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W H PREECE: NINETEENTH-CENTURY TELEGRAPH, TELEPHONE AND POWER STATION ENGINEER

by D G Tucker

SUMMARY: W H Preece, 1834-1913, was, in his lifetime, an extremely well-known and influential electrical engineer, dominating British Post Office engineering through the 1880's and 1890's and assisting the development of public electric lighting systems during the same period by his private practice as a consulting engineer. He was less successful as a research engineer or scientist. He was a man of immense energy and industry, and a prolific writer and lecturer. His obituaries were historically unsatisfactory and there appears to be no proper biography of him. In this short paper an attempt is made to indicate his historical significance.

INTRODUCTION

William Henry Preece was born on 15 February 1834 at Caernarvon, and died there on 6 November, 1913. He was best known as Electrician and later Engineer-in-Chief to the Post Office, and was well-known as a Consulting Engineer for electric lighting and electricity generation projects.

He had some academic education at Kings College, London until 1852, and then had a short spell (less than a year) with Edwin Clark, a notable civil engineer. On 11 May 1853 he was appointed Engineer's Assistant in the Electrical and International Telegraph Company at 30/- a week.(1) On 15 March 1856 he was promoted to Superintendent in the South Western District of the E&IT Co at £3 a week, with headquarters at Southampton, Staff problems loomed large in his work then. There were some amusing incidents: he was admonished in August 1857 for allowing the Cowes office to be used for irregular purposes: "Let the Birds and Dog be at once removed - let the place be cleaned up ......"(1)

In 1858 he was appointed engineer to the Channel Islands Telegraph Co and held this post in parallel with his E&IT Co post until 1862, getting good practical experience of cable work; e.g in February 1860 he personally supervised from the steam tug "Resolute" the search for and raising of the damaged portion of the Channel Islands cable.(2)

In 1860 he was additionally appointed to the London and South Western Railway Co., holding his post of Superintendent jointly between the railway and telegraph companies.(3) This appointment

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led him to work on railway signalling, especially the introduction of the block signalling system, electrical repeating of distant signals, and passenger-toguard communication ("pull the cord" devices).[4] It was during this period that he started educational lecturing by setting up courses in telegraphy at the Hartley Institution, later to become the University of Southampton.[5] On the nationalisation of telegraphs in 1870, Preece was appointed to the Post Office as a Divisional Engineer, and promoted to Electrician to the Post Office in 1877. He was made Engineer-in-Chief in 1892 and retained this title until his retirement in 1899. It was during the years 1877-94 that he made his most interesting and controversial contributions to telecommunications, although he is probably best known at present for his encouragement of the young Guglielmo Marconi in 1897. During this period he also developed his interest in electric lighting and electricity generation and started to become a consulting engineer in this field. He was elected FRS in 1881. On retirement he was knighted (KCB).

There is no doubt whatever that Preece was a remarkable man, distinguished by administrative ability and some scientific and technical insight, but above all by his immense industry, incredible activity, and remarkable breadth of interest. Throughout most of his working life he successfully conducted several professional careers simultaneously, each one of which would be regarded as a full-time job by most people. In addition to various branches of electrical engineering, he took an interest in several other technical fields; e.g sanitary engineering, on which subject - concentrating mainly on water supply and sewage disposal - he gave the Inaugural Address as President to the 1899 Congress of the Sanitary Institute. He published profusely. It is difficult to make an accurate count of his published papers and lectures, for not only were most of them reprinted in several journals, but he frequently gave substantially the same paper to several societies and Institutions. However, a reasonably reliable figure [6] is 136 separate papers and printed lectures, although their contents overlap a good deal. Of these, no fewer than 99 belong to the specially-productive period 1877-94 which we have already mentioned. In addition to the papers and printed lectures, there were innumerable published contributions to discussions and many unpublished lectures. He was a very popular public speaker. There were numerous reviews of Preece's work published on his retirement, and there were later numerous obituaries, some of them as long as this article. Yet somehow they all managed to avoid discussion of the unsatisfactory parts of Preece's work, and made no reference at all to his consulting work on electric lighting and generation done while he was still in the Post Office. Typically we read "After his retirement he began to practise in Westminster as an engineer in conjunction with his two sons and the late Major Cardew".[7] But his important consulting work was nearly all done <u>before</u> his retirement.

The remainder of this short article will be devoted to just the three topics:

1. Preece and long-distance telephony,

2. Preece and wireless communication,

3. His contribution to electric lighting and electricity generation.

I believe that it is primarily in these three respects that Preece is of historical importance.

