Preprint Series No. 159, September 1993

Armagh's Longcase Regulators

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To appear in **Clocks** (September 1993); Argus Specialist Publications.

Armagh's Longcase Regulators

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Armagh Observatory in Northern Ireland has a collection of six longcase timepieces all dating from the late eighteenth century. Although all these are extremely interesting horological instruments, three at least are of paramount historical importance. A clock by Thomas Earnshaw has been described as 'probably the best in the world' (in terms of accuracy) but was nevertheless Earnshaw's very first clock. The clock known as the 'Royal Shelton' was used by King George III at his private observatory in Kew and a clock by John Crosthwaite of Dublin is thought to be the oldest surviving example of Irish astronomical clockwork.

Armagh Observatory was founded in the year 1791 by Archbishop Richard Robinson, the Protestant Primate of All Ireland. Robinson was a great benefactor in the small city of Armagh and the establishment of an observatory was the first step towards founding a University of Armagh, which was sadly never realised[1]. After the appointment of Dr James Hamilton as director for the Observatory, the buildings were constructed in 1789-1790 and observations begun in 1793. During its subsequent career the Observatory's importance has waxed and waned. Significant work was done under the directorships of Thomas Romney Robinson and John Dreyer and in the modern era the Observatory has achieved an international reputation.

The six clocks or regulators in the Observatory's possession come from several sources; two were supplied by Earnshaw on the request of the Astronomer Royal Nevil Maskelyne who was acting on behalf of Primate Robinson, one was bought from Dunsink Observatory (near Dublin), two came from King George III's collection of instruments and one may have been donated by William Davenport (Observatory director from 1815 to 1823). Although none of these timepieces are currently in use, scientifically or otherwise, they have played a vital role throughout the Observatory's career.

Time is an important concept in astronomy, indeed time was first measured by astronomical observation. The position of the stars in the sky at a particular time depends on where you are on the Earth and this fact explains many of the uses of the clocks at Armagh. For example, Hamilton published details of a method for determining the longitude difference between observatories by timing the transit of the moon and a close-by star across the meridian at the two sites. The meridian is a line which passes from north to south through the zenith. Similarly, the right ascension (celestial longitude) of a star in the sky can be determined by finding the exact time it crosses the meridian. In these types of observation it is essential that the known error of the clock can be checked by observing a star of accurately known position. An important requirement is that the clock error remains predictable throughout a long sequence of observations. The fruits of these often laborious calculations which depend so much on the clock maker's ability are to be seen, for example, in T. R. Robinson's compendious volume entitled 'Places of 5345 Stars Observed from 1828 to 1854 from Armagh Observatory'[2].

Of the two clocks by Earnshaw at the Observatory the one known as No. 1 (IA6.1)[3] is an extremely interesting piece, not least because it was the first regulator Earnshaw constructed. Thomas Earnshaw (1749-1829)[4] was an ingenious watch and chronometer maker based in London. His invention of the spring detent escapement, which later became a standard in marine instruments, has assured his prominent place in horological history. It was on the suggestion of the Astronomer Royal Nevil Maskelyne that Earnshaw constructed his first clock. Maskelyne had been heavily involved with the makers Arnold, Harrison and Mudge concerning the admiralty's reward offered for a technique for the accurate determination of longitude at sea. A simple method involves comparing one's local time (measured through

astronomical observation) and the local time at some fixed meridian of known longitude. Since this required transporting a chronometer showing the local time at the fixed meridian and which would keep time accurately, the best chronometer maker's were in fierce competition for the Admiralty's reward. How Earnshaw came to be caught up in this story is well documented in his 'Appeal to the Public'[5] but suffice it to say that Earnshaw fought for over ten years with both his horological rivals and the government for some reward for his endeavors; a battle which left him with 'many gaping wounds'[6] and still did not attain him a proportionate compensation.

