

ESCAPADES

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In our family, it was ordained that a boy child should have an interest in watches. The first nickname to which I answered was "Tick-Tock," hung on me by an older cousin whose watch I always demanded to hear the moment I saw him. I no longer remember that watch, but it was probably distinctive; for my grandfather had started a company to make watch cases with capital furnished by his grandfather, and both our households overflowed with watches of every kind and description, their cases often designed by the cousin and produced under the supervision of my father.

Watches were in our genes. My great-grandfather had invented an early stem winding mechanism in the 1870's. Thinking that as a Crown Subject he could not apply for a U. S. patent, he sold the idea to Waltham for ten thousand bucks. Family legend insists the Old Boy was hornswoggled. I'm not so sure. He might just have been pretty canny to collect the loot while passing along the bother and expense of developing and marketing a better mousetrap. Later, during the First World War, my father's older brother invented a standard feature of the modern wristwatch. While Pa was making the world safe for democracy, Uncle Arth - the second of the family to forgo the Patent Office - was designing a water-resistant case for use in the trenches and inventing those little spring bars that hold the strap or bracelet of a wristwatch to its lugs. Wadsworths seemed destined to tick and tock right down the generations.

As a boy, I lived in an atmosphere of watches, spending lots of time at the factory and with the makers' reps who regularly stopped at our house. At fourteen, I toured the plants of Waltham, Elgin, and Hamilton; at twenty, the Girard-Perregaux works in La Chaux-de-Fonds. The upshot has been a lifelong fascination with watches and something of an insider's appreciation of their innards as well as of their faces and their skins. I'm not a collector of watches, but I'm sufficiently alert to them that Gibby Carey has warned the unsuspecting to, and I quote, "Look out! Ducky is a man who notices your watch."

The paper that follows ticks between two Englishmen, prodigies of horology at opposite poles in the story of the mechanical watch, inventors whose names you might all recognize if only their timing had been better. But the ship of world fame sailed away without the first, while for the second it may never sail at all.

Let me cut to first of these figures by asking you to recall your first watch. A hand-me-down? An Ingersoll ("The watch that made the dollar famous")? A Mickey Mouse? Or, Heaven forbid, one of those cheap watches put out under the Wadsworth name after our company became a subsidiary of Elgin in 1950? Unless you grew up after quartz, when you looked at that watch with the wondering eyes of boyhood, you ought to have thanked Thomas Mudge for the miracle of reasonably accurate time on your wrist.

Thomas Mudge: not a refugee from a children's book with humorous names or a character out of Dickens, but a London watchmaker, whose invention, the lever escapement, has been at the heart of most mechanical watches for over 150 years. John Diehl will probably recognize Mudge, and perhaps a handful of others present, a proportion I'd guess obtains in the world at large. Eminent in his own day, maker to royalty and producer of historic watches brimming with innovation, Mudge has been eclipsed in fame by his older contemporary John Harrison, winner, for his marine chronometer, of the British Parliament's longitude prize.

It is not hard to see why Harrison has figured more prominently in popular history than Mudge, given the dramatic appeal of his epic struggle against obstacles both scientific and political. Still, Harrison's only lasting contribution to watchmaking was his so-called maintaining power, a mechanism that kept his chronometer running while it was being wound.

The escapement that ultimately regulated Everyman's watch was invented in 1754 by Mudge. Here is the OED definition of escapement:

In a watch or clock, the mechanism which intervenes between the motive power and the regulator, and which alternately checks and releases the train, thus causing an intermittent impulse to be given to the regulator.

Mudge's lever escapement didn't take over at once, but by about 1830 it had been modified by the Swiss into its current configuration and was well on its way to dominance. This escapement existed in two forms. The version that became the heart of watches pretending to quality had jeweled pallets where the lever engaged the escape wheel and is usually called the "Swiss Anchor." In the other variation, the tips of the lever that engaged the escape wheel were merely steel pins. It was this cheaper version that ticked away in the first workingmen's watches of the mid-nineteenth century, in the Ingersoll "Dollar Watch" and its cousin the Mickey Mouse, and in the Danbury and Westclox alarm clocks. After the Second World War, a later variant of the pin-lever escapement ticked noisily in the first Timex.

