

Surface Finishing

tools, techniques and tips

The art of inishing takes years of experience to perfect. Here are some basic principles and techniques of grinding, hand stoning and diamond polishing that will provide a good start.

Surface finishing is a process that requires a variety of tools, materials, and most importantly – highly specialized skills. One of the most technically advanced types of surface finishing is moldmaking, where the surface of the mold has a direct impact on the surface of the product being molded. Proper finishing is essential.

While the art of finishing takes years of experience to perfect, there are some basic principles and techniques which provide a good start. Let's take a look at the three major processes necessary to produce a highly polished, lustrous metal surface:

- **Grinding**
- **Hand stoning**
- **Diamond polishing.**



Grinding

Proper grinding techniques

Machining is technically the starting point of the surface finishing process, but grinding is where the real work begins. After metal is machined, its surface condition is usually rough with ridges and cutter marks. Finishers must use a hand grinder, the basic tool for light metal removal, to get the surface smooth enough to eventually finish with hand stones and, ultimately, diamond polish.

Hand grinders can be used with a variety of grinding wheels and stones in a variety of shapes, sizes and grits. Selection of grit is important, because starting with too fine a grit can waste stones and time. Choose a coarser grit for roughing, and use increasingly finer grits as the surface begins to attain its final shape and size. After deciding



which stone or wheel to use, mount it in the grinder while inserting the shank as deeply as possible to avoid whipping. Light "dressing," shaping the stone to the contour of the finished surface with a dressing stone, is required each time a stone is mounted in a grinder. This ensures concentricity of the abrasive surface.

Grinders have a tendency to follow the wavy contours of the rough surface, which makes it difficult to develop the smooth or flat surfaces required for subsequent stoning. Whenever possible, direct the grinding strokes at a 45 deg to 90 deg angle relative to the grooves developed in the machining process. Be sure that your hands and forearms are braced to provide maximum control over the tool, as this will influence the smoothness of the surface and the amount of finishing that will be required later.

Before starting the actual grinding operation, decide how the grinder will be

supported and how to hold it to permit the wheel or stone to properly address the surface. If possible, move the surface to a position that enables steady grinder control and permits easy, firm strokes.

Speed and rotation

Give careful consideration to the direction of rotation. When taking a stroke in a direction opposite to a cutting tool rotation, the grinder has a tendency to run away from the cut. Conversely, stroking into

the rotation of the wheel can cause the stone to cut deeper than is desired.

Grinder speed is another important factor. Remember, the speed that matters most is the surface speed of the cutting tool against the metal. In other words, the surface speed of a small stone is less than the surface speed of a larger wheel, even though the spindle rpm is the same. Use a rheostat, a two-terminal variable resistor, if greater control of the surface speed is required. Do not try to cover too large an area at

any one time. It's difficult to maintain control and uniform pressure on the wheel over a large area. An experienced craftsman will work on a number of small areas and then blend them together.

Another good practice is to criss-cross the grinding strokes to ensure a uniform surface. When smoothing a surface, grind in one direction to completely cover the area being worked on. Then cross the grinding strokes until all of the previous grinder marks have been removed. Keep in mind that the finisher con-

trols the grinder. The grinder must never be allowed to control the finisher. Power can easily result in problems so always respect the tool.



Listen and feel

There are a number of important signs regarding hand grinder use that become more recognizable with experience. For instance, if the motor slows down while grinding, too much pressure is being applied. The wheel or stone cuts only while it is turning at the proper speed. The faster the cutting tool rotates, the faster the metal is being removed.

A change in the sound of the grinder signifies a change in grinder speed. The amount of pressure is a matter of "feel," but much is learned by listening to the sound of the grinder and closely watching the surface being developed. If the stone or the wheel begins to bounce and it becomes difficult to move it

smoothly over the metal surface, it's probably caused by it being worn out-of-round, or loaded with metal chips. Correct this condition by doing a light dressing with the dressing stone.

If the grinding does not remain constant, it's due to an increase or decrease in speed. Covering too large of an area reduces control over the tool and causes fluctuating pressure, thus erratic speed. Again, work a small area at a time; then blend the areas together. The steadiness of the grinder, the evenness of the strokes and the uniformity of the pressure applied to the cutting tool will determine the quality of the job and the amount of time needed for final completion. Take care to avoid re-

moving more metal than necessary, as this can add significant time and difficulty to a project.



