One Man, Two Wars And Wireless:
The signals and intelligence work of E.W.B. Gill OBE, MA, BSc

by Brian Austin, G0GSF

Few men who made so many really significant scientific contributions to Britain's war effort, during two world wars, managed to keep themselves so much out of the limelight. And, perhaps even more remarkably, he also avoided photographers like the plague. Despite making a detailed search of the available records, and after scouring the Internet, I only discovered two photos of Walter Gill: one taken when he was at school and the other, in 1922, when he was back at Oxford in its Department of Physics. It was there, at Merton College, that Gill pursued a career in research into electrical phenomena – in the broadest possible sense. Research was a very important part of his life but there was much more to the man than just being a scientist.

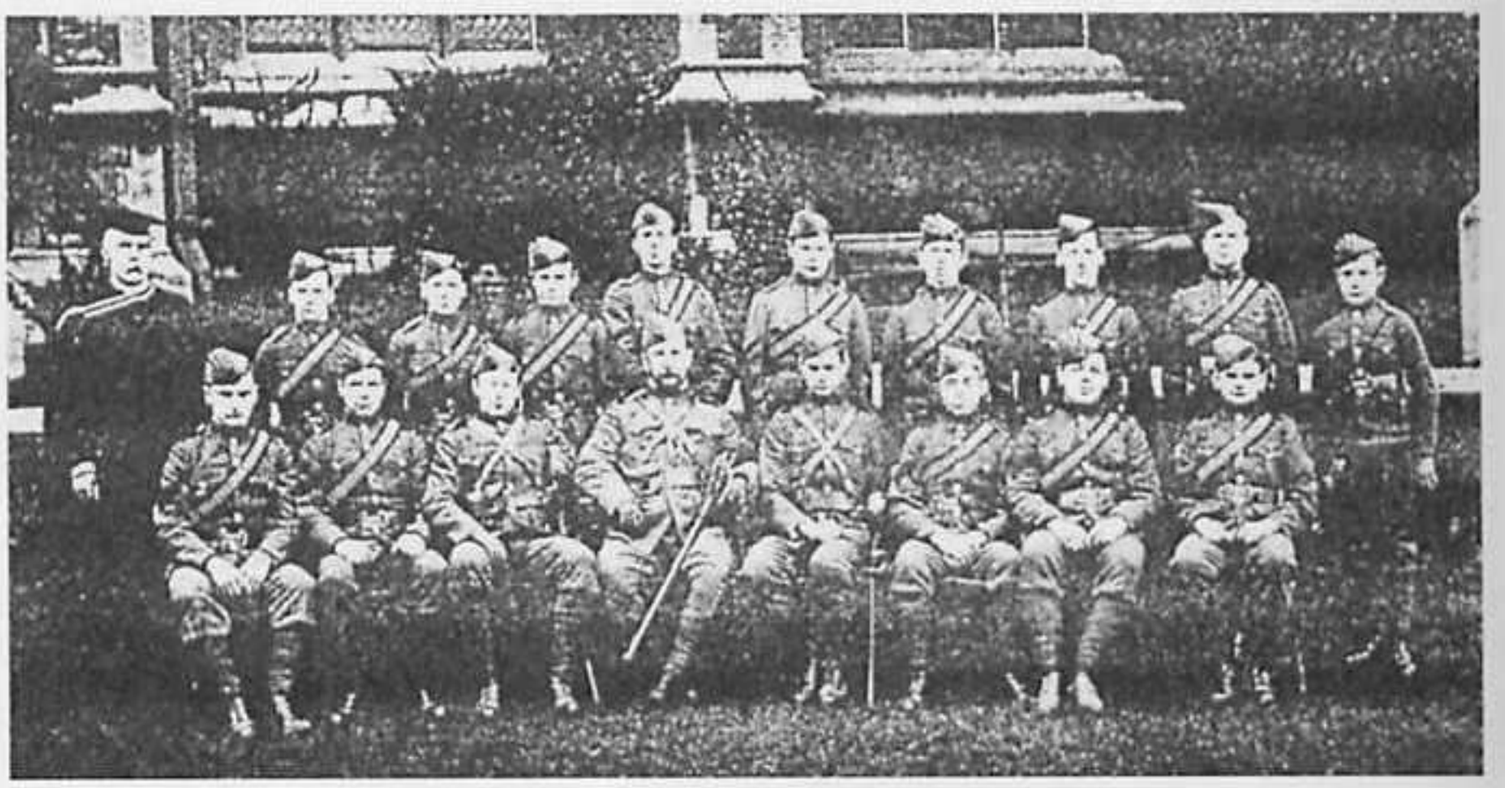


Fig.1. Officers and NCOs from the Bristol Grammar School cadet corps of 1901. Lieut. Walter Gill, with crossed belts, sword and feet together, is sitting to the right of his bearded commanding officer

Ernest Walter Brudenell Gill was born in London in 1883, the son of a Church of England canon. He died after a long illness in 1959. Those intervening 76 years saw Britain engaged in two World Wars and they were also a period of massive change – social, scientific and technological. Gill was educated at Bristol Grammar School where he distinguished himself as a mathematician. He was also an enthusiastic member of the School's cadet corps, becoming the senior student officer in his final year. In addition, he was a regular contributor on corps events and activities to the school magazine. (**Figure 1**)

In 1903 Gill went up to Christ Church, Oxford to read physics, having won a scholarship (then known as an exhibition). Three years later he achieved a first-class pass and proceeded to complete his BSc. In 1909 he was appointed to the staff as a demonstrator (what we would call a lecturer nowadays) in the Electrical Laboratory and was made a Fellow the following year.

The First World War

Very soon after the outbreak of war Gill offered his services to the Army. But they rejected him as being too old for a commission. He was then 31. Undaunted, and certainly uncomplaining – for that was his way – he immediately took himself to the nearest recruiting office and signed on as a private soldier. The outfit to which he was allocated turned out to be a territorial cyclist battalion and along with his fellow cyclists Gill was sent immediately to defend the Isle of Wight. Apparently this unlikely destination was seen by someone in London as the part of England most likely to be assailed by the invading hordes from the Kaiser's Army. Rumour had it that almost every German tourist who had enjoyed the delights of the island over previous years was in fact a spy and therefore the island, obviously mapped in the finest detail, was the target and the invasion was seen to be imminent. Sergeant Gill, for he had been promoted with rapidity when it was realised that he was a man of some intellect, was charged, along with his men, of fighting off the assault. To do so required them to dig trenches.