PREECE AND LONG-DISTANCE TELEPHONY

Preece had to combine his scientific and technical interests with his responsibilities to the Post Office to help to provide an efficient and economical telecommunication service. He was quite quick to adopt for Post Office use such developments as quadruplex and multiplex (i.e. Delaney multiplex,(8) or in modern terms, time-division multiplex) telegraph systems, in 1879 and 1886 respectively. He believed in telegraphy as the backbone of telecommunications, and appeared to subscribe to the general British Government view of the 1880's that telephony had only limited potentiality, (9) mainly for local communication. He was, however, technically interested in telephony, including long-distance telephony. When François van Rysselberghe demonstrated in 1882 (only four years after the first introduction of commercial telephony) his system for working long-distance telephone circuits over existing telegraph wires without interference between telegraph and telephone,(10) Preece took notice but no action. By 1887 there was a sizeable long-distance telephone network in Europe - over 12,000 miles of it - almost all on the van Rysselberghe system, but there was none in Britain, London had no telephone link with any other town except Brighton until 1890. Unwise anti-company legislation was a partial cause of this, but Preece gave technical reasons.(11) He said that in Britain we used the Wheatstone automatic telegraph system and this was a high-speed system, working up to 300 words/min, and produced too much interference with telephony. The van Rysselberghe system eliminated interference from telegraph to telephone by what was effectively a low-pass filter, but Preece claimed that this would be no good with the Wheatstone system. He may well have been right, but he made only arbitrary statements on the matter. I wish I could find some evidence that he made some experiments, or some calculations, or considered whether the van Rysselberghe system could be used on <u>some</u> routes in Britain. As it was, it does seem that it was, at least in part, Preece's intuitive opposition that made Britain practically the last country in Europe to have a long-distance telephone network.

On the credit side we can record Preece's real interest in the technicalities of long-distance telephony, and in particular some experiments he made in 1885-7 on the limiting distance of telephony over various kinds of wire when there was no interference. First, a new route was constructed, remote as far as possible from telegraph routes, using a metallic loop (or pair) circuit with twists throughout to neutralise inductive pick-up, and running from the outskirts of London to Warrington. Open iron wire of 400 lb/mile was used except for short stretches of underground cable. Second, a similar new line was constructed from Swansea to Newport and the industrial valleys. Finally, when a new telegraph route was built in the winter 1886-7 from London to Nevin (North Wales) as part of a new Irish telegraph, using copper conductors of 150 lb/mile, the opportunity was taken to experiment with telephony upon it. His results[12] are summarised in Table 1. His limiting distances for acceptable telephony were 40-50 miles for underground cable, 120 miles for open iron wire-loop, and around 250 miles for open copper-wire loop. This was useful work.

Unfortunately, Preece built a theory for long-distance telephony on these few results. He contended that the law which governed the transmission of speech over a wire was the same as that applying to telegraph signals in a long cable, namely Thomson's (or Kelvin's) KR law,[13] since the time-constant, which is proportional to KRl^2, "limits the number of vibrations persecond that can be sent through any circuit." K is the capacitance, R the resistance, both per unit length of line, and l is the length of the line. He then stated a formula for the limiting distance, x, of telephony. It was

$$x^2 = A/KR$$

where A is a constant for a particular type of circuit. From his experiments he gave

A = 15,000 for overhead copper wire
A = 12,000 for cables with copper wire
A = 10,000 for overhead iron wire

TABLE 1
SUMMARY OF PREECE'S EXPERIMENTS

CIRCUIT	MILES	TYPE	KR	RESULT
Denham-Atherstone	(90 (+ 2.5	Iron) Cable)	2247	Good
Denham-Stafford	(119 (+ 5	Iron) Cable)	4716	Fairly good
South Wales	(72 (+1.25	Iron) Cable)	5680	Satisfactory
Denham-Nantwich	(146 (+ 7	Iron) Cable)	7612	Very weak
Denham-Warrington	(172 (+ 8	Iron) Cable)	10400	Impossible
London-Nevin	(251 (+18.5	Copper) Cable)	15771	Fair
London-Denham	21	Cable	2963	Good
London-Hanwell-Denham	39	Cable	10221	Fairly Good

N.B. All the cable had copper conductors.

NOTES.

1. All the above tests were made using the Gower-Bell telephone, except for the London-Nevin test which used Berliner's telephone. Preece's comment on the Nevin test was "some voices good".

2. Other experiments were made which involved long stretches of cable as well as of open wire, e.g. 30 miles of cable plus 30 miles of open iron wire in the Newcastle District, which with KR = 12640 gave very poor results. Some other experiments were made on circuits with several intermediate derived circuits using choke or transformer couplings.