Grinding tips

- Exercise extreme care to prevent the grinder from following the ridges and removing more material than required;
- Whenever possible, direct grinding strokes at a 45 deg to 90 deg angle relative to the grooves developed in the machining process;
- (Brace your hands and forearms to provide maximum control over the grinder tool;
- (Use a rheostat, if necessary, since the surface speed of the cutting tool against the metal is paramount;
- When mounting a stone or wheel in the grinder, insert the shank as deeply as possible to avoid whipping;
- Choose a position that allows the grinder to be held steadily while permitting easy, firm strokes;
- Don't try to cover too large an area at any one time;
- Crisscross the grinding strokes to ensure a uniform surface;
- Listen to changes in the sound of the grinder to determine changes in grinding speed;
- Dress the grinder with a dressing stone if it becomes loaded down with metal chips.

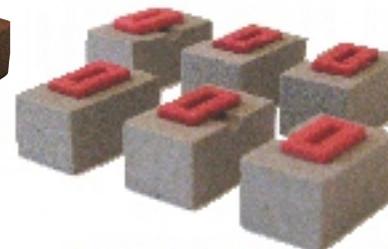
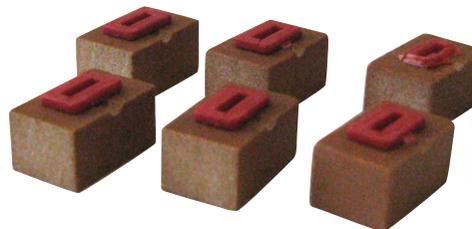


Hand stoning

Proper hand stoning techniques

Once you've arrived at the point where all the metal has been ground to satisfaction, the surface should be examined to determine if it's ready for hand stoning. Check milled surfaces to see if the cutter marks are fine enough to make further hand grinding unnecessary. Surface ground finishes should be free of tears. Hand-ground finishes must be fine and shouldn't have chatter marks or irregularities. Be sure that file marks are free of tears and waves. If all finishes are the best possible, it's time to begin stoning.

Choosing the initial grit of stone depends upon the degree of finish left by the machining, grinding or filing operation. Machining usually results in a coarser finish than grinding; therefore, a coarser grit stone should usually be used. For a ground finish, stoning can begin with a finer grit stone.



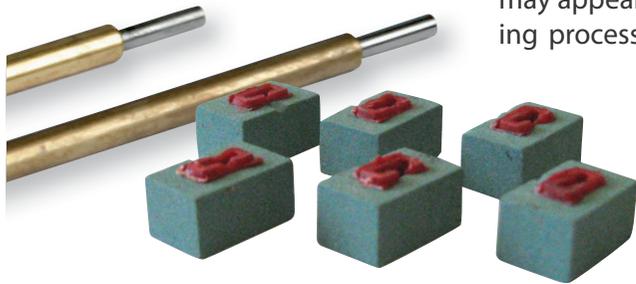
Preliminary stoning may be done with a 240 grit stone to remove final dips, depressions, waves or other imperfections and achieve a flat or properly contoured surface. If defects are not too great, a 320 grit stone will be sufficient. The stone should be moved back and forth, with medium pressure applied,

over the surface in a direction 45 deg or 90 deg from the direction made by the last tool marks.



Clean and lubricate stones

Before using the stones, soak them in a contaminant-free, oil-based lubricant. Continue to clean the stones frequently by dipping them in the oil lubricant. Constant stone cleaning is necessary to clear away



the fine metal chips that tend to clog or load up the stone. Should the stone fill with such metal chips, they could cause the cutting of deep scratches on the surface being polished. This is known as "picking up." Stoning oil or other lubricants, in addition to keeping the stone clean, improve the cutting action.

A number of ridges and high spots may appear at the start of the stoning process. All of these irregulari-

ties must be removed to obtain a truly flat and smooth surface. This is especially true if the ultimate goal is a high-luster diamond polish. Surfaces that have been ground will often have areas where the metal has been burnt by the action of the grinding wheel. These burnt areas must be removed in order to maintain a constant surface hardness.

Overlap all scratches

Polishing, from a purely physical point of view, is the process of producing a series of overlapping "scratches" that get finer and finer. To accomplish this, it's important that for each finer grade of stone used, the angle (direction) be changed relative to the marks made by the preceding coarser stone. In this way, the marks of one grit size are "erased" by the subsequent finer-grit stone. It is critical that each finer grit stone completely removes the marks of the last grit. Neglecting to do so will result in a shiny, but nonetheless, scratched surface.



