COMPOUND DIES AND CUT AND CARRY OR PUSH BACK OPERATIONS

The term compound die usually refers to a one-station die, designed around a common vertical centerline, in which two or more operations are completed during a single press stroke. Usually, only cutting operations are done, such as combined blanking and piercing.

A common characteristic of compound-die design is the inverted construction, with the blanking die on the upper die shoe and the blanking punch on the lower die shoe. The pierced slugs fall out through the lower die shoe. The part or finished blank is retained in the female die, which is mounted on the upper shoe.

Sectional View of Compound Die

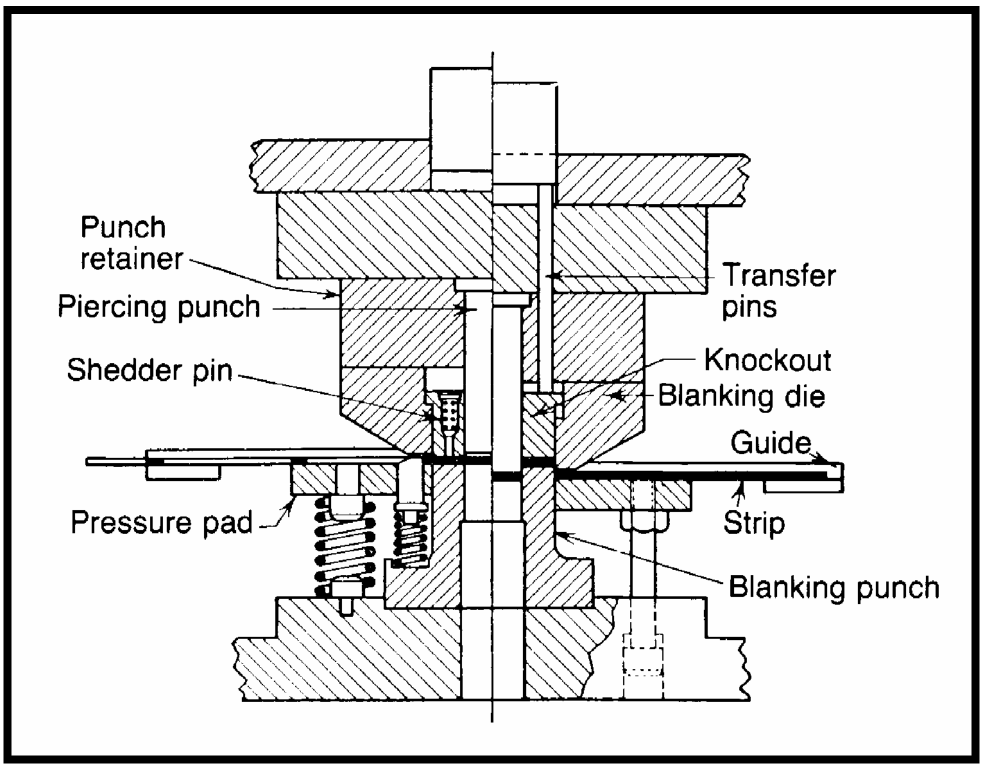

Figure 1. A compound blanking and piercing die to produce a washer: dies of this type are widely used to produce accurate flat blanks. *Cousino Metal Products Company*

Compound Blank and Pierce Dies

Compound dies are widely used to produce pierced blanks to close dimensional and flatness tolerances. Generally, the sheet material is lifted off the blanking punch by a spring-actuated stripper, which may be provided with guides to feed the material. If hand-fed, a stop is provided to position the strip for the next stroke.

The blank normally remains in the upper die, and is usually removed by a positive knockout at the top of the press stroke. Ejection of the blank from the die by spring-loaded or positive knockout occurs at the top of the stroke. Because of this feature, the die does not require angular die clearance. Not providing angular die clearance both simplifies die construction, and assures constant blank size through the life of the die.

Example of Compound Washer Die

A compound die for making a washer is shown in Figure 1. The center hole is cut and the outer diameter trimmed in a single die station in one press stroke. The material is 0.015-inch (0.38 mm) cold-rolled steel strip. The piercing punch is attached to the upper die shoe. The blanking punch is attached to the lower die shoe.

In this design, the piercing punch contacts the material slightly ahead of the blanking die. The part is stripped from both the blanking die and piercing punch by a positive knockout. The blanked strip is lifted off the blanking punch by a spring-loaded pressure pad.

Part Removal from Compound Dies

A potential disadvantage of compound dies is that the part must be removed from the upper die at the top of each stroke. The part is usually knocked out at the top of the stroke by means of a press-actuated knockout bar.

