Signalling at the Battle of Passchendaele, July to November, 1917

By Dr Elizabeth Bruton

Military communications in World War One evolved to meet new battlefield and military challenges during this period. Battles were won and lost on the strength of an army’s ability to communicate on the battlefield. New and old systems of communications were used side-by-side and interchangeably.

This was as much true of early battles on what became known as the Western Front as well as later battle such as the Battle of Passchendaele (also known as the Third Battle of Ypres) which took place from 31 July through to 10 November 1917. The Allied plan was for French, Belgium, and British troops as well as those from the British empire including Australians, Canadians, Indians, New Zealanders, and South Africans to take the high ground (ridge) south and east of the city of Ypres. The Battle of Passchendaele is of particular interest not because it was the site of any particular telecommunications innovations but rather because signalling failures contributed to the ultimate failure of the Allied attack and secondly because the battle is representative of signalling practice and operations at this stage of the war.

Image available in the public domain via IWM.
Communications failures occurred at both the First and Second Battle of Passchendaele. During the early stages of the First Battle of Passchendaele on 12 October 1917, the two lead British commanders Douglas Haig and Herbert Plumer believed – due to delays in communication and misleading information – that the advance had been successful and were unaware that the German counter-attack in the afternoon had wiped almost all of the Allied advance. Of particular problem was terrain in the area around Passchendaele as well as Ypres and Messines which was unsuitable terrain for laying cables. Furthermore, the ground had been heavily bombarded by German artillery as well as intense rainfall in the weeks leading up to the attack. At the Second Battle of Passchendaele which took place between 26 October and 10 November 1917, the retreat of the 4th Canadian Division from Decline Copse was due to communication failures between the Canadian and Australian units to the south as well as German counterattacks.

The British Army commonly used telegraph cables and telephones on the Western Front to communicate between the front line soldiers and commanders. But heavy artillery (gun) bombardment meant these lines of communications were easily broken. These lines of communications were also easily intercepted by the German army, as were the very basic wireless telegraph sets used by the British Army. Despite this, the speed of telephone and telegraph communication meant they were the most commonly used telecommunications systems used by the British Army.
As a brief aside, these two evocative of photographs of field telephony in the war representing life more generally on the front were reproduced in various publications including printed periodicals such as War Illustrated News as well as postcards. These two particular photographs were kindly provided Dr Kate MacDonald from Postcards box GB9 – WW1: Postcards of life at the Front in the John Johnson Collection of Printed Ephemera held by the Bodleian Library, University of Oxford. The former postcard of Ruins as telephone posts was produced by Newspaper Illustrations in England and credited as an official photograph of Le Section Photographique de L’Armee Francaise.
Hence alternative methods of communication were required until (so the plan went) the higher ground was taken where cables could be used. Problems with these alternative methods of communications including carrier pigeons being hindered by high wind and messenger dog handlers becoming casualties were in part the cause for the misplaced belief by Haig and Plumer that the initial stages of the attack were successful.

More generally from 1915 onwards, non-telecommunications systems of signalling were used in parallel with and as a backup to telegraph and telephones. The British Army was forced to adapt, using older forms of communication such as carrier pigeons and written messages delivered by runners and messenger dogs to keep the lines of communications open. Messenger runners had one of the most dangerous jobs in the war having to run across open ground and risk being shot by snipers in order to make sure a message was delivered. Signalling flags were also used but could be only used in the daytime but were easily visible to the enemy.

Tactically, it was around the time of the Battle of Passchendaele that the German Army switched tactics and began to use “defence in depth”, that is delaying rather than preventing an enemy attack with the hope that the enemy would lose momentum as they cover an increasingly larger area. This had an impact upon signalling: Allied forward signal parties frequently became involved in the fighting and the larger areas covered by the Allies as a result of this tactic required artillery stations to be moved necessitating the improvisation of a fresh series of artillery signal communications.
During the war, aeroplanes developed rapidly from kite-like aeroplanes where pilots shot at each other with small guns to bombers and fighter planes. As the aeroplanes developed during the war, so did their means of communications. At the start of the war, pilots communicated using visual signalling such as rocking their wings and flags. By the time of the Battle of Passchendaele in late 1917, aircraft were commonly used for reconnaissance and long-range artillery spotting. Indeed by this stage of the war, most artillery spotting was done by aircraft using wireless communications: pilots communicating wirelessly with artillery stations on the ground, correcting the aims of British guns firing beyond the “line of sight” (what they could see) to German targets. Wireless communication was achieved using a mixture of radio telephony (voice over radio) and wireless telegraphy (Morse code over wireless).

For example, on 12 October 1917 – the day of the First Battle of Passchendaele – there were one hundred and twenty-four zone (ranging) calls to the artillery for fire on active batteries, troops, transport, and machine-gun posts. Source: Jones, H. A. *The War in the Air, Being the Part Played in the Great War by the Royal Air Force* Volume 4 (Oxford: Clarendon Press, 1934), 206. By the end of the war, pilots were equipped with radio telephony (voice over radio) and were able to communicate over short distances with other aeroplanes and over longer distances with ground wireless stations.
To conclude, the Battle of Passchendaele was not the site of any particular telecommunications innovation and indeed the lack of British success was in part due to communications problem. The landscape did cause some limitations in terms of problems laying cables but otherwise it was representative of telecommunications operations at the time: old and new signalling systems being used adjacent and interchangeably. By late 1917, wireless communication in aircraft was commonly used for co-ordinating artillery and this was very much the case at the Battle of Passchendaele in mid- to late-1917.

Sources and Further Reading

BBC iPlayer – The Great War Interviews – 8. John Willis Palmer (recommended by Graeme Gooday)
http://www.bbc.co.uk/iplayer/episode/p01td2np/the-great-war-interviews-8-john-willis-palmer#group=p01tbj6p
John Willis Palmer, a Signaller with the Royal Field Artillery, recalls how the mud and fatigue at Passchendaele broke his spirit.

IWM Podcast 31: Passchendaele by Kate Clements
http://www.iwm.org.uk/history/podcasts/voices-of-the-first-world-war/podcast-31-passchendaele

Internet archive: https://archive.org/stream/warinairbeingsto04rale

Internet Archive: https://archive.org/stream/signalserviceine00prie

Wikipedia: Battle of Passchendaele
Guest post by Len Barnett: Learning to use Signals Intelligence in the Royal Navy up to 1915

Learning to use Signals Intelligence: The Royal Navy from the Development of Wireless to the War Years of 1914-1915


This monograph arose partly from my personal research into civilian mariners involved in the Great War 1914-19 and also encouragement from a friend, Dr. Marcus Faulkner. My original background had been in communications-operation in the Royal Navy, Foreign & Commonwealth Office and variously in the City of London. Although having left this field of endeavour two decades ago, I have retained a past professional interest in communications systems and their operation.

In reading day-to-day wartime operational records and naval staff monographs I had noticed from occasional references and snippets that Room 40's products were more widely used at sea than has been acknowledged. This was especially so in the multifarious activities around the United Kingdom's shores and in the North Sea.

These can be generally characterised in two ways. Firstly, there were the offensive operations carried out by forces of the regular navies of both sides. The largest of these, such as the famous Dogger Bank action of January 1915, have often had their Signals Intelligence (Sigint) aspects covered in published works: although lesser ones have not. However, with Handelskrieg mit U-booten (trade war with submarines), initially conducted by the Kaiserliche Marine in February 1915, a second struggle developed in these same waters. This was carried out overwhelmingly by submarines for the Germans; and an assortment of naval units, ranging from destroyers to a miscellany of reservist small craft and also merchantmen for the Allies.

It was also known that there had been a Sigint aspect in hunting down and eventually sinking
the German cruiser Dresden, in Chilean waters in March 1915. Careful reference to operational records and another naval staff monograph unearthed useful detail and further usage of intelligence material. Also, in dealing with international political affairs, particularly with the United States of America that were immensely important in the development of the war, from other sources I became aware of yet more aspects of British Signals Intelligence efforts.

Having read all the standard works on First World War Sigint I realised that none of these showed the then state of wireless communications technology though. As a past communicator, I regarded this as utterly inherent in making a proper study and so, made thorough investigations. Having done so, I noticed that my take on this was significantly different to other commentators. In one respect this was to be expected, as long experience had shown me that non-communicators tended to regard communicators either as practitioners of esoteric arts, or, unfortunately, as mere drones. (The reality, of course, has always been somewhere in between!)

