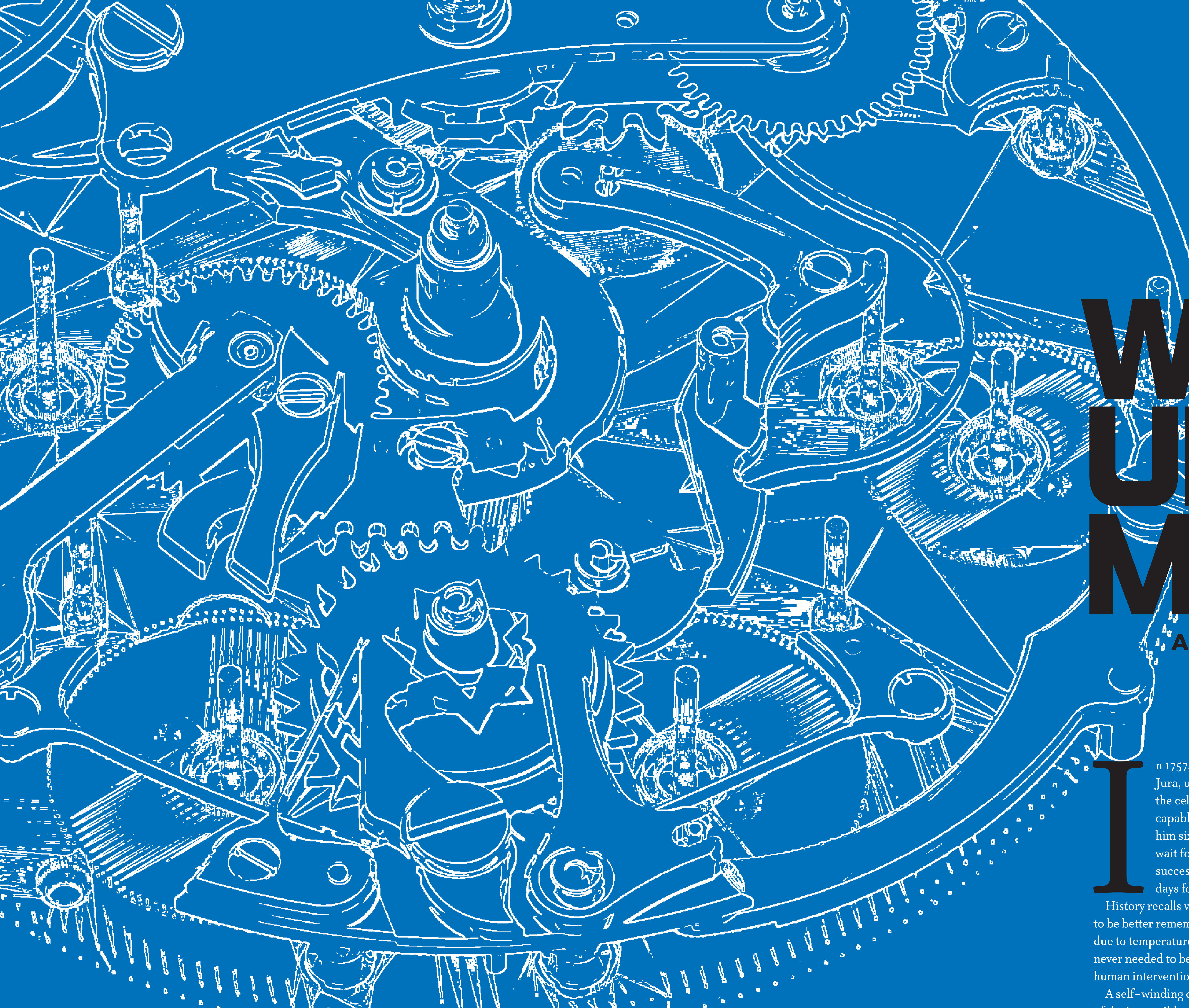


Today's automatic watches use high-tech ceramics and cutting-edge engineering to wring every last drop of power from the motion of the owner's wrist — but their story was centuries in the making BY JACK FORSTER

