FILING PERFE

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Clockmakers and repairers often need to make a square on a round-section bar, such as the front extensions of barrel arbors to fit a winding key. Other instances are to fit the hands, especially the minute hand. Parts of the strikework, such as lifting piece, countwheel detent and gathering pallet, may also be fitted on to a square. On British clocks the wheels are often fitted to round-section arbors, usually with a collet, but the greatwheels of some early lantern clocks use a square instead. This is very commonly found on Continental lantern clocks and rural clocks. Recently I had to make a complete new striking train for a much-altered quarter-striking lantern clock from Central Italy and several squares needed forming on arbors to match those on the surviving going and quarter-striking trains. Since one of these was quite large it was easy to photograph and provided the inspiration for this article.

Those with a milling machine might prefer to use that, but it is often quicker to do the job by hand than to set up the machine for a one-off. In any event I find it more satisfying to use a file, but ex-engineers may take a different approach.

To file a square two items are needed, as well as a file of course. Firstly, the bar needs to be held in a collet or chuck that can be indexed to form the required number of flats. Here this is assumed to be four, but any number can be filed. Most small lathes have some means of doing this or a simple attachment can be made. How this is done will depend on your own lathe, so no details are given here, especially since this has been described many times in the model engineering literature. My own early Schaublin SV70 has two circles of 30 and 48 holes in the rear of the spindle pulley and a sliding detent to provide a wide range of divisions, but to avoid miscounting marks have been added to identify the correct holes when filing squares. Similar indexing methods are to be found on the WW (Webster-Whitcomb) type of watchmaker's lathe and Pultra lathes.

The other item needed is a filing rest, which comes in two basic types: one with two rollers and the other with a single roller. **Figure 1** shows a two-roller filing rest made to a design in *Horological Journal*, but others have been described in model engineering magazines. It is basically two parallel rollers in a frame that can be clamped to the lathe bed to straddle the workpiece and can be raised or lowered. The rollers limit how much metal is removed and after indexing the bar four times a perfect square is,

Figure 1. Filing rest made to fit on a Pultra lathe. There is screw adjustment for the height, a clamping screw and jacking screws for producing tapered squares.

in theory, produced. The rollers run freely on spindles that are fixed into the sides and there is a fine screw thread to provide vertical adjustment, a keyway and a closely-fitting pin to prevent rotation. A flange on the rollers produces flats of equal length. It requires accurate machining to produce a satisfactory fit of all the components. Since the rollers are parallel to the axis of the workpiece a straight square is produced, but if a taper is required then the rest is tilted, either by using a shim under the headstock-end of the base and the lathe bed, or, as in this case, using a couple of jacking screws.

Both this filing rest and the next one were designed to fit on the bed of a Pultra lathe, which has now been largely superseded by the Schaublin. On some lathes it might be more convenient to fit the rest on a bar held in the tool post.

An alternative design is shown in **figure 2**, which was one of the items included in a small set of drawers bought at a BHI auction. It has a simpler construction with the body being a short length of U-shaped iron channel. The rollers have integral pivots and simply sit in round-bottom slots in the channel, the tops of which have been punched over to retain the rollers. As found there was just a vertical stem with no means of height

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Figure 2. Two-roller design of filing rest made using a U-shaped iron channel.

adjustment. It was fitted into what had originally been made as a sophisticated hand-turning rest for a watchmaker's lathe with screw height adjustment. This had been described in the American publication *NAWCC Bulletin* (now called the *Watch & Clock Bulletin*) , but it proved to be too sophisticated for its own good. The screw height adjustment was ingenious and very neat, but quite unnecessary and the whole thing was too bulky so that a graver could not be held close to the surface on which it rested. This lay in a drawer for a long time until a new use was eventually found for it.

The simplest type of filing rest uses just one roller, **figure 3**. This was also found in the set of drawers from the BHI auction and it too languished in a drawer as I could not understand how such a simple device could be of any use. Eventually a watchmaker in the USA explained how it was used and then it all became clear to me. It comprises a single roller pivoted in cone bearings in a shallow U-shaped frame. When needed it is swapped for the graver rest on my tip-over hand-turning rest. The tip-over facility is extremely convenient when using the graver as the work can be examined easily, but it is by no means essential when filing. It is held on the bed of my Schaublin lathe with a T-clamp, but, like the other type, the method of fixing will clearly depend on the model of lathe used. No fine height adjustment is necessary.

