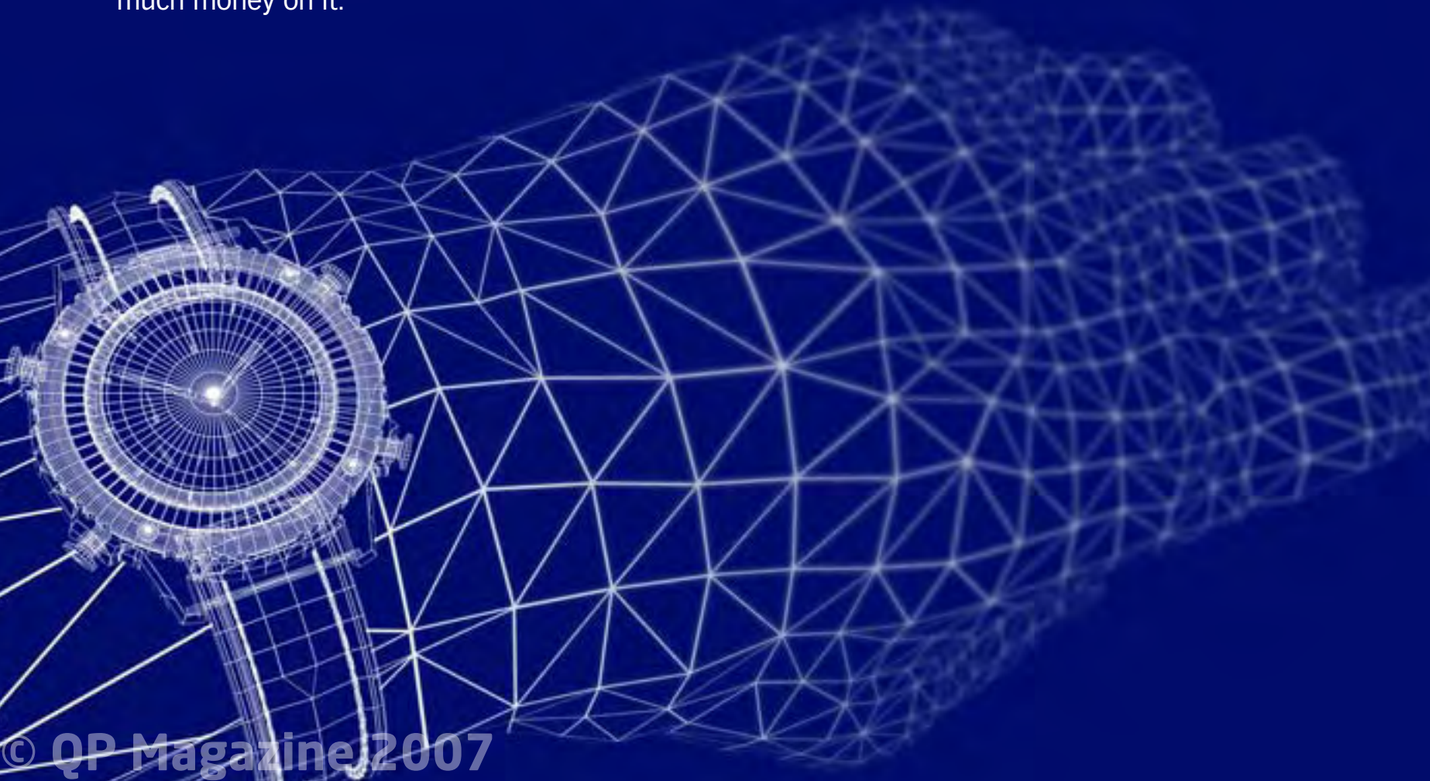
Watch Knowledge

Some basics to help you decide what you want from a watch

by Timothy Treffry

The most important factors in choosing a watch are that you like the look of it, want to wear it and (let's admit it) want to be seen wearing it. But it also helps to know what is going on inside. Knowledge of the basics, and some of the more exotic features, will enable you to appreciate what you are buying and help you rationalise to yourself, and explain to others, why you have spent so much money on it.



Back to basics

So how does a watch work? Throughout recorded history, man has wanted to measure the passage of time and has done this by counting something that happens regularly, e.g. the seasons, the full moon or the movement of the Earth around the sun. At least 800 years ago, mechanical oscillators (things that swing or vibrate in a regular way) were discovered and became the basis for clocks. A timekeeper simply needs an oscillator, a source of power to keep it going and a way of counting the oscillations.

