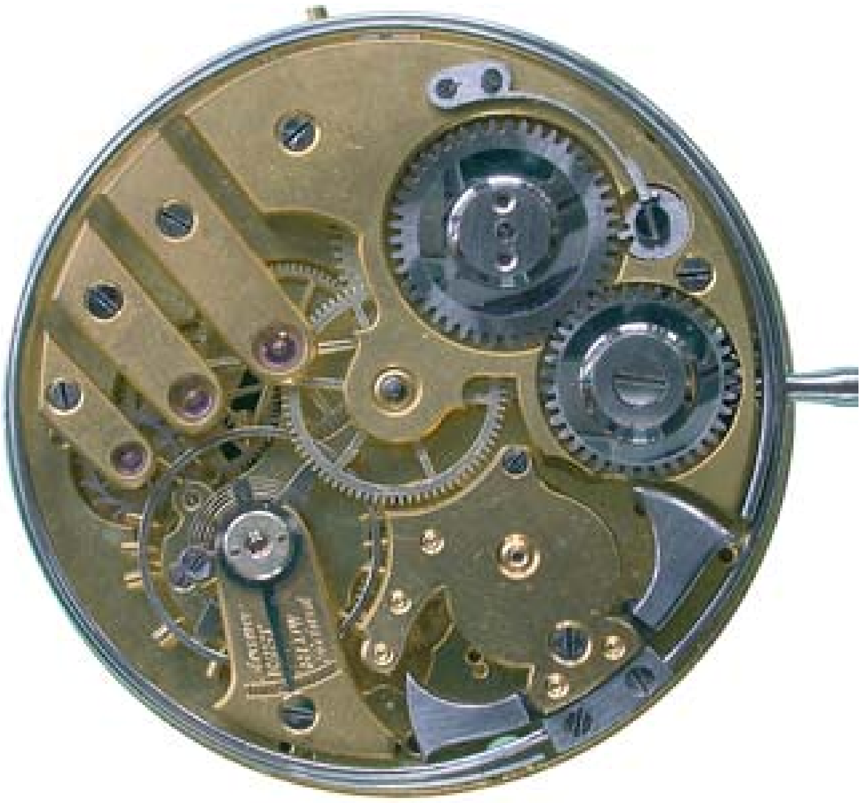
Servicing a Quarter Repeater

Richard French describes the mechanism and servicing of a modern quarter repeating pocket watch and its adjustment

1. Open faced quarter repeater with a single sunk dial in a gun metal case.



2. Gilt continental bar movement with pale lilac coloured jewels.

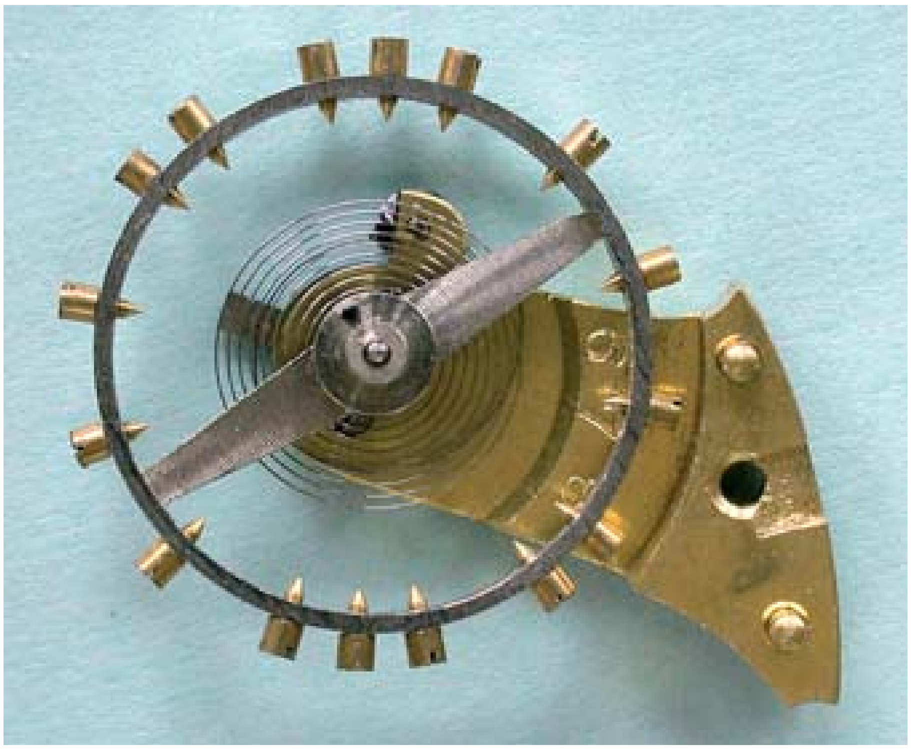
I BOUGHT the quarter repeater described here from a small antique shop in Auckland, New Zealand. I went in to look at a pocket watch with Auckland on the dial, which turned out to be a very poor English full plate. The shopkeeper offered me the repeater for a reasonable price, claiming a master watchmaker had just cleaned it! In fact it was dirty and only just ran, but it was in good condition with a nice dial so I bought it. Repeaters are fairly rare and expensive, so the opportunity to buy one at a moderate price was welcomed.

