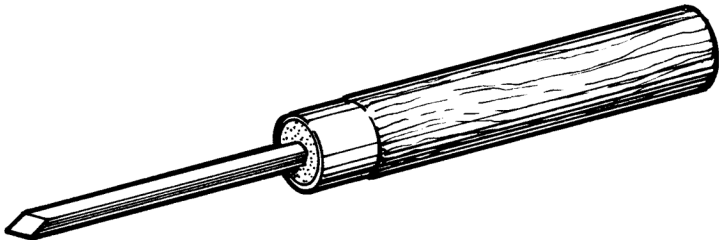

SHERLINE PRODUCTS
INCORPORATED 1974

Making Gravers

By William R. Smith

William R. Smith is well known in the field of clock making. He has recently designed a T-rest for the Sherline lathe that makes it possible to hand turn parts using a tool called a "Graver", which is a common technique in watch- and clock making. This technique is also used in instrument making and modelmaking for turning special shapes like ball ends without having to grind a specially shaped cutter for the job. Mr. Smith's credentials include a degree in mechanical engineering as well as FBHI (Fellow, British Horological Institute), FNAWCC (Fellow, National Association of Watch and Clock Collectors), CMC (Certified Master Clockmaker), CMW (Certified Master Watchmaker) and CMEW (Certified Master Electronic Watchmaker.). He has published several books and videos on clock making which will be of interest to anyone wishing to learn more about hand turning techniques or about making clocks.

CAUTION: Use gravers carefully. Hold work materials with a collet. Do not use gravers with a 3-jaw or 4-jaw chuck. A graver which is inadvertently pushed into a spinning chuck jaw can be flung from your hands. See T-rest instructions for further cautions and turning techniques.

Carbide Gravers

I have often been asked to explain why I seem so unimpressed with tungsten carbide gravers. Actually, I have a very high regard for them. However, I am always fearful that a newcomer will purchase a set of them in the belief that they well be a solution to all of the turning problems. Just the opposite is true. In most instances, the person will have fallen heir to a thankless task of trying to keep them sharp, a most time consuming and unnecessary problem.

Carbide gravers are very brittle, chip easily, must be sharpened on a diamond lap and require so much time to keep them in good condition that they are unsuited for general hand turning and the turning of most tempered steels. However, some steels (high grade watch staffs, French clock arbors, etc.) are so hard that one must resort to their use. Thus, when a carbide graver is needed, there is absolutely no substitute of which I am aware. As such, I have the greatest respect for them. However, the determining rule for saving time by avoiding their use should be: Use carbide gravers only when no other grave will cut the metal at hand and only after the gravers described below have been tried and have failed. Each of those described below is far harder than an ordinary high carbon steel graver, and the hardness and wear resistance increases in the order listed.

Carbon Steel and Cobalt Gravers

The old fashioned high carbon steel gravers which have been the mainstay of the horological world for hundreds of years consume much time when being sharpened. Since shaping them on the bench grinder will draw the temper and ruin them, all sharpening must be done by hand on a bench stone or a special wet grinder.

The gravers to be described here do not suffer this problem. Though harder than high carbon steel gravers and slightly more prone to chip, they can be reshaped at the bench grinder quickly and without harm provided one does not let them go red or cool them in water during the shaping process. Once properly shaped, the honing takes only a few strokes. Thus, far less time is consumed keeping them sharp than is required by either the carbide or the traditional high carbon steel gravers. Additionally, since they will cut almost any steel encountered in clock making and most of the steels encountered in other applications, they readily replace the carbide gravers for all uses except for a very few steels that are difficult to manage. However, both types of gravers are required and should be kept at hand.

Making Your Own Gravers

At the hardware store, purchase a 1/2" diameter wooden dowel rod. At the hobby shop, purchase a length of 7/16" O.D. thin wall brass tubing. Saw the dowel into 3" lengths, install one in the lathe and turn a 3/8" long spigot that is 0.005" larger than the I.D. of the brass tubing, tapering its end slightly. Drive the dowel into the tubing, reinstall the dowel in the lathe and part the brass, leaving a 3/8" to 516" long ferrule. Drill a 1/8" hole in this end, round the other end, sand and varnish.

