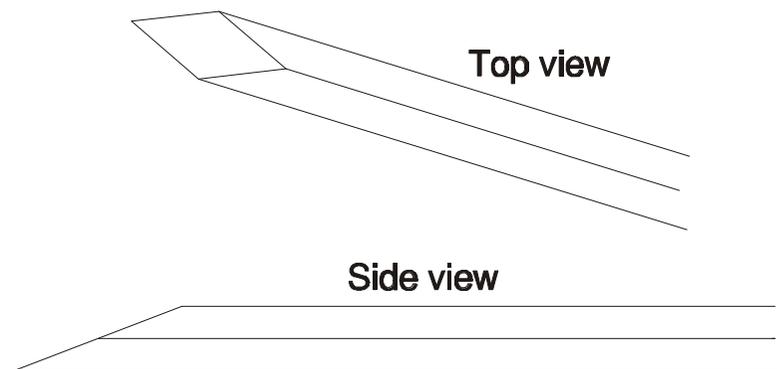


The Graver

The most usual tool to use for all hand turning, whether this be on turns or on the lathe, is the Graver. This is nothing more than a length of hardened tool steel, normally of square section, and with one end cut off at an oblique angle and stoned to have sharp edges.

For all practical purposes the ideal size is 1/8" (3mm) square and about 5" (125mm) long. For clock work on a 10mm lathe the size may be increased to 3/16" (5mm) square but for most watch work this will be found cumbersome. A 3/32" (2mm) square graver may be used for the smallest watch pivot work but is too delicate for general use. An old square needle file, annealed by heating to dull red heat and allowing it to cool slowly and with the teeth stoned away and the end broken off makes an ideal starting point.



The working tip should initially be ground or filed diagonally at an angle of about 35° and the elongated diamond shape produced should be symmetrical. The shape which you finally adopt may vary from this but, at the outset, it is wise to begin with a symmetrical tool and learn its

possibilities fully before changing its basic geometry. The preparation of the graver and its continued maintenance are of fundamental importance to the business of turning and the effort spent in achieving a perfect cutting tool will be amply rewarded.

The most difficult part of the exercise is grinding and stoning the face of the tool completely flat and with jewel-sharp edges. A number of gadgets are available to assist in this but you will find that the use of these will tend to slow down your work and, because of the tedium of having to set up the graver exactly in the appliance each time, will lead to a reluctance to sharpen the graver every time its edge dulls with consequent ill effects of the work. Sharpening the graver without such a gadget is not difficult, it is simply the learning of the 'knack' and a bit of practice.

Once the raw face of the steel rod has been filed or ground to a rough angle, it is smoothed on progressively finer stones until a polish is achieved. The stones used should be of Silicon Carbide or Aluminium Oxide abrasive and should be of a reasonably large size - at least 4" x 2" (100mm x 50mm) on the face. One end of the stone is rested on the workbench whilst the other is lifted with the non-dominant hand and supported with fingers resting on the workbench underneath (see illustration). This allows the stone to move slightly in response to varying pressure from the tool as it is moved



over the surface and helps to achieve a flat working face. This cannot be achieved if the stone is used flat on the bench. The graver is held in the dominant hand with the index finger running down its length and the thumb and middle or ring finger

lightly supporting it against the palm. It should not be tightly gripped as the working face must stay in close contact with the stone despite movements of the hand. Pressure is applied with the index finger to the tip of the tool so as to press the centre of the working face flat against the stone and the tool is then worked against the stone in small, figure of eight movements maintaining this pressure. An oval movement may be substituted for the figure of eight but this is less effective in achieving a



flat face. All these action should be around the centre of the stone and pressure must be maintained with the tip of the index finger to keep the graver in firm contact with the stone.

At intervals the graver is removed and the progress inspected. Any 'wire edge' formed on the edges of the tool is removed by placing the

graver side dead flat against the stone and giving a couple of strokes in the direction of the graver's length. As the face becomes flat, you may progress to a finer stone. A useful sequence may be 200, 400, 600 grits.

When the face and sides of the graver are almost polished it is time to harden and temper the work. This hardens the working faces so that they will cut steel or brass of a lesser hardness whilst the tempering releases stresses in the metal and removes brittleness so that the cutting edges will not crack and break away in use.