It appears that in April 1789 Maskelyne was considering various scientific instruments on behalf of Primate Robinson. Maskelyne refers to a 'very good workman who has invented a detached escapement'[7] and mentions the possibility of a trial of such an instrument. By the following February Maskelyne writes 'Earnshaw, who insists on it that he was the first inventor of the detached escapement... has undertaken to make a clock upon principles to me to be much superior to any hitherto practiced.'[8]

The exchange between Maskelyne and Earnshaw concerning this commission is infamous. When asked to construct a clock for an astronomical observatory Earnshaw replied that he 'never had made a clock and did not know how many wheels were in one'[9]. Maskelyne suggested the clock should not err by greater than half a second per day to which Earnshaw responded 'if the great clock makers, Graham, Harrison, Shelton, Kendal and Arnold could not make a clock go to half a second per day, what hope had he [Maskelyne] that I could do it who had never yet made one'[10].

Yet Earnshaw accepted this challenge and constructed his 'first infant endeavor in clockwork'[11] which was delivered for trial at the Royal Greenwich Observatory in February 1792. It remained there for two years and was finally installed at Armagh on August 18th 1794 by Earnshaw himself where it remains to this day[12].

The Earnshaw No. 1 is an impressive piece. The mahogany case stands at almost 2 meters and is hermetically sealed by large brass-headed screws. On Maskelyne's suggestion Earnshaw made the case virtually air-tight by the application of waxed cloth between all the joints. This was to ensure the exclusion of airborn dust particles (which would degrade the lubricant) and any external air currents which might affect pendulum action. For the mechanism Earnshaw brought many of his chronometer maker's habits such as the use of high numbers of teeth in the gearing, a profusion of jewelling at the bearings and a small angle of escape (0.5 deg).

The escapement itself has an interesting history. Originally Maskelyne was under the impression that Earnshaw would use his patented detached escapement but the clock actually contains a jewelled Graham dead beat escapement. This was assumed to be a replacement but it seems more likely that Earnshaw abandoned his original plan at a very early stage in the clock's construction.

The 8-day movement contains five pillars with a four wheel train, all the pivots being jewelled with endstones. It is interesting to note that the Buchanan clock (see below) now contains an identical pendulum to this clock and this is possibly a replacement by Earnshaw for his No. 1 which was initially over-compensated. The present mercury compensated pendulum, which originally had a barometric compensation, was fitted by the Dublin clock maker Christopher Sharp in 1830. Several other minor alterations to the clock were carried out at this time including a spring device to eliminate crutch pin friction. There is a clock of similar appearance at the Old Royal Observatory Greenwich which is marked with another makers name but contains a pendulum similar to that on the Earnshaw No. 2[13].

The constant accuracy of this instrument over long periods of time, the principle qualification of an astronomical regulator, has impressed successive directors of the Observatory. It has been described as an 'unusually good instrument'[14] and a 'clock of most excellent performance'[15]. In 1853 Thomas Robinson felt justified in writing that the Earnshaw clock was 'probably the best in the world'[16]. Indeed an accuracy of 0.25[17] seconds in transit observations at the end of the eighteenth century was a remarkable achievement.

The second clock by Earnshaw (known as the No. 2) is of a quite standard quality and it has been postulated that Earnshaw may have 'bought-in' this clock to supply with its superior companion. When enquiring of Hamilton for the rates for No. 1 Earnshaw writes 'the other clock, though an inferior one, if you can write anything on it, will likewise be very acceptable'[18]. Earnshaw was in the process of writing a protracted testimony to the accuracy of his timepieces so he may have been enquiring as to the running of his own clock or attempting to compare his No. 1 to a bought-in piece. Hence the provenance of the No. 2 is unclear but if it is indeed by Earnshaw then it represents along with its companion Earnshaw's first attempts in clock making.

The No. 2 (IA6.2) is simply but elegantly constructed. The veneered mahogany case has a waisted

trunk reminiscent of a journeyman and is not hermetically sealed. A five bar zinc and steel gridiron pendulum is suspended from a cast iron support. An 8-day four pillar movement consists of a four wheel train with pinions of eight and, like the No. 1, keeps sidereal time. Jewelling is found on the pallet and escape arbors whilst the escapement is a Graham dead beat with Harrison's maintaining power.

