots locate the stock strip or part. The pilot working length extends beyond the perforating punches and a fully extended stripper.

The pilot nose picks up an existing hole and moves the stock strip or part into proper location before the stripper makes contact.

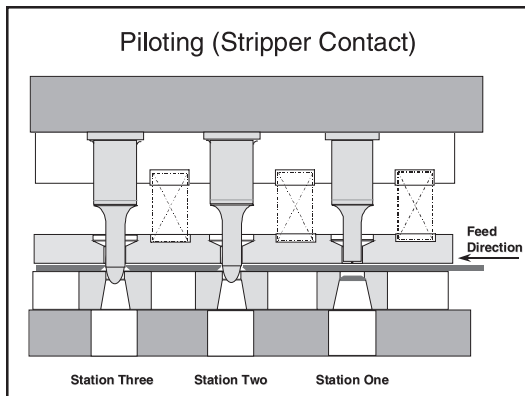
Pilot point diameters are commonly dimensioned .001” smaller than the punch point diameter used to perforate the locating hole. This prevents the stock strip or part from sticking.



Pilots locate the part material in the stamping tool.

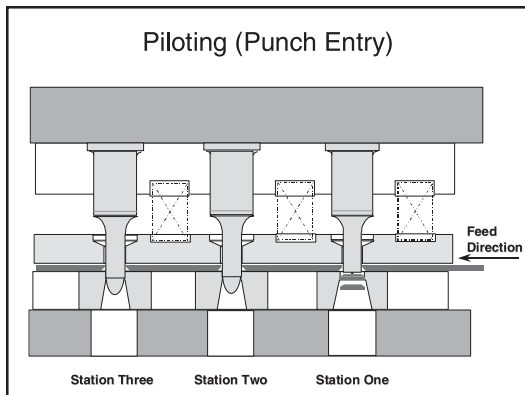


Pilots have rounded or tapered noses, allowing it to enter an existing hole without deforming the part material. Once the pilot nose starts entry, the feeder releases the part material. This allows the pilot to pull the part material into proper location.



The stripper then makes contact, holding the part material in position. Perforating punches should be the last component to contact the part material.

The working length of the pilots are generally .080" to .125" longer than the perforating punches in simple die applications. The difference in length between the punches and pilots varies depending on whether you use shear and heal on the punches and if forming operations are being performed.



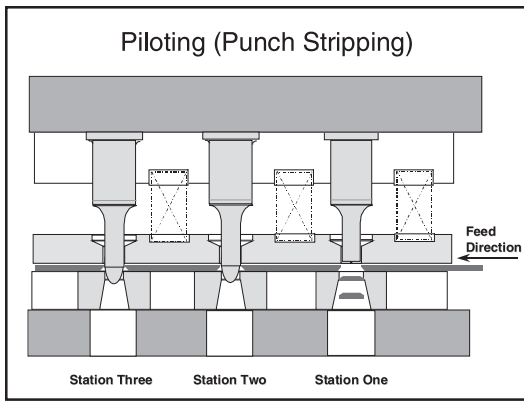
As the pilot continues through the material, it enters the matrix or die.

Proper die clearance for pilots is subject to debate. Many designers maintain a very tight clearance of .0005" or less, incorporating the matrix as a guide below the part material. This offers additional lateral support that results in better part location when forming or working with thick material.

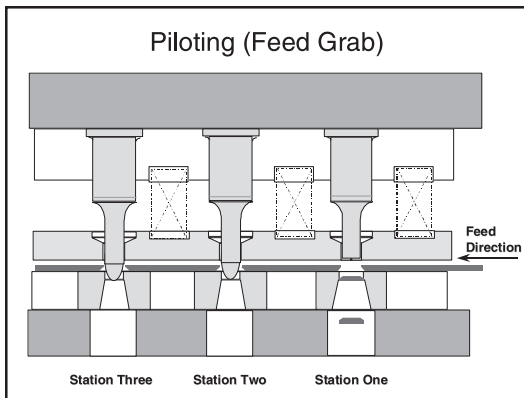
The drawback with tight clearance around a pilot is when a misfeed causes a pilot to perforate a hole. The extreme stripping force created by the tight clearance galls the pilot, possibly pulling it from the retainer. Ball lock pilots are particularly vulnerable to pulling due to misfeeds.

Another practice employed by designers is to use material thickness as the clearance per side around pilots. The intent is to allow enough room around the pilot for the part material to extrude down into the matrix without grabbing the pilot. The problem is that when the material pierces and extrudes down, it tends to spring back resulting in excessive stripping force.

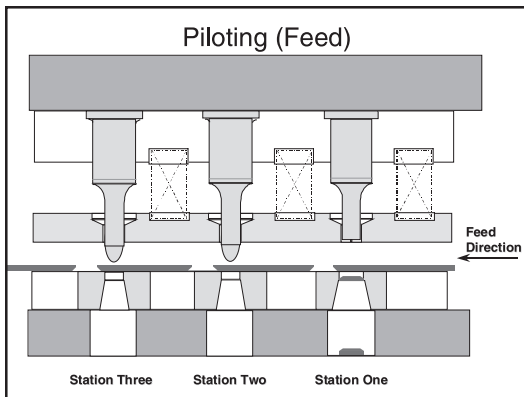
If misfeeds are a problem, use a clearance similar to the clearance used for perforating.



