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British World War I Wireless Intercept Station

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THE A.W.A. REVIEW

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THE COVER:
This British WW I wireless intercept station is being operated by a corporal in the Royal Engineers who is transcribing a message from a one-tube receiver. It was pictured on a postcard noted as "Roundway Down, Devinzel, 1917." It is one of the many intercept stations pictured and described in our lead article: RADIO SPIES: EPISODES IN THE ETHER WARS by Bart Lee, KV6LEE.

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All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.
The Marconi Room of the Olympic as seen during her maiden voyage in June, 1911. In this volume, Parks Stephenson who is a member of the Marine Forensic Panel, contrasts the apparatus on board the Titanic with that on the Olympic in the light of the recent photographic exploration of the radio room on the Titanic.

The Rogers model 200 was a 7-tube TRF receiver (5 tubes plus 2 rectifiers) that cost $395 (Tubes included). It is one of the many Rogers radios described and pictured in the article by Maurice Chaplin which traces the history of this pioneering Canadian company.
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FOREWORD

For 2002, the Antique Wireless Association is proud to present Volume 15 of the AWA Review. This volume represents an attempt to link the articles in the Review more closely with the papers and exhibits at the annual AWA Conferences in Rochester, NY. Three of the four articles are based on papers or exhibits at past conferences. We hope that the Review will act as a showcase for some of the excellent material presented at the conferences and that it will motivate people to attend and make scholarly presentations. The fourth article, although not based on a conference presentation, is particularly timely since it reports on the Marconi Wireless Apparatus on the Titanic as revealed and confirmed by the latest photographs of the radio rooms on the wreck. Each of our authors has carefully researched the material in their papers and we hope that this volume will be a valuable technical resource for collectors and historians.

The lead article was written by Bart Lee and it describes in well-illustrated and documented form, the role that wireless interception has played from the first days of wireless communication to the present. This is an exceptionally thorough and far-reaching paper and it is based on his 2001 AWA Conference presentation. Bart played an extremely important role in the amateur radio communications networks during the 911 tragedy and his expertise is revealed in this article. It is entitled: RADIO SPIES: EPISODES IN THE ETHER WARS.

The second article was written by Parks Stephenson who has been carefully researching the exact configuration of the Marconi wireless apparatus used on the Titanic. His research has recently been supplemented by actual underwater photographs of the radio rooms which show that her apparatus was quite unlike that of her sister ship. His article is entitled: THE MARCONI WIRELESS TELEGRAPH APPARATUS IN R.M.S. TITANIC CONFIRMED BY OBSERVATIONS OF THE WRECK.

The third article was written by George Freeman and it is based on his exhibit at the 2001 AWA Conference. He has documented the Radio and Seed Business of Henry Field and others who turned out to be both excellent businessmen and radio pioneers. It is entitled: SOWING SEEDS: GROWING AMERICA'S BROADCASTING SYSTEM.

The final article was written by Maurice Chaplin and it is based on his presentation at the 1983 AWA Conference. Bob Murray was able to obtain a copy of his original presentation but found that the original pictures could not be located. Bob arranged to obtain and/or take new photographs to illustrate the article and he edited the material for publication. The title of this paper is: "JUST PLUG-IN - THEN TUNE IN" - THE FIRST COMMERCIAL LIGHT-SOCKET OPERATED RADIO RECEIVERS FROM ROGERS RADIO LTD., TORONTO, CANADA.
The CUMULATIVE TABLE OF CONTENTS at the end of this volume allows readers to see the title of every article in every volume of the AWA Review since it began publication in 1986. This makes it easier for historians and collectors to search for relevant articles and to order copies of the back issues from AWA.

Since some of the back issues of the Review are out of print, AWA offers the out-of-print volumes on CD’s. Only the out-of-print issues are available on CD’s at present but future plans call for all volumes to be made available in this format. Storage of the early volumes is a problem for AWA and CD’s are much easier to store and ship. Future plans call for allowing the printed volumes to gradually become exhausted and to replace them with the CD’s. For information about these CD’s please visit the AWA website at: http://www.antiquewireless.org

Special thanks go to Bill Fizette who somehow found time to edit, produce, and/or oversee all of the volumes of the AWA review. Every one of them is an outstanding achievement combining his skilled editing and layout with his choice of excellent authors.

Thanks also to all of the authors who worked with me to try to make their papers as complete and accurate as possible. We have jointly tried to present the material in a logical and readable format and your comments are welcome.

Tom Perera: Editor
RADIO SPIES: EPISODES IN THE ETHER WARS

Bartholomew Lee
KV6LEE - xWPE2DLT

Introduction: Telling the Story of Radio Interception for Intelligence Purposes

Radio's virtue as a broadcasting medium, that many may listen, is exactly its vice as a means of communication. From the early days of wireless telegraphy, radio's inability to avoid attentive ears has given rise to dramatic consequences. In political, diplomatic, and especially military contexts, the senders of certain messages want to keep secret from discovery not only the content of the messages, but indeed often the existence of the message traffic itself. Conversely, and especially to those for whom it is not meant, that traffic may be a matter of life or death.¹

The forces of good fought the forces of evil in many of the contests of the last century. It is, however, not the purpose of this paper to make those judgments, which history itself has made. Rather, this paper seeks to tell some of the stories of the work of radio interception through the end of the Second World War. That work, that has gone on now for nearly a century, includes startling events and some remarkable episodes, many of which are little known. Radio also played important roles in covert action and irregular warfare, especially as a source of intelligence about occupied territory, also thereby giving rise to special intercept challenges.

Radio intercept operators, largely unsung heroes, not of combat so much as of discipline, did the work of monitoring the ether. Much of that work remains "secret" and it has been done by similarly situated Americans, British, Australians, Germans, Japanese, Russians, Poles and many others. They have tuned their radio receivers all over the world for nearly a hundred years, often subject to all the risks of war, often in appalling conditions, often for impossibly long shifts, often without relief for weeks, striving for perfect copy of enemy traffic. Inasmuch as these signals were rarely sent in plain language, the intercept operators could almost never understand the traffic they took down. They knew only that the signals came from an enemy and that they put their countrymen in deadly peril, and they did their duty.

¹To use a cold war example, U.S. spy satellites monitored the automobile radio telephone traffic of Moscow for several years, gleaning much valuable intelligence from the conversations of the elite of the Soviet Union, including the Russian Premier and the Politburo. [3]

More recently, the "Echelon" program of the Anglo-American alliance of intelligence agencies monitors email and data traffic world wide. It is, of course, illegal for American intelligence agencies (as opposed the F.B.I.), to spy on Americans domestically, so that task has long been delegated to the British, who share the take. "The more things change..."
The radiomen on both sides of many conflicts earned the respect due worthy adversaries. It is from this perspective that this paper will relate the work of the intercept corps that has been so important in this century of conflict as well as some of radio’s roles in irregular warfare. As Winston Churchill wrote: “This was the secret war, whose battles were lost or won unknown to the public, and only with difficulty comprehended, even now, by those outside the small, high scientific circles concerned. No such warfare had ever been waged by mortal men.” [25]

The First Radio Spies, 1900, and the First Intercept: Suez, 1904
As early as 1900 in the Boer War, the Royal Navy in South Africa appears to have used wireless sets inherited from the Royal Engineers to signal from the neutral port of Lourenço Marques “information relative to the enemy” albeit in violation of international law. [71] This first use of radio for intelligence purposes depended, of course, on the inability of others to intercept the signals, but in 1900, only the British in that part of the world had any wireless capability.

