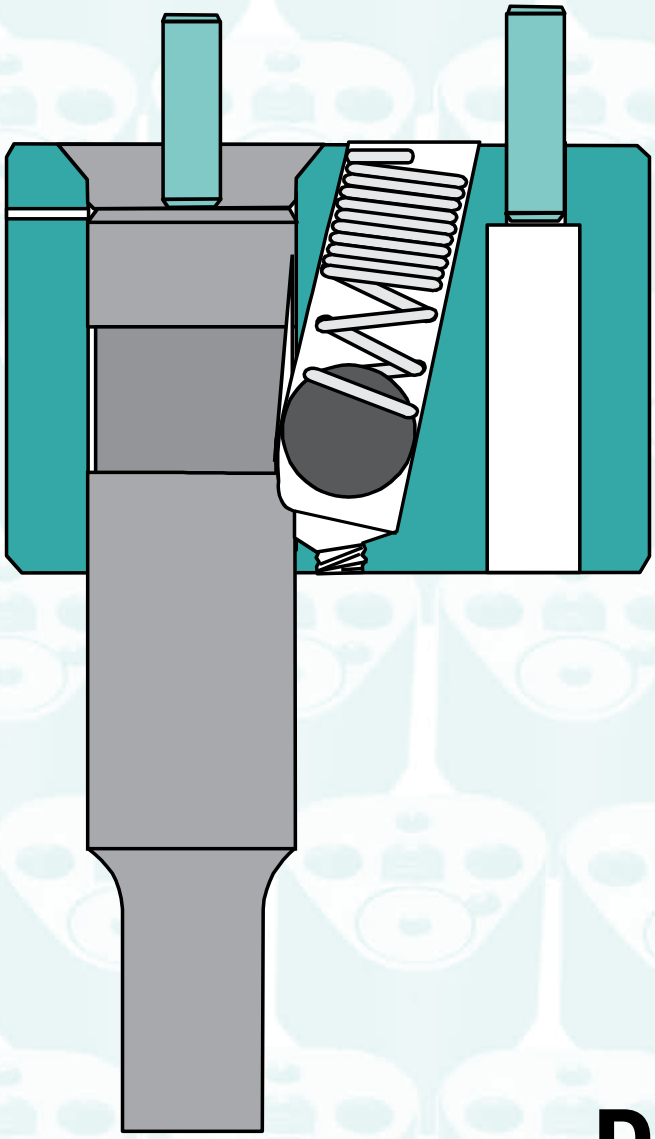
The Ball Lock System



DAYTON TRUE® POSITION RETAINERS

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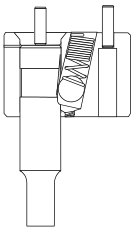


DAYTON TRUE® POSITION RETAINERS

The Ball Lock System

1

Dayton Progress True Position Retainers

This program illustrates the features, benefits, & value of working with True Position Ball Lock Punch & Matrix Retainers.

It will also cover the inherent problems associated with End & Square Retainers with Backing Plates.

Where are Ball Lock Products Used?

- **High volume production.**
- **Moderate precision.**
- **For soft or mild Steel.**
- **Material thickness from .035" to .375".**
- **Low or medium speed press operations.**

2

Ball Lock products are used in high volume, moderate precision applications to perforate soft or mild steel.

Thin material applications requiring tight die clearance may exceed the precision capabilities of Ball Lock components. The minimum recommended clearance is .0015" per side.

Thick and hard materials generate a tremendous amount of shock at impact and snap-through. This shock may exceed punch retention limits resulting in punch pumping and ball breakage.

High-speed applications may also cause punch pumping and ball breakage. Maximum speed limitations will vary based on specific operating conditions. Part material hardness and thickness, punch entry, and cutting clearance, type of die construction, and the condition of the press are just a few of the many variables which can affect how ball lock products will perform in a given application. As a general rule, press speeds should be kept below 250 strokes per minute.

Where are they used? Heavy Duty vs. Light Duty

Heavy Duty

- **.035" to .375" thick mild material up to 75 RB**
- ***.035" to .125" thick mild material up to 95 RB**
- **Not recommended for materials above 95 RB**

Light Duty

- **.035" to .125" thick mild material up to 75 RB**
- **Not recommended for materials above 75 RB**

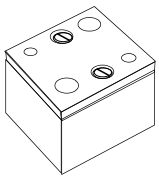
*Booster and/or heavy duty retainer ball spring recommended.

