



THE 216,000 VIBRATIONS/HOUR OF THE LOUIS MOINET COMPTEUR DE TIERCES

In one of his handwritten letters (1), Louis Moinet tells the story: "After various stays in Paris where I spent time with Breguet the elder, I went there for the last time in 1815 to have a compteur de tierces or 60ths of a second made, which I wanted to use for an astronomical instrument that I had built some time before and that Mr Fortin had made for me." In another note (1), the inventor specifies that this compteur "was not completed until 1816". Designed to measure tierces (a French term referring to a third subdivision of hours after the minutes and seconds), for the first time in the history of watchmaking, this instrument was equipped with an escapement beating at 216,000 vibrations per hour (vph). Although there was a similar attempt by the English watchmaker John Arnold the elder, which did not lead to any significant development, the height of this frequency was truly prodigious at the time of its creation.

The origins of precision

The horological history of frequencies began in 1675 when Christian Huygens invented a regulating balance-spring paired with a circular balance featuring constant periodic motion. Also known as a hairspring, this coiled steel wire provides the torque required to make the balance oscillate and to regulate its frequency, i.e. the number of oscillations, an oscillation equivalent to two vibrations, performed within a unit of time, such as an hour or a second.

In 1754, Jean Romilly presented the first so-called deadbeat seconds watch to the Académie royale des Sciences in Paris. Twenty-two years later, Jean-Moïse Pouzait submitted an independent deadbeat seconds watch to the Société des Arts in Geneva with a balance oscillating at 7,200 vph (1 Hertz). Its double mechanism made it possible to halt the seconds hand without stopping the main movement. At the end of the 18th century, various models were introduced with escapements beating at 14,400, 18,000 and 21,600 vph respectively, with a small jumping hand called a foudroyante or diabolotine to indicate quarters, fifths or – in the 19th century – sixths of a second. Given that background, how can one explain this prodigious and instantaneous leap to Moinet's 216,000 vph (30 Hz) in 1816, at a time when soldiers adjusting cannon fire and bettors assessing the performance of racehorses were generally satisfied with 18,000 vph (2.5 Hz)?

From 18,000 to 216,000 vph in one giant step

The answer to this question lies in astronomers' new expectations sparked by the 17th century appearance of the ancestor of the telescope that would establish itself two centuries later. The meridian telescope was specially designed to measure the heights of the stars above the horizon at the exact moment of their passage through the meridian plane by virtue of diurnal motion. Knowing these two items of data enabled the elaboration of sky charts, star catalogues and ephemerides, the accuracy of which depends on that of the time measuring instrument used. At the time, the tierce, an astronomical calculation unit simultaneously dividing the second and the degree of angle, was THE benchmark because it served to measure both time and space.



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In spite of the prodigious progress made by the *compteur de tierces*, it did not become widely known in scientific circles. Moinet had had it made for his own use and for some unknown reason its invention was not published. The proposal to make it "available to anyone who would like to have it built in large numbers", was not taken up (3).

Striking a balance between scientists' requirements and R&D

In 1816, Louis Moinet had a lead of some five or six years on Nicolas-Matthieu Rieussec. The latter proved capable of timing – in fifths of a second and using an apparatus he had invented – a horse race organised on September 1st 1821 on the Champ de Mars in Paris (4). Even more remarkably, the *compteur de tierces* preceded Heuer's *Mikrograph* by 100 years.

In watchmaking, an increase in frequency improves precision, with the corollary of certain hard to resolve technical problems, including increased energy consumption, inertia of the wheels and pinions, as well as impact on lubrication.

Twentieth of a second measurement was achieved in 1896 with the Nicole, Nielsen & Co stopwatch, featuring a balance oscillating at 72,000 vph (10 Hz).

In 1916, one hundred years after Moinet's *compteur de tierces*, Heuer patented two pocket stopwatches: the *Semikrograph* indicating fiftieths of a second, 180,000 vph (25 Hz), and the *Mikrograph* indicating hundredths of a second, 360,000 vph (50 Hz). The latter would be produced for 60 years. In 2011, TAG Heuer presented its *Mikrograph 1/100*, the first self-winding wrist chronograph capable of measuring and displaying one hundredths of a second with a jumping seconds hand that makes one full turn around the dial in one second. It incorporates two escapements: one beating at 28,800 vph (4 Hz) and reserved for the time functions, the other at 360,000 vph (50 Hz) for the chronograph. In the same year, the Manufacture further explored the field of high frequencies. Its *Microtimer Concept Chronograph* was the first in the world to mechanically measure one thousandths of a second (3,600,000 vph, 500 Hz). In 2012, TAG Heuer presented its *Mikrogirder*, displaying two-thousandths of a second. Its escapement beats at 7,200,000 vph (1,000 Hz) and is 250 times faster than that of a conventional watch. Its central seconds hand then makes 20 turns of the dial per second, a speed making it impossible to follow with the naked eye.

In each successive era, watchmakers have pushed back the limits of the rules of physics and mechanics, transcending the realms of apparent feasibility in order to overturn burdensome habits and preconceptions. When it comes to the field of high-frequency watchmaking, it is unquestionably Louis Moinet who first blazed this particular trail.



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SOURCES

- (1) Private collection
- (2) *Nouveau Traité Général d'Horlogerie*, Louis Moinet, 1848 edition, volume 1, p. 47.
- (3) *Nouveau Traité Général d'Horlogerie*, Louis Moinet, 1848 edition, volume 2, article 1531.
- (4) *The Mastery of Time*, Dominique Fléchon, Editions Flammarion, 2011, p. 257.

