

# A Chronology of Clocks

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## BEFORE CHRIST

The Sumarians as early as 21st century BC had a calendar year lasting 360 days long. This was derived from rounding off the lunar month to 30 days and there being 12 lunations in the year. The system was also based on the numbers 6 and 60 which when multiplied give 360.

The Babylonians continued the Sumarian system and divided the day into 24 hours which is divisible by 6 and also itself divides 15 times in to 360.

**16th century BC** - Earliest attribution of the Clepsydra in Babylon, and also reference on a tomb in Egypt.

**1400 BC** - Earliest surviving fragments of an Egyptian water clock from the reign of Amenhotep III at Karnak.

Egyptians improved the calendar and changed to a solar based system with a year of 365 days consisting of twelve 30-day months plus five birthdays for Isis, Osirus, Horus, Nephthys and Set.

**4th century BC** - Fragments of basalt clepsydrae in British Museum Collections.

**3rd century BC** - Ctesibius of Alexandria named by Vitruvius as the inventor of the in-flow water clock with a float to indicate the time.

**1st century BC** - Tower of the Winds water clock by Andronicus at Kyros.

**500 ca.** - The monumental water clock "The Hercules" at Gaza.

**87 BC ca.** - Antikithera machine: the earliest known geared mechanism in the form of a hand set calendar.

## ANNO DOMINI

**2nd century** - Anaphoric dials.

**520 ca.** - Geared portable instruments.

**670** - Bewcastle Cross installed, one facet contains the earliest surviving sundial in England.

### 11<sup>th</sup> Century

**1090** - Su Sung's planetary machine.

### 12<sup>th</sup> Century

**1160** - Monumental water clock made by Mohammed Ibn Ali Ibn Rustam al Churasani al Sa'ati was burnt in 1166/7 and then restored by his son.

**1198 ca.** - Monastic water clock. The Chronicle of Jocelyn of Brakeland at St Edmondsbury describes a water-driven alarm clock used to announce Matins. The water from the clock was used to put out a fire.

### 13<sup>th</sup> Century

**1206** - Castle water clock of Ibn ar-Razzaz al-Jazari (manuscript in the Topkapi Museum, Istanbul).

**1232** - Emperor Frederick II received a large water clock with astronomical indications from Baghdad.

**1235** - Villard de Honnecourt illustration of a tower construction possibly to house a clock.

**1240 ca.** - Guilamus Alvernus used water clocks.

**1271** - Robert the Englishman writes a commentary on Johannes de Sacrobosco's *Tractus de Sphera Mundi* in which he states that clockmakers have not found a method by which a wheel will make one revolution for every one of the equinoctial circle.

**1275 ca.** - Albrecht, author of *Juengeren Titirel* describes a clock which showed the passage of the sun and moon, etc.

**1283** - Dunstable Priory of the Austin Canons. *Eodem anno fecimus horologium quod est supra pulpitem collocatum*. Referring to the installation of a clock on top of the rood

screen between the choir and the altar. It should be noted that the term pulpit in medieval times alluded to this screen and not the modern interpretation of the raised platform from which sermons are preached.

**1284** - Repairs done to the church bells, musical instruments and clock in Exeter Cathedral.

**1284** - Bishop Gulielmus Durandus. *Rationale Divinorum Officiorum* describes the construction and content of an ideal church, including a clock 'somewhere in the nave'.

**1286** - St Paul's Cathedral. Clockmaker mentioned in the accounts for drawing rations.  
- Bartholomo Orologario. Also in the Brewer's Account, *Compotus bracerii* is a reference to xxiii bollae or bowl of beer for the said Bartholomo.

### 14<sup>th</sup> Century

**1300 ca.** - Pierre Pipelart built the first recorded public clock in Paris.

**1305** - A simple clock made for the Convent of San Domenico.

**1306** - Regulation in Sarum "before the clock of the cathedral had struck one, no person was to purchase or cause to be purchased, flesh, fish or other victuals".

