

The History of Watches

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Overview and Intent

This paper is a literature study that discusses the changes that have occurred in watches over time. It covers mainly mechanical changes, but the user should also be aware of the changes in fashions that dictated changes in decoration and style of the watch.

For the purposes of this paper, a watch is defined as a spring driven timekeeper, small enough to carry on a person. Generally, this group would contain early watches worn on a chain around the neck, pocket watches and then wrist watches.

It is intended to give the reader dates of the first introduction of the various features and improvements of the mechanical watch. Wherever possible, approximate end dates are also included. This information may be valuable when viewing timepieces to check their authenticity¹.

The problem of authenticity is further complicated by the fact that old timepieces undergo repairs and may also gather pieces contemporary to the time of repair.

With respect to mechanical improvements, the main milestones of watch evolution can be stated as

- Prior to 1600 – The Earliest Watches.
- 1600-1675 – The Age of Decoration.
- 1675-1700 – The Balance Spring.
- 1700-1775 – Steady Progress
- 1775-1830 – The First Chronometers
- 1830-1900 - The Era of Complications
- 1900 on – Metallurgy to the Rescue

This paper follows this timeline.

Where historical items are deemed to be of interest they are usually included as footnotes.

Exclusion of Clocks.

This paper does not deal with any developments in the clock area that does not affect clocks. Therefore, items such as dead beat escapements and pendulum compensation methods are not covered. However, a section on the marine chronometer is included because of its general interest and the effects it had on current chronometers.

¹ It should be noted that forgeries are not restricted to modern times. Abraham-Louis Breguet (watches c1780 onwards) had people forging his watches in his own lifetime (al-la Rolex today) and he included a secret signature on his dials to show authenticity. Tompion, Graham and Arnold also dealt with forgeries during their own time.

Prior to 1600 – The Earliest Watches

Before 1600 the main problem in portable timekeeping was the driving power. Typically, the timepieces of the day were driven by weights, and therefore were impractical to transport on one's person.

In 1524, 15 florins was paid to Henlein for a gilt musk-apple with a watch. This was the earliest known date of a watch being produced. Other watches appeared in 1548, and were probably of German or French origin. The Swiss and the English products do not occur till about 1575.

In the horological industry, this period was one of great advancement and innovation.

The first movements were made of steel, but brass movements appeared shortly thereafter². The first movements were straight verge movements, with no balance springs. These first timepieces were notoriously inaccurate. Most watches had only the hour hand and had to be wound twice a day.

It was before the introduction of the gear cutting engine and steel production was not as precise as it is today. The variations in quality, and the fact that many steel alloys had not even been discovered at this time, meant that timekeeping was not the art it is today.

In this period, the first use was made of the spiral-leaf main spring. This was crucial to the production of the first watches, as it allowed horologists to power a movement without the need for the common hanging weights. This however, opened up a whole range of problems for watchmakers. Typically, a spiral spring's tension will not be constant from fully wound to unwound. Thus watchmakers found a significant difference in timing between the short arcs³ and the long arcs⁴

In an attempt to reduce this spring force error, the watchmakers found that they could increase the accuracy of their timepieces by using only a portion of the mainspring that produced nearly linear tension on the train. This helped, but in the quest for better accuracy, other methods of providing constant torque on the train were tried.

The stackfreed was a German invention⁵ that had a cam at the end of the barrel arbor. The cam

² It may appear that reason for the change to brass was to do with the properties of the metal. The properties that are appealing include ease of working, corrosion resistance and reduction in friction. However, the real reason was that different Guilds (trades) that were involved in the manufacture of watches. In the first instance, the two guilds that were permitted to make watches were blacksmiths and locksmiths. Blacksmiths obviously worked in steel and the locksmiths in brass. However, when watches became smaller and smaller, it was the locksmiths that were more able to adapt their metal to the requirements of the watch, Thus most movements were made of brass, not steel.

³ Mainspring nearly unwound.

⁴ Fully wound mainspring.

