Platinum and the Greenwich System of Time-Signals in Britain

THE WORK OF GEORGE BIDDELL AIRY AND CHARLES VINCENT WALKER FROM 1849 TO 1870

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The establishment of regular time-signals and their distribution throughout Britain by means of galvanic telegraphy was largely the outcome of collaboration between G. B. Airy and C. V. Walker, with some assistance from the brothers E. and L. Clark. The early history of this development, and the role which platinum occupied in its successful operation, is traced largely from records preserved in the archives of the Royal Greenwich Observatory at Herstmonceux Castle.

A broad historical survey of Greenwich time is to be found in a recent book by Howse (1), and for anyone having a particular interest in the introduction and development of the Greenwich time-signal service from a horological standpoint there are excellent accounts supplied more than a century ago by Ellis (2), who was then employed as an Assistant at the Royal Observatory, Greenwich, and had day-to-day responsibility for overseeing the time-signal service.

The service only became feasible following the extensive development of the electric telegraph, the current for which came from numbers of galvanic cells connected together in series to form batteries. In one respect Ellis's account was not explicit about the type of battery used at Greenwich, for he referred only to a battery consisting of cells in which the two poles were of copper and zinc, and we know that several types of copper-zinc cells existed at that period, some of which were certainly employed for telegraphic purposes (3).

A recent study of documents preserved in the archives of the Royal Greenwich Observatory (4) has served to clarify the position however, and it can now be said that from the start of the service a variety of galvanic batteries were in use at Greenwich, though within a few years preference was given almost entirely to batteries having metallic platinum present in one form or another.

The service whereby time-signals were made available throughout the country by way of the electric telegraph came about mainly through the efforts of two men: George Biddell Airy who in 1835 was appointed Astronomer Royal (5), and Charles Vincent Walker who ten years later became Telegraph Superintendent to the South Eastern Railway Company (6).

Airy had no practical experience in galvanic telegraphy (7) but he recognised that possible advantages might accrue from the introduction of galvanic systems in the Royal Observatory. As a starting point he wondered whether with the assistance of a galvanic battery it would be possible to make the going of two or more clocks at the Observatory depend on that of the transit-clock. With this in mind he consulted an eminent London chronometer maker, Edward John Dent, mentioning that ideally the galvanic battery should not require frequent renewal but be competent to operate for at least a week and if possible a month (8). Dent replied that there would be no difficulty in putting Airy's proposition into effect, but mentioned that in trials made at an earlier date he had encountered difficulty from oxidation of the metallic surfaces

George Biddell Airy
1801–1892

A distinguished mathematician, author and administrator, Airy was often called upon by Government for advice on scientific matters during the forty-six years that he was Astronomer Royal. One of many honours bestowed on him was the Honorary Freedom of the City of London in recognition of his eminent services which had "so materially benefited the cause of commerce and civilisation"

where the electrical circuit was made and broken. His own experience had revealed that by using a battery of Smee cells and having platinum and pure gold as the metals where electrical contact was made and broken, such a battery would last for months (9).

Airy's Plan

Having received that assurance as regards the existence of a suitable galvanic battery, Airy realised that it should be possible to send electrical impulses every second to control the movement of "sympathetic" (or slave) clocks situated outside the Observatory; and if he could have a telegraph line connected from the Observatory to one of the existing telegraph systems, he could also make his galvanic time-signals available at designated hours throughout a large area of the country (10).

His opportunity came when he heard that the South Eastern Railway Company proposed to install a telegraph line that would pass within nine furlongs (approx. 1.8 km) of the Observatory. He realised that if he could get permission for a telegraph connection to be made from the Observatory to one of the stations on the South Eastern Railway (SER), he might be allowed to transmit his time-signals along the railway's telegraph lines to London Bridge Station. From there the time-signals might be distributed to stations already on the SER's telegraph system, and also perhaps to the English Telegraph Company (ETC) whose central telegraph station was situated at Founder's Court, Lothbury, in the City of London. That being so, distribution throughout the country could then be made over the telegraph network operated commercially by the ETC, to serve other railway companies, and any public institutions or private firms who might wish to display Greenwich time.

An approach was made to Walker in 1849 informing him of Airy's wish to have a telegraph line laid down from the Observatory to Lewisham Station (11). Walker responded at once, promising his cordial co-operation; and after consulting with the Directors of the SER he was able to inform Airy that in giving their assent to his plan they regretted that it would not be possible for them to bear the cost of installing the proposed telegraph line (12).