A complete and satisfactory explanation of the Swiss Anchor is as far from necessary here as it is beyond my ability to deliver, but a quick sketch may help you understand both its one crucial shortcoming and, later, a modern attempt to fix it. The first component is the club-toothed escape wheel, which receives power from the mainspring through a train of intermediate wheels. This wheel is alternately checked and released by a lever moved by the action of a balance wheel that oscillates under the power of a hairspring. The lever resembles a miniature anchor, except that the flukes point downward. The anchor is pivoted at the base of its shaft, between the flukes, so that any up or down motion of the flukes will move the top of the lever, and vice-versa. When the rotation of the balance wheel rocks the lever and releases a tooth on the escape wheel, the tooth thus freed scrapes rapidly for about a millimeter against an inclined face on its corresponding fluke or pallet, forcing it further up. This sharp upward movement

causes the top of the lever to impel the balance wheel through the rest of its oscillation, until the hairspring causes it to reverse its direction and repeat the process going the other way.

If that is not entirely clear, don't worry. The crucial point is this: the lever escapement moves the balance wheel without recoiling against it and so disturbing its motion, which is a Good Thing. But here's the rub: the scraping of escape wheel teeth against jeweled pallets is sliding friction, which requires lubrication. In a typical application today, this adds up to a quarter mile of sliding contact every day. As the lubricant dissipates or breaks down over time, the increased friction affects the amplitude of the balance and the rate of going. While parts can be designed to minimize dissipation and modern synthetic lubricants hold up better than ever, what Abraham-Louis Breguet famously said to Louis XVI still applies: "Sire, if you will find me the perfect oil, I will make you the perfect watch." Even the best watch with this escapement should be serviced every three to five years to maintain its rate and to avoid damage.

The dominance of the continental anchor has owed less to the inherent qualities of the escapement than to the Swiss mastery of process. Swiss makers have long been rationalized to keep competitors at bay. From early on, the master assemblers of high quality watches, gathered for the most part in quite small production facilities, could rely on specialized makers of geared wheels, springs, jeweled bearings, levers, plates, bridges, dials, hands - almost everything they needed. The Swiss had also evolved the manufacture of *ébauches*, rough movements in uniform sizes that could be worked up into watches of superior grades by the addition or substitution of better parts and by hand finishing improving both performance and appearance. Once established, the improved lever escapement spread rapidly through this tightly organized trade, generating an inertia that would keep it in place. While the modified lever was not the perfect escapement, it was good enough to help the Swiss to an ever larger share of the market. Even so, the Swiss enterprise still resembled a cottage industry until after the American Civil War, when a study of American methods prompted a radical shift in home manufacture.

I had always assumed that the American makers industrialized by imitating the methods of Whitney and Colt. A different tale is told by David Landes, Coolidge Professor of History and Professor of Economics at Harvard in his standard one-volume history, *Revolution in Time*. Landes argues that in fact the uniformity principle had been successfully applied to the making of wooden clocks as early as 1803 by one Eli Terry. Terry in turn was the teacher of Seth Thomas and of Chauncey Jerome, who began making brass clocks with interchangeable parts in 1837. Refining Jerome's methods to make smaller parts to closer tolerances, American firms started up to make watches in quantity: Howard in 1857, Waltham in 1859, Elgin in 1864, Illinois in 1869. The Swiss were unimpressed.

But not for long. In 1876, dismayed by the numbers and quality of American watches, the Swiss industry sent an official representative to the Centennial Exposition in Philadelphia. After a further visit to the Waltham plant, this emissary returned to Switzerland with the news that the American factory timepieces were as reliable and

accurate as the best Swiss ones assembled by hand, and this at a time when the annual production of Waltham alone challenged that of the entire Swiss enterprise. The Swiss moved at once to study and then to emulate their rivals, so that by the turn of the twentieth century, most of their watches, too, were factory made by the American method, which relied on the manufacture of large numbers of parts that were then measured for conformation to standard, sorted by weight, diameter, or force, and then matched accordingly. As Landes says, "No need, then, for fine tuning: just choose a target and let statistical distribution take care of the rest." (Landes, 1983, 316.)

