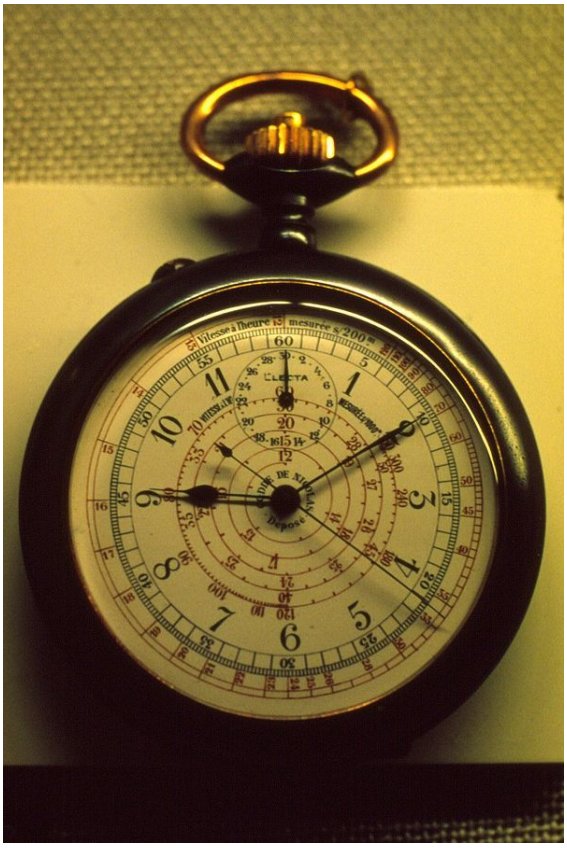
Chronograph

For an instrument used to measure the velocity of a projectile, see gun chronograph.

A **chronograph** is a specific type of watch that is used as a stopwatch combined with a display watch. A basic chronograph has an independent sweep second hand; it can be started, stopped, and returned to zero by successive pressure on the stem. Less simple chronographs use additional complications and can have multiple independent hands to measure seconds, minutes, hours and even tenths of a second. In addition, many modern chronographs use moveable bezels as tachymeters for rapid calculations of speed or distance. Louis Moinet invented the chronograph in 1816 for use in tracking astronomical objects.[1][2] Chronographs were also used heavily in artillery fire in the mid to late 1800s. More modern uses of chronographs involve piloting airplanes, car racing, diving and submarine maneuvering.



Electa Pocket Chronograph (ca. 1890s) manufactured by the Gallet Watch Company in La Chaux-de-Fonds, Switzerland.

Gallet MultiChron Astronomic (ca. 1959)—complex mechanical chronograph with 12-hour recoding capabilities, automatic day, date, month, and moon phase display

A modern Seiko quartz wristwatch using the chronograph function (movement 7T92).

1 History

The term, Chronograph comes from the Greek word for time, “chronos”, combined with the Greek word for writ-

Citizen Atessa Eco-Drive ATV53-3023 analog-digital chronograph with 4 area Radio Controlled reception (North America, Europe, China, Japan).

ing, “graph”. Early versions of the chronograph are the only ones that actually used any “writing": marking the dial with a small pen attached to the index so that the length of the pen mark would indicate how much time has elapsed.[3][4][5][6] The first modern chronograph was invented by Louis Moinet in 1816,[7] solely for working with astronomical equipment. It was Nicolas Mathieu Rieussec who developed the first marketed chronograph at the behest of King Louis XVIII in 1821. The King greatly enjoyed watching horse races, but wanted to know exactly how long each race lasted, so Rieussec was commissioned to invent a contraption that would do the job: as a result he developed the first ever commercialized chronograph. Rieussec was considered the inventor of the chronograph until the Louis Moinet pocket chronograph discovery in 2013 when history was rewritten.[8]

In 1844 Adolphe Nicole's updated version of the chronograph was the first to include a re-setting feature which now allowed successive measurements, unlike the constantly moving needle in the original chronograph.[5][9]

In the early part of the 20th Century many chronographs were sold with fixed bezels marked in order to function as a tachymeter. In 1958 the watch company Heuer introduced a model with a rotating bezel tachymeter for more complex calculations.[10][11]

Chronographs were very popular with aviators as they allowed them to make rapid calculations and conduct precise timing. The demand for chronographs grew along with the aviation industry in the early part of the 20th century. As the US exploration of outer space initially involved only test pilots, by order of President Eisenhower,[12][13] chronographs were on the wrists of many early astronauts. Chronograph usage followed a similar trajectory for many fields that involve very precise and/or repeated timing around increasingly more complicated high performance machinery, automobile racing and naval submarine navigation being two examples. As different uses for the chronograph were discovered, the industry responded with different models introducing such features as the 'flyback' (where the second hand could be rapidly reset to zero), minute and hour timers, Rattrapante (or multiple second hands one of which can be stopped and started independently) and waterproof models for divers and swimmers.