⁵ The stackfreed was not adopted by any other country and thus is found only in watches made in Germany

had another spring (leaf) acting on it that attempted to compensate for the variations in spring tension.

The English and French solution was to use the fusee. The fusee improved the regulation of spring tension markedly, and was used extensively till the 1900's. The first fusees stopped the clock during winding.

In an attempt to prevent over oscillation of the balance wheel, stops were also included as a crude form of regulator. These stops were typically of stiff hog bristle.

At that end of this period, astronomical data and dates were already being displayed on watches, but even with all these embellishments, timekeeping was still very poor.

1600-1675 - The Age of Decoration

This period saw little in the way of technical innovation, but watches were becoming more a jewelry piece⁶. The cases were of gilt metal or precious metal, and were engraved, jeweled, pierced and enameled for decoration⁷. Thus the watch was seen as a piece of jewelry that was more or less ostentatious depending on whether it was exposed (pendant) or not (pocket watch).

The shapes of cases went from a tambour cylinder⁸ with a lid to being circular, with hinged, domed covers front and back. Decoration included champlevé enamel and relieved cases filled with coloured enamel. To protect the intricate cases the manufacturers supplied a protective outer case that was designed to be worn together with the watch. This was unimaginatively known as a pair-case watch.

Glass crystal was fitted to the cases around 1620, but it was usually as an alternative to a metal opaque cover. The glass was translucent only; therefore the owner was still unable to see the time without removing the cover.

The owners still had to open the covers to wind and regulate the watches; therefore all parts of the cases needed to be attractive. The main form of internal decoration was piercing to the balance cock and fine work to the pillars, such as tulip design.

On German watches, the Arabic '2' was usually shaped like a 'Z'. Dials usually had an outer chapter marked I-XII and an inner chapter marked 13-24. This was to accommodate the 24-hour convention used in Italy, Bohemia and southwest Germany. The inside chapter ring was usually engraved with a star or rose. The hands were always of steel and carefully shaped.

In England, unornamented watches became popular around 1625, as a result of the Puritan

⁶ Towards the end of the period a fusee chain replaced the fusee gut.

⁷ Surviving cases for the period were usually of thick base metal, so that the artisans could show their capabilities by fine engraving. It is suspected that precious metal cases of the period were melted down when the watches broke or retired from use because of their woeful inaccuracy.

⁸ Ie in the shape of a drum.

movement. After 1660, exuberant shapes and adornment were usually confined to women's watches.

1675 – 1700 – The Balance Spring

While a spiral spring was first used for the mainspring in around 1500, it was not until 1675 that a spiral balance spring was used. This one step took daily timekeeping accuracy from fractions of an hour to fractions of a minute⁹.

There is some dispute as to who first applied the spiral spring to balances. Both Huygens and Hook were working with springs, but Huygens worked with the spiral spring whereas Hook has attributed to working with flat springs. Hook also worked with Tompion, a master craftsman of his time. Tompion also invented an adjustable rack type regulator, with bristle curb springs, for the balance spring.

The main hope when the balance spring was introduced was that it would make the balance isochronous¹⁰, but this hope was dashed when it was found that temperature affected the rate, because of the elasticity of the mainspring.

With the increase in accuracy it was also noted that the position of the watch had an effect. The watch would gain or lose time depending on the pendant and face positions¹¹.

Because accuracy had increase so much, a minute hand and a dial subdivided into minutes was added. The face convention was to have the hours marked in Roman numerals and the minutes in Arabic numbers. A fourth wheel was also added so that the watch could be wound once a day instead of every 12 hours.

In 1675, Charles II of England introduced long waistcoats. This became the fashion, and men's watches were then worn in pockets of the waistcoat instead of pendant style from the neck.

After 1690 the use of three wheel trains is very unusual, being restricted to old-fashioned watchmakers. The four-wheel train and six-leaf pinion were just about universal.