Alexander Popov early on (circa 1895) in Russia used a Branly-style coherer to detect lightning strikes at a distance. This worked because the electromagnetic pulse generated by the lightning rendered the coherer’s filings conductive, permitting a signal bell to announce the strike, otherwise unseen or heard. With the development of wireless communications by Marconi and others in this period, Popov quickly turned to communications circuits. He installed such a wireless set on a grounded Russian battleship in January, 1900. The success of this and related salvage and rescue work persuaded the Russian Navy to install wireless sets on many of its ships. In early 1904, the Russian fleet prepared for war with Japan. The British then had the opportunity to intercept Russian naval wireless signals:

“An intelligence report on signals intercepted by HMS Diana at Suez shows that the rate of working was extremely slow by British standards, while the Royal Navy interpreters were particularly critical of the poor standard of grammar and spelling among the Russian operators.” [71]

The apparatus on HMS Diana in 1904 was likely not Marconi-made, but rather the work of Royal Navy wireless pioneer Captain H. B. Jackson, judging by the data on Royal Navy installations of wireless gear in this early period. [71]

The Japanese Enter the 20th Century with the First Wireless Combat Intercepts and Others Follow Their Lead
The Japanese undertook the earliest combat wireless interception in the Russo-Japanese war of 1904. Lee De Forest had equipped a news gathering vessel with his new system which was capable of working a post in China from as far away as Nagasaki, Japan. The Japanese Navy monitored these transmissions for what information they could derive from them, but eventually shut the operation down. [30] The Japanese also monitored the then primitive wireless capabilities of the Russian Navy [32] (and probably vice versa). [67]

For some of this country’s early efforts, see Bartholomew Lee, America’s Wireless Spies [53]; for World War Two work against Axis spies, see George Sterling, Spies Use Radio, The Radio Intelligence Division In WW II [92] both in Volume 5, Antique Wireless Association Review (1990).
The early success of the Japanese Navy in the interception of Russian messages emphasized the importance of this new technical intelligence. [32]

Jack London as a war correspondent in this conflict sent his dispatches out by wireless. [47] The San Francisco Examiner on April 17, 1904 reported that the belligerents regarded war correspondents as spies for using wireless, under the headline “Wireless is Contraband of War.” [47] The Japanese earned their place in the 20th Century by way of their defeat of the Imperial Russian Fleet at the Battle of Tsushima in May, 1905, preceded by their sneak attack at Port Arthur in February, 1904. [31, 93, 73]

The German Wilhelm F. Flicke, in his 1945 WAR SECRETS IN THE ETHER [35] summarizes military intelligence use of wireless intercepts before the outbreak of World War One. Ironically, nearly a hundred years later, Bosnia and Herzegovina are still in the news.

“During the crises which arose in 1908 between Austria and Italy in connection with the annexation by Austria of Bosnia and Herzegovina all Italian radio traffic on the continent and at sea was intercepted by the Austrians. . . . This proved of great value for Austrian foreign policy. . . . In 1911, when war broke out between Italy and Turkey over Tripolitania and Cyrenaica, the Austrian intercept service had an opportunity, for the first time, to prove its worth in the military as well as the political field. Since the Italians had set up several relay stations between Rome and Tripoli where the first Italian landings were made, the Austrians had a fine opportunity to intercept all transmissions more than once — and therefore very completely. . . . This was the first time in history that the course of military operations . . . could be followed move by move. . . . using technical means at a distance of hundreds of kilometers.” [35]

In these Balkan and Mediterranean conflicts, Austrian intercept services provided political and military intelligence four times in five years. [35]

![Figure 1. Wireless intercept 1911 heightens public awareness; preserved in the Seefred W6EA log c. 1912 [85].](image-url)
Figure 2. The earliest surviving intercept, from the Avalon circuit 1911; preserved in the Seefred W6EA log c. 1912 [85].

Figure 3. Wireless intercept 1911 gets mixed reaction; preserved in the Seefred W6EA log c. 1912. [85].

Figure 4. Charles Apgar 2MN and the receiver he used for monitoring the German station WSL. (Electrical Experimenter, Sept., 1915).

Figure 5. Army horse-drawn wireless set in Mexico 1916. (Wireless Age cover Aug., 1916)
In France as well as Austria, intelligence operations set out to understand peacetime wireless circuits, patterns, traffic and messages, in order to be prepared for war. In France, this task fell to the Duexieme Bureau of the Military General Staff (i.e., G-2), and in Austria to the Evidenzbuero, each feeding the intercepted coded messages to their respective Foreign Ministries. [35]

In 1911, a domestic interception sensitized Americans to the danger and the opportunity that wireless eavesdropping posed. The Los Angeles Polytechnic High School trained boys in wireless operations as schools today train their students in Internet use. The school had spawned some 300 young radio enthusiasts. [85] The nearby Avalon, Catalina Island to San Pedro, Los Angeles circuit was easy pickings. [Fig. 1] One particular message (between the De Forest Los Angeles station, first using call letter “D” for De Forest, and the Catalina Avalon’s station “PI,” earlier “A” for Avalon) [Fig. 11] evidenced a Hearst press conspiracy. [Fig. 2] Three of the boys publicized their interception to the enormous embarrassment of the Hearst interests. [Fig. 3] This was big news at the time. These particular clippings were preserved in the amateur radio logbook of Howard Seefred (6EA), and date from his early interests in radio in Los Angeles in 1908-1912. [85] The Hearst interests had the boys criminally prosecuted by the Los Angeles County District Attorney. This case was, however, ultimately dismissed, but wireless interception and the case received national publicity in Hugo Gernsback’s Modern Electrics, in September and December, 1911. [37]

On the East Coast, Charles Apgar’s 1915 interception from New Jersey [Fig. 4] of the German Telefunken station on Long Island at Sayville, call sign WSL, communicating with Nauen, in Germany, call sign POZ, is well remembered in part from the work of Rexford Matlock, W3CFC (A.W.A.). [60, 53, 14] As early as 1913, Apgar recorded wireless interceptions on Edison disks. In August, 1914, he intercepted German Navy wireless transmissions from Europe using his one-Audion Armstrong regenerative radio circuit. (The low, near zero, sunspot numbers of 1914 would have favored lower frequency propagation). [94] The Navy as well as Apgar listened to the “Nauen buzz” from WSL. The Navy station listened from its location on Fire Island off Long Island in New York and from Station NAA in Virginia. Apgar, however, figured out how to record, and then slow the traffic down to normal speed for analysis. Two decades later the German Military attache in the Embassy to the United States at the time, Franz von Papen, told of the German code to be used in wireless messages “which made it possible to send military information in the guise of commercial messages.” He gave as an example that “60,000 bales of cotton F.O.B. Alexandria” meant 60,000 British troops at Abbeville, France. He complained, however, that wireless communication with Nauen suffered from atmospherics. [70]