The Quarter Repeater

The repeater I bought is an open-faced pocket watch in a brown gunmetal case, with a gold bow, push piece and hinges, **1**. The gunmetal has some rust spots and needs to be polished and blued. The white porcelain dial is free of cracks and chips. It has Roman numerals with single sunk small seconds and is held on the movement by a brass rim fitting tightly over the pillar plate. The dial was originally made with dial feet, which were neatly removed when it was fitted to the movement, as the dial feet would have interfered with the repeat work located under the dial. The delicate spade hands are blued steel and were somewhat rusty, but steel hands are straightforward to repolish and blue. The gilded brass movement, **2** and **3**, is a Swiss bar type with individual cocks for the escape, fourth and third wheels. The centre wheel is under the barrel bridge. The case is marked 'BB' with three dots like a

R. French

3. Breguet overcoil balance spring with index regulator.



4. Uncut balance with alloy spring and triangular polished steel impulse pin.

'therefore' sign and the serial number 81678, which is also marked on the pillar plate, **6**.

The movement has 13 jewels, including three large pale lilac coloured ones for the escape, fourth and third arbors, **5**. The less visible jewels in the lever cock and the bottom plate are small, and the bottom third and the centre holes are plain. The impulse pin is triangular shaped and surprisingly, of polished steel not ruby, but may not be original. The top centre hole is worn but even so, the movement has a good action of 270° after cleaning and oiling. The escapement has a modern Swiss lever and escape wheel, **5**. The keyless work is well polished, with a good click spring screwed to the top plate, **2**, rather than the usual wire spring. The balance has screws in the rim but is uncut, which at first sight looks poor. However, the balance spring is alloy, which requires an uncut balance for temperature compensation, and has the Breguet overcoil found in better movements. The ratchet wheel is fastened in place by a boss with two holes, which needs the special tool, **12**, to turn it.

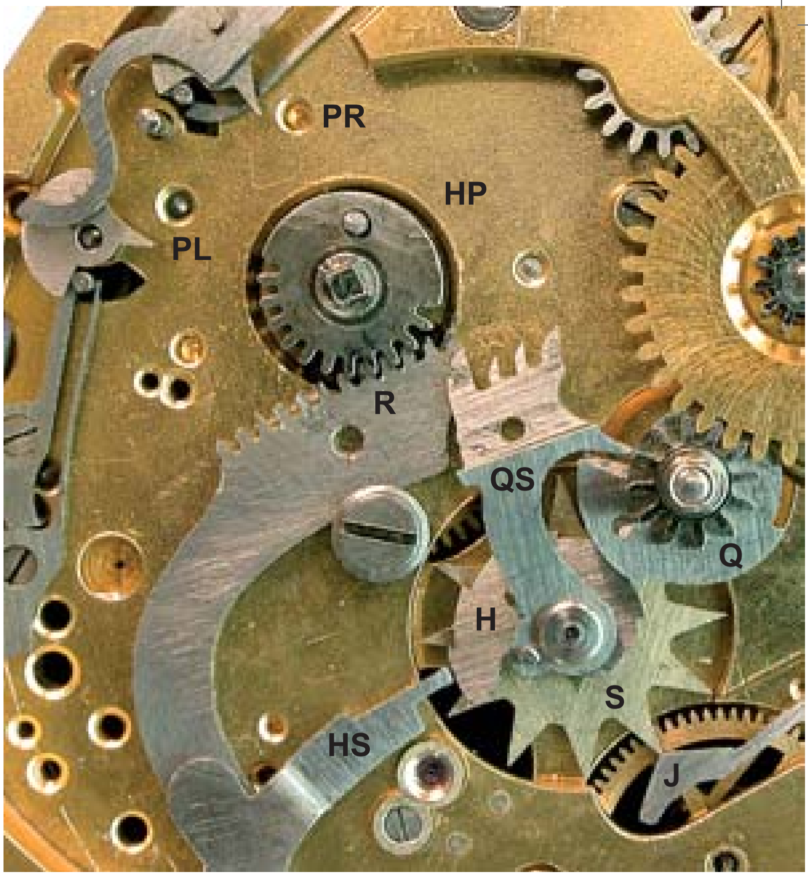
After asking 'what is it and who made it?' the next questions tend to be 'when was it made and is it any good?' When, is difficult to answer since the case does not have a hallmark, or a recognised maker's mark and there is no name on the movement. One can only go on the construction and the style. The earlier features are the rubbed-in jewels and lack of shockproof balance jewels; later ones are the alloy balance spring and uncut balance, modern escapement and keyless work. My guess is about 1920, but it is only a guess. As for how good it is, the Breguet overcoil balance spring, the jewelling and the general crispness and finish of the parts indicates good quality, but the absence of jewels in the repeat train or for the hammer pivots and the lack of a name is not so good.