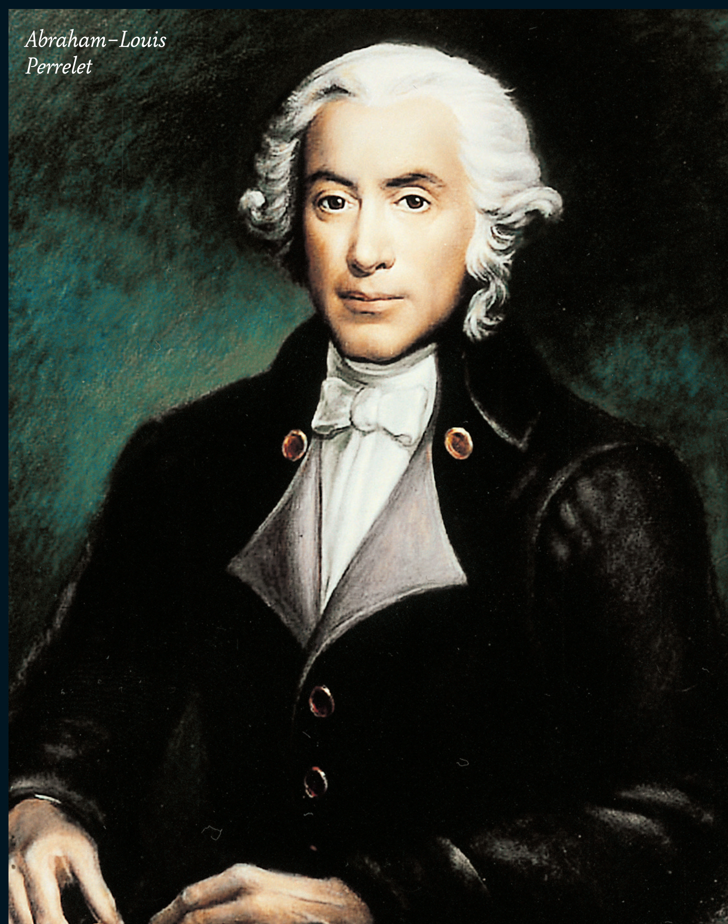
WIND ME UP, WIND ME DOWN

A HISTORY OF THE SELF-WINDING WATCH

In 1757, a young watchmaker named Pierre Jaquet-Droz, from the town of La Chaux-de-Fonds in the Swiss Jura, undertook a long and hazardous journey from Switzerland to Madrid. Jaquet-Droz, who later became the celebrated creator of some of the 18th century's most spectacular automata (robot-like figurines capable of executing complex movements, such as writing and playing musical instruments), brought with him six clocks, which he presented, after a month-and-a-half-long journey and another five months' wait for an appointment, to the King and Queen of Spain. The risky and expensive trip was a resounding success. Both the King and Queen were so delighted with the clocks that all were purchased within a few days for 2,000 gold pieces, and found places of honor in the royal palaces of Madrid and Villaviciosa.

History recalls vividly the automata associated with the clocks, but an almost-forgotten footnote to the event deserves to be better remembered. One of the clocks had a bimetallic mechanism, in which the unequal expansion of two metals due to temperature changes was exploited to move a series of levers that wound the mainspring. The clock, therefore, never needed to be wound by hand, and would, except for necessary maintenance intervals, run indefinitely without human intervention. This is perhaps the earliest known example of a self-winding timepiece.

A self-winding clock or watch holds a powerful attraction for both watchmaker and owner. There's a small touch of the impossible dream of perpetual motion in the idea; something that runs indefinitely is a little defiant thumbing of the mortal nose at the reality of entropy. For a watchmaker, the idea is attractive for two reasons. First, a constant replenishing of the source of power to the oscillator (whether a balance wheel or a pendulum) means less variation in the rate of the watch — a problem significant enough that clever inventions, from the remontoire d'égalité to the chain and fuseé, to elaborate and (mostly) impractical constant force escapements, have been developed and discarded over the centuries in order to address it. Secondly, it reduces the degree to which the owner needs to physically interact with the watch — which, from a watchmaker's perspective, is nearly always desirable, as the ham-fisted clumsiness of the customer's ministrations is the culprit behind any number of horological woes.