In the case of small parts, once knocked out of the upper die, they may be ejected by a timed blast of air. Larger parts can be removed by means of a shuttle unloader that enters the die opening as the ram ascends. The press ram normally drives the unloader, although air, hydraulic, or servo motor driven units may be used. Accomplishing positive part removal during each press stroke may limit the speed of the operation. For low production jobs, manual removal with appropriate safeguarding precautions may suffice.

Cut-and-Carry or Pushback Operations

Cut-and-carry operations are very useful for producing parts with high flatness requirements. The cutting station in cut-and-carry dies is normally an upside-down compound die. The part is cut and then pushed back into the carrier strip rather than ejected. The feature of pushing the part back into the carrier strip or scrap skeleton provides a positive means to get the part out of the die without an auxiliary unloading means required with a conventional compound die. Cut-and-carry operations are useful stations in progressive dies.

The cutting station makes use of a counterforce pad. Springs or nitrogen cylinders usually supply the pressure. Figure 2 illustrates a typical cut-and-carry operation. The part may progress through several other stations before being pushed out of the carrier strip in a knockout station. The knockout station must have approximately double the clearance of the cutting station in order to accommodate normal part expansion and pitch growth errors. Otherwise, the production of slivers could be a problem.

Sectional View of Cut-and-Carry or Push-Back Die

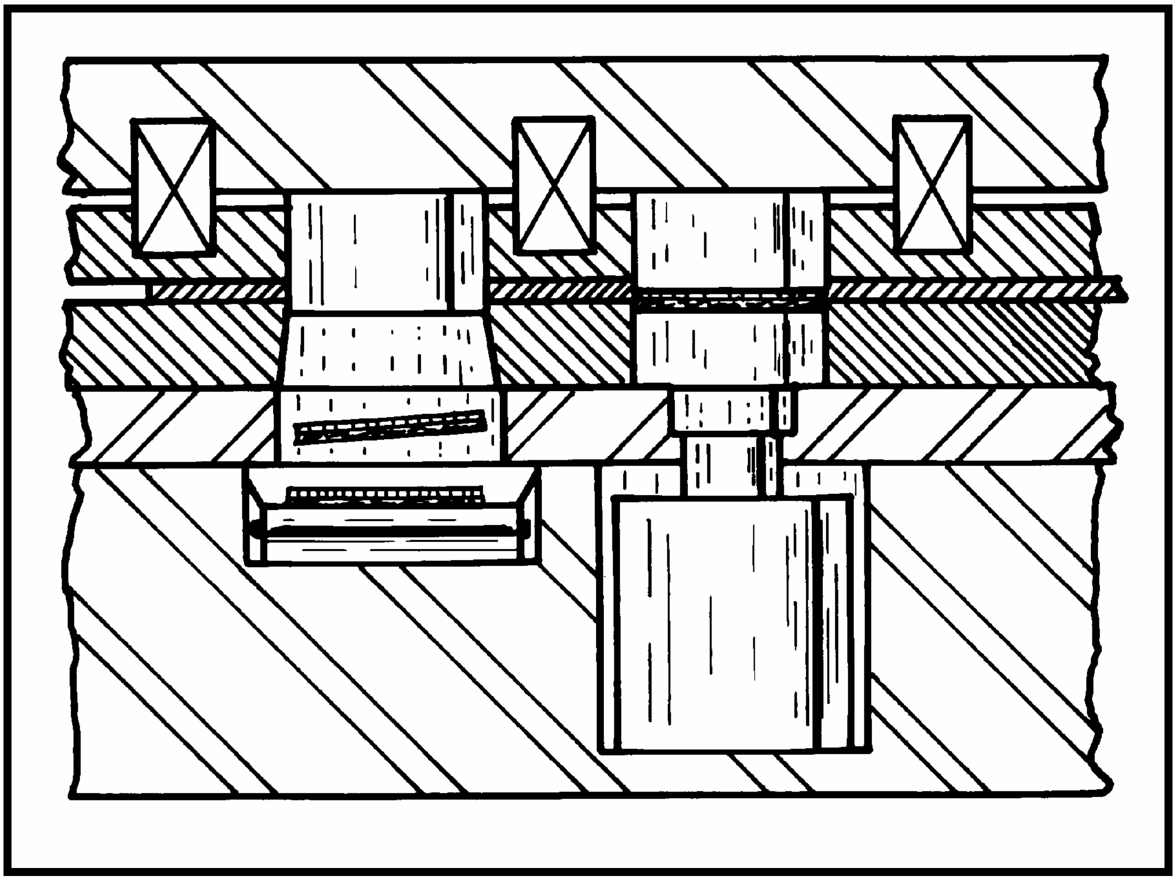

Figure 2. Section through a typical cut-and -carry die. *Smith & Associates*

Cut-and-Carry Success Factors

Successful cut-and-carry stations must completely fracture the part from the material and always contain the part within the carrier opening. Figure 3 shows three close-up views of the fractured edge in the cut-and-carry station. Should the part not completely fracture, a double breakage condition occurs in the push-out station.