3

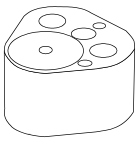
Heavy Duty punches and retainers generally work in mild steel applications up to .375" thick. A booster and or a heavy duty ball spring should be used when perforating part materials thicker than .250" or harder than Rockwell "B" 75.

Light Duty punches and retainers are limited to mild part materials up to .125" thick and a hardness of less than Rockwell "B" 75. Booster and heavy duty ball springs are not applicable in Light Duty retainers.

Backing Plate Type Vs. Dayton Retainers



Backing Plate Type



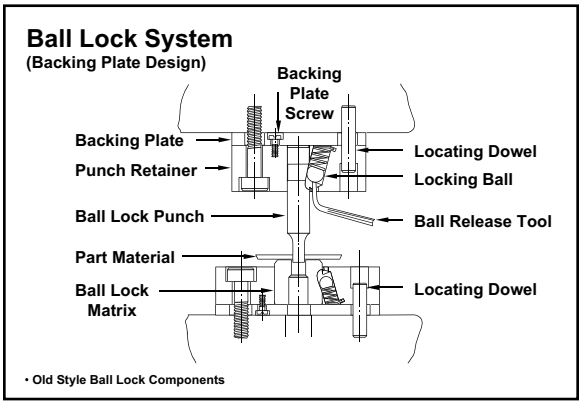
Dayton True Position

- **Old Vs. New**

4

Through the years ball lock components have been continually refined to improve precision and reliability. The most significant improvement was the introduction of the backing plug with in-line primary dowel.

This change eliminated the need for a backing plate. Backing Plugs, along with many other features introduced by Dayton Progress, are discussed in this program.

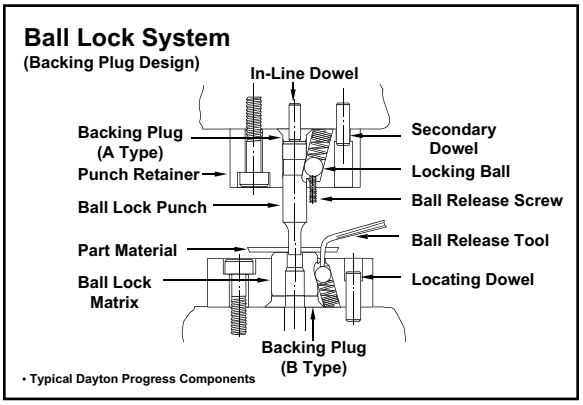


5

The old style ball lock retention system utilized hardened backing plates to prevent the punch and matrix from embedding into the die shoe. This support was necessary to help dissipate load normally dispersed by the head of a traditional punch.

To allow for slug clearance, hardened backing plates under the matrix are either removed or modified by drilling a clearance hole through them. Removal of the backing plate in heavy applications may allow the matrix to embed into the shoe.

Ball return springs in old style retainers have minimal pressure. The travel requirements to release the punch or matrix are limited due to the short distance to the bottom of backing plate.



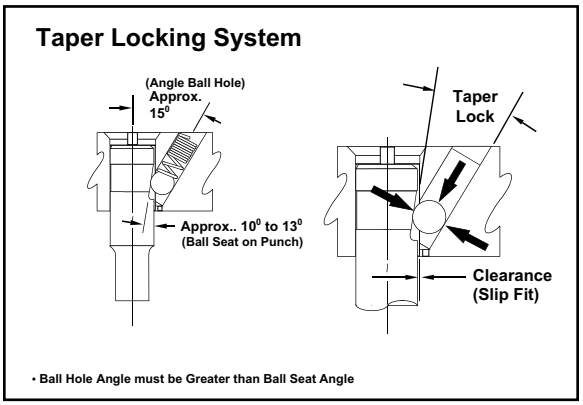
6

Although appearing similar to the old backing plate type ball lock retainers, the Dayton True Position retainers have several significant differences.

The most obvious are the Backing Plug, In-line Dowel and the Threaded Ball Release Hole.

This illustration shows an “A” type backing plug with an in-line dowel hole behind the punch and a “B” type backing plug with a slug clearance hole behind the matrix.

