OFFICIAL JOURNAL OF THE BRITISH HOROLOGICAL INSTITUTE

The Horological Journal

FEBRUARY 2020
www.bhi.co.uk

Service and Repair of a Minute-Repeating Chronograph

Mending a Complicated Watch

Robert Horan MBHI

A minute-repeating pocket watch with chronograph arrived for servicing and repair. The owner stated that although the repeat didn't work, the time and chronograph did. I was looking forward to this because although I have experience with these complications, I have never worked on a watch that combines them all, **Figures 1 and 2**. Typical for minute repeaters, I could not find any maker's marks, calibre numbers, or any other identification that would provide clues as to who had manufactured the movement. I did notice something interesting, though: all the previous minute repeaters I have serviced had the repeat work located above and to the left of the stem. On this one it was the opposite, with the repeat work located below and to the right of the stem.

Before disassembly, I have to unwind all springs to prevent uncontrolled release and possible damage to the movement. But first, knowing that the balance assembly is the most delicate part of a movement and is easily damaged, I remove it. I was not expecting to see a helical balance spring, as would be found in a marine chronometer. In all the years I have been servicing watches, I don't believe I have seen one with a helical balance spring. No doubt, and I am sure that you will agree, this balance assembly is a beautiful piece of craftsmanship, **Figure 3**.

As for the age of this watch, its movement number (13168) is very close to that of a similar watch, serial number 13123, from the Djanogly collection. This was listed by Sotheby's in 2017 (citing an earlier publication by Camerer Cuss) as being from circa 1877 and comparing the two, I suggest that this is a reasonable dating.[1]

After admiring and not finding any defects with the balance assembly, I stored it in a safe place. I let down the going mainspring, which is straightforward and no different from most watches.

The repeater is a stand-alone complication (its only connection to the going train is via the cannon pin) and it has its own mainspring, which will also need to be let down. This spring drives the repeating train, thus activating the hammers which ring out the time. There are two hammers, one each for the high and low-tone gongs. The train regulates the speed of repeat. Releasing this spring requires a different procedure from the one used on the going mainspring. The repeat spring is set-up (or 'pre-loaded'), meaning that even when at rest, i.e. not running, the amount of stored energy is quite high. The 'at rest' position of the spring is only one turn down from fully wound. The repeat work has no stem, so I let the spring down

Figure 1.

Figure 2.

Figure 3.

using a pin vice, being sure not to leave any marks on the polished square.* The pin vice is secured to the square of the repeat mainspring arbor, **Figure 4**, but as you can see in the photo, there isn't enough of the arbor sticking out to attach the pin vice safely, so disassembly of the repeater is needed to gain access. If you are not familiar with minute repeaters, this is a good time for a short review of the relationship between the repeater barrel, spring, and arbor.

The repeater barrel and mainspring are located on the top side of the movement, **Figure 5**. The barrel arbor extends downward through the pillar plate toward the dial side. The arbor is squared where it emerges through the plate. Installed on this square is the repeat rack pinion (it meshes with the teeth of the winding rack), the hour rack, and the gathering pallet. These parts are secured with a taper pin, inserted through a cross-hole at the end of the arbor. The rack pinion has two functions: first, it allows the winding rack to wind our repeater mainspring and second, it acts as a stop for the at-rest and fully-wound positions of the winding rack. I now find out why the repeater didn't work. Parts were assembled incorrectly and, more concerning, the taper pin was missing from the arbor. If you don't install a pin, it could result in the rack pinion moving upward and disengaging from the winding rack, resulting in serious damage to the train. I suspect that someone attempted to service the movement and quickly realised that they were in over their head. I disassemble the repeater to gain access to the arbor, and only when the rack pinion and winding rack remain do I secure my pin vice to the arbor square, rotating it slightly to release the spring tension. With the pin vice holding the tension, the winding rack is removed. Next, I carefully loosen my grip – the pin vice rotates – and the repeat mainspring is safely let down.

* A watch key or a universal key ('bench key') might also be used to advantage. —Tech. Ed.