If the part is shoved completely out of the carrier, the part will expand and the carrier opening will shrink due to release of residual stresses created in the cutting operation. Attempting to force the part back into the opening may result in distortion and possible cold-welding problems.

Proper Fracture in Cut-and-Carry Station

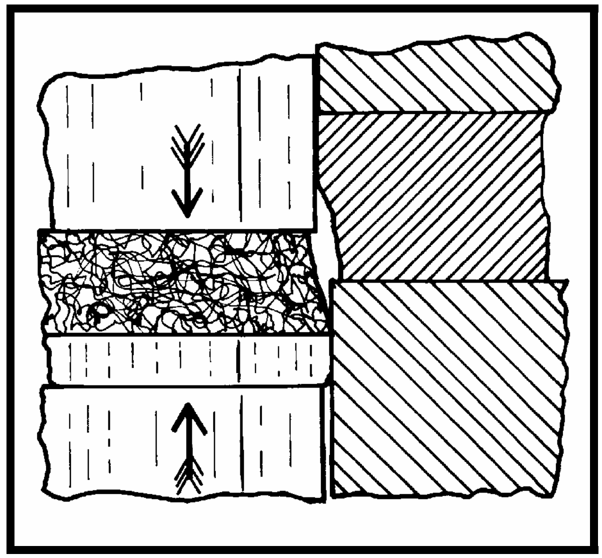

Figure 3. A close-up view of the fractured edge in the cut-and-carry station illustrating proper fracture. *Smith & Associates*

Incomplete Fracture in Cut-and-Carry Station

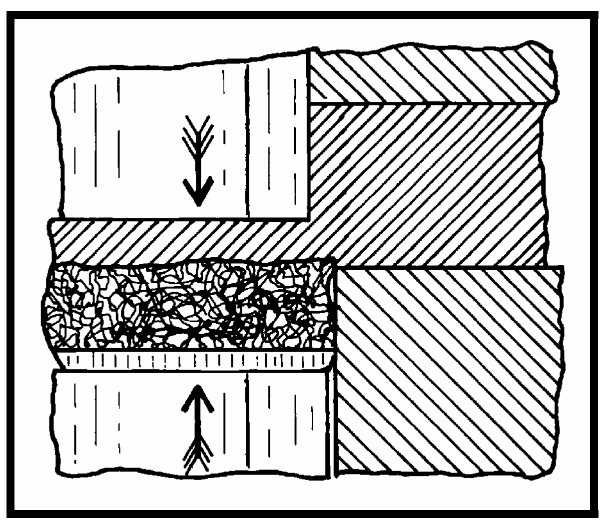

Figure 4. A close-up view of the fractured edge in the cut-and-carry station illustrating incomplete fracture. This will result in a secondary or double breakage in the knockout station. *Smith & Associates*

Cut-an-Carry Process Control Variables

Three main variables are available to control the process. The main cut-and-carry success factors are:

1. Completely fracturing the part from the material.
2. Always containing the part within the carrier opening.

The variables are, in order of effectiveness:

1. Controlling the depth of punch entry.
2. Amount of die clearance.
3. Control of material properties.

Double Breakage in Knockout Station

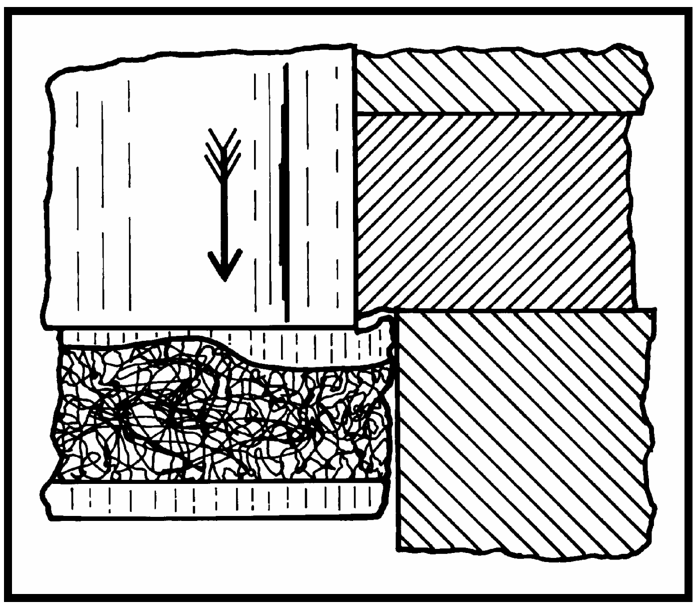

Figure 5. A close-up view of the fractured edge illustrating a secondary or double breakage in the knockout station. *Smith & Associates*

Variation of the spring or nitrogen pressure used to supply the counterforce is not a good variable. If too low a pressure is used, the part flatness will be affected. The depth of punch entry is a means to accommodate range of material properties. Changing die clearances can only be accomplished by modifying or changing the die details. The correct clearance is often determined by experimentation in critical operations. Minimizing cutting forces with optimal clearances normally results in correct operation.