Financial constraints probably precluded Airy from taking any immediate action to implement his plan and it was not until the year 1851 that he felt able to proceed. His first act was to go with Walker to look at some examples of sympathetic clock systems already operating in London, all of which were the work of Charles Shepherd, a well-known London clockmaker. He also went to see the clock

Charles Vincent Walker
1812–1882

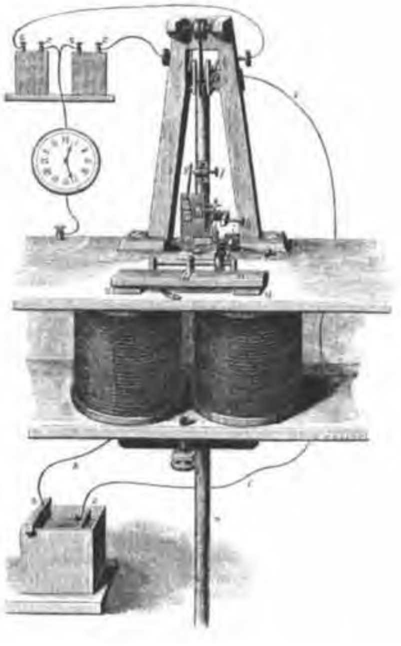
Inventor, author, editor, and translator of works on electricity and its applications, Walker took an active part in the newly formed London Electrical Society. He has been described as the "father" of the profession of electrical engineers, and for thirty-seven years he served as Engineer and Telegraph Superintendent to the South Eastern Railway, in which capacity he assisted Airy greatly in the establishment of the Greenwich system of time-signals

system which had been installed by Shepherd at the Great Exhibition building in Hyde Park, being accompanied on that occasion by Shepherd's son (13). Airy then consulted Shepherd and asked him to provide an estimate of the cost of a sympathetic clock system for the Observatory, including some arrangement for operating the Greenwich Time-Ball electrically, and also whatever batteries would be required to operate the entire system (14).

The SER was informed that Airy now wished to have six or more telegraph lines installed from the Observatory to Lewisham Station, some to go through to London and others to provide a means of communication between the Royal Observatory and the principal European Observatories, once the submarine line from England to France was completed (15). A draft agreement was submitted to Airy by the SER, and he then wrote to the Board of Admiralty setting out his reasons for wishing to proceed (16). The Board's approval was given shortly afterwards and Airy immediately instructed Shepherd to start work on the clock system, and Walker was requested to have the installation of the telegraph lines put in hand.

Clock and Telegraph Batteries

The Smee battery, in the form of one or more cells, was the one generally favoured for operating electric clocks, as it required little maintenance and was capable of producing a strong current provided it was not required to operate continuously. The Smee cell was introduced in 1840 by Alfred Smee and immediately became available commercially (17). It was of the single-fluid type, the electrolyte being sulphuric acid diluted in the proportion of one part acid to seven parts water. A sheet of pure rolled zinc, well amalgamated, formed the negative plate, and the positive plate could be platinum, palladium, or pure silver. Before use the positive plate had to undergo special treatment, the surface being first roughened all over and then platinised by electrolysis for a short time to acquire a thin coating of platinum black. Sandpaper was used to roughen plates of platinum or palladium, but in the case of silver the surface was etched with strong nitric acid and then washed clean with water (18). The function of this platinising treatment was to promote the easy disengagement of hydrogen bubbles which Smee had observed always tended to adhere more readily to a smooth surface than they did to one that was irregular; it had the desired effect of considerably reducing polarisation when the cell was in operation, and thereby increased its efficiency. The e.m.f. of the cell was about 1.1 volts (19), and its internal resistance around one ohm.