At a machine tool supplier, purchase several each of the following ground lathe tool bits: 1/8" square x 2-1/2" long, M1 high speed steel, M33 cobalt steel and M46 super cobalt steel. Avoid imports. One supplier of these is the firm MSC at 1-800-645-7270. I prefer the Mo-Max brand made by the Cleveland Twist Drill Co. These items and their MSC catalog numbers are:

- 1/8" Sq. #71093082 Mo-Max, M1, Hi. Speed. Steel

- 1/8" Sq. #71094080 Mo-Max, M33, Cobalt
- 1/8" Sq. #71095087 Mo-Max, M46, Super Cobalt

Cone one end of the lathe bit. Grip the bit in a vise with the coned end sticking up and drive the wooden handle down onto the bit leaving about 1-3/8" of the bit protruding. Be sure to mark the steel number on the handle. Using an ordinary bench grinder, grind the end of the cutter to a normal diamond shaped graver face, angled so the face of the diamond makes a 60° angle with the axis of the graver; i.e., the angle between the graver axis and a line containing the point and the heel of the diamond face. (For rough cuts, a face angle of 55° offers more support allowing more metal to be removed.)

Do not let the metal go red, and do not cool it in water during this shaping process. The makers say these increase the tendency to chip and crack. A blue color will do no harm. You now have a set of the finest gravers that can be had anywhere at an price. They are, in fact, far better than most commercial gravers presently being offered.

Removing Grinder Marks

In most instances, when received, the sides of the lathe tool will be found to have grinder marks. In order to end up with a tool that has a polished edge, these marks must be rubbed away. If available, hold the graver flat on the surface of a fine diamond lap or the fine side of an India stone and rub it back and forth down its axis—never sideways. This will remove the objectionable grinder marks but will leave very fine grit marks from the diamond lap. These must then be rubbed away on the fine side of an India stone.

Blued pivot steel, staff wire and straight music wire are all steels associated with machining. They have been fully hardened and tempered so no further heat treatment is required when making custom parts. Any of the three graver types described here, when properly shaped and honed, will cut these materials like butter.

Sharpening Your Gravers

Since you now have at hand three graver types made by the previous descriptions, it is important to know how to properly shape, hone and polish them. This will result in a great savings of time when compared to the use of other graver types. The first of the processes is the shaping. This is done on the face of the bench grinder wheel as previously described. It gives the graver a diamond face that has the same curvature as the grinding wheel—a most important point as will be shown later.

As the graver is used it either develops small chips or the edge and/or the point wears away and requires either rehoning or reshaping followed by honing. Usually one rehoning can be done before reshaping is required. The amount of hollow grind remaining at the center of the diamond face determines whether to reshape and hone or to rehone. After the initial shaping (at the bench grinder—no red heat and no water cooling allowed), the graver must be honed. The time-honored stone for this is the fine side of a 2" x 6" coarse/fine India bench stone. I know of no satisfactory substitute. A Carborundum stone is definitely a no-no!

With the stone lying on the bench in front of you, hold the end of the graver with a pencil grip and place the diamond face as flat against the stone as possible. Because of the curved surface caused by the bench grinder, the graver will rest on its point and its heel and neither the right and left corners of the square will be touching the stone. So, tilt the top of the graver slightly to the right until the point, heel and right corner of the square touch the stone. Now, make long strokes with pressure. (This is quite important. Two short strokes which total the length of one long stroke will roll the graver twice as much as the single long stroke.) Eight or fewer such strokes (usually five) should bring up the two right hand edges of the diamond face. Now, with the face flat against the stone, tilt the top of the graver slightly to the left until the left corner of the graver touches the stone. Make long strokes with pressure. Again, eight or fewer strokes should bring up the other two edges of the diamond face. If more strokes are required, something is being done incorrectly. Now, lay the graver flat on each of its two cutting edge sides and, pushing along its axis, hone away any feather raised when honing the diamond face. All three graver types described are honed in this manner. (See Figure 1.)

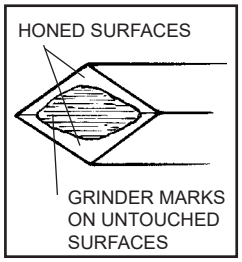

FIGURE 1—Sharpened tool tip

This is all the sharpening required for general turning and roughing cuts. In trained hands and using a properly set up lathe, such a graver can rough out a 1/16" O.D. x 3/16" long pivot on 1/8" O.D. tempered steel, chamfer the shoulder and round the end in less than one minute. However, before stoning with an Arkansas stone in preparation for burnishing, the pivot should have a final cut with a polished graver.

Polishing a Cutting Surface for Finish Cuts

Remembering that only a polished tool cuts a polished surface, a graver to be used for making a polished cut should have a polished cutting edge. Following the shaping at the bench grinder and the honing on a fine India stone as described above, for finish cuts, the graver must then be polished on a hard Arkansas stone. As a general rule, a hard Arkansas stone is almost completely white—only slightly off white, is very slick and offers almost no resistance to the graver during honing. Such stones polish more than they cut. A soft Arkansas stone usually contains more color, has a rougher surface and is not satisfactory for this use. It cuts more than it polishes.