Although self winding watches and clockwork have been around since the late 1700s, the automatic (self winding) chronograph was not invented until 1969 when the watch companies Heuer, Breitling, and Hamilton, and movement specialist Dubois Depraz, developed it in partnership. They developed this technology secretly in an effort to prevent other companies from beating them to the patent. It was in Geneva and in New York that this partnership shared the first automatic chronograph with the world on March 3, 1969. These first automatic chronographs were labeled “Chrono-matic”.[14][15]

Many companies sell their own styles of chronographs. While today most chronographs are in the form of wrist watches, in the early 20th century pocket chronographs were very popular.[16]

2 Uses

The term chronograph is often confused with the term chronometer. Where “Chronograph” refers to the function of a watch, chronometer is a measure of how well a given timepiece performs: in order to be labeled a chronometer the timepiece must be certified by the COSC, the official Swiss Chronometer testing institute,[16] after undergoing a series of rigorous tests for robustness, accuracy and precision under adverse conditions. A simple watch, without the stopwatch functionality, can be certified a chronometer, as can a clock, for example a ship’s clock used for navigation.

Originally the term chronograph was mainly used in connection with artillery and the velocity of missiles. The Chronograph’s main function is to allow a comparison of observation between a time base and, before the electronic stopwatch was invented, a permanent recording of the observer’s findings. For example, one of the first applications of the chronograph was to record the time elapsed during horse races.[9]

Some more important uses of the chronograph include the Langley Chronograph, which is used by the US Navy

to record, calculate, and analyse data given off by aeroplane launching catapults. Another famous usage of the chronograph was during all of NASA's Apollo missions to the moon, each astronaut was equipped with a fully functioning chronograph, the Omega Speedmaster. You can now find chronographs that are used to record heart beats within hospitals, calculate speed and/or distance on an athletic field, or even as simple as a cooking tool for the kitchen.[4][17][18][19]

3 Function

Chronographs can be extremely complicated devices, but they all have the basic function of telling time, as they are watches, and of displaying elapsed time. Rieussec's chronograph was fairly simple. It was composed of two faces, a top and bottom face. The bottom face held a pool of ink, while the upper had a pen-like needle attached to it. When activated, the upper face pushed down on the lower face, while revolving around a central axis, which pulled the needle. This dragged the ink, in a circular fashion, recording the time elapsed by the line of ink that the motion created. There was room left for improvement, because Rieussec's chronograph was not easily ready for multiple uses.[3][5]

This paved the way for the hundreds of patents that have been handed out to people for updating and upgrading this device. Automatic, non-digital chronographs do not require a battery, because the arm or wrist of the wearer creates kinetic energy, which results in the total energy source needed for this device to work. Throughout the day, while the wearer of the watch is walking, the swinging motion of his arm forces a semicircular rotor to turn on a pivot within the watch. The rotor is attached to a ratchet that winds the mainspring in the watch, so that it is ready for use at all times.[3][20]

The modern day chronograph works by pushing a start button, normally located at the two o'clock position, to begin recording time, and by pushing the same button to stop the recording. When the button is pushed to start the recording, a series of three (in more complicated and more precise chronographs there are more wheels) train wheels start turning. The smallest has a revolution time of one second, the next sixty seconds, and the final one has a revolution time of sixty minutes. The three train wheels interact with one another and record how long it has been since the start button has been activated.[20]

Tachymeter bezels are a complication that allows rapid calculations of speed or distance. Rotating bezels allow for more complex calculations or repeated calculations without requiring a reset of the timer.[10][11]

A 'Seiko Automatic-Chronograph' Cal. 6139, the Pogue Seiko, *the first automatic chronograph in space*[21][22]

Seiko Flyback-Automatic-Chronograph Cal. 7016, the so-called „Seiko-Monaco" *(1976).*

4 Types

The original chronographs that Rieussec invented were called tape chronographs. They consisted of a tape that was constantly being dragged along at a controlled speed. When activated, a pen would be pushed onto the tape and begin recording until deactivated.[9]

Specialized chronographs are used by deep sea and scuba

divers. While basic functionality is the same as other chronographs, diving models have longer and more practical straps to wear over equipment, are made to be waterproof to deeper depths, have more rounded corners to prevent catching and luminous dials for reading in the murky depths. Also divers chronographs are fitted with large bezels that have at least one luminous marking: at the start of a dive the bezel is rotated to place the marking at the extent of time allowed by the air supply giving the ability to very quickly determine how much time remains for safe diving. Surface supplied divers can use the same to make quick calculations of distance traveled over time.

Metered bezels: Many chronographs have a bezel, that is either fixed or can rotate, around the outside of the dial that is marked to specific scales to allow rapid calculations. While any wristwatch can have a bezel, the chronograph stop start feature, as well as the rotation of the bezel, allows more complex calculations or repeated measurements for a series of calculations. The most popular meter is for Tachymeter readings: a simple scale that allows rapid calculations of speed. Other bezels feature Telemeter scale, for distance. The watchmaking company Breitling offers a model with a rotating bezel, in conjunction with another, fixed, meter on the dial, scaled for use as a slide rule for more complex calculations.

