

## A balance vibrating tool – 8

by Guy Gibbons

### Jewelling and the balance staff

Traditionally jewel holes and end stones were 'rubbed-in' to brass chatons as they were not that round on their outer diameter, but today friction fit jewels can be pressed directly into the brass.

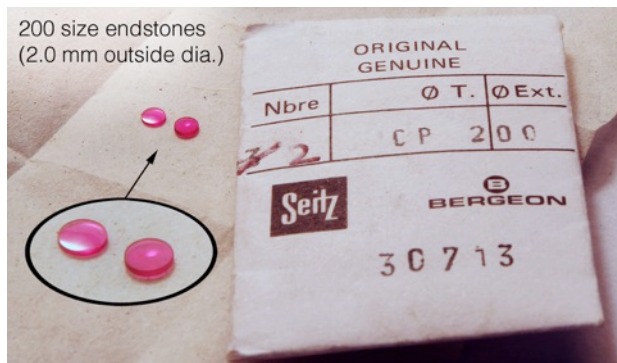
Friction fit jewels are available in a wide variety of shapes and sizes, and the recommended jewels are listed below. Other sizes are acceptable; the outside diameter is of no great significance for this application, so if 200 size jewels (2 mm outside diameter) are not available use whatever size you have, though bear in mind that if they are smaller this may require some adjustment to the jiggling arrangements that centralise the cock to the baseplate. The end stone does not have to be the same outside diameter as the jewel hole.

The hole size is a little more important; too large and the balance will come to rest more quickly than a balance fitted with smaller diameter pivots (and hence smaller jewel holes). Too small and the pivots may be too fragile for a workshop tool. Our balance wheel will be larger than a typical watch or even a platform escapement balance, so we suggest you aim for a hole size between 20 and 30 (20/100 to 30/100 or 0.2 mm dia. to 0.3 mm dia.), the smaller the size the lower the friction and therefore the longer the balance will maintain a reasonable amplitude of oscillation after it has been set going. If this is the first time you will be making balance staff pivots a 30 size jewel hole may be the most appropriate.

As the turning the balance staff pivots requires us to have the jewels to hand, we will include the description of its manufacture in this section.

### Materials required

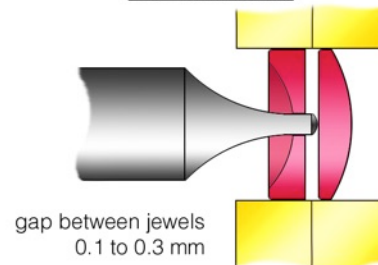
- 2 off size 200 x 30 train jewels (available in packs of three)
- 2 off size 200 end stones (available in packs of three)
- length (100mm) of blue pivot steel, 1.85 mm dia.
- short length (50 mm) of brass wire 1.6 mm dia. (16 gauge or  $\frac{1}{16}$  in.)



### Design and drawings

The relationship of the jewels and balance staff pivot is important, so take a look at the arrangement sketch if you are not familiar with jewelled pivots.

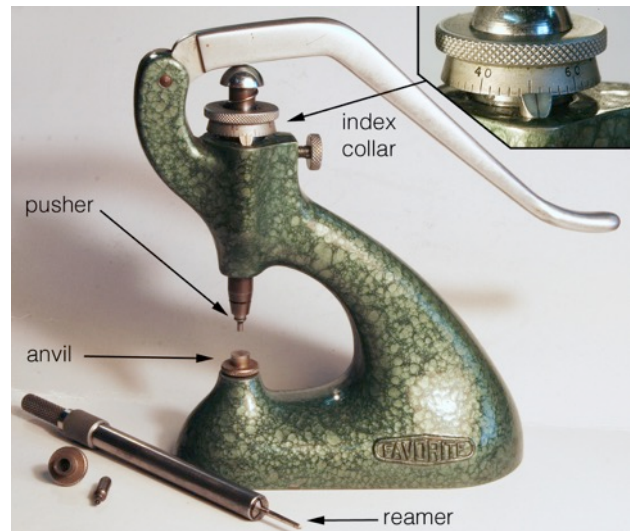
ARRANGEMENT OF JEWEL HOLE AND ENDSTONE



If you cannot source endstones it would be possible to replace the endstone chatons with dead hard steel discs made from silver steel, which would be perfectly adequate for demonstration purposes. The top end stone in particular could easily be made of hard steel polished to a high finish; being at the top it carries no weight at all and so is subject to very little wear.

### Jewelling

Although it is possible to fit a jewel without a jewelling tool, using an appropriate tool will make it far more certain. We will be using friction fit jewels which are much easier to fit than the old rub-in jewels. Friction fit jewels are made to very accurate tolerances and are simply pressed into a hole that is a very slight interference fit in the chaton or other component into which they are fitted. Jewelling tools come with precision ground reamers designed to ensure the correct interference fit, and most have a graduated collar at the upper end which controls the depth to which the jewel is pressed. A selection of pushers and anvils is provided to suit the various sizes of jewels.