Material properties will have some effect on the ratio of shear to fracture. In general, harder materials will fracture more easily than softer ones.
Cut-and-carry or pushback dies are a proven method to enhance part flatness while providing a convenient means to carry the part out of the die. Complete fracture must occur, and the punch and counterforce must be configured to prevent the part from leaving the carrier in the cut-and-carry station.

Example of Complete Fracture in the Push Back Station

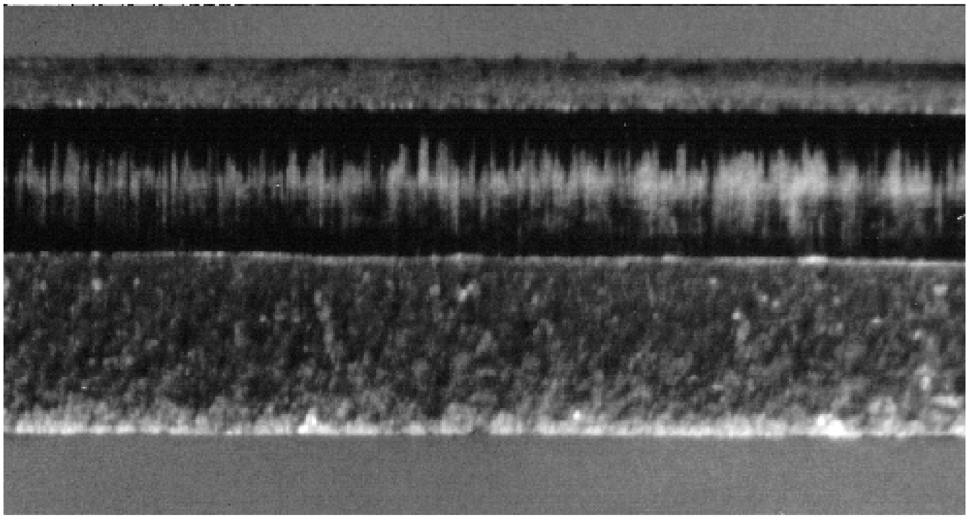

Figure 6. A complete clean fracture in a push back station. The part is made of 0.108-inch (2.74 mm) hard HSLA steel that fractures cleanly. *Smith & Associates*

Example of Bad Fracture in the Knock out Station

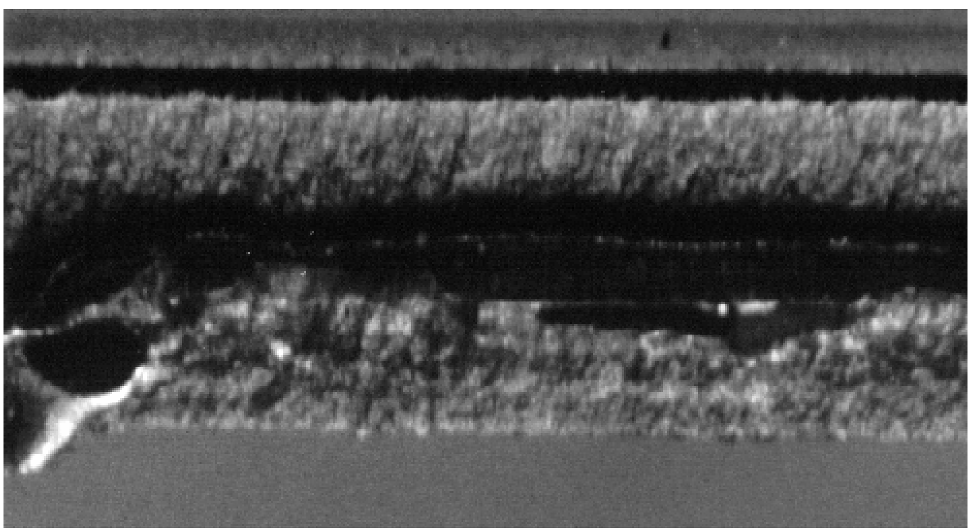

Figure 7. Complete double breakage in the knock out station. The same die as Figure 6 was used. The material is gummy 1020 high manganese steel. *Smith & Associates*

NOTES: ____

____

____