As well as this, although admittedly not having used hand cypher very often (and even then, only in the FCO), I had been trained in this field. However, I found from published sources that generally I could not understand how these codes and cyphers actually worked. Therefore, I studied as many contemporaneous examples, both British and German that I could find. This practical handling allowed for greater grasp and hopefully, a clear exposition.

Finally, a word on Franz Rintelen might not go amiss. Only briefly mentioned in this monograph, the ‘Dark Invader’ as he dubbed himself in the early 1930s was a fascinating character. (For those not au fait with him, for reasons that are still not entirely clear, he published an explosive ‘biography’ in English, where he claimed that he had been a super spook-saboteur in the United States in 1915, working against the Allies. Wide-ranging investigations have shown me that his life was far more complicated than even he made out and potentially, there are some intelligence aspects that have not yet been uncovered properly. Even if a biography is out of the question for me, purely on grounds of the amount of time, money and effort required, I intend producing a monograph on him. So, it is entirely possible that more might be learned on the intercepted telegrams from 1915 that are in British naval files.

About the author: Len Barnett is an experienced freelance maritime researcher and author. For further details of his research and work and to order Learning to use Signals Intelligence: The Royal Navy from the Development of Wireless to the War Years of 1914-1915 see his website at http://www.barnettmaritime.co.uk

This entry was posted in Guest posts, Military, Signals Intelligence, Wireless Telegraph and tagged Royal Navy, sigint, wireless telegraphy on 14 July 2015 by Elizabeth Bruton.
Hippisley Hut: Wireless interception at the outbreak of World War One

By Elizabeth Bruton

Update on 23/03/15: Hippisley Hut is now available for sale via Bedfords & Co at http://www.bedfords.co.uk/SearchPropertyDetails.aspx?propid=35329_BUR130028 and in the meantime is available to rent as a holiday home at http://www.kettcountrycottages.co.uk/cottage/hippisley-hut/

Update on 29/07/14: Much thanks to Brian Austin for clarifying the details of Richard L. Hippisley and Richard John Bayntun Hippisley; the article has now been amended accordingly.

Hippisley Hut, Hunstanton, as it looks today. Image courtesy of Sowerby’s.

Hippisley Hut in Hunstanton, Norfolk is now up for sale by Sowerby’s. This ordinary wooden house near Hunstanton on the Norfolk coast is of historic interest being the birthplace of wireless interception during World War One. So who was Hippisley and what was his role in development of wireless interception during World War One? Why did he choose Hunstanton for his wireless interception “hut”?

Hippisley’s background and role in wireless interception at the outbreak of war

Richard John Bayntun Hippisley (1865-1956) (known as Bayntun and referred to as such throughout this article) was born in Somerset in 1865 and was educated and trained in electrical and mechanical engineering: he was trained at Hammond College (later Faraday House), London and apprenticed at Thorn Engineering Company. In July 1888, Bayntun was gazetted as a 2nd Lieutenant in the North Somerset Yeomanry.

Bayntun Hippisley’s interest in science and technology was very much following in a family tradition. His grandfather, known as the “Old Squire”, was a member of many of Europe’s leading scientific societies and a Fellow of the Royal Society (FRS), and Bayntun inherited this interest in science. Bayntun Hippisley’s specific interest in electrical engineering and telecommunications may have been sparked by the earlier work of a relative (a half-Uncle, by my reckoning), Richard Lionel (R.L.) Hippisley (1853-1936). R.L. Hippisley was a member of the Royal Engineers and served as Director of Telegraphs in South Africa during the Second Boer War (1899-1902). In 1902, Colonel Hippisley returned to England and served as Chief Engineer (Scottish Command) of the Royal Engineers until 1910 when he retired. In 1903, Colonel Hippisley wrote History of Telegraph Operations during the South African War, 1899 – 1902 and in 1903 and 1906 he served as one of the British representatives at the International Conferences on Wireless Telegraphy held in Berlin.
In 1908, Bayntun followed his elder relative’s path in the armed services, becoming an honorary Lieutenant Colonel of the North Somerset Yeomanry. It was also around this time, and possibly due to his relative’s interest in wireless telegraphy, that Bayntun too began to develop an interest in wireless. Soon Bayntun acquired a wireless license from the Post Office to operate his own wireless station, operating under the callsign HLX (later 2CW). In 1912, he operated a wireless station in the Lizard, Cornwall and picked up messages from the Titanic. In 1913, Hippisley was appointed a member of the War Office Committee on Wireless Telegraphy.

At the outbreak of war, many pre-war wireless amateurs including Bayntun approached the Admiralty about setting up a network of wireless stations to intercept enemy wireless traffic. Lacking the resources and manpower to establish this network themselves, the Admiralty gladly accepted and many pre-war wireless amateurs became naval “voluntary interceptors”.

Two of these wireless amateurs who joined up had already been logging intercepts of German traffic at their amateur stations in London and Wales respectively, despite the official call to confiscate all privately-owned wireless receivers. These two men were friends and wireless amateurs Edward Russell Clarke, (callsign THX) a barrister and automotive pioneer, and Bayntun Hippisley.

From their wireless stations in Wales and London respectively, Bayntun and Russell Clarke were receiving German naval signals from the German Navy on a lower wavelength than was currently being received by the existing Marconi stations. They had isolated and reported a number of regular signals they believed to be from German naval wireless stations at Neumunster and Norddeich. Their report was passed onto the Admiralty’s Intelligence Division and so, along with many other such amateurs, they were sent to work for Naval Intelligence as ‘voluntary interceptors’ (VIs) and reported their signals intelligence back to Room 40. Bayntun was appointed Commander RNVR for service with the Naval Intelligence Division.

In late 1914, Bayntun and Russell Clarke were sent to Hunstanton on the Norfolk coast to setup a listening post in a former coastguard station in what became known as ‘Hippisley’s Hut’. Hunstanton was chosen because it was the highest point nearest the German coast and was also home to an existing Marconi wireless station.

**Marconi wireless station at Hunstanton**

The Marconi wireless station at Hunstanton was established about 1909 and the former power station is still in place today.
Two of the contemporary images of the Marconi wireless station at Hunstanton come from the Empire Series. The “Empire Series” (or sometimes “E.S.”) was published by the Pictorial Post Card Company which operated from Red Lion Square, London between 1904 and 1909. They also printed view-cards, novelty cards, actors and actresses, and comic cards by Donald McGill as well as the Empire Series postcards.

Wireless interception at Hunstanton

When Bayntun and Russell Clarke arrived at the coastguard station at Hunstanton in late 1914, they found a wooden mast with no aerial but they were soon intercepting signals. The station was very successful, intercepting German naval and airship wireless signals, and led to a series of 14 wireless intercept (Y stations) being setup along the British coast as well as station in Italy and Malta.

As a result of his wartime service and successes, Bayntun was awarded an OBE (military) in 1918; this was promoted to a CBE (civil) in 1937.

Hunstanton was also home, at least temporarily, to a wireless direction-finding station (B station) which was used to locate the position of German naval vessels and airships by triangulating their wireless signals.

Utilising this combination of signal interception and direction-finding, the resulting intelligence came to the fore in 1916 with notable successes during the First Blitz by Zeppelins and the Battle of Jutland. By 1917 a turning point had been reached with more U-boats sunk and Zeppelins downed than any previous years mostly in thanks to wireless interception and decryption. Wireless was also successfully employed with the clearing of the Western Approaches in late 1917, a development which was credit to Bayntun himself. By 1918 the Admiralty signals intelligence (or ‘SIGINT’) guaranteed complete control of the airwaves and during the first four months of the year four Zeppelins were shot down over England and twenty-four U-boats sunk.

After the war

After the war, Bayntun returned to his family’s estate Ston Easton in Somerset and resumed his pre-war life. In 1931 he was elected a County Alderman for Somerset, and appointed Traffic Commissioner for the Western Counties. He was awarded the CBE (Civil) in 1937. Bayntun died in April 1956 at the age of 90 and his life was remembered with an obituary in the Journal of the Institution of Electrical Engineers as well as letter in The Times from his friend Lieutenant-Colonel H.W. Kettlewell. Kettlewell’s letter in The Times praised Bayntun as “an almost unique personality … [who possessed] a most remarkable mechanical and scientific gift…” In particular, Kettlewell highlighted Bayntun’s contribution to the war effort during the First World War:

[Bayntun was] given carte blanche to select, organize and maintain throughout the war the wireless stations round these [British] isles; so secret and of such importance was his work that he could then only be communicated with through the Admiralty. Some 20 years or more I happened to meet a well-known admiral, who, when I mentioned Bayntun Hippisley as among my friends, remarked: “He was one of the men who really won the war.”