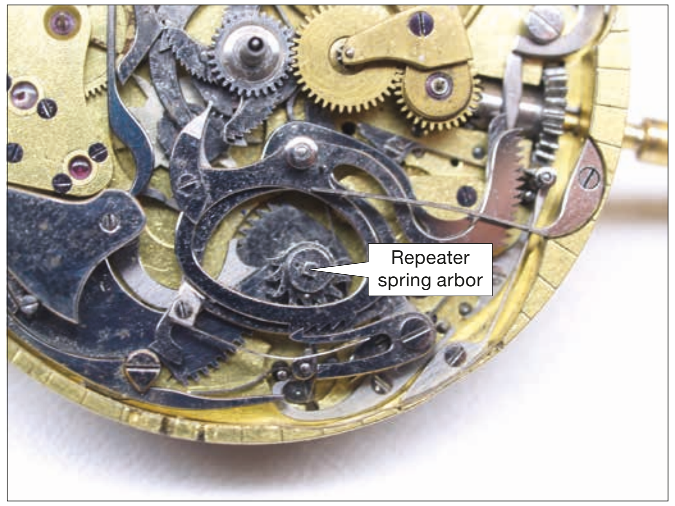

Figure 4.

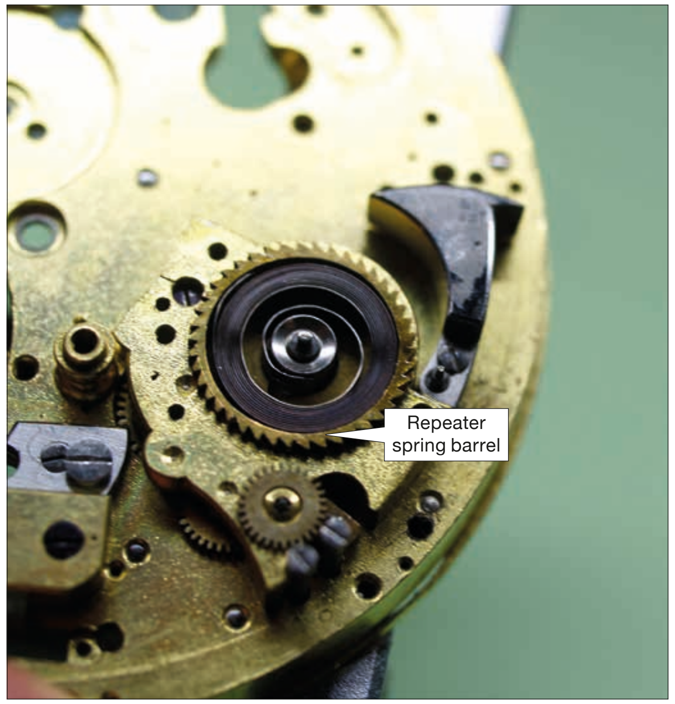

Figure 5.

Now I can remove the rack pinion with my hand lifting levers. Unfortunately, I encounter two problems. First, the pinion is only a fraction of a millimetre clear above the pillar plate; the gap is narrower than my lifting levers. To be able to fit my levers under the rack pinion, I thin the tips with a stone. This works, and with the levers seated in position, I apply equal downward pressure to the end of each lever, which should lift off the rack pinion. Now I have a second problem: the pinion is extremely tight and won't budge. It feels as if it was hammered in place. All I can do is increase the downward pressure on the levers, hoping that the rack pinion comes off without damaging anything. Eventually the pinion comes free, but not without providing a few tense moments along the way. The pinion should have a firm, snug fit to the arbor square with no play and it should also be easy to remove. This one is too tight and needs repair, so I carefully reduce the size of the arbor square with a fine Arkansas slip, frequently