**1322 -1325** - A large astronomical clock with automata installed in Norwich Cathedral Priory.

**1327 - 1336** - Richard of Wallingford's astronomical clock at St Albans Abbey.

**1336** - Galvano Fiamma Hour striking described in the clock of San Gotardo in Milan. The clock is described as having a very large bell which is struck 24 times with one at the first hour, two at the second and so on.

**1339** - Visconti, who commissioned the San Gotardo clock in Milan is described as having died in the twentieth hour - about 3 o'clock in the afternoon.

**1344** - Jacopo Dondi built a striking clock in for Padua which automatically strikes the equinoctial hours rather than canonical hours.

**1344** - Walter the Organer's indenture with Dean and Chapter of St Paul's to make a dial for the already existing clock. The dial to be on the outside of the building.

**1345/6** - Earliest reference to the use of a sand glass. Receipts for supplies to the English ship *La George* include a number of sand-glasses.

- 1348** - A striking clock recorded in London.
- 1353** - Clock built at Avignon.
- 1354** - Strasbourg Cathedral has its first clock.
- 1356** - Perpignan clock built.
- 1364 ca.** - De Dondi's Planetary Clock.
- 1370** - Henri de Vic made the clock at the Royal Palace in Paris.
- 1377** - Clock installed in the Campanile in Ghent struck the hours on a bell.
- 1376** - King Pere's description of a clock sent to his daughter.
- 1386** - Salisbury cathedral clock first recorded.

### **15<sup>th</sup> Century**

- 1410** - Prague Town Hall clock completed.
- 1420** - Inventory of Philip the Good, Duke of Burgundy (1396 - 1467): 12 July 1420 - Item: a small square clock, gilt on the outside, and its white enamelled zodiac has one bell on top to ring the hours. Inventory of Margaret of Burgundy 1423: 'a small gilt clock. There are two panels on either side made of gilt silver, as is also the dial.
- 1432** - Repairs to St. Mary's church clock in Launceston, Cornwall.
- 1440 -1460 ca.** Jehan de Souhade Velin *Le Livre d' Horloge de Sapience* - illustrates weight and spring-driven clocks.
- 1450 ca.** - Earliest surviving spring-driven clocks from Burgundy.
- 1459** - Jehan de Lycbourg's spring clock.
- 1470** - Inventory of the Duke of Burgundy refers to a small gold table clock set with twelve rubies with a dial in the upper face.
- 1470 ca.** - Brunelleschi's drawing showing coiled helical springs and fusees.
- 1480 ca.** - The Prince of Milan and his courtiers had very small clocks.

**1482** - A letter dated 21 August to Comino de Pontevico describes the mainspring and fusee and also refers to the watch.

**1480 - 1485** - The Almanus Manuscript is written.

**1490 ca.** - Cothele House clock, Cornwall, although some believe it to be earlier (see Beeson, *English Church Clocks*).

## **16<sup>th</sup> Century**

**1500** - Lorenzo Benvenuto della Volpaia makes an astronomical clock in Florence for King Matthias Corvinus.

**1512** - Cocchleus in *Cosmographia Pomponii Melae* notes that in Nuremberg, striking clocks were being made small enough to be worn in a purse or pouch. He also refers to Peter Hele (Henlein) making timepieces which, without any weights and in any position, indicate and go for forty hours.

**1518** - Julien Couldrday of Blois made two daggers for King Francis I, each with a watch set in the hilt.

**1524** - Peter Henlein described by Dopplmayr as a locksmith who gained renown through the small watch-works which he was one of the first to make.

**1525** - Jacob Zech clock, the earliest dated clock with a fusee.

**1528** - Hans Holbein the Younger's portrait of Nicholas Kratzer (1487 - ?1550), a mathematician originally from Munich who became '*devisor of the King's horloges*' to King Henry VIII.

