General Project 34—Cutting a Tiny Watch Escape Wheel/Jerry Kieffer

Extremely tiny watch parts can be made on Sherline tools, but sometimes special techniques are required. Magnification of the tool and work using a mill-mounted microscope (P/N 2127) is almost a requirement when working on parts this small and intricate. Jerry Kieffer is an expert at making very small parts, and he explains here how he went about it.

A replacement watch escape wheel with center pinion is seen resting between pennies for size scale. A specially ground stone is used for one of the final operations. See following pages for the sequence of producing these shapes.

“Over the years and again recently I have occasionally been asked how I cut watch escape wheels. Rather than give a long explanation each time, I thought I would explain a recent example here to refer to in the future. Hopefully it will also be of some interest to others.

I was recently asked to repair a Swiss "Huguenin" 18L pocket watch. To make a long story short, it had two busted escape teeth due to a poor repair procedure in the past. Surprisingly, there was no other damage. Even though it was a higher grade movement, it would not normally warrant this type repair effort. However, in this case it had a military inscription to a known individual and required repair with cost being of little concern.

When planning a job such as this, I take great effort to place myself at an advantage regarding cutting tool visibility, accuracy and efficiency.

The first concern when cutting a wheel such as this is the arbor and wheel blank. Because of the size (.270" or 6.85mm dia.), I do not use an arbor or wheel blank. Instead, I machine the wheel on the end of solid stock that also allows me to part off extra wheels. I find I can machine small wheels more accurately with this setup because it is far more rigid. In this example the teeth were machined .100" long allowing three wheels to be parted off in the lathe when machining was completed.

For Horological wheel and pinion cutting, I no longer use anything other than an appropriate size milling machine. Their simple setup, accuracy and efficiency are unequaled for this type work.

For indexing, a rotary table was selected over direct indexing because of its many advantages. The rotary table allows for highly controlled and accurate positioning of a wheel tooth in relation to a cutter. Once in position, indexing can begin at that point. In addition, slight corrections in position can be made at any time and indexing can resume at that exact position. For this setup the rotary table was center positioned at the rear of the mill bed facing forward. This allows the wheel blank face to also face forward directly behind the cutter. This in turn allows for maximum cutter visibility by eye or microscope. The general arrangement can be seen in the first attached Photo. (Sorry about the photo quality but will give the general idea.)

For monitoring the cutting process, a spindle head-mounted microscope is used. By mounting on the spindle head, the scope remains in sharp focus while tracking the cutter tip. If not head-mounted it is very difficult to keep the scope in sharp focus with a moving cutting tool, especially at higher powers where focus is far more sensitive. In addition, the scope can be rotated to the side for easy tool access while remaining in focus.

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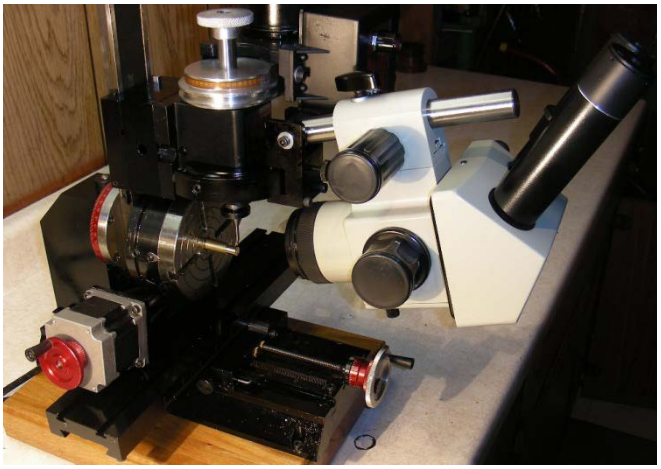

Photo 1

When setup as in the first photo, the first cut on the face of the blank is made with the side of an End mill. By rotating the blank against the side of the rotating end mill, a small centered stub is machined on the end of the blank. This stub is sized to fit the center hole of the original escape wheel. The wheel is then placed over the stub. This allows the cutters to be very accurately positioned using the old wheel as reference under microscope observation. No measurements are required when using this procedure. Cutter position accuracy is really amazing at 30x and higher. Cutter tip axis control and R/T rotation control make alignment simple, easy and highly accurate.