Although the Earnshaw No. 2 was only ever used as an assistant clock at the Observatory and no records of its accuracy have yet been found, further testimony to Earnshaw's ability to apply himself to astronomical regulators is found in Hamilton's description of the clock as 'an excellent piece of work... [which] performs admirably'[19].

There has been some confusion over the provenance of the clock signed 'John Crosthwaite/Dublin' at Armagh. It now seems clear that the instrument (IA4) was constructed for Dr Ussher, the director of Dunsink Observatory near Dublin in about 1785. Dunsink possessed two clocks by the famous Arnold but these were under repair by Crosthwaite who supplied his own clock as a temporary replacement. After the return of the Arnold clocks, which was delayed due to Crosthwaite's retirement, and then the death of Dr Ussher, the Crosthwaite was sold to Armagh Observatory for 40 guineas. This was just before or at the same time as the Earnshaws arrived at Armagh (c.1794).

This 8-day regulator has a six pillar movement with a four wheel train, a steel escape wheel and is housed in a flat-top mahogany case. It has a jewelled dead beat escapement with Harrison's maintaining power. Ussher described the pendulum as 'a glass rod and brass bob. The latter is fixed to the glass rod at a point somewhat below the bob's centre in order to provide temperature compensation... the pallets are of sapphire and the suspension spring of alloyed gold- it beats dead seconds, goes a week and is wound up on Saturday'[20]. An account of the pendulum which had an unusual diamond suspension can be found in the Transactions of the Royal Irish Academy for 1788. According to Armagh documents a new suspension spring and glass pendulum were fitted in October 1794 and the clock now contains a later cast iron pendulum support. The silvered brass dial has conventional concentric hour and minute hands unlike the other regulators.

The so-called Buchanan clock dates from about 1785 and although contemporary with the Earnshaws and the Crosthwaite does not appear to have been an original purchase. It was probably donated by the wife of William Davenport the Observatory director from 1815 to 1823. There are records of a clock being bought from Davenport and since he came to Armagh from Dublin it seems likely that he brought this clock with him. Although there is evidence that the clock was in use in the 1830s, there is no information concerning when it first came to Armagh.

The clock's provenance is also less than clear. It is virtually identical to those produced by Matthew and Thomas Dutton in the late 1790s and it seems likely that Buchanan, a Dublin maker, bought the mechanism from London and sold the clock in his own case with his signature attached. An oval cartouche applied to the dial bears the words 'Archibald Buchanan, Dublin'. As yet no other evidence for the clock's origin has been found.

This clock is undoubtedly English. The mechanism consists of a substantial high-quality five pillar movement with five wheel train, a dead-beat escapement and Harrison's maintaining power. The present pendulum is identical to Earnshaw's nine-bar gridiron design and is probably a replacement supplied by Earnshaw for his No. 1. No trace of an original Dutton-type pendulum has been found.

Two of the Observatory clocks originally came from the Kew collection. The Kew instruments were collected by King George III to accommodate his interest in astronomy. They eventually became the private property of Her Majesty Queen Victoria. It seems that Sir James South, an eminent but amateur astronomer, first suggested that these instruments be acquired for the Armagh Observatory. This transaction turned out to be a complicated affair[21] but eventually the Queen consented to the despatch of a list of items drawn up by South and these arrived in Armagh in April 1841.

The Shelton clock (IA1.10) which came from Kew is often referred to as the 'Royal Shelton' since it was used by George III himself to time the transit of Venus on June 3rd 1769. Incidently Armagh Observatory also possesses the telescope by Short (1745) used for the observation. Present with the King on this occasion, among others, were Queen Charlotte and the clock makers Benjamin and Justin Vulliamy. It appears the Kew Observatory (then called the King's Private Observatory) was established initially to observe this event and that the Shelton clock was constructed specifically to time the transit.