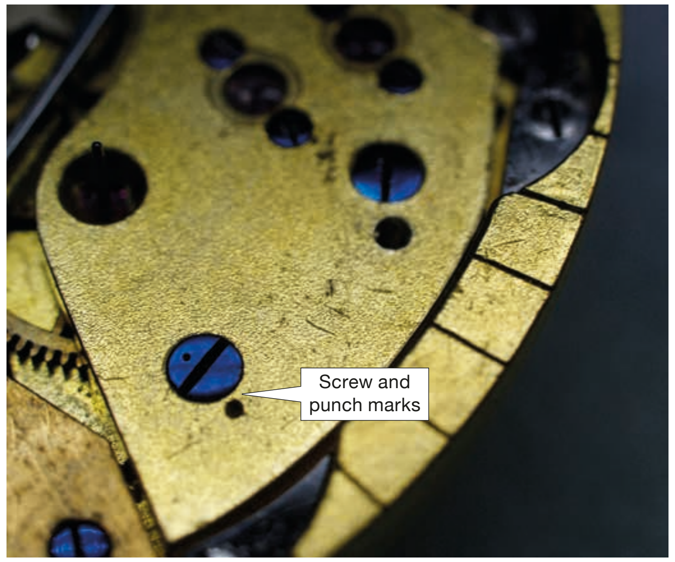

Figure 6.

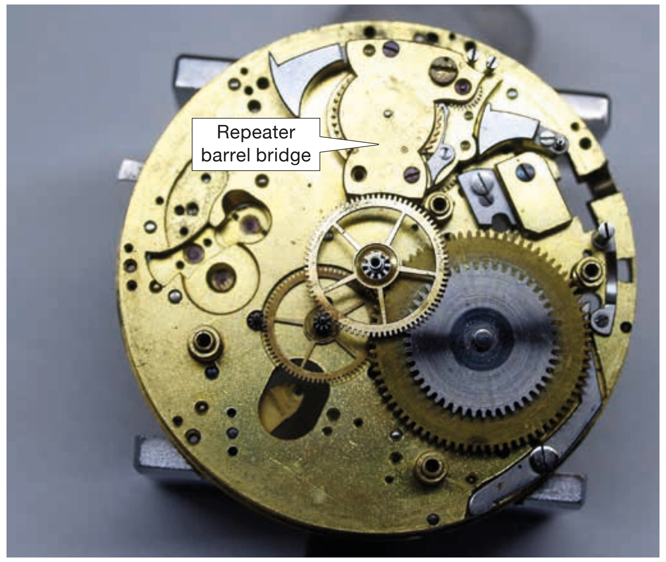

Figure 8.

Figure 7.

checking the fit with the rack pinion. Eventually enough material is removed. With the pinion installed there is no play, and only a firm push is required to install or remove it. The dimensions of the arbor square are critical. The tolerance between an overly tight fit or a loose one is very small, which is why I use a fine stone and check my progress along the way. Next, I disassemble the repeating train and identify why it doesn't work: the final pinion in the train has a broken pivot. With the repeat work dismantled, I turn the movement over and carry on with taking apart the chronograph and going train. I can't help but admire the chronograph components; they are all elegantly shaped and finished to a very high standard. The wheel rims and crossings impress me as well. They are very thin, and the seconds drive wheel has the smallest teeth I have ever seen. More on this later.

My standard dismantling practice is that if a component has a screw, the screw and component remain together. This practice applies to any movement, but on a minute repeater it is critical. Many of the screws are not interchangeable, and with the high number of parts and screws, it's easy to mix them up. Sometimes the manufacturer provides a screw location guide. For example, the bridge shown in **Figure 6** is secured with two screws. The head of one has a punch mark corresponding to a mark on the bridge which serve to identify the location of that screw.