Bayntun Hippisley’s vital role in World War One was further highlighted in a 1995 article in The Times by William Rees-Mogg, “Tradition and the innovative talent”:

In Somerset we believe that Bayntun Hippisley personally won the First World War. He came from a family with an engineering and scientific talent; his grandfather had been a Fellow of the Royal Society. Bayntun was an early pioneer of radio research; in 1913 he was appointed a
member of the Parliamentary Commission of Wireless for the Army. When war broke out in 1914 he joined Naval Intelligence and was made a commander. He was the man who solved the problem of listening to U-boats when they were talking to each on the radio by devising a double-tuning device which simultaneously identified the waveband and precise wavelength. That, it is said, was essential to clearing the Western Approaches in late 1917, when American troops were coming over. Bayntun Hippisley sat in Goonhilly listening to the U-boat captains as they chatted happily to each other in clear German; he told the destroyers where to find them; the food and the Americans got through.

Sources and further information

A Brief History of the Hippisley Family by Mike Matthews

Auto Biography & History Michael John Hippisley Born 18th July 1934

Grace's Guide: Baynton Hippisley

h2g2: Richard John Bayntun Hippisley (1865-1956)


About the author: Dr Elizabeth Bruton is postdoctoral researcher for “Innovating in Combat”. See her Academia.edu profile for further details.

This entry was posted in Military, Signals Intelligence, Wireless Telegraph and tagged elizabeth bruton, Hippisley, Hunstanton, radio amateur, sigint, signals intelligence, world war one on 29 July 2014 by Elizabeth Bruton.

Guest post by David Barlow: Wireless announces the outbreak of war

By David Barlow, Lizard Wireless Museum
Early on the morning of 5 August, a wireless message was sent by the powerful long-distance Marconi wireless station at Poldhu (callsign ZZ) on behalf of the Admiralty to all British merchant vessels. The message was the first public announcement of war and warned British merchant vessels not to go to German ports.

On the previous day, 4 August 1914, the German Army had crossed the Belgian border on their way to France and hence ignored Belgian neutrality. As guarantors of Belgian neutrality, Britain was obliged to declare war upon Germany and her allies. Reports differ as to the actual time that the Prime Minister Herbert Asquith declared war against Germany as it was a Bank Holiday. The following morning, newspapers varied in their times between 7pm and 11pm with the official time of declaration of war between Britain and Germany was probably midnight.

As well as warning British merchant vessels, the Admiralty had to, of course, advise ships of the Royal Navy that war had been declared as soon as it was announced. This would have been done both by landline and using its network of shore stations to advise ships at sea. Merchant ships also had to be advised both of the outbreak of war and not to go to German ports. This was done by not only sending the message to the Post Office run coast stations which were in contact with merchant and passenger ships but to ensure it was received out in the Atlantic it was sent to the high powered station at Poldhu in Cornwall.
The connection between the Admiralty and the Marconi Company – first established as the Wireless Telegraph & Signal Company in 1897 and later renamed Marconi’s Wireless Telegraph Company in 1900 – dated back to 1896 when Marconi gave early demonstrations of his wireless system to officers from the Royal Navy including one Captain Henry Jackson. Jackson had been experimenting with wireless telegraphy himself and was probably the first person to signal from ship-to-ship using wireless telegraphy. Jackson advised Marconi on adapting his wireless system to make it more suitable for maritime use and supported the integration of Marconi’s wireless system into the Royal Navy, in parallel with the development of his own system.

The Marconi Company sent wireless telegraphy apparatus out to South Africa for use by the British Army in the Second Boer War (1899-1902). Atmospheric and geographical conditions as well as the relatively experimental nature of the wireless apparatus meant they were unsuitable for use on land but the wireless apparatus was adapted by the Royal Navy for use at sea and was used to support the naval blockade of Delagoa Bay. This was the first use of wireless telegraphy under wartime conditions.

In part as a result of these successes, in 1901 the Admiralty signed an agreement with the Marconi Company to supply wireless telegraphy apparatus for Royal Navy ships and to set up coast stations to receive signals from the ships. This contract was further extended in 1903 and in 1904 the Royal Navy began to use the Marconi wireless system exclusively. By 1908, the importance of Admiralty wireless messages was acknowledged in the “Handbook for Wireless Operators” which noted that distress calls had priority followed by Admiralty messages and then safety messages, also known as danger messages, which were preceded by the Morse code signal TTT.

Meanwhile, coastal wireless shore stations selected included “Telegraph Tower” on the Isles of Scilly as well as Culver Cliff, Dover, Portland, Spurn Head and Languard in England, St. Anne’s Head in Wales and Roche’s Point and Bere Island in Ireland. The Admiralty also had hub stations in major locations such as Gibraltar & Malta with a central station in London called “Whitehall Wireless.” In 1911, the central Admiralty wireless station in London was moved to the Admiralty buildings in Whitehall and this was probably used as the communications and receiving centre for “Room 40”, the Admiralty’s centre for naval intelligence including signals intelligence during World War One.

To mark the centenary of the outbreak of World War One and to highlight the role of wireless in alerting the world especially shipping to the outbreak of war, a special callsign GB100ZZ has been allocated to a wireless station at Poldhu, near to the former site of the Marconi long-distance wireless station. GB100 callsigns are rare and are only given to mark centenary national events.

**GB100ZZ Station Details**

Active from Poldhu home of GB2GM from 3-30 August 2014.

QTH – Poldhu site where declaration of war was transmitted on night of 4 August 1914.
Station organised by the Radio Officers’ Association to honour the Wireless Operators who gave their lives in the Great War on both sides of the conflict. This event will be run by the Poldhu Amateur Radio Club from the site of the Marconi Centre.
Guest post by Keith Thrower: Technical factors affecting CW radio communication in WW1, part 3

Summary: This paper summarises the factors that affected the development of CW radio communication during the period up to 1918. It shows that most of the important circuits had been invented by 1914. The major technical factor affecting the successful development of CW radios for battlefield communication was the unavailability of robust radio valves: these did not become available until late in 1915 with the introduction of the French TM valve. Up until that time almost all radios were spark transmitters and crystal detector receivers.

Full version of the paper: Technical factors affecting CW radio communication in WW1 [pdf] Part 1 Part 2

Circuit development up to 1914

1. Oscillator

Several people have claimed the invention of the valve oscillator but priority was given to Meissner who took out a German patent in April 1913 [21, 22]. Two important by-products of this invention were the heterodyne circuit and regenerative feedback (sometimes called reaction).

Significant improvements in oscillator design were made by Hartley and Colpitts, both working for Western Electric.

2. The heterodyne

The heterodyne receiver was patented by Reginald Fessenden in 1901 [23]. The patent shows the use of two alternators at the transmitter connected on a common shaft and differing slightly in frequency. The outputs from these were each connected to separate antennas. At the receiver there was, likewise, two antennas and these were connected to coils wound on an iron core with a telephonic diaphragm at one end. In 1905 Fessenden applied for a further patent where he used one alternator in the transmitter and one in the receiver, the two frequencies being adjusted to produce an audible signal in the headphones [24].

A further improvement was made by Lee and Hogan in November 1912 when they used an alternator (or arc generator) in the receiver and a crystal detector [25].

The advantage of the heterodyne receiver was shown in the US naval trials from the Arlington station to the USS Salem, which commenced on 15 February 1913 [26, 27]. The trials compared the performance of the heterodyne receiver against that of a conventional crystal receiver and one using a ‘ticker’ to break up the incoming CW signal into short bursts.

A further improvement was made by Henry Round of the British Marconi Company with the invention of the Autodyne receiver which he patented in December 1913 [28]. The Autodyne was a self-oscillating mixer where the frequency of the oscillator was adjusted to differ slightly from that to the incoming signal. The valve used was the Marconi type C, soft triode.

3. Regenerative feedback (reaction)

Edwin Armstrong had been seeking means to improve the sensitivity of the audion receiver which he had built as a student at Columbia University. He achieved this by regenerative feedback from the anode circuit to the grid circuit, the feedback being adjusted to just below the point of oscillation. This form of feedback became known as reaction. His circuit was witnessed by a notary on 31 January 1913 and he applied for a US patent later that year [29].
In Britain the Marconi engineer Charles Franklin patented his regenerative receiver circuit on 12 June 1913, four months before Armstrong. Franklin, it would appear, was the first person to note that the regenerative action increased the input impedance of the valve and thereby reduced the loading on the tuned circuit [30].

