From the Workbench

The Watch Movement

Part 3

Final touch: finish and assembly.

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Before the final assembly of the wristwatch, all of the cut-out, drilled and machined parts – discussed in Part 2 – must be finished to a pre-meditated level of quality. Generally speaking, finishing falls into two basic categories: the absolutely necessary and the visual. However, it goes without saying that for habitués of high-end watchmaking there is only one level of finish: perfection!

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(Above) One of four 100th anniversary Breitling Grandes Complications pocket watches. The Geneva striping is perfectly aligned from bridge to bridge.

(Previous page) In this back view of the LU Chopard calibre 1.96 movement – finished to Geneva Seal standards (this is the gold seal above the winding stem) – several different types of finish can be seen. The asymmetrically situated yellow-gold winding rotor is stamped with a sunray pattern around the Chopard cartouche. The surface circling the rotor's axis has been subject to radial sanding – a visually basic, yet technically challenging process. Above this in the recess beneath, perlage finishing is clearly visible. These small roundels are microscopic in size, and must be perfectly placed, radiating outwards from the central rotor axis. The large bridges, as well as the subsidiary bridge dead centre are finished in *Côte de Genève*, or Geneva stripe finish. This is particularly difficult when the pattern must 'jump' across different bridges, as shown here. Note also the anglage along the edges of each bridge, the polished countersink edges surrounding each screw head, the Parachoc ruby for the balance wheel pivot and a ruby set in a gold chaton next to the letter 'L'.

Depending upon the price of the watch, more or less time will be given to the visual finishing of the watch's movement, with higher prices directly corresponding to greater detail of workmanship. 'Absolutely necessary' finishing includes the removal of burrs, smoothing-down potential friction points on the faces of gear teeth and pinions, and treatment of basic surfaces with fine emery paper; considered standard treatment even in mass produced movements costing only $100 a piece, since these issues can directly affect basic timekeeping properties.

However, 'visual' finishing has no such repercussions; a watch can lack a high visual finish, but keep accurate time. In fact, this is *de rigueur* for the vast majority of mechanical wristwatches sold today, including every watch produced by Rolex. For those to whom a wristwatch is a work of art or symbol of perfection, the choice between one or the other will not do. In this particular and rarefied horological world, every microscopic edge, corner and interior shape will be hand-rounded and then highly polished at several stages to yield a mirror finish, scratch-free even under the greatest magnification.

Every screw head will be polished (in some brands, even the *underside* of the head is polished, as well as the groove itself!) and occasionally anodised to a distinctive 'electric blue' hue. The flat surfaces of the movement bridges and plates can be treated with Geneva stripes, perlage and sunray shapes, among many other patterns. Parts of the watch that may only be seen by another watchmaker in 100 years' time will be finished with the same patience as those visible through the sapphire glass case back.

All in the technique

The basic methods behind many of these techniques are in principle rather straightforward, but the visual effect achieved depends inevitably on the skill of the watchmaker and the constancy of the work he performs.

Classic Geneva stripes are achieved through the application of small, wooden bits turned from a species of Gentian tree, commonly found in mountainous areas of Switzerland. Boxwood, similar in structure and more commercially available, is often used as well.

The bit is turned on a lathe and carved to the correct thickness required for the stripe. It is then mounted vertically in a drill and the movement baseplate is positioned below on a sliding platform capable of moving front to back, as well as sideways. The rotating nib is lowered, until it is lightly touching the baseplate's surface. The platform is then moved forwards, creating a stripe as the turning nib rubs over the surface; the speed of the platform during the forward movement affecting the look of the stripe. The drill is lifted, the platform is moved one step sideways, and the next stripe is applied. Despite the relatively basic principles at play here, one mistake will doubtless yield rejection.

True Geneva striping is only a light surface embellishment; many factories these days use much harder carborundum bits that literally cut into the metal, leaving a surface that looks 'gouged' rather than brushed.