**1530** - Gemma Frisius of Louvain first suggests that a clock could be used to establish differences in longitude.

**1532** - Florimond Robertet, Royal Treasurer leaves 12 watches in his will.

**1534** - Copernicus - *De Revolutionibus Orbium Coelestium* published.

**1535 - 1538** - Juanelo Torriano makes clocks for Emperor Charles V.

**1540ca.** - earliest references to the use of a fusee chain.

**1544** - Clockmakers' Guild established in Paris.

**1548** - Earliest surviving dated watch inscribed CW (for Caspar Werner of Nuremberg ?).

**1548** - *Tribute to the sublime Gate*, money and luxury goods, including clocks, are paid annually to Sulieman the Magnificent and his successors by the Holy Roman Emperor.

**1552** - Jost Bürgi is born in Lichtensteig, Switzerland.

**1560** - Landgrave Wilhelm IV of Hesse-Kassel's first astronomical observatory.

**1564** - Clockmakers' Guild established in Augsburg.

**1565** - Clockmakers' Guild established in Nuremberg.

**1569** - Jacques Besson published the cross-beat escapement.

**1572** - St Bartholomew's Day Massacre in Paris.

**1574** - The second Strasbourg Cathedral clock, designed by Conrad Dasypodius and constructed chiefly by Isaac Habrecht is completed.

**1575** - Ambrosio de Morales. *Las Antiquedades de Las Ciudades de Espana* records that Juanelo, clockmaker to Charles V used a machine to cut teeth on wheels.

**1576** - King Frederick II of Denmark founds the observatory on the Island of Hveen. Tycho Brahe used for observation four clocks which showed minutes and seconds. The largest of the clocks had only three wheels, the biggest, of cast brass had a diameter of about one metre and 1,200 teeth.

**1570s** - Brass begins to be used for the plates in watch and clock movements shortly followed by its use for wheels.

**1579** - Jost Bürgi begins working for the Landgraf Wilhelm IV of Hesn Kassel

**1580 ca.** - Jost Bürgi introduces the use of the train remontoire.

**1582** - Pope Gregory XIII's calendar reform adopted in most catholic states in Europe but not universally so.

**1583** - Galileo recognised the isochronous properties of the pendulum.

**1584** - Jost Bürgi (1555 - 1632) made clocks of remarkable accuracy. In a letter to Tycho Brahe, Landgrave Wilhelm IV states '*not only in the interstellar distances and the heights of the meridian, but also by our special minute and second registering clock, which often do not vary more than a minute from one meridian to the next*'.

**1585 ca.** - Jost Bürgi made long duration clocks going for 3 months at one wind.

**1585 ca.** - Jost Bürgi developed the cross-beat escapement.

**1586** - Tycho Brahe, *Astronomiae Instauratae Progymnasmata* published.

**1589** - Isaac Habrecht's carillon clock (British Museum).

**1592** - Jost Bürgi visits Rudolf II in Prague.

**1598** - Nicholas Vallin's carillon clock (British Museum).

**1598** - King Philip II of Spain offers a substantial reward of cash and a life pension for anyone who can discover the longitude.

### **17<sup>th</sup> Century**

**1602** - Edward East is born.

**1603** - Emperor Rudolf II gained permission from Moritz, the new Landgrave of Hesse-Kassel, for Jost Bürgi to move to Prague as clockmaker to the Emperor.

**1603** - Serious outbreak of plague in London.

**1607** - Ahasuerus Fromanteel the elder born in Norwich. Joined the Blacksmiths' Company in London in 1631 and the Clockmakers' Company in 1632.

**1609** - 'Instrument to cut wheels' mentioned in Peter De Hind's will.

**1609** - Johann Lipperhey (ca.1560 -1619) invented the telescope.

**1610** - Galileo discovers Jupiter's moons using the newly invented telescope.

**1612** - Rudolf II dies.

**1618** - Beginning of 30 Years War.

**1622** - First petition of the clock makers of London.

**1629** - Christiaan Huygens is born.

**1630s** - Painting in enamel technique perfected by Jean and Henri Toutin.

**1631** - Pierre Vernier introduces his fractional measuring scale.

**1632** - Jost Bürgi died.

**1632** - Foundation of the Clockmakers' Company in London.

**1636** - Galileo writes to the States General of Holland proposing the use of a pendulum as a device for timing observations.