For a short term before and after the century, the makers of low class watches placed the balance immediately under the dial. The balance was visible through the dial, and it was intended to trick

⁹ All this talk of the woeful accuracy of timepieces does not indicate that correct times were not known at all. The astronomers were able to determine very accurately the "same" time from preceding days by viewing the positions of the stars. Clocks improved in accuracy and was usually an order of magnitude better than a watch. This was due mainly to the availability of a constant driving force (weights) and a (nearly) isochronous pendulum for regulation.

¹⁰ The time of oscillation, or period, would be the same regardless of the strength of the mainspring, or the arc of movement of the balance.

¹¹ These same problems, position and temperature, still apply to mechanical watches today. Some inventions, like the *tourbillon*, have attempted to reduce or minimize the errors, but they have not been eliminated.

the unwary into believing the watch had the supposedly attributed powers of a pendulum, which was fashionable at the time.

1700-1775 – Steady Progress

In 1704, English watchmakers Facio de Duillier and P. and J. Debaufre developed methods for using jewels as bearings. By 1715, this practice was still rare. After about 1725 it was common to find a fairly large diamond endstone mounted in the cock. However, even at the end of the period, only the upper bearing of the balance shaft, i.e. in the cock, were likely to have jewels. For nearly a century the art of jewellery remained exclusive to the English.

After the turn of the century, makers paid greater attention to lubrication. In about 1715 Sully discovered that forming a small sink around each hole would retain the oil, due to its surface tension. This was not usually found in watches before 1750.

The commonest watches of the period had pair cases in gold or silver, both of which were plain. The casemaker's initial is found on plain gold and silver cases. Where a watch does not have the same initials on the inner and outer case, the outer is non-original. In good class watches, the watch number is repeated on the cases. The gold cases of the period are 22 carat and silver-gilt, brass-gilt and Pinchbeck¹² are all found. Silver cases were rarely hallmarked before 1740¹³, although gold hallmarks are fairly common. Dust caps were fitted to provide better accuracy. The size of the English watch was 1.75 inches, down from 2 inches, and about one inch thick.

Dials were mainly champlévé, but were slowly replaced by white enamel dials with block numbers. The earliest enamel dials were somewhat dull and pitted, but after 1725 they are smooth and polished. The markings on the face included bold Arabic numerals for the hours. Most of the minute markings had disappeared or made very small, and at 15-minute intervals. However, by the end of the century the markings on the faces became much lighter and more elegant. The maker's name never appeared on the dials before 1750. By 1775, champlévé was rare. In English watches the hands were usually of the beetle and poker style, although the hour hand sometimes had a tulip pattern. The hands were usually made of black steel, although better class watches had blued hands.

In single-handed French watches, it was common for the winding square to be in the center of the dial, protruding through the boss on which the hand is mounted.

After the initial flurry of technical development, decoration then took over as a method of differentiation. From 1715 onwards, repouse¹⁴ and adornment¹⁵ of outcases was the vogue.

¹² Pinchbeck is an amalgam of copper and zinc intended to imitate gold.

¹³ The Sterling Silver Standard (English) was abandoned from 1696 until 1720. Silver bullion was used mainly to mint their coinage, To obtain silver bullion, people "clipped" some off the edges of the coins, then melted it down to form an ingot. In 1696, a new statute recalled the old silver coins and new coins were issued. The Act also prohibited the use of Sterling Silver for making spoons, tankards, watch cases and other items under a severe penalty of 500 pounds fine.

¹⁴ The hammering of a design from the other side of the case.

After 1750 it declined and was rarely found after 1775. Pendants became more elegant, and glasses were snapped in from early in the century. Movement decoration still occurred even though they were covered by dust covers. Balance cocks were very large¹⁶ and were decorated and pierced. On the Continent, the balance cock had no foot. It was a circular bridge screwed at either end. From 1750 on, the foot ceased to be pierced, and extra decoration was uncommon from then to this day. Pillars became progressively simple, from tulip to round and then square.

Up to 1700 there had been little change to the verge escapement. In 1726 Graham refined the horizontal, or cylinder escapement¹⁷. This was more accurate than the verge, but also more fragile. Early cylinders were made of steel, and the escape wheel of brass. This promoted excessive wear on the cylinder, but this was corrected later. The cylinder, as an escapement, had a run of about 200 years.