No matter what type of filing rest is used it is essential *not* to lubricate the roller bearings, otherwise they will jam up with filings. Also the rollers can be hardened and the roller will just rotate with the movement of the file and the teeth will not be damaged.

While the two-roller filing rest seems a more sophisticated system there are some serious drawbacks with it. Firstly, the clearance under the workpiece limits the diameter of bar which can be used. While this is not a serious issue for small work, I had to modify the published design to accept larger diameters. More seriously there is not enough space for a micrometer to measure the size of the square without removing the filing rest,

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with the uncertainty of returning it to its original position. Without the screw for height adjustment being calibrated, obtaining a precise size of square is rather hit-and-miss. While it seems simple enough to keep filing until no more metal can be removed, in practice the file rocks on one or other of the rollers until it contacts both rollers and the work. Also the file has to be horizontal, which might be satisfactory when working standing up at a large lathe (by horological standards) such as a Myford or a Boxford, but much less so when sitting at a smaller bench lathe.

In comparison the single roller can be at any distance in front of the work and at any height, so the file can be at the most convenient angle for ease of filing. Since the roller does not need to be close to the work and there is nothing underneath it there is no limitation to the diameter of bar, nor any problems when measuring it with a micrometer. There is also no need for precise height adjustment. The only requirement being that during filing the rest does not get pushed down. If in doubt a sleeve over the vertical stem will stop this. For parallel squares the roller should be parallel to the axis of the lathe spindle, but if a taper is required just swivel the roller a little. In this case measurements, which are a vital part of using a single roller, must be made at the same position each time. To ensure that the length of each flat is the same, slip a free-running collar over the work and allow just the correct amount of bar

Figure 3. Simple single-roller filing rest. The tip-over base and the separate rotation lock are not essential.

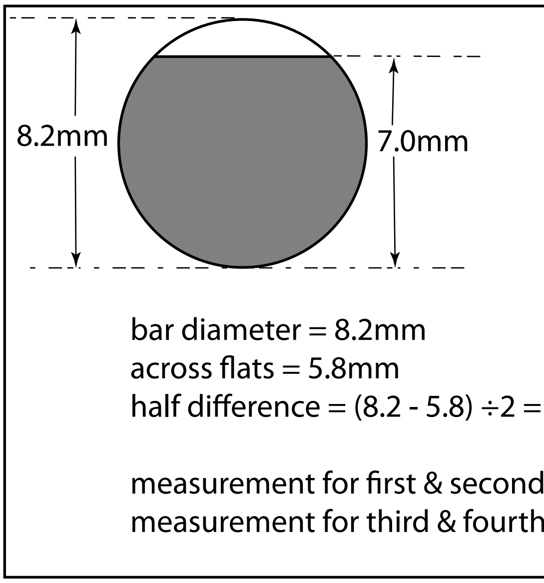


Figure 4 (above). The stages in filing a square.

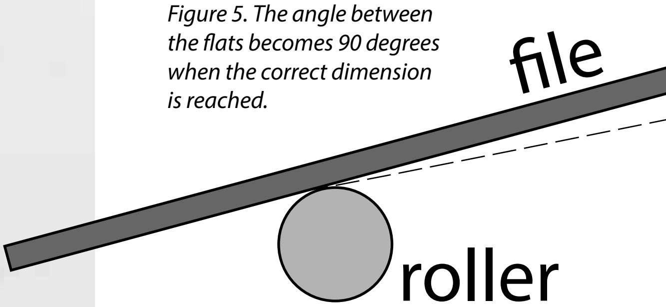


Figure 5. The angle between the flats becomes 90 degrees when the correct dimension is reached.