During the Civil War, the Swiss had flooded the American market with cheap watches inferior to the domestic product and named to confuse buyers. Americans, once bitten, were easily prompted to buy the increasing numbers of reasonably-priced watches made at home. Hampered as well by high American tariffs, the Swiss were not again a force here until after 1900, when they exploited a customs loophole: they could pay less on watches imported by American agents and cased here. The only problem was where to find cases of high quality that would fit Swiss movements, made in their own unique range of sizes. (I need not tell you what northern Kentucky firm was for many years the only one to fill that bill.) At the same time, three makers opened American works to finish movements made in their own Swiss factories: Benrus, Bulova, and Cincinnati's own Gruen, all of whose famous Veri-Thin and Curvex cases also came from just across the river in Dayton.

The 'twenties and 'thirties were by and large better for the Americans than for the Swiss, their European markets devastated. The Swiss first engaged in some ruthless consolidations, at the same time strongly encouraging makers not to shop elsewhere for components. When these remedies proved inadequate in the Great Depression, the Swiss Government sponsored the creation of a national cartel that lasted till after the Second World War. In the meantime, the American makers stayed alive by sliding down market, conditioning their buyers to think of the watch as a cheap commodity rather than as a fine instrument or as jewelry.

This was also an era of increasing hype in the industry. The Swiss touted refinement and Old World craftsmanship, the Americans value for money. The one major innovation of this period, the self-winding watch, failed to take off, largely because the rotor in the original mechanism did not swing full circle but thudded annoyingly against a bumper at either end of its travel. Even so, Rolex did sell quite a few of their "Oyster Perpetual," leading many to believe that they had originated the automatic, actually invented by John Harwood, another Englishman largely lost to history. After the Second World War, when Eterna perfected the modern self-winder without bumpers, the Americans missed the boat. Complacent behind our tariff, we didn't bother to make a decent automatic, and the premium forced on the Swiss by that same tariff suddenly seemed reasonable. Bad days were ahead, but not, as it turned out, for the Americans alone.

Still, while the good times ticked, both the high-end Swiss shops and the industrial firms in both countries made watches able to keep remarkable time, if never

perfect time. The top grades were adjusted by the makers, tested over time to check their variance from strict timekeeping in each of several positions and under different temperatures. An experienced adjuster, finding an error under a particular condition, must have a good idea what parts need to be modified or swapped to improve performance. The process is usually illustrated by the mathematicians' analogy of the drunk and the lamp post: a man so sozzled he cannot take more than one or two steps without randomly changing direction tries to walk away from a lamp post but finds that he keeps circling back to it, having never traveled very far. The adjuster's job is to make the drunken watch's circle as small as it can be. The likelihood that the watch will not stagger at all, much less that its stagger will be uniform under all conditions, is nil. What the serious owner of a new mechanical watch can do is to let it "settle": that is, wear it for a while until the oil reaches working consistency and the watch's rate reflects his own patterns of movement. Then he should have the watch regulated to tune out the average daily error.

Until the middle 'fifties, almost any American who wanted a watch capable of good timekeeping could afford one and, with a little effort, have it perform up to specs. Then came the Timex, a watch so cheap its abysmal performance--perhaps two minutes a day--didn't matter to buyers interested in a rock-bottom price. Timex systematically invaded one market after another, converting large numbers to the throwaway persuasion. The other American companies continued their swoon, guaranteeing that your Tick-Tock here would not ply the family trade but would instead be inflicted on several generations of hapless students.