By 1916, the U.S. Army had used mobile wireless interceptions inside Mexico to learn from Carranza’s forces the whereabouts of Pancho Villa’s rebel army. [53] [Fig. 5] The U.S. Army, from 1916 through at least 1920, employed a direction finding station manned by three lieutenants in Mexico City to get cross bearings with the cooperation of 10 other stations on the border and one in Maine. [90]

Just before the United States listened so intently to the Mexicans, the Japanese off the West Coast of Mexico grounded their cruiser HIMJS Asama,
accompanied by a fleet of three other cruisers and related vessels for several months ending in April, 1915. The Japanese Fleet had wireless capability and this was an ideal site for eavesdropping on the American Navy operating out of San Diego. [96]

Radio Intelligence Developments During World War I; The World War I Wireless Intercept Services

By 1914, radio communications, or "wireless telegraphy" as these communications were then known, were used by all of the world's military and naval forces. The relationships among frequency or wavelength, power, directivity and range were not well understood. In the beginning, signals officers and commanders in the field and at headquarters rarely took into account the possibility of interception, or deception. The soldiers and sailors of the European nations soon bore the costs of such negligence. The British forced the Germans into the use of wireless by cutting and seizing their undersea communication cables. As noted historian Barbara W. Tuchman put it:

"... from that moment on, Germany was sealed off from direct cable communication with the overseas world, and the burden of communication fell on Nauen, the powerful German wireless station a few miles outside of Berlin. Nothing can stop an enemy from picking wireless messages out of the free air — and nothing did. In England, Room 40 was born." [96]
The British Admiralty, in its Room 40, analyzed the intercepted traffic. [8, 73]

In 1914 British Radio Operators Organized the Royal Navy Radio Intercept Service, Feeding Traffic to Admiralty Room 40 for Cryptanalysis

Maurice Wright became a Marconi engineer in England in 1912 (and was later Engineer in Chief). Wright experimented with the then new triode vacuum tube in a radio receiving circuit in 1914. Two days before the outbreak of hostilities in August of 1914, he copied German Navy wireless traffic. He worked with H. J. Round (later a colleague and supporter of Major E. H. Armstrong after America entered the war). Their circuit details are lost to time, but it was undoubtedly a regenerative configuration, for it "made the interception of long range communications possible for the first time." This was later reported by Peter Wright, Maurice's son, who became a high official in the British Counter Intelligence Service (MI-5). [111]

Working at his lab at Marconi at Chelmsford, Wright realized he was listening to the German Navy. He brought the intercepts to Captain William Reginald "Reggie" Hall of Naval Intelligence which was located in Room 40 of the Admiralty. [73, 111] Hall appreciated the bonanza in his hands, and put Wright to work building a chain of intercept stations for the Admiralty. Wright and Round also developed aperiodic direction finding techniques to track the German fleet. They provided sufficient warning to allow the British fleet to find and engage the Germans on the high seas. In the process, Wright established a clandestine intercept station in Norway in 1915. [111]

The intercept stations set up in this effort were known as the "Y" stations. Marconi receiving stations, British Post Office stations, and an Admiralty "police" station all provided intercepts for Hall's Room 40 code breakers. These stations were soon joined by enthusiastic amateurs. Barrister Russell Clarke and Col. Richard Hippisley had been logging intercepts of German traffic at their amateur
stations in London and Wales. They reported these intercepts to, and then went to work for, Hall. New intercept stations quickly went up on the coast and soon, practically all German naval wireless traffic also found its way to Room 40. [8, 107]

The German high power long wave station at Norddeich provided fodder for the code breakers through the “Y” stations, which soon turned to higher frequency interception as well. [8] In 1915 these intercepts helped the British to win the naval battle at Dogger Bank, [56] and played vital roles in later naval engagements:

“Warned of a new German raid [on England] on the night of 23-24 January, [1915] by radio intercepts, [Admiral Sir David] Beatty’s force made a rendezvous off the Dogger Bank... The outnumbered Germans turned in flight.... the Kaiser, fearful of losing capital ships, ordered his navy to avoid all further risks.” [56]

The direction finding stations working under Round also provided intercepts to Room 40. [8] The directionals tracked U-boats and Zeppelins as well as naval craft. [8] Both of these new weapons had major impacts on the war, but the impact of the Zeppelins was mostly psychological as countermeasures proved effective. [56] A map of Zeppelin movements over the North Sea created through the use of Marconi directionals [Fig. 6] appears nearby. [107] The “Y” station intercepts showed that the 1915 sinking of the Lusitania had the approval of the German high command, despite its denials. [8] In December of 1914, Round took direction finding aerials and 70 foot masts to France for tactical work at Abbeville and Blendecques, and then at Calais and Amiens. [86]

The foremost history of the astonishing success of British intelligence in the First World War concludes: “[the] Y stations made it all possible.” [107]
Room 40 read more than 15,000 secret German messages. [73] The most famous intercept of all was the infamous 1917 Zimmerman Telegram that brought America into the war. Germany promised Mexico it could have back the territory it lost in the Mexican American War, if it would join Germany against the United States. [96] Snatched from the ether by intercept stations and decrypted by Room 40, it enraged Americans, and motivated America to enter the war. [8, 96, 107] Captain Reggie Hall of Room 40 claimed “Alone I did this.” [8]

As early as November, 1914 there had been a call in the British press for the use of private wireless stations to monitor for spy transmissions out of England. [107] While there is no evidence of any wireless transmission of espionage out of England during that war, the demand that the amateur radio fraternity turn its expertise to the interception process was met, and the system that would become so effective in the next war was foreshadowed.

The British Navy successfully intercepted wireless messages on the high seas as well. Signal Officer Charles Stuart of the cruiser HMS Glasgow worked an outstanding feat of code breaking. After the late 1914 battles of Coronel and the Falkland Islands [56], he determined that the German cruiser SMS Dresden would coal at Juan Fernandez Island (Robinson Crusoe’s old second home) off Chile. He managed to discover this solely from deciphering his intercept of one message from the Telefunken station at Nauen. [8] HMS Glasgow was able to interdict SMS Dresden at Juan Fernandez.

