Remounting a wheel to a collet

In an occasional HJ series, Arthur Jones, of Jones and Chambault, looks at Workshop Practice from his Belgium home.

The manner in which wheels are mounted is a key factor in ensuring the smooth running of the gearing of a clock or watch movement. The following is an attempt at describing the process of wheel mounting to a collet as I have developed it over the years.

Equipment needed

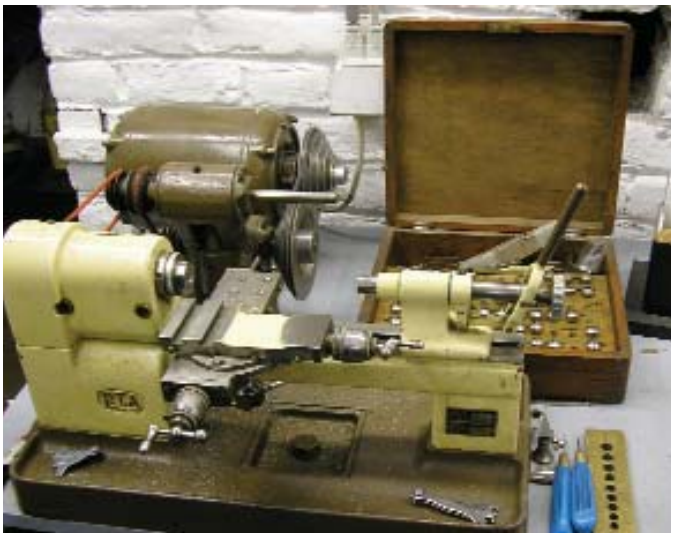

Figure 1: Lathe and equipment

Ideally a 10mm lathe with either a good range of collets or at least an accurate three-jaw self centring chuck. This size lathe is suitable for both clock and watch work. A T-rest with a vertical peg in it, a graver, a burnisher, a split stake and a collection of punches for seating and removing wheels. Commercially available punches are not always of a suitable size and the professional horologist or the keen amateur has to resort to making his or her own staking punches as the need arises.

Making a punch

Silver steel is the most suitable material from which to make punches as it is durable, readily available and easy to heat treat. Dimensions depend on the type of clocks or watches being repaired or restored but as a general rule 4.5-5mm diameter silver steel is suitable for French clock punches and 6-8mm diameter silver steel for longcase work.

The following is a description for making a punch to remove the escape wheel of a longcase clock with a long extension for a seconds hand.

Take a piece of 6mm diameter silver steel 100mm long. Dome one end in the lathe. Measure the length from the tip of the arbor to the face of the wheel. Let us say it is 45mm and the arbor has a diameter of 3.5mm. After the wheel rivet has been undercut, the wheel hole can be measured. Let us assume it is 5mm in diameter. With the plain end of the rod protruding from a three-jaw chuck or collet face off the end, drill the silver steel 3.8mm diameter and 55mm deep. This is ample to slide over a pinion of 45mm in length and 3.5mm in diameter. Machine a 4.5mm diameter for about 4mm along from the front face. This will fit inside a wheel with a hole of 5mm in diameter. Heat about 25mm from each end to cherry red, one after the other and quench it in oil. Clean up until bright, reheat each end to a dark straw and quench in oil. The punch is now ready to use.

Figure 2: The finished punch

The circumstances under which a wheel needs to be remounted

Pinions have to be renewed for various reasons. This inevitably entails the removal and the remounting of the original wheel. A pinion might be badly worn or have a broken leaf. It may have been repivoted off-centre or shortened because of a broken pivot. The arbor is, in the latter case, running in a raised bush protruding from the clock plate.

Meshing with a wheel might be faulty because the pitch diameter of the pinion is too small or too large causing the teeth to butt.

A worn wheel which can be re-used may also need remounting to an existing pinion. In this case the wheel has worn teeth on one side of the acting face. A typical example is that of the third wheel and pinion of an English dial clock which engages with the escape pinion. The action of the recoil escapement reverses the gearing at every tooth, causing heavy wear on the escape pinion and on one side of the third wheel teeth. If the third wheel is removed, turned over and remounted the life of the wheel and pinion can be greatly extended especially if the newly mounted third wheel is positioned to run on an unworn part of the escape wheel pinion.