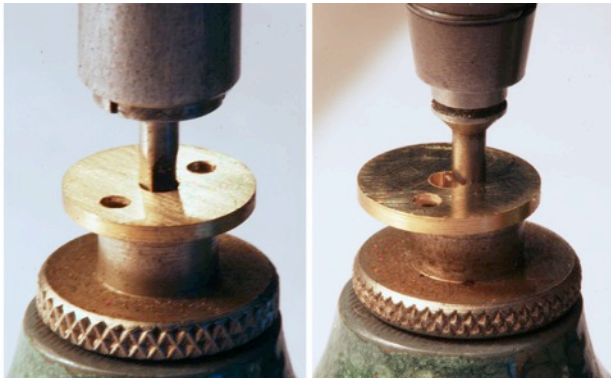


### Fitting the endstones

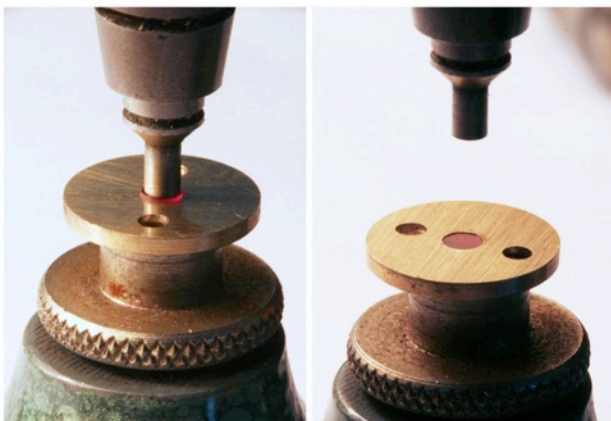
The steps in fitting an endstone are illustrated in the sequence of numbered photographs.

1. The first step is to ream the hole in the upper and lower endstone chatons, which is done by fitting the appropriate sized reamer into the colletted reamer head. The reamer is fitted to the jewelling tool and the central

hole in the first chaton reamed to just short of the full length of the flutes. Use a hollow anvil. Very lightly deburr the edge of the hole so that when the jewel is pressed-in no burr will be raised by any metal deformed by the pressing-in operation.



1. reaming to 2.0 mm dia. 2. adjusting the index collar



3. pressing in the endstone 4. the endstone fitted

2. The reamer head is removed and an appropriate size pusher fitted. If you are using 200 size endstones, a 180 size (1.8 mm outside diameter) pusher is appropriate. The first chaton is placed the correct way up on a solid anvil and the pusher pressed against the chaton so the index collar can be adjusted so the chaton just slides between the gap between pusher and anvil. Note the index collar reading. The index collar is now lowered by about 10 graduations or 0.1 mm so that when the jewel is pressed in the flat face will lie just below the surface of the chaton.

3. Now place the endstone convex side down on the chaton and position the chaton so the pusher is perfectly central on the endstone. Press the endstone into the full depth as set by the index collar, making absolutely sure that it stays flat to the surface of the chaton.

If you have to use what appears to be excessive force on the lever, you may need to ream the hole out slightly by repeating the reaming operation to a slightly greater depth. This is a process which requires a knowledge of your jewellery tool and its idiosyncrasies. If you open the hole out to far and the endstone drops through, you have two choices; either start again with a new chaton or use a larger diameter endstone. Punching-up the hole and re-reaming is not recommended.

4. Once complete make sure that the flat face of the endstone is just slightly below the surface of the chaton. Repeat for the second endstone chaton.

Do not go on to fit the jewel holes at this stage, which we will do after we have made up a dummy balance staff to ascertain its length.

### The balance staff

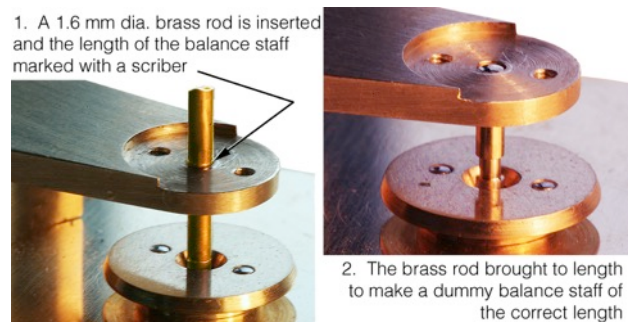
The balance staff is of a simple form as it is anticipated that this might be your first exercise in turning pivots to fit jewel holes. Before you start you need to have the jewel holes you will be using to hand so that you can try the fit as the final finishing cuts are taken on the pivots. In the drawings it is assumed that you will use 30 size jewel holes (0.3 mm bore).

You also need to have the balance spring to hand; as the split in the centre collet will prevent it from being opened out by a cutting tool (drill, reamer or cutting broach) the balance staff needs to be the correct diameter for the collet. We will say a little more about this in a moment.

Now make up a dummy balance staff to ascertain the length between endstones. To do this we should fit the balance cock and lower endstone chaton to the baseplate. Make sure the mating surfaces are scrupulously clean and free from burrs before fitting them.

