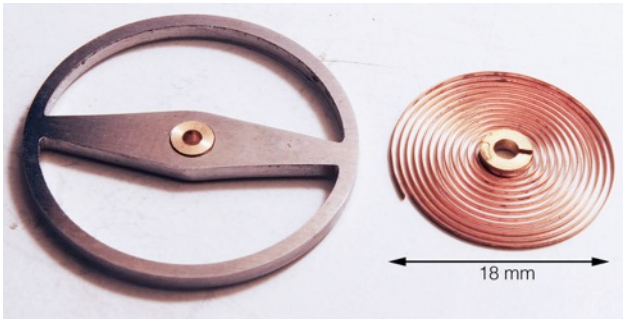
A balance vibrating tool – 7

by Guy Gibbons

The balance

The natural frequency of oscillation of a balance (wheel) is determined by its moment of inertia and the stiffness of the balance spring. This is not easy to determine as it requires a detailed knowledge of the disposition of the mass in the balance, which we will not attempt to calculate.



Suffice it to say that the more the mass is concentrated at the rim, the greater the moment of inertia, which is why balances are crossed out to leave the bulk of the metal in the rim:

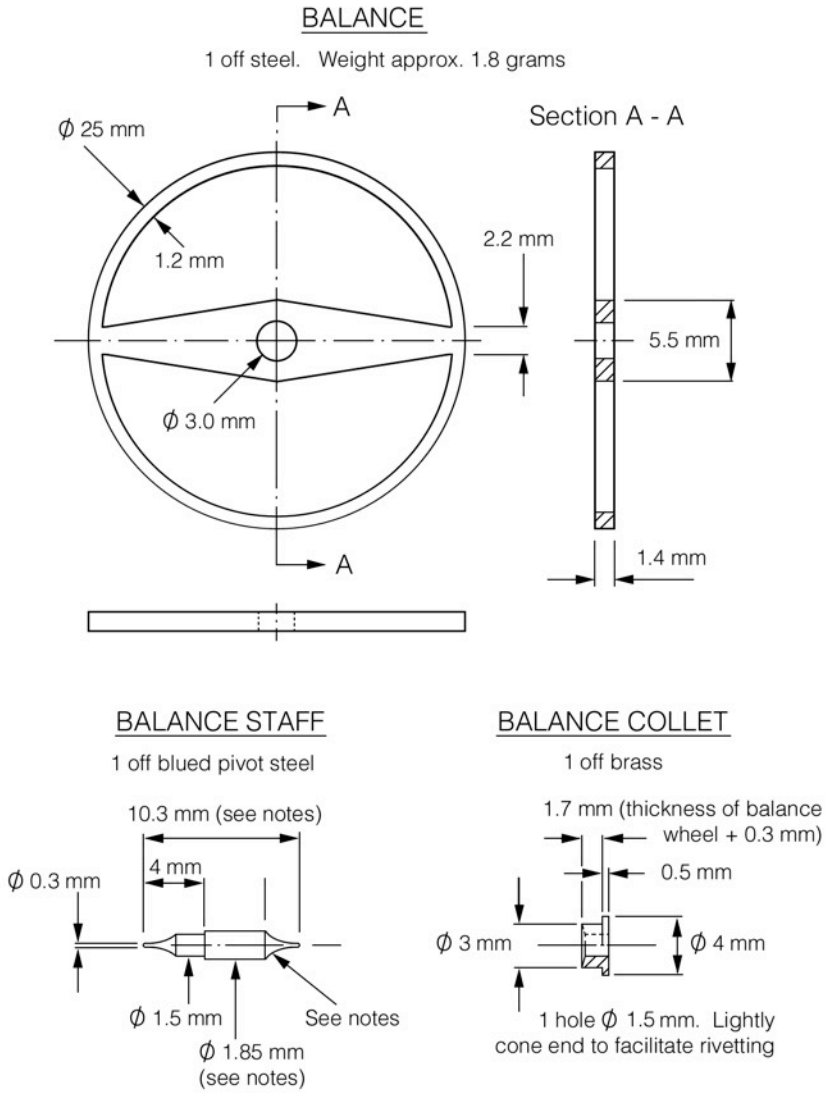
- increasing the mass of the balance (and especially the balance rim) will increase the period of oscillation (slow it down).