This clock stands at two metres and has a typical Shelton style mahogany case with a flat-top hood. In addition a sliding, jointed brass lamp or candle holder is attached to the hood and was used to illuminate the dial during night-time observations. The clock was designed to give mean solar time. The movement plates are also of typical Shelton design, with six latched pillars. Originally the clock was month

going with a five wheel train and bolt and shutter maintaining power which would have incorporated Shelton's 'drawback' device. Many 19th century alterations have been made to the mechanism which now consists of an 8-day train with four wheels and a jewelled dead-beat escapement with Harrison's maintaining power[22]. The clock's authenticity is certain since the pendulum beat scale is scratch-marked 'January 1769 Shelton' and the dial is signed beneath an attached 24-hour dial added by Sharpe.

Also shipped to Armagh from the George III collection was an astronomical clock by Recordon (IA1.8). In 1851, along with various other items, and with the consent of Queen Victoria, this clock was loaned to Queen's University Belfast. It was returned in the 1960s but unfortunately had suffered slightly with disrepair, the pendulum also being lost.

Louis Recordon was a well known and respected London horologist in the late 18th and early 19th centuries. He specialised in quality watchwork but his instrument now at Armagh is an 8-day centre seconds regulator signed 'Recordon Late Emery London'. This would date the timepiece in the mid 1790s.

This elegant drum-hooded clock has no jewelling in its unusual double-frame movement with seven pillars. It has a paddle wheel dead-beat escapement and Harrison's maintaining power. Originally it probably contained some sort of gridiron pendulum.

Apart from the Recordon and Crosthwaite clocks the dials of all these instruments are in the regulator style, ie. with separate hour, minute and second dials. All of them have 'observatory marks' at five second intervals on the seconds dials which were probably added in the 19th century to enable easier reading of transit times.

In addition to the six clocks described above Armagh Observatory has owned other important instruments which were later sold or lost. A regulator by Alexander Waugh of Armagh (c.1796) is reported to have been 'taken by Mr Holmes'[23] in the early part of the 19th century. Hamilton tells us that the clock was 'an astronomical clock' with a maintaining power designed 'on a very correct principle'[24]. The clock was rated at sidereal time and was used for transit observations until the Earnshaw clocks arrived. A clock by Christopher Sharp of Dublin was in use in the 1830s for the determination of the longitude difference between Armagh and Dublin but this mysteriously disappeared in the 1970s.

Among the other items that came to Armagh from Kew in 1841 were two further journeyman clocks by Shelton and pieces by Graham and Vulliamy. These four clocks were sold to the well known English collector D. A. F. Weatherfield in 1918 for a total of only £25. This transaction is still a mystery since, for no known reason, the clocks were sold on the advice of Professor H. H. Turner, Savillian Professor of Astronomy at Oxford as 'being of no practical use to the Observatory'. Weatherfield's collection was sold after his death in 1928. Apparently Shelton's journeyman spring clock went to a private English collection and his weight driven journeyman went to the USA. All trace of the Graham journeyman has been lost but the small split seconds timer by Vulliamy went to Robert Foulkes and on his death was bequeathed to the National Maritime Museum and is on display at the Old Royal Observatory.

The Armagh collection of clocks is extremely important both to horologists, historians and astronomers. Their designers, constructors and employers are all of considerable note. Crosthwaite and Buchanan of Dublin were outstanding workmen and produced timepieces comparable to those of the best London and Paris workshops. Recordon, who was the English agent of A. L. Breguet, was also highly regarded as a watch maker and patented a self-winding watch in 1780. Shelton is a famous figure having been apprenticed with George Graham in 1711. He had a hand in the construction of the Graham regulators for the Greenwich Observatory and many Graham timepieces have in fact been credited to Shelton. Shelton probably went solo on Graham's death in 1751 and produced many excellent regulators. One of these went with Captain James Cook aboard *Discovery* during the charting of New Zealand and the Australian East Coast and was used to time the 1769 transit of Venus from Tahiti. It appears however that Shelton died a destitute man. Earnshaw's story too is one of hardship. If the publication of Earnshaw's 'Appeal to the Public' in 1808, in which he presented the evidence of his worth, did not secure him the recognition and reward he deserved, then his craftsmanship and ingenuity are today undoubted. His clock, his 'first infant endeavor' is a glowing testimonial.