Perlage is achieved in a similar fashion, but is generally performed freehand, making it difficult to create a regular visual effect. In this case, the bit is made of soft rubber, not so different from that found at the end of a pencil. The turning bit is lowered over the component to be treated, and pressed lightly against the surface. The soft rubber leaves behind a roundel of brushstrokes. The trick is in the correct placement of each consecutive roundel relying on just hand–eye co-ordination for a regular visual pattern.

Anglage is perhaps the most time-consuming finishing technique of all. The edge of each bridge and movement component must be rounded ('angled') in several stages, using wooden rods covered in various grades of fine emery paper. The rounded edge must have a constant width throughout and faithfully follow the curvature and arcs of the part involved. Proper anglage on a simple wristwatch can take days of meticulous work. For a complicated piece such as a repeater wristwatch this will take weeks. Here also, machines have made their *entrée*. Machine anglage is characterised by its narrow width, steep angularity and lack of high polish.

Close-up view of Geneva stripes, from the Chopard calibre 3.96.

Components that may only be seen by another watchmaker in 100 years' time will be finished with the same patience and devotion as those visible through the case back.

Labour of love

As you can well imagine, this is all extraordinarily time-consuming work that adds many days' labour to production. The price for it will be high indeed: a simple, manually wound watch showing only the hours, minutes and seconds manufactured in this fashion will cost appreciably more than a minor complication from a famous brand.

But the greatest watchmakers in the world today will deliver nothing less than this level, and the buyer who can afford it will (or certainly should!) appreciate the perfection and historical tradition on which this work is based. Indeed, to the watch connoisseur, this is the stuff of which dreams are made, with every metal part having been given

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These two pictures show details from a Philippe Dufour wristwatch, perfectly exemplifying how handmade classical anglage should appear. A movement treated like this is the very picture of horological elegance.

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Whatever degree of finish is executed, all of the completed and finished parts for each individual watch are then placed in a set of about three flat, rectangular boxes, each of which contains about 20 smaller compartments. The whole packet represents a sort of horological puzzle, with the smallest parts light enough to blow away in a breeze. This is where the watchmaker's work really begins…

Double the fun

Each watch is assembled twice, so the watchmakers can be forgiven if they suffer from a continuous sensation of *déjà vu*. In the first run, the watch is assembled in its entirety, down to the last screw and spring, whether a complication or simple watch. The proper fit of each part is checked and rechecked. The predefined allowances for play between each part – throughout all dimensions, height clearances, gear engagements, date changers, spring tension and dozens of other elements – pass the watchmaker's searching eyes.

This ensures not only the completeness of the watch, but also serves as mechanical and visual quality control for machining tolerances and finish. The efforts placed on visual beautification of the movement mean the watchmaker is walking a tightrope. Should, during assembly, the screwdriver or tweezers scratch a part due to lapse in concentration, it must either be redone or thrown out and a new one made. In the case of some tourbillon parts that each take a whole day to shape and polish by hand, this is a very unhappy thought indeed. Those photographs in

This, the Number 3 movement from RW Smith, demonstrates vastly different techniques to that of the Chopard calibre 1.96. The finish is known as 'frosting', or 'matting', and is applied to the surface by a spinning brass or steel mop. The surface is then gold plated, which prevents tarnishing. Also, note the screw heads, which have been anodised to impart a striking blue hue.

watch catalogues of quiet and orderly workshops surrounded by farmland are not just a sales pitch; the creation of a quiet working atmosphere is essential for just such reasons. At this stage, the watch will be oiled and then checked for general timekeeping, although it will not usually be completely calibrated. The watchmaker can then take everything apart and clean it, only to start all over again!

The second and final assembly starts with everything being completely rechecked yet again. Tolerances are narrowed down even further and the entire movement is finally assembled. Casing of the movement, running-in, final timing adjustment and another quality control all follow. Then, at last, the watch can finally be sent out into the world, driven by an intricate workhorse that embodies a plethora of diverse and well-honed techniques. ○

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