For this information of the beginnings of Gill's military career, and for much else about how it turned out over the next four years, I turned not to his service record buried within the bowels of the National Archives but rather to a delightful little book, a mere 90 pages, which he wrote in 1934. Called *War, Wireless and Wangles* [1] it tells the story, in frequently hilarious fashion, of the way all armies go about fighting a war, at least as seen through the eyes of the soldiers a very long way removed from the military potentates at the top. The book also contains a number of wonderful cartoons drawn by Ruth Mary Wood. As will be seen, they much illuminated Gill's prose. (**Figure 2**)

Gill viewed those about him, and especially above him, in uniform with a quizzical eye. It was clear that the Army worked in a rather different way to those who inhabited the colleges and corridors of Oxford. But he adapted and found much to amuse him. Nothing

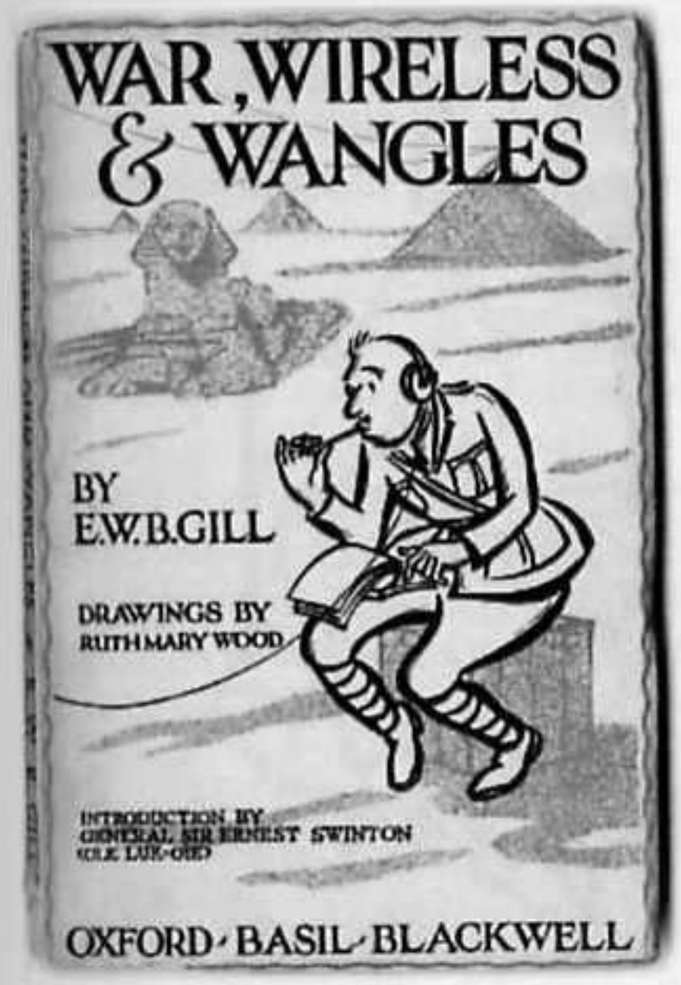
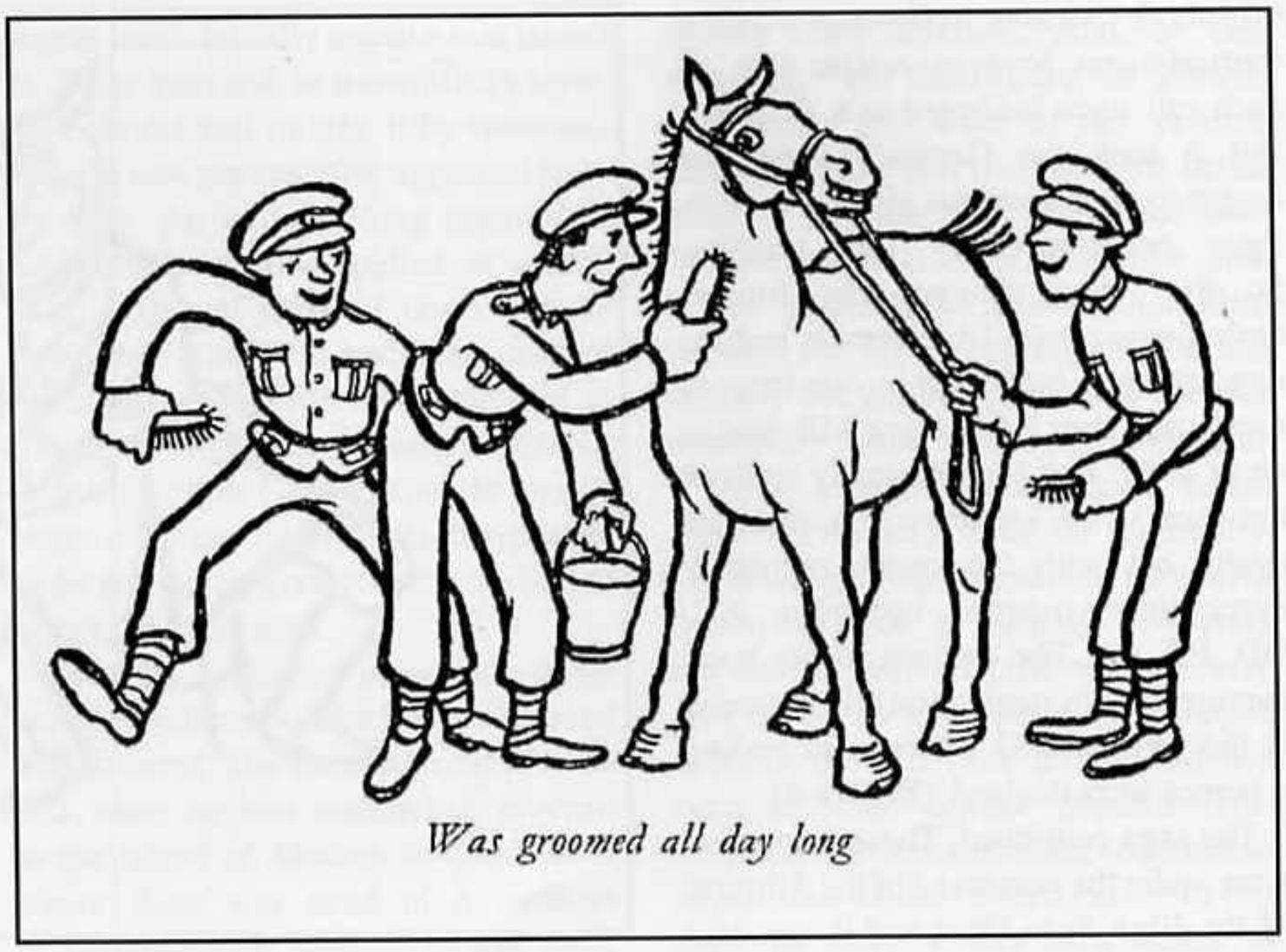


Fig.2. The cover of E. W. B. Gill's most amusing account of his service during the First World War



Was groomed all day long

Fig.3. Multiple grooming of a Heavy Artillery beast of burden

the Army did necessarily followed the logical route but its purpose was generally well-intended. There were, however, occasions when the system unravelled and what then followed often descended (or possibly ascended) into the realms of pure comedy.