In 1917, American Haradan Pratt (later communications advisor to Presidents Truman and Eisenhower) managed wireless communications on the West Coast for the U.S. Navy. In this capacity, he had occasion to use direction finding techniques from Los Angeles and San Diego to locate a German wireless transmitter in Mexico, at Chapultepec near Mexico City. [76] German Telefunken engineers had escaped WSL in Long Island and set up a 100 kilowatt spark transmitter in Mexico for communications with Nauen. [1] In 1918 the British Secret Service sent two agents to destroy the German station in Mexico at Ixtapalpa. This they did by smashing its Audions, and thus putting the German agent Herr Kurt Jahnke out of business. [8] Jahnke reappeared in German intelligence in World War Two. [73].

The success of British Army signals units in intercepting German wireless traffic convinced British commanders that wireless was too dangerous to use. The signals units thus turned almost exclusively to monitoring and intercept work. [107] German Army divisions used spark transmitters with a range of 300 kilometers (km), and reconnaissance transmitters with ranges of 100 km. The German field sets had a range of three km. Their coastal fortresses had high power transmitters to reach ships at sea. The main transmitter at Nauen enjoyed a world-wide range of 11,000 km by 1916. [86] The British, the French and later the Americans had much to listen to.

**Imperial German Army Interception of Russian Wireless Traffic in 1914 Leads to the Decisive German Victory at Tannenberg, Blunting the Russian Advance West**

Germany established an intercept corps in 1914 under the command of Captain Ludwig Voit. It consisted of a radio station and cryptography section located in general staff headquarters. Voit arranged to have his intercept stations
attempt to copy Allied traffic. In 1914, the Russian Army used wireless to coordinate its campaigns but it apparently took no precautions against interception and did not encode its traffic. In 1914, the Germans won the decisive battle of Tannenberg against the Russians. Between August 26th and September 5th the Russian armies suffered massive defeats and could only escape by moving East. The German wireless operators had all of the Russian traffic intercepted and readable by the German radio station at Thorn in West Prussia, and in Koenigsberg in East Prussia, about 85 miles to the North. While the Germans may not have made as much use of this traffic as its importance would dictate, Generals Paul von Hindenberg and Erich Ludendorff could, and likely did, know as much about what the Russians would do as the Russians did themselves.

The Battle of Tannenberg showed how important intercepts could be and the Germans set up wireless intercept stations on all fronts. The German Navy Intelligence Branch activated 24 intercept and high frequency direction finding stations along the coast. The earliest intercepts were delivered directly to General Hindenberg by motorcycle entirely at the personal initiative of the chief of the Thorn station. Moreover, the whole effort began as an amateur and even sporting endeavor of the operators with time on their hands.

Tactical Intercepts by All Belligerent Signal Services Provide Important Battlefield Intelligence, and Radio Deception Becomes a Weapon

In early September, 1914 the Russians intercepted a message from German Army Staff Headquarters from which the Russians inferred a threat from a new large force, and therefore they held back forces of their own in the upcoming battle. The German Eighth Army staff, however, anticipating interception, had transmitted in plain text from its station at Koenigsberg the completely false message. Radio deception thus began to play its counterpoint to radio interception at the commencement of the Great War. The Germans used radio deception again successfully within weeks.

The Battle of Tannenberg taught the Germans the value of their nascent intercept efforts. The Russian traffic was read from August 1914 to the close of 1915. One Russian General officer termed the Russians’ use of plain text and its failure to take precautions “unpardonable negligence.” The Germans were not alone in listening to Russian wireless. The Austrians had also integrated their intercept service into their Chancellery cryptographic section at the beginning of the war. They regularly intercepted and decrypted Russian traffic all throughout the war.

The Germans then proceeded to make in the West, the very errors from which they had profited in the East. The French, even before the war, strove to intercept relevant traffic. At the beginning of the war in the West, the Germans sought to thrust their forces deep into France in order to defeat the French armies east of Paris. The French had discovered the whole order of battle by radio intercepts and up to the minute tactical intelligence. Just as the Russian thrust failed in the East for want of radio discipline, so too the German thrust in the West turned to defeat at the Battle of the Marne between the 5th and 10th of September, 1914 for exactly the same reasons.
"One of the great ironies of German radio traffic in 1914 was that it helped the French far more than the unfortunate [General Helmuth von] Moltke, who, despite his radio networks, was unable to keep track of his own troops..." [74]

Field Marshall Alfred, Graf von Schlieffen (who died in 1913), Chief of the German General Staff, had envisioned a knock-out blow against France, and at best a stalemate against the Russians. Germany got, in large measure as a result of wireless interceptions, the opposite: the knock-out of the Russians at Tannenberg and the stalemate of Western Europe's trench warfare for four years. [56]

The French, who bore much of the burden of the Great War, had seen the value of wireless interception shortly before it began. [74] Major François Cartier created eight intercept stations reporting to the Ministry of War. Under his direction, the French early-on initiated traffic analysis,3 aided by the simple regime of German call signs and the lack of operator discipline among the Germans. [74] His work was hampered by a lack of direction finding equipment until 1916 (although the French Navy helped in this regard), but it was advanced by success in code breaking after September, 1914. [74]

After these 1914 failures to achieve early decisive victories, the Great War degenerated into trenches, artillery, and gassing for four horrible years. The superior material and manpower of the allies, bolstered by the entrance of the United States in April, 1917, the success of the French in August, 1918, and the battles of September through November, 1918 fought in large measure by American troops, turned the tide of the war. [56]

The United States also joined the war in the ether. Strategically, in 1918, the U.S. Army Signal Corps established its first long range intercept station at Houlton, Maine, to listen to Europe, under Lt. Arthur E. Boeder. [5] American

3Traffic analysis is described by the U.S Army in 1944 thus: "Although messages may be cryptographed, a systematic analysis of intercepted radio traffic may provide the enemy with much useful information. This traffic analysis is based upon: (a) Amount of traffic and length of messages. (b) Call signs. (c) Routing and relay instructions. (d) Precedence (priorities). (e) Procedure signs and operating signals. (f) Times of origin and receipt." [98](FM 24-18).
Figure 8. Army RDF combat post in France WW I. [51]

Figure 9. Army receiving station France 1918. Sam Corpe (later W6LM) is standing in the center. [28]

Figure 10. Army WW I Goniometric RDF post for finding enemy aircraft. [90, p. 312]
intercept stations monitored Nauen’s transmissions to German agents in Mexico and South America. [8] The U.S. Army, throughout the war, knew that German agents were able to maintain contact with Germany. The Signal Corps believed that the high powered German wireless stations, such as Nauen, were the culprits:

“It was impossible, however, to prevent the enemy from sending from its high powered radio stations, messages which could be received in the United States and in the countries to the south. The Radio Section of the Signal Corps, therefore, systematically intercepted enemy radio cipher messages from these stations all of which were duly reported to the Military Intelligence Division.” [90]

Tactically, the U.S. Army had used mobile intercept stations as well as land stations in 1916 on the Mexican border [Fig. 7], and well on into the 1920s. Marfa, Texas, Fort Sam Houston, and Fort Bliss, and Las Cruces, New Mexico hosted intercept stations, as did several other locations. [53] During the entire First World War, a full field signal battalion, the Seventh, operated on the Mexican border. [90] The Signal Corps brought its Mexican operations expertise with it to France in the American Expeditionary Force.