**1638** - Galileo publishes *Discorsi e Diminstrazioni Matematiche Intorno a due Nuovo Scienza*.

**1639** - Thomas Tompion born.

**1641** - In collaboration with his son Vincenzo, Galileo has a drawing made of a time measuring device incorporating a pendulum as the controller.

**1642** - Galileo dies.

**1643** - Evangelista Torricelli invents the barometer.

**1647** - Daniel Quare born.

**1648** - Thirty Years War ends.

**1649** - Viviani Galilei's drawing of the pendulum timekeeper.

**1649** - Vincenzo Galilei constructs a pendulum clock.

**1650 ca.** - Hans Buschmann's year-going clock.

**1650s** - Introduction of the fusee chain in watches.

**1656** - Giuseppe and Pietro Campani begin making night-clocks in Rome.

**1657** - 12 January, first mention of Huygens pendulum clock.

**1657** - 28 March, first evidence of Huygens' pendulum with silk suspension and crutch piece.

**1657** - 16 June. Patent granted to Salomon Coster for making 'the New Invention of Clocks'.

**1658** - Christiaan Huygens' *Horologium*, published.

**1658** - Ahasuerus Fromanteel advertises clocks in the *London Mercury* to run for a week, a month or a year.

**1659** - Salomon Coster dies.

**1659** - 20 December - first reference to cycloidal cheeks to make a pendulum, swinging through long arcs, isochronous.



**1660** - Robert Hooke applies a straight spring to a watch balance to improve timekeeping.

**1660 ca.** - First appearance of the longcase clock.

**1660 ca.** - Anti-friction roller bearings used by Ahasuerus Fromanteel in a cage back-cock - the precursor of roller bearings and ball races.

**1662** - Foundation of the Royal Society in London.

**1662 - 1693** - Sea trial of Huygens' pendulum clocks.

**1664** - Patent granted by the States General of Holland to Huygens for 20 years for his pendulum clock.

**1665** - The Great Plague of London.

**1665** - Huygens' discovery that two pendulums operating in close proximity will affect each other.

**1665** - Huygens *Kort Onderwys Aengaende het gebruyck Der Horologien Tot het vinden der Lengthen van Oost en West* - containing one of the earliest tables of the equation of time.

**1666** - Foundation of the Académie Royale des Sciences in Paris.

**1666** - The Great Fire of London.

**1667** - Foundation of the Paris Observatory.

**1670 ca.** - The anchor escapement invented, probably by William Clement. John Smith in *Horological Disquisitions*, 1694 says "From *Holland*, the fame of this invention (the pendulum) soon passed over into *England* where several eminent and ingenious workmen applied themselves to rectify some defects which as yet was found therein; among which that eminent and well-known artist Mr. *William Clement*, had at last the good fortune to give it the finishing stroke, he being indeed the real contriver of that curious kind of long pendulum, which is at this day so universally in use among us."

**1670** - Joseph Knibb makes a clock with an anchor escapement for Wadham College, Oxford.

**1672** - Huygens drawing of a triangular pendulum for marine timekeepers.

**1673** - Huygens publishes *Horologium Oscillatorium*.

**1674** - Abbé de Hautefeuille applies a long straight spring to a watch balance.

**1675** - Huygens' letter to Oldenburg concerning the use of a spiral spring to control the action of an oscillating balance wheel.

**1675** - Memoir - The Seigneur Huygens de Zulichem, of the Académie Royale des Sciences has invented a new construction of portable clocks.

**1675** - Foundation of the Greenwich Royal Observatory.

**1675** - Christiaan Huygens invents the balance spring for portable timekeepers at the same time as Robert Hooke claims the same invention and expounds his law - *ut tensio sic vis* - for the properties of springs.