Commission

By December 1914, the Army realised that men of Gill's calibre were not necessarily in abundant supply. A letter from London informed him that he was to be offered a commission in the Heavy Artillery and he was ordered to report to Woolwich. There he found himself among a varied group of other educated men whose purpose, they were informed, was to become experts in the art and science of firing those heavy calibre weapons. Unfortunately, at that early stage of the war, Woolwich had no guns. But since the guns were towed into battle by horses, the Royal Artillery officers were all, supposedly, required to be accomplished horsemen. But Woolwich had no horses either. However, when the first specimen of that breed arrived, Gill and his officer colleagues had by then become most accomplished grooms and they were itching to put theory into practice. That lone animal soon outshone any other within a considerable radius. (**Figure 3**)

As always within the military, courses of instruction were plentiful and Gill attended many. Those that particularly intrigued him were on the more technical subjects where he had some competence, of course, but where, as he put it, "it was regarded as being unsoldierly" to make much play of that. He also discovered that one's level of knowledge, on any matter, followed directly from the rank one possessed. He cited an example to illustrate this. No one under the rank of major could be allowed to speak of the atomic theory; colonels might mention radio activity; but only Field Marshals could cope with Einstein.

Hush Hush Wireless

After about six weeks at Woolwich Gill was again on the move, both physically and regimentally. He was informed that there was a particular need for men who understood wireless and since wireless involved a fair bit of physics Gill seemed admirably equipped. He was, therefore, transferred to the Royal Engineers who, in those days, through the auspices of their Telegraph Battalion were responsible for all manner of signalling within the British Army. But of even more importance to the Army was the fact that wireless was proving itself to be a powerful weapon in its own right on the battlefield.

Intelligence, military intelligence – a term that sometimes causes confusion – was ripe for exploitation. And naturally it was classified top secret. As a result we learn little about the technicalities involved; Gill makes it clear in his book that the Official Secrets Act still hung over everything to do with the war, even two decades later when he sat down to record his memorable account. But we now know many of those details thanks to the considerable passage of time and the huge strides made in the electronic art: the equipment of Gill's day, carborundum crystals and coherers, spark transmitters and the earliest of thermionic valves have, fortunately been preserved in museum collections, there to be studied in detail.

The wireless equipment used by the opposing sides in the conflict was manufactured, by and large, by two companies, Marconi's in England and Telefunken in Germany. Its use in battle, and by the supporting arms, was naturally under the control of the respective military authorities themselves. And this is where the military mindset played a not inconsiderable part. Gill was characteristically frank about this when describing the approach of the German military to the use of codes and ciphers: "Nobody could desire more admirable opponents for this class of work", he wrote. "The orderly Teutonic mind was especially suited for deriving schemes which any child could unravel". He gave an example. The wireless call signs of all Zeppelin airships early in the war consisted of two letters beginning with L. Thus, LA, LB, and so on consecutively. It did not

take those listening to German wireless transmissions long to realise that all such call signs belonged to a Zeppelin. But it took the Germans somewhat longer to appreciate the glaring security lapse occasioned by this practice. So they then changed the format. Orderliness prevailed, however, and the new sequence moved on by one letter in every case, thus LA became MB, and so on in order. And then, to really confuse the enemy, the sequence was changed again, but with clockwork regularity every three months, becoming NC, OD, PE, etc. The cartoon in his book captures Gill's perception of the scene at the German HQ where such coding schemes were devised. (**Figure 4**)

The saga continued. Those Zeppelins were under the command of the Admiral of the High Seas Fleet and it was laid down in naval standing orders that every Zeppelin, once aloft, would report its position to the Fleet on the hour, every hour. And this they duly did. Once again British intercept stations, backed up by wireless direction-finding equipment, monitored these regular reports and thereby they knew, almost instantly, the identification and position of every Zeppelin long before these craft even crossed the British coastline.

Gill told of numerous other instances of poor radio practice by the Kaiser's wireless operators, and particularly his senior staff. The intelligence gained was always useful, sometimes significantly so. He attributed much of these German shortcomings to what he called "a master move of superhuman cunning" on the part of their British adversaries. It concerned the visit to England, shortly before the outbreak of war, by the renowned German wireless expert Baron Egbert von Lepel. One of the places the Baron visited was the army experimental wireless station at Aldershot. According to Gill the station was filled with the most amazing collection of antediluvian junk ever seen outside a museum. He concluded, therefore, that von Lepel, on viewing this array of British wireless technology, must have convinced himself that there was nothing to fear from the British Army's wireless intelligence.

Fig.4. Devising schemes which any child could unravel

To Egypt And The Med

Much to Gill's pleasure he was informed, early in 1916, that he was to be posted to Egypt as the wireless expert with an intelligence section soon to be established in that theatre of operations. Gill, of course, never referred to himself in such terms but to those around him he was undoubtedly a man of much competence. After a brief period of orientation in Alexandria, where he encountered his commanding officer, an Irishman brimful of enthusiasm as well as more hare-brained schemes in a week than most people have in a lifetime, Gill and his C.O. set sail for Cyprus. Their purpose there was to establish a wireless direction-finding station by erecting the four-masted Marconi-Adcock aerial system that had been adopted by the Army following its initial success when operated by the RE in France. This, presumably, was the same equipment that was used to follow the well-announced progress of the Zeppelins as they advanced ponderously on England.

As well as being responsible for the technicalities of the D.F. stations, Gill was also in charge of the setting up of wireless monitoring stations wherever they were required. At that stage in the development of the art of radio communications, most of the receivers used one form of crystal detector or another; very few had advanced to the point of being equipped with valves. As a result their sensitivity was limited and so the aerial or antenna (as you please) had to be a substantial length, and usually vertical in orientation, given that only low frequencies (some hundreds of kilohertz) were radiated, which generally implied propagation via the ground wave. Achieving adequate height was always a challenge and many were the calamities when the home-constructed wooden masts, built under the direction of the Irish C.O., frequently collapsed during their erection phase.