“Radio intelligence firmly established itself as an Army intelligence tool in France. In addition to monitoring U.S. traffic for security violations, Signal Corps intercept stations located all along the enemy front copied enemy traffic and pin-pointed the location of enemy positions by goniometric radio direction finding. Intercepted traffic was passed to radio intelligence sections at General Headquarters and with the two field armies, where specialists analyzed message flow patterns and attempted to decrypt the messages themselves.” [33]

(“Goniometric” refers to direction finding by comparing the angles of the nulls of the loop antennas [See Figs. 10, 18]).

An American World War II Communications Security poster quotes the following First World War example in order to heighten security awareness among U.S. operators:

“As early as 1914 the German station at Norddeich sent out by telegraph regular weather reports in mixed text. In these, the cipher clerks had not taken the trouble to encipher the letters and numbers ordinarily used for indicating the direction and strength of the wind, etc.

“The station at Brugge, on the contrary, committed the inexcusable stupidity of transmitting the same telegram after having enciphered the said figures and letters. A comparison of the two telegrams gave an exceedingly valuable clue to the code used, and permitted ... a gradual reconstruction of great parts of it.” [33, 39]

Illustrations appear nearby of a U.S. Army Radio Direction Finding (RDF) station in France [Fig. 8] and a photo [Fig. 9] of an Army station in France with G. S. Corpe standing behind the operator. [28] “Sam” Corpe (later W6LM) had been an early (circa 1912) United Wireless Company operator at Avalon on Catalina Island off Los Angeles [Fig. 11]. This had been the first American circuit to handle paid wireless traffic about 1902 as stations “D” and “A”. He captioned this photo:

“U.S. Signal Corps Army Receiving Station France, 1918. W6LM in center, standing with Head Phones. Close to where Major Armstrong developed Super Het Circuits.”
Figure 11. Avalon Station A Catalina Island, California. This was one end of the 1911 intercepted circuit and Sam Corpe’s first radio work. (postcard, author’s collection)

Figure 12. Army WW I Headquarters station, Marne, France. [90, p. 304]

Figure 13. Army WW I shortwave intercept, RDF, and long wave (AEF Monitoring Post No. 2 communication security) stations (Left to Right). [51, 33]

Figure 14. Army WW I (First Army Headquarters) intercept post with ‘artist’s conception’ equipment. [51]
Just after the war, Major General George O. Squire issued his REPORT OF THE CHIEF SIGNAL OFFICER [90] detailing the work of the Signal Corps in Europe. The Second Field Signal Battalion put up one of the first American radio intercept stations at Souilly, Meuse on November 14, 1917, taking 393 messages and 1,173 calls in its first two weeks of operation. Headquarters implemented the first intercept station, [Fig. 14] devoted to press coverage, in September, 1917. [90] Other stations followed at Toul, then "Radio Hill" near Masey. Direction finding stations (known as the "goniometric stations" from their technique) sprang up along the front lines taking an average of 150 bearings a day. [90] Radio tractors (trucks) also took on direction finding duties. By November, 1918, at least a dozen radio intercept stations were working, along with at least eight direction finding stations. [90] [Figs. 12, 13] The five main intercept stations took a total of 72,688 messages and 232,977 calls. The directionals took 177,913 bearings from 20 stations. In addition, the stations picked up 5,342 enemy aircraft transmissions and called for 102 aircraft warning alerts. [90] The Signal Corps also sent false traffic successfully in October, 1918 to deceive the Germans. [90]

The circuits used in these receiving stations did the job with a minimum of hardware. A schematic diagram for the basic English direction finding radio [Fig. 15] appears nearby. [19]

Major Edwin Howard Armstrong’s superheterodyne circuit remained essentially in the developmental stages up to the end of the war. [22] During the war, according to a definitive postwar account, tuned radio frequency (TRF) amplifiers did yeoman’s work at the intercept stations. They were French designs, known as R-2-bis and R-3-ter. [52]

The full complement of French equipment in the American intercept stations included Receivers (tuners) Types A-1, No. 2 (range of 150 to 6000 meters wavelength), and No. 3 (range of 300 meters to 15,000 meters wavelength), Amplifiers Type 3-ter, R-2-bis and R-3-ter, and Wave Meter Type No. 2. Marconi equipment also gave a good account of itself. [52] Direction finding stations used a Type L-3 amplifier connected to the loop antenna and tuning 200 to 100 meters wavelength. Appearing nearby are a circuit diagram [Fig. 16] and a 1917 photo [Fig. 17] of a British radio station operated by a corporal in the Royal Engineers who is transcribing a message from a one tube receiver. A power panel sits to his left, as do two large receiving inductances. The
telegraph key is not a wireless transmitting key and was probably hooked into a land-line telegraph circuit.

The work of the American direction finding station in the American sector during an attack on the Toul front in May of 1918 stands out. Two radiomen in the station took 650 bearings (by tuning, then nulling twice, then taking a call or noting a message, and then recording and transmitting the data), over 24 hours of continuous operation. This amounted to a full bearing every two minutes without surcease. [52] Soon, other similar stations went into operation, including three very successful trucks (known as radio tractors).

The Signal Corps also operated ground effect “listening stations” to intercept enemy front line telephone and telegraph messages which used the earth ground as part of their circuits. This work was more dangerous than the radio work. It required ground plates to be inserted near enemy positions. The Signalmen who volunteered to work their way into “no man’s land” to place the grounds risked their lives every night. They “combine the duties of both the scout and the spy…” [51]

General Squire in his post war report complimented the wireless intercept operators many times, for example:

“Upon several occasions the efficient work of our intercept operators was cited in secret reports. During the St. Mihiel operations, messages picked up by these means enabled the General Staff to learn of a counterattack, as well as its strength, and the time and place it would occur, three hours before it took place.

“In the early days of the service, a commendatory report on the operations of the radio section stated that: ‘The net result has been that in this period of ... days, the information furnished by the radio section has probably saved more men than are engaged in this service. Such results would have been impossible without energetic and loyal cooperation of the Signal Corps operators. The work of the Signal Corps officers and men of the radio section deserves the highest commendation.’” [90]

Radio Intelligence Work Between the Wars: The British Continue to Monitor and Decrypt, Especially Soviet Subversion in the 1920s

Downsizing was the aftermath of the Great War’s end, as it is of all wars. Intercept services and intelligence functions shrank. There were, however,
soon untoward “consequences of the peace” (to use Lord Keynes’ phrase). As wireless and radio came to play a part in the unfolding events, so did radio interception.

At the close of the First World War, the allies turned their attention not only to the other nations of the world, but also to the subversion effected by the international communist movement (the “Commintern”). With the success of the Bolshevik Revolution in Russia in 1917, all of the Great Powers faced a new threat, that of revolution from within. In 1919, as the British sought to project its Navy into the Baltic to counter the new Soviet Union, the Bolsheviks turned to wireless to counteract English intentions. Mutiny loomed as a real threat among disaffected sailors.