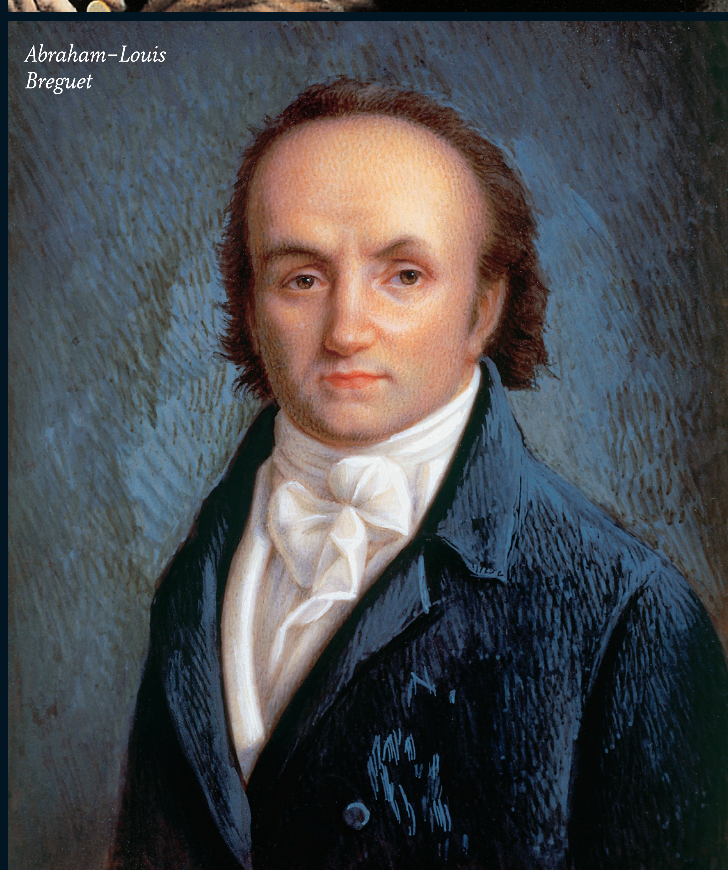

Abraham-Louis Perrelet

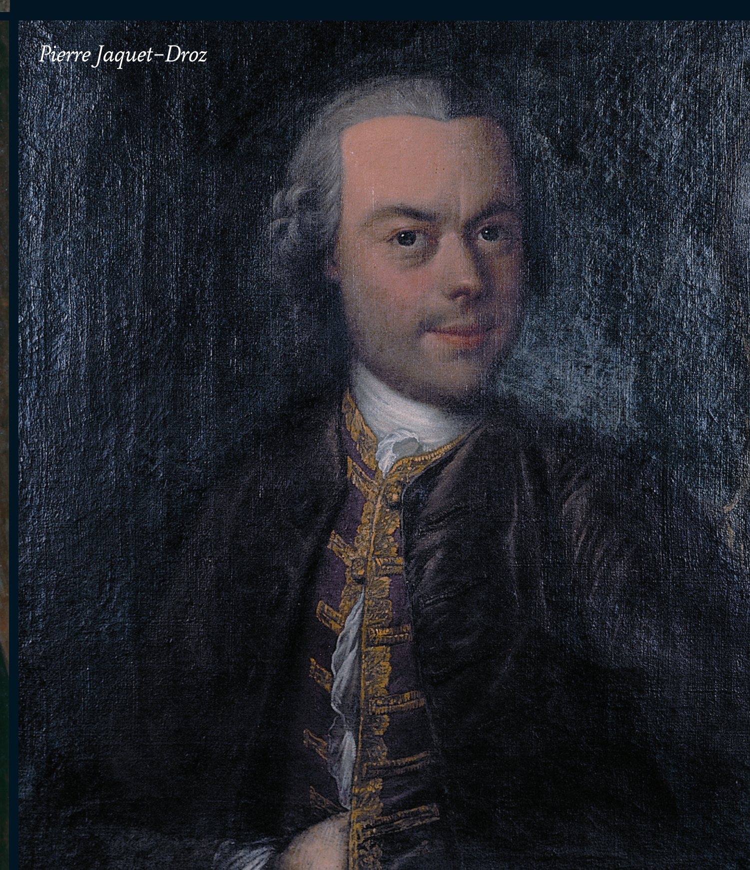
WHO INVENTED THE ROTOR? It's intriguing that despite early evidence that the potential of temperature change to wind a mainspring was appreciated as early as the mid-18th century, the idea seems to have essentially lain fallow for two-and-a-half centuries until it was revived in the United States, of all places, by an independent watchmaker named Steven Phillips. The obscurity into which the idea fell is all the more strange as the ingenuity of some of watchmaking's greatest names was devoted, for the next quarter millennium, to the perfection of a mechanism for winding watches mechanically.

> IT'S GENERALLY AGREED THAT ABRAHAM-LOUIS PERRELET INVENTED THE ROTOR-WOUND WATCH

Rotor-operated winding systems are not particularly suited to pocket watches, which were essentially the only kind of watch made in any numbers until the 20th century. This was because the pocket watch is in a static position for much of the time it's carried, and the slight to-and-fro movement it experiences is a meager diet on which to feed a winding mechanism. But it is generally agreed that the inventor of the rotor mechanism for automatic winding was one of the great watchmakers of the 18th and 19th centuries: Abraham-Louis Perrelet.

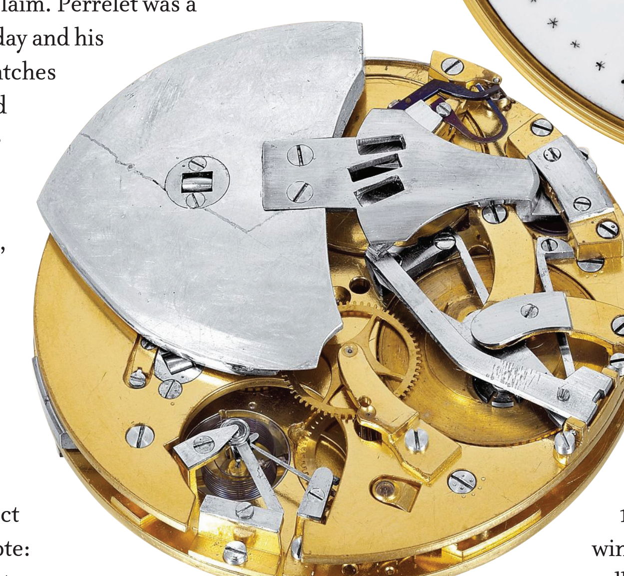
Perrelet was gifted, at a time when life was still generally "nasty, brutish and short", with great longevity (1729–1826) and came to be known as "l'Ancien". His claim to the credit for inventing the rotor is generally considered unassailable. No less an authority than the éminence grise of horological historians, Alfred Chapuis, states with finality in *Technique and History of the Swiss Watch*: "Abraham-Louis Perrelet, called the Old One (1729–1826), professed his lengthy career in Le Locle. He was a watchmaker of exceptional intelligence and great sagacity, and provided considerable impulsion to the watchmaking industry of Le Locle by sharing with his colleagues. We give him the credit for inventing the 'perpetual' or 'self-winding' watch, which is wound by the simple movement of the wrist. The first watches of this kind were bought by Breguet and Louis Recordon in London."