To add to the consternation of the man in command, he always insisted that the full complement of his staff should attend the erection ceremony, regardless of how early in the day this should occur. Their mirth, when the structure frequently returned to earth somewhat precipitately, could hardly be suppressed. Gill, having witnessed such events more than once, was always on the lookout for other, less rickety, means of support for the single wire of the aerial. And he discovered one that met his purposes admirably. The Great Pyramid at Giza, constructed as it was of exceedingly dry stone (given its age), and being of considerable altitude, would make the ideal support with the inclusion of just a short pole at its apex. This he arranged and on the C.O.'s return from some foray or another, Gill informed him that he had discovered the ideal structural support for the aerial wire amongst the (almost) natural landscape of Egypt. Naturally, given his wide knowledge of the arid and treeless desert that extended forever in almost every direction, the man in command was somewhat sceptical. But before he could accuse Gill of attempting to take the rise out of him his

subaltern pointed him in the direction of the Pyramid and there he saw a most admirable semi-vertical wire of considerable length. Its termination was the single-valve receiver – a rarity – that was accommodated in a building known as the Palace, at the foot of one of the wonders of the world. (**Figure 5**) As an indication of how well this particular antenna worked, Gill noted that the one-valve receiver picked up the transmissions of a Zeppelin over England. As he said, this was "no mean feat in those early days of wireless".

Mosquitoes And Matelots

From Cyprus, Gill travelled to Salonika (the present day Thessalonika) to take charge of the intelligence wireless station there. He, rather like St. Paul before him, wasn't too impressed with what he found, but unlike the apostle who didn't tarry but "contended himself thereafter by writing epistles to the inhabitants", Gill's physical presence was needed. However, a rather more pressing issue even than wireless intelligence was the concern about the likelihood of his Majesty's soldiers contracting malaria. The swampy nature of the surrounding countryside and the swarms of mosquitoes that inhabited it made this a distinct possibility. Help, though, in the form of the R.A.M.C. was at hand. Initially quinine was issued to all the men and, in true military style, they almost had to take it by numbers. Then, a new preventative appeared from on high. An evil smelling grease-like substance was to be applied, at sunset, to all exposed parts of one's person. After this procedure had been enacted for a few days, Gill was interested to overhear the regimental sergeant major enquiring of the C.O. whether he should remove the mosquitoes which appeared to be eating the grease in the tin before issuing it to the men.

Salonika continued to provide many similar challenges, which Gill observed with interest. His stay there came to an end when he was ordered to proceed to the island of Mudros in the Aegean where there was need of a wireless direction finding station. It was there that he encountered the Royal Navy in the form of an admiral and discovered that not only was the Army, in general, seen by the senior service to be somewhat beyond the pale but Gill, as a mere part-time member of it, was a "ghastly temporary thing the Army had got landed with owing to the necessities of war". However, they reached an accord and Gill set about trying to find the best location for his D.F. station.

As happens when one starts some new venture in the Army, Gill's obvious sense of purpose and energy caused a long dormant Staff Officer to surface, almost from nowhere. And, as Gill observed, "the Staff were, as always, omniscient and were of the opinion that a wireless installation must be on a hill". The site they suggested was, however, almost insurmountable and, as he patiently explained, the ideal location for his sort of installation was actually flat ground. A suitable site was eventually found. It was right alongside a naval establishment which meant more encounters with the admiralty. On hearing of his intentions they were driven to issue a warning. Evidently the site he had selected was the very spot on which a Zeppelin had dropped a bomb the last time an air raid had been mounted against Mudros. This remarkable statement made an indelible impression on the Oxford man. "To this day", he said, "I have been unable to follow it out to its logical conclusion – if any".

Fig.5. The Great Pyramid at Giza photographed during the next conflict when its temporary aerial had been removed. The author's father is aboard the camel on the right

The Cipher Expert

The interception of the enemy's wireless messages was by now becoming a fairly routine matter, as was the fixing of the positions of the transmitting stations by means of the D.F. system. Gill, now back in Egypt, and never one to allow time merely to pass by decided, along with an officer colleague, to have a go at deciphering some of those German messages themselves. And in a remarkably short time they had deciphered a fair number. This, of course, was contrary to all standard procedures where intercepted messages were simply to be cabled to the appropriate War Office department in London. Gill and his colleague therefore expected to receive the proverbial 'rocket' when they announced their success. However, officialdom in London reacted in quite the opposite way, and offered to send out an expert who would inform them of the latest techniques used in breaking German codes. As before, Gill maintained that their success had far less to do with any special skills he might have possessed but, rather, was all to do with the cavalier practices and lack of any real security exhibited by the enemy's coders and telegraphists. However, that experience as well as such skills as he had learnt at the feet of the W.O. expert were to stand him in good stead twenty years later during the next encounter.

By 1918 and the end of World War One Major Gill was in charge of all the

Army's intelligence wireless stations with his headquarters on the Downs near Devizes. Their role had now changed from monitoring the wireless transmission of His Majesty's enemies to monitoring those of all his friends and allies as well. Gill admitted that they were busier than ever. He finally received his discharge from the Army in July 1919 after five years service and a not inconsiderable amount of experience, gathered along the way, of how the Army functions and how the minds of those who inhabit its ranks – from the lowest to the highest – operate.

Achievement

What *War, Wireless and Wangles* for all its highly amusing accounts of army life didn't tell us is what Walter Gill himself achieved scientifically. There is clearly no doubt that, by virtue of his technical leadership, both the art and science of wireless direction finding advanced significantly during the war. Equally one imagines that his close involvement with the equipment, both in those DF stations and in the monitoring stations he set up across the Middle East, would have seen him take a close look at what we would call the 'electronics' nowadays. The thermionic diode was just beginning to take over from the crystal detector while the triode, as both an amplifier and an oscillator, was used in more and more of the more recent radio transmitters and receivers that went into service in the final years of the war.

No doubt matters to do with official secrecy intruded, as he himself alluded to early in his book, but one also knows that Gill, a man of natural reticence, was certainly not given to blowing any trumpets, least of all his own. So we have to look elsewhere to find out more. For his wartime service Gill was awarded the O.B.E. as well as being twice mentioned in dispatches.

An Oxford Don Again

Back at Merton College, Oxford, Gill resumed his research work. Judging by the fact that he and a colleague published what became a very significant paper in 1922 on the special oscillating characteristics of a valve, one must presume that his wartime involvement with those devices provided the impetus for their research. In essence Gill and J. H. Morrell described a form of electronic oscillator in which the frequency of oscillation was related directly to the inter-electrode characteristics of a valve and those of the external circuit connected to the valve [2]. By contrast, at virtually the same time, a pair of German researchers (Barkhausen and Kurz) were working on almost the same problem, but their results showed that only those internal valve characteristics influenced the oscillating frequency. Now since the inter-electrode spacings of thermionic tubes are very small it was not surprising that the resulting oscillations occurred at extremely high frequencies, what we would call microwaves these days.

