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Pivots and Re-Pivoting

Re-finishing Pivots

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One of the most common jobs when restoring timepieces is re-finishing grooved pivots or making and fitting replacement pivots. If the pivots have slight grooving then it is possible to reduce with the pivot file and burnish. Sometimes, the pivots are too small having been re-finished before, in which case there is no alternative but remove the old pivot and re-pivot the arbor. When pivots are reduced by a significant amount then obviously the plates have to be re-bushed.

Figure 1 shows a six-cut file the rear of which is a burnisher. There's also a double-ended pivot file with burnisher, and various carbide burnishers. Six-cut seems to be the finest cut available in the normal range of precision files.

The pivot/file and burnisher shown is an exception: checking under a powerful eyeglass, the cut looks to be around eight-cut. When considering watch and platform pivots, a narrow file/burnisher is available. **Figure 2** shows a sapphire burnisher and two Degusset stones.

Figure 1. A six-cut file.

Figure 2. A sapphire burnisher and two Degusset stones.

Figure 3 shows a pivot that has not previously been reduced and can satisfactorily be re-finished.

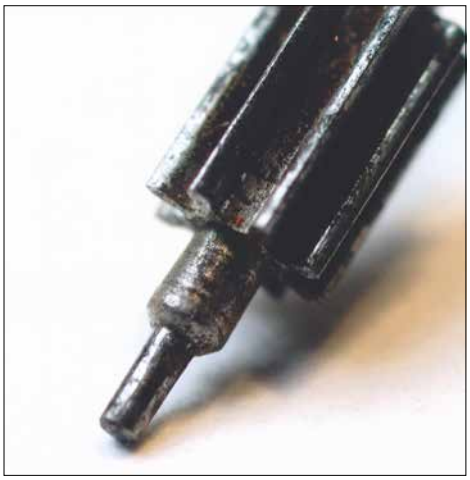


Figure 3. A pivot that has not previously been reduced.

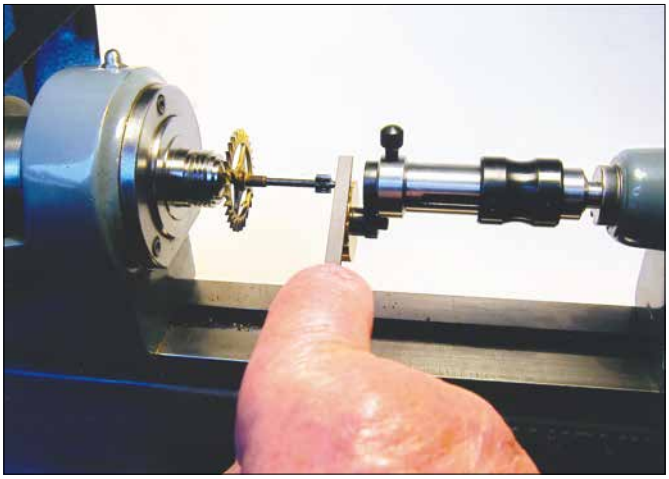
Figures 4A and 4B show the set-up for re-finishing the pivot in the Schaublin 70 lathe. The Jacot tool is mounted in the tailstock. **Figure 4C** is the complete tool in a fitted case with drills and drill plate. With the pivoting tool shown, the drill plate not only supports the work, it also acts as a guide for the drill. This is in contrast to the standard drill plate supplied with the watchmaker's lathe, which is a deep cone which enables the end of the arbor to protrude, so that either the pivot can be supported for burnishing or allowing the end of the arbor to show through sufficiently for it to be centred and drilled.

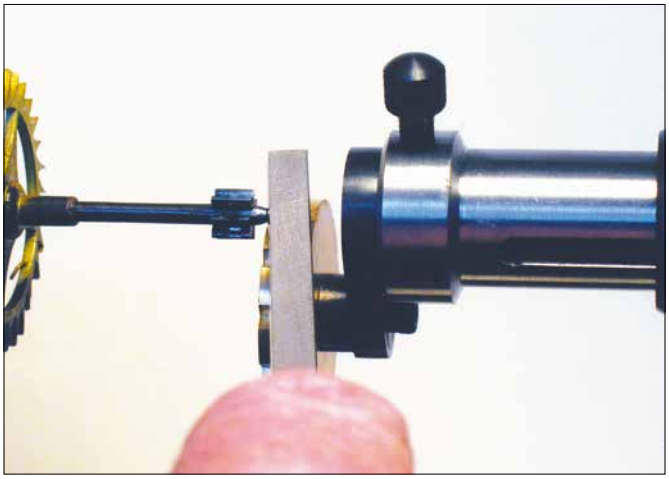
Figure 5 shows the Jacot drum and locator to ensure the correct vee groove is central.

Figure 6 shows how the pivot is reduced until all grooves and imperfections are removed. Next, the burnisher is used to produce a smooth and hardened surface finish, which in turn reduces friction between train hole and pivot. Note: a lubricant is used on the burnisher, just a slight smear of oil or grease, **Figure 7** (for many years I have used olive oil). I know Jim Arnfield recommends this on his burnisher tool. Burnishers must be sharpened or 'made', which is to give them a very slight grain. **Figure 8** shows a pivot burnisher being sharpened on a fine diamond block.

As the step between using the pivot file and the burnisher is large, it is useful to use either Degussit stones or Gesswein stones. The former are sintered ruby, and the latter are available in precise grades of aluminium oxide and silicon carbide. Various grades are available. **Figure 8** also shows a sapphire burnisher, useful to obtain a good finish on finer pivots.

Sometimes it is not easy to obtain a good finish if small grooves still remain in the pivot. Use the pivot file again, then





Figures 4A and 4B. The set-up for re-finishing the pivot in the Schaublin 70 lathe.