Abraham-Louis Breguet


Pierre Jaquet-Droz

Considerable contemporary evidence backs his right to the claim. Perrelet was a celebrity in his day and his self-winding watches were bought and studied by some of his most illustrious contemporaries, including Abraham-Louis Breguet, Recordon, Jaquet-Droz, and Philippe Du Bois. Horace-Bénédict de Saussure wrote: "Master Perrelet, watchmaker, has made a watch in such a way that it winds itself in the wearer's pocket as he walks; 15 minutes' walking suffices to make the watch run eight days. Owing to a stopwork, continuation of the walking motion cannot damage the watch." This brief excerpt from de Saussure's report to the Society of Arts of Geneva is dated 1776, and numerous other contemporary written and historical accounts all name Perrelet as the famous inventor of the rotor-wound automatic. Though the date can't be established with complete accuracy, most sources agree that it was from Perrelet that Breguet and others derived their designs. (However, the claim that 15 minutes' activity could wind eight days' reserve into the mainspring seems somewhat less plausible.)

Few aspects of horological history are without controversy, though.

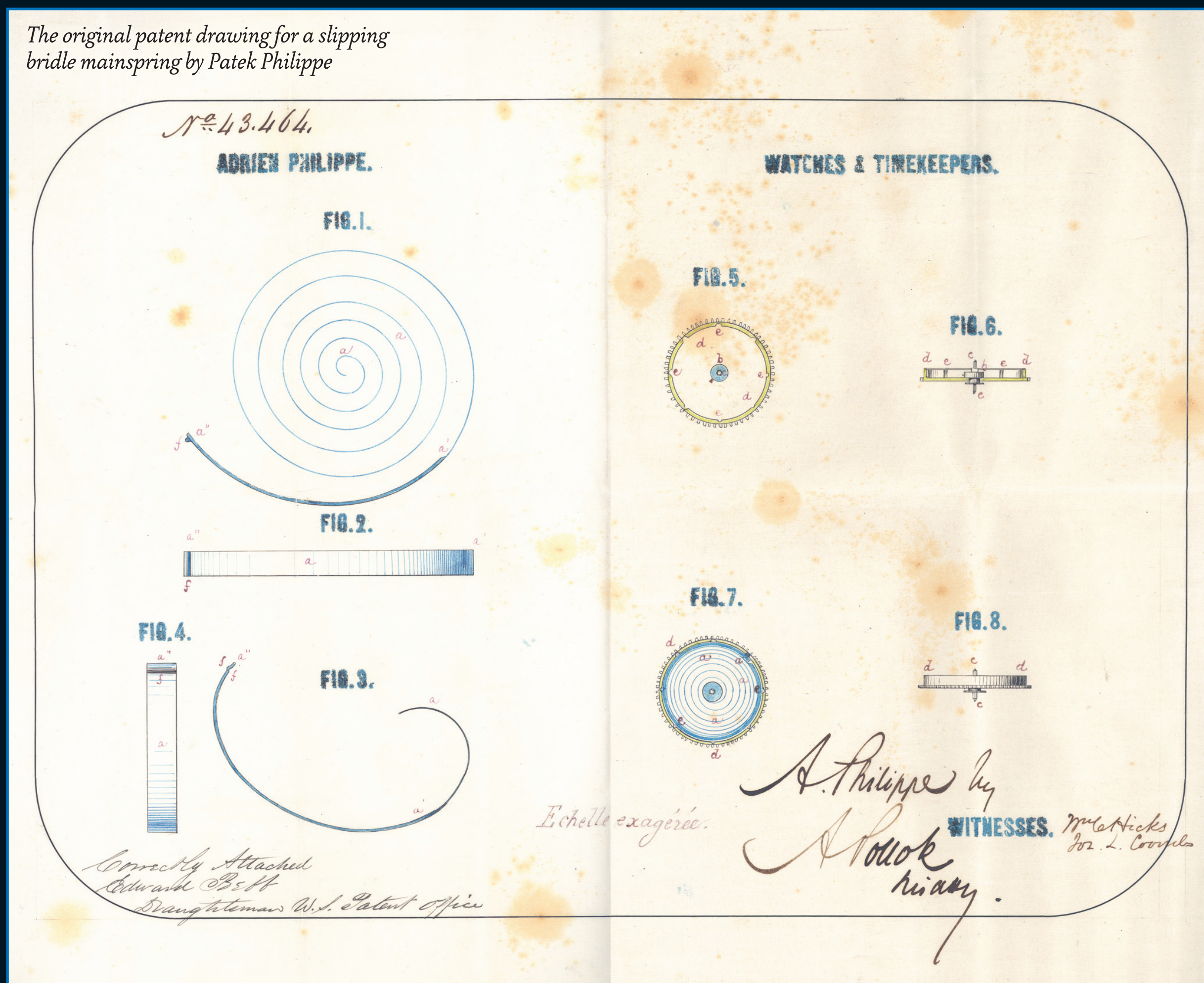


Early perpétuelle (self-winding) watch by A. L. Breguet

Images courtesy of Antiquorum

Historian Joseph Flores, author of *Perpetuals, Wheels of Chance* (the term "perpetual" referring to a self-winding watch, not a perpetual calendar) claims to have uncovered evidence that one Hubert Sarton, a watchmaker from Liège, was the real inventor of the rotor-wound automatic pocket watch, citing a patent document from 1778, which describes an automatic winding system he claims is identical in crucial respects to the watch attributed by Chapuis to Perrelet (erroneously, according to Flores) that was auctioned by Antiquorum in April 1993. Given the inconsistency with which patents, at that period in industrial history, can be considered to definitively establish primacy of place, it's unlikely that the issue will ever be finalized — perhaps all for the better, as were the question to be conclusively answered, "many keen horologists would be deprived of the pleasure of getting angry with each other" (to steal a phrase from historian Kenneth Ullyett, who was writing about the debate over the invention of the lever escapement).