Ball springs have greater pressure than springs with the backing plate design. This is achieved by utilizing the additional ball hole length to obtain the appropriate travel required by a higher pressured spring.

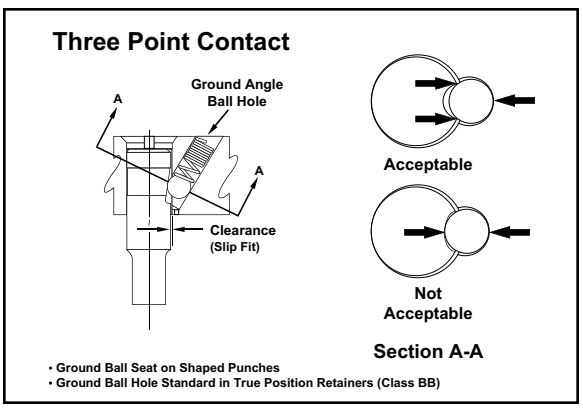


7

The ball lock retention system uses the wedge principle to retain a punch or matrix in the retainer.

Component installation is accomplished by simply inserting the punch or matrix and twisting until it locks into the retainer. It is advisable to intentionally misalign the ball seat with the ball hole in the retainer when initially inserting the component. This will allow you to feel the ball snap into place to assure a proper lock.

Removal of the component is accomplished by first depressing the ball. Once the component is free from the ball, it can then be removed from the retainer.

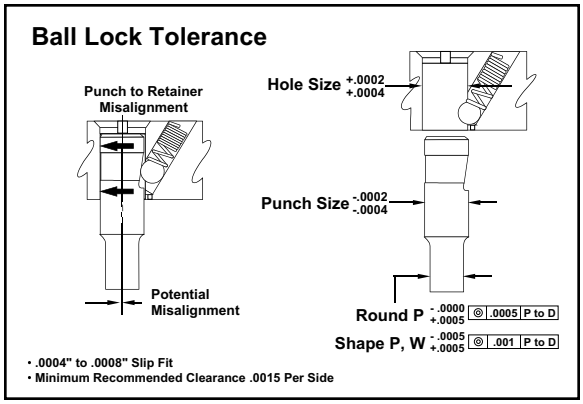


8

Radial orientation of shaped punches and matrixes is critical. Three point contact provides accurate radial location.

Two of the three ball contact points are on the ball seat. The ball seat is smaller than the diameter of the retaining ball. This permits the ball to contact only the edges of the ball seat. The third ball contact point is in the ball hole.

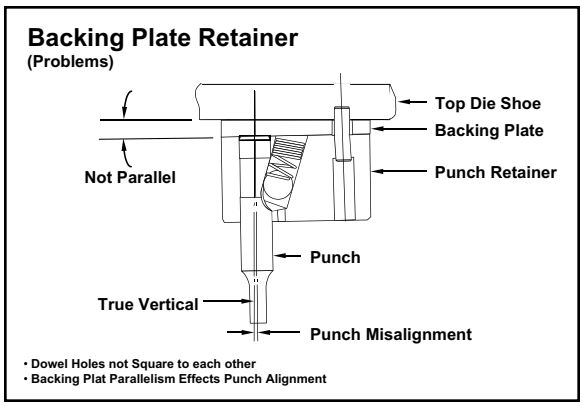
Ground ball seats on shaped punches and matrixes as well as a ground ball hole in the retainer assure proper radial orientation.



9

The minimum recommended clearance is .0015" per side between punch and matrix.

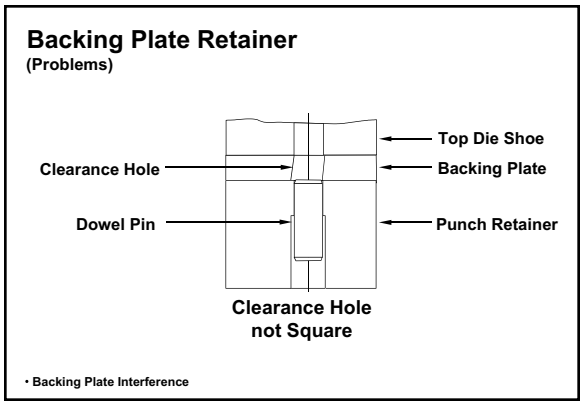
Ball lock punches and matrixes have a slip fit clearance of .0004" to .0008" into the retainer. The slip fit combined with the accumulation of tolerance from the punch and matrix can create as much as .0015" misalignment.