This is a good time for a short refresher on the workings of a repeater. The repeat strike and chime should sound out at a constant rate. As mentioned already, this rate is controlled by the last pinion of the repeating train acting as a speed controller (or 'fly'). In this watch, the speed controller is of the type with a weighted brass collet fitted to a pinion, **Figure 7**. One pivot sits in a fixed jewel in the pillar plate and the other pivot sits in an eccentric bearing that has a screw slot for adjustment. This is used to control the depth of engagement of the pinion and the wheel driving it. The eccentric is friction fit into the repeater barrel bridge. The pivot hole is offset,

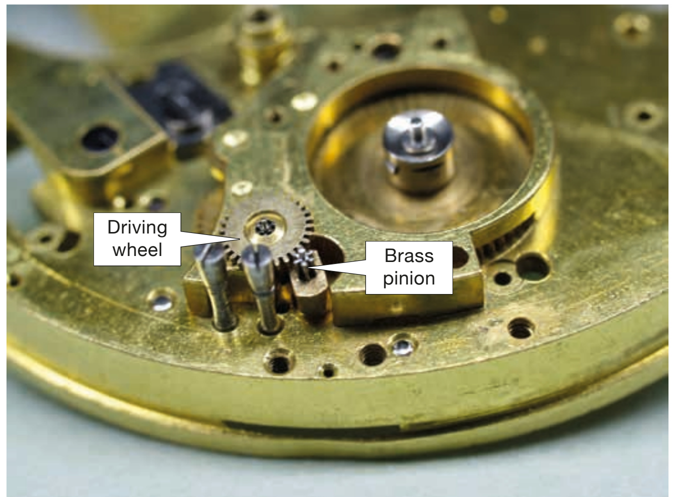

Figure 9.

relative to the centre rotation point of the eccentric. The offset allows you – with a screwdriver – to rotate the eccentric. This alters the train friction and the speed of unwinding, and with it the rate of chiming. At least in theory that is how it works. In practice, it leaves something to be desired, **Figures 8 and 9**.

There are several problems with this eccentric. It has too much static friction because it is too tight in its hole. I see this quite often, especially on chronograph movements that have many eccentrics. Often it is easy to identify the eccentrics that are too tight; the screw head is damaged or sheared off. An eccentric should have enough friction to maintain its adjustment, but it should not require excessive force to rotate it with a screwdriver, **Figure 10**. Another problem with excessive turning force is a lack of feedback relative to the position of the wheel and pinion gear teeth engagement. On a properly-fitted eccentric, if you reach the point at which the pinion and wheel teeth are fully engaged, you should feel resistance and recognise that you have reached the limit and that if you continue turning in the same direction, you risk damaging the pinion or the wheel, or breaking a pivot. It would be useful if the repeater barrel bridge had markings showing the limits of adjustment, or even which direction of rotation increases or decreases the chiming speed. Finally, I

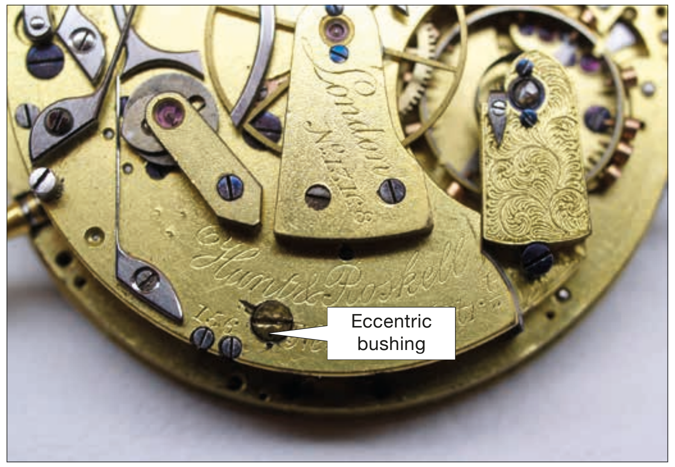

Figure 10.

