Righting the Wrongs

Interesting repairs to a Verge Watch by **Ian W Wright**

Fig 1.

Fig 2.

I am continually amazed by the number of antique watches which land on my workbench as a result of bad repairs by other 'watchmakers' either now or in the past. The watch I am about to describe falls fair and square into this category as both the main problems it had were directly caused by previous attempts at repair.

The watch itself is a nice verge pocket watch in a gold pair case which is London hallmarked for 1761. Like many such watches still in existence, it has obviously enjoyed a long and useful life as a timekeeper, indicated by the wear marks around the inner case and the fact that the pendant has, at some time in the past, been replaced. (Figs 1 & 2)

The two main problems with the movement were that (i) the mainspring set-up wheel was missing completely and (ii) the fusee ratchet mechanism was totally destroyed.

Considering this latter problem first, the initial state of the fusee can be seen in fig. 3 where you can see that the click is completely missing and the circular brass spring controlling it has the acting end broken off. Not only this, but the ratchet teeth on the periphery of the fusee have been crudely and unevenly filed in an attempt to deepen them and persuade an obviously ailing ratchet system to work. In actual fact, of course, it is this filing of the teeth which undoubtedly led to the demise of the click which was being asked to work at an awkward angle and to accept loadings which it wasn't designed for.

The teeth filed into the fusee, Fig 4, presented something of a dilemma - should the fusee be completely replaced with a new one, or should a restoration be carried out which would preserve as much of the original part as possible? In the event it was decided that an attempt should be made to preserve the original part.

The old brass circular click spring was carefully removed from the great wheel - it was pinned into place by three small brass pins, the wheel recess was cleaned out and the distortion where the click had broken out was tapped level. The spring was now measured and a new ring of hard brass was turned to form the basis of the new spring. This allowed an assessment to be made of the correct outside diameter of the ratchet wheel. At the same time a decision was made as to the thickness of the new ratchet. In this case, it was not possible to see where the original ratchet had been as it had all been filed away in deepening the teeth but it was considered appropriate to select a point on the fusee which would leave a web of brass under the chain hooking slot of the same thickness as that above the slot. This gave a thickness for the new ratchet of 0.68mm which visually balanced well with the height of the spring and click at 0.41mm (it is normal in verge fusees for

Fig 3. Damaged fusee from top showing missing click, broken spring and badly filed teeth.

Fig 4. Underside of damaged fusee cone showing roughly filed teeth

the ratchet teeth to be around 1.5 times the height of the recess in the great wheel).

Next, the height of the fusee cone was measured and, in the lathe, this was reduced by the correct amount to accept a new ratchet. This step is critical as final freedom of the winding depends upon the finished overall length being exactly the same as the original. In this particular case, the existing filed teeth still encroached onto the actual cone and chain track but it

Fig 5. Cutting the new ratchet wheel

was felt that, as there was no mechanical interference with the operation of the chain, the cosmetic imperfections could be tolerated. The original fusee body is made of cast brass and so, to maintain as much similarity as possible, a disk was cut from a cast brass sheet and turned to the overall size of the new ratchet. It was possible to determine from the filed teeth that the original ratchet had 60 teeth - a very convenient number, and so the blank, mounted on a wax chuck, could be easily cut in the normal watch lathe using the index holes on the pulley. (Fig 5.)

Once the wheel had been cut and cleaned up, it had a central hole bored which would just slip over the fusee

Fig 6. Ratchet fitted to fusee and new spring blank.

arbor and was temporarily secured to the fusee with a couple of dabs of 'superglue'. Now, carefully considering distances and angles, four holes were drilled through the ratchet into the fusee for securing pins. As the centre of the ratchet would be turned away to clear the central boss of the great wheel and yet the pins must not protrude into any of the chain track, these holes had to be at an angle matching the fusee cone and within a very narrow band. Of course, as the pins are at an angle, they form the only retention necessary with, perhaps, the added security that the ratchet is always trapped between the fusee and the great wheel. With the holes drilled, four slightly tapered brass pins were hammered into place and the ends turned level and polished to merge in with the ratchet. Now the centre of the new ratchet could be turned away until it was clear of the great wheel boss and the new blended smoothly into the old.