In order for the balance to become an oscillator, it needs to be combined with a spring – the balance spring (sometimes called the hairspring). The stiffness of the balance spring is determined by its length and cross-sectional dimensions:

- increasing the stiffness of the spring will reduce the period of oscillation (speed it up).

To bring a balance and balance spring assembly to the required rate of oscillation, two methods are normally used:

- to vary the moment of inertia of the balance timing screws (weights) on the balance rim can be added, adjusted or removed, and
- to vary the stiffness of the spring the effective spring length can be adjusted by means of the index on which the curb pins or boot are fixed. (Shorter springs are stiffer than longer springs.)



In this vibrating tool we will be making a plain uncompensated balance. Timing screws will not be fitted to the rim, and we will rely solely on adjustment of the length of the balance spring by means of the index. As the balance is uncompensated, the rate will vary with temperature.

To suit most platform escapements and watches we need a rate of 18,000 beats per hour, which can be restated as a period of oscillation of 0.4 seconds (scientific notation) or a frequency of 5 beats per second (2.5 Hz).

The balance has been proportioned sized to accept balance springs that are readily available at the time of writing; if you vary the dimensions or mass significantly (and this includes making it in a material of a different density such as a copper alloy), the balance spring may not be suitable.

Materials required

- steel disc 25 mm dia. x 1.5mm thick
- short length (25 mm) of 4 mm dia. brass rod.

Design and drawings

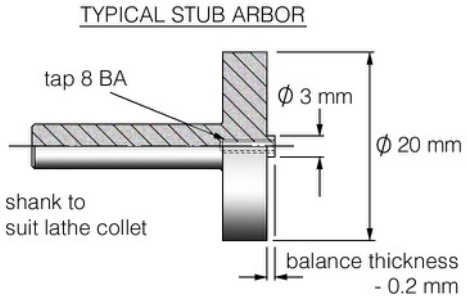
In the balance drawn, the rim is not raised up partly to simplify the crossing out and partly because we do not need the greater depth to accommodate timing screws. In addition the balance is riveted onto a collet rather than directly onto the balance staff, so that should things go wrong during its construction, the balance and/or balance staff will not have to be scrapped and a new one made.

Construction – balance wheel and bush

Take or cut a disc of steel slightly larger than 25 mm diameter from dead-flat 1.5 mm steel sheet. Chuck in the lathe using a four-jaw chuck so it runs as true as possible and drill and ream a hole 3.0 mm diameter at its centre. Deburr the edges of the hole. If you do not have a reamer, do not worry; just drill the hole 2.9 mm dia and broach to make it a snug fit on the spigot of the stub arbor we will be describing next.

(Coincidentally the balance wheel is slightly smaller than the size of a UK two pence piece, those made after 1991 being copper-plated steel. As it is illegal to deface coinage, a two pence piece cannot be used legally as a source of material.)

Make a stub arbor with a spigot of 3.0 mm dia. that protrudes by 1.2 mm and drill it centrally for a depth of 8 mm. Tap the hole 8 BA or similar. Make sure the stub arbor is running true to the lathe centres (for example, by holding in a collet or four-jaw chuck) and mount the disc on the stub arbor. Clamp the disc to the stub arbor with a washer and 8 BA screw, and turn the outer diameter to 25 mm.



Once the balance wheel has been brought to its outside dimensions, mark the balance wheel for the spokes and crossing out. After drilling a 2 mm dia. hole where each cut-out will be, insert a piercing saw blade and cut out the waste material. File the two spaces to the shape and dimensions given. Filing the rim to its correct width (inside diameter) can be simplified by the use of a filing jig, which is turned from silver steel as shown in the photograph, though as it will blunt the needle files you should not use your best files. Final draw-filing of the edges is done with the balance wheel removed from the jig. The balance wheel is finally finished on its upper and lower surfaces by rubbing on a fine diamond stone or wet and dry paper. The surfaces may be polished if you wish. The weight of the balance should not exceed 1.8 grams.

The next step is to make the brass bush which is a simple turning job, though it is as well to leave the central hole slightly small so that it can be broached to a push fit on the balance staff once it has been made. Once complete, the bush can be riveted into the centre hole and the riveted end brought flush with the surface of the balance wheel before re-finishing to the same standard as the upper surface (the side with the flange of the bush). Annealing the brass bush before riveting will make the riveting easier.