Both the British and German team's modes of operation could be controlled by the magnitude and polarity of the potentials applied to the valve's electrodes but they were distinctly different and each would prove to be of significance as the quest to produce higher and higher frequencies of oscillation continued. Even today these two distinct modes are known as BK and GM modes in honour of their discoverers. They laid some of the foundations for the remarkable work still to come in the development of microwave devices such as the magnetron. What is also interesting is that Barkhausen was a German signals officer during the war employed in monitoring the wireless traffic emanating from the British lines during the momentous battles across Belgium and France. He and Gill were clearly fellow combatants who went on to make significant scientific contributions in closely associated fields of research.

In 1922 a group photograph was taken of Merton research students and there, in the front row, is Mr E.W.B. Gill, one of their supervisors. This is the only photograph of Gill that seems to exist anywhere in the public domain. He looks enigmatic and remained so throughout his academic and military careers. (**Figure 6**)

Two years later, in December 1924, Gill was involved in assisting with a very significant experiment when he provided laboratory facilities for Edward Appleton and his colleague Miles Barnett. They were there, from Cambridge, to test Appleton's theory that a radio wave transmitted from some distance away could be detected after it had been reflected by an ionised region above the earth's surface. In fact it was a theory jointly propounded some years before by two men, Heaviside in England and Kennelly in the United States, who had independently suggested that such a region might exist and that it would function, effectively, as a reflector of radio waves. The experiment was a success and that discovery led, ultimately, to Appleton winning the Nobel Prize for physics. It also opened the way to world-wide radio communications.

Rebuking Sin

When asked what, if any, hobbies he had Gill always answered immediately and unequivocally. "Rebuking sin", he said. To Gill there was almost no greater offence, both to God or mammon, than cant, snobbery and humbug and he set himself to deflating many a supercharged ego but always in the nicest possible way and always with a good leavening of humour. As an example, he had on one occasion the need to speak to a university colleague by the name of Hartley whose room was in one of the other Oxford Colleges. Gill duly telephoned and when the College porter answered Gill asked to be put through to Mr Hartley. "Oh you mean Brigadier General Hartley, sir", said the porter. "Yes I suppose I do", said Gill. "Would you please tell him that Corporal Gill would like to speak to him?".

Amongst his university colleagues Gill was regarded as something of an institution. To those whose fields of speciality extended no further than the humanities he was seen as a philistine, but then so were all men of science at the 'old universities' in those days. Of course, that view was never tested because Gill just ignored the slur and never felt the need to engage its protagonists in any debate on the matter. Had he done so they might have been surprised to discover that he had endowed a poetry prize to his old school and would soon present an extremely rare folio of Shakespeare to the United States Library of Congress in recognition of America's entry into the Second World War. He was to be seen around the College in his trench coat, with a pipe between his teeth and both beneath a formidably bushy moustache. These traits, as well as good humour and a decidedly Edwardian turn of phrase, set him apart from many. His general practicality had been noted, especially when he had personally set

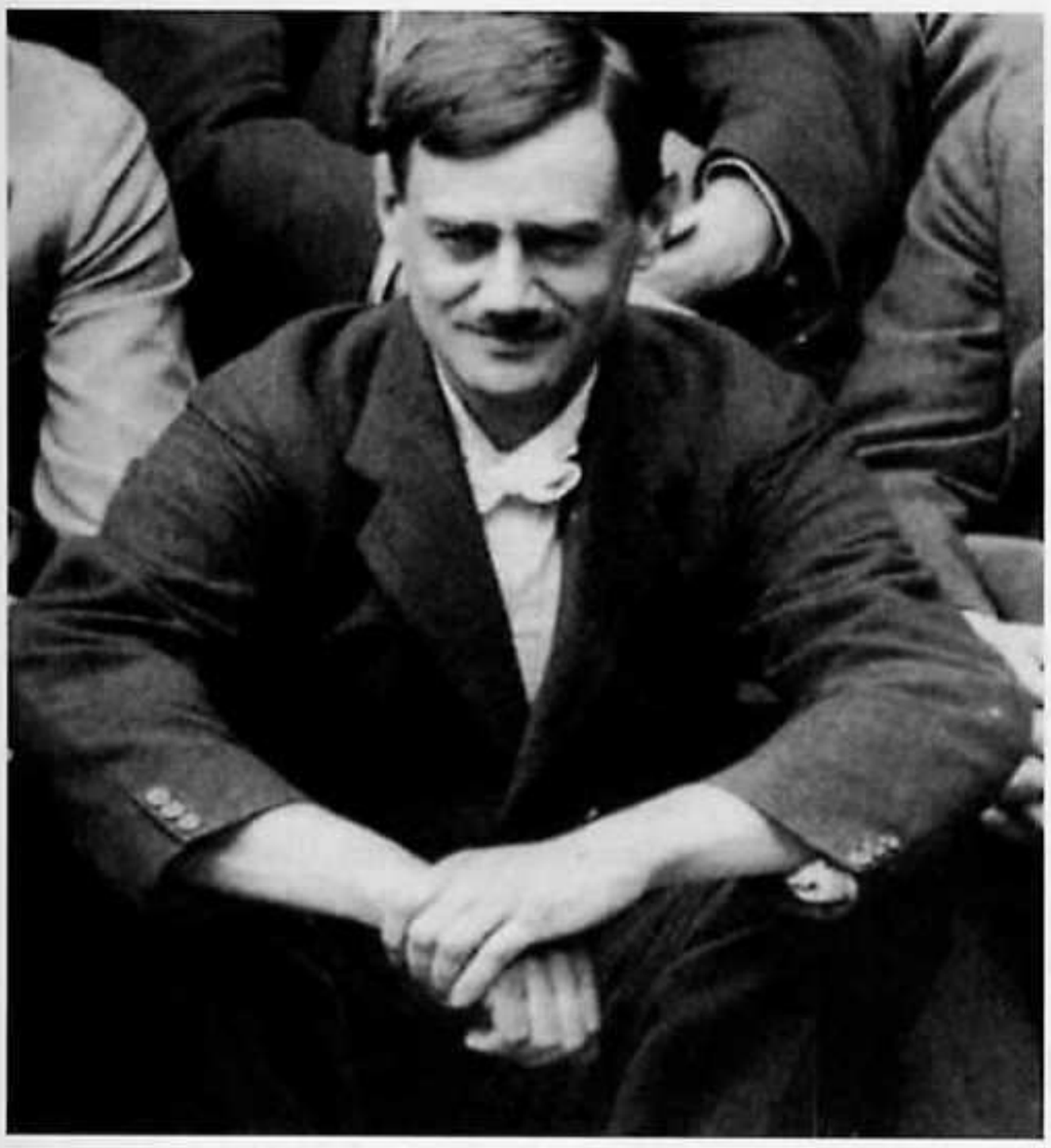


Fig.6. E.W.B. Gill in a photo taken at Oxford in 1922

Fig.7. Hugh Trevor-Roper in uniform during the war

out to drag Merton College into the twentieth century by designing, and having installed, a system of electric lighting for the quad, all driven by a water-powered generator situated in the river nearby.