As they had done earlier before adopting American methods, the Swiss made a study of the competition and were about to fight back when something even worse happened, partly brought on by themselves. It was a Swiss firm, Bulova that brought out the first electronic watch. (Anyone remember the Accutron with its tuning-fork regulator?) As early as 1969, Girard-Perregaux made a quartz-crystal watch movement that vibrated at 32,768 times a second, creating what later became the world standard. A series of trials pushed by the Swiss industry turned up some cumbersome quartz wrist chronometers by Omega that could humiliate any conventional watch ever made. So what did the Swiss do? They decided not to jeopardize their conventional business by getting into quartz watches and abandoned the technology to the rest of the world with a result that everyone knows. Before long, quartz watches from the Far East so outclassed the original Timex that they could go for several times its price and still undersell the better mechanicals by enough to clean up in the market, finish off the Americans, and put the Swiss on the ropes.

By the early 'eighties, the Swiss seemed to have only two options: they could try to make something of the shrinking market for high quality mechanical watches, or they could use their unrivalled skill in the machining of tiny parts to crank out numbers of cheap movements and parts to sell wherever they could. Their expertise gave them an advantage not only in mechanical movements, after all, but in quartz movements with analog dials, since both involve gear trains, long their province. They could even compete in the purely electronic realm as well, since some branches of their holding

company for movements had developed competitive quartz modules. But such a course would invert their usual practice of fanning out the cruder work while doing the finishing at home, and, worse, it would devalue a hard-earned reputation for high quality. It would be dangerous as well because customers for upstream parts need not remain with the Swiss for the sake of tradition alone if Indians, Thais, or Chinese could undersell them.

They went both ways. This was thanks largely to the Swatch, developed in 1979 by Ernest Thomke, at that time head of Ébauches, S. A., the leading Swiss maker of movements. In the early 'eighties, the banks that controlled Ébauches and its holding company brought in an Austrian consultant, Nicholas Hayek, who took charge not only of finances, but of marketing the Swatch in the United States. Since then, profits from the sale of throwaway plastic watches have made possible the investments in manufacture and marketing to save the mechanical watch as a moneymaker. The number of Swiss firms in the industry may have fallen from 1,600 in the 'fifties to some 600 today, but those remaining firms are sitting pretty, whether they make components or movements, whether they supply watches to the top, the middle, or the bottom of the range. The Swiss have survived by reverting to form and allowing Mr. Hayek to become the Bill Gates of the industry.

If the stereotypical French male's fantasy is horizontal, that of a Swiss is probably vertical. Remember that the Swiss makers have a history of monopolistic practices, then look at Swatch today under Hayek, a monopoly in the making if ever there was one. Swatch holding companies own Ébauches (now renamed ETA), Nouvelle Lemania, and F. Piguet, together the largest producers of movements to the trade. They control Nivarox and FAR, the sole producer of springs and the largest maker of escapements. Some parts from one or both of these companies are found in almost every Swiss watch, mechanical or quartz, and in millions of watches assembled elsewhere. Swatch owns two of the most respected large makers of cases. Among watch brands, they own Breguet, Blancpain, Omega, Rado, Longines, Tissot, Hamilton, Certina, Mido, and Swatch. In addition, they control several specialty brands and two high-end German makers, Glashütte Original and Union Glashütte. Rather than buy from foreigners for less, other Swiss firms deal with Swatch, even when this ends in paradox. Consider Eterna, still independent of Swatch, who nevertheless buy from the combine all their mechanical movements, every one of them wound by a variant of Eterna's own 1948 auto-wind module. In looking at Swiss brands, it is easier to say who does not use movements from the Swatch Group than to say who does: Patek-Philippe, Zenith, Parmigiani, Jaeger-Le Coultre, Rolex, Chopard, and a handful of small makers almost none of us would recognize. Moreover, the great preponderance of watches certified by the Swiss as "chronometers" come from only two sources, Swatch and Rolex.