A mechanical watch has a *balance wheel*, which swings back and forth under the influence of a *balance spring* (sometimes called a 'hair spring' because it is very thin). The *mainspring* keeps the balance wheel swinging via a gear train and an *escapement*. The balance will only accept an *impulse* from the escapement once per swing, and so controls the rate at which the wheels in the *gear-train* turn. Because the balance has a fixed rate of oscillation, it is possible to choose the gear ratios so that one wheel turns twice a day (we can put the hour hand on that), another turns once an hour (we put the minute hand on that) and another turns once a minute (and you should be able to guess what we put on that).

The quartz watch is essentially the same, except that the power comes from a battery (or some other source of electricity), the oscillator is a quartz crystal and the gear-train is an electronic circuit. If it is an analogue watch (one with hands), there is also a stepping motor and real gears to move the hands.

Features of a mechanical watch

It is the mechanical watch that captures the imagination and aspirations of the watch buff. A surprisingly tough sliver of steel – the *mainspring* – is the sole power source and must cater for all of the watch's functions. As the name suggests, you wind *manual wind* watches yourself using the *crown*, which is also used to set the hands and perhaps change the date. If you want your watch to be *water resistant* (it is illegal to use the term 'water proof' in the UK), the crown is the weak point. Rolex solved this problem years ago with the *screw-down crown* of its 'Oyster' case. Others have now copied it or use modern seals that can be very effective.

The balance assembly from a Lange & Söhne movement, showing the balance wheel with its characteristic studs and a 'swan-neck' adjustment lever. Lange & Söhne have risen to reclaim their position as one of Germany's – and the world's – finest watch-making houses over the last decade.

In the *automatic* or *self-winding* watch, an eccentric weight (*rotor*) responds to the wearer's movements and winds the watch as it swings on the wearer's arm. Normal activity will keep the watch fully wound, and most watches have a 'power reserve' – the length of time they will keep running without being wound again – of about 40 hr. There is a special IWC automatic that can store enough power to run for 7 days. Patek Philippe tops this with 10 days, but you have to wind it by hand. A *power reserve indicator* is now provided on some watches. In a manual watch this little dial is a useful reminder, and on an automatic it can show that a manual 'top up' may be of value. Most watches perform best if they are not allowed to approach the 'run-down' state, when the power of the spring is waning.

Power reserve indicators are particularly useful for watches not worn every day – and also add a dash of technical mystique at little extra cost.

The rotor on an automatic may wind the watch when it swings in either direction, or just in one. Opinion is divided as to which is best; it depends on the lifestyle of the owner. Over-winding is dealt with by allowing the mainspring to slip; this inevitably causes wear, and excessive over-winding should be avoided. The swing of the rotor usually approaches the diameter of the watch itself and adds to its thickness. The most elegant dress watches are usually manual wind, and the thinnest just have two hands to show the time

The challenge of creating ultra-slim movements still interests watchmakers. Jaeger-LeCoultre's Master series above is typical of the type.

The heart of the Zenith El Primero is its 5 Hz (36,000 A/h) balance. The only current movement to work at this speed, it is famous in its own right.

and nothing else. Do you need anything more? Some automatics have a smaller *micro-rotor*, which can be accommodated within the design of the watch *movement* (the mechanism inside the watch case) and doesn't increase its thickness.

The balance wheel is designed to swing back and forth at a fixed rate. Unfortunately, there are two ways of describing this. Traditionally, watchmakers say that when the balance swings from one side to the other this is a vibration or alternation, and they count the number of alternations per hour (*A/h*); 28,800 A/h is common in modern watches. To a physicist, an oscillation is when the balance swings from one side to the other *and back again*; the number of times it does this per second is the frequency and this is expressed in Hertz (*Hz*). A 28,800 A/h movement has a frequency of 4 Hz.

As a general rule, the higher the frequency of the oscillator, the more accurate the timekeeper. The crystals in quartz watches usually have a frequency of 32,768 A/h; that is why these watches are so accurate. The highest frequency tried commercially in a mechanical watch is 5 Hz (36,000 A/h). This seems to be too fast. A balance swings one way and stops, swings the other way and stops; to do this five times a second just seems too much for the metal in its rim or the oil in its pivots. These *high beat* watches are now quite rare. Another common frequency is 3 Hz (21,600 A/h). Older watches are almost invariably 2.5 Hz (18,000 A/h).

