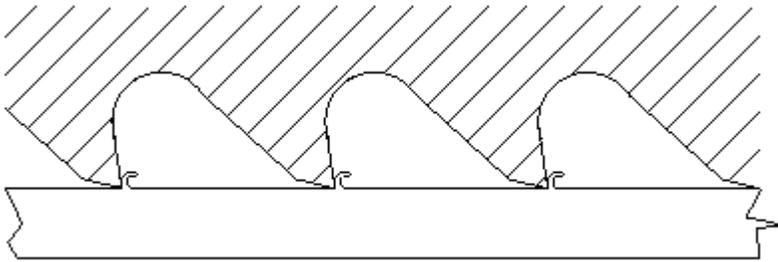


## Broaching Principles

*Broaching* is a machining process that pushes or pulls a cutting tool (called a broach) over or through the surface being machined. Its high-production, metal-removal process is sometimes required to make one-of-a-kind parts. The concept of broaching as a legitimate machining process can be traced back to the early 1850s. Early broaching applications were cutting keyways in pulleys and gears. After World War 1, broaching contributed to the rifling of gun barrels. Advances in broaching machines and form grinding during the 1920s and 30s enabled tolerances to be tightened and broaching costs to become competitive with other machining processes. Today, almost every conceivable type of form and material can be broached. It represents a machining operation that, while known for many years, is still in its infancy. New uses for broaching are being devised every day.



**Figure 1.** Cutting action of a broaching tool.

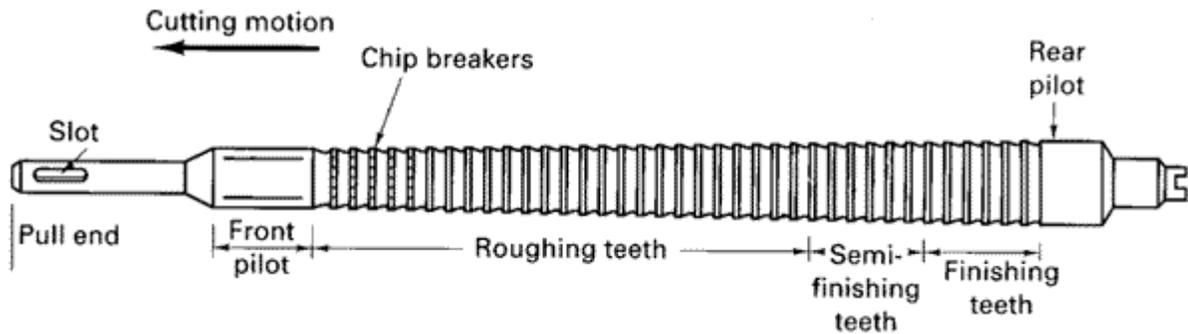
Broaching is similar to planing, turning, milling, and other metal cutting operations in that each tooth removes a small amount of material (Figure 1).



**Figure 2.** Typical push keyway broaching tools and a shim.

The broaching tool has a series of teeth so arranged that they cut metal when the broach is given a linear movement as indicated in figure 1. The broach cuts away the material since its teeth are progressively increasing in height.

Properly used, broaching can greatly increase productivity, hold tight tolerance, and produce precision finishes. Tooling is the heart of broaching. The broach tool's construction is unique for it combines rough, semi-finish, and finish teeth in one tool (Figure 3).



**Figure 3.** Parts of a broaching tool.

There are two types of broaching procedures: internal broaching and external broaching. For exterior broaching, the broach tool may be pulled or pushed across a workpiece surface, or the surface may move across the tool. Internal broaching requires a starting hole or opening in the workpiece so the tool can be inserted. The tool, or workpiece, is then pushed or pulled to force the tool through the starter hole.

Almost any irregular cross-section can be broached as long as all surfaces of the section remain parallel to the direction of broach travel (Figure 4). Helical cuts can also be produced by twisting the broach tool as it passes the workpiece surface.