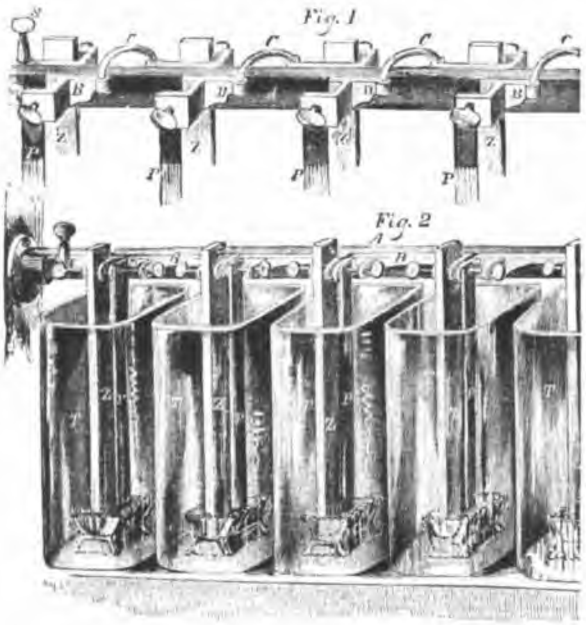
Perspective view of Shepherd's clock, as fitted up in the Royal Observatory at Greenwich, and employed in connection with the distribution of time-signals. It shows the pendulum, its remontoir escapement, and the arrangements by which electromagnetism was made to be its maintaining power. To the left is shown the arrangement by which a dial and its Smee batteries were connected with the pendulum. The illustration is reproduced from an English translation made by C. V. Walker from A. de la Rive's "Traité d'Électricité" (31)

The position with regard to telegraph batteries was much more complex. In the late 1840s the SER and the ETC both employed batteries consisting of large numbers of cells of the type introduced by William F. Cooke. Each cell consisted of a copper and an amalgamated zinc plate, both plunged into a trough of siliceous sand moistened with sulphuric acid diluted with fifteen parts of water (20). The e.m.f. of such a cell was 1.05 volts, and cells were generally connected in series in blocks of 24, 48, 72 or even 96 cells, when they were usually referred to as "sand-batteries". These batteries were not at all popular with Walker, who described them as being "good enough when fresh: bad enough when stale; at best variable" (21).

Information which reached Airy early in 1849 indicated that Grove batteries were employed in the American telegraph system, and had been used in some experiments involving the transmission of time-signals over a distance of some 500 miles (22). These batteries were invented by William R. Grove, and were of the two-fluid type. An amalgamated plate of common rolled zinc was suspended inside a porous pot containing sulphuric acid diluted with four to five parts water, and the pot stood in a vessel of concentrated nitric acid in which a thin sheet of platinum was partially immersed (23). When such a cell is in operation the hydrogen liberated at the zinc plate passes through the pores of the pot and is then oxidised by the nitric acid before reaching the platinum sheet, and polarisation of the cell is thereby eliminated.

A serious disadvantage of the Grove cell is its production of poisonous fumes of nitrogen peroxide, and to absorb this gas Grove advised that the battery should be provided with a cover containing lime. There are other features associated with the Grove cell, however, which it might be thought would have militated against its use: the current was not constant for any length of time; the materials were intrinsically dear and difficult to handle; the battery needed daily attention; and it had to be dismantled when not required for active service (24). One can only assume that the Grove battery was preferred at that time in America as being more suitable for operating telegraphs over considerable distances, the Grove cell having a low internal resistance and also an e.m.f. of 1.9 volts which far exceeded that of any other galvanic battery then available.

The same reason may also have accounted for the use of Grove batteries in the South Australian telegraph system although Smee batteries were also used there, probably only for local telegraph circuits, in a commercial form



Chester's battery in which each Smee cell was housed in its own glass jar. Airy's battery was similar in design but the jars were replaced by a battery box of gutta-percha, moulded in one piece without any joints, to provide twelve entirely separate compartments each housing one Smee cell (26)

known as the "Chester" battery (25), such batteries being manufactured by the New York firm C. T. & J. N. Chester (26).

In Britain in the mid-1850s the sand-battery was replaced for telegraph use either by the "sulphate battery" invented by John Fuller (27), a battery which needed monthly attention, or by the so-called "gravity" battery invented by Cromwell F. Varley (28), the latter battery only operating successfully provided it was not subjected to any kind of movement.

In April 1849 Walker produced his first "graphite" battery, a modification of the Cooke sand-battery in which the negative copper plate was replaced by slices of graphite obtained from the corrosion deposited in the interior of old gas retorts. A graphite plate was first pickled for a few days in sulphuric acid and water, and then drilled and electrotyped with copper at the top; this copper was then tinned, a connecting metal strap rivetted to it with tinned rivets, and then soldered. A small slipper of gutta-percha was fixed to the bottom of the zinc plate, to contain a little mercury for the purpose of amalgamation by capillary action. When the containing vessel was considerably deeper than the zinc plate, so that the solution of zinc sulphate could fall to the bottom as it formed, the graphite cell lasted a long time (29). Walker exhibited his battery at the Great Exhibition of 1851, claiming that its working life was much longer than that of any other copper-zinc battery, because there was no copper present in the electrolyte to produce local action on the zinc plate when the battery was not in use (30).