Flyback chronographs have a timing hand that can be rapidly reset, or 'flyback', to zero. Ordinarily the sweep second hand is stopped to record the time and started again at that spot on the dial, or reset by spinning the second hand all the way to zero again, clockwise. The flyback allows a reading and a quick reset, a counterclockwise 'flyback', for the next measurement to start at zero.[8]

Rattrapante, sometimes called a “double chronograph”, have multiple second hands, at least one of which can be stopped and started independently. When not activated the second hands travel together, one under the other, to appear as just one second hand.[8]

Tourbillon. Although not strictly limited to chronographs, a tourbillon is an escapement set in a cage and placed in a rotating balance in order to minimize the effects of gravity on the escapement and increase precision. Because chronograph escapements are generally larger and connect with more complications a tourbillion in a chronograph will differ from a tourbillion in a more simple timepiece.

Other types of modern-day chronographs are the automatic chronograph and the digital chronograph. The automatic chronograph depends solely on kinetic energy as its power source, while the digital chronograph is much like the common stopwatch and uses a battery to gain power as well as quartz for timing.

Other, more specific, types of chronographs include split second chronographs, tide chronographs, and asthometer chronographs. Each of these chronographs has an added feature that sets them apart.[23]

5 See also

- Louis Moinet - Inventor of the Chronograph
- Double chronograph
- Flyback chronograph
- Complication (horology)
- Chronometer (disambiguation)
- Marine chronometer

6 References

[1] Worldtempus, Louis Moinet The chronograph’s inventor

[2] Elizabeth Doerr, Forbes, History Rebooted: The Chronograph’s Inventor is...Louis Moinet! .

[3] Hood, Peter. How Time Is Measured. London: Oxford U.P., 1969. Print.

[4] Cowan, Harrison J. Time and Its Measurement; from the Stone Age to the Nuclear Age. Cleveland: World Pub., 1958. Print.

[5] Chronographs Archived March 16, 2012, at the Wayback Machine. Accessed 25 March 2012

[6] http://www.wired.com/2011/04/skywatch-chrono/ Wired (magazine)

[7] Louis Moinet unveils the world’s first chronograph, Monochrome-watches

[8] A technical perspective, the chronograph, Xavier Markl, Monochrome-watches

[9] De, Carle Donald. Watch and Clock Encyclopedia. Ipswich England: N.A.G., 1983. Print.

[10] http://www.onthedash.com/thoughts/heuers-innovation-the-rotating-tachymeter-bezel-for-race-timing/

[11] http://www.wisegeek.com/what-is-a-tachymeter.htm

[12] “James H. Ragan: NASA’s man behind the MoonWatch”. *Press Release*. OMEGA SA. 21 July 2009. Retrieved 9 April 2011.

[13] Linz, Alexander; James H. Ragan (June 2009). “How Omega Got to the Moon”. *Watch Time*: 124–125. Once and for all: it never happened that way. That story s a complete invention.

[14] “Chronometer”. Columbia Electronic Encyclopedia, 6th Edition (2011)

[15] Stein, Jeffrey M. (2008), Project 99 – The Race to Develop the First Automatic Chronograph

[16] So what is a Chronograph and why is a Chronometer? chronograph.org.uk Accessed 25 MAR 2012.

[17] Baugh, Frank G.; Benjamin Jr, Ludy T. (2006). "Walter Miles, Pop Warner, B. C. Graves, and the Psychology of Football". *Journal of the History of the Behavioral Sciences* **42** (1): 3–18. doi:10.1002/jhbs.20134.

[18] Vroom, G. B. (1923). "THE LANGLEY CHRONOGRAPH". *Journal of the American Society for Naval Engineers* **35**: 375–380. doi:10.1111/j.1559-3584.1923.tb00184.x.

[19] Jin-He, Tao (2006). "The General Method For Fixing the Gauges of Relativistic Astronomical Reference Systems". *Astrophysics & Space Science* **302** (1-4): 93–98.

[20] Mond, Robert L., and Meyer Wilderman. "A New Improved Type of Chronograph". Philosophical Magazine Series 6 (2003). Taylor and Francis, 16 Apr. 2009.

[21] *William Pogue's Seiko 6139 Watch Flown on Board the Skylab 4 Mission, from his Personal Collection... The First Automatic Chronograph to be Worn in Space.*

[22] *The "Colonel Pogue" Seiko 6139*, dreamchrono.com.

[23] Chronograph Functions Chronomaster Mechanical Watches. Accessed 25 March 2012.

7 External links

- Chronograph watches Keulen, Robert. 1996. Accessed 25 MAR 2012
- Patek Philippe Chronograph Comparison Gray & Sons NOV 2014
- A technical perspective, the chronograph, *Monochrome-watches, Xavier Markl*, February 2016
- TAG Heuer's 01 chronograph watch movement explained with videos WatchTime June 2016

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