**Figure 4.** Different types of broaches.

### Hints for successfully broaching a keyway

#### Set-up

Maintain a rigid set-up at all times. The workpiece must be solidly fixed or nested

perfectly square with the baseplate and ram face. Check to make sure that all square and parallel surfaces on the face of the ram and the baseplate remain true.

### **Alignment**

Proper alignment of the broach, workpiece, and ram is the most important factor in all broaching operations. Misalignment can cause drifting, deflection, and even breakage.

Alignment Tips--If a keyway broach drifts and cuts a taper, try the following:

- 1.** Reverse workpiece or turn broach so teeth face toward the back of the press.
- 2.** Let the bushing protrude above the workpiece to give more support to the back of the broach thereby helping to keep it aligned. If a collared bushing is used, place it upside down under the workpiece.
- 3.** Make sure the broach is centered under the ram at the beginning of the cut. If the broach moves out of alignment after starting to cut, back off the pressure on the ram and align the broach itself. Repeat during successive cuts to ensure perfectly straight cuts.

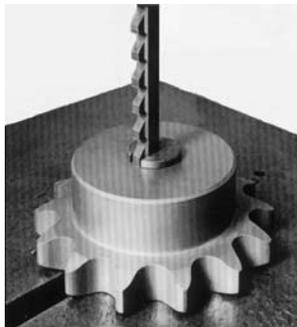
## Broaching Procedures



### Broaching with Keyway Sets or Individual Keyway Broaches

Bushings are required. Shims are required with all but the smallest broaches, and are provided with each individual keyway broach and broach set for cutting to standard depth.

1. Select the right bushing for the bore (sizes are plainly marked) and insert in the bore of work.
2. Insert broach (which is also plainly marked for size) for the desired width of keyway into the bushing slot and check alignment.
3. Place this assembly in the press.
4. Lubricate.
5. Push Broach through.
6. Clean broach.
7. Insert shims as required to obtain exact keyway depth.



### Broaching with One-Pass Keyway Broaches

No shims are necessary. "C" style bushings are required.

1. Insert bushing in part.
2. Insert broach and check alignment.
3. Lubricate.
4. Push broach through.
5. Clean broach.

### **Broaching with Production Keyway Broaches**

No shims or bushings required.

1. Insert broach pilot into bore of part.
2. Lubricate.
3. Push broach through.
4. Clean broach.



### **Broaching with Internal Hole Broaches**

Round, Square, Hexagon, and Special Shapes. No shims or bushings required.

1. Insert broach and check alignment. (The use of a ram adapter is advised with all round, oval, D-hole broaches, and for square and hexagon broaches 1/4" and smaller).
2. Lubricate.
3. Push broach through.
4. Clean broach.
5. Ram Speed: Always use proper ram speed to prevent chatter marks and edge wear.  
(See *Metals Handbook*--Vol. 3 "Machining".)

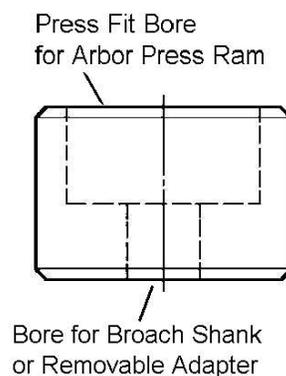
6. Pilot Holes: Properly drilled pilot holes are essential for a true and clean cut. Never use a dull or poorly sharpened drill to make pilot holes.



### Ram Adapters

Ram adapters, or rear guides, provide support and guidance for the broach at the shank end, minimizing the possibility of deflection or breakage. Ram adapters are recommended for all standard round, oval, D-hole broaches, square and hexagon broaches 1/4" and smaller, and in certain other situations where an extraordinarily high degree of accuracy is required.

If a ram adapter is used as a rear guide for the broach, the hole in the ram adapter must be in alignment with the pilot hole in the workpiece. Whenever ram adapters are used they must provide a tight, true fit to both the press ram and the broach shank.



*Ram Adapter to guide broach shank: When using special broaches, all D, Double-D, and most rectangular broaches have a tendency to deflect. To prevent this, the simple ram adapter, which can be fitted to either an arbor or hydraulic press, will guide the broach throughout the cut.*