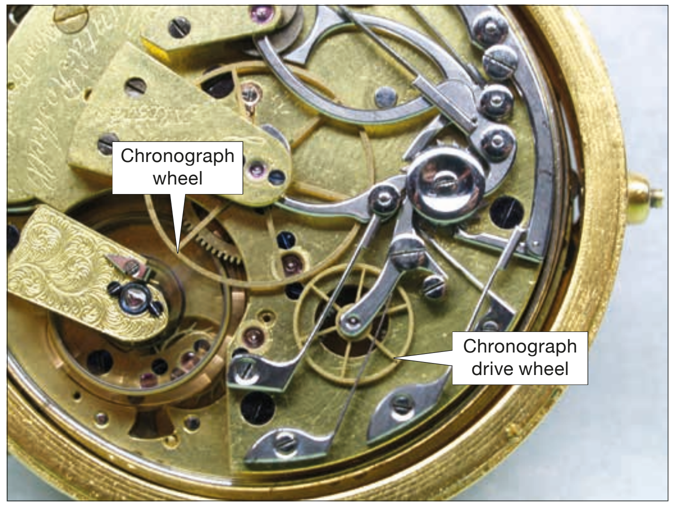

Figure 11.

believe that the eccentric pivot hole is too far from the centre of rotation; this results in excessive lateral movement of the brass pinion. A full 360 degrees of rotation of the eccentric should be possible without any risk of causing damage. At the closest position, the pinion leaves and wheel teeth should be fully engaged but with slight play and, at the furthest-out position, the tips of the wheel teeth should remain engaged to prevent uncontrolled runaway of the repeating train. Having identified all of these problems, let's get to work on fixing them.

Repair of the broken pivot of the weighted pinion is straightforward; similar processes have been described many times in the *HJ*. With a new pivot installed, I turned my attention to the eccentric. I removed the eccentric from the barrel bridge and carefully reduced its diameter until it was a snug fit in its hole. Next, the repeating train was re-assembled. The existing repeater mainspring is blued steel which will eventually fail, so as a preventative measure I replaced it with a modern unbreakable alloy spring. With the eccentric in the middle position and the pinion and wheel teeth engaged along what I considered their common pitch circle, I activated the repeat. It was *extremely* slow, so I adjusted the eccentric to move the pinion outwards – reducing engagement and therefore friction – and increasing the speed. Unfortunately, there was no change. It remained slow, even with only the tips of the wheel and pinion teeth mating. What next? Your first thought may be to install a stronger spring. Doing this could speed up the train, but the stronger force could also cause excessive and accelerated wear of the train pivots; not an acceptable solution. Since the mainspring was set up by hand using the pin vice, I had a good feel for how much force it exerted, and it was significant. As with any problem that doesn't have an immediate solution, I put the watch to one side to consider my options.

As luck would have it, my Canadian friend and mentor, John Bouwman MBHI, called me on Skype the following day. When the conversation turned to 'so, what do you have on the bench today?', I briefed him on the repeater and asked if he had any suggestions on how to increase the speed of the train when the repeat is running. After discussing a few options, John suggested lightening the weighted pinion, the idea being that weight reduction would reduce the inertia and, one hopes,

Figure 12.

result in the repeating train speeding up. This sounded like a good idea, so I gave it a try. The brass collet was turned down using the lathe, reducing the diameter in stages and installing and checking the progress. Sure enough, as the brass collet got smaller and became lighter, the speed increased. With about 50% of the brass machined away, the strike and chime sounded out at a pleasing rate. With that taken care of, next up was assembly of the rest of the movement.

There were no more faults and the only odd issue was the escapement. On this movement, the escape wheel and pallet share a bridge. There is nothing technically wrong with them sharing a bridge, other than the fact that this bridge made it impossible to see and inspect the relationship between the pallet and escape wheel. Many movements have inspection holes in the pillar plate directly under each pallet to allow viewing from the dial side, but on this movement there weren't any.

Assembly of the chronograph was straightforward. It is a single-pusher type with three modes: Starting, Stopping and Return to Zero (or 'fly-back'). This particular one has unique features that I want to explore in more detail. Most chronographs follow a standard layout: the fourth wheel of

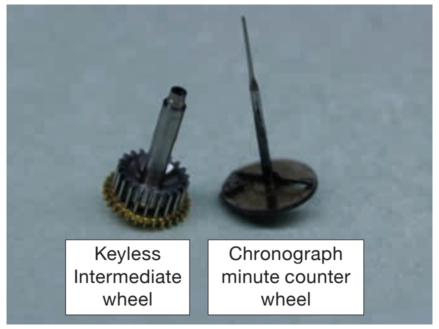

Figure 13.