Fine adjustment of the frequency of the balance can also been done in two ways. The most common is by using a lever – the *index* – which alters the effective length of the balance spring. In cheaper watches, this index is kept in place by friction and is pushed one way or the other by the watch repairer. In better watches, this adjustment is made more precise by a lateral screw. Adjusting a watch by changing the balance spring alters the poise of the balance, introducing a source of error. Some watches don't have an index; they have *free-sprung* balances. The rate of these balances is adjusted using special weights on the balance rim, which are moved in opposite pairs, altering the frequency but not the poise. Rolex and Patek Philippe make watches with free-sprung balances.

The pursuit of perfect poise in a watch balance has always tantalised watchmakers. One inherent problem is the spiral balance spring. The inner end is fixed to the balance staff (its axle), and the other end, effectively, to the watch plate. When the balance swings one way the spiral tightens; when it swings the other way it opens. The distribution of the mass of the balance spring varies and so does the poise of the balance. This effect can be partially corrected by bending the end of the spring up and bringing it back over the rest of the spiral before attaching it: this is a *Breguet overcoil*.

A more exotic solution to the poise problem, again invented by Breguet 200 years ago, is the

Automatic watches rely on the kinetic energy created by rotating weights to keep the watch wound. These usually occupy the whole diameter of the movement, but some companies use micro-rotors to allow their movements to be appreciated without obstruction.

tourbillon. In the tourbillon watch the entire balance and escapement are assembled in a frame, or *carriage*, and rotate slowly (usually once a minute) as the watch runs. By rotating the balance as it swings, poise errors are averaged and their effects eliminated. Until recently, tourbillon watches were extremely rare and expensive, but new production methods have now made them more affordable. Such watches are undoubtedly desirable as examples of fine micro-engineering, but they do not in fact perform any better than a well-adjusted, good-quality conventional watch.

In any mechanical watch, the balance's swing will have greater amplitude when the watch is held flat than when it is on edge. When flat, the balance can spin freely, like a top. On edge, there is more friction in the balance pivots and the amplitude is lower. In a well-made watch, this change of amplitude should not greatly affect performance. To check this, watches are tested *in positions*. In addition, tests are also done at different temperatures to check that the watch will perform well in all the conditions it is likely to meet.

Almost all mechanical watches sold today have the lever escapement. It is the most successful escapement ever made, but it is absolutely dependent on efficient lubrication and is the main reason these watches need regular servicing. Omega have introduced the Daniels Co-Axial Escapement, which is more efficient and less dependent on lubrication. Ulysse Nardin use an absolutely unique, very high-tech *dual wheel escapement* in an extraordinary new

watch called the Freak, but it is still rather an unknown quantity.

Timing as well as time

Some watches have extra knobs and dials. These are *chronographs* and can be used to time events. The central seconds hand can be started and stopped at will, and the hours and minutes of longer events are recorded on subsidiary dials. Although most owners of chronographs almost certainly never use them for their intended function, there is a tremendous vogue for watches with extra dials and knobs. Until recently, they all had a very macho appearance with as much stylistic appeal as a manhole cover. Fortunately there are now exceptions; quite stylish, and even feminine, versions can now be found.

The most widely used chronograph movement ever made is undoubtedly the Valjoux 7750. Developed in 1973, it is now made by ETA and is available in a variety of marques sold over a broad price range. Cams hidden inside the movement control the chronograph functions. Now that watches commonly have transparent backs, allowing owners to admire finish and appreciate function, there is a demand for *column wheel* chronographs. In these watches, the response to the case buttons is controlled by levers acting on the column wheel and can be observed, understood eventually, and proudly described to anyone who will listen. Even more desirable is the *split-second* chronograph. In a mechanical watch, this is a very clever mechanism indeed. There are two centre seconds-hands superimposed. When you start timing an event they both move off together, but if you want to note a lap time, for example, press a button and one hand will stop while the other keeps going. Having noted the time, press again and the stopped hand will flick forward (or back) to rejoin its partner. The process can be repeated at will and can also be used to record the times of those who take 1st and 2nd places in an event. ○