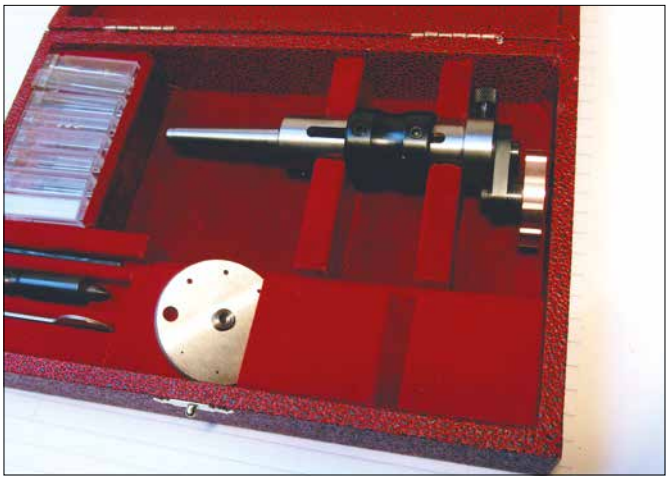


Figure 4C. The complete tool in a fitted case with drills and drill plate.

Figure 5. The Jacot drum and locator.

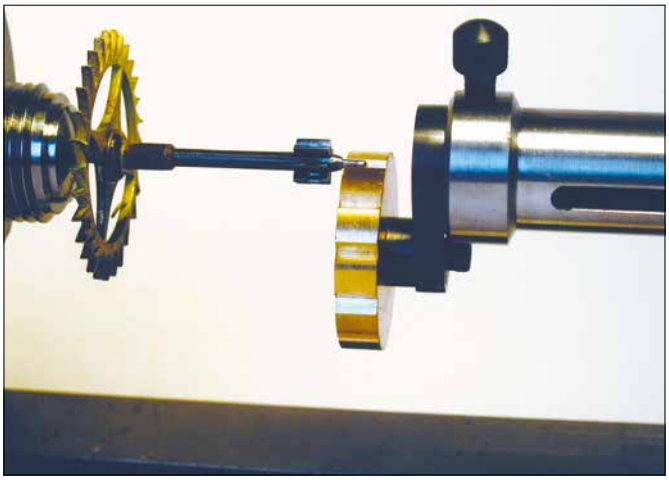


Figure 6. The pivot is reduced until all grooves and imperfections are removed.

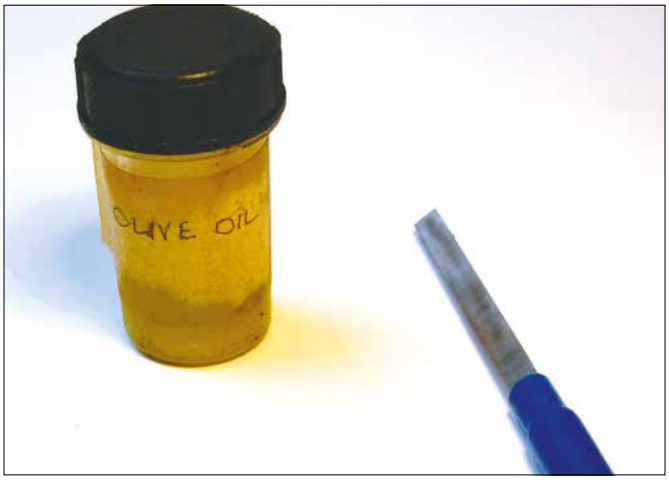


Figure 7. A lubricant is used on the burnisher.

with olive oil on the burnisher, apply a little more pressure with the lathe spindle running at 100–200 RPM, to prolong the life of the pivot file. A light smear of oil is beneficial. It prevents the file teeth from becoming clogged. Note: these Swiss files and burnishers are extremely expensive. **Figure 9** shows a completed pivot.

Various lathe attachments have been produced over the years to deal with pivot re-finishing. The tool shown here is the Hardinge Pivot Polisher, which fits the 8mm lathe. The tool is supplied with various circular laps and the pivot polisher is driven from the lathe overhead drive, **Figure 10**.

Figure 11 shows the tool in a Hardinge catalogue with a variety of circular laps. A number of burnishing tools with carbide wheels have been produced. The first one shown here

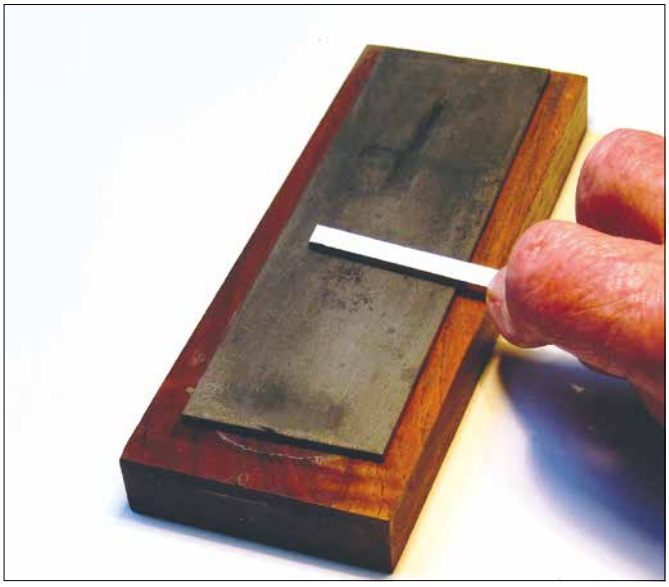


Figure 8. A pivot burnisher being sharpened on a fine diamond block.