10

It can be difficult to grind a hardened backing plate flat and parallel.

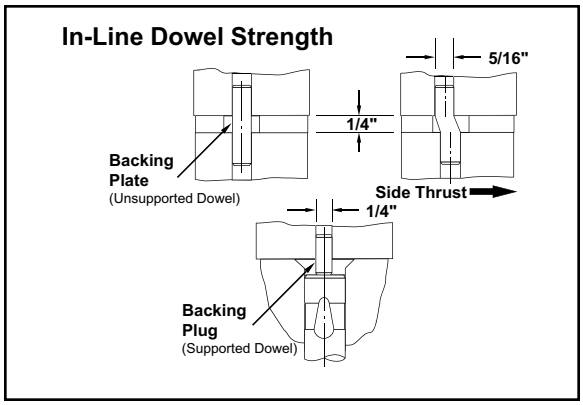
Flatness and parallelism problems tilt the retainer out of square creating a dowel and punch to matrix misalignment problem. Long punches will have the greatest misalignment.



11

Machining and grinding backing plates creates perpendicularity problems in holes that do not get ground as a final operation. This problem will become apparent when transferring holes. A transfer punch or reamer will hit the backing plate preventing them from functioning properly.

It is recommended to transfer and ream the dowel holes with the backing plate removed to eliminate chip buildup at the backing plate clearance hole. The chip buildup may result in drill or reamer breakage. In this case the backing plate interference problem will be encountered when the dowels are driven in as shown here.

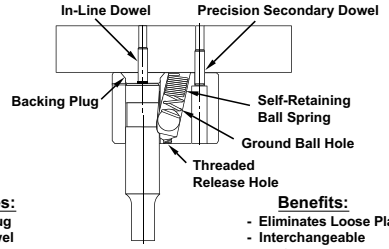


12

The backing plate between the die shoe and the retainer leaves an unsupported area of equal distance around locating dowels.

A 5/16" locating dowel with a 1/4" unsupported length maintains only 67% of its rated shear strength. On the contrary, a 1/4" locating dowel fully supported delivers 108% of its rated shear strength.

True Position Retainers



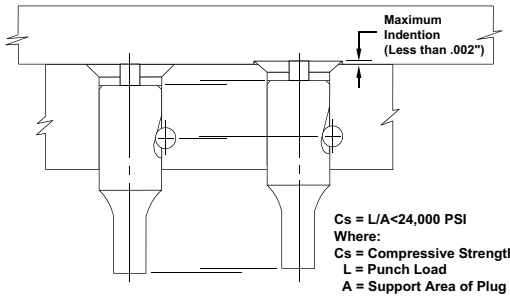
Features:
- Backing Plug
- In-Line Dowel
- Threaded Release Hole
- Self-Retaining Ball Spring
- Ground Ball Hole (Class BB)
- Precision Screw & Dowel Hole Locations

Benefits:
- Eliminates Loose Plates
- Interchangeable
- No Special Tools Needed
- Easy Assembly & Mounting
- Precision Radial Orientation
- Simplifies Design & Build

13

True Position retainers offer many benefits. These benefits are noted in the illustration.

Backing Plug Indention



Cs = L/A<24,000 PSI
Where:
Cs = Compressive Strength
L = Punch Load
A = Support Area of Plug

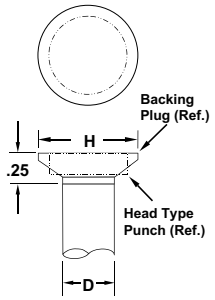
• Load not to exceed 24,000 PSI of Backing Plug Area

14

Under severe load, the backing plug may indent into the surface of the die shoe. If this happens, the support area of the shoe will work-harden, becoming increasingly stronger. Indention of a few thousandths of an inch has no effect on performance of the punch or retainer.

Most die shoes have a compressive strength between 20,000 and 24,000 pounds per square inch.

Backing Plug Support Area



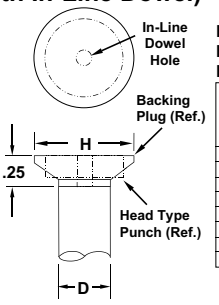
Backing Plugs have more support area than Head Type punches.

