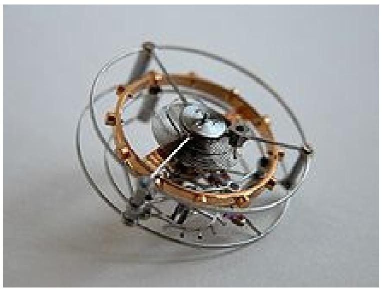
TOURBILLON   clockworks ... for special JTP unique watches

Stuhrling Tourbillon Movement (high resolution)

In horology, a **tourbillon** (pronounced /tʊərˈbɪljən/, French: [tuʁbijɔ̃], "whirlwind") is an addition to the mechanics of a watch escapement. Developed around 1795 by the French - Swiss watchmaker Abraham-Louis Breguet from an earlier idea by the English chronometer maker John Arnold a tourbillon counters the effects of gravity by mounting the escapement and balance wheel in a rotating cage, ostensibly in order to negate the effect of gravity when the timepiece (and thus the escapement) is rotated. Originally an attempt to improve accuracy, tourbillions is still included in some expensive modern watches as a novelty and demonstration of watch making virtuosity. The mechanism is usually exposed on the watch's face to show it off.

Mechanics of the Tourbillon



An assembled tourbillon, clearly showing balance wheel, pallet fork and escape wheel.

Gravity has a direct effect on the most delicate parts of the escapement, namely pallet fork, balance wheel and hairspring. Most notably the hairspring, which functions as a regulator for the escapement and is thus the most sensitive part to any exterior effects, such as magnetism, shocks, temperature, and inner effects such as pinning positions(inner collets), terminal curve and heavy points on the balance wheel.Many different inventions have been developed to counteract these problems. temperature and magnetism have all but been eliminated as problems with new materials. Shocks have much less effect today than at Breguet's time thanks to stronger and more resistive materials. The escapement still gets deregulated at the moment of the shock, but the hairspring does not get as easily deformed from shocks as before.

Gravity comes into play on the remaining effects, one of them is easily taken away, namely heavy point on the balance wheel. This leaves pinning point and terminal curve. Both of these are what adds a lot of variation to the regulation of a watch, depending on how it is assembled and regulated by the watchmaker and positioned in the watch and later by the owner. As the balance wheel goes from one extreme position to the other in its swing back and forth, the hairsprings coils extend and contract a great deal, leading to problems that are extremely hard to counteract. Some have tried using hair springs that are cylindrical or even spherical instead of flat as is prominent today. Some variations of Breguets over coil have been developed to counteract the effects of the terminal curve. As for the pinning point, Grossmann, Berthoud, Breguet, Caspari and Leroy [1] tried many different things, but not much was gained.

The biggest obstacle for a watchmaker regulating a watch, even today, is getting a similar result from the escapement no matter the position it is kept in. This has been made infinitely easier with accurate timing machines which give instantaneous timing results, where as in Breguet's time all that watchmakers had was a another watch to regulate from, so results were not very exact and it could take weeks to get them. Effects of gravity on an escapement can have quite significant effects with slight variations of position, even if a pocket watch was most of the time in a breast pocket, the exact position could still vary over 45°. A tourbillion quite neatly takes away this problem. The watchmaker now only needs to regulate for 3 different positions, instead of 6 like before. Those are two horizontal positions, dial up and down, and four vertical positions, crown at 12, 3, 6 and 9 o'clock.

A tourbillion most often makes one complete revolution per minute, which has no effect in the two horizontal positions, but makes all the difference in the 4 vertical positions, since even if a watch is stationary in a random vertical position, the tourbillion makes the escapement spin around its own axis, effectively cancelling out the effects of gravity of each of the 4 generalized positions. Even today with new materials and improved theories, is it nearly impossible to regulate a watch so it keeps the same time in all positions. A tourbillion allows watchmakers today to obtain results that are better than normal mechanical watches. Although, this is still immensely inferior to quartz, which normally vary 3 seconds per month, where a good mechanical watch keeps 3 seconds per day.

Mechanical watches today are mostly sold to buyers who value craftsmanship and aesthetics over very accurate timing. Most tourbillons use standard Swiss lever escapements, but some have a decent escapement.

The tourbillon is considered to be one of the most challenging of watch mechanisms to make [2] (although technically not a complication itself) and is valued for its engineering and design principles. The first production tourbillion mechanism was produced by Breguet for Napoleon in one of his carriage clocks (travel clocks of the time were of considerable weight, typically weighing almost 200 pounds).

Double-axis tourbillon

In 2003, inspired by the double axis tourbillon invented in the 1970s by Richard Good (see below), the young German watchmaker Thomas Prescher developed for the Thomas Prescher Haute Horlogerie the first flying double-axis tourbillon in a pocket watch and, in 2004, the first flying double-axis tourbillon with constant force in the carriage in a wristwatch. Shown at the Baselworld Fair 2003 /2004 in Switzerland.

A characteristic of this tourbillon is that it turns around two axes, both of which rotate once per minute. The whole tourbillon is powered by a special constant-force mechanism, called a *remontoire*[3]. Thomas Prescher invented the constant-force mechanism to equalize the effects of a wound and unwound mainspring, friction, and gravitation. Thereby even force is always supplied to the oscillation regulating system of the double-axis tourbillon. The device incorporates a modified system after a design by Henri Jeanneret.[4]

Modern tourbillon watches

In modern mechanical watch designs, a tourbillon is not required to produce a highly accurate timepiece; there is even debate amongst horologists as to whether tourbillons ever improved the accuracy of mechanical time pieces, even when they were first introduced, or whether the time pieces of the day were inherently inaccurate due to design and manufacturing techniques. Nevertheless, the tourbillon is one of the most valued features of collectors' watches and premium timepieces (Ref. August 2006 WatchTime article *Girard-Perregaux's Tourbillon Icon*), possibly for the same reason that mechanical watches fetch a much higher price than similar quartz watches that are much more accurate. High-quality tourbillon wristwatches, which are usually made by the Swiss luxury watch industry, are very expensive, and typically retail for at least thousands of dollars or euros, with much higher prices in the tens of thousands of dollars/euros being common. A recent renaissance of interest in tourbillons has been met by the industry with increased availability of time pieces bearing the feature, with the result that prices for basic tourbillon models have receded somewhat in recent years (where as previously they were very rare, in either antiques or new merchandise); however, any time piece that has a tourbillon will cost a great deal more than an equivalent piece without the feature.

Modern implementations typically allow the tourbillon to be seen through a window in the watch face. In addition to enhancing the charm of the piece, the tourbillon can act as a second hand for some watches as it generally rotates once per minute. However some Tourbillons spin faster (Gruebel Forsey's 24-second tourbillon for example.). There are many "Tourbillon" fake/replicas of premium brand watches that emulate this feature with the oscillating balance wheel visible through the watch dial; however, these are not tourbillons. This feature is often referred to as "open heart".

In the late 20th century, the first research into multi-axis tourbillion movements was done by British clock makers Anthony Randall and Richard Good

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(wikipedia sources / tourbillion description)