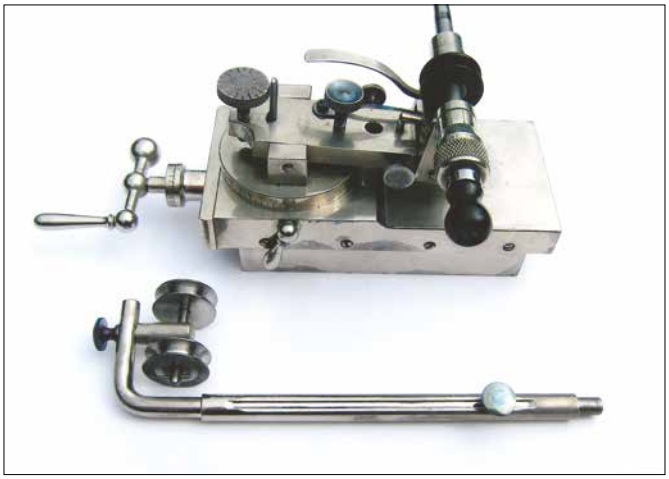


Figure 10. The pivot polisher is driven from the lathe overhead drive.

is the Bergeon Pivot Polisher, **Figures 12 and 13**, set-up in the lathe, kindly loaned by Chris Lowe of Richards of Burton. The tool has a W12 arbor suitable for mounting directly into the Schaublin 70 precision lathe.

The Rollimat pivot polisher is shown in **Figure 14** with 8 mm arbor mounted on the favourite No. 3 precision lathe. Again, the tool is driven from the lathe overhead drive. Rollimat also produce this tool mounted on a stand. This enables pivots on bracket clocks, longcase clocks and escapement pallets to be finished as it is not possible to rotate the arbor with the crutch attached.

The Pivofix bench machine is for fine pivots, such as watch and platform escapement pivots. **Figures 15A and 15B** show some of the accessories. Two carbide wheels are supplied, one with a sharp corner and one with a slight radius for burnishing balance staff pivots. Also for fine burnishing work is the Steinel Bench Model, **Figure 16**. This is for production work, where larger quantities of components require finishing.

Finally, shown in **Figure 17**, is a burnishing attachment designed by Jim Arnfield (described in the *Horological Journal* November 2012) and a full description of how to make the tool commences in the *HJ*, January 2013. Whereas most of the burnishers described above have wheels that are presented to the work in a peripheral manner (where the burnishing wheel axis is parallel to that of the workpiece), Jim's tool is arranged with the wheel sideways, the two axes square to each other, so that no circular grooves can be imparted into the work. This is the preferred method of the Swiss Watch industry*.

Figure 9. A completed pivot.

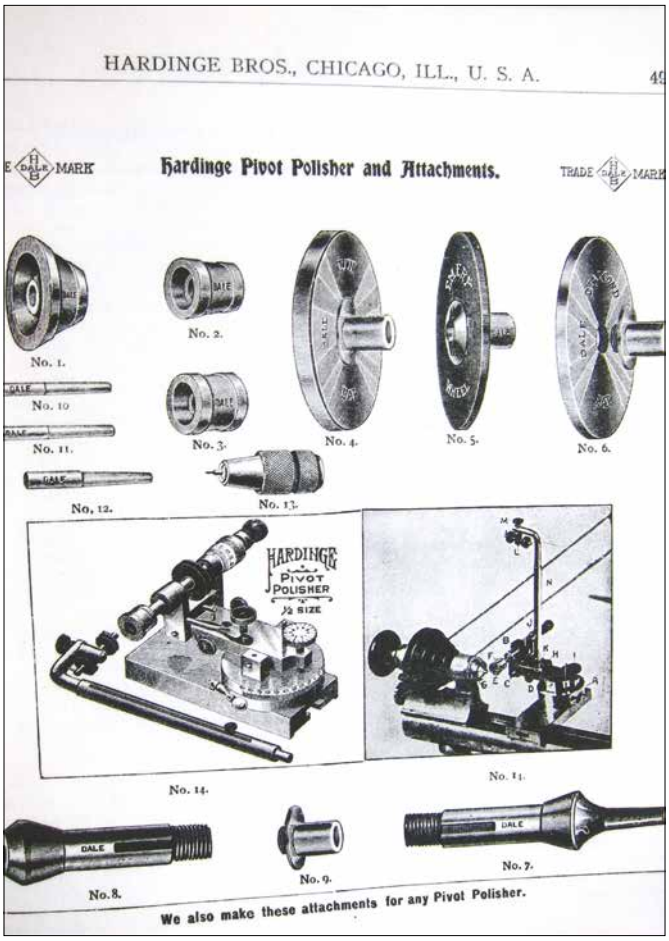
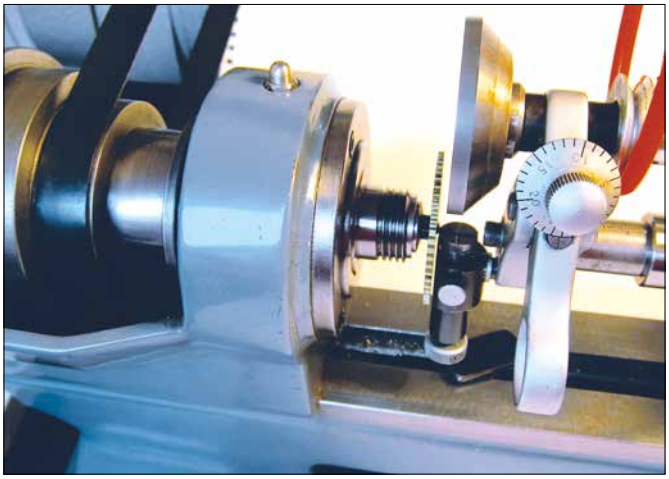


Figure 11. The tool in a Hardinge catalogue.

* The illustration in the Hardinge catalogue shows that tool similarly oriented, with the burnishing wheel square to the workpiece.



Figures 12 and 13. A burnishing tool by Bergeon.

