A balance vibrating tool – 12

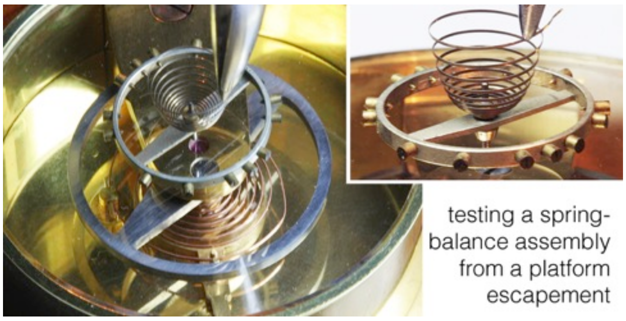
by Guy Gibbons

Using your vibrating tool

Now all work is complete on the tool, it is as well to calibrate it for rate. This should ideally be done for temperature and isochronism using a timing instrument of known accuracy. But before we do, try fitting a spring-balance assembly to get a feel of how the tool is used.

Select a spring-balance assembly (e.g. from a discarded platform escapement) making sure the lower pivot is in good condition (not broken) and clip the balance spring between the tweezer jaws at the curb pins or boot position. Tighten the tweezer jaws onto the spring. Do not worry if the inner jaw tends to contact the adjacent balance spring coil; once it is dangling it will take up a beehive shape and be clear. With the spring-balance dangling, adjust the height of the scaffold so the balance is (a) level, (b) centred on the cover of the tool, (c) the lower balance staff pivot just rests on the cover, and (d) the spokes of the two balance wheels line up (adjusted by rotating the vibrating tool in the recess in the scaffold base). As the balance under test will tend to rise and fall as it oscillates due to the winding and unwinding of the balance spring, you may need to make small adjustment to the height of the scaffold to ensure it remains in contact with the cover.

(Some authorities suggest the balance staff should leave and re-contact the cover at each oscillation, so the 'tap' at each contact can be heard and counted. We do not suggest this is necessary, which is a technique more appropriate to counting oscillations for comparison with a reference timekeeper with a sweep-seconds hand.)



testing a spring-balance assembly from a platform escapement

Grip the scaffold base and give it a sharp twist centred on the centre of the balance. If you twist it about any other axis or move it laterally, the balance under test will tend to skate across the surface of the cover. (In a professionally made tool this is cannot happen as the base is designed to rotate about the balance staff axis.) Aim for an amplitude of oscillation of about ± 90 degrees, and with any luck you should see the two balance wheels stay approximately in synchronisation. With a little less luck the balance wheels will gradually drift out of synchronisation; this is what needs to be corrected by re-clipping the balance spring at a different place to make the effective length of the spring shorter (= faster) or longer (= slower).

As the oscillations decay you will also note that the balance under test oscillates for far longer than the vibrating tool balance, which just indicates how much friction there is in even a jewelled pivot and hole.

twisting the wooden base to set the balances in motion

Calibration

With the casing removed and using the timing machine set-up shown in section 10, it is possible to see how isochronism is affected by balance amplitude and room temperature. To give yourself time to note down the readings and estimate the balance amplitude at the time each reading is recorded, set the timing machine to measure 60 counts (60 beats). Start the timing machine and give the balance an initial twist of 180 degrees and release. The first timing machine reading will be in error but the next one should be recorded. If your machine is set to beep at each refresh (60-count) note down an estimate of the balance amplitude and then the timing machine reading. Repeat until the amplitude drops to about ± 40 degrees. Repeat the trial several times (Trial A, Trial B, etc.) to get an average trend.

Now tabulate your results, and a suggested format is shown below.