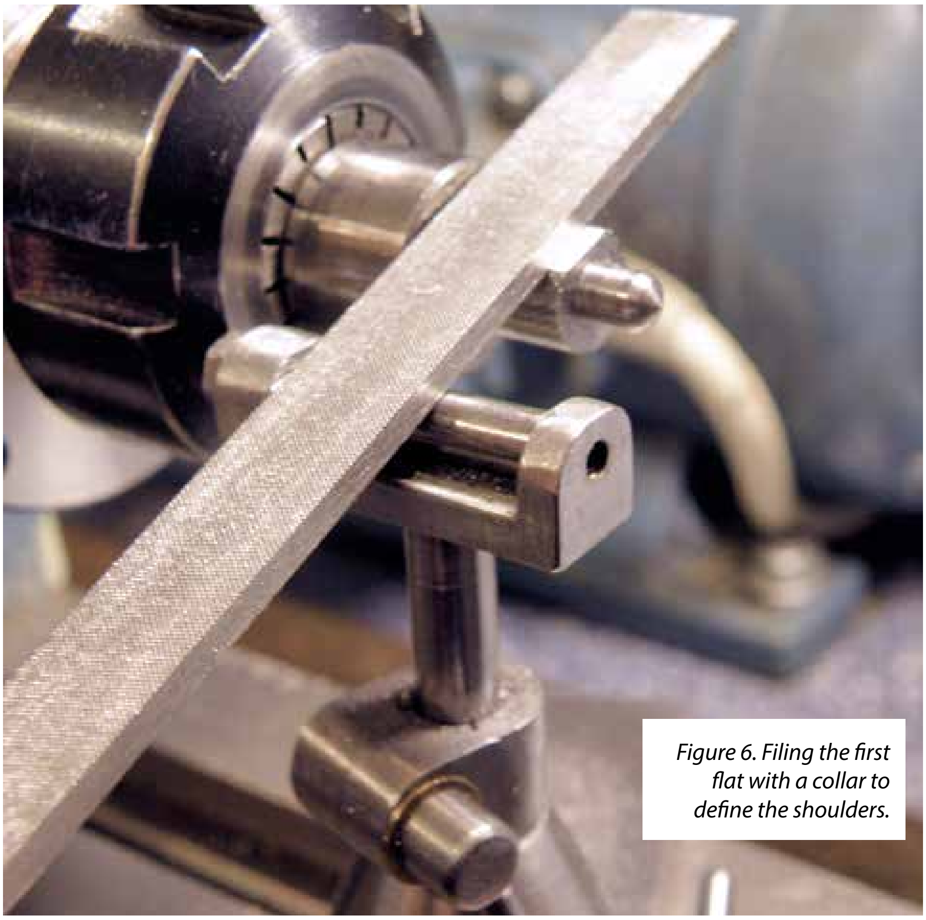
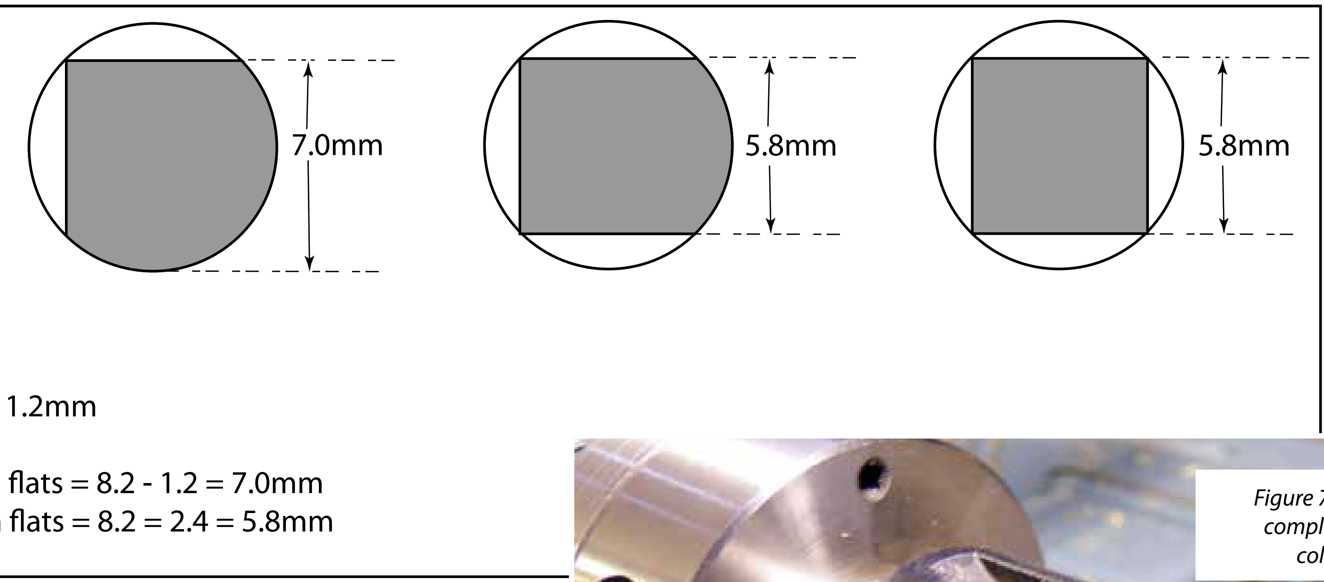