K is expressed in μF and R in ohms. He had made a general deduction from too little data, and we find rather poor agreement when we test his formula on other people's experimental results. But the main criticism we can level at his formula is that it is based on a wrong premise; it completely ignores the distortion of speech, and the differing quality of speech over cable, open copper, and open iron circuits. Oliver Heaviside,[14] an eccentric genius, rather younger than Preece, saw clearly that the inductance and leakance of the line played dominant roles in telephone (and, for that matter, also in telegraph) transmission,[15] and that improvement could often be obtained by increasing them.
Preece published his own calculations of inductance in lines, and argued that it was quite negligible, and that increasing it could only do harm;[16] but Heaviside showed him to be seriously in error and was extremely sarcastic.[17] Heaviside continued to despise Preece, and in 1900 wrote in a Preface [18] that the KR law "became so ridiculously wrong (say 1000 per cent) that it was impossible to save appearances by any manipulation of figures" and that "It is to be hoped and expected that the late important removals in the British Telegraph Department will lead to much improvement in the quality of official science". On the title page of his own copy of the book[19] he wrote that "The book was all ready before the end of that year (1899), save the Preface. It was kept back, I was informed, to allow W H Preece to make sure of his knighthood". Whether there was any truth in this would be hard to discover. Preece certainly stuck most obstinately to his KR law, and would have nothing to do with the idea of inductive loading of cables until the success of Pupin from 1899 onwards forced him to change his ideas a little. He had the courage to give a paper [20] to the British Association in 1907 (8 years after he had retired) in which he admitted that inductive loading could be effective in increasing the distance over which telephony was possible, and gave his own explanations as to why this should be so; but he still maintained that "The establishment of the telephone trunk system in Great Britain in 1896 showed the practical value of the KR law in determining the construction of an aerial system". In the discussion on this paper, Sir Oliver Lodge, S G Brown and Silvanus P Thompson all stressed Heaviside's great contribution to the subject, but Preece "did not agree with the other speakers as to the services rendered... by Oliver Heaviside"!

It is, of course, rather easy to see the adverse effects of Preece on telephony, but much harder to assess the positive good he did by his energetic prosecution of some important projects and by his general administration of his Department. Among the important projects we might mention the London - Paris telephone link,(21) opened in 1891. Preece had given much personal attention to the design of the cable and to the actual setting-up of the circuit, and it was certainly successful.

PREECE AND WIRELESS COMMUNICATION

In his work on wireless communication, Preece shows up more constructively than in his work on telephone transmission. His interest in the matter seems to have stemmed from his observations of interference between telegraph and telephone circuits that were well separated in space. If isolated circuits could thus communicate, why not turn the effect to some useful purpose? An opportunity to test his ideas came in March 1882 when the cable to the Isle of Wight broke down. He attempted to communicate from Southampton to Newport (I.O.W.) by the following arrangement: "Large metal plates were immersed in the sea at opposite ends of the Solent, namely at Portsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire passing through Newport; the circuit was completed by the sea, and signals were passed easily so as to be read by the Morse system, but speech was not practical".(22)

Preece recognised that this was a conductive system. He appreciated that electrostatic and electromagnetic systems were also possible, and set up experiments in 1885 near Newcastle-upon-Tyne, carried out by A W Heaviside, a Post Office engineer who was brother to the great Oliver Heaviside. Inductive transmission between loops of wire 440 yards square was proved up to separations of 1000 yards; and on a larger scale, using groups of telegraph wires many miles long and several miles apart, inductive transmission of a.c. signals at aroud 500 Hz was achieved over separations up to 10 miles, and with some reservations up to 40 miles.(23) Further experiments in other places established the technique,(24) culminating in a permanent installation in 1898 providing communication between Lavernock Point and Flatholm in the Bristol Channel. Preece had proved to his satisfaction in 1892 that the communication in this case was <u>in</u>ductive and not <u>con</u>ductive, but Garratt has recently referred to this installation as conductive in describing separate experiments which the Post Office carried out with Marconi between the same points in May 1897 to test the Marconi system of using Hertzian waves for communication.(25)

The connection between Preece and Marconi has recently received much publicity,(26,27) and it is greatly to Preece's credit that he encouraged the young Marconi in 1896, and collaborated with him in experimental work until the formation of the Marconi Company in July 1897. Yet by 1900 he thought Marconi's system had no future,(28) and was still rather pessimistic about its general value in 1905.(29) The Marconi Company had little respect for him by then, for Hall, the Managing Director of the Company, wrote to Marconi complaining of Preece's 1905 paper to the British Association:- "Either he is wilfully misleading the public or is so ignorant of the subject of his paper that it is presumption for him to have read it at all" (30).