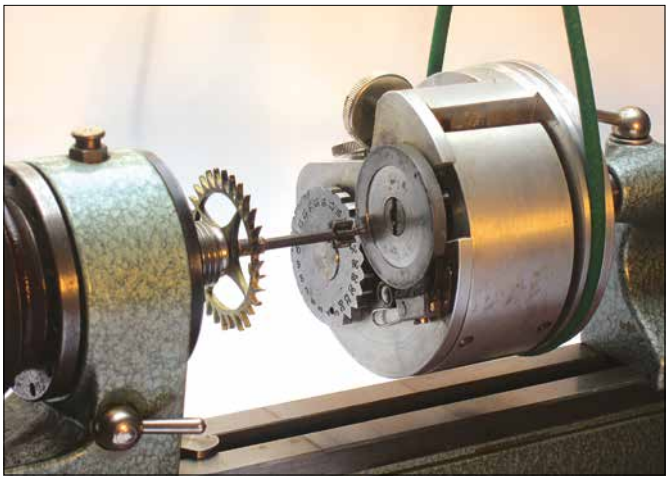


Figure 14. The Rollimat pivot polisher.

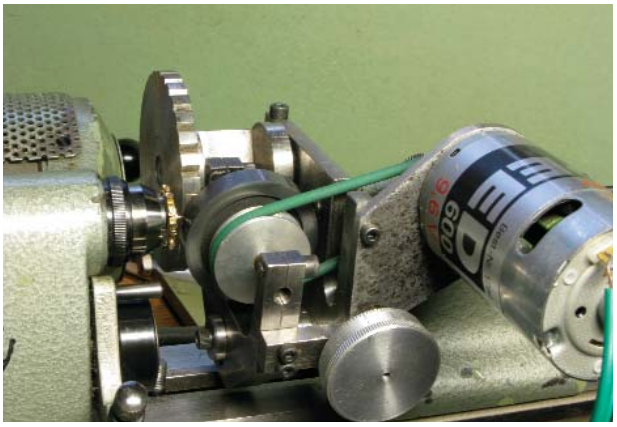
Figure 16. The Steinel Bench Model.

Figures 15A and 15B. Some of the accessories for the Pivofix bench machine.

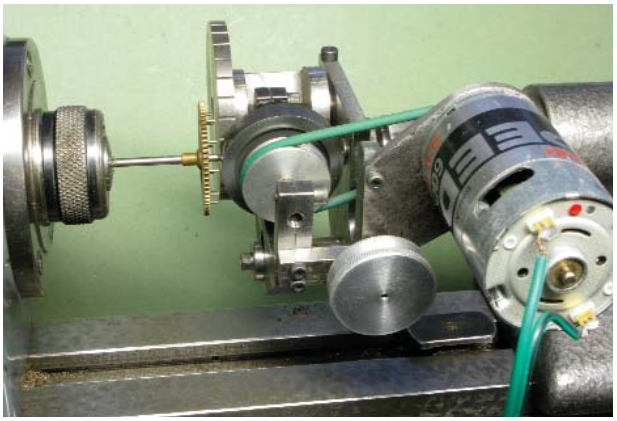
Smaller Pivots

Figure 18 is a centre wheel and arbor from a French clock, where the pivot is grooved. This is mounted in the watchmaker's lathe with a coned drill plate. Select the correct hole and locate it with the centre as shown. **Figures 19A and 19B** show the cone plate supporting the centre arbor at the pinion leaves, leaving the pivot protruding from the cone plate, ready for re-finishing. This is an alternative to using the Jacot drum.

In **Figure 20**, the Steiner turns are being used. Note the adjustable brass eccentric. This is a modification I made to give fine adjustment. The standard design for the Steiner and Bergeon lathes, has a plain dovetail and not easy to adjust to obtain correct centres so as to align with the tailstock Jacot drum or drill plate.



1. A pocket watch balance having the bottom pivot burnished in a Boley F1 watchmakers lathe.



2. A clock striking arbor having a pivot burnished in a Schaublin 70 precision lathe.

Figure 17. A burnishing attachment designed by Jim Arnfield (Horological Journal, 2012).

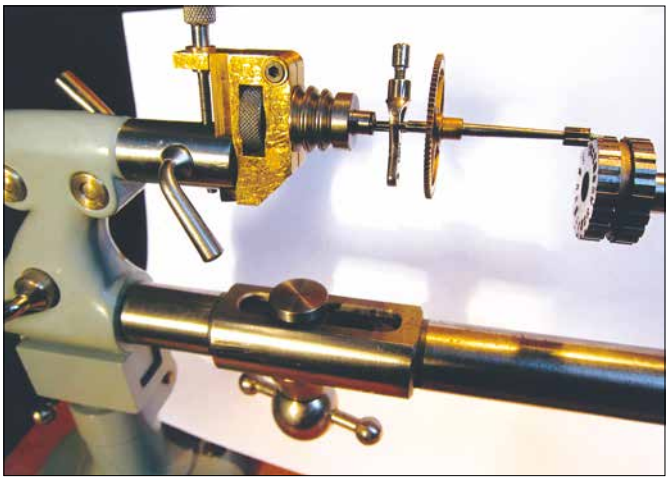


Figure 20. The Steiner turns being used.