"Chronometer" was once reserved only for large marine timepieces. In 1973, the several Swiss facilities that had been testing and certifying the performance of watch movements were consolidated into one body, known as COSC, and began to certify as a "chronometer" any movement that passed a series of tests for consistent performance in five positions and over a range of temperatures. A certified movement is guaranteed to run between plus six seconds and minus four seconds per day. In fact, most of the

movements so certified run better than that, keeping time, once they have settled, to a couple of seconds a day. This uniformly high performance results largely from the shift to watches that beat at 28,800 beats per hour, as opposed to the former standard of 18,000. One company, Zenith, even builds watches that run at 36,000, but these are notorious for needing expensive service at short intervals.

The COSC figures for 2001, the last I've been able to find, are revealing. Out of more than 1.2 million mechanical movements tested, only 4.5 percent failed. Of this total, 64 percent or more than 760,000 movements were submitted by Rolex, all of whose mechanical movements are certified for purposes of advertising. (If you thought Rolex was anything but mass produced, think again.) Next highest are Omega, with over 207,000 or 17 percent, and Breitling at 142,000 for some 11 percent. The Omegas, the Breitlings, and all but about two percent of the rest of the brands tested use movements made by ETA or one of the other Swatch companies. And - oh, yes - there is still one Earnshaw-derived marine chronometer being certified: it is made in Russia by Poljot and incongruously marketed by Girard-Perregaux as the John Harrison model.

Why are there so few chronometers from such prestige makers as Patek-Philippe, who presented only 1,286 movements? According to the head of COSC, the reason is that the best performing movements were designed from the start to achieve the standard and then made with machines so expensive that they can be amortized only with large production runs. These state-of-the-art movements exploit computer-aided design and laser-assisted manufacture to achieve miracles of precision never before known in mass production. The in-house movements of most of the smaller companies can meet the standard only after a great deal of expensive hand adjustment. In fact, some highly respected firms, rather than add to the cost of their own tweaking the additional \$250 or so that COSC charges, simply forgo the chronometer rating altogether. Jaeger-Le Coultre, for example, claim to test each of their watches for 1,000 hours, and they charge accordingly.

If any of you should sport a contemporary mechanical watch that says "chronometer" on its dial and is not a Rolex, you should not be shocked, shocked to learn that you almost certainly have a movement from one of the Swatch companies. The usual suspects are the ETA 2892 A2, the Valjoux 7750 (for chronographs), The ETA 2824, and a couple of recent chronograph movements by F. Piguet. Some makers claim to have modified a Swatch-Group works so radically that they can legitimately call the finished product an in-house movement (which lends snob appeal in some circles); but houses that suppress completely the origin of such a movement take a big risk: Swatch typically stiffens such makers when they need parts for repairs. Smart firms play the Swatch game, as in the case of the latest offerings from Tiffany, their "Mark" series. A recent ad shows the works of one watch through its display back. The plate is hallmarked "ETA 2892 A2." You bet! Tiffany has secured the best combination of performance and robustness available in industrial quantities, while preserving access to parts down the road.

No need today to cry for the Swiss. The Federation of the Swiss Watch Industry reports that out of the 500 million or so finished watches produced world wide in 2002,

28.3 million (or about 18 percent) were Swiss. (For a watch or movement to be called "Swiss," it must contain 50% parts made in Switzerland and be assembled there.) But this 18% of world production represented over 40 percent of the value reaped by the entire industry, and over half of that value resided in the 2.9 million finished Swiss mechanical watches. With only 10 percent of Swiss sales but 20 percent of world value and over half of Swiss value, those watches are a cash cow. You can bet that the Swiss, having not long ago nearly sold the farm, will milk Bossy for all she's worth.

But why, in the age of quartz, does the old technology still appeal? Let me turn to Professor Landes, for he is as grave, rational, scholarly, and eloquent as I am not.

It is hard to love a quartz timepiece. . . There is really nothing to see . . . But a movement! That is something else. A good movement, especially a complicated one, has art and grace and life. The parts sweep and swirl. Every edge is carefully beveled. The screws are sometimes heated to a deep electric blue. The bridges and plates are gilded or highly finished, and often decorated, chased, or damascened. The red jewels gleam, usually in a setting of gold. The balance wheel swings tirelessly to and fro; the hairspring breathes; the pallet arms move in and out like a living being. It is hard to believe that so much can be squeezed into so small a space. Even someone who knows nothing about the mechanics of timekeeping can admire so cunning and artful device. (Landes, 1983, 352.)