PREECE AS CONSULTING ENGINEER FOR ELECTRIC LIGHTING AND POWER SCHEMES

Preece had been taking an interest in the developments in electricity generation and in electric lighting in the 1870's and had started to take part in the discussions at meetings concerned with these topics at least as early as the end of 1878.(31) As with telecommunications, he was sometimes badly wrong in his opinions; for instance, in 1879 he stated that "a subdivision of the electric light is an absolute ignis fatuus",(32) by which he meant that parallel operation of incandescent lamps was impossible; yet it was precisely on the basis of parallel operation of incandescent lamps that electric lighting systems developed. He published his first paper on electric mlighting in 1881,(33) but had given a public lecture on the subject at the Albert Hall in 1880.(34)

I have not explored Preece's consulting career exhaustively, and so I am not quite sure how early it started. Certainly he was consultant to the Bristol Corporation in 1884 and submitted his first report to them on 4 December 1884, recommending them not to proceed with setting up an electric lighting system until the science and art were more advanced. He submitted similar reports of 16 October 1885 and on 20 September 1887, but on 31 May 1889 he advised that the time was now ripe for the Corporation to go ahead,(35) the recent improvements in plant having been very significant and the financial situation being more suitable. Preece then became responsible for the preparation of plans and specifications and for supervising the contractors; he employed Gisbert Kapp(36) as his assistant. He managed to find time to attend meetings of the Corporation and its committees at Bristol every few weeks. The Bristol Central Electric Lighting Station opened in 1893,(37) but Preece remained as a consultant at Bristol for many years. Although demand quickly outstripped the capacity of the station, it was technically very satisfactory.

Another major electricity undertaking for which Preece was, as at Bristol, not only adviser but also supervisor, was that at Worcester, 1892-4.(38) This was Britain's largest 19th-century hyc electric station used for public supply, with a water-generated capacity of about 400kW. It was partially successful, and endured for over 30 years, but the hydraulic calculations had not been don very well, and it was often short of water and had to rely heavily on its steam stand-by plant.

As an example of his activity we may note that during the twc years 1893-4 Preece was, in addition to his work at Bristol and Worcester, consultant to the following electric light schemes (anc possibly also to others), having in every case to visit the place concerned, study its problems, and prepare a report making defini technical and financial recommendations - sometimes a good deal more than this:-

Arundel Castle, Cheltenham, Croydon, Dewsbury, Hampstead, Kingston, Lambeth, Poplar, Tunbridge Wells.

In one or two cases he worked with his son A H Preece who was also a consulting engineer. A full list of his consultancies through the 1880's and 90's would clearly be very long indeed.

As examples of slightly different consulting work, we may mention that Preece was through most of the 1890's consultant to the Government on lighting in Malta and Gibraltar;(39) was earlier consultant to the Government on lighting in the House of Commons, the British Museum and the Dublin Museum;(40) was in 1894 consultant to the Commission of Sewers regarding gas explosions in the City of London;(41) and was in 1895 a member, with Lord Kelvin and Major Cardew, of the Board of Trade Committee appointed to report on the proposed new electric lighting regulations.(42)

Preece's extensive private practice did not escape the eye of Parliament; questions were asked in the Commons(43) as to how a full-time Civil Servant could be allowed to do this private work, which was against the rules. The official answer was "That the case of Mr Preece is exceptional" and no action was to be taken to hinder him. I doubt if they could have stopped him; his consultancy earnings must have greatly exceeded his Post Office salary.

Did Preece's consulting work contribute much to progress? I believe it did, for he was very highly regarded in this field, advised on some of the most important schemes, and on the whole gave very sound advice. His reports show understanding and judgment. He was not an innovator but was very up-to-date in his knowledge and views. He must have contributed greatly to the success of the early electricity supply systems in Britain.

CONCLUSION

I see Preece as an important figure in the later 19th-century electrical scene, not really an inventor, but an innovator in the sense that he was usually ready to try any good idea that was being developed; in a sense an entrepreneur, but primarily an engineer and a successful one; a would-be scientist but unsuccessful in this ill-fitting role; an outgoing, self-confident, likeable, sometimes incredibly prejudiced but usually open-minded, incredibly busy and hard-working man of wide intellectual grasp. Not a man of the intellectual eminence of Kelvin, of the intuitive genius of Edison or Marconi, or of the solid technical achievement of John Hopkinson or Gisbert Kapp, but perhaps in the same class as Crompton and Ferranti. He had a big influence in his time, but perhaps has left rather less to posterity than these others.

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