After each grit finish is completed, thoroughly wash the entire work area with unused stoning oil and wipe with a clean tissue to remove all particles of the grit remaining on the surface. This is necessary to ensure that none of the particles of the coarser grit will be picked up later by a finer grit stone, causing deeper scratches. To further ensure that coarser grits don't contaminate the finer stones, lubricate the stones in a fresh can of stoning oil; not the same oil used for the coarser grit. It's best to keep each grit of stone in a separate can.

EVERY STEP OF THE WAY



Hand stoning tips

- Do not use too coarse a stone;
- Always dress (form) the polishing stone with a grinding wheel or coarse paper to provide the maximum contact with the work surface;
- Use care when dressing the polishing stone;
- Use sufficient stoning oil to prevent the stone from loading;
- Hold the polishing stone firmly for directional control, but press only hard enough to make the stone cut;
- Make sure the stone marks from the previous grit size are removed;
- Change stoning direction with each successive grit;
- Clean the work area thoroughly between each change of grit;
- Keep each grit of polishing stone in a separate stoning oil can; and
- Exercise utmost care when stoning at an edge (parting line).

Proper diamond polishing techniques

Diamond polishing

Diamond polishing is the last step of the polishing process – dependent on how much of a smooth luster must be achieved. However, unless all previous stoning steps have been done properly, the final finish smooth luster will not be satisfactory. If mistakes have been made in earlier finishing work, they'll certainly show up on the surface as the final luster develops.

The starting point of diamond polishing will depend, to some degree, on the sequence of stones that have been used to prepare the surface. A variety of diamond compounds – diamond particles suspended in some proprietary vehicle



like an oil – are available in the marketplace. Begin by applying a small amount of coarser diamond compound to the surface being worked. Then, by means of a bristle, brass or steel brush, swirl the compound over the surface using a rotary tool at a slow speed to avoid throwing the compound off the surface. A speed of 500 rpm for roughing, and 5,000-10,000 rpm maximum for final polishing, is a good rule.



EVERY STEP OF THE WAY

Crisscrossed brushing

Using light to moderate pressure, take care to keep the brush flat to the surface to avoid cutting deep swirl marks. The same “crisscrossing” action used with stones should be employed when using diamond compound. Typically, the compound will become darker, indicating that the metal is being removed and mixed with the compound.

Brush the surface until all that is visible are fine swirly marks left by the brush’s rotary action. There should

be no stoning marks visible at all. If there are, apply a coarser grade of diamond compound with a brass brush and very light pressure until the stoning marks are removed. This same coarser grade should then be applied with a bristle brush to remove marks left by the brass brush. (If this coarser grade doesn’t remove the stoning marks, then a stoning operation, with a finer stone than previously used, will be required before diamond polishing can resume)

Diamond polishing tips

- Apply a small amount of diamond compound at first, then add more if required;
- Do not mix grades of diamond compound;
- If the compound gets dry or hard, add a clean diamond thinner or lubricant;
- Keep the brush or felt flat on the work area;
- If the first grade of diamond compound used does not remove marks from the last stoning operation, stop and remove them with a coarser grade of compound or highly polished, shiny scratches will be present;
- Clean surfaces thoroughly before progressing to a finer grade of compound;
- Do not use more than one grade of compound on the same brush or felt;
- Be sure that each step completely removes the marks left from the previous step;
- To avoid contamination, locate the polishing activity in a part of the shop away from grinding areas or in a separate polishing room;
- The high luster of a final mirror finish will be achieved through patience and skill.

Felting

The next step – removing the swirly marks left by the bristle brush – is accomplished with a felt product, usually a felt “bob.” Felt bobs are available in various degrees of hardness, pre-assembled to a shank or retained in a shanked nylon holder. Mount the bob in a rotary tool and, using light to moderate pressure, polish the surface with diamond compound until all that is visible are felt swirls.

Before progressing to a finer grade of diamond compound, thoroughly

clean the mold surface to remove all residual particles of the previous grade. This is usually done with clean tissue paper or cotton and a very refined oil or alcohol. Don’t use the brushes and felts used with one grade compound on the next grade of compound.

These steps – brushing, felting and cleaning – should be followed with each grade of diamond compound to arrive at the final step. Polish the surface with fine tissue paper, felt sticks or cotton swabs with an ultra-fine grade of compound to arrive at the final high gloss luster.

There are no short cuts when polishing. Since a high degree of technique, even “art,” is required, it often takes years for metalworkers to become proficient polishers. Obviously, no article or list of tips can take the place of individual training under the guidance of a master craftsman.

However, following the fundamental pointers outlined in this article can provide a good head start on learning this highly specialized skill and creating outstanding metal surfaces.

