

GOOD CUTTING PUNCH AND DIE MAINTENANCE

A skilled observer can tell a great deal about both stamping shops and die construction facilities through simple observation. For example, a production shop that routinely shims die details with large stacks of poorly fitting shims probably performs breakdown maintenance in the press. Likewise, die shops that are dirty and poorly organized are not good sources for efficient die maintenance.

The term punch and die maintenance often is loosely used to refer to the maintenance of cutting dies. However, pressworking tooling having punches also includes cast iron alloy drawing punches for automotive outer skin panels and form punches for the frame rails used in heavy trucks. Therefore, our discussion is limited to cutting punches and dies.

Follow Good Grinding Practices

The routine maintenance of cutting tools nearly always involves grinding. In the event of severe damage, welded repairs followed by grinding may be required. It is essential to use the best procedures when grinding tool steel die parts. Poor procedures compromise the life and dependability of the die.

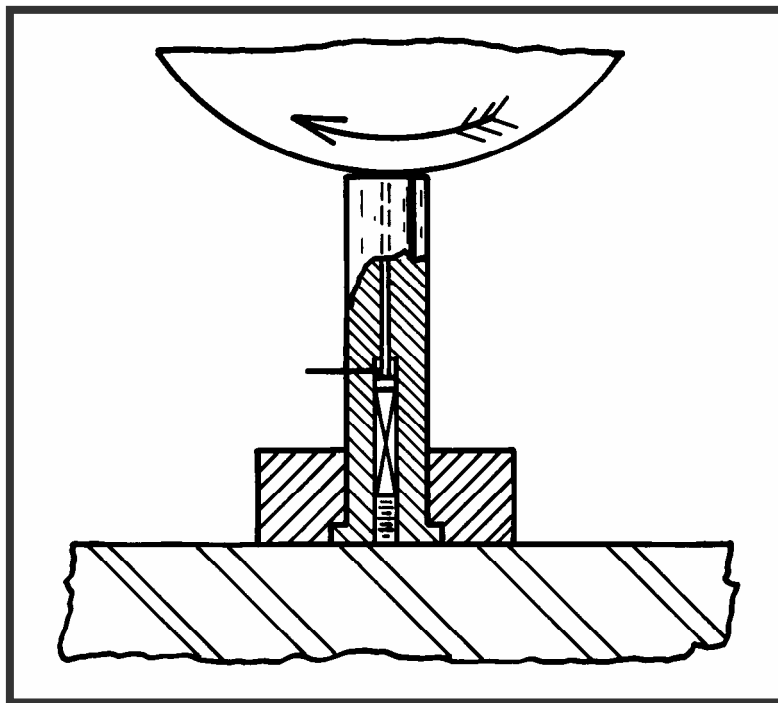


Figure 1. Grinding the worn end of a punch to sharpen. A wire inserted through a breather hole—a Dayton Progress Patent, retracts the spring loaded slug shedder pin.
Smith & Associates

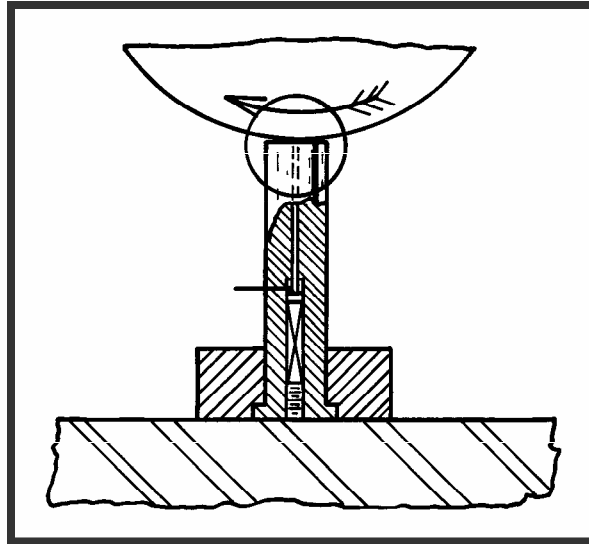


Figure 2. Close up view of grinding wheel sharpening a punch. The grinding procedure must be correct to insure good tooling performance. *Smith & Associates*

Surface grinders are machine tools and grinding is a machining process. The cutting tools are the projecting sharp abrasive grains on the wheel. The abrasive grains used for sharpening tool steels are typically aluminum oxide and less frequently silicon carbide. Cubic boron nitride (CBN) and diamond are also used for tool room work. The grains are held together by a bonding material. Vitrified bonds are the most popular for tool room work because they are stable in both wet and dry work. The bond can be compounded with a very wide range of densities and strengths to provide job specific hardness and self-sharpening breakdown characteristics.