What is certain is that at the end of the 18th and in the early 19th centuries, there was a great deal of experimentation with self-winding systems. Breguet was fond of them; his self-winding watches, called "perpétuelles", formed a significant fraction of the output of his workshop. In many respects, the design represents the standard form of the self-winding pocket watch. The central rotor — apparently employed by Perrelet (or, at least, employed in the watch attributed to him by Chapuis) — is replaced by a pendulum carrying a heavy platinum bob, which is restrained in its motion by a buffer spring. Some of Breguet's earliest watches were self-winding, including the earliest known surviving Breguet No. 2, made for Marie Antoinette in or around 1782 (which is not, of course, the famous "Marie-Antoinette" recently returned to the Meyer Museum of Islamic Art). The Habsburg Antiquorum catalogue, *The Art of Breguet*, disparages Perrelet's design as "unsuccessful", requiring the wearer to "virtually run" in order to wind the watch at all (this in startling contrast to the contemporary account of its efficiency by de Saussure; certainly, the weight of plausibility is



The original patent drawing for a slipping bridle mainspring by Patek Philippe

Image courtesy of Patek Philippe

rather more on the side of the catalogue).

Breguet was almost certainly the first to make self-winding watches in any quantity, and his use of two mainspring barrels and a more efficient gearing for the winding system seems to have made for a practical design. Of course, improvements were constantly being made.

The book *Watches* by George Daniels and Cecil Clutton notes that the stopwork for the early Breguet perpétuelles was inadequate to prevent continued tension on the mainspring after it was already fully wound, and the result was often "a major explosion" (and an expensive one, as the early perpétuelles were all repeaters). Breguet recalled and modified as many from the first batch as he could. Interestingly, the first perpétuelles had no provision made for key-winding. Thus, the movement could be completely sealed, and Breguet used this as a selling point, claiming that the watches would need to be cleaned less frequently as the case was resistant to dust and moisture.

Over the years, other developments included a pocket watch that was wound by the respirations of the wearer, and hunter cased pocket watches in which the mainspring was wound by the opening and closing of the cover. But the self-winding pocket watch remained something of a curio, despite Breguet's initial output.

The Coat of Arms of Vittorio Emanuele complex pocket watch, from the Patek Philippe Museum collection

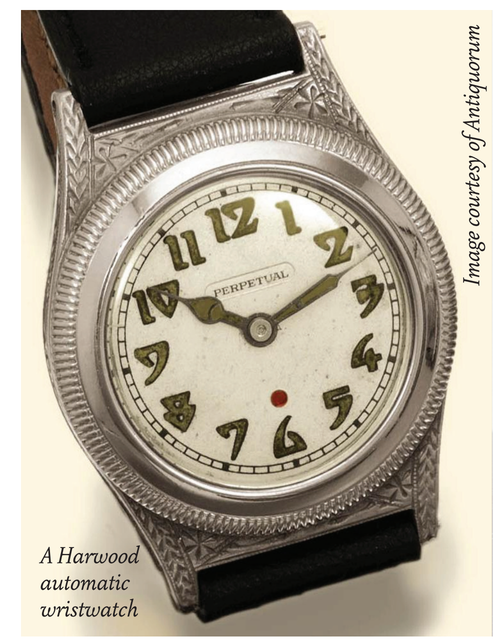
There was, however, one 19th-century invention that was to have significant implications for automatic watches. This was the slipping bridle mainspring, patented by Patek Philippe in 1863.

One of the challenges in designing a self-winding watch is to prevent the winding system from putting excessive tension on the mainspring after it's already fully wound. The first rotation of unwinding is undesirable, as the power output is too high, which may cause the balance to knock, and the friction of the spring coils against each other tends to produce erratic power delivery. In addition, the constant tension may break the spring.

The solution, in general, was to use a stopwork that would prevent winding from occurring after the spring was fully wound, but the invention of the slipping bridle mainspring — in which the outer coil of the mainspring is not physically attached to the barrel wall, but rather maintained there by the pressure of a bridle that's free to slip — allowed the modern automatic watch as we know it to be developed.