Method

The method I advocate demands more equipment and attention to detail than might seem necessary but this approach ensures that no harm comes to the old wheel as it is removed and remounted and that the finished wheel and collet run perfectly true.

I have heard repairers say, 'Just heat the collet and wheel, unsolder it from the old arbor and re-solder it to the new one'. This is definitely not the way to do it. The wheel seat had been turned on the original collet after it had been soldered in place. Even if the original collet was a reasonable fit on the old arbor the possibility of any movement between collet and arbor as the solder cools will lead to serious running errors in the gearing.

The only sound way of remounting a wheel is to remove the old wheel from its collet, solder a rough collet in place, machine the wheel seat and remount the wheel. Finally the collet has to be finished to match the original. ▸▸

Author's notes

I set up Jones & Chambault in West Wales in 1984. My expertise extends from wheel and pinion cutting, designing and making clock movements on commission and extensive clock and watch restoration projects. Since relocating to Belgium in 2005 I have built links with Namur School of Horology. Two of their students will join me in 2007 for a period of training.

Removing the wheel from its collet

Wheels are fragile near their centre where the crossings meet the hub. Because the collet is riveted over into a chamfer in the face of the wheel at its centre, avoid driving out the rivet with a punch. Even if the crossings are not damaged the wheel will be distorted and will need to be flattened. Flattening a wheel is a difficult process to achieve without causing damage and is time consuming.

Remove the rivet by machining it away with either a graver or a fixed turning tool in the lathe's tool post. Support the arbor well in the lathe headstock by holding it in an accurate three-jaw chuck or collet .

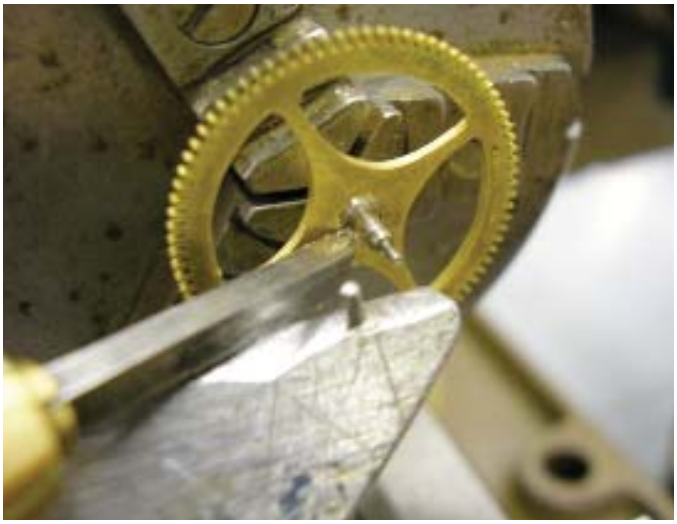

Figure no 3: Removing the rivet

When removing the rivet, cutting pressures are high so the set-up must be rigid during machining.

Undercut at approximately a 30 degree angle as shown in figure no 3. Gently feed the tool in until it almost touches the arbor and then towards the headstock. Stop when you see a faint outline of the hole through the wheel or at such time when you judge having removed sufficient metal from the rivet.

Punching out the wheel

Place the wheel on a split stake whose hole is a little larger than the diameter of the collet. Select a punch whose internal diameter fits over the arbor and whose external diameter is a little smaller than the centre hole of the wheel. With a light hammer blow drive out the wheel as shown in figure no 4.

Figure no 4: Wheel, stake and punch

Machining a collet

In replacing a wheel collet the colour, dimensions and style must match those of the original. In the case of new movements modern brass can be used but when restoring antique movements use cast brass rod to get the correct colour. Place a suitable length of modern or cast brass rod, as applicable, in the three-jaw lathe chuck. Face it off, turn the diameter slightly larger than the original allowing an extra 1mm in length. Part off the blank, hold it in the chuck and drill it to be a snug but free fit on the arbor.