Early balance springs were soft and untempered, and very easily distorted. The earliest springs had only 1.5 to 2 turns, but by 1750 4 to 5 turns were more usual.

In 1740 Frenchman Le Roy introduced a screw adjusted sliding plates containing pivot holes, so the escape wheel could be positioned very accurately.

Lepine departed from the then usual practice of having the movement between two parallel plates and the balance wheel outside the top plate. He discarded the top plate altogether and used individual cocks mounted on a single plate, including the balance. This formed the model for manufacture of all watches to the present day. The use of cocks made assembly and repair of the watches much easier, and more importantly, made them much thinner. Lepine also dispensed with the fusee and used a going barrel to drive the train directly. This improvement was facilitated by using the cylinder escapement and better springs.

In England, however, the verge and fusee were still used and, at the end of the period it was generally acknowledged that English watchmakers were producing the best watches.

English watches had the hour and minute hand, whereas the continental watches of the same period tended to only have the hour hand.

In the evolution to a detached escapement, non-detached escapements other than the verge were also tried. The duplex escapement¹⁸ was invented by Dutertre in 1720, and modified to be more usable by 1750. The rack lever was invented by Abbe'de Hautefeuille in about 1720 and improved by Litherland in England in 1791.

Around 1750-1760 Mudge designed the detached lever escapement¹⁹. However, it was left to

¹⁵ Mostly inlaid with tortoise shell or precious metals covered with translucent horn.

¹⁶ Because of large balance wheels.

¹⁷ Tompion, in co-operation with Edward Booth and William Houghton, invented the cylinder escapement. It was patented in 1695.

¹⁸ This escapement was used mainly in England.

¹⁹ The first lever watch ever made was constructed in 1759-1760 by Thomas Mudge, for George

others to refine the escapement to its present form. The main problem with the first lever escapements is that the escape wheel teeth had no draw²⁰. It was introduced much later by the Swiss, Leschot.

The first forms of the lever were with the lever arm at a tangent to the escape wheel. English watchmakers preferred the right angle arrangement, while the European watchmakers preferred the straight-line lever.

The English right-angle layout was persisted with until the first quarter of the twentieth century.

1775-1830 - The First Chronometers

In 1761²¹ John Harrison made a clock that was sufficiently accurate to be used to measure Longitude during a sea voyage²². In spite of this feat, Harrison's clock did not contribute significantly to horology as the timepiece was too complicated²³. It was left to other horologists²⁴ to produce a practical marine chronometer and pocket chronometer.

The basics of the designs included a balance completely detached²⁵ from the train, a helical balance spring²⁶ instead of a spiral spring and maintaining power whilst being wound. All designs had some form of temperature compensation²⁷. A fusee was still in use.

By 1800, the pocket chronometer was a readily available accurate watch.

With the newer, more accurate escapements, other changes occurred to timepieces. A seconds

III and was given to him by Queen Charlotte. It needed winding only once year. It still resides with a royal family, who can recount nearly everyone who has ever wound the watch.

²⁰ This is a form of undercut to a tooth so the pallet is held firmly in contact with the escape wheel.

²¹ Britten's book gives this date as 1759.

²² The actual contest, started in 1714, was to determine the latitude during a journey from the British Isles to the West Indies. The rewards offered were for E£10,000 for an accuracy of within one degree, E£15,000 for accuracy within 40' and E£20,000 for accuracy within 30'. The reward was offered by the Board of Longitude in England. The voyage would take about six weeks and the chronometer could not be out by more than 3 seconds a day.

²³ Only three of the patterns were ever made, Harrison # 3 and # 4 and Kendall # 1.

²⁴ Such as Pierre Le Roy, in 1766. The Le Roy chronometer had a detached escapement and compensated balance, whereas Harrison's did not. In England, by 1780, Arnold and Ernschaw evolved a design that has been the model for marine chronometers ever since. They were both bitter rivals and accused each other of plagiarism. The absolute determination of who was first has never been established. Frenchman Ferdinand Berthoud also reached the same point at about the same time. The Englishmen made about 1000 chronometers, compared to Berthoud, who made about 70 in the same period.