The next job was to make a new click. This was simply done by turning a spigot on the end of a piece of 3mm steel rod such that it would be a reasonably close fit in the hole in the great wheel, and then filing the adjacent portion of the rod into the rough form of the click. Parted off from the rest of the rod, the shape of the raw click ccould then be refined using escapement files, and its height reduced and polished to finished size. With the click riveted into the wheel and moving freely, the action of the ratchet could be tried and attention turned to its spring. A portion of the brass ring was cut away and the end which would eventually press on the click ws tapered, hammer hardened a little more, and bent so that it would give a clean action to the click. The other end of the spring was squared off and decorated as the original. With great care, the rotational position of the spring was decided upon so that it could exert maximum force on the click without becoming trapped or distorted and a small (0.3mm) drill was used to mark through the position of the original pin holes. These holes were drilled through the new spring and new brass pins used to rivet it in place. A new steel pin was now fitted for the chain to hook onto and a hole drilled vertically through the original hole in the fusee cone into the new ratchet, followed by a tightly fitting steel pin which was finished clean with the surface of the chain track.

So, work on the fusee was now complete and the parts could be reassembled and tested. A satisfying result, but

Fig 7. The repaired fusee

one which had taken the best part of a day to complete and which shouldn't have been necessary if the original repair had been better done.

The missing mainspring set-up wheel was simply the result of carelessness on the part of a previous watchmaker. This is not a part which normally suffers from mechanical distress and is usually a close push fit onto a square on the barrel arbor. This had simply been lost by a previous repairer and the watch reassembled without it in the full knowledge that the watch wouldn't function.

Its replacement gave me an opportunity to show how CAD can be used to determine the shape and size of missing parts. The screen shot, Fig. 8 shows a CAD program in which an image of the actual watch can be used as a background on which to base the design.

This method is equally appropriate to both watches and clocks and is very useful in determining the shape and size of missing strike levers, etc., where a photograph can be taken with the wheels / pins in a suitable critical relationship with one another. This, then, is used as a background on which to draw the lines of the lever.

In this case, a circle of the same diameter as the outer edge of the movement was first drawn on the screen and this was then used to position and scale a graphic image of the bottom plate. Now, by zooming in to the relevant portion, circles representing the outer diameter of the new wheel and the root diameter of the teeth could be drawn so that their intersection with the existing worm

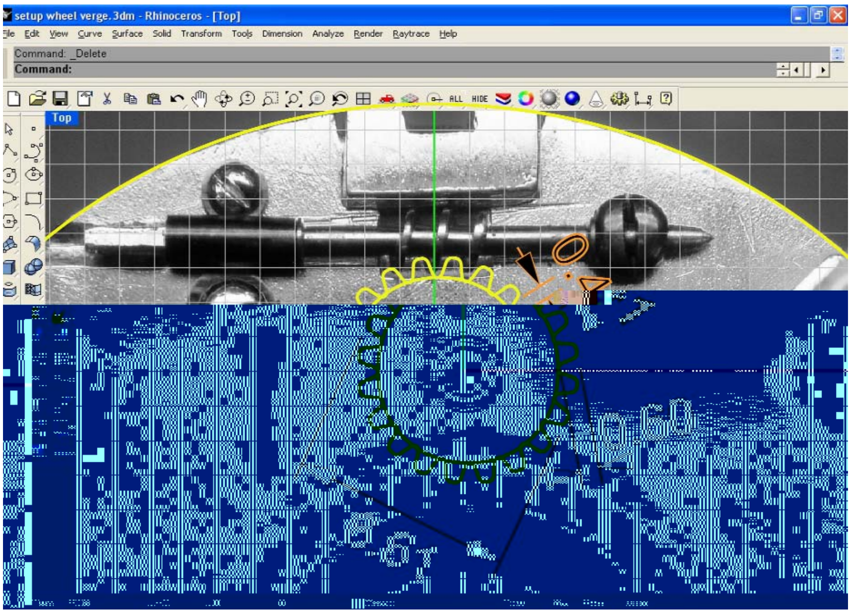

Fig 8. Design of new wheel shown in yellow.

'looks right' (yellow lines). By drawing lines from the centre of these circles to the tips of the worm teeth and measuring the angles between them, the number of teeth could be deduced - in this case 20, and a suitable tooth profile could be worked out and arrayed around the circle to give a picture of the finished wheel. Lines drawn along the axis of the worm and aligned with its teeth allowed measurement of the helix angle and, consequently, the angle of the wheel teeth.

Cutting of the wheel is relatively straightforward and so I shall not describe it here but I am happy to report that the watch is now once again fully functional and keeping time to within a few seconds a day.

Fig 9. The new set-up wheel fitted to the barrel arbor.