4. RF amplifier

Although the triode valve had been invented by Lee de Forest at the end of 1906 it was not used successfully as an amplifier until 1911. The earliest recorded amplifier using the audion valve would appear to be that of Otto von Bronk, a Telefunken engineer who applied for a German patent on 2 September 1911 [31]. The circuit shown is of an RF amplifier (without grid blocking capacitor as used by de Forest in his detector and early attempts to produce an amplifier). The output from the valve is shown connected by an RF transformer to a crystal detector and telephone earpiece.

Conclusions

1. Before the outbreak of WW1 in August 1914 many of the circuits to be used in later years for CW radio communications had already been invented, although most of these were still at an early stage of practical applications. These circuits include the radio wave detector, the oscillator, the heterodyne, the RF amplifier and regeneration.

2. The British Marconi Company embodied all of these in the Marconi Short Distance Wireless Telephone Transmitter and Receiver which was produced in 1914 and used on ship-to-shore trials.

3. There were few valves available in 1914 for use in radio equipment. The de Forest audion was erratic in operation, fragile and had a short filament life. The Marconi soft valves, the C and T, were produced in 1913 and used in the radio mentioned in the previous paragraph. The C was a receiver valve and the T a transmitter valve. Both of these were difficult to manufacture and not suitable use on the battlefield. Apart from this the T valve required a power of 6-volts, 4-amps for its filament which meant very frequent replacement of the storage battery. Also an HT of several hundred volts was required.

4. One important application of the Marconi C valve was in direction finding receivers and these continued to be used throughout the War until suitable hard valves became available from 1916.

5. Until more robust valves became available the only way to communicate by radio from the trenches was by spark transmitters and crystal detector receivers. The transmitted signal from the spark transmitters was noisy and rich in harmonics which were spread over a wide spectrum. This meant that the radios had to be widely separated to prevent mutual interference.

6. Even so it might have been possible to deploy a small number of an improved version of the Marconi Short Distance Wireless Telephone Transmitter and Receiver for use in Headquarters and some vehicles, but this did not happen.

7. The situation changed dramatically with the introduction of the French TM valve in the early months of 1916. These valves were not well suited for use as RF amplifiers, except, maybe, at frequencies below 600 kHz. They were, however, well suited for use as radio detectors and audio amplifiers, not just in radios but also for the amplifiers required for the power buzzers. A valve more suitable as a detector and, possibly, as an RF amplifier was the Marconi O. However, this valve proved difficult to manufacture in large quantities.

8. It is well documented that there had been a reluctance in the Army to adopt radios and there was too much reliance on line communication, even though the cables were being constantly destroyed. Some of this reluctance was probably due to the problems of using spark transmitters in the trenches which were cumbersome and required skilled operators for the Morse transmissions. Their aerials also marked the position of the radios for enemy gunfire.

9. The most obvious places for CW radios were in aeroplanes, motor vehicles and tanks and there should have been a concerted programme to design and manufacture radios for these.

10. For use in trenches the requirement would have been for portable radios and these would have been required in large numbers during the last two years of the War.

11. It is difficult to assess how many radios could have been produced by the British and French in the last two years of the War. The manufacturing companies would have been short of skilled labour and engineers because of the enormous toll of lives that had taken place, particularly of those men in the Signal Service.

References

22. Meissner, A, German patent, appl. 10 April 1913.
Guest post by Keith Thrower: Technical factors affecting CW radio communication in WW1, part 2

Summary: This paper summarises the factors that affected the development of CW radio communication during the period up to 1918. It shows that most of the important circuits had been invented by 1914. The major technical factor affecting the successful development of CW radios for battlefield communication was the unavailability of robust radio valves: these did not become available until late in 1915 with the introduction of the French TM valve. Up until that time almost all radios were spark transmitters and crystal detector receivers.

Full version of the paper: Technical factors affecting CW radio communication in WW1 [pdf] Part 1 Part 3

5. The Marconi Company

The Marconi’s Wireless Telegraph Company (MWT) never manufactured radio valves. All the valves that they used up to 1919 were either manufactured by the Edison Swan Electric Company (Ediswan) or by the Osram-Roberson Lamp Works of the British General Electric Company (GEC).

In 1919, Marconi’s and GEC decided to set up a joint company for valve design and manufacture that could benefit from their pooled know-how and valve patents. The company was incorporated on 20 October of that year and was originally called Marconi-Osram Valve Co. Ltd., but the name was changed in the following year to M.O. Valve Co. Ltd. (MOV). Production was at the Osram-Roberson Lamp Works and included many of the types previously manufactured by Ediswan.

6. The Marconi-Round ‘soft’ triodes
Towards the end of 1911, Henry J Round of the Marconi Company commenced the design of a diode valve. Because of other commitments, however, this activity was suspended until November 1912, when Round extended his earlier work to include both diode and triode valve development. There is good reason to believe that the design of these valves was influenced by the soft valve development of von Lieben, Reisz and Strauss, as a result of a technology exchange agreement between the Marconi and Telefunken companies.

The first successful soft valves of Round were manufactured by Ediswan in 1913. Amongst the earliest of these were the type C, a receiver valve, and the type T, a transmitter valve, both of which were used in World War 1 in various items of radio equipment (see below). The type C had a platinum wire filament, which was oxide coated; the grid was of fine mesh nickel wire that fully surrounded the filament, and the anode was a solid nickel cylinder.

A distinctive feature of the C valve (and indeed of most of the other Round soft valves) was a glass extension tube at the top of the bulb which contained a wad of asbestos. As time progressed, the gas pressure in the valve tended to fall, resulting in a loss of sensitivity. In order to raise the gas pressure to an optimum value, it was necessary to heat the asbestos, either electrically, or by holding a lighted match close to the extension tube, which released occluded gas into the enclosed glass bulb.

The type T transmitter valve had three filaments of tungsten or platinum wire. According to Picken ‘Although usually classed as a soft valve, it was actually exhausted as thoroughly as its construction and vacuum technique available permitted. The pellet at its extremity was inherited from its prototype, the soft receiving valve, and was an unnecessary appendage’ [14]. Some of the valves were manufactured without an extension tube at the top; instead they had a metal cap which was used as a top support.

The type TN was introduced in 1914. This valve, together with the type C, was used in the Marconi Short-Distance Wireless Telephone Transmitter and Receiver (Early in 1914, the two Marconi engineers, Round and Tremellen, used the type T valve to transmit voice signals over a distance of 70km, probably using equipment similar to this.) [15].

According to Dowsett the TN was a soft valve and fitted either with two lime-coated platinum filaments or plain tungsten filaments. This meant that a comparatively high anode current could be obtained without using a very high anode voltage.

Other soft receiving valves made for the Marconi Company by Ediswan were the types CA, CT, D and N. Amongst the small transmitter valves, apart from the Type T, there were also the LT and TN.

There is little doubt that the Round soft valves were very difficult to manufacture, but during the early years of World War 1 there were no suitable alternatives. To quote from Round [16]:

"It was probably fortunate in the first year of our work that we used the soft valves because no hard valve had been constructed which can compare with these ‘C’ type tubes as high-frequency magnifiers. These necessitated, however, trained men in their manufacture, and trained operators for their efficient use … Again and again we lost the knack of making good tubes, owing to some slight change in the materials used in their manufacture. A thorough investigation was impossible, as all hands were out on the stations. On several occasions we were down to our last dozen tubes."

The principal use of the C valve during WW1 was in a single-valve direction-finding equipment where its sensitivity was equivalent to three of more of the French TM valves in cascade. (See next section of this paper.) These DF receivers were mainly located around the south and east coasts of England and some were also located on the European mainland.

The T valves was used in some radios of the Royal Flying Corp but little information has been found on these. The equipment identified were a W/T 120-watt ground set covering the wavelength 600 to 1000m and used as a tonic train transmitter. There was also another ground station version of this which was used for wireless telephony. Dates of installation and quantities produced are unknown but there would have been used in small numbers, probably from 1916.

