

The Little Mechanism That Made Precise Time-keeping Possible

Originalartikel

Backup

<html> <p>There are few things to which we pay as much attention as the passage of time. We don’t want to be late for work, or a date. Even more importantly, we don’t want to age and die. Good time keeping is an all important human activity, and we started to worry about it as soon as we abandoned our hunter-gatherer lifestyle and agriculture and commerce emerged.</p>

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300w" sizes=„(max-width: 158px) 100vw, 158px"/><figcaption class=„wp-caption-text">A candle clock</figcaption></figure><p>Measuring time needs two things: a repetitive process to mark equal increments of time, and a way of tracking and displaying the result. The first timekeeping devices relied of course on the movement of the sun. Ancient Egyptians, around 3500 BC, built obelisks that, by casting a shadow on the ground at different positions, gave an approximate idea of the time. Next came the use of some medium that was consumed at a regular pace: candle, incense, water and sand clocks are examples. A great advancement came with the advent of the mechanical clock, and here is

where the escapement mechanism appears.



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https://hackadaycom.files.wordpress.com/2016/11/washstand_by_philo_of_byzantium.png?w=476&h=625 476w" sizes=„(max-width: 254px) 100vw, 254px"/><figcaption class=„wp-caption-text">Earliest known escapement in a Greek washstand automaton.</figcaption></figure><p>A clock needs energy to work. Think of the escapement as a way to release that energy in small quantities at constant intervals. In the animation at the right, the wheel is connected to the source of energy: a spring or weight. By itself, the wheel will rotate continuously as fast as it can until the energy stored in the spring is exhausted. But if we add the anchor shaped piece, the wheel rotates a few degrees at a time, in constant time intervals, just what we need for time measurement.</p><p>The earliest known escapement was described by the Greek engineer Philo of Byzantium in the 3rd century BC. From the <a href=„<https://en.wikipedia.org/wiki/Escapement>“ target=„_blank">Wikipedia entry: A counter weighted spoon, supplied by a water tank, tips over in a basin when full, releasing a spherical piece of pumice in the process. Once the spoon has emptied, it is pulled up again by the counterweight, closing the door on the pumice by the tightening string.</p> <figure id=„attachment_231254“ style=„width: 400px“ class=„wp-caption alignleft"><a href=„<https://vimeo.com/43772707>“ target=„_blank"><img data-attachment-id=„231254“ data-permalink=„<http://hackaday.com/2016/11/15/the-little-mechanism-that-made-precise-time-keeping-possible/su-song-water-wheel-astronomical-clock/>“

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text">Escapement mechanism of Su Song's clock uses buckets on a water wheel</figcaption></figure><p>Another early escapement was built by famous Chinese inventor Su Song in 1094. It used a large water wheel to keep time. The wheel is stopped by a mechanism that will only release once the weight in the currently filling bucket reaches a certain level. As long as the water flows at a constant rate, the wheel rotates at constant time intervals too. It is known as an Astronomical Clock Tower (and was very large. Although lost to antiquity, <a

href=„<https://vimeo.com/43772707>“ target=„_blank“>this animated rendering of the structure, originally shown on the History Channel’s Ancient

Discoveries, gives a good feel for what the structure was like and how it worked.</p>

<p>The first all-mechanical clocks were made possible thanks to the Verge escapement. It appeared in 14th century mechanical clocks found in large towers along Europe, and its origin is unknown. Perhaps the accuracy was not much better than that of the water clocks, but at least they did not freeze in winter. The verge escapement remained the king of time-keeping for four centuries, until the invention of the pendulum and balance spring in 1657, which increased the accuracy from hours a day, to minutes a day.</p> <figure id=„attachment_230991“ style=„width: 176px“ class=„wp-caption alignright“><img data-attachment-id=„230991“

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Escapement</figcaption></figure><p>After pendulum clocks were invented, a large number (more than 300!) of escapement designs were developed. Of course only a few of them remained in use.