“The Bolsheviks attempted to capitalize on the sailors’ grievances by aiming wireless broadcasts at them which urged them to refuse duty and hasten the cause of World Revolution. This was the first time radio had been used for propaganda purposes.” [31]

(The British as early as 1917 had, themselves, broadcast a much exaggerated report, for propaganda purposes, of Germans destroying a religious site in Jerusalem.) [70]

British troops fought in post revolutionary Russia after 1918. British army units supported the White Russian counter-revolutionaries. The Russians at the same time intensified their work to kindle a revolution in England. “The prospect of a revolution in Britain was frighteningly real in 1919, so real that the War Office [asked] if the troops would ‘remain loyal in case of a revolution in England.” [31]

Since 1917, the Russians had dedicated themselves to the overthrow of the United Kingdom and the English were aware of this as a result of intercepts and seized documents as early as 1919. [111]
In England in 1918, the ratio of workers to strikers was only three to one (25% striking, and the number rising). [56] (In Russia in 1917 some 60% of workers were on strike.) Demobilization mutinies welled up among British troops in France and “3000 men marched from Victoria Station to occupy the Horse Guards Parade [Grounds].” [56]

After the collapse of diplomacy (as well as British subversion of the Soviets) in Russia in 1918-1920, only radio provided a link between the English and the Russian government. [31] After taking hostages, the English put one of them up to communicating with Moscow by radio to disclose the hostage-taking and to promote a trade. The ploy worked and the hostages were exchanged 11 days later. [31]

The United States, starting on September 2, 1918, projected an expeditionary force allied to British and Czech forces, into Russian Siberia. Major General William S. Graves commanded the 9,000 troops. [31] The Signal Corps “Americanized” the existing Russian telegraph lines which stretched some 2,900 miles West from Vladivostok on Russia’s East Coast into the Baikal area of the interior, where the U.S. 27th Infantry was stationed. At the Vladivostok end, a line was run to an American wireless station on a nearby Russian island, “so that the press reports received by that station might be distributed throughout the entire American Expeditionary Forces.” [90]

The military intelligence services in Europe after the war also monitored the communications of the communists. In 1918, the existence of the Bolshevik Free State of Bavaria, communist-led mutinies in the German Navy, general strikes and workers’ takeovers [56] led to recognition of the real threat of the Bolshevik revolution spreading to Germany and all of Europe. Nearby is a photo [Fig. 19] of a U.S. mobile intercept station at work in Germany after the end of the war. [33] The Germans themselves valued their military intelligence section which was reinstalled on a permanent basis as early as 1919. [49] Within Germany itself, the paramilitary Free-Corps who were determined to resist the Bolsheviks, [70] set up a monitoring station to listen to the communists. [35] By 1925, it had a staff of 32. [49]

The official German Military Intelligence intercept service (Abwehr = “shield”) concentrated on the international press radio service until 1925, gradually turning its attention to diplomatic transmissions. [35] By the mid 1920s, the German Abwehr’s three sections were Reconnaissance, Cipher and Radio Monitoring, and Counterespionage. [73] As early as 1926, the German intercept corps encoded its intracorps transmissions and its target intercept frequencies to deny its adversaries intelligence about its success. [86]

In the estimation of Willhelm Flicke, the leading German expert, the English had the superior radio intercept service between the wars. It was devoted not only to military intelligence but also to diplomatic traffic. [35] By the 1930s, the Germans were, however, reading most of the important messages among their future enemies:

“... Hitler was receiving summaries of intercepted diplomatic messages, world wide, from a larger organization [than that of the English] ... and this enabled Hitler to march surefootedly into the Rheinland, Austria, the Sudetenland, Czechoslovakia, completely reassured that the French and British would not oppose him militarily, and even into Poland knowing exactly how the Allies were likely to react.” [86]
By 1934 the Nazi Research Bureau (Forschungsamt or "FA") had two radio intercept departments, B and C, for internal and external intercepts respectively. [86] After 1931, the French had a spy who was so highly placed in the German hierarchy that the internal organizational documents of the Research Bureau (the FA), including the management of radio interception stations (Forschungsstellen), were in Allied hands as soon as they became available to German staff. [86] In the mid 1930s the FA made millions of interceptions to generate, for example, a 1935 intake of 34,000 internal messages and 8,500 external messages. [86] In addition to its stations in Germany, the FA set up a monitoring post in Berne, Switzerland, for Swiss, Italian and French traffic. [86] The Germans could read all neutral wireless traffic and most enemy traffic except the British and American ciphers. [70]

The French also maintained their intercept service as did other nations. By 1939, French headquarters and each of the eight French armies had intercept companies. [86] The Russians maintained the best discipline and were perhaps the most effective. The Poles more than held their own, especially in the 1930s with respect to the German "Enigma" traffic which was intercepted by three radio monitoring stations in northwest Poland (at Posnan, Starogard and near Krakow). [86] The Italians ran a lax operation, and other nations had only indifferent success. [35]

In November, 1919, the English organized the Government Code and Cipher School (G.C. & C.S.), amalgamating Room 40 of the Admiralty and Military Intelligence. [73] To support its work, the English formed the Royal Corps of Signals, which in conjunction with Admiralty monitoring, provided the messages for the code breakers. [107] The British Secret Service also took to putting its agents aboard merchant ships as Marconi wireless operators when particular ports of call were of interest. [111]

Soviet subversion in England provided G.C. & C.S. with its first important work at a time when civil unrest was widely feared. The London Times ran a story that wireless intercepts had revealed the fact that the Soviets were funding subversive activity in August of 1920. This sort of security breach by the press happened all too often as the years progressed. Despite a treaty prohibiting domestic subversion, the Soviets kept it up, particularly through their support of the Comintern ("Communist International") agents. Their subversive communications were monitored in detail by the wireless intercept stations and decrypted at G.C. & C.S. between 1917 and 1930. [107, 73] Various diplomatic initiatives suppressed the subversion for a while but they also motivated the use of one-time encoding pads for diplomatic traffic which were very difficult to decrypt. [107]

In 1930 an intercept station detected a circuit between Moscow and a suburb of London. [107] There is no indication that it was ever closed down, leading to an inference that the British found the existence of the circuit advantageous. Perhaps analysis of the traffic provided useful intelligence on Soviet spies in England. It now seems possible that the traffic was decrypted, permitting derivation of useful intelligence directly from message analysis. The one-time-pad had come into use by diplomats in 1930, but it appears the cipher was indeed compromised by the British Secret Service; [107] moreover Comintern communications did not enjoy one-time-pad security. It was not until the Spanish Civil War in 1936 that the British turned away from their focus on the Soviets.
One can speculate why the circuit between Moscow and London was permitted to continue. It is possible that it was fully decrypted by British Intelligence and that it was left in place to monitor the success of Comintern ("Communist International")'s subversion at Cambridge and Oxford Universities which led to the Philby affair many years later.4 [3, 13]