D	Area H	Square Inches	Additional Support
Punch Size	Back Plug	Head Type	Advantage %
.250	.196	.110	78
.375	.307	.196	57
.500	.442	.307	44
.625	.601	.442	36
.750	.785	.601	31
.875	.994	.785	27
1.000	1.227	.994	23
1.250	1.767	1.485	19

15

Ball lock backing plugs have a greater support area than heads on headed punches.

Backing Plug Support Area (With In-Line Dowel)

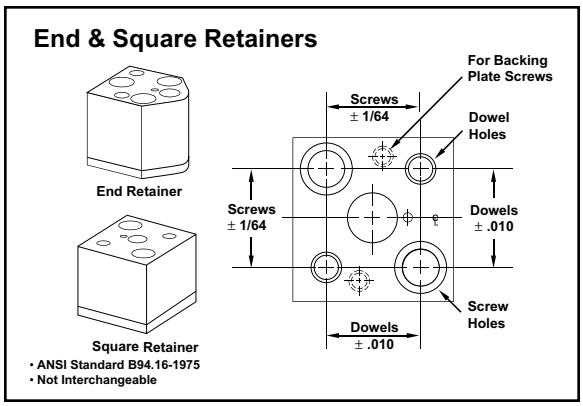


Backing Plugs with In-Line Dowels have more support area than Head Type punches.

D	Area H	Square Inches	Additional Support
Punch Size	Back Plug	Head Type	Advantage %
.250	.184	.110	67
.375	.279	.196	42
.500	.393	.307	28
.625	.552	.442	25
.750	.736	.601	22
.875	.945	.785	20
1.000	1.178	.994	19
1.250	1.718	1.485	16

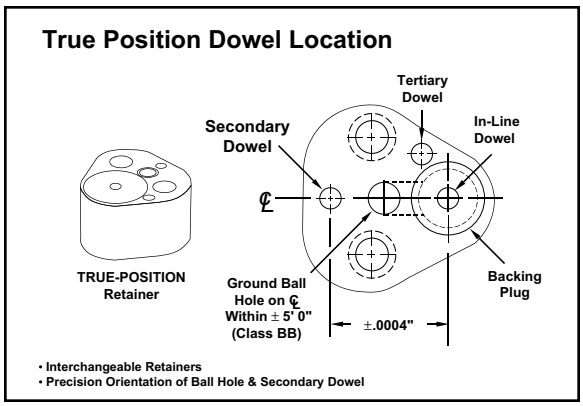
16

Although the In-line dowel reduces the surface area against the die shoe, it still provides more support than a headed punch.



17

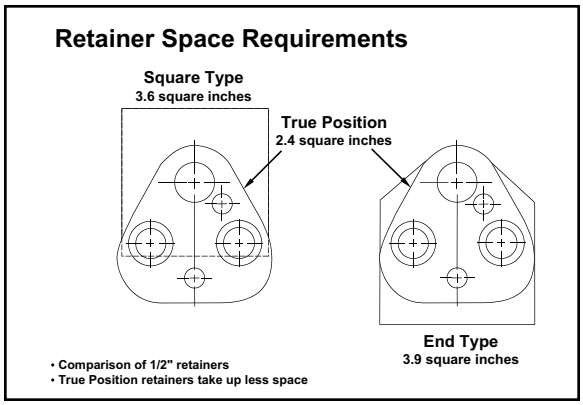
End and Square retainers per ANSI Standard B94.16-1975 are not interchangeable. A dowel hole location tolerance of ±.010" in relation to the punch or matrix location will require custom machining and fitting when mounting or replacing each retainer. Interchangeability of End and Square retainers is nearly impossible.



18

Standardized screw and dowel locations along with the use of a precision ground ball hole allows designers to layout a fully detailed die ready for machining. The ball hole is held within ± 5' 0" of the centerline for the in-line and secondary dowel holes assuring proper radial orientation of shaped punches and matrixes.