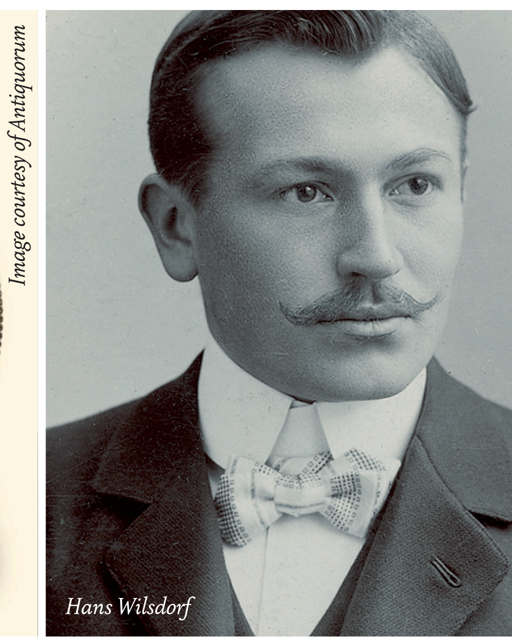
PATENT NO. 106583 AND THE RISE OF THE CROWN

Englishman John Harwood, in photographs, bears a strong resemblance to Sir Arthur Conan Doyle's description of Dr. Mortimer in *The Hound of the Baskervilles*: thin, long-fingered, with an air of nervous myopia exaggerated by his thick, horn-rimmed spectacles. Harwood fought in the First World War and, having served in the trenches, might well have had an appreciation for the effects of dirt and moisture on watches, as some biographers have suggested. What is certain is that he invented the first modern automatic watch, albeit one that was not entirely commercially successful. Born on the Isle of Man, like many English watchmakers of the 20th century, he found it necessary to go to Switzerland to find support for his ideas. In 1923, Harwood brought two working prototypes with him to the patent office in Berne, and he and his business partner Harry Cutts, with whom he shared the patent number 106583, developed a so-called "hammer" or "bumper" winding system, as it's sometimes called, in which the rotor moves through a portion of a circle, swinging through a 300-degree arc, and is restrained at the extremes of its swing by spring-mounted shock absorbers (many later bumper designs dispense with these and simply use the springs themselves).



A Harwood automatic wristwatch

Image courtesy of Antiquorum



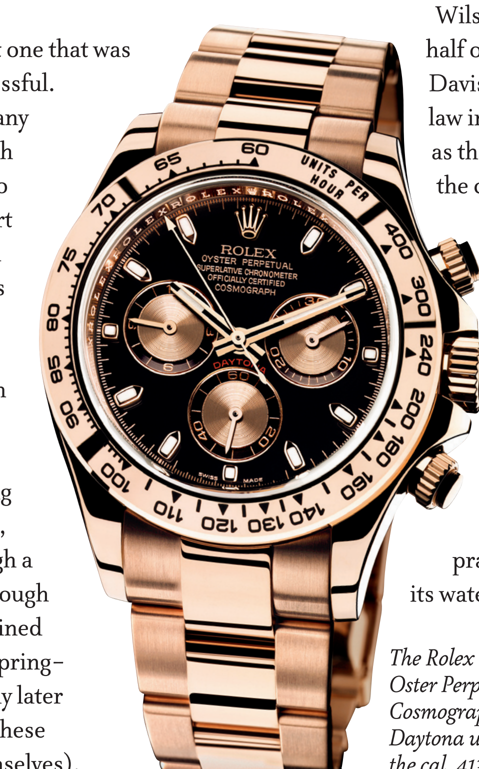
Hans Wilsdorf

Harwood's design also eliminated the keyless works and crown. The case was completely sealed, in a reprise of Breguet's innovation with his sealed-case perpétuelles of one and a half centuries before; in the absence of a crown, the watch was instead set with a turning bezel that, when activated for handsetting, disengaged the automatic winding train.

The Harwood Self-Winding Watch Company was an initial success. Movements were made and finished by A. Schild and Fortis, and Blancpain also produced some watches to the Harwood design. Fashionable people were photographed wearing them, including American Hearst star journalist Lady Grace Marguerite Hay Drummond-Hay, the magnetic and seductive adventuress who wore a Harwood automatic during the circumnavigation of the world by the German airship Graf Zeppelin in 1929. (The lady had great timing: she'd come by her title by marrying a nobleman 50 years her senior, and her fortune when he expired three years later.)

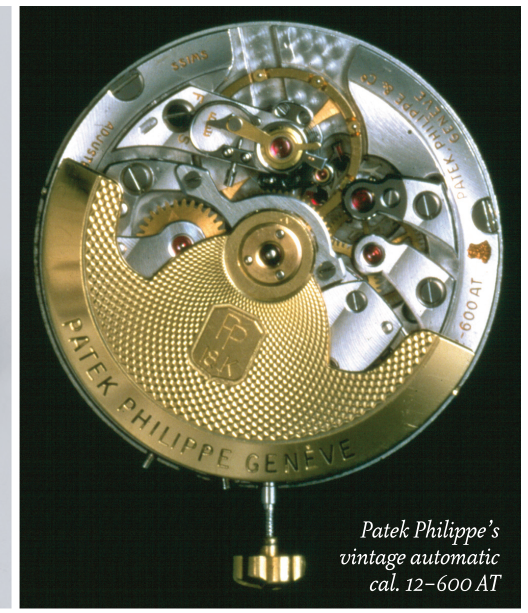
But despite early success and celebrity endorsements (including the appearance of Joan Crawford in a print ad), Harwood's company did not survive the Great Depression and went out of business in 1931, never to be revived again, even though Harwood himself was to live till 1965.