A similar and perhaps related circuit during the Second World War, carrying the traffic of the Soviet agent “Sonia,” [73] as early as 1941, was also not shut down. Officially, the British claimed it never existed, but its wartime existence was later verified. [111] Sonia, a woman of many names, and perhaps more than one “Sonia,” spied for the Soviet Union all over the world in the 1930s. A “Sonia” was a protegee of Soviet master spy Richard Sorge in Asia. In Germany in 1938, she recruited Britons as spies. She moved to England in February, 1941, went to the Oxford area at the behest of her Soviet controllers, [111] and she began her radio transmissions to the Soviet Union that spring. [73] Kim Philby had taken the initiative to reconnect himself to the Soviets shortly before. The British, in Switzerland, learned that Sonia was a Soviet spy in 1940 but let her into England the next year. [73] She died, having been much honored in Socialist countries, in July, 2000. [106]

However interesting Soviet intrigue may have been, the English had first to deal with the NAZI’s, who had even more immediate plans, as became clear after 1936. This was complicated all the more by Japanese expansion.

The English had maintained since 1925 a “Y” committee to coordinate the work of intercepting radio signals. The British Army had its own chain of stations throughout the Empire, as did the Navy. In the Great War, the British operated intercept companies in Turkey and Iraq. [86] In 1923, they merged into Number Two Wireless Company and moved to Sarafand (near Jaffa on the Mediterranean coast) and to Palestine (near modern day Tel Aviv). Another intercept company became Number One Wireless Company and moved to Cherat in India’s North West Frontier Province (now Pakistan). [86] The focus of the work of these companies was the diplomatic traffic in the Far East. In 1939, Britain targeted Red Army operations in the South of Russia. [86] The British Far East Central Bureau (Singapore Naval Dockyard) did cryptanalysis [93] and had charge of radio interception. [82] Radio intercept “Q-Team” operated on Stone Cutters Island in Hong Kong after 1935. [86, 93]

The British Post Office and the Air Ministry ran the domestic stations. [107] The listeners heard and logged the traffic, but making sense of it was another matter because the NAZIs had implemented Enigma machine encoding. With the coming of “real” war in 1939, only the Poles had made any progress in decoding these communications. The story of the decryption of the Enigma traffic is now well known [48, 107] although for many years extending long after the war and up until 1972, it was the “ULTRA” secret.

That work may well have won the war in Europe and it certainly contributed to the war effort in amounts far beyond its cost. What is not widely known is that enemy radio operators’ errors gave away the codes far more effectively than even the new electronic computers could decipher them. The analysis of

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4 Many high Soviet intelligence officers always believed that H.A.R. “Kim” Philby was an English triple agent. [3, 13] Some former Soviet intelligence operatives believe that Mikhail Gorbachev was a Western agent. [44] The two men were connected through Premier Yuri Andropov, earlier KGB Director, Philby’s “control” and Gorbachev’s mentor.
The U.S. Army and Navy Continued monitoring in the 1920s and 1930s, Especially Japanese Diplomatic Communications

Until 1929, American military intelligence fed wireless intercepts to the "Black Chamber" of Major Herbert O. Yardley. Secretary of War Henry L. Stimson was scandalized at this spying and put an end to it, shutting down MI-8, the cryptography unit of the Military Intelligence Division of the General Staff (G-2). [38] He said later: "Gentlemen do not read each other's mail." Yardley's success in decryption went for naught, and he went public in 1931 in the Saturday Evening Post and in a book. [107] Yardley's disclosures resulted in much tighter Japanese communications security. [38]

American cable intercept efforts had borne fruit at the 1921 Washington Peace Conference. Army MI-8 codebreakers decrypted the Japanese diplomatic code and achieved a considerable negotiating advantage. [33] As early as 1926, the United States Coast Guard intercepted occasional Japanese radio messages and turned them over to the Army. [38]

The U.S. Navy also focused on the Japanese (as to some extent had the British as well). In October, 1927 Captain (later Admiral) Ellis M. Zacharias monitored Japanese traffic from the USS Marblehead, [73] and then set up a monitoring station at Shanghai. It was the first of a chain of stations stretching across the Pacific. [61] Zacharias set up his receivers on the fourth floor of the American Consulate [5] and manned them with U.S. Marine radio operators. Navy monitoring of Japanese traffic began as early as 1924 in Shanghai with self-trained radiomen and it was also conducted on board the USS Huron, which was the Flagship of the Pacific Fleet. [86] In 1927, the Shanghai station transferred over to the USS General Alava in Shanghai. In 1925, a station in Hawaii also focused its attention on Japanese Navy traffic. Beijing got an U.S. Navy intercept station manned by Marines in 1925 or 1927. In 1929, the Navy "dis-established" its Shanghai station but put one of its radiomen to work establishing an intercept station on Guam Island. Beijing station closed in July, 1935 but waited until Shanghai was reestablished as Station A under Marine Corps command. It was controlled by the Navy at Cavite, P.I. and was part of the Asiatic Group which included Guam Island. [86, 73] A 1928 Navy intercept from Shanghai station [Fig. 20] appears nearby.

5 The U.S. also intercepted and decrypted its allies' cable messages before the 1945 U.N. Conference in San Francisco to great advantage. [3, 42]
By 1940 the chain of stations included the Aleutian Islands, the Philippines at Corregidor, Samoa, Guam and Hawaii, [5, 61] and Bainbridge Island, Washington State as well as Winter Harbor, Maine, Jupiter, Florida, and Chelten on Oahu in Hawaii. [107] The Navy also established lesser monitoring stations at Imperial Beach, CA and Amagansett, L.I., NY. [5]

Station A’s March, 1938 equipment list shows wide spectrum capability. Direction finding equipment included a portable Model DR for 200 kcs (kilocycles, now “kilohertz – kHz”) to 18 mcs (megacycles, now “megahertz – MHz”), and a Model DG covering 100 kHz to 1000 kHz. The low frequencies which were so favored by navies were covered by a Navy Model RAA receiver. Medium frequencies were covered by two Model RAB receivers. High frequencies were handled by three Model RT-2 and one Model RS-1 receivers. A frequency meter, line amplifiers and generators filled out the equipment. For recording Morse Code transmissions, the station used a Boehme paper tape recorder and two Boehme tape pullers. [86] VHF capabilities came on line in November, 1938 with the addition of a National 1-10 receiver for 27 + MHz to 300 MHz (ten meters to one meter wavelengths, hence “1-10”) [see Figs. 62 and 63 for a later Navy NC-1-10 as the RBT]. A National HRO receiver replaced one of the model RAB receivers extending coverage higher into the high frequency range (3 to 30 MHz). A “Telediphone” made recordings of the Moscow and Tokyo circuit for transmission to headquarters. A Telediphone is a commercial Dictaphone-like disk recorder designed to record telephone conversations. It was used to record the audio of radio signals. In December, 1940, the station was “dis-established” and the personnel transferred to the Philippines. [86]