Clearly in recognition of these many talents, as well as a stolidity of personality that ensured reliability, Gill was made Bursar of Merton, a role he filled for many years. Again there were many good stories told about him, none more so than one illustrating his kindness towards those less fortunate than himself. A research student, who helped with tuition, was paid nine-and-a-half guineas instead of ten pounds, not because Gill was protecting the College coffers, by saving a pittance, but because he wished to keep the student out of the clutches of the taxman.

Once More At War

Within just weeks of Britain declaring war on Germany, in September 1939, Gill offered his services, once again, to the Army. He was, by now, 56 and therefore long past the age where he might be expected to serve. But a scheme initiated by Lord Hankey, when war with Germany appeared inevitable, in terms of which a register was made of all graduate scientists and engineers in the country, identified Gill as a key man. He was appointed head of what was called the discrimination section of the Radio Security Service (R.S.S.), known more officially as M.I.8c, a body charged with tracking down German spies suspected of operating clandestine radio equipment in England.

The R.S.S. members were predominantly radio amateurs who possessed the necessary Morse code skills which would enable them to read the messages being sent back to the Fatherland. That was the theory. In practice it turned out that there were no active German spies in the country, those that had arrived, by various means, had been arrested and 'turned'. The alternative to serving their new masters was an appointment with the hangman. Another task confronting the R.S.S. and the security services in general was that those same spies, or indeed others, were operating so-called head-beacons – radio transmitters sited close to selected key points across England – by means of which they were guiding German bombers to their intended targets. But it soon turned out that none of those beacons existed either; Gill himself deduced that the direction from which the German 'beams', that had been discovered, were coming indicated transmitting sites somewhere in occupied France and Germany itself. This turned out to be correct and all attention was directed towards tracking down those transmitting sites and also to monitor any other radio transmissions from Germany and occupied Europe in general [3].

In Jail!

Gill occupied a cell at Wormwood Scrubs jail in London during the period but he was not incarcerated there! The intelligence service M.I.5 had taken over the jail, having transferred its regular inmates elsewhere, and so the 'Scrubs' became part of the intelligence machinery then gaining momentum. Sharing a cell with Gill was another Oxford man, a history don by the name of Hugh Trevor-Roper. (**Figure 7**) Though even more different in make-up, background and academic pursuits as chalk could ever be from cheese, Gill and Trevor-Roper not only got on well together but actually liked each other.

Gill had recruited Trevor-Roper to join him in the R.S.S. because he knew of the historian's abilities and also his familiarity with Germany and its language. Both could well be useful when tackling German codes [4]. But it was not the R.S.S.'s job to decipher anything. Their mission was to receive the radio traffic and then, after Gill and his team had done an initial analysis of it, based on both direction-finding information that indicated its likely geographical origin, the message format, and the operator chat that was a common

feature of German radio operating, to pass those messages to Bletchley Park. That casual communication between German radio operators turned out to be crucial in identifying the sources of those radio signals. Gill put it all very succinctly: "... the downfall (of the German system) was due to the habit ingrained in the Hun by an all-seeing Providence of sending the same message twice in different ciphers ..." [3]. He had encountered exactly the same tendency during the previous war and had commented upon it then [1].

Gill followed procedures and forwarded to B.P. the messages as they came in from the R.S.S. radio amateur operators scattered about the whole of the United Kingdom. But the code-breakers at Bletchley, already heavily loaded with so much raw material to work on, rejected Gill's offerings as being of no importance. This did not satisfy Gill or his willing assistant Trevor-Roper and since they happened to share a flat in Ealing they took those messages home with them at night and set about cracking the code themselves. We must remember that Gill was no stranger to code-breaking. They succeeded in a very short space of time and from their content it was clear that these messages had originated from within the Abwehr, the German military intelligence service. They then succeeded in breaking the next four messages that had reached the R.S.S. from the same sources. Their commanding officer, Col. Worlledge, was as delighted as they were when they presented him with the news and in December 1940 Worlledge told Trevor-Roper to write a report for circulation further up the chain of command as well as to other agencies such as M.I.6.

At this point Gill's presence was requested elsewhere – and with some urgency too. It transpired that at this early stage in the radar war there was an urgent need for more personnel trained in the radar art so that they could assist in the manning of radar-controlled anti-aircraft batteries. Gill was ordered to return to Oxford to establish there such a radar training school. Meanwhile Trevor-Roper's report, on reaching M.I.6, produced what he termed "an explosion" and its author was threatened with a court-martial [5]. This was more an indication of the almost internecine struggle then going on between those two arms of Britain's security services, M.I.5 and M.I.6.

Closer to the ground relations between B.P. and the R.S.S. were soon mended and B.P. set up its own section under Oliver Strachey (the brother of Lytton) to decipher these Abwehr codes under what became known as I.S.O.S. (Intelligence Service Oliver Strachey). The R.S.S. was told not to involve itself further in that activity. The R.S.S. also underwent a shake-up in its personnel. Col. Worlledge went into retirement while Gill, who knew nothing about the row that had broken out, was dismissed, presumably because Trevor-Roper was working under his direct command. Gill was summarily transferred to the Royal Signals Training Centre at Catterick. He was also demoted in rank to captain. Trevor-Roper survived.

Operational Research

Gill being Gill made no comment to anyone about this shabby treatment and he certainly didn't commit his thoughts to paper. But Trevor-Roper did. Many years later he wrote as follows: "The real genius of the affair, Major Gill, was also deliberately overlooked. Left to find other employment he became a radar officer and an expert on captured German equipment. Under the new regime (in the R.S.S.) his name was never mentioned. Although I don't think he would have found himself at ease among the self-important mandarins of S.I.S., the manner of his exclusion seemed to me rather shabby. After all, he had thrown them a lifebelt which, after they had run their ship aground, had enabled them to be winched to safety. And afterwards, on dry land, to congratulate themselves on what they would claim as their achievement" [5].

Quite what Gill did at Catterick we don't know because it too wasn't recorded anywhere. Apparently he remained there for the duration of 1941, but around Easter 1942 we discover that he had joined the Army Operational Research Group (A.O.R.G.) in Roehampton, then under the command of Col. (later Brig.) Basil Schonland. How this came about we do not know. But since the Royal Corps of Signals was well-represented in the A.O.R.G., with a number of its officers occupying senior posts, we must assume that word reached Schonland's ear about Gill's existence and his academic and military pedigree and so his transfer to Roehampton followed forthwith.