If the correct wheel is selected, the extremely hard abrasive grains will cut the hardened tool steel until the wheel becomes dull. Like any dull tool, more cutting pressure is developed than if a sharp tool is used. The increased pressure will cause the dull grain to break away from the bond material. Thus, the grain size and type is chosen for the best cutting action and finish on the tool steel being ground. The bond structure and type determines how strongly the abrasive grains are attached to the wheel. The abrasive grains should break away as they become dull exposing sharp grains as the wheel wears.

Wheel Selection

Tool room grinding wheels used in the United States are usually marked with the ANSI Standard B74.13-1990 identification code. The code is a series of short numbers and single letters printed in the paper washer in the center of the wheel. The series starts with a prefix number followed with a letter. The following is an example similar to the ANSI standard sample information. Figure 3 illustrates how to read the ANSI code information on the wheel.

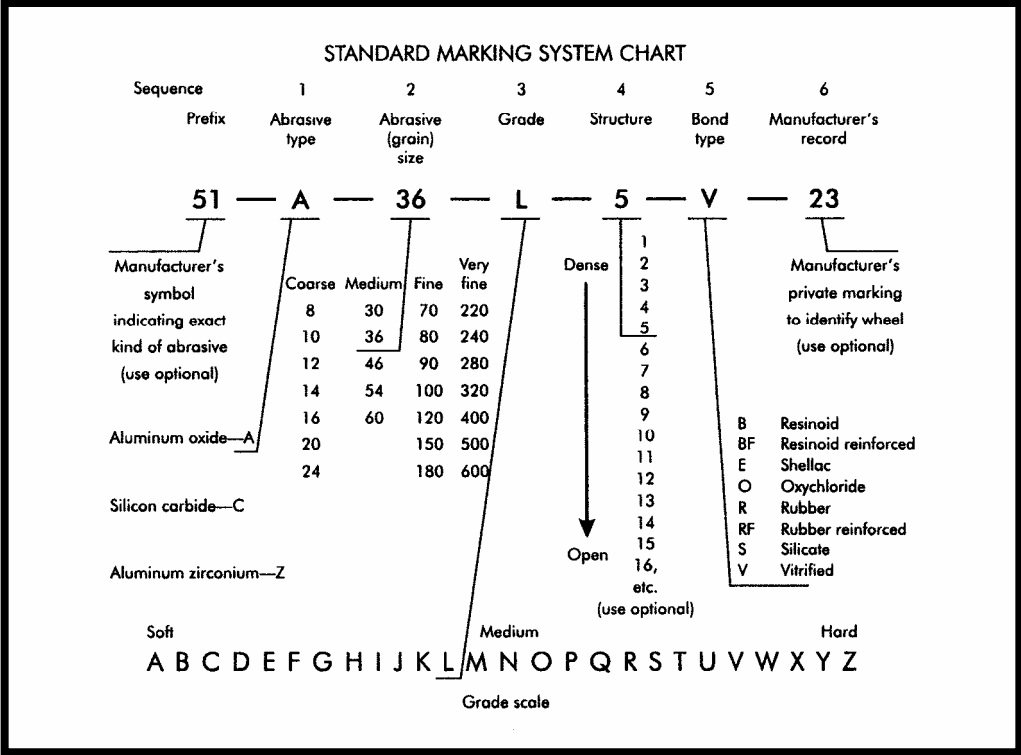


Figure 3. Standard ANSI marking system for aluminum oxide, silicon carbide and aluminum zirconium grinding wheels. *ANSI*

The most important information includes the abrasive type, grain size and bond hardness. A is aluminum oxide, the most common type for toolroom surface grinder work. The next most common abrasive is silicon carbide designated C. Silicon carbide is useful in the toolroom for heavy offhand grinding wheels as well as surface grinding of cast iron and hard bronze alloys.