The success of the design, however, had not escaped the notice of one Hans Wilsdorf. Wilsdorf, of course, was the Bavarian-born half of what had started out as Wilsdorf & Davis, which he'd started with his brother-in-law in 1905 and which, after 1919, was known as the Rolex Watch Company. Wilsdorf moved the company to Geneva in 1912 in order to escape export duties and taxes, and it's interesting to reflect that under different circumstances, Rolex might have been an English company — although had it stayed one, it's likely it would have gone the way of not only other English watch companies, but many English manufacturing industries as well. Wilsdorf was a practical man and he was interested in making practical watches. The Rolex Oyster, with its waterproof case and screwdown crown, was already one of the foremost technical wristwatches in the world; it needed only the addition of an automatic winding system to perfect it. With an accurate



The Rolex Oyster Perpetual Cosmograph Daytona uses the cal. 4130

Vintage IWC Pellaton automatic winding system

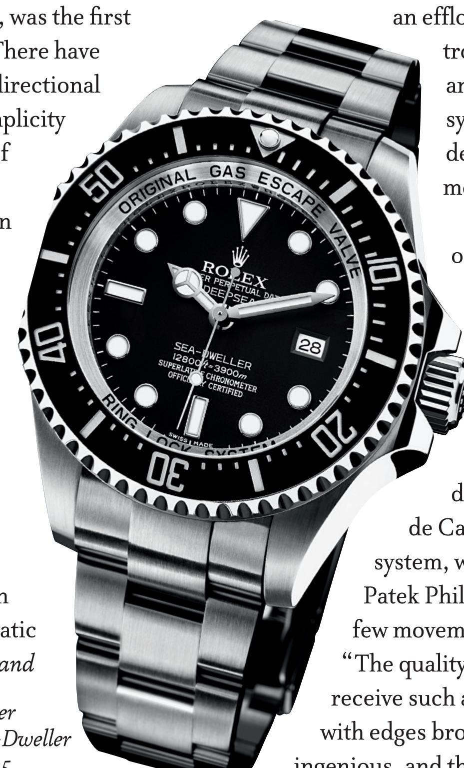


Patek Philippe's vintage automatic cal. 12-600 AT

movement, an automatic winding system, and a hermetically sealed case, the Rolex Oyster became the Rolex Oyster Perpetual in 1931, and Harwood's pioneering design was swept aside. Unlike Harwood's bumper automatic, the Rolex Oyster Perpetual's movement had a rotor that swung a full 360 degrees. With the incorporation of an automatic winding system into the first truly modern, sealed watch case, the outlines of the modern, practical sports watch as we know it were established.

THE GOLDEN AGE OF THE AUTOMATIC WATCH In 1942, the Felsa company of Grenchen, Switzerland, introduced an historic movement: the Felsa "Bidynator", which, as the name implies, was the first automatic movement to wind in both directions. There have been an enormous variety of schemes to effect bidirectional winding since, but the Bidynator's system was simplicity itself. The main wheel attached to the underside of the rotor was geared to another wheel attached to the end of a pivoting arm. When the rotor swung in one direction, the arm would carry the gear into engagement with one of the two main wheels in the automatic winding train; when it swung the other direction, the arm would carry the gear into contact with the other. This simple system is the ancestor of all modern bidirectional winding designs.

The subsequent years saw a bewildering proliferation of movement types. In 1956, the great British horological writer, watchmaker and historian, Donald de Carle (who collaborated with Chapuis on the latter's definitive history of automatic winding systems), published *Complicated Watches and Their Repair*. In it, he discusses such arcana as the repair of minute repeaters and rattrapante chronographs, but the bulk of the book is devoted to the plethora of automatic movements, which, by then, had emerged. During that era, the wristwatch reached an unprecedented level of public acceptance, as the pocket watch finally faded into either a foppish affectation or the stubborn habit of an oldster, and evolutionary pressure combined with



The Rolex Oyster Perpetual Sea-Dweller uses the cal.3135

IN THE 1950S, DE CARLE WROTE, "... ALMOST EVERY WEEK A NEW MODEL IS INTRODUCED."

a favorable environment conspired to do what it always does — create an efflorescent diversity of forms worthy of an unmolested tropical rainforest. As brands sought to evade one another's patents and introduce their own unique systems, innovation followed on innovation, so that de Carle could write, "almost every week a new model is introduced".

Some of the great, classic automatic movements of all time find themselves in his book — movements which are still prized by collectors, and whose innovations, in many instances, are still with us today, in one form or another: the Rolex series 1000 and 1500 movements; the IWC automatic caliber 85 family, with its dual pawl "Pellaton" winding system, named for IWC technical director Albert Pellaton, which the usually reticent de Carle describes as "a simple and most ingenious system, well constructed and beautifully finished"; and the Patek Philippe cal. 12-600 AT, which is another one of the few movements that de Carle goes out of his way to praise: "The quality of the movement is superb (the only movement to receive such an accolade)... the steelwork is straight-grained, with edges broken and polished... the action is simple and ingenious, and there appears to be nothing [going] wrong."