**1675 - 1680** - Watches with minute hands and sometimes seconds hands introduced.

**1676** - Edward Barlow invents the rack striking mechanism and the first repeating clocks are made.

**1686** - Isaac Newton publishes *Principia*.

**1687** - Daniel Quare and Thomas Tompion submit quarter repeating watches to James II for assessment in the quest of a patent - Quare's version is preferred.

**1693** - Ahasuerus Fromanteel the elder died.

**1693** - John Harrison is born.

**1694** - John Smith publishes *Horological Disquisitions*. "Concerning the Nature of Time, and the reasons why all days, from noon to noon, are not alike twenty four hours long". The book also contains an equation table and a second section entitled "The best Rules for the Ordering and Use Both of the Quick-silver and Spirit Weatherglass".

**1695** - Christiaan Huygens dies.

**1696** - William Derham FRS, publishes *The Artificial Clockmaker*: "A treatise of watch and clock-work, wherein the art of calculating numbers for most sorts of movements is explained to the unlearned".

**1697** - Edward East dies.

## **18<sup>th</sup> Century**

**1700 ca.** - Pierre Debaufre invents the club-tooth verge escapement for watches.

**1703** - John Ellicott junior is born.

**1704** - Nicholas Facio Di Duillier (1664 - 1753) with Pierre and Jacob DeBaufre obtains a patent for piercing and polishing jewels for watches.

**1711** - "Abrege De Quelques Règles pour faire un bon usage des Montres Avec des Réflexions utiles sur la manière de les bien raccommoder".

**1711** - George Graham's mercurial compensation pendulum - see 1721 below.

**1714** - The Longitude Act (July 8th).

A scale of rewards for anyone who 'shall discover a more certain and practical method of ascertaining the longitude'.

£10,000 for within 1 degree or 60 nautical miles

£15,000 for within 2/3 degree or 40 nautical miles

£20,000 for within 1/2 degree or 30 nautical miles

over a voyage from England to the West Indies, about 6 weeks.

**1714** - Antoine Thiout publishes a version of the gridiron pendulum.

**1715 ca** - Daniel Delander's duplex escapement for clocks.

**1715 ca.** - George Graham's dead-beat escapement.

**1716** - Henry Sully's first *Montre pour la Mer* presented to the Académie des Sciences.

**1719** - Julien Le Roy, *Avis concernant les vrais moyens de régler les montres tant simple qu'a répétition*. 'Notes on the true way of regulating watches, plain and repeating'.

**1720** - Joseph Williamson - A letter of Mr Joseph Williamson, Watchmaker, to the Publisher, wherein he asserts his right to the curious and useful invention of making clocks to keep time with the sun's apparent motion. In *Philosophical Transactions of the Royal Society* Volume 30, Williamson claims here to have made a clock in about 1700 for Daniel Quare which showed true solar time. However, there are earlier examples made by Thomas Tompion, one a clock for William III still in the Royal Collections.

**1721** - George Graham's mercury pendulum, as a result of work which he said he had done ten years earlier.

**1722** - Abbé de Hautefeuille, *Construction nouvelle de trois montres, d'un nouveau balancier en forme de du croix, qui fait les oscillation des pendules très petites, d'un Gnomon spéculaire pour régler juste au Soleil*. The new escapement is a modified form of anchor escapement.

**1723** - Henry Sully's second and third sea clocks.

**1725** - John Harrison investigates expansion of metals resulting in his gridiron pendulum.

**1726** - John and James Harrison make two wooden regulators containing Harrison's grasshopper escapement.

**1726** - Henry Sully publishes *Une Horloge inventée et exécutée par M. Sulli*.

**1726** - George Graham, *A contrivance to avoid irregularities in a clock's motion*. Published in *Philosophical Transactions of the Royal Society in 1726*. Graham says that in about 1715 he tried to see whether there was any considerable difference in expansion of different metals when subjected to temperature change.

**1726** - Antoine Thiout, *Quadrature d'une Pendule qui marque le temps vrai et le temps moyen en minutes et seconds*. Layout for a clock which shows true (solar) time and mean (clock) time in minutes and seconds.