The watch needed cleaning, particularly as the pinions and wheels in the going train had been coated with black grease! The balance spring was badly adjusted, with the overcoil failing to pass naturally between the curb pins. The spring was taken off the staff and mounted in the balance cock so it could be adjusted to lie between the curb pins with the collet lying directly over the jewel hole, with the spring level.[1] This is difficult with an overcoil, as the spring has to be taken off the cock to adjust the overcoil, which otherwise is inaccessible under the spring. Working through the spring is not recommended, particularly with a soft alloy balance spring. Several attempts were needed to get it right as it is better to

1. H B Fried. Bench practices for watch and clockmakers. Columbia Communications Inc. 370 Lexington Avenue, New York, NY 10017.

5. Modern in line lever and escape wheel. Also the repeat barrel, governor train, hammers and gongs. The balance has been removed.

6. Repeat push piece and winding mechanism under the dial.



7. The hour and quarter snails and stops, just before the hour, the surprise piece not showing.

progress in small steps rather then bending too far and then back again. Alloy balance springs can become unstable if bent too often.

Working on Repeaters

Repeating watches are generally considered to be difficult; probably because they are unfamiliar and have a lot of parts. The whole watch has a total of 114 parts, of which the repeat work accounts for almost half. However, none of them is as delicate as the balance and spring. Assembly and adjustment is more complicated, but does not require the delicate touch needed to set a balance spring flat and centred over the jewel hole. What does require care is dealing with the repeater's complexity. You need to keep each part with its associated screw separate during dismantling and cleaning, and to make an accurate record of how the repeat work is assembled. If the watch were simply pulled to pieces without a record and the parts mixed, it would take a long while to get it back together again. However with the right approach, the repeat work is straightforward and there should be no real problem.

There are two essentials in this respect. One is plenty of divided storage with a compartment for each part and its screw, preferably a heavy plastic box with a close fitting lid, rather than the light round trays which spill or muddle their contents when knocked. The other is an accurate record of the mechanism made stage by stage as the watch is dismantled. This can be several pencil sketches, annotated with notes recording for example, which screw is the long one, or which way up a pinion goes. Alternatively a digital camera can be used to take a series of photographs stage by stage, which are read into a personal computer. The watch should be set to a convenient time, like 12.05, before dismantling and making the sketches as an aid to reassembly. The pencil sketch is better for adding notes and indicating what lies underneath a part, the camera is more accurate and may record aspects not noticed when sketched, but may not show up some detail. I use a combination of both.

The Repeat Mechanism

The repeat work can be operated at any time by pressing the push piece, **1**, and releasing it to sound the previous hour and quarters on wire gongs. First the lower pitched gong is struck once for each hour followed after a short pause by one, two or three twin strikes to indicate the quarters. Each twin strike is a blow on the higher pitched gong, followed by a blow on the lower pitched one, known as ting tang striking. So between 12.45 and 1.00 o'clock there are 12 'tangs', followed by three 'ting tangs'. The young airline stewardess on the Cathay Pacific plane coming home heard it as she went past my seat and asked what it was. She was enchanted by it, never having seen a mechanical watch, let alone a repeating pocket watch. During the flight several of her colleagues came along to see it as well.