Galvanic Batteries at Greenwich

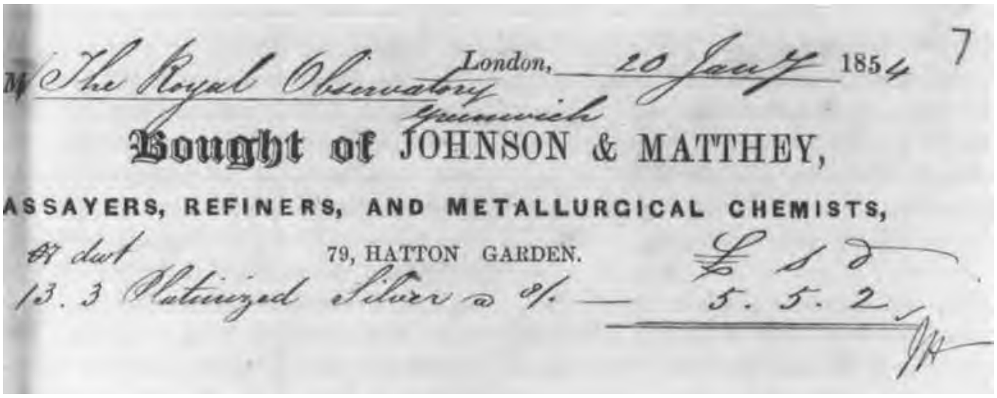
In mid-July 1852 preparations were almost complete for the launch of Airy's time-signal service. Shepherd had already installed his Normal Mean Time Clock, which was kept constantly adjusted to Greenwich mean solar time, together with the associated slave clocks, all operated by twenty-eight large Smee batteries provided by Shepherd (31). A few days later Walker suggested that a trial transmission be made by sending a time-signal automatically over the telegraph line from the Observatory

An engraving from "The Illustrated London News" of 11 September 1852, showing the Time-Ball which Edwin Clark caused to be erected above the roof of the Electric Telegraph Company's Office in the Strand. It was operated by an electric current sent from Greenwich Observatory at 1 p.m. each day, and Clark reported: "the public assemble in crowds" to see it in action "and the chronometer makers think it a great boon"

through Lewisham Station to the SER switch-room at London Bridge and thence on to Dover. On discovering that Airy had no batteries available for such a trial, Walker lent him three 24-plate sand-batteries belonging to the SER (32), and the trial proving satisfactory, Airy's time-signal service came into operation over the SER network using those same batteries on 19 August 1852 (33). A few days afterwards the telegraph connection was completed from London Bridge to the ETC's office in the Strand, where Edwin Clark had arranged for a time-ball to be erected above the roof of the building, and the ball was then dropped each day at 1 p.m. by means of an electric signal sent from Greenwich (34).

Walker intended to replace the sand-batteries at Greenwich by graphite batteries of his own construction, and to that end he began cutting graphite plates; however he found this no easy task and over a year passed before he was able to deliver any graphite batteries (35).

In the meantime Airy must have decided to use Smee batteries as a replacement for the sand-batteries belonging to the SER. From Walker he learnt that platinised silver could be obtained from Johnson & Matthey of Hatton Garden (36). It is probable that the fine silver used was prepared by Edward Cock in his home workshop in Rodney Street, Pentonville, and was then platinised at Hatton Garden by Edward Matthey who at the time was serving his apprenticeship to Percival Johnson. This was certainly the procedure being carried out in



Invoice relating to the supply by Johnson & Matthey of sixty platinised silver plates required by Airy in the manufacture of Smee batteries to be used for transmitting his Greenwich time-signals. The plates measured five by three inches, and were about 0.0026 inches thick

1857 by Johnson & Matthey (37), to meet an order for large platinised silver plates required by Edward O. W. Whitehouse for the construction of his modified form of Smee battery, the "Whitehouse Laminated or Perpetual Maintenance Battery", for use in conjunction with the first Atlantic telegraph cable (38).

