Chapter 3
Standard Time

This chapter is all about time, what it is and why we need it, although it will not be until the next chapter that we will see in detail why it is such an important part of meteorology.

It could almost pass without argument to contend that some form of standard time was essential for the two methods of transport that developed during the 19th century. Railways transported goods and people while telegraphs transported a new commodity, namely information. Okay, so railways could convey information the argument had to do with the speed of information flow. Before these came on the scene, the horse or the carrier pigeon were the fastest methods for all weather transmission of data, but once it was realised that the telegraph was an essential component in the control of the railways, then the future developments of these two technologies and their reliance on standard time were inextricably linked. Having said all that we should not forget that in the UK at least there was an awareness of the importance of time at an earlier period, prompted not least by the question of longitude. While ships at sea can measure latitude by reference to celestial objects, the determination of longitude requires time-comparison with some fixed position[*]. On 22 October 1707 a naval fleet led by Adm. Sir Cloudsley Shovel misjudged their position and four warships were destroyed (with the loss of 2000 men) on the Gilstone Ledge off St Agnes (Scilly isles). This led Parliament to pass the *Longitude Act* in 1714 which offered a prize of £20,000 to anyone who could deliver a solution. Dava Sobel[**] describes the efforts which John Harrison made between 1735 - 1773 to perfect ever better clocks. Although the arguments between Harrison and Neville Maskelyne whether chronometers or celestial observations were the ultimate answer, it is quite clear that there was an appreciation of the importance of accurate time in that the Office of True Time was established in 1752 with a remit to ensure the availability of the right data at the right time and at an affordable price. The major interested parties were the Board of Ordnance, the Board of Admiralty, Astronomer and Chronometer Royal, the Royal Society and (for reasons which no longer seem clear) the Church of England. In much the same way as the BBC is funded out of the TV license, the Office of True Time was funded through the right to exploit the Royal Society's knowledge of time and its derivatives. It held patents for clock components and other time-based publications. It applied a charge to all who held a clock or watch with only the Church of England and the Royal Navy exempt. It administered the license which covered the display of time in public places. This included Church clocks (except for Anglican churches) and public clocks (e.g. town halls, railways, etc).

The Royal Mail were amongst the first on land to be significantly conscious of time and the differences in time across the UK (easting and westing). A mail coach was operated by a staff of two. The coachman was an employee of the coach company, while the guard was an employee of the Post Office, responsible for the safety of the mails and keeping the coach to time. He carried firearms and a time-piece. This was designed to gain about 15 minutes in 24 hours, so that when travelling eastwards it might accord with real time. For westward journeys a watch with the reverse properties was used[+]. London time came to be accepted across much of the country even if they operated to their local times. The railways moved to 'Railway Time', although the Irish Mail (train) from London to Holyhead ran to London time from its inception in 1848. Each morning an Admiralty messenger carried a watch bearing

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[*] Given that the earth rotates 360º in 24 hours, one hour represents 15º of longitude

[**] Dava Sobel "Longitude" Harper-Collins 2005

[+] Derek Howse "Greenwich Time and the discovery of Longitude", OUP 1980 p. 83

the correct London time which he gave to the guard at Euston. On arrival at Holyhead the watch was handed to officials on the Kingstown (now called Dun Laoghaire) mail-boat, who carried it to Dublin. According to Howse (*loc. cit.* p.89) on the return journey the watch was carried back to London and handed back to the Admiralty messenger who met the train*.

A method of denoting accurate time was the 'time-ball' first installed at Greenwich by Astronomer Royal, John Pond in 1833. It was intended for the notification of mariners and chronometer makers. The process took place at 1pm because the astronomers might be busy with observations at noon. At five minutes before the hour the ball was raised half way up the pole to which it was fixed. At two minutes before one it was raised to its full height and at precisely on the hour it was dropped.

The time-ball at Greenwich

Railways, telegraphs and the transmission of time

Following the invention of the electric telegraph by Cooke and Wheatstone they set up a company, the Electric Telegraph Company (ETC), established by Act of Parliament in 1846). Its evolution was symbiotic with the railways as their development coincided in time and in mutual requirements. The railways needed a reliable system for the transmission of signalling information so that they could increase the density of trains on any line while minimising the risks of a collision.