Making Final Cuts

Making the final cuts with a graver treated in this manner avoids the need to use a pivot file. Instead, you should go directly to a 1/4" square hard Arkansas stone that has been rubbed on 125 grit sandpaper until its corners are sharp. The sharp corners are important in preventing the formation of fillets at the pivot root. With this, remove any rings that may remain. Then use a burnisher that has been "made" by rubbing down a length of 125 grit sandpaper to put marks across it. The burnisher will result in a pivot that is very slick and with a long wearing outer shell. No pivot finished with abrasives can equal the wearing qualities of a well burnished pivot. An abrasive finished pivot has a surface hardness equal to the parent metal. A burnished pivot has a surface shell that is much harder than the parent metal.

Testing the Sharpness of Your Graver

There are several tests for the sharpness of a graver. Those with experience can look at the cutting edge and tell if it is worn. If it is sharp, no bright line can be seen at the cutting edge. Wear rounds the edge and makes a bright line there. Another method is to test both the point and the edge against the top of your fingernail. If it slides it is dull, if it digs in it is sharp.

Avoiding Unwanted Burnishing

Remember, letting a dull graver slide without cutting will usually burnish tempered steel. This burnish, being harder than the parent metal, may also end up being harder than the graver that has been cutting it nicely, and will thus no longer cut it. Avoid high lathe speeds and dull gravers. Both can burnish your work.

Speed Range for Turning with Gravers

The best graver work for small shafts is done with a lathe running within a range of 250 to 500 RPM. Standard lathe speed charts are not too useful when applied to use of a graver. Turning speeds are generally slower than with a conventional lathe tool, but experimentation on your part will determine the best speed for each application.

With any lathe tool, metal must be removed in a continuous strip. If the tool is not fed fast enough, it skips across the surface, occasionally digging in. This is called tool "chatter". When a tool is chattering, it cannot make a smooth cut. As there are limits to how fast you can feed a tool, the answer lies in adjusting both the turning speed and the feed rate to allow the tool to bite in and eliminate the chatter. Remember this general machining rule and apply it:

"If the tool chatters, decrease speed and increase feed."

Holding a Graver

There are two normal positions for holding a graver for cutting. They are shown in Figure 2. In position "A", the graver is held like a pencil in the right hand while the left hand guides the tool. The thumb of the left had pushes on the end of the graver while the first finger pushes from the side of the tool. In position "B", the end of the tool is against the palm of your right hand while held between the thumb and first finger and supported by the other three fingers. The first finger of the left hand is "rolled" on the T-rest to provide very accurate control of the movement of the tool.

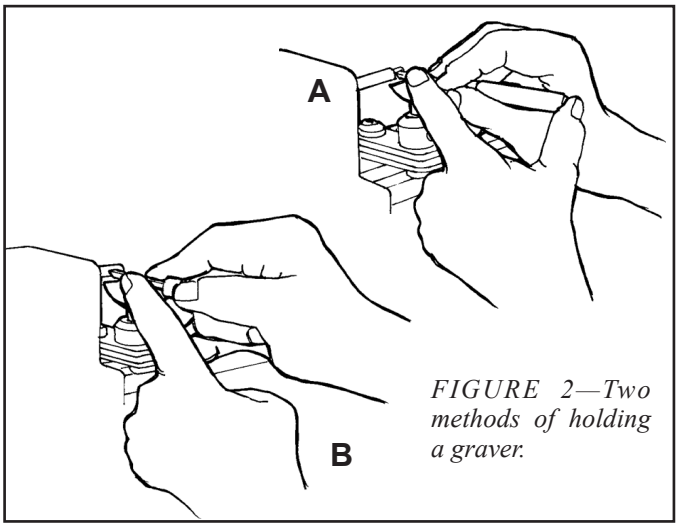

FIGURE 2—Two methods of holding a graver.

For more information on using the T-rest and gravers, see the instructions that come with the T-rest, Sherline Part Number 2110.

—William R. Smith

A Note from Sherline

If you desire more information on gravers, Mr. Smith has written several books, including one called *Workshop Techniques for Clockmakers and Modelmakers*. In addition, he has produced a two-hour video called *Graver Making and Hand Turning for Clockmakers and Modelmakers*, which would be of interest to any machinist wishing to learn more about the use of the T-rest and gravers for turning metal with hand held tools. A portion of the video demonstrates this technique using the Sherline lathe and T-rest. The cost of the video is $60.00 postpaid in the U.S. His website also offers a number of other books and videos on clock making. You can find out more or order them by going to his website: wrsmithclocks.com

For more information on clock making and on Mr. Smith's books and videos, see our website's "Related Links and Resources" section.