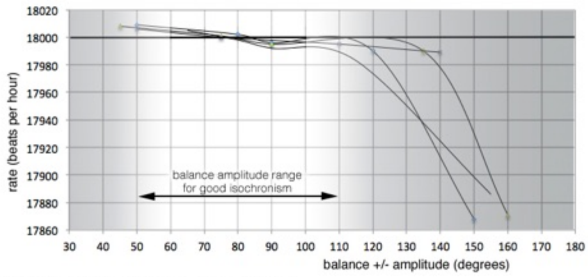
Temperature = ***8 degrees C***	Initial amplitude ***± 180 degrees***
Timing instrument count interval: ***60 counts (60 beats)***	

Trial "A"		
Count group	**Estimated amplitude**	**Recorded bph**
0	*Not recorded*	*Not recorded*
1	*± 135 degrees*	*17990*
2	*± 90 degrees*	*17995*
3	*± 75 degrees*	*18001*
etc.		

Notes *Index not adjusted during trials.*
Timing machine: Mumford Microset timer with optical sensor.
Etc.

The results from four trials conducted on for the prototype instrument were plotted on a graph. From this it is possible to deduce:

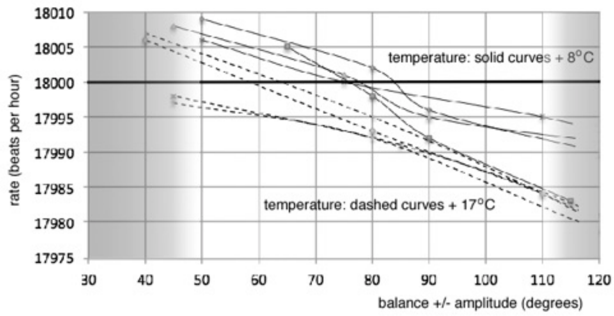
- 18000 beats per hour is achieved at ± 80 degrees amplitude
- isochronism is good between about ± 50 degrees and ± 110
- isochronism is poor above about ± 110 degrees amplitude.



measured at a temperature of + 8 degrees Celsius

A more detailed analysis of the data showed there to be a variation of less than ± 10 beats per hour up to an amplitude of ± 110 degrees, which would equate to a timekeeping error of 48 seconds a day.

The reason for poor isochronism beyond 110 degrees was not conclusively identified, but is probably due to the balance spring coils touching one another or some part of the base assembly.



The trials were undertaken in a cool workshop of just 8 degrees C. They were repeated some hours later after the vibrating tool had been transferred to a warmer room at 17 degrees C. The second graph shows an enlarged detail of the earlier graph along with four new curves plotted at the higher temperature as well. Unsurprisingly anisochronism versus amplitude remained much the same, but the rate dropped by an average of 8 beats per hour over the range of amplitude of interest (equivalent to 38 seconds a day). This is what would be expected as the uncompensated balance spring loses some of its elasticity (and hence stiffness) at the warmer temperature.

This is not the place to discuss why our vibrating tool does not perform perfectly as the factors affecting isochronism and temperature compensation are covered in other texts by far more learned authorities than I. However, do think about the results you obtain from your own trials.

What the above calibration trials tell us is that within the amplitude limits identified, the tool is quite capable of being used to select suitable balance springs for a clock or watch where the spring is missing. And as you may well have found already, to induce a high balance amplitude in this tool (greater than ± 120 degrees) by a single twist of the scaffold assembly is not easy. By the time you have got your eye in to check the synchronisation of the two balances this amplitude will have dropped to within the isochronous range (in the prototype balance less than ± 110 degrees).

In some of the professionally made tools a spring-loaded lever is provided to give the twist to set the balance going, so the initial amplitude will tend to be constant. Because of our much simplified design, our vibrating tool relies on a more qualitative flick of the wrist, which is why it is useful to do the calibration trials suggested.

Final remarks

You have now completed the balance vibrating tool and I hope that you will spend some time thinking about the issues that affect spring-balance design and construction. You also have a tool of which you can be proud, and one day will be of use to you in your future work.

Of course real clocks and watches have an escapement, and the experience you gain from making this tool will give you an excellent understanding of the fundamentals of the spring-balance oscillator as you tackle both watches, clocks or platform escapements in the future.