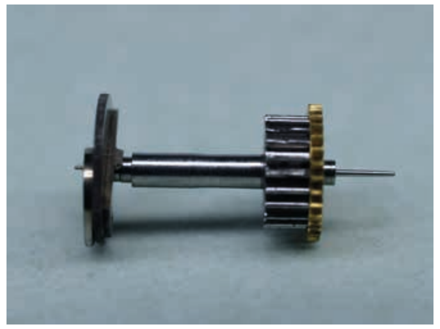
Figure 14.

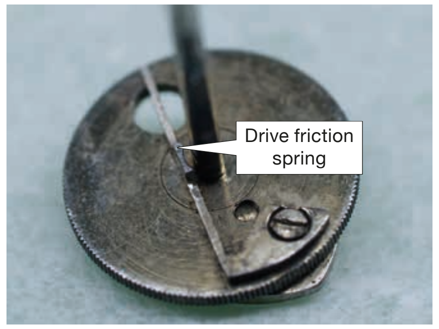

Figure 15.

the train has an extended pivot on to which a drive wheel is fitted. The motion from this drive wheel is carried to the chronograph wheel by an idler, which in turn puts in motion the minute counter. The chronograph wheel (or centre-seconds 'runner') typically has a single drive finger attached to it. This finger instantaneously advances the minute-counter each minute.

Figure 11 shows that the seconds design on our movement is similar to a modern one. An unusual feature is the small size of the teeth of the drive wheel, **Figure 12**. The minute recorder (or minute counter) is of the continuous (non-jumping) type. Another unusual feature is that the minute counter wheel is driven by the motion work's intermediate wheel, under the dial, next to the keyless work. In **Figure 13**, this is shown on the left, with its extended hollow arbor. The arbor passes through the pillar plate from the dial side and terminates at the three-quarter plate, where it protrudes slightly. The intermediate wheel teeth are in constant mesh with the motion work's minute-wheel teeth, always rotating when the movement is running. On the right in **Figure 13** is the chronograph minute-recording wheel. Note the long arbor that fits inside the hollow intermediate wheel arbor, **Figure 14**.

Let's explore how the intermediate wheel drives the minute recorder. A friction spring is attached to the underside of the minute-recording wheel, **Figure 15**. With the minute-recording wheel in place, the spring rests against the outer surface of the hollow intermediate wheel arbor. It's important to check the spring pressure against the hollow arbor: it must be firm enough to prevent the minute-recording hand from slipping when the chronograph is running, and it has to be weak enough to have a minimal effect on the timekeeping with the chronograph stopped. When the chronograph is running, the minute-recording friction spring and intermediate wheel hollow arbor effectively become one – they rotate together. When the chronograph is not running, the hollow arbor continues to turn but the minute recorder and its friction spring remain stationary. To meet both conditions (no hand slippage, and minimal effect on timekeeping) I verify that the spring and hollow arbor are clean, apply a small amount of HP-1300, and assemble the chronograph, **Figure 16**. I temporarily install the minute hand on the minute-recorder arbor, and with the chronograph running, I carefully try to move the hand. The tension of the spring feels strong enough to prevent the hand from slipping. Next, I place the movement on my eTimer, and observe the amplitude and rate with the chronograph both running and stopped. There is no noticeable change in amplitude, which confirms that the friction spring is adjusted correctly.