1. Take a piece of 1.6 mm dia. brass wire and radius and polish one end in the lathe to a slightly domed shape. Remove the wire from the lathe collet and slip it through the holes for the balance staff jewels in the cock and baseplate so that the radiused end rests on the lower endstone. Mark with a scribe and cut off.

2. Turn the dummy balance staff to the exact length by a process of trial and error so that there is just a perceptible amount of end shake when the upper endstone chaton is fitted. Again make sure the end is domed so it rests on the endstone and not the edge of the hole. Measure its length with a micrometer or digital calipers and set it aside.



1. A 1.6 mm dia. brass rod is inserted and the length of the balance staff marked with a scribe

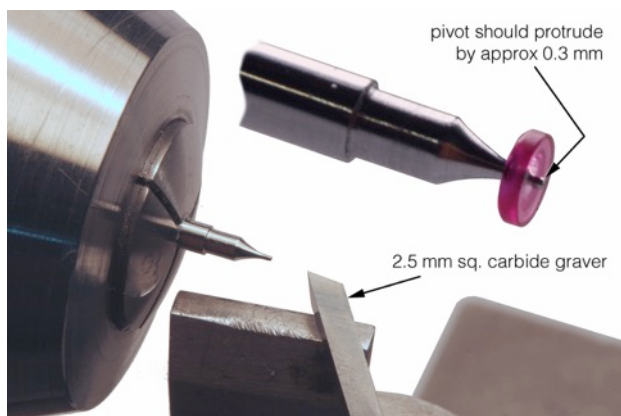
2. The brass rod brought to length to make a dummy balance staff of the correct length

The balance staff proper can now be turned. If you have access to 1.85 mm dia blued pivot steel, this is ideal for the balance springs recommended, which seem to be a good fit on a slightly-expanded 1.80 mm dia. split collet. However, the main thing is to ascertain what size you need to suit your selected balance spring centre collet. A little more will be said about this in the next section.

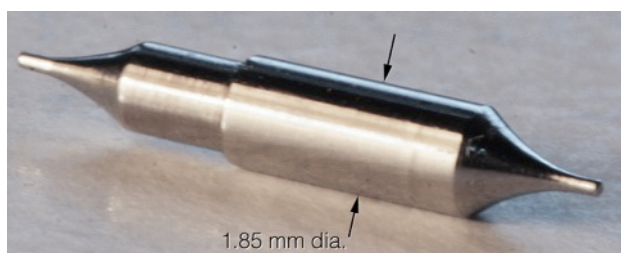
Turning pivots is not easy and you will probably have to make several attempts, especially when turning the second end as it is essential to get the length overall a perfect fit between the endstones. Using a graver and T-rest, turn the pivot to the shape shown, taking very fine cuts as you near the final size. You can measure the tip

diameter with calipers, making sure that you achieve a fine finish before trying the jewel hole onto the pivot. When it just won't fit (if that makes sense), set up the jacot head in the tailstock and burnish with a burnisher. It is probable that the tip will be slightly tapered so you will need to turn it parallel for the last few fractions of a millimetre until it fits with the tip protruding as shown. There should be no perceptible side-shake and the jewel, having a parallel hole, should show very little sign of wobbling when on the pivot. It will be given its final freedom when burnished for the very last time.

Describing what is wanted is difficult, and the only way to learn is by making pivots. Once you are satisfied with your first pivot, turn the 1.5 mm dia. portion to the length shown on the drawing and bring it to a fine finish. Remove the pivot steel from your collet and cut to length using your dummy balance staff as a gauge.



The second end is now faced off to 0.1 mm over-length and the pivot turned in the same way as the first. Once the pivot fits in the jewel hole you need to bring the staff to an identical length to the dummy balance staff. If you are uncertain of your ability not to bend the pivot with the graver, a fine stone can be used, removing and checking the length and fit frequently as you near the finished size.



Finally burnish the pivots using a Jacot tool and burnisher, treating the ends of the pivots at the same time to bring the length exactly the same as your dummy staff. Keep your dummy staff in case you have to make a replacement staff for any reason.

### Fitting the jewel holes

Now the jewel holes can be fitted to the cock and baseplate using much the same technique as for the endstones. If your jewellery tool has them, a pusher that has a sprung-loaded centre can be used so as to make sure the hole is being pushed centrally and hence evenly into its housing. Finally try the balance staff in position and check that it runs freely without any perceptible side shake and just a perceptible touch of endshake. If it does, congratulations – you have made your first balance staff!



Now broach out the bush in the balance wheel so that it is a light push fit on the 1.5 mm dia. part of the balance staff. Very lightly chamfer the hole at the shouldered end so it seats well against the shoulder of the staff. If you broach out the hole too much you will probably have to make a new bush, so take great care with this operation.

### A first fitting

After all the work so far, you are now in a position to assemble the balance for the first time to see if it swings freely. If it does you will probably find that it is not 'poised', always coming to rest in one position when held on its side. While this is not critical for a vibrating tool that only has to work in an upright position (i.e. with the staff upright), it is good practice to bring it as closely as possible to being in poise. As there are no posing weights fitted to the balance rim, this can only be done by filing metal from the edge of the spokes or inside the rim.