A balance vibrating tool – 4

by Guy Gibbons

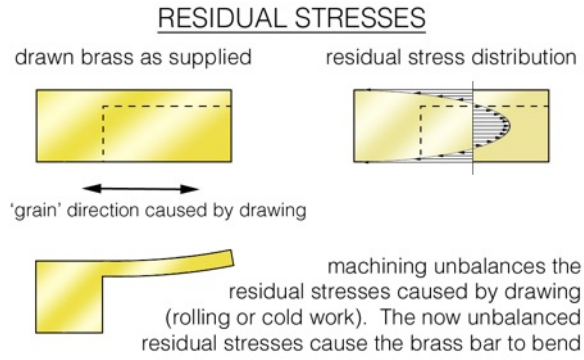
The balance cock

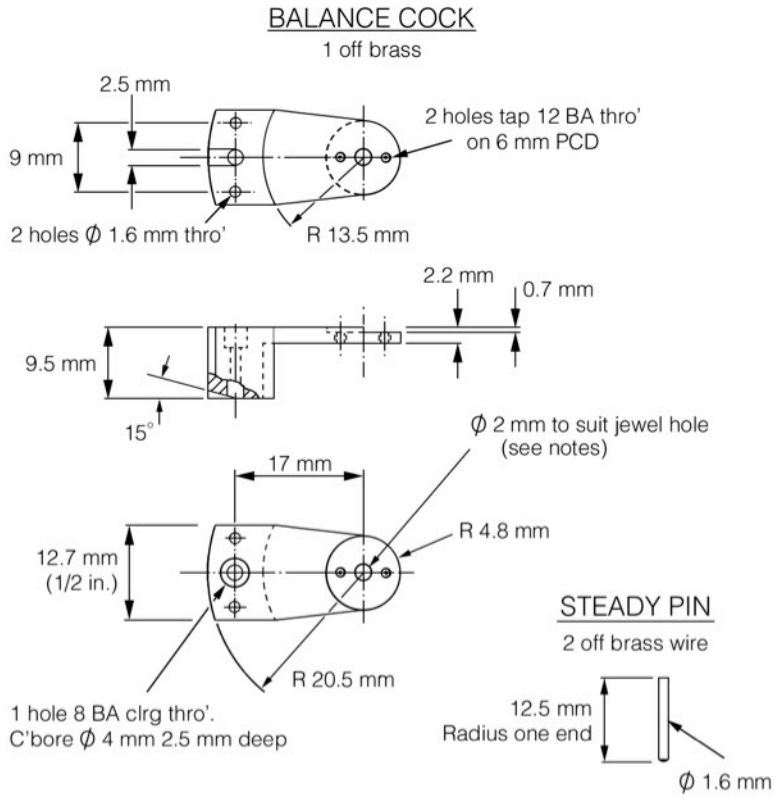
Never an easy component to make (and in particular hold during manufacture), the cock provides the upper support for the balance staff. It is of vital importance that the hole for the upper jewel is precisely above the lower jewel so that the balance staff is truly upright. As we will be using cylindrical train jewels rather than jewels with an olive-shaped hole, any angular misalignment will cause the pivots to become scored very quickly as they bear on the edges of the hole. We will not be using olive-shaped jewel holes because they might not be available in the larger hole sizes we want.

Materials required

- $^1/_2$ in. x 1 $^1/_2$ in. rectangular brass bar (section) x $^1/_2$ in. long)
- length of 1.6 mm dia. approx. brass wire for steady pins
- short length of 4 mm dia. silver steel rod for the securing screw
- temporary 8 BA x ½ in. screw (or screw to suit the thread you will be using)
- length of 10 mm dia. silver steel (for filing buttons).

Note: a length of $^3/_8$ in. x $^1/_2$ in. rectangular brass bar may seem more suitable and can indeed be used. However, because of the high internal stresses in the 'skin' caused by the drawing process, the cock will bend when the underside recess is cut away (see diagram).





If you use drawn bar in this orientation you will need to straighten it before bringing to final size (height). Alternatively, the brass can be annealed by heating to red heat and allowing to cool slowly, but this will make the cock softer and more liable to be subsequently bent. By using the recommended material with the upper and lower surfaces of the cock formed from the 'end grain' of the drawn bar, no bending will occur and the brass will remain in its half-hard condition.