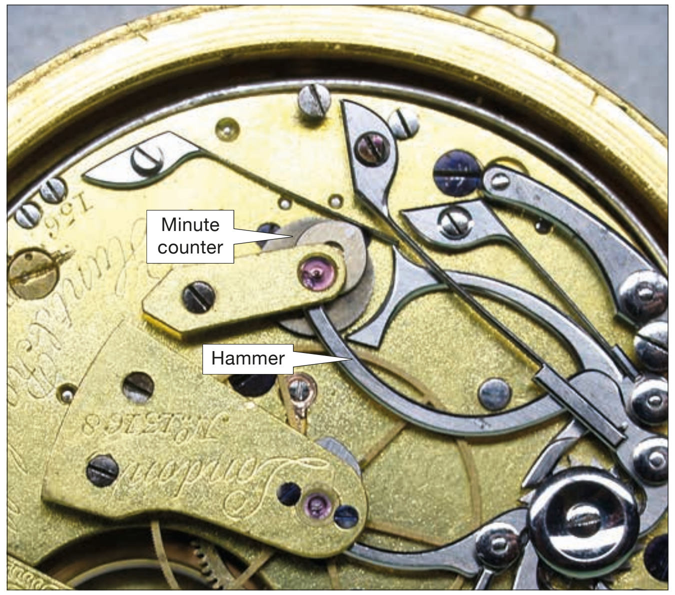

Figure 16.

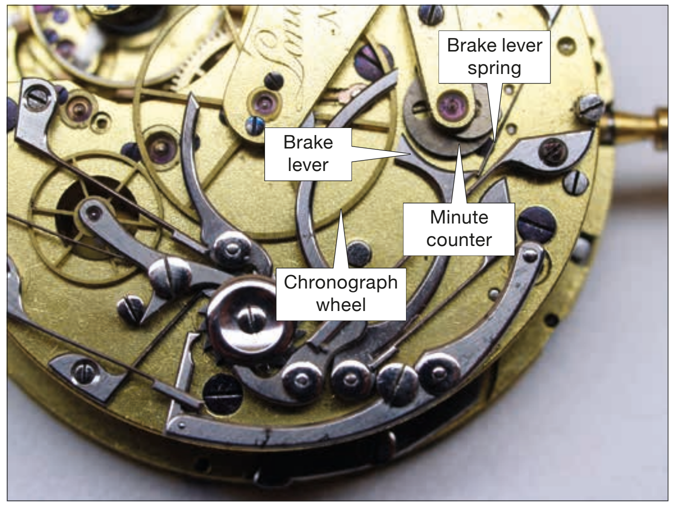

Figure 17.

Because this is a single-pusher chronograph (what the Swiss call a 'triple-action chronograph', in which all three functions are operated by only one pusher), the workings may not be familiar to all readers. Here is a short description of what happens when the chronograph is stopped. In **Figure 17**, please note that the device is shown in the 'Start' or running position. Unfortunately, I have no photos of the device in the braked position, and so the situation has to be visualised from this image. In the stopped position, the return-to-zero hammers are disengaged from the minute-recording and centre-seconds chronograph heart cams. The drive wheel is disengaged from the chronograph wheel. The chronograph wheel is held by its brake lever. The minute-recorder has no brake lever of its own; instead, this wheel is braked by contact with the spring of the chronograph seconds brake lever. The minute-recorder wheel has what appear to be fine teeth. These are not for any driving engagement; rather, they appear to have been made to increase friction against the brake spring. **Figure 18** shows the dial side.

A final comment. In the *HJ* of June 2017, I wrote an article on servicing a minute-repeating watch ('Vacheron Constantin Minute Repeater') and suggested good reference books to have on hand. While conducting research for this repair, I discovered a new (at least to me) book entitled *A Guide to Complicated Watches* by Francois Lecoultre. I bought my copy directly from the publisher, Antoine Simonin in Neuchatel, Switzerland, and I am very pleased with it. It is in hardcover, which I prefer, and is an excellent reference on various complications, including minute repeaters.**

** The cited book is a facsimile of the 1952 original. Mr Simonin recently informed me that a fully revised and modernised version is about to be published, so it might be worth the short wait before buying. Or just buy both! —Tech. Ed.

ENDNOTE

1. Terence Camerer Cuss, *The English Watch 1585–1970* (Antique Collectors Club, 2009) p412.


Figure 18.