Figure 6. Filing the first flat with a collar to define the shoulders.

to protrude. A pillar file with a smooth or 'safe' edge should be used.

So how can just one roller give a perfect square without the file being limited by a rear roller? The answer is that the limitation is provided by measurement and some very simple arithmetic. Just two dimensions are needed: the diameter of the bar and the across-flats size of the square. If the diagonal of the square is to be the same as the diameter of the bar the square will be 0.71 times the diameter, but this is not essential. Of course if the square is to be larger than this the corners will be rounded. First make a simple calculation; subtract the size of the square from the diameter. Half of this needs to be filed off each side, so subtract half the difference from the diameter and this is the required measurement for the first two sides. As an example, if the bar is 8.2mm diameter and the square needs to be 5.8mm a total of 2.4mm needs filing off, 1.2mm from each side. Start to file until the micrometer shows 8.2 - 1.2 = 7.0mm. Index to the next side and repeat. The third and fourth sides are then filed until the measurement is 8.2 - 2.8 = 5.8mm and the job is done, **figure 4**. I much prefer to use metric measurements, especially for small sizes, and imperial



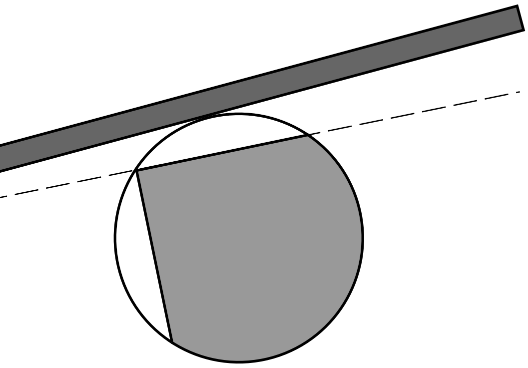


Figure 7. The square completed and the collar removed.

fractions have long been abandoned, though it must be admitted that 6ft is easier for me to visualise than 1.8 metres. For those still addicted to imperial measurements the same procedure should be followed using decimal inches.

It should soon become obvious that when filing the second and subsequent flats, although initially the angle between them is more than 90 degrees it reduces to a perfect right angle when the appropriate dimension is reached, **figure 5**. **Figures 6** and **7** show stages in forming a share on an arbor to take the greatwheel of the aforementioned Italian clock. The finished arbor is shown in **figure 8**, with a small square at the rear to take the countwheel pinion and a groove for the wire ring that retains the rope pulley. The pivots have still to receive their final polish.

Where no great precision is needed there is an even simpler method of filing a square that does not need a lathe or a rest, but relies on the jaws of a vice for indexing. Hold the bar in a vice so it protrudes above the jaws, which should be smooth not serrated so as to avoid scarring the work. File a flat, then replace in the vice with the first flat against the rear jaw, File the second flat, ensuring that the file is parallel with the top of the jaws. Repeat until all four sides are completed. Progress can be monitored by taking measurements as before, while ensuring that the corners are of equal width will result in an acceptable square for many applications.

Figure 8. The finished arbor with a small square to take the count-wheel pinion.

The use of a single-roller filing rest to produce a perfect square is a well-known technique among watchmakers, but amateur clockmakers and those without a formal horological training have been seduced by the engineering approach provided by two rollers. If it is good enough for watchmakers then it is even better for clockmakers. It is hoped that this article will persuade clockmakers to adopt the much simpler, easier and accurate method described here.