Note: In this context, 'drawn' describes the process of drawing the brass through a rectangular die plate to produce its rectangular shape. In so doing, the brass is work-hardened.

Design and drawings

As for the baseplate, the cock ideally requires equipment that will permit two diametrically opposed holes to be drilled on a pitch circle diameter in mating components. In a well-equipped workshop this would be done on an indexing rotary

table or a lathe headstock-mounted dividing attachment and cross-slide drilling spindle. But do not worry if you do not have such equipment as an alternative method will be described.

Construction

Using a four-jaw chuck, machine one surface flat. Reverse and bring the brass bar to a finished height of 9.5 mm, making sure it is truly parallel with the first surface. To ensure it is parallel, press the work hard against the chuck body as you tighten the jaws, which with an engineer's lathe can sometimes be facilitated by applying light pressure from the end of the tailstock barrel as the jaws are tightened.

Remove from the chuck and mark out the position of the holes on the upper and lower surfaces, and scribe the lower surface with arcs struck from the balance staff position.

At the centre of each hole press the scriber point lightly into the surface of the brass, inspecting whether you have got the indentation exactly on the cross-lines using an eye-glass. Adjust until perfectly centred and press harder so that the indentation from the scriber is deep enough to take the point of a centre punch. Tap the centre punch with a hammer and check again with the eye-glass. If necessary, draw the punch mark over by leaning the punch in the required direction and tapping again

The holes need to be drilled truly vertically, so use a drilling machine. If a drilling machine is not available, hold the brass bar against a pad in the tailstock and drill from the lathe spindle. But before you drill the holes, it is now important to think ahead before selecting the drill size for each hole:

- Steady pin holes: Check the diameter of the brass wire and drill to the exact same size or very slightly smaller. For example, if the brass wire is measured at 1.57 mm diameter, drill 1.55 mm or 1.50 mm. We will bring the brass wire to a push fit in the holes using a piece of fine grade (600 or 1200 grade) wet and dry paper.
- Cock securing screw: Drill the hole the tapping size for an 8 BA screw or the thread you intend to use (e.g. M2). Counterbore to a depth of 3 mm using a 4 mm dia. drill, making sure you clamp the brass bar and using a depth stop in case the drill 'snatches' in the work. Finally fit a 4 mm dia. cutter with a flat end to flat face the bottom of the counterbore. If you do not have one, you can make a D-bit from 4 mm dia. silver steel.
- Balance staff hole: Drill a 1.7 mm dia. hole at the jewel hole position (being the outside diameter of a 10 BA screw, 1.7 mm is suggested for the reasons mentioned when drilling the baseplate jewel hole position).
- Upper end stone chaton securing screw holes: do not drill at this stage.

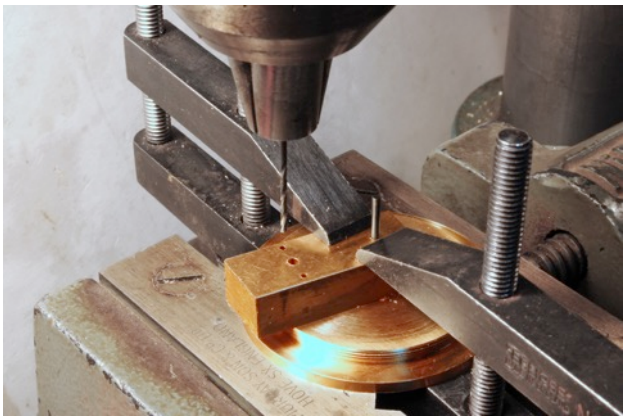
Very lightly de-burr all holes so the brass bar will lie flat and free from any 'rocking' on a surface plate.

If the holes are truly square to the top and bottom of the cock, we can now use a bit of cunning to avoid the need to 'upright' the balance staff when planting the cock securing screw and steady pins. If there is any doubt, then you will need to 'upright the holes', which we will describe later.