**1727-1728** - In 1725 John Harrison was investigating the expansion of metals caused by the effects of heat and cold, an investigation which resulted in his gridiron pendulum of 1727-1728.

**1728** - Henry Sully dies.

**1730** - John Harrison's manuscript, in which he explains how he used the observation of a star giving him sidereal time and by adjusting the result by 3 minutes 54 seconds arrived at mean solar time.

**1735** - Jean Baptiste Dutertre's new escapement consisting of a duplex with two balances geared together. Also a double pendulum clock for use at sea.

**1735** - John Harrison completes his first marine timekeeper H1.

**1737** - Commissioners of the Board of Longitude meet for the first time.

**1738** - John Ellicott FRS, 'A Description of the Manner of Using an Instrument for measuring the Degrees of the expansion of Metals by Heat' submitted to the Royal Society in October 1736 and published in *Philosophical Transactions of the Royal Society* Vol. XXXIX in . A presentation paper concerning his new pyrometer with which the expansion of a metal bar caused by heat could be measured to the 7/200th part of an inch..

**1738** - William Derham FRS, 'Experiments concerning the Vibrations of Pendulums', *Philosophical Transactions of the Royal Society*, volume 39. Firstly that the arc of a pendulum increased when placed in a vacuum and the rate to be slower than in air. He also carried out experiments to determine the effect of heat and cold on a pendulum.

**1739** - John Harrison completes his second marine timekeeper H2.

**1740** - S. Faggot, *Gedanken über die Veränderungen der Metalle durch Wärme und Kälte*. A publication in which he introduces an iron bar compensation pendulum.

**1740 - 1742** - Benjamin Huntsman, clockmaker of Doncaster invents the process for making crucible steel.

**1741** - Antoine Thiout, *Traité d'Horlogerie Mécanique et Pratique*. An important treatise on practical clock and watchmaking.

**1744** - John Ellicott FRS, An account of the influence which two pendulum clocks were observed to have on each other. Published in *Philosophical Transactions of the Royal Society*.

**1748** - Pierre Le Roy's pivoted detent escapement.

**1749** - Published findings of Celsius in his experiments on the expansion of wood rods with heat. He observed that all varieties of wood expand with a reduction of temperature within the range +14 degrees to -14 degrees Reaumur.

**1751** - In a controversy between the Paris Guild of Clockmakers and Pierre de Rivaz, with Pierre Le Roy acting on behalf of the Clockmakers' Guild, LeRoy says in a Memoire that several makers had used pendulum rods of ebony, walnut or boxwood and that George Graham always used wooden rods for his regulators.

**1752** - Pierre Le Roy announces his detent escapement in *Histoire et Mémoires de l'Académie Royale des Sciences* of 1748.

**1752** - England adopts the Gregorian Calendar. In that year September 2nd was followed by September 13th, thus 'losing' 11 days.

**1753** - John Jeffrys makes a watch to John Harrison's specification. The earliest compensation curb, although Ellicott claimed an earlier application to a watch in 1748 which he announced in a paper to the Royal Society at the end of his paper 'A Description.....' see next entry.

**1753** - John Ellicott FRS, 'A Description of two methods by which the Irregularity of the Motion of a clock arising from the influence of Heat and Cold upon the rod of the Pendulum, may be prevented'. Published in *Philosophical Transactions of the Royal Society* Volume 47. This publication caused considerable controversy, provoking letters from James Short et al.

**1754** - Pierre Le Roy announces his 1748 detent escapement in design for a marine timekeeper in *Histoire et Mémoires de l'Académie Royale des Sciences*.

**1754** - Ferdinand Berthoud deposits a design for a marine timekeeper *L'Académie Royale des Sciences*.

**1754** - Thomas Mudge's Experimental Marine timekeeper, the first example of the detached lever escapement.

**1755** - Jean-André Lepaute, *Traité d'Horlogerie*. Containing Lepaute's pin-wheel lever escapement and his one-wheel clock.