Gill, with his rank of major restored, took up a post in a section known as A.O.R.S.3 responsible for 'Signals in the Field'. As the name implies, this was a broad area covering all aspects of the Army's communications and especially those that had been problematic or were likely to be so as the various theatres of operations changed from the deserts of North Africa, to Europe and ultimately to the Far East. Fortunately, both for posterity and for historians of this rather arcane area of military science, the A.O.R.G. required its section heads to write reports on their activities during the conflict. In November 1944 Gill duly wrote his and it is invaluable especially as it caused this most self-effacing of men to disclose some of what he, personally, did [6].

Signals In The Field

As one might expect, army communications while at war is a vast subject in its own right. The A.O.R.G. was called in when there were problems. During the three years he spent there, Gill became immersed in many of them and his report provided brief summaries of the issues involved, the background and the solutions (if any) that he and his colleagues came up with. A detailed account of all this was published recently [7] and so it will not be repeated here. However, there were two really significant contributions that Gill made, as well as an extremely novel piece of research that he conducted and published soon after the war, that are worthy of a brief look.

Possibly the most important experimental investigation he carried out was in comparing the relative effectiveness of HF and VHF radio communications when used by an army on the move. It had long been established practice in the British Army that all its short-range communications would take place using frequencies at the lower end of the HF band where propagation would be via the ground wave.

Since all antennas, whether mounted on a vehicle or on a man's back, were short vertical rods, they were well-suited to this mode of propagation where the signal effectively follows the contours of the ground. But its rate of attenuation is fairly high unless low frequencies are used. And this requirement immediately posed problems because those short antennas are extremely inefficient at such long wavelengths. However,

there was apparently no alternative, at least as seen in the 1930s when this Signals doctrine was laid down. VHF, at frequencies above 30MHz, was not an option then because suitable equipment did not exist and – most importantly, given the state of knowledge at that time – VHF was seen to suffer from the same limitation as light: it only travelled in straight lines and so obstacles in the path, and the curvature of the earth, would render it useless over practical distances. So the British Army went to war in 1939 with virtually no VHF equipment at all and many problems ensued.

After Professor John Cockcroft's visit to the United States as a member of the famous Tizard mission he arranged for the delivery to the A.O.R.G. of a couple of SCR-610 VHF (27 – 39MHz) sets for evaluation. Gill admitted that, initially, he was as sceptical as everyone else about the suitability of VHF but he then read a report originating from the Admiralty Signals Establishment which showed that VHF communications were possible over distances of 40 miles at sea. This was well beyond line of sight. To satisfy himself he immediately took the '610 sets to the Bristol Channel were he confirmed that this was indeed the case. With his curiosity well and truly aroused he then visited the police in Birmingham who, it was reported, had been using the much higher frequency of 100MHz with much success within the heavily built up city. And there he witnessed its excellent performance once again.

A full-scale trial was clearly required to compare the performance of the VHF equipment with the HF sets then in use by the Army. To do this he chose a variety of terrain from open countryside and dense woods of Somerset to the mountains of the Lake District and even Mount Snowdon in north Wales. Again the results, contrary to all expectations, showed that very reliable communications were possible at VHF despite the irregularity of the propagation path. In his subsequent report, released in August 1943 [8], Gill argued strongly for the adoption of VHF equipment. Not only had his tests confirmed both the American experience and that of the Royal Navy and the Birmingham constabulary, but VHF was vastly superior to HF for other important reasons too. It could accommodate far more communications channels; in addition there was an almost complete absence of noise and next to no interference. Finally, and most importantly, transmission security was far better than at HF where the possibility of sky wave propagation over considerable distances always existed. Though signal strengths at VHF were likely to be lower, the signal-to-noise ratio – always the deciding factor – was much higher. It was therefore indisputable: VHF won hands down.

But the wheels at the War Office turned exceedingly slowly. It was a year before Professor Edward Appleton's committee responsible for such matters took a decision – and then it was to call for another series of trials comparing VHF with HF! This astounded Gill and he wrote forthrightly about it in his report at the end of the war. "It is scarcely surprising that after such a length of time the whole point is now being missed. There is not the slightest reason for a competition between HF and VHF". He continued, "If future generations want an instance of how not to treat scientific work they cannot get a better example than the above. Nobody claims that scientists are always right, they make mistakes like other mortals, but the VHF matter was perfectly clear cut."

The Final Word In Aerials

Though a convinced protagonist for the use of VHF in relatively short-range applications, Gill was also involved in improving the performance of HF systems. His analysis of the behaviour of an end-fed wire antenna in relatively close proximity to the ground, established, possibly for the first time, the criteria that determined its performance in high-angle, short-range HF communications. In a previous article in *Radio Bygones* [9] I described his work in this field in some detail so won't revisit it here. However, it is important to appreciate that in doing this work Gill displayed a feature of his make-up that was so evident throughout his scientific life: a thorough understanding of the physics that underpinned whichever problem he tackled.

In August 1944, when writing to Brigadier Schonland who was now on Montgomery's staff in 21 Army Group, the new superintendent of the A.O.R.G., Col. Omond Solandt, informed his predecessor of Gill's progress. "Gill thinks that he has found the final word in aerials – a low inverted L – will send you details. I believe the Australians have been using it in New Guinea." To which Schonland replied, "send the details soon". The date is significant. It was just a month before the fateful battle for the bridge at Arnhem when poor wireless communications was just one of the problems that confronted the British Army. As I related in [9], where horizontal wire aerials were used during the battle, particularly by the artillery and by that enigmatic group known as Phantom, communications were effective. But the short rods on the Army's Jeeps and on men's backs were decidedly less so. The low powered wireless sets and the ground-wave attenuation took a serious toll.

Measuring The Ground Constants

Gill's only publication in the scientific literature on any aspect of his wartime work appeared in the *Proceedings of the IEE* in 1949 [10]. It was a paper that dealt with a very clever and most unusual method of measuring the electrical conductivity ó and relative permittivity ε_r of the ground. Such numerical values are important because they have a direct bearing on the effectiveness of ground-wave propagation. The measurement technique effectively allowed the so-called bulk values of those quantities to be calculated rather than the values obtained at specific places (and depths) which would be given by the measurement of soil or rock samples in the laboratory. It was therefore considerably more useful because the numbers that resulted were a measure of the electrical characteristics of a large area of ground, both laterally and to some depth. By contrast, methods based on laboratory samples are essentially meaningless.

The technique involved measuring, in two stages, the voltages induced in two short tilted wire aerials, one aligned accurately in the plane of an advancing radio wave and the other at right angles to it as indicated in **Figure 8**. By adjusting the height of each tilted wire above ground level it was possible to vary the angles between the wires and the horizontal plane. Then, by using the mathematical relationships between the various quantities involvement and

some careful graphical plotting, it was possible to determine the values of conductivity and relative permittivity of the ground of the test site and at some selected test frequency.