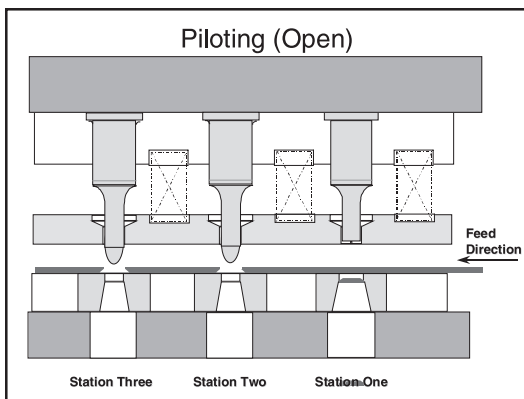
Because the working length of pilots reaches beyond a fully extended stripper plate, the part material may not strip properly. To minimize this problem, do not allow pilots to reach more than 1/3 to 1/2 stock thickness beyond the fully extended stripper.



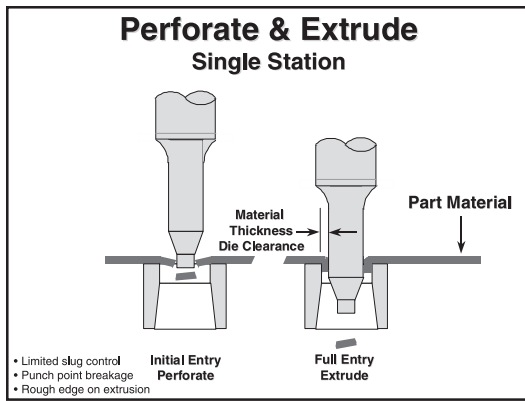
Time the feeder to engage the stock strip before the stripper leaves the part material.



After the pilots totally withdraw from the stock strip, the feeder feeds the part material to the next station.



Once the part material has been fed to the next station, the cycle repeats.



Perforate and Extrude

Single-station perforate-and-extrude operations, typically occur in single-hit (simple) dies or progressive dies where space is limited.

While a single-station perforate-and-extrude operation is viable, product quality is lower and tooling reliability is questionable.

Because the punch perforates the initial hole without the benefit of proper die clearance, the following problems are likely to occur:

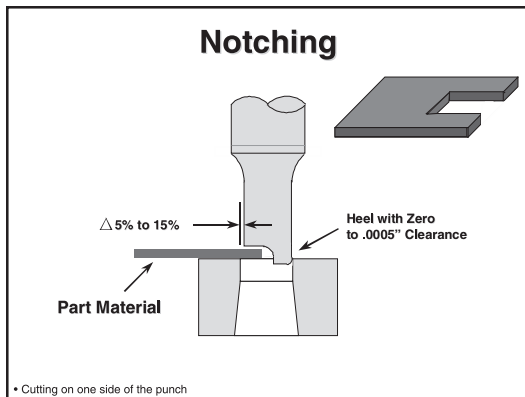
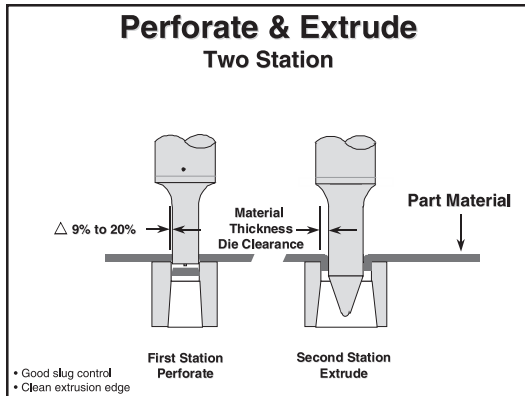
1. Rough and inconsistent extrusion edge
2. Punch nose breakage
3. Slug tumbling, pulling, and jamming

This is not the recommended process for extrusions.

The recommended process for extruding is to perforate the initial hole in one station and extrude the hole in a later station.

This approach offers optimum slug control and tool reliability as well as provides a clean extrusion edge.

Standard pilots are often used as extrusion form punches. For best results, pilots should be stoned and polished.

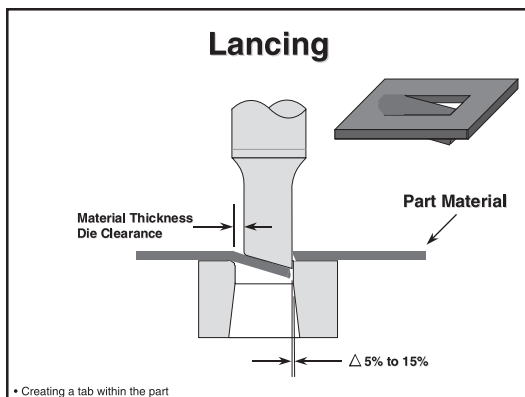


Notching

Notching produces a partial hole in the edge of the part.