7. The French TM triode

One of the most important of the early European triode valves was a device developed under Colonel (later General) Gustave Ferrié who was in charge of the French Military Telegraphic Service during World War 1. The valve, which came in two slightly different constructions known as the ‘S’ and Métal, was developed from an audition sample that was brought to France in August 1914 by Paul Pichon [17]; it had a straight tungsten filament of length 21mm, a spiral grid with 11 or 12 turns made either of molybdenum or nickel of length 16mm by 4.5mm diameter, and a cylindrical nickel anode 15mm long by 10mm diameter. The filament rating was 4-volts, 0.65-amps. A patent application for the valve was taken out in October 1915 [18]. It was immensely successful and widely used during World War 1, during which time over 100,000 were manufactured by the two French companies, Fotos
The TM was a hard valve, evacuated to a low pressure, and during the manufacturing process the glass and metal parts were heated to a sufficient temperature to release the occluded gases. An interesting feature of the valve was the use of a four-pin base, which later became a standard throughout Europe, including Britain. The electrodes were mounted on a glass stem inside a spherical glass bulb. At the top of the stem the glass was formed into a ‘pinch seal’. From here nickel support wires went to the electrodes, and at the bottom of the seal copper wires connected to the external pins. The airtight seal was formed by small pieces of platinum wire welded to the pieces of copper and nickel. Platinum was chosen because its temperature coefficient of expansion matched that of the glass. The base (or cap as it was frequently called) consisted of four pins mounted in an insulating material and surrounded by a metal shell.

With the introduction of the French valve it now became possible to manufacture reliable and robust CW radios for wireless telephony and telegraphy. The first equipment using this new valve came into use early in 1916.

8. The British R valve

By 1916, the French TM valve was being produced in Britain where it was known as the R-valve. Amongst the first manufacturers were BT-H and Ediswan. During World War 1, it was also produced by Cossor, Cryselco, the Osram-Robertson Lamp Works of GEC, Metropolitan Vickers, Stearn and Moorhead Laboratories of San Francisco.

It is interesting to note that the R valve was not manufactured by Osram until September 1917.

9 The Q valve

The principal disadvantage of the TM and R valves was the high internal capacitance between the grid and anode which restricted its use as an RF amplifier to frequencies below 600 kHz.

A partial solution to this shortcoming was the design of a quite remarkable valve by Capt. Henry Round of the Marconi Company in 1916. This, the type Q, featured small size and low capacitance.

The valve was made by Edison Swan for the Marconi Company, but production was transferred to MOV in 1919 following its formation. (This last statement needs checking. MOV replaced the Q valve with an improved detector, the Qx, in 1921.)

The valve has a straight tungsten filament terminated into pointed metal caps at each end. The grid is a nickel wire gauze and the anode a nickel cylinder. Both the grid and anode connections are taken to two further caps near one end of the tubular glass bulb. Physical details are as follows:

- Overall length: 73 +/- 2mm.
- Bulb diameter: Approx. 16mm.
- Overall width: 26 +/- 1.5mm.
- Anode: Nickel sheet bent to a complete cylinder; 18mm long, 14mm diameter and 0.05mm thick.
- Grid: Mesh of 0.07mm nickel wire welded to a nickel frame, 28mm long and 6mm diameter.
- Filament: Drawn tungsten wire of length 23mm and diameter 0.043mm, held by nickel supports at each end. 5-volts, 0.45-amps.

The valve has a very high value of anode resistance (150kΩ), which results from the large spacing between the anode and grid electrodes. For this reason it was not particularly suited for use as either an r.f. or a.f. amplifier, its main use being as a detector. Nevertheless, three Q valves were used in the Marconi Field Station Receiver Type 38a—one as a detector and the other two as ‘note magnifiers’ (an old name for audio amplifier stages) [19]. More usually the Q valve was used in conjunction with the V.24 (see below).

10. The V24 valve

Like the Q valve, the V.24 was designed by Capt. Henry Round of the Marconi Company. The design probably dates from 1917, with production in 1918. Manufacture was initially undertaken by Ediswan, but was transferred to MOV in 1919. It continued to be manufactured into the late 1930s. The type reference V.24 was chosen because the valve was intended to operate from an h.t. supply of 24 volts, which was the standard battery in use by the British armed services.

The V.24 was used in a wide range of early Marconi receivers including the Valve Amplifier Type 55 (6 x V.24 plus 1 x Q); the Marine Portable Telephony Set Type 11 (5 x V.24 plus 1 x Q); the Direction Finder Type 11a, a variant of the Type 11; the Amplifier Type 71 (3 x V.24—later 2 x V.24 plus 1 x QX); and the Local Oscillator Type 123 (a single V.24).
During the last year of WW1 the prime use of the V.24 was in direction finding receivers, such as the Type 55 used, principally, by the British navy.

### 11. Other British valves

By 1917 many other valves were being manufactured for use in military equipment. Those produced specifically for the Navy will not be covered here but a detailed description of these can be found in a paper by Gossling [20].

The type B was a higher power version of the R with a 6-volt, 0.84-amp filament and was rated as a 30-watt transmitting valve. This, and the R valve, were also manufactured in the US by Moorhead. The Osram-Robertson Company first made the B valve in November 1917.

Two other transmitting valves were the T2A and T2B, introduced by Osram-Robertson in August 1917. Both of these valves were rated at 250 watts.

Two other low-power transmitting valves were the Types AT25 and F. Some higher power valves were also made for the Navy.

### References:

15. Picken, ibid, pp.38–46
22. Meissner, A, German patent, appl. 10 April 1913.

This entry was posted in Guest posts, Wireless Telegraph and tagged HJ Round, Keith Thrower, Marconi, radio valves on 23 June 2014 by Elizabeth Bruton.

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Guest post by Keith Thrower: Technical factors affecting CW radio communication in WW1, part 1

**Summary:** This paper summarises the factors that affected the development of CW radio communication during the period up to 1918. It shows that most of the important circuits had been invented by 1914. The major technical factor affecting the successful development of CW radios for battlefield communication was the unavailability of robust radio valves: these did not become available until late in 1915 with the introduction of the French TM valve. Up until that time almost all radios were spark transmitters and crystal detector receivers.

Full version of the paper: [Technical factors affecting CW radio communication in WW1](pdf) [Part 2 Part 3]

### Valve development to 1918

#### 1. Fleming diode

The diode valve used as a radio wave detector was patented by John Ambrose Fleming in October 1904 [1]. This had the important feature of a solid cylindrical anode that totally enclosed the carbon filament. In 1908 Fleming took out a patent for a tungsten filament [2]. However, the technique had not yet been perfected for ductile tungsten and the filament became brittle after being heated to incandescence.

The Fleming diode only had limited usage and was quickly superseded by the crystal detector which was far more reliable and didn’t require a lead-acid battery to power it. However, the carborundum crystal did require a small bias voltage for optimum sensitivity but this was supplied by a small dry-cell battery. Other crystals, such as the Perikon, did not require a bias but they required frequent re-adjustment.

#### 2. De Forest audion

The US engineer, Lee de Forest, believed he could make a more sensitive detector than the Fleming diode. After several unsuccessful attempts the decisive and historic step was made at the end of 1906 when, on 31 December, de Forest inserted a third element, shaped like a grid iron, between the
The first grid audions had a carbon filament; both the grid and anode were made of nickel and the glass envelope was spherical. As further valves were made, however, the manufacturer, McCandless, used a variety of materials and there were great variations in the constructional methods and their dimensions. The carbon filament was replaced by tantalum, but this was found to warp. In about 1908, tungsten became available for use in electric lamps. As mentioned above, at the time, the manufacturing process had not been perfected and the material became brittle at the temperature required for incandescence. Tungsten had the advantage that it could provide a higher emission than tantalum, which gave rise to a suggestion made to de Forest by Walter Hudson that he should construct his filaments from tungsten wrapped with fine tantalum wire, a process later modified to cover the tungsten with a tantalum paste. This simplified the manufacturing process and, in this form, the Hudson filament, as it became known, was used for many years by de Forest.

When first produced, the audion valve had many shortcomings, because the technology used for its manufacture was new and poorly developed. Particular problems were the use of unsuitable materials in its construction, a short filament life and poor evacuation of gas from the sealed bulb, resulting in a soft vacuum.

For several years, from 1907 to 1913, the audion was only used as a radio detector, as its conduction mechanism and general principles of operation were not understood. De Forest carried out some experimental work on low frequency amplification for telephone repeaters, but his early efforts were not successful. This was probably because he used r.f. instead of a.f. coupling and did not correctly bias the valve.

The basic problems of the audion were eventually overcome by the industrial laboratories of AT&T, (Western Electric) and General Electric, both companies working independently. The driving force for AT&T was the need to develop a reliable amplifier for their telephone repeaters to improve long-distance telephony. For General Electric the driving force was to provide a speech modulator for their high-frequency alternators, as this would then make radio telephony a practical possibility.

(Note: The BT-H company manufactured the audion valve in 1916 and pumped it to a high vacuum to overcome some of its erratic performance. It was used for a year or so by the Navy in one-valve heterodyne receivers.)