I've come back to a similar appreciation: after some fifteen years with quartz, I like knowing that inside my watch there isn't just another Oakland, California - the place of which Gertrude Stein said that there was "no there there."

The market for mechanicals today, buoyed from without by the sales of quartz pieces, is sustained from within by a wide range of buyers. I know a collector who retains as his advisor the former maker of Tiffany's watches. This man is willing to pay up to \$100,000 for a new minute repeater by the likes of Michel Pannigiani or the American master Roland G. Murphy. Other very dear pieces by the likes of Franck Muller of Geneva, a favorite with the celebrity crowd, go for tens of thousands. Many of these highly finished pieces are furnished with display backs, to show off their decorated works. But the bulk of production features the industry's "tractors." Some of these, too, have display backs, although the decoration is more likely to be the work of robots than of gnomes, a simulacrum of old-fashioned workmanship meant to shore up a luxury price tag. The no-nonsense folks at Rolex don't bother with display backs, and the insides of their watches are in fact quite disappointing to horologists. One pays the Rolex premium for engineering, not for finish. At the other end of the scale, the numerous lovers of the military style can have a handsome and accurate piece for a few hundred dollars, as these are turned out in droves by a number of Swiss and German firms, usually employing either the ETA 2824 or the Valjoux 7750. Several web sites help enthusiasts stay up to speed with new models and with the pricing practices of the marketers, which in some

cases are as slippery as ever. ETA sells makers two versions of the 2824, one at about \$60 and the other at about \$90, yet watches with these movements range in price from less than \$400 to around \$2,000. It's Rosie O'Grady and the Colonel's Lady all over: the bargain drab and the high-maintenance consort are sisters under the skin. The staff of jewelry stores, the pimps and madams of the trade, love to rip off the Johns by confounding the two. Knowing buyers work with authorized dealers specializing in timepieces. Only bottom-feeders rely on Ebay, favorite resort of the Frankenwatch, cobbled from pieces of classics.

Between these extremes, there are many watches suited to a wide range of motives, from mere snobbery and pure Veblen-style conspicuous consumption to the romantic, the technical, and the esthetic. Luckily, there are enough collectors, snobs, and label shoppers that an ordinary buyer can still get a thoroughly satisfying mechanical watch and escape with all his limbs.

Some 35 percent of Swiss mechanicals go to the European market, about 15 percent to the States. "Old Europe," it seems, still values tradition. In America, a gold Rolex may glitter above the manacles of the odd corporate perp as he's led away, but it is no longer routine here, as it still is in Europe, for "crats" of all stripes who have arrive signal their standing with mechanical watches from prestigious houses: aristo-, auto-, bureau-, Euroc-, Pluto-, techno-: name your crat. Some of the remaining buyers, many whom populate watch web sites, are simply watch enthusiasts, sometimes even amateur makers and repairers of timepieces. Regulars on Timezone, the largest serious watch community on the web, call themselves watch idiot-savants (abbreviated WIS). They exchange a great deal of information on vintage watches and on the history and continued production of their favorite makes. From the amount of traffic on this site, and it comes from all over the world, I'd guess that the market won't dry up in the immediate future. Indeed, the number of Swiss movements has gone up in each of the past two years and still climbing, world disruptions notwithstanding.

Thomas Mudge's invention has had a remarkably long run, even survived a Near Death Experience, but that doesn't mean it is beyond improvement, or that the mechanical watch trade shouldn't still welcome all the help it can get. Writing in 1983, Landes included this intriguing note:

British horologist George Daniels tells me that he has invented an escapement that will revive the fortunes and reputation of the mechanical watch. The trouble is that he has not yet found a Swiss manufacturer ready to undertake commercial production. (Landes, 1983, 352.)