However, it is interesting to note that this symbiosis was recognised even earlier than the formation of the ETC. In fact the Railway Regulation Act of 1844 says in Section 13: "And whereas Electric Telegraphs have been established on certain Railways and may become more extensively established hereafter and it is expedient to provide for their due Regulation: be it enacted That every Railway Company on being required so to do by the Lords of the said Committee (*Lords of the Committee of Privy Council for Trade and Plantations, later the Board of Trade*) with Servants and Workmen, at all reasonable Times to enter upon their Lands and to establish and lay down on such lands adjoining the Line of Such Railway, a Line of Electric Telegraphs for Her Majesties Service and give to him or them every reasonable facility for laying down the same, and for using the same for the Purpose of receiving and sending Messages on Her Majesty's Service, subject to such reasonable Remuneration to the Company as may be agreed . . . ."

* Even though UK and Ireland were connected by telegraph cable from 1852 onwards, this practice was continued until 1939 (P. Bagwell "The Transport Revolution from 1770" Batsford, London 1970).

Section 14 of the same Act dictates that electric telegraphs whether belonging to the railway company or some other company must be open to the public "all Persons alike, without Favour or Preference".

Telegraphs required way-leave for the erection of their system of poles upon which to hang their wires. Instead of having to negotiate with numerous land-owners they had arrangements with the individual railway companies. Telegraph poles ran alongside the tracks on railway land, bringing signals to railway stations and to signal boxes. One of the first lines was along the Great Western Railway from Paddington to Slough and very soon the public appreciation of the potential of the telegraph was raised when it was used to send a message down the line for the apprehension of a murderer who was known to have left Paddington by train. This led to the realisation that the telegraph could provide a means for the rapid dissemination of "intelligence" such as general news, financial news and betting news. With this type of traffic the Electric Telegraph Co expanded rapidly, and for those railway companies that operated to London time, the ETC provided a facility for the synchronisation of clocks.

The differences in time across the UK caused a major embarrassment when in 1851 a group of dignitaries travelling to the Great Exhibition, arrived at Bristol Temple Meads station at the local appointed time only to find that Brunel's excursion train (which operated to London time) had left 10 minutes earlier. The Astronomer Royal, George Biddell Airey, who was in the process of establishing Greenwich as the prime meridian was told by Prince Albert to do something about this state of affairs.

"Airy held the post at the Royal Observatory in Greenwich from 1835 to 1881. In his time, he transformed the observatory, installing some of the most advanced astronomical apparatus of his day and expanding both staff numbers and their workload. Staff had to clock-in and clock-out - common practice in Victorian factories and he also introduced new methods for dealing with the larger scale of the organisation. Further steps to automate systems and the production of strict step-by-step guidelines, all helped to reduce human error and increase efficiency.

The Airy Transit Circle, installed in 1850 and first used on 4th January 1851 is emblematic of the revolution in working practice introduced by Airy at the Royal Observatory. It sits on the north-south line, which today marks longitude 0°. This Prime Meridian, signals the start of the Universal day for the entire world. At the time of its installation, the Airy Transit Circle marked a huge advance on existing technology.