3. Valve improvements at AT&T

AT&T had recognised the importance of an amplifier for use with their telephone circuits as early as 1910. Work was carried out by Harold Arnold in their subsidiary company, Western Electric, during 1911 to 1912. The device developed was a mercury vapour discharge tube using magnetic control of the ionised current. Although some success was achieved, the device was never put into production because it was superseded by the possibility of using the de Forest audion valve as an amplifying device.

In January 1912, Fritz Lowenstein demonstrated to Bell staff an amplifier contained within a sealed box. (This box was lead-lined to prevent X-ray photographs being taken.) The performance of the amplifier was erratic and because Lowenstein would not disclose details of his device, there was no way that the Bell Company could judge its suitability. Matters were thus allowed to rest for a while. Later in 1912, John Stone, an ex-employee of the Bell company in America, had seen a demonstration by de Forest of the audion and recognised its potential as a telephone amplifier. At the end of October 1912, he arranged for de Forest to demonstrate the circuit to Bell staff, with a full disclosure of the circuit used. The performance, as with the Lowenstein demonstration several months earlier, was erratic. Nevertheless, the Bell staff were impressed and they arranged for a development project to be undertaken by Western Electric to investigate the audion device and its suitability as an amplifier in telephone circuits [4].

Within a short period of time, Arnold, van der Bijl and other engineering scientists of AT&T had turned the primitive audion of de Forest into a reliable telephone relay amplifier. Their main improvements were:

1. The production of a high vacuum device, where the conduction was governed by electron current rather than ionisation. This high vacuum was achieved by the use of the Gaede molecular pump that was introduced from Germany in April 1913.
2. A more reliable filament. This was made from a strip of platinum coated with barium nitrate to improve emission and thereby allow a lower temperature to be used. The coated filament was a direct development from the pioneering work of Wehnelt.
3. A stronger internal construction to support the electrode assembly.

One of the first valves to go into production at Western Electric was the Type A. The first telephone repeater to use this valve went into service on 18 October 1913 and this provided the necessary amplification to achieve long distance line communication. By 1915, improved valves were produced which were claimed to have a filament life of 4500 hours.

AT&T bought the de Forest audion patent for a total sum of $390,000, but this was made in three separate payments. Initially, in 1913 for $50,000, they bought the rights in all fields except wireless telegraphy and telephony. Then in 1914, for $90,000, the company bought a non-exclusive licence in the wireless telephony field. Finally, in 1917, AT&T paid $250,000 for an exclusive licence to all remaining rights.
The amplifier that Lowenstein demonstrated to the Bell staff in January 1912 was later shown to be an audion valve without a grid blocking capacitor, but with negative grid bias. Lowenstein took out a patent for this method of bias in 1912, which he subsequently sold to AT&T for $150,000 [5, 6]. In later years the negative bias patent assumed great importance and was the subject of much litigation.

The most important requirements for repeater valves was long life and constancy of their characteristics. Manufacturing costs was of secondary importance. The valves were used in the benign environment of telephone offices and would not be subject to severe shock, vibration or extremes of temperature.

With the possibility of the USA entering WW1, Western Electric began the development of valves for military use and these had to be mechanically robust, have a reasonable life and withstand extremes of temperature.

America entered the war in April 1917, 22 months after the British and 19 months before the armistice which brought the war to an abrupt end.

Two of the valves mass-produced by Western Electric were the VT-1 and VT-2. The VT-1, was a general-purpose triode for use in radio receivers as a detector, amplifier or low-power oscillator. Initially, the valve was deemed too fragile for use under battlefield conditions but over the ensuing months there were significant structural changes. The VT-2 was designed as a 5-watt transmitting valves and became available in 1917.

The following is an interesting abstract from A History of Engineering and Science in the Bell System. The Early Years: 1875–1925, p.368:

The War came to Europe before the vacuum art had been applied to telephony and as a consequence the vacuum tube received only limited use in the European nations and only for radiotelegraphy. In the United States it was possible to continue peacetime development for several years after the war began and as a consequence this country's technicians were in a much better position to apply radiotelephony to the war effort.

4. Valve Improvements at General Electric

General Electric became interested in the audion valve through the desire to provide speech modulation for their high frequency alternators. The company was a major manufacturer of electrical equipment, including large power generators. Their interest in high-frequency alternators was stimulated by Reginald Fessenden, a brilliant, enigmatic engineer who headed a small company called NESCO (National Electric Signalling Company). Amongst his many inventions was the heterodyne method of reception, whereby the incoming radio frequency signal was beat against a local oscillation to give a low, audio frequency that could be applied directly to headphones (described later in this paper).

Fessenden was one of the pioneers of radio telephony and his ideas were many years ahead of the time. His earliest attempts to transmit voice signals were in 1900 when he used a microphone to modulate a rotating spark generator, although articulation was poor. He was aware of the work of Elihu Thomson and Nikola Tesla with high frequency generators. However, with these, the frequency achieved was no higher than 5 kHz. In 1900, Fessenden wrote to Charles Steinmetz, the consulting engineer of General Electric, enclosing a specification for a high-frequency alternator. The first machine, produced by Steinmetz in 1903, had an output power of 1kW, but the maximum frequency was only 10 kHz, making it unsuitable for direct transmission purposes.

The second G.E. machine for Fessenden was designed by a young Swedish engineer, Ernst Alexanderson, who had recently settled in the United States. This machine, delivered to Fessenden at his Brant Rock radio station in August 1906, could generate a modest output power of 500W at a frequency of 76 kHz. Initially, the range achieved for telephonic signals was only 11 miles, but in July 1907, speech was transmitted between Brant Rock and Jamaica, a distance of nearly 200 miles [7].

Over the next few years, Alexanderson developed larger h.f. alternators capable of delivering several hundred kilowatts at a frequency of 100 to 200 kHz [8]. For wireless telephony applications, these alternators required a high power modulator. There were two possible approaches: one was to modulate directly with a microphone, but this resulted in excessive power dissipation (specially cooled microphones were developed for this purpose). The second approach was to insert an amplifier between the microphone and the alternator. In 1912, Alexanderson developed a magnetic amplifier with some success, but he was not entirely satisfied with its performance.

Two of Alexanderson’s h.f. alternators were delivered to John Hammond Jr at his Massachusetts laboratory in 1912. Whilst there, Alexanderson was told of the audion valve. In spite of its inherent weaknesses at that time, he thought it might be adapted into an amplifying device to overcome his modulation problem. General Electric were ideally equipped to develop the primitive audion valve into a robust product. They were a major manufacturer of electric lamps and had extensive research and development facilities. Amongst the staff at that time were many brilliant engineering scientists, including Coolidge and Langmuir (who in 1932 received the Nobel Chemistry Prize). Coolidge had recently perfected a process for manufacturing ductile tungsten for use as filaments in electric lamps, which gave a greater light output per watt and was also more reliable [9, 10]. The
The task of developing the audion into a satisfactory device was given to Langmuir, assisted by William White.

Langmuir recognised that one of the main limitations with the audion was its poor vacuum; this was quite contrary to the strongly held view of others at that time. He was familiar with the work of Richardson, Fleming and other leading scientists of the day, and he immediately set out to understand the operation of thermionic emission.

In 1913 he published an important paper in the *Physical Review* in which he verified Richardson’s equation for emission from a hot cathode, but also showed that as the cathode temperature was raised, the increased emission of electrons gave rise to a space charge that formed between the cathode and anode [11]. This had the effect of repelling the electrons back to the cathode. Thus, when the space charge was present, the actual current that flowed to the anode was less than that given by Richardson’s law. This current was found to be proportional to the anode voltage raised to the power of 1.5. Langmuir established that this relationship between anode current and anode voltage was true irrespective of the shape of the electrodes: a similar result had been found by C.D. Child in 1911 for the flow of positive ions between two parallel plates [12].

Langmuir expanded on this work in his famous paper of 1915, ‘The Pure Electron Discharge’ [13].

According to White in an unpublished document, dated 1 March 1929:

‘Until the outbreak of War [presumably April 1917], all work on tubes was almost entirely of a research and experimental nature. … Prior to the War, owing to the patent situation, there was no commercial outlet possible for receiving tubes.

…The coming of the War changed this because it was early recognized by the Signal Corps of the Army that vacuum tubes would probably play an important part. [This is a 60-page document and makes very interesting reading, particularly the sections covering tube development for the Army and Navy, together with the manufacturing problems and how these were overcome].