**1757** - John Harrison completes his third marine timekeeper H3.

**1759** - John Harrison completes his fourth marine timekeeper H4 a complete departure in technology from his earlier three machines.

**1761-1762** - First trial of Harrison's H4 on a voyage to Jamaica. At the end of the 3 month voyage the timekeeper's error was calculated as 5.1 seconds in 62 days. On the return voyage, on arriving at Spithead, the watch had lost 1 minute 54 seconds in 147 days. Doubts were raised about the validity of these rates and a re-trial was ordered by the Board of Longitude. This time the voyage was to Barbados.

**1761** - First transit of Venus observations. Said to have been unsatisfactory because of the difficulty of observing, caused by a factor known as the black drop.

**1761** - Ferdinand Berthoud's First Marine timekeeper.

**1764** - Second trial of Harrison's H4. Over 156 days an error of 1/10th second per day was measured.

**1765** - Pierre Le Roy in Paris invents the self-compensating balance.

**1765** - John Harrison's timekeeper H4 examined by a committee appointed by the Board of Longitude.

**1766** - Alexander Cumming *The Elements of Clock and Watch Work*, publishes his first constant Force Escapement.

**1766** - Pierre Leroy's Pivoted Detent escapement, the earliest detached escapement.

**1767** - John and William Harrison begin work on H5 an improved version of H4.

**1767** - Harrison's *Principles* published.

**1768** - George III has an observatory built.

**1769** - Second transit of Venus observations.

**1769** - Larcum Kendall's copy of Harrison's H4, known as K1 was completed. Larcum Kendall had co-incidentally been the apprentice of John Jeffrys.

**1769** - Thomas Mudge completes his detached lever watch for Queen Charlotte.

**1770** - Harrison's fifth marine timekeeper H5 completed.

**1770s** - Introduction of the white dial clock in Birmingham.

**1771** - Francis Wollaston FRS 'An Account of the Going of an Astronomical Clock' *Philosophical Transactions of the Royal Society*. Report to the Royal Society of a regulator by John Holmes with a wood-rod pendulum Clock by John Holmes.

**1771** - John Arnold working on a pivoted detent escapement.

**1772** - Osborn and Wilson's advertisement of white clock dials.

**1772** - James Cox opens his mechanical museum in the Great Room in Spring Gardens London.

**1772** - Harrison's marine timekeeper H5 is tested at King George III's private observatory - and recorded having gained 42 seconds in 71 days.

**1773** - Following the intervention of George III, Harrison is finally paid £8,750. This means that he received £22,750 in total.

**1773** - Ferdinand Berthoud publishes *Traité des Horloges Marines*.

**1774** - Thomas Mudge completes his Marine Timekeeper no.1 incorporating a constant-force escapement.

**1774** - Alexander Cumming's gravity escapement.

**1775** - John Arnold's patent for his first compensation balance.

**1780** - Thomas Earnshaw claims to have been working on a pivoted detent escapement.

**1782** - John Arnold's patent for a spring detent escapement.

**1783** - Thomas Wright's patent for the spring detent escapement.

**1784** - James Peto's cross-detent escapement.

**1785** - John Leroux's lever escapement with draw.

**1790** - By this time both John Arnold and Thomas Earnshaw were supplying the Royal navy and merchant fleets with marine chronometers capable of sufficiently reliable rates to calculate longitude at sea.

**1791** - John Arnold, *Certificates and Circumstances relative to the going of Mr. Arnold's Chronometers*.

**1792** - French Revolutionary Calendar began at mid night between 21 and 22 September but was not formally adopted until 4 Frimaire year II or 24 November 1793. The calendar continued in use until 10 Nivose year XIV or 31 December 1805 when the Gregorian calendar was restored.