Cutting on one side of the punch generates lateral deflection of the punch point. For this reason, notching punches typically require a heel, with little or no clearance, opposite the cutting edge.

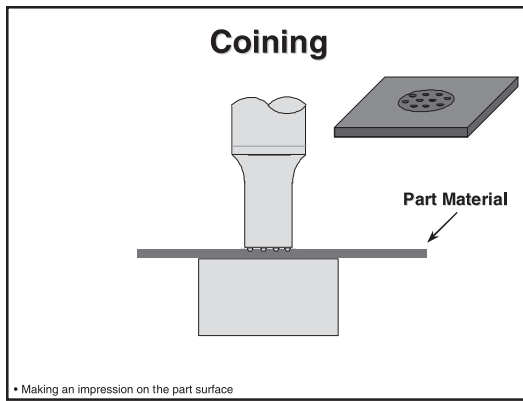
The heel of the punch picks up on the matrix before the cutting edge contacts the part material. A small radius on the heel prevents it from clipping the top edge of the matrix, which could possibly break the punch and matrix.



Lancing

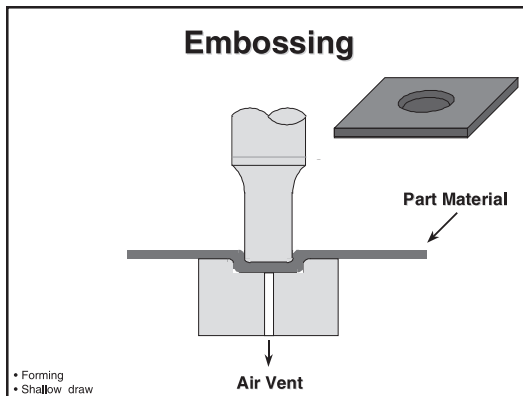
Lancing creates a tab within the part. No slug is removed. This operation commonly incorporates a single shear angle on the face of the punch.

Normal perforating clearance is applied to areas of the tab to be cut free. The portion of the tab that remains connected is bent to the desired angle over the matrix. Clearance between the radius portion of the punch and matrix equals the material thickness.



Coining

Coining leaves an impression in the part surface. You can apply this process to one or both sides of the part. In many cases coining is used to thin or displace material. No slug is removed in coining operations.

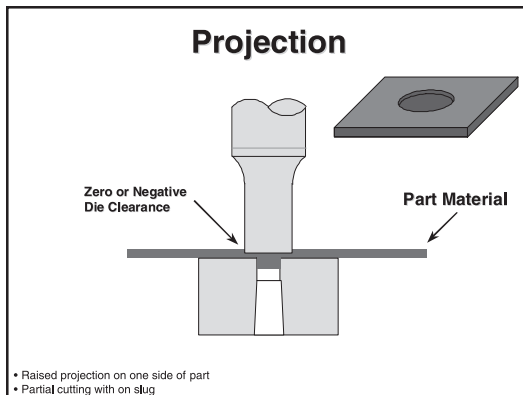


Embossing

Embossing deforms a shape within the part, but without intentional thinning of the part material.

A punch is used to form material into a blind hole. The punch bottoms out to produce a flat surface at the bottom of the form.

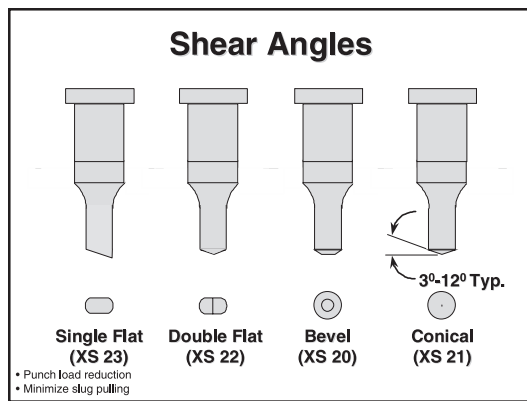
It is important to provide an air vent hole through the bottom of the lower die to prevent irregular bulging in the part or breakage of the tooling components.



Projection

A projection partially perforates a hole with zero or negative punch-to-matrix clearance. This process extrudes or partially perforates a projection on the matrix side of the part material.

The projected material is commonly used as a welding contact or locator for a mating part.



Shear Angles

You can reduce punch load and improve slug control by utilizing shear angles on the punch face.

Shear angles come in many configurations. The most applicable styles for metal stamping operations are shown at left.

Single flat shear reduces the load, but tends to deflect the punch laterally causing uneven and excessive wear, punch and matrix chipping, and punch point breakage. The single flat shear is typically used on shaped punch points.

The double flat shear has two flats on the face and is often referred to as a roof-top shear. It works best on oblong and rectangular punch point shapes. Avoid concave roof-top shear, which can lead to punch point chipping and splitting.

A bevel shear reduces punch load and minimizes punch point chipping. However, it tends to induce wear.

Conical shear is the best configuration when perforating with a round punch. Load reduction is greater than with the bevel shear. Wear evenly distributes around the point, and the slug deforms enough to minimize slug pulling.

For More Information...

For additional assistance or other technical support, feel free to contact any of our offices listed on the back of this report. Or check out our website at www.daytonprogress.com

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