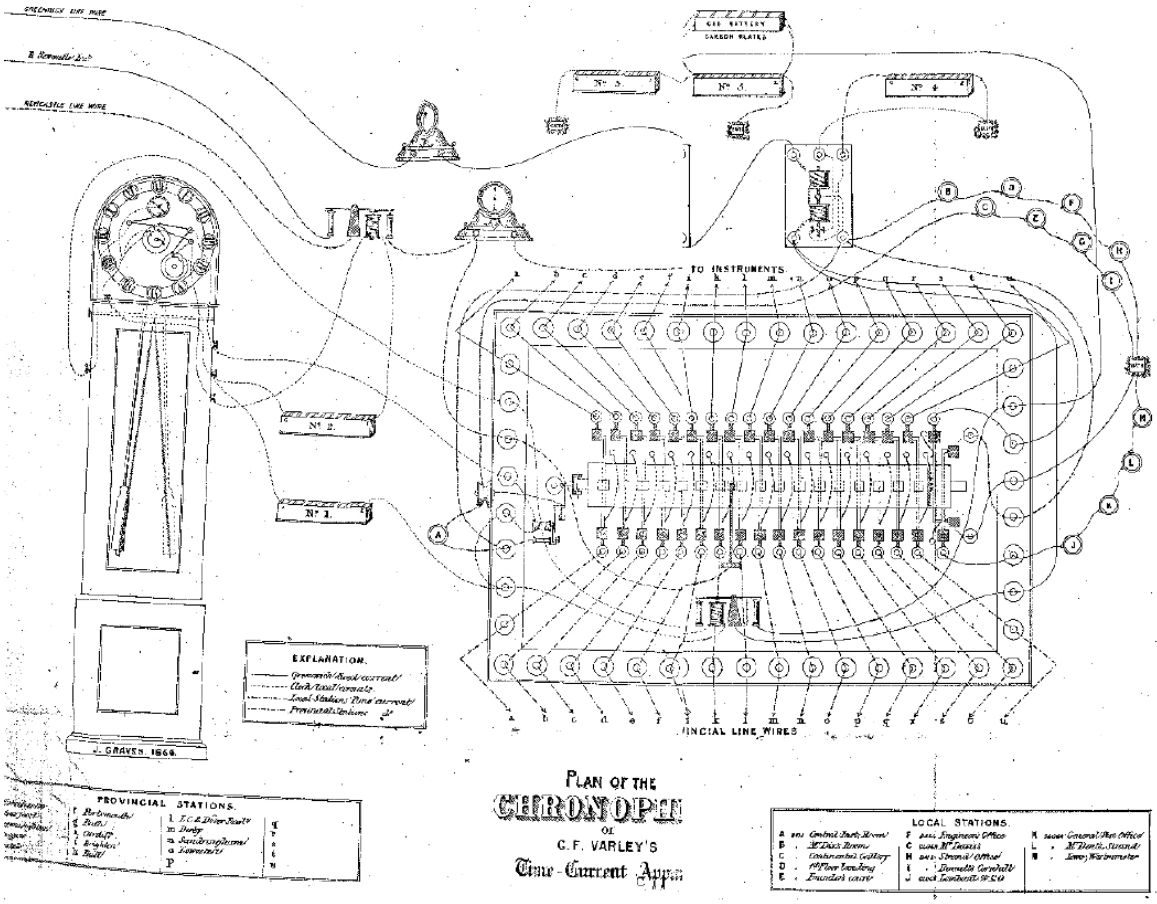
A transit instrument is always lined up with a north-south line, or meridian. When a star passes over the meridian, the transit instrument can be used to measure the angle at which this happens. Whilst this happens, an extremely accurate clock, called a regulator, is used to measure the time it occurs. These two measurements give the co-ordinates of that star, which can be used to make a star chart - and star position tables to aid navigation. The production of these tables, published annually to this day in the Nautical Almanac, was fundamental to the founding duty of the Observatory, which was to improve navigation."

http://www.bbc.co.uk/history/british/victorians/airy_george_04.shtml

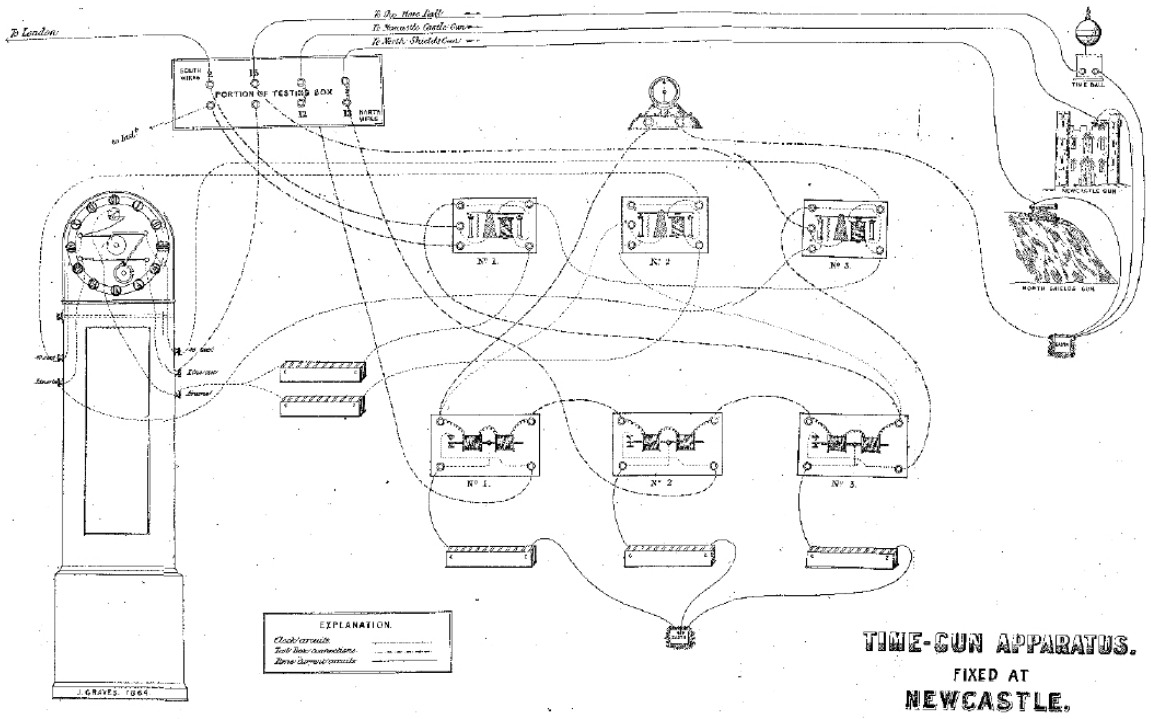
In 1852, Airey, after 3 years of planning and negotiations with the Admiralty installed a Mean Solar Standard Clock (by Shepherd) to drive the time-ball.