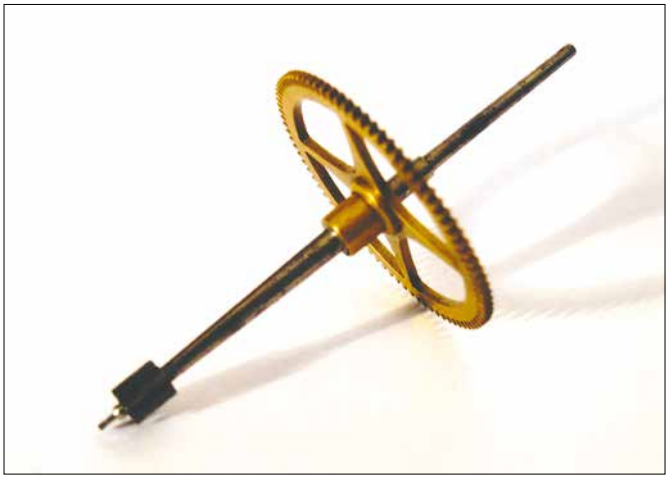
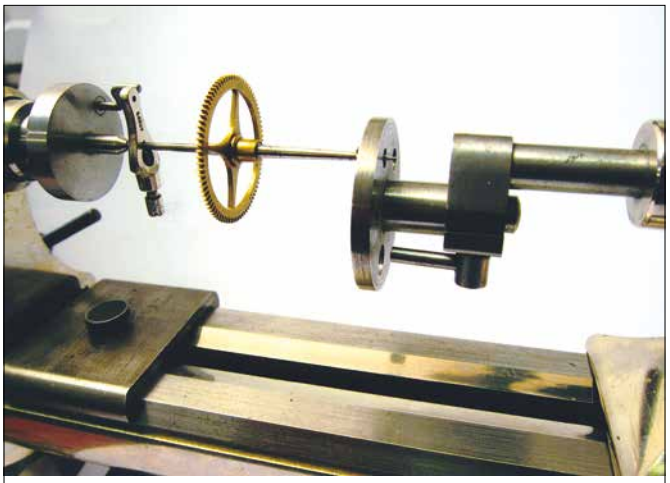
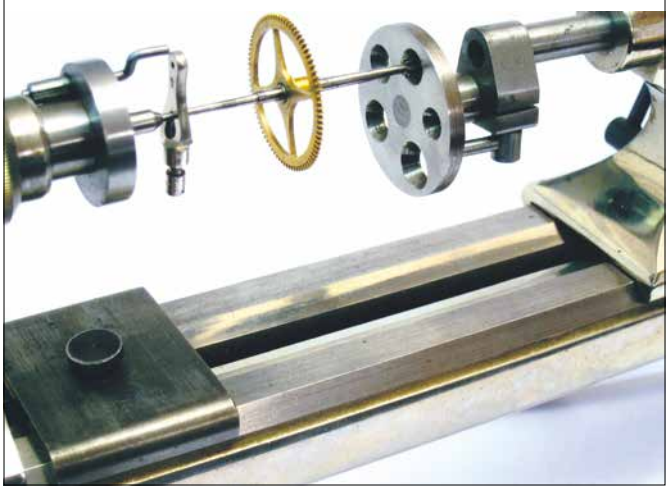


Figure 18. A centre wheel and arbor from a French clock.





Figures 19A and 19B. The cone plate supporting the centre arbor at the pinion leaves.

Figure 21. Another range of Fenn drills are the spotting drills.

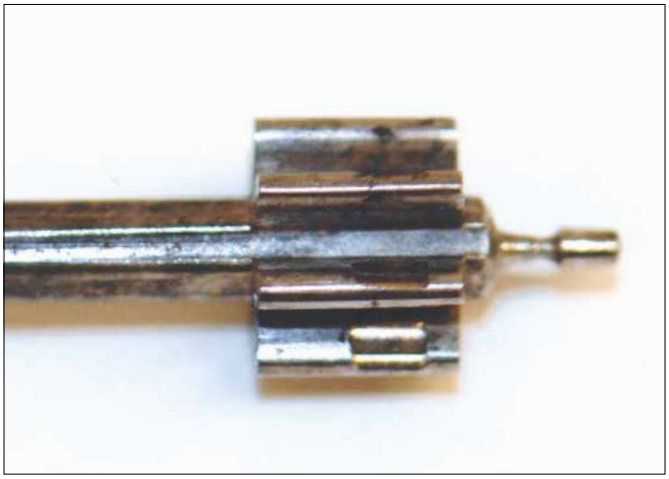


Figure 22. The damaged pivot is cut off.

Burnishing

This process causes a small amount of plastic flow in the micro-surface of the work. This hardens and smooths the work and effectively polishes it, although no abrasive material is used. It will reduce friction in the pivot hole and the burnished/hardened surface of the pivot will last much longer than an untreated surface. Some later German clocks have plated pivots. These cannot be burnished as it will result in all the plating being removed. If the surface finish is not damaged then it may be possible to polish these with Solvol Autosol (aluminium oxide paste).

Fitting New Pivots

Drills

Carbide drills are the best, but care has to be taken as the carbide drill is very brittle, and if not used correctly can easily break in the work, causing a major problem. Sometimes even carbide drills will not cut a hard arbor. In that case, softening of the materials will have to be undertaken. Small carbide drills are difficult to find. Straight flutes are the best and strongest.

Carbide drills with spiral flutes are available from Fenn Tools, and are classed as micro drills. Unfortunately, they are in packs of ten and can be expensive. These are the drills I supply with my Pivot and Jacot Tool, sizes 0.6 mm–1.8 mm. Shank diameters do vary throughout the range. The smallest drill available is 0.20 mm on a 1.0 mm shank.

Cousins supply a good range of carbide drills: these can be purchased individually and are mounted on a common shank diameter of 2.35 mm. This is equivalent to 3/32 in diameter. This is to accommodate the traditional diameter of 'flexible shaft' handpiece drills, as used by jewellers and goldsmiths. Sizes range from 0.50 mm to 2.30 mm diameter in 0.1 mm steps. Another range of Fenn drills is the spotting drills, **Figure 21**. These have a four-faceted drill point and are ideal for centring the work. They range from 0.20 mm to 1.50 mm diameter. The flute length is short for stability, but sometimes sufficient to drill deep enough to fit small diameter pivots. The shank diameter is 1.5 mm throughout the range.

Another company that supplies a large range of carbide micro drills is M. A. Ford, and they also produce an excellent catalogue. Their range commences at 0.1 mm diameter to 3.15 mm diameter, all diameters up to 1.1 are on a common shank diameter. For larger pivots M. A. Ford supplies HI-ROC straight fluted drills. These are ideal for pivoting, having a strong core. The range commences at 0.85 mm and increases in steps of 0.05 mm*.

Figure 23. A centre being cut with the graver.

When the method of holding the work has been decided upon, the first operation is to centre the arbor. Cut off the damaged pivot and face the end of the arbor, **Figure 22**. **Figure 23** shows a centre being cut with the graver.