In the actual experiments conducted by Gill and his colleagues, he used a standard Army wireless set, the W.S. No. 38 that operated on any frequency between 7.3 and 8.8MHz. Since the 38 set contains no means of displaying the magnitude of the received signal Gill relied on his ears. It turned out that the human ear is remarkably sensitive to very small changes in audio signal strengths so, by modulating the transmission with a particular tone, it was possible to adjust the angles of those wire aerials very accurately to cause equal signals from the 38's headset.

Conclusion

E.W.B. Gill was almost the antithesis of a conventional Oxford don. He abhorred snobbery and deflated many a swollen ego by his impish, though perceptively barbed, humour. He was also the most self-effacing of men. This latter personal trait has meant that so few people – even those with an interest in military radio history – have ever heard of him and his achievements in both world wars. That one man, already regarded as being too old for military service in WWI, should make significant contributions to wireless communications and intelligence, not just in that encounter but in the next one as well, is remarkable.

In the words of one of his obituarists, he never received the recognition he deserved either as a scientist or for his work in the administration of the University. In the Army his good humour and taciturn approach to life's 'situations' made him seemingly impervious to the military's interminable bureaucracy and occasional personal slights. At least there his service was recognised by the award of the OBE and two mentions in dispatches to boot. ***RB***

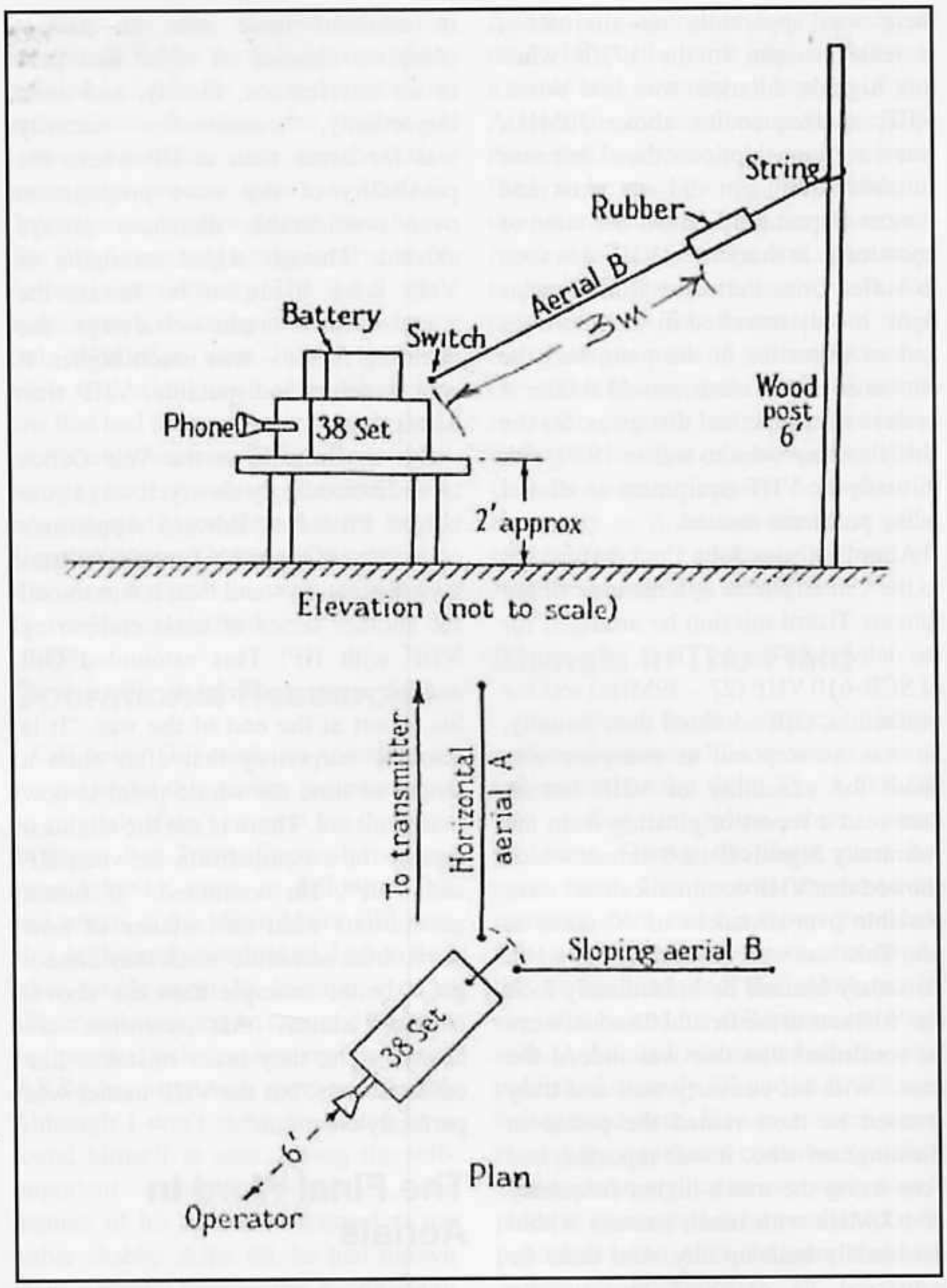


Fig.8. The test set-up for measuring electric field strengths (from Gill's IEE paper)

References

1. E.W.B. Gill, *War, Wireless and Wangles*, Oxford, Basil Blackwell, 1934.
2. E.W.B. Gill and J.H. Morrell, *Short electric waves obtained by valves*, Philosophical Magazine, 44, 269, 1922.
3. E.D.R. Harrison, *British Radio Security and Intelligence, 1939-43*, English Historical Review, Vol.124, No.506, 2009.
4. A. Sisman, Hugh Trevor-Roper: The biography, Weidenfeld, 2010
5. H. Trevor-Roper (Lord Dacre), *Sideways into S.I.S.*, 1994, available at **http://www.zamboodle.demon.co.uk/R.S.S._old/htr-sis.htm**
6. E.W.B. Gill, *Work on Signals and Jamming: AORS3*, RMCS Reports Section R/81/517, Nov. 1944.
7. B.A. Austin, *EWB Gill – Taking Wireless to War*, The Journal of the Royal Signals Institution, Vol.29, No.2, 2010.
8. E.W.B. Gill, *The relative merits of HF and VHF for short-distance communications*', AORG Memorandum No. 144, Aug. 1943.
9. B.A. Austin, *End-Fed Wire Antennas, NVIS and the Battle of Arnhem*, Radio Bygones, No. 127, Oct./Nov. 2010.
10. E.W.B. Gill, *A Simple Method of Measuring Electrical Earth-Constants*, Proceedings of the IEE., Vol.96, pt.3, 1949.