²⁵ This feature means that the only friction on the balance is when impulse is given to the pallets.

²⁶ A helical balance spring can be made isochronous more easily than a spiral spring.

²⁷ The most common form of temperature compensation was a bi-metallic balance.

hand²⁸ was added to the watches. Jewelling was more extensively used, with some extremely large jewels being placed on the visible plate²⁹. A ratchet and pawl mechanism was used under the dial, instead of the usual worm and wheel. Plates were arranged to consider servicing and repair.

Pillars and cocks had little decoration. Tompion's style of rack adjustment for the regulator was dispensed with and the current lever with curb pins was introduced.

Bimetallic balances were still rare, and decoration was minimal. However, the watch was finally accurate enough to be used as a timekeeper, not just jewelry.

Verge watches were still in use in this period, and many of the improvements were also applied to them. Bridges were added for ease of assembly. This also required the repositioning of the verge's contrate wheel to the other side of the train. Regulation was also upgraded to the newer, simpler style. The watch diameter increased substantially, but the thickness was not reduced.

By 1830, pair cases were rare, except on a verge watch. Where pair cases did exist, they were usually of silver or gold, with various shaped pendants and stirrup shaped bows.

The watches were wound by opening a hinged back to reveal a second fixed bottom pierced with a winding hole. The pendant was a spherical knob often pierced by a push piece.

Dials were usually of white enamel. Roman and Arabic numbers were both used, but Roman numerals were more common³⁰. Dials with seconds hands³¹ were flat and hands became simpler. Materials used for the hands were either blued steel or gold. The counter sinking of subsidiary dials was unusual in English watches before 1860.

After 1800 dials in four- colour gold became popular³². This type of watch usually had lustrous gold hands.

Around this period, the table roller lever escapement, which was first used in 1823, was becoming established.

In Europe, the going barrel was replacing the fusee. Cocks were small pierced bridges and the silvered regulator dial continued. Some watches had a Chinese duplex escarpment and this produced a watch where the second hand moved only once per second.

While escapements such as the virgule and Pouzait gained some favour, the lever was gaining

²⁸ This was usually placed in a subsidiary dial above the six hour mark.

²⁹ This is sometimes called Liverpool jewellery, indicating the importance of the Lancashire watch industry at the time.

³⁰ In Europe, Arabic numbers were more common.

³¹ Seconds hands were not universal.

³² Four colour gold was made by mixing other substances to give red, yellow, green and white tints. The dial would be one colour and the numbers of another colour would be soldered to the face. Finally a two-tone band of foliate would be on the outside.

strength of numbers all the time³³.

The great Breguet started his own production in 1780. In 1787, he produced lever watches in France, but it is not known if Julien Le Roy preceded Mudge's development of the lever in England. Breguet produced straight-line lever layouts with a cut compensating balance. Other Breguet innovations included a ruby cylinder watch, the overcoil³⁴ on balance springs, the 'parachute' balance staff suspension³⁵, a self winding watch, or 'perpetuelle', the 'tipsy' key that prevented reverse winding and the tourbillon.

A Swiss called Perrelet conceived self-winding watches in 1770. Breguet produced them from 1780. Even though the self-winding watch was invented then, not even Breguet's magnificent workmanship could make one that would work reliably for a long period. He therefore gave up making the 'perpetuelle' around 1800³⁶.

Another difference between the English and European watches was in the escape wheel. The English used a wheel with pointed teeth and the Europeans used a wheel with clubfoot teeth. The clubfoot teeth, as well as the pallets, provided lift to the balance, whereas in the English version the wheel provided all the lift.

Pair cases began to go out of fashion by 1775, when the French started to make thinner watches.

As a historical note, Breguet died in 1823.