In **Figure 24** the arbor is held in the collet and the front end has a brass sleeve over the pinion. The sleeve should be machined to give a good fit over the pinion leaves. To make sure the arbor is running true, use the tailstock with a female cone, then adjust the three steady dogs and lubricate with a small spot of grease. With this method it is not necessary to remove the wheel. The centring is carried out using a Fenn four-faceted centre drill. Care is required when presenting the drill to the work. Use a scraping action with the point of the drill to start the centre true. **Figure 25** is a home-made 'D' bit centre drill. For this to cut correctly, the cutting edge requires

* 'PCB drills' for drilling printed circuit boards are quite cheaply available in a range of sizes from 0.2 mm upward. These are typically supplied by Chinese vendors on websites such as Banggood and AliExpress. They have 2.35 mm shanks, and although not of the engineering quality illustrated here, are popular for their price and facility.

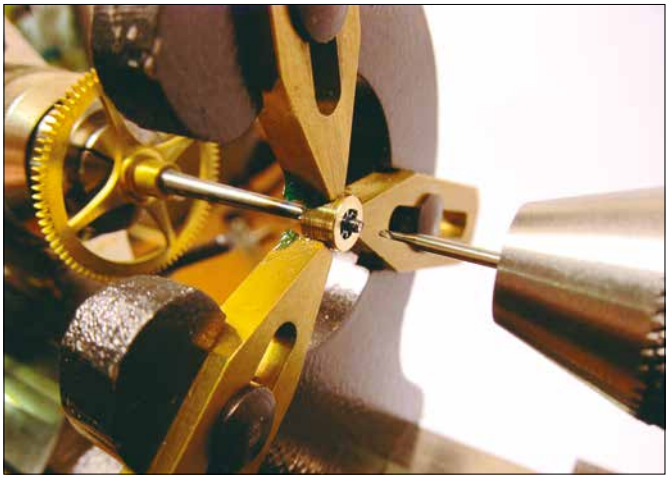


Figure 24. The arbor is held in the collet.

Figure 25. A homemade 'D' bit centre drill.

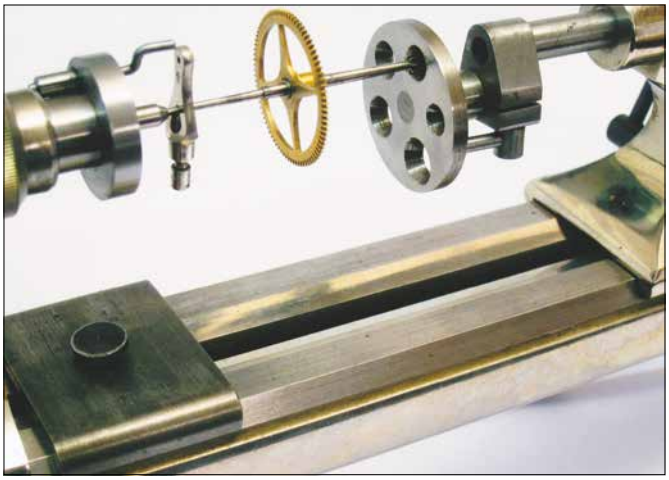


Figure 26. The work being supported between centres.

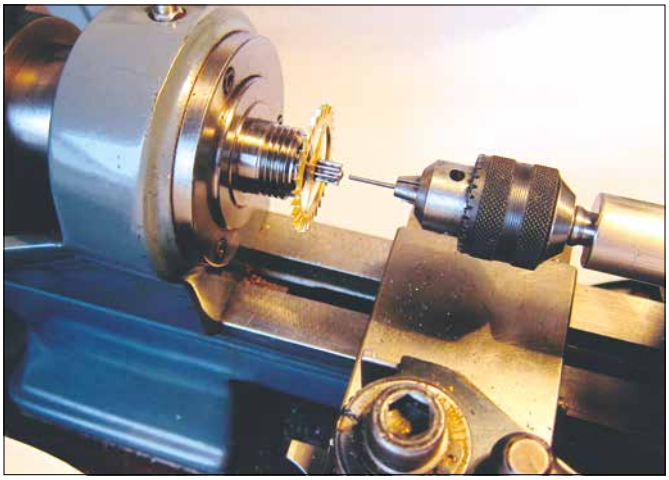


Figure 27. An escape wheel and arbor, held in a good collet and drilled from the tailstock.

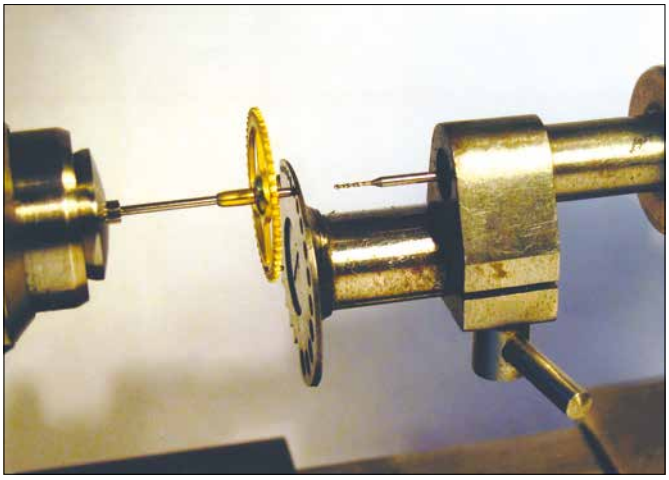


Figure 28. The arbor, held on the pinion and supported by the drill plate.

Figure 29. A knurled brass knob affixed to the runner.