The grain size is given in the screen mesh size that will pass the grains given in inch dimensions. Commercial grinding wheel grain sizes run from approximately 8, a very course grit through 220, which is fine. Sharpening flat die sections on a manual surface grinder requires gentle stock removal and good surface finishes. A suggested range of type A or aluminum oxide grit sizes is grade 36 through 60 mesh.

The relative bond hardness is designated alphabetically from A through Z, which ranges from soft to hard. The bond should be soft enough to allow the wheel to break down exposing new grains as the grains become dull. Bond harnesses G and H are among those suitable for flat surface grinder die sharpening work. If a sharp corner must be ground square, a fine hard wheel such as a 220 grain J bond wheel may be required to square up the corner. A perfectly square corner cannot be ground or cut with EDM processes. Two tool steel sections are normally butted together to form a perfectly square corner.

The structure number indicates the relative amount of abrasive in the wheel. A larger number means that the percentage of abrasive in the wheel is less. This means that the wheel structure is more open than the case with a smaller number designator.

Selecting the Wheel

Grinding wheels for sharpening tool steel punches and dies should have an open structure with a moderately soft bond. Fine-grained wheels with hard bonds tend to dull quickly and create excessive heat. Soft open bond wheels break down in use and remain sharp.

A grinding wheel functions by cutting, not by frictional melting of the metal being ground. As the wheel wears down to a smaller diameter, the lower cutting velocity will result in the wheel acting softer than a full size wheel. A good storage practice for used wheels is to neatly store used wheels on wall-mounted pegs near the surface grinder. When selecting a used wheel, choosing a smaller diameter worn wheel will result in the wheel acting softer by a grade letter or more.

Proper Wheel Dressing

Most tool steel sharpening with a surface grinder requires an aluminum oxide wheel having a soft bond structure. Wheel dressing requires a single point or diamond cluster set in a holder to dress the wheel. When using a single point diamond to dress the wheel, turn it in its holder from time to time to expose a sharp corner. Diamonds do wear and become blunt.

Make enough passes across the diamond to true the wheel. The crosswise motion of the diamond should be fast enough to continually dislodge old grains without remaining in contact long enough to dull the newly exposed abrasive. Make the last pass rapidly. In no case should the diamond take a final pass without removing wheel material. This will avoid the blunting of the exposed abrasive edges by the much harder dressing diamond.

Use Safe Wheels

Toolroom work using both machine and offhand grinding tools must be carried out safely. Always use proper guards. Never alter wheel-mounting methods or exceed the manufacturer's rated speed. Examine all wheels before use. New wheels may have been damaged in shipping and handling. When gently tapped, a sound wheel will have a clear bell like tone. This is called ring testing the wheel. The wheel is held by the center hole and gently tapped with a soft object such as a wooden hammer handle or screwdriver handle—never a metal object. A sound wheel will ring with a clear bell like tone. Cracked wheels will emit a dull sound—these should be destroyed.

Grinding Burrs and Sharp Edges

When sharpening punches and dies by grinding, a very sharp edge or burr may occur. Grinding is a machining process—the sharp projections on the wheel abrasive grains act as cutting tools. A small burr normally results. This burr is illustrated in Figures 4 and 5.

In order to insure long tool life, this burr must be removed. Also sharp edges should be blunted slightly. A dead sharp edge is subject to extreme pressures during the cutting process. Since the cutting process is really a controlled plastic deformation, a dead sharp edge is often undesirable because it will chip and/or otherwise dull quickly.