1830-1900 – The Era of Complications

By 1850, in England, the lever³⁷ watch reigned supreme. By 1860 the design of the lever had changed from a straight-sided design to a curved one. The fusee continued till the last decades of the century.

Watches were thinning by using a three-quarter or half plate movement. In the three-quarter movement, the balance, lever and escape wheel were placed with separate cocks in a space obtained by cutting away a section of the plate. In the half plate, the fourth wheel also had a separate cock.

³³ In Switzerland however, the cylinder escapement was starting a run in production that lasted about 200 years.

³⁴ The overcoil, to make a spiral spring isochronous, was Breguet's lasting legacy to horology. In a watch with an overcoil, it is not possible to regulate the balance.

³⁵ This consisted of two spring steel arms that housed the end stones of the balance shaft. The arms were lone enough to provide sufficient deflection that an excessive jar would deform the arms before breaking the balance staff pivots. The arms would then spring back to the normal position.

³⁶ It was not till about 1930 that wristwatches were fitted with successful self-winding (automatic) mechanisms.

³⁷ Right angled lever arrangement.

Winding

In 1814 Massey first used a push or pump winder with a rack operated by pushing the pendant that turned a ratchet on the fusee or going barrel. Various winding systems were devised around the first and second decades, but the first man to devise winding and hand setting through the pendant was Audemars in 1838. Initially the change of mode from hand set to wind was done via an external lever, but eventually this was dispensed with.

With keyless wind and pendant hand setting, the cases had no need to be opened all the time. A snap on bezel was introduced, and the hinged back was snapped firmly shut, with a small lifting ear to assist opening.

The dust cap changed to a small hinged cover fitted inside the back, and the movement was screwed in place instead of being hinged.

England was still using fusees at this stage, and the keyless wind and hand set were designed to work only with a going barrel. It was not until the 1890's that the English changed from the fusee to a going barrel, but they still continued to use keywind systems.

The watches still used full plate movements, and extravagant Liverpool jewellery was replaced with smaller jewels.

As the Victorian era progressed, cases and dials became heavier to the eye and hands became slimmer.

With the introduction of the second hand, some makers provided for the hand to be stopped like a chronometer. However, in these early watches, stopping the seconds hand also stopped the whole watch. The dials were divided to show fifths of a second and the number of beats was raised to increase accuracy.

The first true chronograph³⁸, as we now know it, was designed in 1844 by Nicole. It was not until 1862 that the contemporary three push³⁹ system was used.

Nearing the end of this period, watchmakers had devised mechanisms for all the grand complications such as repeaters, moonwork, alarm, striking, musical, automata, jaquemarts, multi-dial, day, date, month and stopwork. A large proportion of the watches with complications were Swiss with lever or cylinder escarpments. An English refinement was the *karrusel*⁴⁰, patented in 1892 by Bonniksen of Coventry.

It should be remembered that up to 1840, watches were all hand-finished, so that parts were not interchangeable. The Swiss however, believed there was a market for cheaper, machine made

³⁸ A watch that could measure the start and end of an event without stopping the mean time train.

³⁹ Start, stop and reset.

⁴⁰ The *karrusel* was a simpler version of Breguet's *tourbillon*, which compensated for positional error.

watches with interchangeable parts.

The designer of the first production machine was Leschot⁴¹. The main change was that holes were drilled using a pantograph, thus making the hole placement repeatable. Parts therefore became interchangeable. It was Frederic-Jalpy (1749-1812), however, that devised machine tools that laid the foundation for mass production.

The Americans were the first to begin volume production, probably around the 1850's. Companies involved in watch production had mixed fortunes, but the main ones were Waltham (1850-1950), Elgin (1864-on) and Hamilton (1892-on). A different concept was followed by the Waterbury Watch Company, founded in 1878. They made a cheap machine made watch with only 54 parts. It had a mainspring coiled behind the watch and the whole movement turned once an hour. This was in effect a *tourbillon* type watch, but the company failed with too cheap an image for their product..