**1795** - Abraham Louis Breguet completes his first *sympathique* clock.

**1795** - Abraham Louis Breguet invents the tourbillon.

**1796** - Abraham Louis Breguet's first modern carriage clock.

**1798** - Abraham Louis Breguet's patent for a constant force escapement.

**1797** - The Act of Parliament granting to his Majesty certain duties on Clocks and Watches.

**1798** - Abraham Louis Breguet exhibits his *sympathique* in a National Exhibition.

**1798** - Abraham Louis Breguet granted a patent for his constant-force escapement.

## **19<sup>th</sup> Century**

**1806** - Board of Longitude publishes *Explanations of Timekeepers constructed by Mr. Thomas Earnshaw and the late Mr. John Arnold*.

**1808** - Thomas Earnshaw, *Appeal to the Public*. An autobiographical account relating to his invention of the spring detent escapement and compensation balance.

**1808** - William Congreve's patent rolling ball clock.

**1808** - Eli Terry, clockmaker of Plymouth, Connecticut undertook to make 4,000 wooden clock movements at \$4 each marking the beginning of mass production.

**1810** - Frederick Japy establishes his first factory at Badarel in France.

**1816** - Francis Ronald's proposes to the British Admiralty the idea of sending messages by telegraph.



- 1821** - John Roger Arnold granted a patent for his 'U'-shaped balance.
- 1824** - First suggestion by Captain Robert Wauchope RN proposed the erection of a time ball. Nothing seems to have come of it.
- 1828** - J.G. Ulrich granted a patent for the first non-magnetic balance.
- 1833** - Admiralty issues notice that the Greenwich time-ball will begin operation 28 October.
- 1837** - First operational telegraph installed between Euston station and Camden Town by Charles Wheatstone and William Cooke.
- 1840** - Captain Basil Hall wrote to Rowland Hill suggesting that all post office clocks should show London Time.
- 1841** - Alexander Bain of Watten in Caithness is granted the first British patent for driving a clock using an electric current.
- 1842** - Matthaus Hipp's 'toggle' electric clock.
- 1848** - Greenwich Time adopted by the city of Edinburgh.
- 1849** - Charles Shepherd's electrically reset gravity escapement.
- 1850** - Charles Shepherd's electric clock installed at Greenwich Royal Observatory.
- 1851** - First cable link between England and France.
- 1851** - The Great Exhibition held in Hyde Park, London.
- 1852** - Charles Shepherd's electric clock installed at Greenwich Observatory.
- 1852** - Greenwich time-ball converted to electric-powered operation.
- 1854** - The mechanism of the clock designed by Edward Beckett Denison for the Palace of Westminster began workshop trials at Edward John Dent's workshop.
- 1855** - The majority of public clocks in Great Britain were set to GMT.
- 1858** - Founding of the British Horological Institute.
- 1858** - First transatlantic cable laid between England and America.
- 1859** - Westminster clock finally installed and working.

**1865** - Second transatlantic cable laid by the *Great Eastern*.

**1873** - End of unequal hours system in Japan.

**1874** - Extensive distribution of Greenwich Time using telegraph.

**1876** - Sanford Flemming introduces time-zones in America for the railway system.

**1880** - Statutes time Act establishes Greenwich Time as the legal time throughout the United Kingdom.

**1883** - Charles F. Dowd suggests the time-zone system.

**1884** - International conference agrees Greenwich as 0 degrees longitude and establishes the international date line and 24 time zones.

## **20<sup>th</sup> Century**

**1900** - Paris International Exhibition includes a speaking clock with human voice reproduced by a phonograph.

**1907** - Frank Hope-Jones, 'Synchronome' electric clock

**1921** - W.H. Shortt - 'Hit and Miss' synchroniser enables the development of the Shortt 'Free Pendulum clock'

**1929 ca** - Warren A. Marrison's first Quartz-crystal controlled clock.

**1936** - Speaking clock was introduced in Britain into the telephone system.

**1943 ca.** - Quartz clocks first used in astronomical observatories.

**1955** - Louis Essen and J.V. Parry's first atomic clock installed at the National Physics Laboratory at Teddington. Used to synchronize a quartz-crystal clock.