Many of these instruments have undergone restoration work and will be preserved for the enjoyment of generations to come; their significance and excellence is undoubted. In addition a wealth of documentation exists in the Observatory archives and further work will surely reveal more information regarding the colourful history of these beautiful and fascinating clocks.

Notes

The 'M' numbers given for some of the citations are references to the Armagh Observatory Archive catalogue numbers. This catalogue is given in full in *The Archives of Armagh Observatory*, J. Butler and M. Hoskin, Journal for the History of Astronomy, Vol. 18, pg 295, 1987.

1. Histories of the Observatory can be found in *Church, State and Astronomy in Ireland: 200 Years of Armagh Observatory*, J. A. Bennett, 1990, Armagh Observatory; *Armagh Observatory: 1790-1967*, P. Moore, 1967, Armagh Observatory; *An Historical Account of the Armagh Observatory*, J. L. Dreyer, 1883, Armagh.
2. *Places of 5345 Stars Observed from 1828 to 1854 at the Armagh Observatory*, T. R. Robinson, 1859, Dublin.
3. A full inventory of instruments is given in *The Historical Instruments of Armagh Observatory*, J. McFarland, Vistas in Astronomy, Vol. 33, pg 149, 1990. Inventory Numbers given for each clock come from this publication.
4. For a description of Earnshaw and his work see *The Marine Chronometer: its History and Development*, R. T. Gould, 1960, London. Also C. T. McKay, Antiquarian Horology, Vol. 12, pg 305.
5. *Longitude: An Appeal to the Public*, T. Earnshaw, 1808, London. Reprinted by the British Horological Institute, 1986.
6. In a letter from Earnshaw to Hamilton dated 7th January 1808, Armagh Observatory Archives (M51.10).
7. In a letter from Maskelyne to Hamilton dated 22nd April 1789, Armagh Observatory Archives (M51.3).
8. In a letter from Maskelyne to Hamilton dated 16th February 1790, Armagh Observatory Archives (M51.4).
9. Earnshaw 1808 (see note 6.), pg 40.
10. ibid, pg 40.
11. In a letter from Earnshaw to Hamilton dated 22nd December 1807, Armagh Observatory Archives (M51.9).
12. A full description of the installation of the clock is found in the observation record book of 1793-1796, Armagh Observatory Archives (M129)
13. Full technical descriptions of this and the other clocks at Armagh Observatory are given in *A Report on the Precision Clocks at Armagh Observatory*, J. Betts, Old Royal Observatory, 1989.
14. *A Historical Account of the Armagh Observatory*, J. L. E. Dreyer, 1883, Armagh, pg 6.
15. In a letter from Hamilton to Earnshaw dated 26th December 1807, quoted in Earnshaw's appeal.
16. In an Observatory report for 1853, Armagh Observatory Archives (M136 Vol. 1). Robinson repeated this opinion in the 1862 Observatory report (M136).
17. In Hamilton's letter of 26th December 1807 (see note 16).
18. In Earnshaw's letter of 22nd December 1807 (see note 12).
19. See note 13.
20. See E. M. Lindsay, Irish Astronomical Journal, Vol 9, pg 57.
21. A full account of the George III collection of instruments and the events surrounding their acquisition is given by P. A. Wayman, Irish Astronomical Journal, Vol 10, pg 121.
22. A description of the Shelton is given in 'Preliminary Report: Shelton', H. Gilmore (restorer), Armagh Observatory, 1989.
23. In an Observatory inventory list, c. 1820, Armagh Observatory Archives (M91).
24. Royal Society Manuscript. L & P VIII, 24; Hamilton (1783), 453.