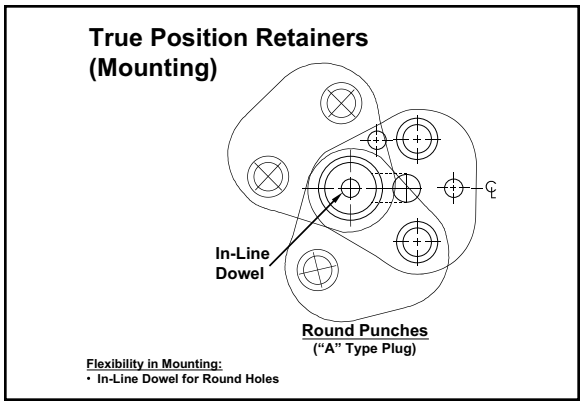
These features are what make True Position retainers interchangeable.



19

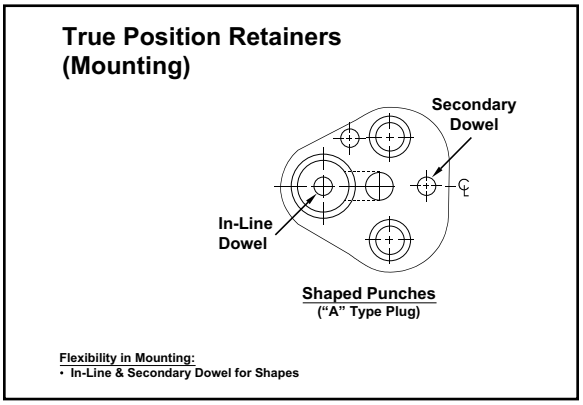
True Position retainers take up less space than end and square retainers.

Smaller retainers allow greater flexibility in tool design. Punches and matrixes can be mounted closer together and leave additional space for die springs and other components.



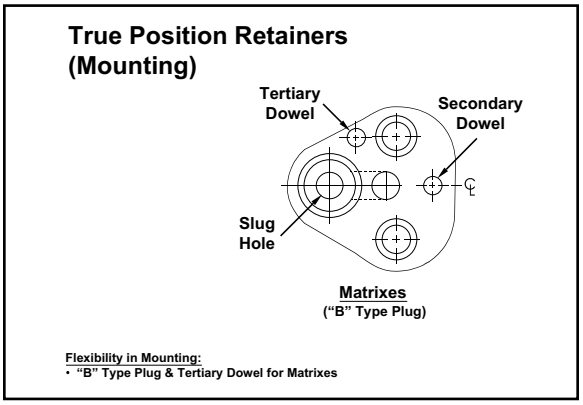
20

In-line dowels provide greater flexibility in mounting. The in-line dowel is the only dowel necessary when retaining a round pointed punch. The body of the retainer can be rotated in any direction to better utilize the available space.



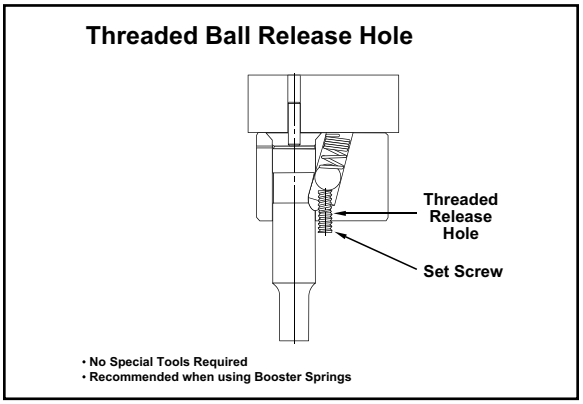
21

The secondary dowel is used to radially orient a shaped punch. This dowel hole is precision ground on the same center line as the punch and ball holes to guarantee proper radial orientation.



22

Matrixes require a "B" type backing plug with slug clearance hole to allow the slugs to freely pass through the bottom of the retainer. Retainers for matrixes require the use of secondary and tertiary dowels. Both holes are precisely located for ease of mounting.



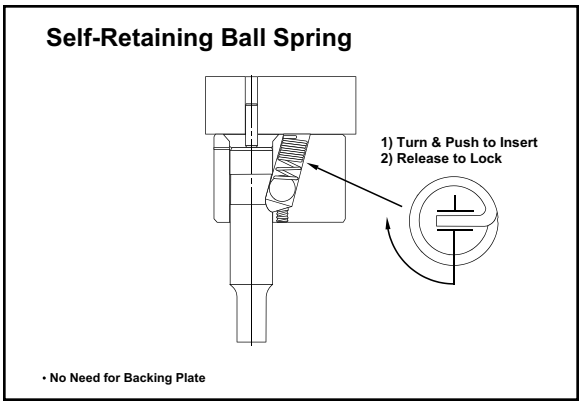
23

The ball release hole in True Position retainers is tapped. This allows the use of a threaded ball release tool or a set screw to depress the ball and remove the punch or matrix.