Airy's first order was invoiced as 4 oz. 15 dwt. at 8*s.* an ounce; his second order involved a strip nine feet long by three inches wide and weighing 8 oz. 2 dwt., so the thickness of the silver must have been about 0.0045 inch (39). Zinc plates 0.25 inch thick were obtained from Henry Treggon & Company, of Jewin Street, Cripplegate (40); the West Ham Gutta Percha Company provided battery boxes, each having twelve individual cells in a single moulding (41); and Joseph Liddon, a metal worker of Royal Hill, Greenwich, was employed by Airy to assemble the batteries from components supplied to him, and to make all the fastenings and galvanic connections required between the zinc and platinised silver plates (42).

Further orders for platinised silver plates were placed with Johnson & Matthey each year until 1857 (43), the thickness of those plates being between 0.0016 and 0.0037 inch; but at the end of that year Airy began using some graphite batteries which he purchased from George Knight & Company, of Foster Lane, Cheapside (44). A further development took place early in 1858 after Airy had received an account of some experiments carried out by Walker which clearly demonstrated the superior value of platinised graphite over both plain graphite and platinised silver plates (45). A few months later Airy began using "platinised graphite" batteries, having purchased platinised graphite plates with amalgamated zinc plates attached by copper straps, as manufactured by William Reid & Company at their works in University Street, London. These were priced at £13.16*s.* a gross (46).

In 1859 the telegraph lines which ran underground from the Observatory to Lewisham Station became defective, and they were replaced with overhead lines installed by the London District Telegraph Company (LDTC) who were interested in providing time-signals to chronometer makers working in London. The work was carried out free of charge on the understanding that the LDTC be permitted also to run its own special wire in communication with the Observatory's regulator clock, over which wire the time-signals would be sent to the LDTC on the hour once or twice a day (47). Airy was not expected to provide batteries for this purpose, as Edward Tyer, the LDTC's Engineer, intended to use twelve of his own modified Smee batteries sited at the London end of the wire and to employ an earth return (48).

In Tyer's cell some scraps of zinc were laid in a saucer containing mercury, placed at the bottom of a glass jar, and a plate of platinised silver was suspended immediately above. The jar was filled with dilute sulphuric acid and a piece of gutta-percha covered wire, bared for 0.25 inch at its lower end, dipped into the mercury to provide the zinc connection (49).

By 1862 Airy had replaced all his Smee batteries with platinised graphite batteries (50), and in 1865 he sold back to Johnson & Matthey his stock of old used platinised silver plates, amounting to thirty-one ounces troy (51).

In view of the details given above concerning the various galvanic batteries employed by Airy in connection with his time-signal service, one might wonder how it was that Ellis should only have mentioned the use of copper-zinc batteries at Greenwich when he delivered his lecture in the year 1865 (52). The reason must surely be that he was then referring specifically to the use of sulphate batteries which had been employed at Greenwich from 1859 onwards for the sole purpose of sending signals direct to the central telegraph station at Lothbury. This station was then operated by the Electric and International Telegraph Company (E&ITC), following the merging of two telegraph companies, but was moved soon afterwards to Telegraph Street, in the City (53).

Earlier the E&ITC had offered to lend 12-cell sulphate batteries to Airy, or to sell them to him at 25*s*. each (54), and in 1861 Latimer Clark assisted Airy by providing from the Company's own stock twelve sulphate batteries in porcelain chambers of 10-pint capacity (55).

Airy was still responsible for providing his own batteries for driving the electric clocks within the Observatory, and he still required batteries for sending time-signals to the SER and for operating the time-ball at Deal. To meet those needs he continued to acquire platinised graphite batteries, but he appears to have had some trouble in obtaining deliveries. In 1861 and 1862 he placed orders with Knight & Co., of Foster Lane (56), and in 1864 he appealed successfully to Walker for help (57). After that he obtained his supplies from the India Rubber Gutta Percha & Telegraph Works Co. Ltd at Silvertown, Essex, the first order being met in 1867 (58) and other orders following until the mid-1870s (59).

All the electric telegraph companies in the country were taken over in 1870 by the General Post Office (GPO) to whom time signals continued to be provided as hitherto by the Royal Observatory. However it was not until 1889 that the GPO became responsible for the maintenance of the telegraph wires and of all the batteries used for the transmission of time-signals from the Observatory to the GPO's central telegraph station located at Telegraph Street (60).

Acknowledgements

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