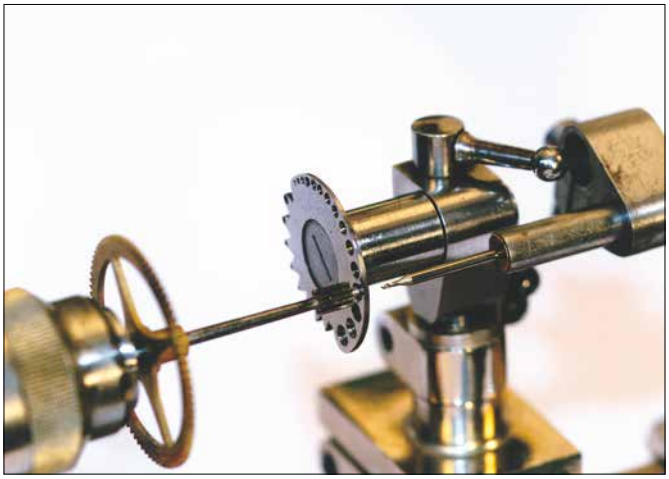


Figure 30. The drill plate mounted on the tee rest base.

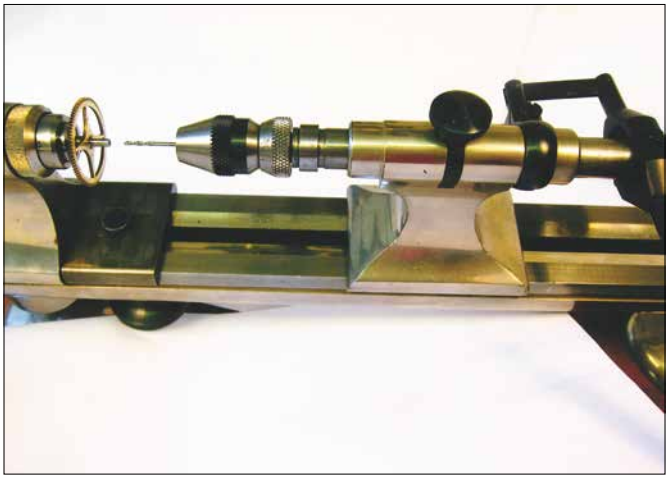


Figure 31. The lever feed tailstock on the 8mm Boley & Leinen precision watchmakers' lathe.

Figure 32. Using the tailstock the author made for the Schaublin 70 lathe.

Figure 33. Using the new lever feed that retro-fits to the author's standard Pivot and Jacot Tool.

relieving. This is best carried out on a tool and cutter grinder, such as the Quorn machine.

When it is required to re-pivot, the main problem is holding and supporting the work. Depending on which end of the arbor needs to be drilled for the new pivot, I do my best to make or use attachments that will hold the work without removing the wheel. Sometimes there is no alternative – the wheel must be removed. Re-fitting the wheel after re-pivoting has taken place is often a challenge to get everything running true again.

Figure 26 shows the work being supported between centres, driven by a small catch plate between the female centre and cone plate. A dog is fastened to the arbor to take the drive. This method often has to be used when there is insufficient arbor to hold in a collet. When drilling, use speeds 3000 to 4000 RPM.

Once a satisfactory centre has been formed, select the right size drill and a corresponding size of blue pivot steel. This material is perfect for new pivots. Ensure the pivot material has a slightly greater diameter than the hole being drilled; then a slight taper can be formed to give a lead in when fitting the pivot. This slight taper can be introduced with a 6 cut file. It is essential it is an interference fit. If only a sliding fit can be tolerated, then use Loctite 638, having first cleaned both items with Loctite cleaner, 7063. If using blued pivot steel, it may not be necessary to burnish as the finish is excellent.

Figure 27 shows an escape wheel and arbor, held in a good collet, and drilled from the tailstock. **Figure 28** is the arbor, held on the pinion, and supported by the drill plate. The drill is held in a small collet, this is on an 8mm, Boley & Leinen watchmaker's lathe, using the standard pivoting arrangement. After centring, the runner that holds the collet and drill is fed towards the work by hand, there being a knurled brass knob affixed to the runner, **Figure 29**. Another method is shown, with the drill plate mounted on the tee rest base, see **Figure 30**.

Three other methods of drilling are shown here. The first is the lever feed tailstock on the 8 mm, Boley & Leinen precision watchmakers' lathe, **Figure 31**. The second method is using the special tailstock I made for the Schaublin 70 lathe, **Figure 32** (see *HJ*, April 2009). Finally, using the new lever feed that retro-fits to my standard Pivot and Jacot Tool, **Figure 33**.

To cut the blued pivot steel, you can either part off with the graver, or alternatively, use the Dremel or Multi-Craft with cut-off wheel, **Figure 34**. **Figure 35** is the wheel and arbor, ready to take the pivot. **Figure 36** shows the blued pivot steel in position. It is only then necessary to finish the end of the pivot and burnish. With relatively larger pivots, it is possible to use a graver to part off excess material. The hole in the arbor for this pivot was drilled with a carbide drill.

Figure 34. The blued pivot steel is cut with a Dremel or Multi-Craft with cut-off wheel.

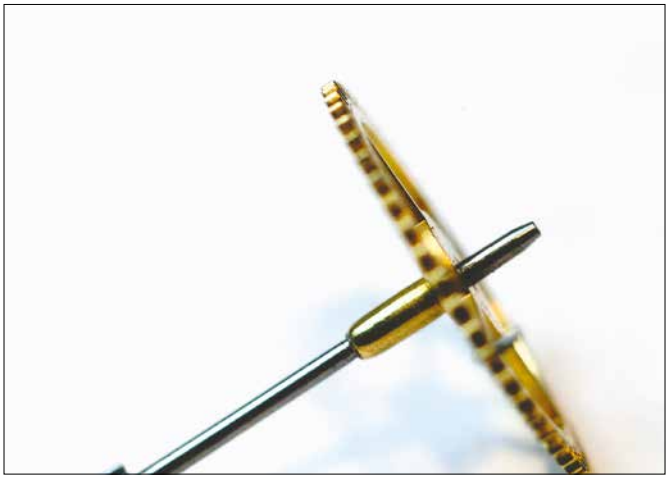


Figure 35. The wheel and arbor, ready to take the pivot.