The repeat mechanism can be looked at in four parts: winding the repeat mainspring, sensing the number of hours and quarters, striking the gongs, and governing the rate of striking.

Winding the Repeat Mainspring

The repeat mainspring is wound by pressing the push piece, **6 P**, which rotates the long lever **L1** about its shoulder screw **S1**. The rack on the end of **L1** engages a matching rack on the lever **L2**, causing it to rotate on its shoulder screw **S2**. The rack **R** on the far end of **L2** engages the half pinion gear **HP** mounted on the squared arbor of the repeat mainspring, housed in its barrel on the other side of the plate. The much larger mainspring barrel, which drives the watch itself, is seen at **B**.

Sensing the Hour and Quarters

There are two snails, **7**: an hour snail **H** with 12 segments and a quarter snail **Q**, with four. The hour snail is fixed to the star wheel **S**, the two being free to turn together on a stud. The star wheel is positioned by the jumper **J**, which causes it to jump forward in whole hours, taking the hour snail with it. The quarter snail is fixed under the cannon pinion and carries a pin which advances the star wheel at the hour. Under the action of the jumper spring, the star wheel jumps forward instantly at the hour and presents the appropriate section of the hour snail to the finger shaped hour stop **HS**, should the repeat be operated. The number of quarters to be repeated is

8.The snails just after the hour, when the surprise piece has shot out, arrow.

sensed by the quarter stop **QS**.

The time represented in **7** is just before 2 o'clock and the jumper is at the peak of a star wheel tooth, about to jump it on anti clockwise. The repeat push piece has been pushed in until the winding was stopped by the hour stop hitting the first segment of the hour snail, (the lever **L2** was wedged in this position to take the photograph). The quarter stop **QS** is pressing on the fourth quarter of the quarter snail under the action of its spring, (not present in **7** but shown in **10**. The rack R, on the end of L2 has wound the half pinion anti clockwise by only some three teeth rather than the full twelve that would be needed at twelve o'clock. Although there are 12 teeth on the rack and half pinion, this could just as well be 11 or 13; the choice is not connected with there being twelve hours. In fact the rotation of the half pinion has to allow for 12 hours to strike and the quarters that follow. The winding and the sensing are not actually separate functions, as the winding is stopped by the hour stop **HS** banking on the hour snail.

There is a hazard in having two snails, which arises at the hour. If the star wheel has jumped forward and presented the next segment of the hour snail for the new hour, it is essential that the quarters snail indicates the first quarter. If not, the new hour will be sounded, but followed by three quarters rather than none. The time sounded on the gongs will be 45 minutes later than it really is. Alternatively if the quarter snail is ahead of the hour snail the old hour will be sounded without any quarters and the time sounded will be 45 minutes slow. This problem is overcome by the surprise piece which is thrown out by the movement of the star wheel at the instant it jumps forward, which ensures that no quarters are sounded the moment the new hour is indicated by the hour snail. The surprise piece, **SP** is hidden just before the hour in **7** and extended just after the hour in **8**, where it ensures the quarter stop senses the full radius of the snail corresponding to no quarters. The surprise piece, which lies under the quarter snail is shown in **9**. It can also be seen that before the hour **7**, the fourth segment of the quarter snail is wider to ensure that three quarters are sounded right up to the point at which the star wheel jumps forward at the hour and the surprise piece flies out.

Striking the Hour

The circular rack, **10 CR**, has ratchet teeth around its edge which engage with two pawls, **PR** and **PL**, which are attached to the hammers that strike the wire gongs. The circular rack is mounted on the squared mainspring arbor above the half pinion and retained by a taper pin. During winding the circular rack is rotated anti clockwise to the correct position to strike the number of hours.

When the push piece is released the rack rotates clockwise and the teeth engage the right hand pawl **PR** which operates the low pitched gong for the hours. The left hand pawl is less deep and is not engaged by these rack teeth. The time in, **10**, is 12.55, with the result that the circular rack is fully anti clockwise and the 12th tooth is ready to catch on the pawl **PR**. The strike proceeds until the rack has rotated to the point where the last hour tooth, marked '**1**' has passed the pawl **PR**.

Striking the Quarters

In addition to the twelve hour teeth, the circular rack has two sets of three teeth which strike the quarters. The first set catch the right hand pawl **PR** and the second set are higher and catch the left hand pawl **PL**. The teeth are positioned so that they operate their pawls alternately, with **PL** first, sounding the high pitched gong, and **PR** second, sounding the low pitched gong. The rack teeth for the quarters are numbered **1** to **6** in the sequence in which the gongs are struck for three quarters.