Classic complication: Audemars Piguet cal. 2120/2808, found in the Jules Audemars Equation of Time 01 & 02 — movement schematics; 03 — perpetual calendar gear train; 04 — sunrise/sunset gear train; 05 — equation of time gear train; 06 — moon phase gear train; 07 & 08 — fully assembled movements

Technical problems continued to be addressed as well, and at least two brands — Jaeger-LeCoultre and Felsa (in its rare "Inversator" movement) — experimented with solutions to the problem of automatics overwinding. The slipping bridle, like most engineering solutions, leaves something to be desired — the friction of the bridle against the inside of the barrel can cause considerable wear and needs very precisely controlled lubrication to work well. Jaeger-LeCoultre and Felsa both incorporated stopworks (in which a bolt blocks the rotor when the mainspring becomes fully wound), but for various reasons, including the increased complexity of the movement, such solutions were never widely adopted.

By now, the basic principles of automatic winding were well understood. The advantages of automatic movements over manually wound watches were numerous. In daily wear, the automatic winding system acted as a kind of train remontoire — since the mainspring was never unwound to its last couple of turnings, the power delivery curve remained fairly constant and, as a result, balance amplitude also tended to remain constant. Automatics reduced the necessity for manipulating the crown, thereby reducing entry of dirt into the case and dramatically reducing a major point of wear. They were also convenient. The only disadvantage automatics of the first postwar generation had was that they were, in many cases, significantly thicker than their manual-wind counterparts — which, in a time when flatness signified elegance and refinement in watchmaking, was a drawback.

However, by the 1960s, the next generation of automatics had appeared, and among them were some of the flattest automatic movements ever created. The king of flat, full-rotor automatic movements is currently in production as the Audemars Piguet caliber 2120, which, with a thickness of 2.45 mm, is a remarkable engineering achievement; the rotor is borne at the periphery by a beryllium rail and rollers, which give the movement its unique appearance. It is both seen as the cal. 2121 with date (in the Royal Oak Jumbo) and as the basis for complications, including the 2120/2808 used in the Audemars Piguet Jules Audemars Equation of Time.

While the cal. 2120 is the flattest full-rotor automatic, the two flattest automatic movements ever made are even thinner. To go flatter, it was necessary not to use a full rotor, but rather a

The ultra-flat Piaget automatic micro-rotor cal. 12P shown with ultra-flat Piaget manual-wind calibers

micro-rotor design, in which the rotor is on the same plane as the rest of the train and plate. The thinnest micro-rotor automatic in current production is the Piaget cal. 12P, at a thickness of 2.3 mm. Despite its incredible proportions, the 12P has a reputation for being a reliable movement capable of holding an excellent rate — a testimony to its build quality, as such extremely flat movements are often challenged to perform well. However, the all-time flattest automatic movement ever created was not made until, surprisingly, 1978, when Bouchet-Lassale created the improbable cal. 2000, which was produced for a time by Lemania as the cal. 2010. The cal. 2000, at a thickness of 2.08 mm, almost certainly represents the final development of the art of the ultra-flat automatic — it was so thin, it had a tendency to actually flex enough to bring the whole movement to a stop. If a modern firm were to decide to push the envelope, though, who knows what might be possible with today's microfabrication methods and high-tech materials?

THE FUTURE OF THE AUTOMATIC MOVEMENT The tractors of today's horological landscape are both ubiquitous and ubiquitously reliable. The millions of ETA 2892s, 2824s and 7750s form the vast majority of modern automatics, and their enormous numbers combined with their legendary reliability are testimony to the refinement of the challenging task of crafting industrially produced movements capable of excellent long-term performance. Many manufacturers in the last ten years have brought out automatic movements of their own, in response to both the perception that an in-house base caliber is increasingly a necessity for any self-respecting brand, and to concern over the (now less overwhelming) monopoly held by the Swatch Group on key components and movements. Brands such as Jaeger-LeCoultre, Audemars Piguet, Rolex, Patek Philippe, Piaget and Vacheron Constantin produce a huge range of in-house automatics, and experimentalists such as Richard Mille, De Bethune and URWERK continue to bring dramatic, eye-catching innovations to the design of the automatic. With new materials bringing improved performance every day, the automatic is assured of a future as dynamic as its past.

It's not possible to close, though, without casting a wistful eye to both the distant and recent

WITH NEW MATERIALS BRINGING IMPROVED PERFORMANCE EVERY DAY, THE AUTOMATIC IS ASSURED OF A DYNAMIC FUTURE

past. One of the earliest self-winding clocks by Pierre Jaquet-Droz wound itself by harvesting the slight changes in ambient temperature; and in early 2003, Steven Phillips showed a prototype of what he called the Eternal Winding System. A strangely beautiful device, the EWS used the same technology as the Jaquet-Droz clock of centuries before — a bimetallic strip harvested changes in temperature with such efficiency that a change in ambient temperature of as little as one degree would wind the mainspring. Sadly, Phillips died before his invention could be licensed and brought into serial production, and the idea now seems to be languishing, forgotten in only a few years. Yet the world is full of energy to be harvested, as closed systems gradually leak their order into the greater cosmos as we progress inexorably towards the heat death of the universe. Perhaps the next great advantages in self-winding movements will finally free us from the tyranny of the rotor, which, after all, is a parasite on the owner. The dream of a truly self-sufficient mechanical watch may yet some day come to pass. ★

COMPLICATION

The Jules Audemars Equation of Time in yellow gold and rose gold (left)

The caseback of the watch reveals cal. 2120/2808 and the skeletonized, hand-engraved rotor