The Swiss kept an ever watchful eye on the Americans and started volume production of both cylinder and lever watches around 1880. Towards the end of the century, Roskopf introduced a cheap pin pallet escapement, and this type of watch set the seen for many years to come.

Markets like Turkey and particularly China imported watches from England and later Switzerland. The movements in the Chinese watches were particularly ornate, with each part intricately engraved. Steel parts were blued or polished. The enamel dials nearly always had centre-seconds hands which moved but once a second.

1900 Onwards – Metallurgy to the Rescue?

The main changes to horology in this period came not from mechanisms but mostly from the advances in metallurgy. With the introduction of the balance spring on the first verge watch, horologists discovered the non-isochronous behavior of the balance due to both temperature and position.

In an attempt to cure the balance problem, self-compensating balances were made with bimetallic properties, cut ends and other compensations. However, they were usually able to compensate for high temperature and low temperature but not for middle temperature errors.

In 1900, Guillaume produced an alloy such that when used with brass in a cut, compensated balance virtually eliminated middle temperature error⁴². He further experimented and in 1919 it was possible to make a mono-metallic balance of Invar controlled by an Elinvar balance spring.

The other main change in this period was the form factor change that allowed the move from pocket watches to wristwatches⁴³. By 1930, the ratio of wrist watches to pocket watches was

⁴¹ This was the same man who introduced draw into Swiss lever escapements and designed standard tools to make lever escapements.

⁴² This was actually called a Guillaume balance.

⁴³ The main instigator for change was the First World War, where it was found that wristwatches

about 50:1. Winding was by button and hand adjustment by rocking bar or shifting sleeve. In early designs or pocket watch conversions, the strap lugs were simple wire loops added to what appeared to be very small pocket watch cases. Hinged or snap bezels and backs were used. Dials were white enamel or metal without decoration but the numbers were sometimes made luminous. Watch glasses started to be made from transparent plastic material which was less fragile, but tended to scratch and yellow with age.

The pocket watch continued till the end of the Second World War (1945) but after that production was minimal⁴⁴.

English production tapered off till it effectively finished in 1930. After the war however, production with new tooling began again. The Swiss watch captured a large percentage of the world's consumption.

In the new watchmaking regime, two escapements won through. The lever was used for expensive jeweled or partly jeweled watches whereas the pin pallet was used in cheaper watches. The cylinder escapement, after two hundred years of life, was finally a casualty of a crowded marketplace.

In 1945 quality wristwatches began to get complications that had been available in pocket watches. The main complication was the Perrelet method of automatic winding⁴⁵. The chronograph became available, often with datework, alarmwork and moonwork etc. Watches were also made more robust, with mechanisms to make them waterproof, shockproof, and able to function in extremes of pressure, vacuum and gravity.

With so much standardization it was now not possible to distinguish a brand's national identity.

The battery-powered watch was available in 1952 as an alternative to the automatic. The electronic watch, which replaced the escapement with electronic vibrations of a tuning fork, was a completely new concept. This changed the beat of the watch from about 2.5 beats per second for a mechanical watch to nearly 2.5 million beats per second for an electronic watch.

This new technology was embraced and enhanced by the Asian watch industry, Japan in particular. This system allowed cheap and very accurate watches to be mass produced in the millions.

By 1970's, these electronic watches were so successful that the mechanical watch was nearly lost forever. The resurgence in the mechanical watch was brought about mainly by the nostalgia of the Italians. Now the market for mechanical watches is flourishing again, mainly in the upper sections of the marketplace. Thirty percent of most Swiss watchmakers production is

were more convenient than pocket watches.

⁴⁴ One of the main contributors to this was exactly the thing that increased their popularity in 1675. The waistcoat was the falling from fashion.

⁴⁵ A problem of autowinding in the wristwatch was over supply of movement, whereas in the pocket watch the reverse was true.

mechanical, with over 6 million movements and ebauches produced in 1995.

Manufacturers like Blancpain, Rolex, Patek Phillippe, Audemars Piguet, Jaegar LeCoultre, Lange & Sohne and Vacheron Constantin all make high quality mechanical watches..

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