Hardening is simply a matter of heating the appropriate part to red heat and quenching it in water - or is it? To achieve best results a number of points need consideration:-

1. The steel needs protecting from oxidation, otherwise the surface becomes covered with a layer of scale which is difficult to remove and disfigures the metal. The best method of protection I have found is to coat the piece with brazing flux. This is a pink powder which will adhere to the steel if this is heated gently before it is dipped into the

powder. As the piece is heated further, the flux melts and forms a glass-like layer over the surface which excludes the air. This particular type of flux also contains fluorides or other reactive elements which clean and brighten the steel at the same time and, after quenching, a polished piece will emerge as bright and shiny as before it was heated. Ordinary Borax or Easy-Flo flux may also be used as may soap, but the metal will, in each case, suffer some discoloration.

2. The steel should be heated to a bright, cherry red colour, that is, a luminous red just short of orange, and it should be kept at that temperature for a little while to let the heat soak right through. For a small graver this can be as short as half a minute or so, but for larger pieces it needs to be longer.
3. Quenching of the hot steel should be done in a large volume of cold brine. Ordinary water can be used but better results are obtained from brine as this speeds up the quench. When hot steel is plunged into water it immediately evaporates the liquid next to it forming steam bubbles. With plain water this steam jackets the work like an insulating blanket and prevents the water from cooling the steel quickly enough to obtain maximum hardness. When salt is added to the water to form brine, the evaporation of the water by the hot steel leaves microscopic crystals of salt on the steel's surface which explode with the heat and burst the steam bubbles - so allowing the water to contact the steel surface again and achieve a quick and effective quench. The amount of water used must be sufficient to absorb all the heat from the steel without its temperature rising noticeably. The water should be stirred and the hot graver plunged into its centre vertically.

Only the end inch or so of the graver needs to be hardened and this may be done quite effectively using a bottled gas torch.

Once the graver is hardened so that its working end cannot be cut by a file, it should be cleaned and re-polished if necessary and then tempered. I still favour the old method of tempering where the shank of the graver is heated at a point about 1" back from the working end, gently warming it until it is

seen to darken and begin to colour. At this point the heat is withdrawn and the progress of the colouring is watched. The steel will begin to go a light yellow which will darken to a brown, then purple and blue before it lightens again to a grey. We are aiming to get all the working end to a light yellow (straw) colour and so, as the shank of the graver passes through the above sequence of colours, we gently add heat so as to persuade the yellow part to spread along the graver until it encompasses the whole of the working end. This should be done without haste so as to let the heat work right through the metal and temper it completely. It is important that the yellow colour reaches the very tip of the tool but, as the section of this end decreases in size, the colour will spread more and more quickly as it approaches the tip and it is easy to 'overcook' it and turn it brown. If this happens, the only course of action is to clean off the graver and re-harden and temper it from scratch as it will be too soft for effective use.

When the graver has been properly hardened and tempered it may be finished by fine stoning and polishing the working faces. This is carried out in the same way as the previous grinding and sharpening but is done on Arkansas stone or one of the fine modern synthetic stones. For final polishing I use a computer microchip! The ceramic material used for some processor and memory chips, which may easily be obtained on the surplus electronic market, produces an excellent mirror finish on hard steelwork with a minimum of effort. However, to be usable for our purposes, the chip should be left soldered onto its circuit board and this should be cut to a suitable size to allow it to be held as I specified before for all stones. In the case of all cutting and polishing stones I use water as a lubricant.

Once the cutting faces have been polished flat and any turned-over edges have been removed, the graver is jabbed into the leg of the workbench a couple of times to clean off any remaining bits of loose metal and the graver is fitted to a handle if desired. The type of handle used is a matter of preference but the graver handles advertised in jewellers catalogues should be avoided at all costs. These are for engraving gravers and are not suitable for turning as they are too bulky. If a handle is required, (I only use handles on



the gravers I use for rough work as I think that handled gravers are too cumbersome for fine work), I would recommend 3" (75mm) lengths of ordinary garden cane, not more than 1/2" in diameter which can be secured to the graver with hot sealing wax. Graver holders used to be available which were quite convenient to use. I use these on some of my gravers and I illustrate the construction of these elsewhere. The difficulty in using fixed handles on gravers is that, from time to time, it is necessary to re-harden and temper the graver and the hassle of having to remove a handle and clean off all the cement can be quite tedious. If a handle is not going to be used, then the butt end of the graver should be stoned to a smooth rounded shape and have all the sharp edges stoned off.