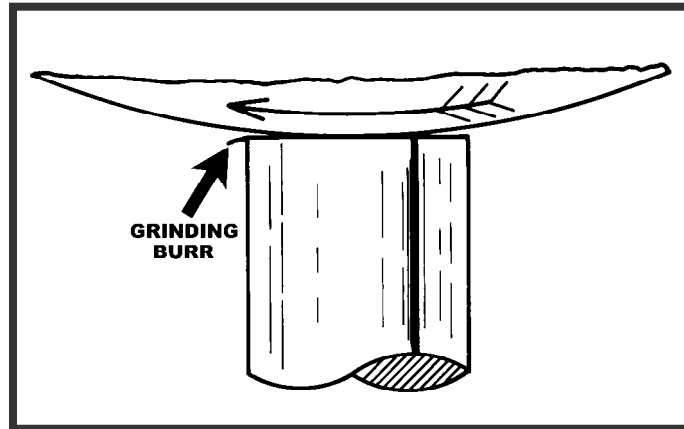


Figure 4. Close up view of grinding wheel sharpening a punch. Note the grinding burr created on the punch edge. *Smith & Associates*

Tool steel edges should be blunted slightly with an Arkansas or fine India stone. Cemented tungsten carbide tools may be blunted with a very fine silicon carbide or boron nitride polishing slip. A copper lap charged with diamond dust may also be used for critical work.

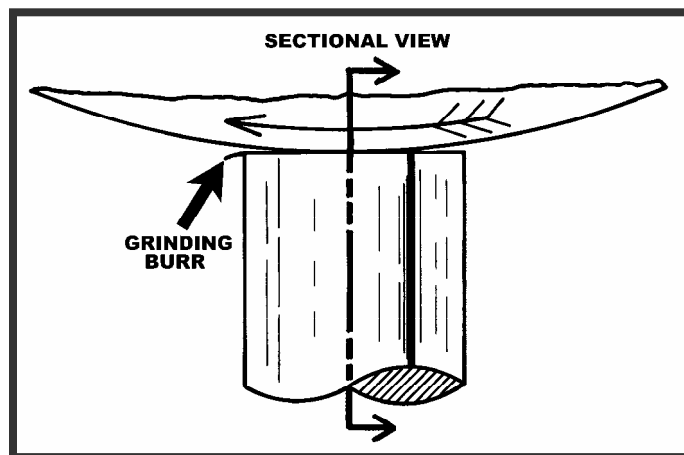


Figure 5. Position of a sectional view through the punch taken to illustrate Figure 5. *Smith & Associates*

Correct Edge Stoning Procedures

Exactly how much and the manner in which a cutting edge is stoned will vary from one type of job to another. Since the purpose of stoning away the grinding burr is to avoid edge chipping thereby increasing the part quality and tool life, any additional blunting of the edge should be done in a way that is correct for each individual job. Cutting thin and/or soft materials requires a very sharp edge and tight cutting clearances. Here, the correct procedure is to hold the stone against the die opening in line with punch and remove only the burr leaving a sharp edge.

Gentle Vs Aggressive and Abusive Grinding

Production grinding is often quite aggressive. Here, the grinding wheel is a tool used to produce a ground shaft or other part made in large quantities. Recirculating flood coolant is used to remove heat. The wheel is selected with great care for maximum metal removal consistent with the desired results.

In the same way, the craftsperson sharpening the die must use great care not to damage the tool steel sections by abusive grinding—the die sections are production tools, not the product so extra care is justified to obtain the best possible tool life. Attempting to hurry the sharpening process through high metal removal rates can overheat and damage the die sections and punches.

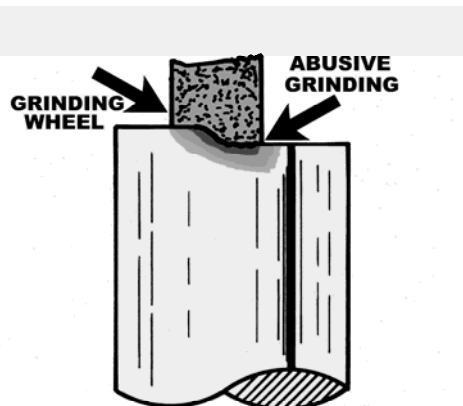


Figure 6. An extreme example of an abusive grinding technique—this damages the punch. Light passes should be taken to minimize heat buildup. *Smith & Associates*

Example of an Abusive Grinding Technique

Figures 6 and 7 illustrate an example of what a craftsperson might do if not properly instructed. In this case the surface grinder is being used much like a milling machine or shaper. The punch being sharpened will be badly overheated. The result is that the hardness will be drawn back and potentially the punch face may be cracked.