A threaded ball release tool or set screw are particularly helpful when depressing a ball with an optional heavy duty or booster spring.

A ball release set screw is furnished with every True Position retainer.

Ball release tools are available from Dayton.

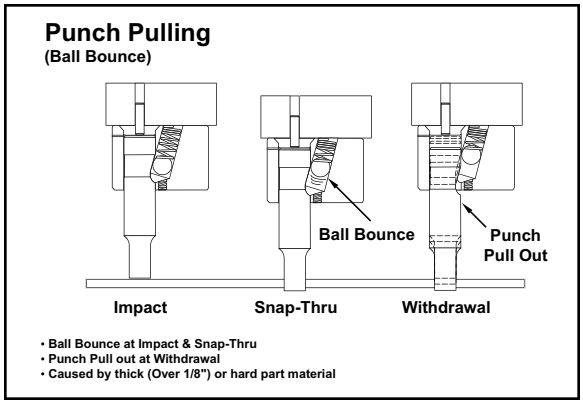


24

True Position retainer springs are self locking. The spring is inserted by gripping the tab and rotating it clockwise into the ball hole. When the tension on the tab is released, the spring expands to the diameter of the hole holding it in place.

There is no need for a backing plate to hold the spring in.

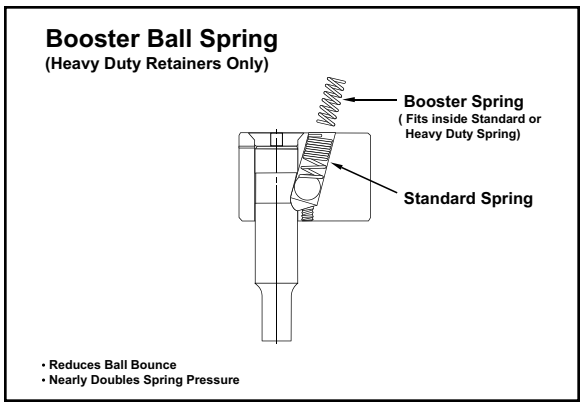
To remove the spring, twist the tab clockwise to release its grip and pull it out.



25

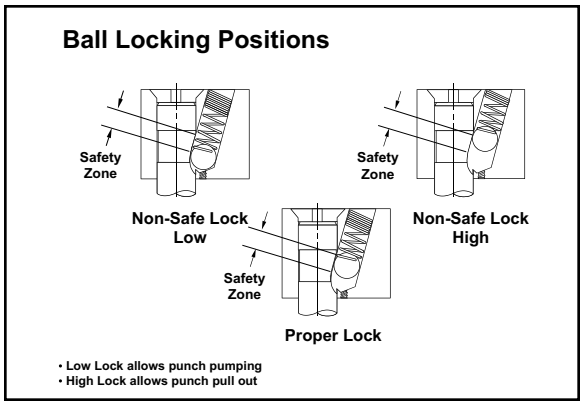
Ball Lock can be troublesome when punching thick or hard materials. The shock generated at impact and snap-thru can cause the ball to bounce. Ball bounce can also occur in high speed stamping applications where press speeds are above 250 strokes a minute.

Ball bounce creates two problems. One is that the bouncing action will eventually cause the ball to fatigue and break. The other problem is punch retention. If the ball is broken or the ball spring pressure does not seat the ball against the punch before withdraw, the punch will fall or be pulled out of the retainer.



26

Ball bounce can be reduced by using a heavy duty and/or a booster spring in the retainer. Heavy duty and booster springs are only available for heavy duty retainers.

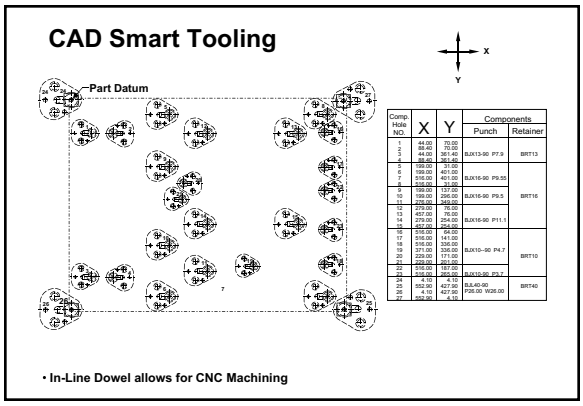


27

The locking position of the ball into the ball seat of the punch is critical.