This lengthy discussion so far has been to show how all the fundamental problems associated with the de Forest audion, with its poor vacuum, erratic performance and fragility had been solved by the two US companies, Western Electric General Electric by 1916.

References
1. Fleming, JA, British patent 24,850, appl. 16 November 1914.
3. de Forest, Lee, US patent 879,532, appl. 29 January 1907.
6. Ref 4, p.228.

This entry was posted in Guest posts, Wireless Telegraph and tagged AT&T, De Forest, Fleming, General Electric, Keith Thrower, radio valves on 23 June 2014 by Elizabeth Bruton.

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**British Pathe wireless films from World War One**

The entire British Pathe archive of over 85,000 films is now available on YouTube at [https://www.youtube.com/user/britishpathe](https://www.youtube.com/user/britishpathe)

This collection includes some wonderful wireless-related films, see [https://www.youtube.com/user/britishpathe/search?query=wireless](https://www.youtube.com/user/britishpathe/search?query=wireless)
Two particular films of interest are:

Arriving For Instructions In Wireless – Telegraphy At Marconi House (1919), which opens with a scene of army wireless operators arriving at Marconi House in London for training.

Wireless Installation On Train (1914-1918) which shows a wireless mast being installed on top of a stopped train.

It was the latter of film which was of particular interest – the description below the video stated that the location of events was unknown and that the nationality of the soldiers were not absolutely certain but might be Belgian.
An answer came via one of our subscribers and Len Blasiol on the Modern Conflict Archaeology Facebook group that the soldiers were definitely French officers and men:

"The helmets look a bit like those of Poilu although it's difficult to tell with certainty whether they have the metal ridge. However, there are two officers in the scene. One leans out of the railroad car at two points, and the other walks up near the end. Both of them have a quatrefoil on the top of their kepi."

So this rather begs the question: why and how were they using a wireless system on a stopped train and where and when might this film be from?

Please answer in our comments below!

Update: Chris Phillips from the University of Leeds, an expert on the logistical administration, in particular trains, of the British Expeditionary Force on the Western Front from 1914 to 1918, suggested that this might be an advance headquarters. For example, Haig had a train advanced headquarters but Chris was unable to comment on how common this might have been in the French Army.

Might anyone be able to provide any further information?
Leeds University Officers Training Corps (OTC) and signalling during World War One

by Elizabeth Bruton

Dave Stowe, Kate Vigurs and others at the Legacies of War project at the University of Leeds have been doing some fascinating research into World War One materials in the University Archive at the University of Leeds.

Through their research, they came across a scrapbook of photographs of University of Leeds War Work from 1914 to 1916. Alongside photographs of laboratory research and experimental farms were included evocative photographs of the Leeds University Officers Training Corps (OTC). The OTC photographs showed general military training of the OTC including rifle training, physical exercises, and some basic signalling including Morse code tapper training and flag signalling. These two methods of signalling, one old and one new, were key to British Army signalling during World War One.

Leeds University OTC

The Officer's Training Corps (OTC) was officially established in July 1908 as part of the general reform of the regular and auxiliary forces of the British Army instigated by Lord Haldane. However, their origins lay in voluntary military work in the education sphere from the mid-nineteenth century onwards. The formation of the OTC was a direct response to concerns about the supply of adequately trained officers in the event of war. The OTC was divided into the Senior Division for universities and the Junior Division for schools and Leeds University OTC, established in 1909, was part of the former.

Further details on Leeds University's OTC during World War One has been provided by Dave Stowe from the Legacies of War project at the university:

It is estimated that no less than 1600 officers from Leeds University were commissioned during the Great War. These numbers included past and present and ex-members and cadets of the university officer training corps among the staff and lecturers who also served. More than 290 officers and other ranks are known to have been killed or died of the 328 names listed on the memorial panels. Many more were wounded or injured and more than 290 military honours were awarded in total – including one VC. Captain David Philip Hirsch was awarded the Victoria Cross (Posthumous) for his part in the fighting when serving with the 4th Yorkshire Regiment in April 1917. D.P. Hirsch had joined the Leeds University OTC as an extra-mural cadet in December 1914 and was commissioned four months later.

Military communications during World War One
Military communications during World War evolved to meet new battlefield and military challenges during this period. Battles were won and lost on the strength of an army’s ability to communicate on the battlefield. New and old systems of communications were used side by side.

On the Western Front, the British Army used telegraph cables and telephones to communicate between the front line soldiers and commanders. But heavy artillery (gun) bombardment meant these lines of communications were easily broken. These lines of communications were also easily intercepted by the German army, as were the very basic wireless telegraph sets used by the British Army. Despite this, the speed of telephone and telegraph communication meant they were the most commonly used telecommunications systems used by the British Army.

However, other systems of communications were also needed to be used in parallel with and as a backup to telegraph and telephones. The British Army was forced to adapt, using older forms of communication such as carrier pigeons and written messages delivered by runners and messenger dogs to keep the lines of communications open. Messenger runners had one of the most dangerous jobs in the war having to run across open ground and risk being shot by snipers in order to make sure a message was delivered. Signalling flags were also used but could only be used in the daytime and were easily visible to the enemy.

Morse code during World War One

This photograph shows two young officers being trained in the use of a Morse code. It is impossible to tell from the photograph whether they are using wireless telegraphy, ordinary telegraphy or the use of the buzzer telephone but all three used Morse code during the war.

Wireless telegraph sets were used by soldiers in the trenches to communicate with generals in headquarters. Wireless sets were useful when telephone wires were broken but could be easily listened in to or intercepted by the enemy. Wireless sets were also heavy and could be unreliable and soldiers needed to know Morse code to send messages.

These were also problems for Royal Flying Corps pilots when they began to use wireless sets early in the war. In 1915, Royal Flying Corps pilots began to experiment with wireless to tell soldiers where to aim their large artillery guns. However, it was still a new technology and was difficult to use while flying an aeroplane. As with use in the trenches, wireless messages could also be intercepted by the enemy.

Morse code continued to be used as an international standard for maritime distress until 1999 but had been discontinued by many navies prior to this. When the French Navy ceased using Morse code on 31 January 31 1997, their final message was “Calling all. This is our last cry before our eternal silence.”
Flag signalling during World War One

Alongside modern electrical apparatus, other, older methods of communications continued to be used throughout World War One and beyond. Visual methods of signalling included Begbie lamps (a paraffin-burning lamp which could be used over relatively long distances), trench signalling lamps, heliographs, and flag signalling.

Flag signalling was used on land as well as on sea and was usually referred to as “semaphore” when used at sea. In both cases, fabric flags were used and, in the case of flag signalling on land, blue and white flags were usually used. In the case of lightweight silk flags, a competent operator could reach about 12 words per minute, were used to send the fastest messages.

Flags were portable but needed good visibility and daylight. Semaphore flags used a form of signalling based on Morse code and required a trained signaller and a trained receiver, with a telescope, pencil and notepad, at either end.

Signallers were regularly employed in forward positions to assist with artillery spotting and provide information about their targets. In these often-isolated positions, signallers were often vulnerable to enemy shelling and attack and, as a result, many signallers lost their lives.

Visual signalling were quicker than sending a messenger but were easily intercepted by the enemy and could only be used over short distances. As a result, flag signalling fell out of use in conflict communications by 1916.

For further details of flag signalling in the British Army, see The Royal Signals ... Signalling with Flags.

Images

These photographs were supplied to Legacies of War by Joanne Fitton, Special Collections Manager at the University of Leeds, and are used with kind permission.

These images are from material in the University Archive at the University of Leeds. The University Archive was set up in 1977 to preserve the records of the University of Leeds and its predecessor bodies the Yorkshire College of Science, Yorkshire College, and Leeds Medical School, from 1874 to the present day. The archivist actively collects material, preserving the memory of the institution, providing the evidence base for its activity and making its records accessible to researchers.

The University of Leeds also holds the Lidde Collection which includes the personal papers of well over 4,000 people who lived through the First World
War, and approximately 500 who experienced the Second World War.

Sources and further information

For further information, see the Leeds University OTC tribute video put together from original historic and archive material by *Legacies of War*’s Dave Stowe. Dave has collected a number of images and press cuttings linked to his research into the Brotherton Library’s War Memorial at the University of Leeds.