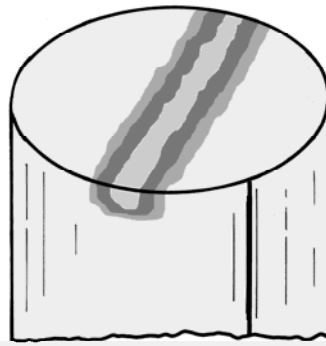


Figure 7. An end view of punch overheated during sharpening. *Smith & Associates*

Effect and Meaning of Discoloration

Figure 7 shows an end view of a punch overheated during sharpening. The color or hue of the discoloration is an indicator of how hot the punch became during the rather abusive grinding process. This is possible because the oxides of iron take on a characteristic color when heated in air depending on the peak temperature attained. The colors that indicate temperature are based on plain carbon steel. Tool steel alloys will not discolor in exactly the same way. A closer view of this area is shown in Figures 8 and 9.

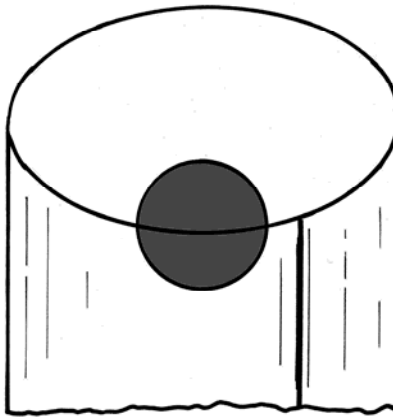


Figure 8. An area for a close up view shown in Figure 8. *Smith & Associates*

Figure 9 Shows Rockwell “C” hardness levels after the punch was overheated. The base metal before sharpening was 62 Rockwell “C”. An area drawn to 48 Rockwell “C” will exhibit a blue coloration. If the area becomes hot enough to turn a whitish gray, it is nearing red heat—hot enough to anneal carbon steel.

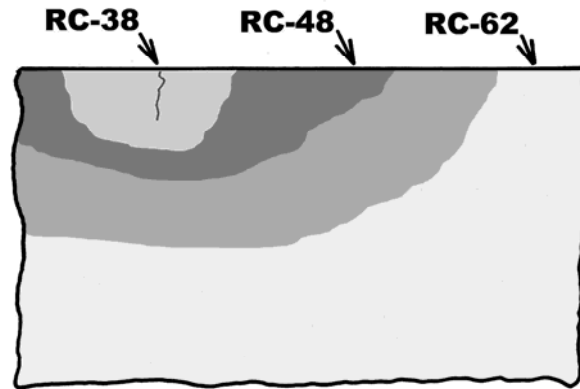


Figure 9. A color change indicates how much overheating occurred. *Smith & Associates*

Crack Formation

When extreme localized overheating of hardened tool steel occurs, the hot area expands and some metal is upset or forced outward. Once the heat source is removed, the hot area is rapidly cooled by the surrounding cold mass of the punch.

If the tensile strength of the hot area is exceeded as cooling occurs, cracks will form at the surface as shown in Figure 9. Any cracks will weaken the punch by providing a local point for stress concentration.

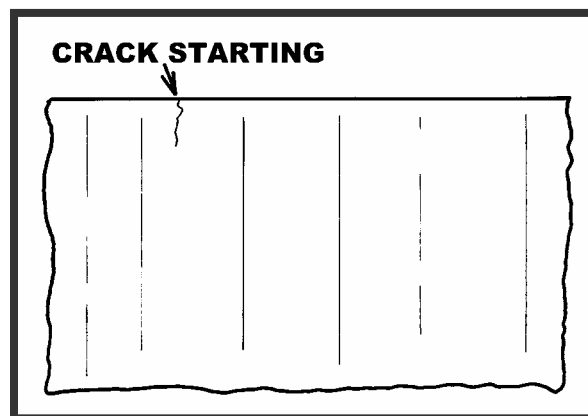


Figure 10. A small stress crack has formed because the punch became overheated while grinding. *Smith & Associates*

Don't Hide the Problem

Unless carefully instructed in what to do, and why a task must be done in a certain way, craftpersons may have a tendency to make mistakes and then attempt to cover them up. After noticing the discoloration, it might make sense to dress the wheel and very carefully grind away the discoloration.