The circular rack, **10**, has a pivoted plate carrying a pin, with a spring tail. When the hour has been struck, the circular rack will have moved round to the point where the pin reaches the quarter stop, as marked by an arrow. The pin will then move the quarter stop towards the post **P** where it will bank and prevent further rotation of the circular rack. If no quarters are to be struck, the pin will engage the quarter stop

9.Close up of the cannon pinion and quarter snail, with the surprise piece extended.

10.The strike rack and pawls, also the hour and quarter stops.

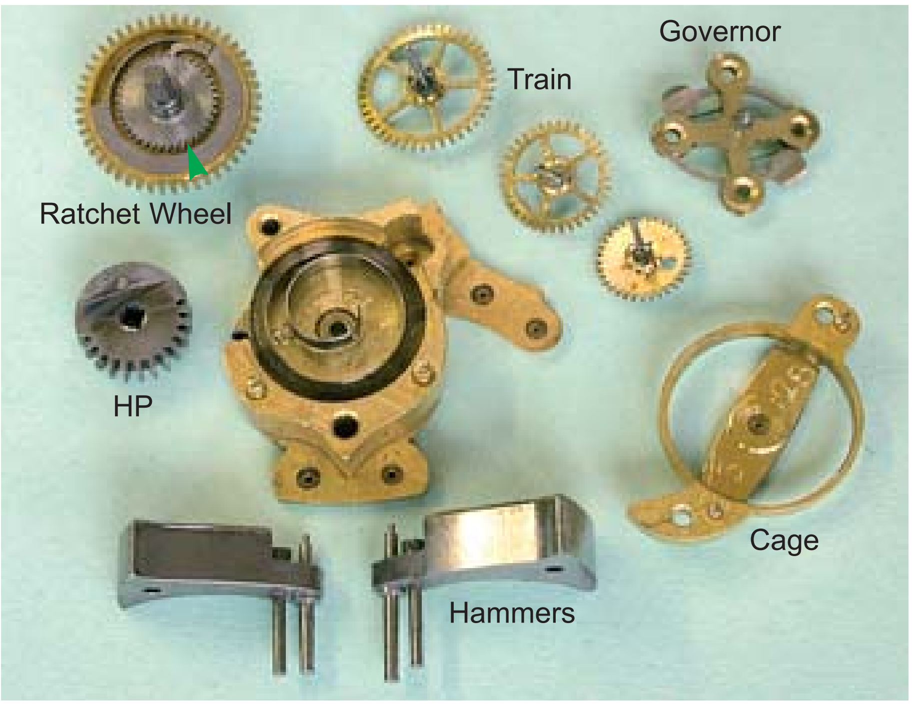
on its right hand side, as shown by **0** in **8**, and the quarter stop will bank immediately on the post. If one quarter is to be struck the quarter stop will be a little to the right, having been pushed by its spring against the quarter snail. The **pin** will engage in the slot marked **1** in the quarter stop, and the circular rack will turn further so that rack teeth **1** and **2** will catch their pawls to strike the first quarter before the quarter stop banks on the post **P**. Similarly, when two or three quarters are to be struck, the **pin** will enter the slots **2** or **3**, allowing the circular rack to turn still further before the quarter stop reaches the post and further rotation is prevented. When the repeat strike is complete both the hour stop and quarter stop will have been carried back from their snails so that the motion work will be free to turn as the watch runs. If the push piece were pressed in and held the watch would eventually stop when the snails jammed against the hour and quarter stops.

The hammers are controlled by springs and stops, **10**, so they can be set at just the right distance from the gongs to sound well and not vibrate against the gongs after striking. This is one of the few critical adjustments in the repeater, which can take some time to get just right to produce a pleasing sound.

The Governor

The watch uses a centrifugal governor, which is considered the best type. It slows the rate of striking so that the hours and quarters can be counted easily, taking twelve seconds for the full strike. Although striking needs to be slowed, winding must be immediate, which is achieved by a ratchet and click in the repeat spring barrel, **11**, which clicks round rapidly as the spring is wound, but engages the governor train during striking. Without the ratchet and click it would take the same time to wind the repeat up as it takes to unwind whilst striking. Also a hard press on the push piece would force the governor train to run excessively fast and damage it.