A ball that locks too low can not be wedged into the taper lock necessary for holding the punch against the backing plug or plate. Low lock will allow the punch to pump, wearing the retainer and fatiguing the ball. A worn retainer and fatigued ball can cause punch misalignment and ball breakage.

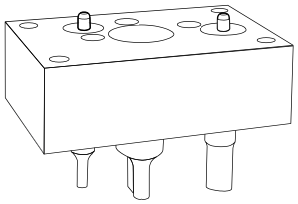
A high lock condition does not offer sufficient retention and may lead to punch pulling.



28

Some applications require numerous retainers to produce a part. True Position retainers have precision In-line and Secondary dowel holes allowing the holes in the die shoe to be machined to print without having to fit each one.

Multi-Position Retainers

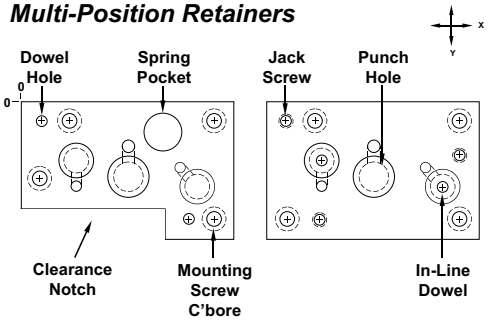


- Reduces Retainer Mounting Time
- Allows Punches to be Mounted in Close Proximity with Each Other
- 4140 Prepared Material leaves retainer machineable at assembly

29

Some applications require numerous retainers to produce a part. True Position retainers have precision In-line and Secondary dowel holes allowing the holes in the die shoe to be machined to print without having to fit each one.

Multi-Position Retainers



- View of retainer from backing plug side

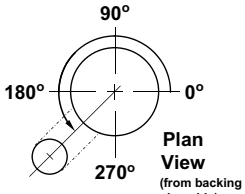
30

Many of the concepts of the True Position retainers can be applied to multiple hole punch (Multi-Position) retainers.

Multi-Position retainers are capable of holding numerous punches in close proximity and can be mounted with relative ease. These retainers are machineable and can be modified at assembly.

Multi-Position retainers provide a low cost solution in building new dies. The use of Multi-Position retainers cuts cost by eliminating the need for special detail drawings. Repairs and engineering changes are also made easy by utilizing the in-line dowel concept along with other design features.

Ball Hole Locations:



Plan View (from backing plug side).

Hole Tolerance Re Datum Point	
Dowel Holes	±.0003
Screw Holes	±.005
Component Holes	±.0003

Specify radial location in degrees counter-clockwise from 0°.

Punch Shape	Ball Hole Class	Radial Tolerance
Round	B	±5°
Shape	BB	±0°5'

- Standard ball seat location is at 90°
- Class B provided unless otherwise specified.

31

This illustration highlights common features available on Multi-Position retainers.

True Position Retainers

Feature	Benefit	Value
Backing Plug	Eliminates Loose Plates	Minimizes Mounting Problems
In-Line Dowel	Precision Punch Location	Reduces Build & Maintenance Cost
Threaded Ball Release Hole	No Special Tools Required	Easy Punch Removal
Self Retaining Ball Spring	No Loose Parts	Easy to Assemble
Ground Ball Hole (Class BB)	Precision Radial Alignment	Interchangeable
Precision Screw & Dowels	CNC Compatible	Simplifies Design & Build

32

A reasonable level of precision can be obtained when using Multi-Position Retainers. Component and dowel hole locations are maintained within ±.0003" in reference to the datum. Screw hole locations are held within ±.005".

Radial orientation of shaped punches is achieved by requesting class BB ball holes which are ground within ±.0005".

Commitment to Quality & Customer Satisfaction

Dayton Lamina is a leading manufacturer of tool, die and mold components for the metal-working and plastics industries. As a customer-focused, world-class supplier of choice, we provide the brands, product breadth, distribution network and technical support for all your metal forming needs.

Our goal is to give our customers the most innovative and value-added products and services.

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