In addition, since an India stone was supplied to remove burrs and sharp edges, it is a simple matter for the craftsperson to stone the punch body to remove any remaining discoloration. However, the punch will have a soft spot that will dull quickly. The crack may grow and cause punch failure. Removing the discoloration will only hide the problem.

Cracks Will Grow

Once a crack in a highly stressed piece of steel such as a punch is formed, it tends to grow or propagate and become larger as shown in figure 11. The rate of growth depends on how highly stressed the punch is when in use.

Figure 12 shows the final failure of the punch. A piece can break away. The result is certain unexpected downtime, scrap and quite possibly serious die damage.

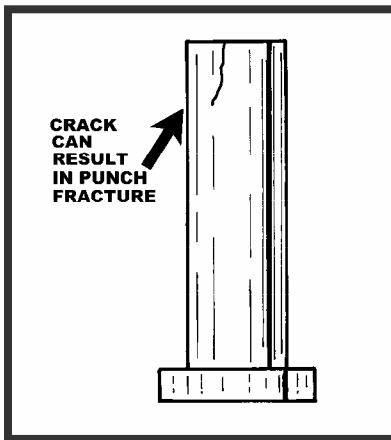


Figure 11. Crack propagation in punch body during use. *Smith & Associates*

Stress Reliving Cutting Tools

Tool steel sections that are subjected to frequent shock and/or high pressures will accumulate internal stresses. These stresses are much like the residual stresses that are relieved by the drawing process that follows quenching during heat treat. Hard worked sections that tend to fail by fatigue fractures can benefit from stress reliving accomplished by redrawing them at a temperature approximately 25 degrees F below the final drawing temperature used in the heat treat process. Exceeding the drawing temperature will reduce the hardness of the section and may result in size change.

This stress reliving procedure is a normal practice for severely worked tool steel details such as coining blocks. Experience obtained from coining high relief in 316 stainless steel medallions using S7 tool steel coining blocks is a good example. The coining pressures approach and may exceed 300 ksi (2,069 mPa) at the form block working faces. The typical failure mode is a fatigue fracture of the raised coining detail subjected to lateral metal flow. A typical average number of hits before failure occurs are 2,000 pieces.

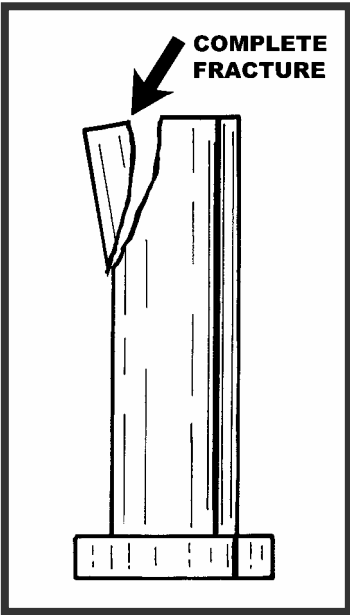


Figure 12. As the crack weakens the punch, failure will occur. *Smith & Associates*

However, stress relieving the form blocks after each 1,000 hits will extend the life to approximately 10,000 pieces. This is done by placing the form blocks in a draw oven at a temperature approximately 25 degrees F below the final drawing temperature. Shop practice typically is to leave the blocks in the oven overnight at the stress relieving temperature.

Cutting sections are subjected to repeated pounding during the production run. This can also create excessive levels of residual stress as well as work hardening. This will result in the Rockwell “C” scale hardness increasing by a point or more. In addition, gentle grinding of cutting sections will introduce or change the amount of stress in the die section. If chipping or cracking is a problem, the stress relieving procedure carried out after grinding often will increase tooling life.

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