Text written by Dominique FLECHON, historian and expert in fine watchmaking.



HOROLOGICAL HIGH FREQUENCIES

1675 : Christiaan Huygens, considered the father of scientific watchmaking, invents the spring balance (also known as the balance-and-spring assembly), a regulating spring associated with a circular balance featuring constant periodic motion). This coiled steel wire provides the torque needed to make the balance oscillate and regulate its frequency.

1816 : For his own astronomical observations, Louis Moinet invents a *compteur de tierces* – the latter corresponding to a third subdivision of hours after the minutes and the seconds. Beating for the first time in the history of watchmaking at a frequency of 216,000 a/h (30 Hz), the instrument does not indicate civil time but measures and displays one sixtieth of a second thanks to its central seconds hand which performs one full turn per second.

1896 : Nicole, Nielsen & Co develops a stopwatch equipped with a balance oscillating at a frequency of 72,000 vph (10 Hz) measuring one twentieths of a second.

1916 : Heuer patents:

- the Mikrograph, the first pocket stopwatch displaying hundredths of a second (360,000 vph, 50 Hz) with a hand sweeping around the dial in three seconds. It will be produced for 60 years;
- the Semikrograph providing fiftieth of a second measurement (180,000 vph, 25 Hz). The hand sweeps the dial in six seconds.

1916 : Minerva introduces a stopwatch measuring hundredths of a second.

1964 : Girard-Perregaux develops the Gyromatic HS, the first high-frequency mechanical wristwatch calibre indicating tenths of a second (36,000 vph, 5 Hz). The Mastery of Time, p. 343.

1967 : Longines: self-winding watch (36 000 vph, 5 Hz).

1967 : Favre Leuba : Sea Raider 36 000, modèle développé en 1965. (36 000 a/h, 5 Hz).

1968 : Seiko: diver's watch, calibre 6159A (36 000 vph, 5 Hz).

1968 : Kurt Vogel: self-winding calibres 1,000, 1,010 and 1020 (28,000 vph, 3.9 Hz).

1969 : Zenith presents El Primero, the first wrist chronograph displaying tenths of a second (36,000 vph, 5 Hz) on January 10th.

2008 : Chopard launches into the development of an escapement beating at 28,800 to 36,000 vph, 8 to 10 Hz. See 2012.



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2009 : Audemars Piguet presents the Jules Audemars watch, 43,200 vph, 6 Hz.

2010 : Breguet launches the Type XXII Breguet self-winding flyback chronograph with silicon escapement, displaying twentieths of a second, 72,000 vph, 10 Hz.

2010 : TAG Heuer Pendulum Concept, the first mechanical movement to feature an oscillator without a hairspring, the latter being replaced by a device consisting of four magnets. (43,200 vph, 6 Hz).

2011 : TAG Heuer Mikrograph 1/100, the world's first mechanical chronograph capable of measuring one hundredths of a second by incorporating two escapements:

- one beating at 28,800 vph 4 Hz, for the timekeeping functions;
- the other at 360,000 vph, 50 Hz, for the chronograph function.

2011 : TAG Heuer Microtimer Concept Chronograph, the world's first mechanical chronograph capable of measuring and displaying thousandths of a second. 3,600,000 vph, 500 Hz.

2012 : TAG Heuer Mikrogirder, the world's first mechanical chronograph capable of measuring and displaying two thousandths of a second. 7,200,000 vph, 1,000 Hz, 250 times faster than a conventional watch. Its central seconds hand then performs 20 turns of the dial per second, a speed that makes it impossible to detect with the naked eye.

2012 : Chopard presents the LUC 8 HF chronometer. 57,600 vph, 8 Hz, sixteenths of a second. See 2008.

2013 : TAG Heuer Carrera MikroPendulum accurate to one hundredth of a second. Double chain system, i.e. a double escapement, one dedicated to the timekeeping functions, the other operating by magnetism, i.e. without a balance-spring, and beating at 360,000 vph, 50 Hz.

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About Louis Moinet

*Jean-Marie Schaller created Les Ateliers Louis Moinet in St-Blaise (NE) in 2004. The fully independent firm was established to honour the memory of Louis Moinet (1768-1853): master watchmaker, inventor of the chronograph and high frequency (216,000 vibrations per hour) in 1816 (certifications by Guinness World Records™). Louis Moinet was a watchmaker, scholar, painter, sculptor, and teacher at the School of Fine Arts – as well as the author of the *Traité d'Horlogerie*, a watchmaking treatise published in 1848 that remained a definitive work of reference for a century.*

*Today, Ateliers Louis Moinet is perpetuating this legacy. The firm's mechanical timepieces are produced as one-of-a-kind models or limited editions only and comprise two categories: "Cosmic Art" and "Mechanical Wonders". Louis Moinet creations often make use of unusual and rare components, such as extraterrestrial meteorites or prehistorical materials. The brand's core values are creativity, exclusivity, art and design. This uniquely creative mechanical approach combined with bespoke fine watchmaking has enabled Louis Moinet to win some of the most coveted honours around the world, including a UNESCO Award of Merit, six Red Dot Design Awards (including one Best of the Best Award), a Horological Creativity Contribution Award, gold and bronze medals in the International Chronometry Competition, ten Good Design Awards, four Middle East Watch of the Year Awards, two Robb Report "Best of the Best" Awards, three German Design Awards, two MUSE Design Awards, a Moscow Grand Prix Award, and a "Chronograph of the year" distinction from *Begin Magazine*, Japan.*