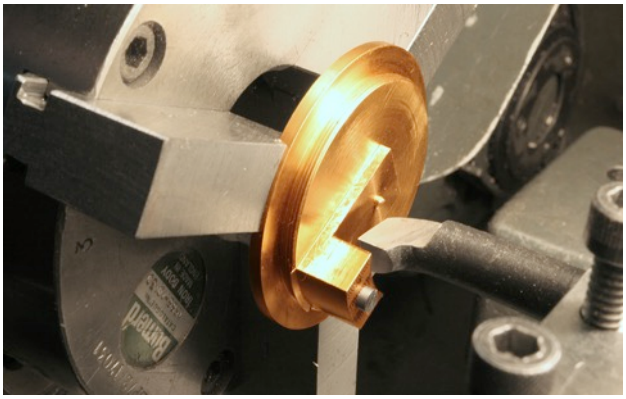
Holes drilled truly square

Using a 1.7 mm dia. drill shank, locate the cock by the balance staff hole on the base plate. Check the drill shank is truly vertical and clamp the two components together using two toolmaker's clamps. Using the already drilled holes in the cock as a guide, drill the baseplate for the securing screw using a drill of the correct tapping size for the screw thread. Also drill the two steady pin holes.

Make sure you have marked which side is the top side of the cock (the side from which you have drilled the original holes), and separate the components. Open the securing screw hole in the cock to the tabulated clearance diameter for the screw thread; if you do not know what this is, choose a drill 0.1 mm larger in diameter than the measured major diameter (outer diameter) of the screw thread. Tap (thread) the hole in the baseplate and remove the burrs.



Next rough out the bulk of the metal to form the recess using a hacksaw. If you have used $^{3}/_{8}$ in. high drawn barstock you will now find that it has bent and will need straightening by gripping in the bench vice and giving the projecting 'wing' a few gentle taps with a hammer. It may be necessary to rub it on a truly flat bench stone (e.g. a diamond bench stone) reserved for brass to bring it truly flat. Alternatively you can stick down a piece of 600 grade wet and dry paper to a hard, flat surface. Sticking the paper down will minimise the rounding of the edges.



Once the upper surface has been brought to a flat plane again, we can now use the baseplate to hold the cock to bring it to its final thickness of 2.2 mm across its entire surface. This is done by holding it upside down against the baseplate, locating it with a drill shank through the 1.7 mm pilot hole for the jewel hole and securing the cock to

the baseplate with a temporary 8 BA screw through its foot. The baseplate is held in a lathe chuck or mandrel and the underside of the cock brought to size using a boring tool. At this same setting, we can also cut the internal radius for clearing the rim of the balance wheel.

While at this setting we can also finish the 20.5 mm back radius using a normal lathe turning tool, taking care not to feed the tool into the baseplate. If anything, make this radius slightly smaller so it will fit comfortably within the casing.

Holes not truly square – 'uprighting'

If you are not confident of your equipment to drill the holes truly square, you should drill the securing screw hole as described previously but not the two steady pin holes. Finish the securing screw hole to size (8 BA clearing) and tap the hole in the baseplate, deburring the holes on completion. Now rough out and finish machine the underside of the cock as described before.

Turn the cock the right way up and secure to the baseplate with a temporary screw, adjusting the position until a drill shank through the balance staff pilot holes is truly upright in both the fore and aft and sideways planes. This can be done by eye, but do hold the cock at eye level and observe it against a strong light uncluttered by extraneous background equipment (a background of daylight through an outside window is ideal). It may be necessary to increase the clearance diameter of the securing screw hole slightly to get the drill shank truly upright. Once satisfied, tighten the securing screw and drill the two steady pin holes (remember: as we described earlier these holes are sized slightly small than the diameter of the wire you will be using for the steady pins). Deburr the holes on the underside only.

Cock removing notch

Before we fit the steady pins we should cut the cock removing notch. When removing the cock, the notch is a useful feature allowing the use of a screwdriver to help lift the cock that reduces the chance of the balance staff pivots being bent or broken. The notch should not be omitted. It can easily be cut with a file; alternatively it can be machined using a slitting saw or woodruff cutter.

Fitting the steady pins

Take the brass wire selected for the steady pin holes and hold in a collet in the lathe and finish one end. Now try to push the wire into the cock steady pin hole, reducing its diameter using wet and dry paper until it is a light push fit through the whole thickness of the cock and 3 mm beyond. Remove and cut the wire off, reverse in the collet and finish the other end to length. Repeat for the second pin and clean thoroughly with methylated spirits in preparation for the next step.