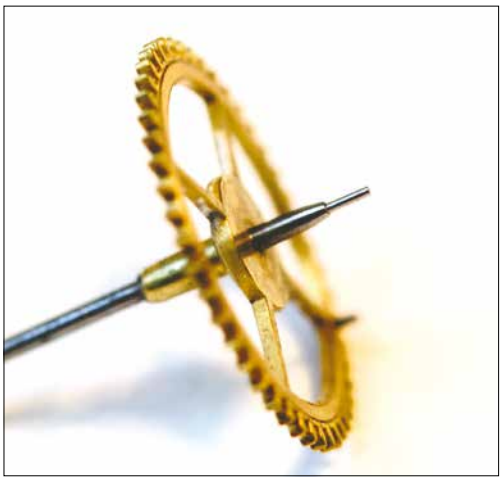
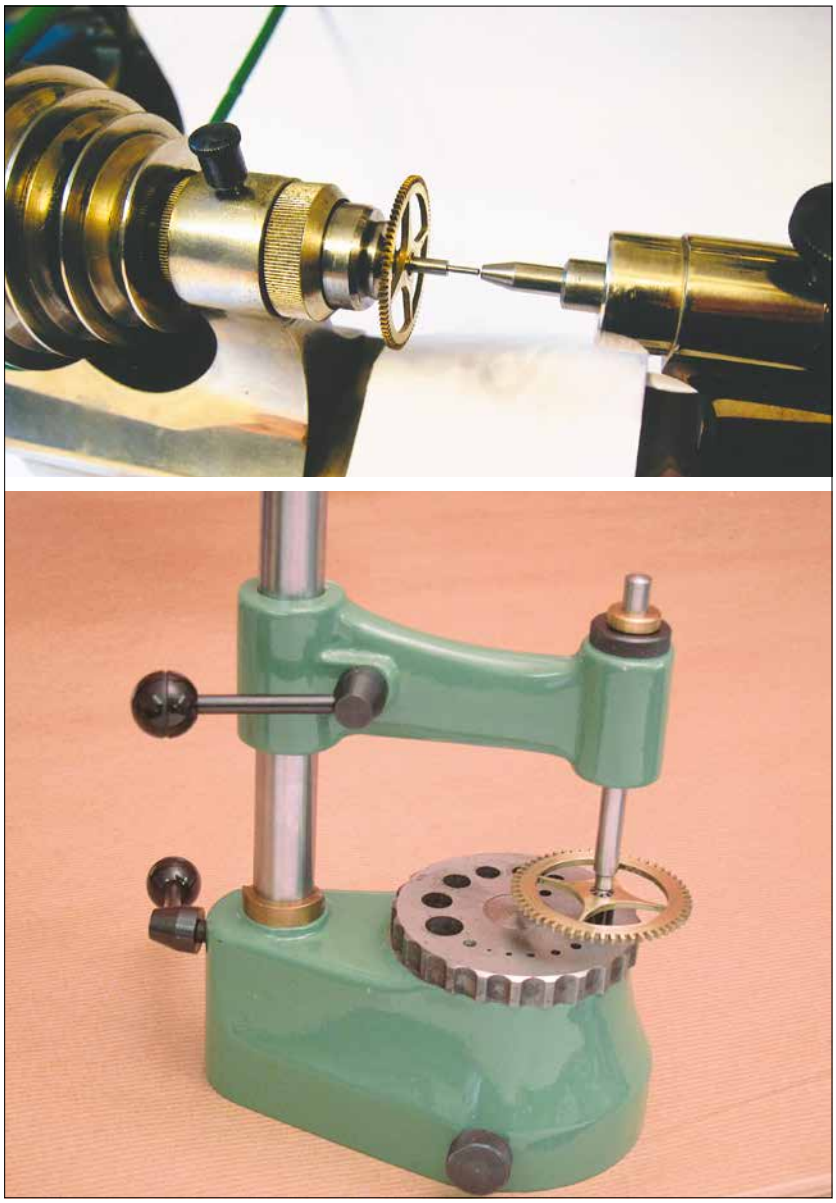


Figure 36. The blued pivot steel in position.



Figures 37A and 37B. Two methods of inserting the pivot materials: using the lathe tailstock with special runner or using a staking tool.

Figure 38. The small lighter fuel gas torch.

Figure 39. When softened, the arbor should be a nice blue.

Figures 37A and 37B show two methods of inserting the pivot materials: using the lathe tailstock with special runner, or by using a staking tool.

Many arbors are very hard, but generally a carbide drill will manage quite well. If the end of the arbor is to be softened, protect the arbor with a brass cap. Various brass caps are shown in **Figure 38**. Also shown is the small lighter fuel gas torch.

When heating the brass plug, check the colour of the arbor, when softened this should be a nice blue, **Figure 39**. The smallest French clock pivot is generally the fly arbor, and diameter seems to be around 0.45 mm (0.016 in), this is the smallest diameter I have comfortably drilled. Watchmakers have to go considerably smaller.

Further Notes on Drilling

It is essential to clean swarf away with a small brush – the rule is 'a little and often'. Sometimes, if drilling is going well, concentration lapses, and then 'snap', you have a drill broken in the work.

You can use a lubricant such as Sherwood Cutting Fluid. I tend to cut dry, as swarf tends to stick to the drill flutes and there is more chance of the drill breaking. If a drill becomes lodged in the hole, it may be possible to break up with a small punch. Alternatively the arbor will have to be cut back and extended with fresh material. Previous generations of clockmakers often decried pivoting in favour of replacing the whole pinion, but we now take a more considered approach to discarding and replacing antique material.

Drills are available from the following companies:

- Fenn Tool Ltd, 44 Springwood Drive, Braintree, Essex CM7 2YN, tel: 01376 347566, email: enquiries@fenntool.co.uk
- Cousins Material House Ltd, Unit J, Chesham Close, Romford, Essex RM7 7PJ, tel: 01708 757800, email: anthony@cousins.uk.com
- M. A. Ford Europe Ltd, 650 City Gate, London Road, Derby DE24 8WY, tel: 01332 267960, email: sales@mafordeurope.com