Some of the most important types are:</p> <a

href=„<https://www.youtube.com/watch?v=VtdXV3AaQSg>“ target=„_blank“>Cylinder

Escapement, by Thomas Tompion And George Graham, 1695-1726. <a

href=„<https://www.youtube.com/watch?v=ISC9jbQke9I>“ target=„_blank“>Duplex Escapement,

by Robert Hooke, 1700. <a href=„<https://www.youtube.com/watch?v=ejgyCZELQ64>“

target=„_blank“>Lever Escapement, Thomas Mudge, 1750. <a

href=„<https://www.youtube.com/watch?v=Z-bSZ1VTq8Q>“ target=„_blank“>Chronometer/Detent

Escapement, John Arnold, 1775. <p>An extremely interesting design is the grasshopper escapement, developed in 1722 by John Harrison. It has a very unusual, almost hypnotic movement. Its main advantage is that it is a mechanism of very low friction.</p> <figure

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height=„338“/><figcaption class=„wp-caption-text“>Grasshopper

escapement.</figcaption></figure><p>Mechanical clock development continued, with great advances in both accuracy and miniaturization, and the escapement was a central part of every clock. But the advent of the electric clock replaced the escapement mechanism with electric means of producing the regular pulses needed in a clock: solenoids, synchronous motors and tuning fork oscillations. Eventually, we ended up with clocks with no clockwork parts at all.</p> <p>In 1927, the first quartz clock was built in Bell Telephone Laboratories. These clocks use the regular oscillations of the quartz crystal to measure the time intervals. Seiko introduced the first quartz clock, the Astron, in 1969. A decade later, the market was dominated by quartz. The combination of low cost and accuracy of the quartz clock led the “a

href=„<https://horahalus.com/2016/05/22/watch-lore-the-quartz-crisis/>“ target=„_blank“>quartz crisis“, where mechanical watches almost disappeared from the market.</p> <p>The final refinement came with atomic clocks, which use the electronic transition frequency of atoms to measure time. This has resulted in unparalleled timekeeping accuracy. They are found in satellites used in the GPS network and any device that syncs with them will benefit from this high-precision timekeeping. In the near future, you will probably have one in your wristwatch, as they have been <a href=„<http://www.microsemi.com/products/timing-synchronization-systems/embedded-timing-solutions/components/sa-45s-chip-scale-atomic-clock#overview>“ target=„_blank“>miniaturized to chip scale.</p> <figure id=„attachment_231110“ style=„width: 268px“ class=„wp-caption alignright“><img data-attachment-id=„231110“

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<https://hackadaycom.files.wordpress.com/2016/11/girard-perregaux-constant-escapement-5.jpg?w=516&h=800> 516w,
<https://hackadaycom.files.wordpress.com/2016/11/girard-perregaux-constant-escapement-5.jpg?w=161&h=250> 161w“ sizes=„(max-width: 258px) 100vw, 258px“/><figcaption class=„wp-caption-text“>This beautiful watch incorporates the constant escapement, developed by Girard Perregaux in 2008.</figcaption></figure><p>Today, mechanical watches that use an escapement mechanism are still manufactured. Of course, we don’t need them. After all, now that we all have cell phones, even the quartz wristwatch becomes redundant. However, there is an inherent beauty in that miniature mechanism. They represent the triumph of craftsmanship over precision.</p><blockquote><p>Mechanical watches are so brilliantly unnecessary. Each one is a miniature world unto itself, a tiny functioning mechanism, a congeries of minute and mysterious moving parts. Moving parts! And consequently these watches are, in a sense, alive. They have heartbeats. They seem to respond, Tamagotchi-like, to “love,” in the form, usually, of the expensive ministrations of specialist technicians. Like ancient steam-tractors or Vincent motorcycles, they can be painstakingly restored from virtually any stage of ruin.</p><p>—<a href=„<https://www.wired.com/1999/01/ebay/>“ target=„_blank“>William Gibson</p></blockquote><p>Modern mechanical watches are some of the most complex and beautiful pieces of mechanical art in existence. They can reach prices in the hundreds of thousands of dollars and of course, are collectible items. Even today, horological engineers continue to work on the development of the escapement, looking to increase accuracy and reliability.</p><p>[Featured image source: Christoph Laimer’s <a href=„<http://www.thingiverse.com/thing:328569>“ target=„_blank“>3D printed mechanical clock with Anchor Escapement. It has long been one of our favorite clock hacks <a href=„<https://hackaday.com/2014/05/24/the-hour-of-the-3d-printed-clock-draws-nigh/>“>which we originally covered back in 2014]</p></html>

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