Photo 2

The position of the cutter for the first cut can be seen in the second photo. The wheel shown is one of the extra wheels that was parted off. It is shown on the outer edge of a US quarter for size comparison. The cutter is, of course, not in the exact location for a cut but shows the general location for the cut. This cut removes more metal than the others so it is made first. This simple cutter was machined as a single point cutter and hardened for use. It was the only special cutter required for cutting this wheel. Cutter speed was about 500 RPM. The rest of the cuts were done with a standard .022" solid carbide end mill. Carbide was selected so that cutting fluid would not be required, allowing chips to be cleared with a constant flow of air. This allowed clear vision of the cutting process at all times. Cutter speed was about 2500 RPM.

Photo 3

The third photo shows the end mill location for the second cut. It was done while maximum strength was still left in that area.

Photo 4

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The fourth photo shows the third cut positioning. Once completed, an additional smaller cut was made to remove the remaining metal in that area.

The rotary Table was rotated slightly before this cut was made to get a slight radius to match the original wheel.

Photo 5

The fifth photo shows the position of the final cut using the side of the End mill.

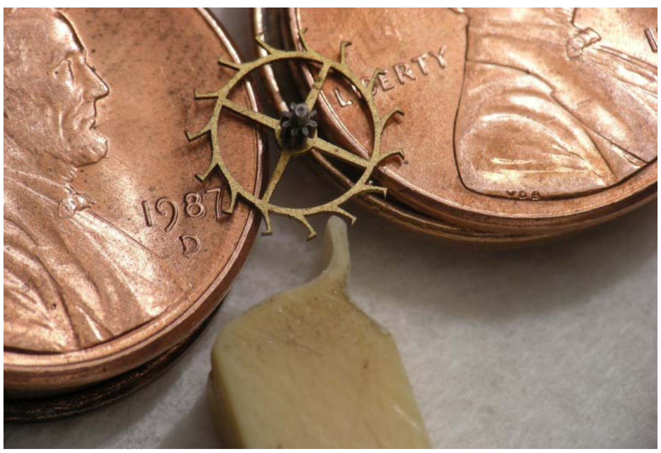

Photo 6

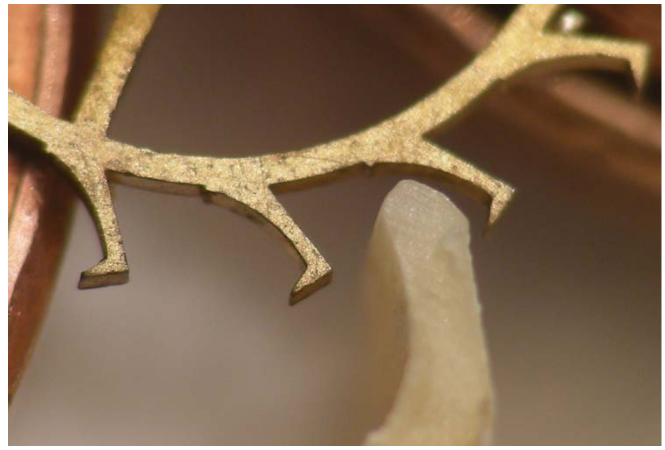

Photo 7

When the wheel was parted, a single light swipe with a very fine miniature stone blended the cut overlap and completed the contour.

At this point the rotary table is placed flat on the mill bed with the face of the cut wheel pointing straight up. This allows the crossing of the wheel to be done with a small end mill while rotating the R/T and moving the slides as require under microscope observation. Sharp corners are touched up with a small needle file if required.

Once parted, the wheels are then placed in a machined exact fit WW pot collet where the center hole is drilled/bored. Boring the collet and then the center hole assures centered arbor mounting. The sample shown, of course, was not used and was never center bored.

From start to finish this job took about three to four hours as I recall. That does not include phone calls, walking the dog etc. In this case the wheel functioned perfectly without any modification other than final polishing."

—*Jerry Kieffer*

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