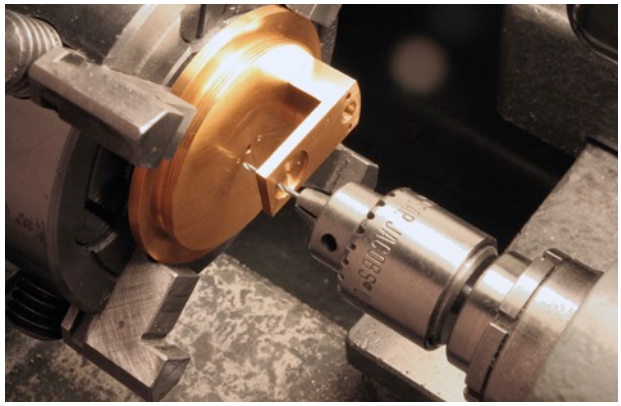
The pins may now be permanently fitted to the cock, using a dab of Loctite (an anaerobic adhesive) to ensure they stay firmly fitted. The outer flat end can also be lightly riveted just to fill any slight chamfer left by over-enthusiastic deburring operations on the hole, but do not use heavy blows or you will bruise the domed lower end. Make sure both pins protrude by an equal amount below the cock. Allow the Loctite to cure for 30 minutes after which time the upper surface can be rubbed on a stone to leave the ends of the pins all but invisible.

Perhaps a 'bearing fit' grade of Loctite is most appropriate for this low duty application, but the actual grade is not important as you should never want to get the pins out again.

Once the pins are secured and finished, the cock is tried in position on the baseplate. Very gently, ease the steady pin holes in the baseplate using a taper reamer until it fits into position with just a hint of stiffness. Very lightly deburr the holes.

Cutting the end stone chaton recess

Fit the cock to the baseplate using a temporary screw and mount the baseplate in a four-jaw chuck in the lathe. Use your locating drill shank to make sure all is well, and centralise the centre hole and tighten the chuck jaws firmly but not so much that they will bruise the edge of the baseplate. Using a boring tool, bore the end stone chaton recess to 9.6 mm diameter 0.7 mm deep.



If you are index drilling the holes for the 10 BA securing screws, set up the headstock dividing attachment and fit the motorised spindle. After centring the motorised spindle, offset the cross-slide by 3 mm ready for centring the two holes on their 6 mm PCD. Centre with a centre drill and then follow up with a 12 BA tapping drill. Tap by hand using the motorised spindle as a back steady and de-burr all the holes.

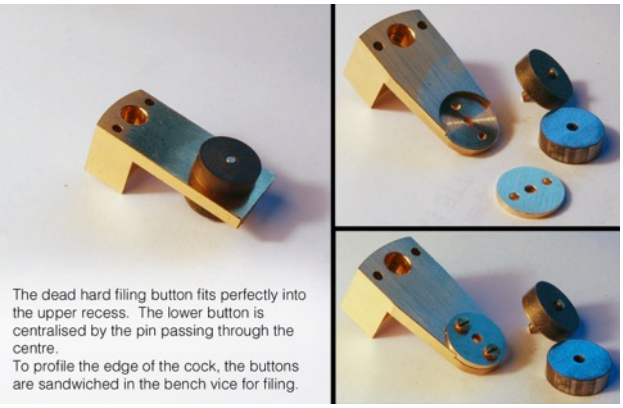
If you are not index drilling the holes, do not mark and drill the holes yet as an alternative, equally satisfactory approach will be described later. In either case the baseplate can now be removed from the chuck.

Filing buttons

The next job is to radius the end of the cock and this is best done with a pair of filing buttons. Take a length of

10 mm diameter silver steel and turn down the outer diameter for a length of 12 mm so that it is an exact fit in the 9.6 mm dia. chaton recess. Drill a central hole to take a short length of wire of the same diameter as the central hole in the cock that will eventually be opened out to take the jewel holes (1.7 mm dia.). Face and part off two lengths about 4 mm long, deburring the holes well and making sure that both ends are flat. Heat the two buttons to bright red heat and quench in cold water to leave them dead-hard.

Polish one end of each button on a stone so that they will not mark the chaton recess and sandwich the cock in between before clamping in the bench vice. You can now file down the sides and end of the cock to a perfect fit on the end stone chaton. Tidy up any burrs on sharp edges with a fine needle file.



The dead hard filing button fits perfectly into the upper recess. The lower button is centralised by the pin passing through the centre.
To profile the edge of the cock, the buttons are sandwiched in the bench vice for filing.