Soldering the blank collet in place.

Figure no 5: Measuring original collet seat distance with vernier gauge

Clean the arbor with steel wool until bright, apply some resin solder flux and position the front face of the collet blank 0.4-0.5 mm nearer the pivot shoulder than the original, using a vernier gauge as shown in figure no 5. This extra length will form the rivet head.

Heat the collet blank gently and without disturbing its position apply soft solder.

Turning the wheel seat

Figure no 6: Wheel seat turning set-up

Use a drill shank to measure the bore of the wheel and with a vernier gauge measure the wheel thickness across the centre hub.

Hold the pinion shank in a suitable size collet or accurate three-jaw chuck and support the other end in a female centre. Never hold the pinion leaves in a three-jaw chuck but it is quite safe to hold them in a collet.

Turn the wheel seat diameter and check the position of the wheel face from the pivot shoulder to ensure that it is the same as the original position. Aim to achieve a wheel seat diameter onto which you can push the wheel onto its seat with a twisting motion. Undercut the rivet face at a 30 degree angle to a suitable depth in the same manner as the rivet was undercut to remove the wheel.

Remove the pinion from the lathe and holding the collet in a pair of pliers twist the wheel onto its seat, tapping it home with a hollow punch if necessary. You should have 0.4 - 0.5mm of collet protruding from the wheel face. Hold the outside diameter of the collet in a three-jaw chuck with the wheel face as close to the jaws as possible.

Mount the T-rest (with its vertical peg) and position it so that the centre height of the burnisher is roughly on the centre line of the pinion. The burnisher is positioned against the T-rest peg which acts as the fulcrum point for levering the burnisher across the rivet face.

Figure no 7: Burnishing up

Start the lathe, position the burnisher behind the peg on the T-rest as shown in figure no 7. Applying considerable pressure sweep the burnisher across the collet face towards you, spinning and spreading the rivet into the chamfer on the wheel face. Cast brass will respond well to this technique and will flow smoothly. If the rivet appears to be too proud of the wheel face, face off a little of the rivet with the side of a graver. Be careful not to remove too much as this would weaken the rivet.

I prefer to spin or burnish over the rivet as opposed to hammering it down with a punch. If the punch is not held and struck absolutely vertically the collet will be compressed and the wheel seat will become distorted, setting the wheel out of true. If the collet is over riveted with a hammer and punch, the wheel can be split across from the centre hole to the crossings.

Practical articles wanted

One of the most common requests HJ receives at HJ is for practical articles like this one.

Can any of our readers help by writing up and photographing practical work they have undertaken in the workshop, sharing useful tips and advice with others?

If you can help please contact Jayne Hall on 01636 817605 to discuss your idea.

Machining the collet to match the original

Figure no 8: Set-up for turning collet to shape

Hold the arbor in a three-jaw chuck or collet and support the end in a female centre (see figure no 8). Machine the rough shape of the collet with a tool held in the tool post. Finish off with a hand held graver, blending in contours. With a little practice it is possible to achieve an exact copy of the original with an authentic finish.

Checking for side wobble

Figure no 9: Bending crossings

Finally, check for side wobble by mounting the arbor between centres in a depthing tool.

If there appears to be a little side wobble it can be corrected by gently bending the appropriate arm of one or more of the crossings.

Place the wheel on a plastic tube as shown in figure no 9 and using a home made brass punch gently tap the crossing to bend it and thus true up the side face of the wheel. On no account should this process be carried out on a wheel which is very delicately crossed out or appears in any way to be cracked or brittle.

If there is excessive side wobble the only safe way of correcting this fault is to remove the wheel and start the whole process again. Do not attempt to correct a large error by bending the crossings.

Using this approach one can safely remove a wheel and remount it whilst exerting the minimum of stress especially on the crossings. For the adequately equipped and skilled horologist mastering this technique can bring great job satisfaction and lead to substantial financial savings.

Arthur Jones