Who is George Daniels? What is his invention, and what has become of it since 1983? George Daniels, MBE and Honorary Doctor of Science, is easily the most significant English horologist and watchmaker since Harrison and Mudge. Other horologists and collectors from around the world regard him as one of the all-time masters of his craft, with an unparalleled understanding of the geometry and physics of

the mechanical watch. His invention is an essentially frictionless escapement that requires no lubrication and thus promises to lengthen the maintenance cycle of the mechanical watch. After a struggle against Swiss intransigence dating from the 'seventies, Daniels at last found in Nicholas Hayek an entrepreneur willing to risk the production of watches using his innovative escapement.

Daniels has risen to his current eminence from an appalling background. One of eleven children of an abusive and improvident father, in 1939 he left school aged fourteen for a series of jobs that offered only occasional escape into a childhood fascination with watches. During military service in Egypt, he became a self-taught repairer of his mates' timepieces. Later, while working through a series of increasingly responsible jobs as a repairer, Daniels completed a three-year night course at the British Institute of Horology. Along the way, he completed one entire term's project in a single evening, causing his instructor to assume he had farmed it out. Luckily, the instructor's assistant and a classmate had seen the work in progress and could vouch for its authenticity. At the completion of the course, Daniels was awarded the Institute's top prize.

Success as a repairer made it possible for Daniels to indulge another passion, restoring and racing vintage cars. A chance meeting in 1962 with Sam Clutton, a founder of the Veteran Sports Car Club and a notable collector of antique clocks and watches, opened a whole new career. Before long, Daniels was the restorer of choice for a growing circle of collectors and co-author with Clutton of a book on antique watches. At about this time Daniels also came to know George Brown, who owned Breguet of Paris, whose founder and namesake, Abraham-Louis Breguet, had long interested Daniels as the model watchmaker. Brown, a businessman with almost no knowledge of watchmaking, needed an associate with Daniels' knowledge; Daniels wanted access to Breguet's archives, the better to study the master's methods. Brown made Daniels his Agent, commissioned a clock from him, and eventually even proposed a watchmaking partnership. Daniels preferred to remain on his own but continued to do repairs on historic pieces for Brown's clients and so preserved his access to Breguet's records, with two important results: a definitive book on Breguet that appeared in 1975 and the firming up of Daniels' ambition to create his own complicated watches, making every part himself and using the best classical hand-finishing techniques.

The first Daniels watch went to Sam Clutton. When Clutton showed the watch around, Daniels was at once swamped with orders for more, for it was clear that his work was in a class with that of such fabled masters as Berthoud and Breguet. Exhibiting workmanship that defies belief, Daniels watches have taken an average of two thousand hours each to make. They have also brought their maker wealth beyond the dreams of avarice, freeing him to follow his inclinations wherever they might lead.

One place they led was to the evolution a new escapement intended to help the mechanical watch survive quartz and perhaps keep Daniels himself from being merely an anachronism. Through the middle and late 'seventies, he made several experimental

pocket watches with slightly different versions of a new escapement that needed no oil. Tested independently, these watches were found to be remarkably stable performers.

Meanwhile, Daniels had a patent for his invention, gained only after a four-year battle against bureaucratic pettifoggery and incomprehension. At the same time he began trying to find a producer, exploiting both the contacts from his travels for Breguet and his reputation as a horologist and maker.

The Co-Axial escapement is sheer hell to describe without pictures (and probably worse to hear described). With luck, a crude naming of its components and their functions will give you some idea of how it works and of how it avoids the need for lubrication.

There are now two escape wheels, a smaller one mounted on the same balance staff above a normal-looking one, the upper now the one driven by the train. The balance wheel is mounted on a roller platform and is moved clockwise by a radial impulse directly from a tooth on the lower escape wheel and counter-clockwise by the action of a lever and pallet arrangement that receives a radial impulse from the upper, smaller escape wheel. After each impulse, the pallets corresponding to the downward-pointing flukes of the conventional Swiss Anchor lock the large escape wheel so the balance can continue its oscillation without recoil. Since the anchor pallets now have no function beyond this locking and unlocking, they require no lubrication. The radial impulses to the balance roller likewise require no lubrication. The latest version occupies no more real estate than a normal Swiss Anchor, so it can be adapted with relative ease to an existing movement.