The Governor train is driven from the ratchet wheel, **11**, and consists of three wheels and pinions driving the centrifugal governor. The two small weights in the governor are mounted on hinged arms which fly out against controlling springs as the regulator spins, until the weights rub on the wall of the cage in which they are mounted. The speed is set by the combination of the mass of the weights, the controlling spring tension and the friction. The weights in the regulator have been filed down at some point, perhaps to restore the speed when a weaker drive spring was fitted or even when manufactured. The governor not only slows the rate of striking, it also keeps the speed constant as the drive spring unwinds. As the speed starts to drop the weights are not thrown out so strongly, the friction against the cage walls is less, so the speed is maintained, or nearly so. As a result the strike does not slow up at the end, sounding as though it might not make it. In a striking clock the strike spring only unwinds a little at each strike, so a simple fly will do. At the end of the week the strike is slower, but this is more acceptable than slowing up during a strike. The train is shown in place on the movement top plate, **5**; the governor is on the other side of the plate, **10**.



11.Repeat spring barrel and regulator train parts.

12. Special tool to undo the click wheel boss.

Setting the Star Wheel Jumper

Properly set up the repeat work should sound the new hour without any quarters as soon as the minute hand reaches 60. The quarters should change at 15, 30 and 45 minutes. The spacing of the quarters is fixed by the division of the quarter snail and can only be corrected by filing the snail, which should not be undertaken hastily. However the relation between the change in the hour and the change in the quarters can be set by adjusting the position of the star wheel jumper. This is done by advancing the motion work until the quarter stop is against the step between the first and second quarter of the quarter snail. The minute hand is then attached to indicate a quarter past. The motion work is than advanced until the minute hand is at 60 and the star wheel jumper adjusted so that the star wheel advances exactly at the hour. The jumper has two screws which when loosened allow the jumper to be moved so the star wheel jumps at the desired moment. The repeat of the quarters will now change accurately at 15 minutes past and as close to 30 and 45 minutes as the division of the quarter snail allows (within about one minute in this watch). If they are not accurate, the best compromise among them can be chosen as the reference before adjusting the star wheel jumper. The moment at which the repeated hour moves forward is determined only by the star wheel and jumper.

Setting up the Repeater Mainspring

The longest run of the repeat mechanism includes 12 hour strikes and six quarter strikes on the gongs, which occurs between 12.45 and 1 o'clock. This run is driven by a half turn of the half pinion, driven by a half turn of the repeater mainspring. This half turn should be taken from the middle of the mainspring run, which takes several turns to fully wind. Consequently, during assembly the mainspring arbor is wound up by one turn before the half pinion is engaged with the rack on lever 2. This ensures that the drive to the repeat mechanism is maintained to the end of the strike, and by being taken from the middle of the mainspring run is as constant a torque as possible. The amount of set up will also affect the rate of the striking, more set up giving a faster strike, although as we have seen above, the action of the governor tends to keep the rate constant.

The mainspring is housed in a small barrel without a lid, the rachet click wheel acting as the lid. When the barrel is lifted off the top plate, the arbor can be left behind allowing the mainspring to spill out. The technique is to leave the barrel until the repeat work has been removed and then push the squared arbor up through the top plate, safely taking the mainspring and barrel with it.

All or Nothing Piece

Better quality repeaters have an all or nothing feature, which ensures that striking only occurs if the push piece is pressed fully home, providing sufficient wind to ensure that the hour and quarters are struck fully.[2] This watch does not have this feature, with the result that a shallow push will result in only some of the hours being struck. You have to be awake enough in the night to press the repeat fully, or be misled as to the time.

Taking the Pictures

The pictures in the article were taken with a Nikon 995 3.3 Megapixel digital camera, which has a close up lens capable of filling the image with an object only 16mm across. Pictures were taken with the camera on a stand made from an enlarger column, using natural sunlight from a window with a mirror on the other side of the watch to reflect the sunlight to give two-sided illumination. Also some artificial lighting was used to produce highlights.

Numerous attempts were required in order to get all the parts visible in the series of corresponding pictures **7**, **8** and **10**. The pictures were processed on an iMAC computer using PHOTOSHOP to crop the pictures accurately, set the levels and where necessary add artificial highlights to make parts show up, as in the two pawls in **10**.

It is the ability to take a picture, see it on the screen, make adjustments to the lighting and retake the picture, all within a few minutes, that makes digital photography so much more powerful than film for this work. ❒

---

2. F J Britten: *Britten's Watch and Clock Maker's Handbook, Dictionary and Guide*. BLOOMSBURY BOOKS, London