From this point the integration of railway, telegraph and astronomical observations became institutionalised. The Chief Electrician of the Electric and International Telegraph Co, Cromwell Fleetwood Varley (see picture below) designed an instrument which took the Greenwich time-signal and transmitted it throughout the entire network of the Company's wires.

The instrument was called a 'Chronopher' and *The Illustrated London News* of 19 December 1874 shows a picture which it claims are two instruments "the old one due to Varley and the new one". It is believed that there is some misunderstanding here, as the original intention of Varley was not just to transmit the signal by the making of a contact, but also to provide the temporary reconnection of the network to the clock so that uniform time could be transmitted. In the figures below we have a set of drawings which were made by James Graves, who keeps reappearing in this work, and who had become assistant to Varley in the early 1860s. It can be seen that he even signed the drawings (under the clock). He clearly shows the chronopher as the <u>entire system</u> and not just the clock.



Graves also drew how the clock was used to drive other devices such as time-balls as well as the Newcastle and North Shields guns



In 1870, following the nationalisation of the UK inland telegraph network the GPO took over responsibility for their operation and maintenance, which in due course led to such things as the speaking clock on the telephone. However there is a wonderful story told about one of the effects of this changeover*

"Large numbers of lines were nominated as chronopher lines with a number of reserves and great care was always taken that all such nominated lines were tested and maintained so that they were in good order for the time signal. One such reserve was the TS-BS London - Bristol - proved and checked every day and regularly at 9.00am the time signal was transmitted, as was thought, to a centre on the north coast of Somerset. . .

An enquiry was begun into whether the cost of maintenance of such lines was justified and in due course the Bristol line came under review, with the remarkable result that no trace of any circuit beyond Bristol could be found. Enquiries established that, years before, the line ran to a Customs and Excise and Coastguard centre on the Somerset coast, but changes had brought the centre into disuse and now only one coastguard remained.

The engineers, being very thorough, traced and recovered what was left of the circuit and found its termination at the coastguard house where, boldly shown in the office window, was the well-known rod and ball with a notice that at 9.00am precisely the ball would fall to indicate Greenwich time.

The coastguard admitted that he had not received a time signal for many years but as the inhabitants expected a signal from him so he knocked the ball down with a stick each day. When asked how he got the time he said that by standing on a chair and looking along and across the road he could see by the 'Brown's' big clock when to knock the ball down.

He was told to cease the practice and the engineers, being curious, went along to examine Brown's clock. They found it a well-built English clock and only 15 seconds slow. Asked how he kept the

* cited by Derek Howse "Greenwich Time and the discovery of longitude, OUP 1980 p. 115. who gives as a source E.C. Baker "Post Office clocks" *Post Office Telecommunications Journal* Feb. 1954 pp. 54 - 55

clock at correct time, Mr Brown said: "On, that's easy. By standing on my stool and peering sideways along and across the road, I can just see in the coastguard's front window the brass ball fall on the rod."

Conclusion

So, finally, having shown how the determination and dissemination of time in the UK was achieved, we are in a position to return to one of the very important ways in which this technology was exploited (the simultaneous collection of meteorological data), something which would not have been possible before the advent of the electric telegraph.