Daniels claims several advantages for his design. There being no lubricant in the escapement itself, there should be no degradation in its performance over time, assuring greater stability over a longer period than is now usual. The new geometry of impulses to the balance guarantees superior consistency in its oscillations. This geometry also makes possible a smaller amplitude for the balance, reducing the effect of gravity on it.

Already rebuffed more than once by the Swiss, Daniels in 1975 fitted an Omega astronaut's watch with his escapement and took it to the company's plant in Bienne. Their head technician thought the principle sound, but there was no interest in gearing up for a half million watches to cover the cost of development.

In 1980, Daniels was approached by Patek-Philippe, the most prestigious maker of all. After a year of back-and-forth, the factory produced a prototype that stopped even as the technicians demonstrated it. When Daniels pointed out the fault in geometry that was the cause of the problem, he was told that Patek's engineers simply did not make watches with his geometry. Daniels took the watch home, altered the offending parts, and returned it in running order. His reward was to be told that the escapement made the watch too thick for Patek to sell in any case. More work produced a slimmer variant of the escapement. This found its way into several prototypes, all of which ran badly because the engineers had once again ignored Daniels' geometry in favor of a sacred

industry standard. Patek of course did not want to produce a watch that wouldn't work, but they were equally unwilling to make it Daniels' way, so the project came to an end.

This episode proved happier for Daniels, yielding more amusement than frustration as the technicians prototyped his unique ideas on computers and kept finding, to their surprise and the inventor's gratification, that, after more than fifty years of deep study, he did in fact know his angles and proportions.

Production models of the Co-Axial have been available since 1999, beginning with a limited edition and spreading slowly into the rest of the range. Omega claims that a watch with this escapement should not need to be serviced for as long as ten years. Initial reviews and anecdotal reports confirm that the watches perform to the highest standard, but many are skeptical of the promised ten-year cycle for maintenance. I can see five to seven years, but then I'd begin to be nervous about wear in the winding rotor or about the bearings of the mainspring barrel and the train.

The evolution of the mechanical watch ought to have ended with its *de facto* displacement by quartz. That it has not attests the power of nostalgia and advertising. A leading maker is now betting the Co-Axial escapement will show that innovation has a place even in today's market. And that maker is not alone, as I discovered only last week, long after the rest of this paper had been tucked into my hard drive. Sinn, a German supplier of watches heretofore exclusively based on ETA movements, plans to introduce an alternative solution to the lubrication problem. Their scheme simply replaces the steel escape wheel of the conventional escapement with a patented wheel of a special hardened alloy that requires no lubrication as it slides across the pallets of the anchor with no more friction, Sinn claims, than in current oiled movements. Production is to begin this year. Will this solution, which ameliorates sliding friction without eliminating it, prevail over a system that eliminates sliding friction altogether? Stay tuned.

If we might say of Mudge and Harrison that the commercial technician has outstripped the visionary in influence, if not in fame, we might say that the visionary Daniels may be helping to assure the continuance in their jobs of today's commercial technicians. Our story ends, nevertheless, as it began, in constrained historical reputation and curtailed fulfillment. Mudge, eclipsed in the collective memory by Harrison, was ahead of his time and died without knowing that his lever escapement would undergird personal timekeeping for 150 years. Daniels - his continuing reputation secure only among horologists, collectors, and determined lovers of the old fashioned - developed his new escapement a generation too late and hopes only that it might, as he says on Omega's web site, "sustain the public affection for the mechanical watch in the 21st century." May he glory in all the satisfaction to be had from that modest expectation.

Work Quoted

Landes, David. *Revolution in Time*. Cambridge, MA, The Belknap Press of Harvard University, 1983.