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**The University of Leeds OTC and Roll of Honour by Dave Stowe via Western Front Association**

**The O. T. C. and the great war (1915) by Captain Alan R. Haig-Brown**

**University Archive at the University of Leeds**

**Liddle Collection at the University of Leeds**

**Royal Signals Museum: World War 1&2 Communications**

**The Royal Signals … Signalling with Flags**

**Worcestershire Regiment: A Signaller in World War 1**

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This entry was posted in **Military**, **Telegraph**, **Wireless Telegraph** and tagged **flag signalling**, **Leeds University**, **Morse code**, **officer training**, **OTC** on **12 May 2014** by **Elizabeth Bruton**.

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**Guest Post by Brian Austin: Wartime Wireless Intelligence and E.W.B. Gill**
A rare image of EWB Gill, taken in 1922

Walter Gill (1883 – 1959) was an Oxford physicist and a specialist in electromagnetic phenomena. He was also a man with an incisive mind – though well-balanced by a ready sense of the absurd. A likely candidate, one would have thought when war broke out in August 1914, for some useful position in the Army then assembling with much urgency. But Gill was too old, so he was told, to be commissioned as an officer and so he took himself to the recruiting office and volunteered as a private.

Following a short spell digging trenches on the Isle of Wight, Gill received a letter from the War Office reconsidering its earlier decision. He was offered a commission in the heavy artillery – his knowledge of trigonometry had clearly helped – and told to report to Woolwich. But the arsenal had no guns so, to keep its newly-created officers busy, they were lectured on the art of grooming horses, incessantly. During the time he spent there, much of which involved such seemingly pointless activities, the not-so-young Second Lieutenant Gill became acquainted with many strange military practices not least of which was the need to salute almost anything that moved.

But the war was itself moving on and soon it was realised that there was need for officers well-versed in the wireless art and especially its use for intelligence purposes. Gill was immediately transferred to the Royal Engineers in whose parish wireless had found itself. This appealed to him for many
and obvious reasons: his physics background equipped him rather better than most for such a technical task and his natural scepticism, when confronted by extravagant claims, made him the ideal intelligence analyst.

After the war, in 1934 in fact, Gill published a delightful book describing his wartime experiences. Called *War, Wireless and Wangles*, and illustrated with some wonderful cartoons, the book recounted, in often hilarious detail, the contest between the “Teutonic mind”, as he saw the German obsession with organisation of the most methodical and precise kind and the, at times, almost shambolic British response. As just one example, he described how the Zeppelins, those cumbersome predecessors of the bombers of the next war, were all equipped with wireless and each had a call sign beginning, shall we say, with the letter L followed by another, thus LA, LB, LC and so on. It took little intelligence, in both senses of the word, on the British side to soon deduce that this grouping of letters was reserved for the German Zeppelin fleet and, from that, considerable operational advantage flowed. Some time later, realising this weakness in their system, the German planners changed their call signs but, in well ordered fashion, so LA became MB and so on. More was to follow.
Every hour, and almost on the hour, those Zeppelins would report their position to the High Seas Fleet under whose command they fell. These regular wireless transmissions were a bonanza of the highest order for the listening British wireless stations with their associated direction-finding facilities. Not only was warning given of an impending attack, several hours before they crossed the British coast, but their positions and courses were plotted as they lumbered on.

But behind the humour was much of historical value too, particularly of a technical nature. The art of direction finding by radio came into its own during the war owing to the work of two brilliant engineers at the Marconi Company: H.J. Round and C.S. Franklin. By means of the infant valve technology of the time that provided unprecedented amplification, and arrays of antennas that produced controlled directivity, these two men gave the Army a formidable intelligence tool. But it was the Royal Navy, initially highly sceptical until they changed their view on seeing the performance of that equipment when deployed in France, that took great advantage of the technology. In May 1916, a 1.5 degree shift in a DF bearing indicated that the German High Seas Fleet was on the move from its anchorage at Wilhelmshaven and this intelligence enabled the Navy to position its Grand Fleet for the Battle of Jutland that took place the next day.
Gill himself was soon on his way to Egypt. He was posted to what would become a wireless intercept station but his first task was to assemble another one on Cyprus so he proceeded thither with the four tall masts of a Bellini-Tosi DF antenna. That they fell down during the erection process was merely part of the Army's day but all was soon well once the guys had been correctly set. By now Gill had become something of an antenna expert and his next contribution followed in short order. Back in Egypt and charged with setting up another intercept station he astounded his commanding officer when he announced that he'd found the ideal very tall supporting structure for its aerial. Since nature had provided nothing taller than palm trees in the region, the CO was naturally sceptical until Gill pointed out the Great Pyramid at Giza with a wire affixed to its pinnacle. This aerial proved itself to be very effective: a Zeppelin, on its mission over England, was heard on the single-valve receiver of the station. No mean feat!

After encounters with Egyptian princes and British Army officers who kept pet chameleons, Gill began to acclimatise to the rather exotic way of life common, or so it seemed, at the eastern end of the Mediterranean. From Cyprus he went to Salonika to take charge of one of the intelligence wireless stations in that region. This was the place, it was alleged, that St Paul only visited once. Afterwards he contented himself by writing epistles to its inhabitants. It turned out that malaria was rife in the country and, as might be expected, the Army took this very seriously. Various deterrents were either to be swallowed or applied as medical science evolved. One day he noted that the latest approved substance bore an uncanny resemblance to gearbox grease. It was claimed to be lethal to mosquitoes. However, Gill was confronted by the regimental sergeant major just before he was due to order all his men apply the stuff to themselves. Should he first remove the mosquitoes from the tin where they appeared to be eating the grease?
By the war’s end, the now Major Gill had become one of the British Army’s experts in the art of wireless intelligence both technologically and operationally. The latter skill he acquired without benefit of formal instruction. When in Egypt, and the flow of intercepted German wireless traffic became a daily occurrence, the standard procedure was to send it all, by cable, to London where it would be deciphered by experts, perhaps at “Room 40” the centre where such dark arts were practised. But to a man of Gill’s intelligence and curiosity, and with the collaboration of a similarly endowed colleague, it seemed only natural to “have a go” themselves. And soon, based on little more than common sense plus the application of a logical mind, they did indeed “crack” the code. It should be said at this stage that it was by no means a high-grade cipher; more like something based on a “child’s first cipher-book”, as Gill put it. German cipher policy, it would seem, differentiated between theatres of war and clearly the further east those happened to be the lower the quality of the cipher required.

They duly sent the deciphered ciphers to London in the approved way and fully expected to be soundly reprimanded for their unauthorised efforts. However, the reaction forthcoming was precisely the opposite: their action was approved and the War Office said they would send one of their experts to Egypt to give Gill and his colleague instruction in the latest cipher-solving devices. This story has interesting repercussions soon after the outbreak of the next World War when, once again, Gill offered his services to the military. And again he found himself at the very sharp end of the intelligence war. However, this time, his indiscretion by once again breaking the German code (emanating from the Abwehr no less) had a very different outcome. That story, though, has been told elsewhere and will not intrude upon this account of his First World War service.

Walter Gill’s war ended in 1918 with him back in England and in command of the Army’s intelligence wireless stations as well as a training school. For his service he was awarded the OBE (mil.) and was twice mentioned in despatches. One of Gill’s many remarkable characteristics was his modesty. He sought no honour for himself nor even any publicity. Finding a single photograph of the man proved a major task and when accomplished it shows Walter Gill, back at Merton College, Oxford, in 1922 where he resumed his academic career until the next encounter with the Germans when he again offered his services.

This blog post is based on Dr Austin’s full-length article on EWB Gill published in The Journal of the Royal Signals Institution vol.29, No.2, Winter 2010 [pdf].
About the author

Dr Brian Austin is a retired engineering academic from the University of Liverpool's Department of Electrical Engineering and Electronics. Before that he spent some years on the academic staff of his alma mater, the University of the Witwatersrand in Johannesburg, South Africa. He also had a spell, a decade in fact, in industry where he led the team that developed an underground radio system for use in South Africa's very deep gold mines.

He also has a great interest in the history of his subject and especially the military applications of radio and electronics. This has seen him publish a number of articles on topics from the first use of wireless in warfare during the Boer War (1899 – 1902) and South Africa’s wartime radar in WW2, to others dealing with the communications problems during the Battle of Arnhem and, most recently, on wireless in the trenches in WW1. He is also the author of the biography of Sir Basil Schonland, the South African pioneer in the study of lightning, scientific adviser to Field Marshall Montgomery’s 21 Army Group and director of the Atomic Energy Research Establishment at Harwell.

Brian Austin lives on the Wirral.

This entry was posted in Guest posts, Military, Signals Intelligence, Wireless Telegraph and tagged aviation, Brian Austin, EWB Gill, wireless on 13 March 2014 by Elizabeth Bruton.