The Army, despite the closing of the Black Chamber, operated the Signal Intelligence Service (S.I.S.) from April, 1930, [73] ostensibly only for “training.” The brilliant William F. Friedman ran the small group which ultimately broke what the U.S. called the Japanese “Purple” Code and provided the MAGIC decrypts that likely won the war in the Pacific. [33, 75, 107] Friedman broke that code without any captured cipher machines or code books (unlike the Polish and English methods of cracking the Enigma codes). Friedman’s was an unequaled feat of mind and one that nearly cost him his mind. [107] By the end of the war, 10,371 officers, enlisted personnel and civilians worked for this agency, by then called the Signal Security Agency, and later called the Army Intelligence and Security Command (INSCOM). [73]

“Reading the mail” later became the euphemism for monitoring radio transmissions, particularly radio-teletype. In the 1930s, however, considerable care had to be exercised by anyone who might want to listen to someone else’s radio traffic. Almost all message traffic moved as Morse code. Interception of this traffic was widely regarded as illegal [38] under the United States’ Wireless Law of 1912, and “immoral eavesdropping” to boot. This applied
even to encrypted traffic from other possibly belligerent nations. This led to
the “training-only” rationale, which Army brass used to circumvent the Wireless
Law and the even more explicit constraints of the Communications Act of
1934, §605. That Act was widely interpreted to criminalize interception and
disclosure of radio transmissions not meant for broadcast. The example made
in 1929 of Col. Yardley could not have been far out of mind. Section 605
provided:

“No person ... shall divulge the contents of any messages transmitted
by such [a radio or wireless] station ... unless legally required to do
so by the court ... or ... competent authority.” [5]

The targeted messages were, however, encrypted and the army could
argue that interception and recording of a still encrypted message did not, by
definition, divulge its still unencrypted contents. Nonetheless, discretion was
prudent. The Army, on a tactical level, also engaged in monitoring and direction
finding between the wars. They also practiced monitoring for training purposes
using the 1940 set pictured nearby [Fig. 48] which is shown being operated in
Hawaii.[33]

The Spy in the Presidio of San Francisco

One “irregular” intercept station appeared in San Francisco, at its Presidio,
as early as 1931. The Presidio of San Francisco, founded by the Spanish in
1776, is the oldest Army base in the country. The U.S. Army took it over in
the Mexican War, circa 1846. Col. Joseph Mauborgne (1881-1971) of the
Signal Corps [109] set up the intercept station on his private initiative. This
is why it is properly considered an “irregular” station. He listened at home (a
busman’s holiday) and recorded the traffic for Friedman. [5] Colonel Mauborgne,
stationed at the Presidio, presumably lived in a nice house in “officers’ country.”
Comfortable though his circumstances may have been, he apparently was not
one to let something like Yardley’s disgrace or Congressional enactments get
in the way of winning a coming war.

Mauborgne had served admirably in France in the Great War. He was one
of only 17 Signal Corps officers to receive the Distinguished Service Medal.
[90] He knew full well the value of interceptions for intelligence purposes. In
1914, he broke the British “Playfair” cypher. During the war, he commanded
the Signal Corps’ Land Division Engineering Section which included all of
the radio units. [90]

As a Major in the Signal Corps after World War One, he acted as the
Chief of the Signal Corps Engineering and Development Division. He signed
off on the design prints of the standardized Army building to be used as radio
stations which included the 1920s WVY station in the Presidio. That building
is still standing in the Presidio as Building 312. It housed the Presidio’s first
radio station after the spark era, with the military call letters WVY. Building
312 is the likely site of the later Monitoring Station Number Two which was
attributed to Fort Scott in 1941 but administratively transferred to the Presidio
in 1942. [97] Its first intercepts may have been made as early as 1926. [2]

War clouds from the Far East spread from Japan in 1931. Japan seized
Manchuria, with obvious designs on both China and Russia. Preoccupied
with the Depression, Americans focused on Europe or turned inward, moving
toward isolationism. The Navy counted Japan as the major threat of its next
war, but the Army looked primarily to Europe and set up its first, experimental
Figure 22. Army 1920s receiver IP-501 as used at the Presidio. [photo OTB]

Figure 23. Army intercept workhorse radio BC 779. [courtesy Moore, Communications Receivers]

Figure 24. Gen. Maubourne who created the US WW II intercept corps. (Radio News)

Figure 25. Prohibition Era Rumrunners' radio code book (page). [7]

Col. Mauborgne’s monitoring station in 1931 may have employed a military receiver. As of 1922, the Presidio radio station WVY [Fig. 21] used AMRAD IP-501 (Navy SE-1420) type receivers [Fig. 22] which employed a regenerative circuit. The more complex superheterodyne circuit was, however, the real state of the art. In 1931, the Hammarlund Company first sold its superhet “Comet” communications receiver. This evolved into the Army’s favorite receiver from Comet to Comet Pro, to Super Pro, to BC-779, [Fig. 23] to SP-600 etc. How advanced Col. Mauborgne’s equipment was is not known, but he did make recordings of his intercepts, which were flown to Washington (probably from the Presidio’s Crissy Field). Inasmuch as he used an automatic recording system, his cannot have been an entirely amateur effort by the man who just happened to be one of the nation’s foremost cryptographers.

Listening to Japanese traffic in 1932 had to be a challenge. Yet, if the Japanese embassy in Washington, D.C. could copy the signals, so could a dedicated monitor in San Francisco. If the gods of propagation be willing, the Presidio is one ionospheric skip closer than Washington. Mauborgne, however, most probably tuned into the Japanese “diplomatic cables” radio telegraph traffic routed through the West Coast on commercial circuits. Tokyo Radio communicated with RCA’s KPH at Marshall to the North of San Francisco, and with ITT/Mackay’s KFS just South of San Francisco at Half Moon Bay. If these commercial stations took the Tokyo traffic by radio telegraphy, so could a radio spy in the Presidio. The technique of siting an intercept station near a commercial receiving station continues to this day with intercept stations being located near satellite receiving nodes. (The Army, in 1936, put into place a listening post for Japanese traffic near the Presidio at a Coast Artillery fortification). [2]

Joseph Mauborgne went on to achieve the rank of Major General. [Fig. 24] He commanded the entire Signal Corps from 1937 to 1941. [66, 109] He was instrumental in the development of RADAR by the Signal Corps. As sensitive as he was to the need for interception and decryption, he established the American Army intercept corps. He activated the “Second Signal Service Company” on January 1, 1939. His formation of this intercept corps provided the foundation of the Army’s intercept work in World War Two, as well as the post-war creation of the Central Security Service which merged into the National Security Agency which continued interception and decryption of communications intelligence. Mauborgne knew that intercept work was hard, and secret, and that the operators deserved premium pay, prestige and perquisites, and that in the absence of sufficient reward and recognition, a peacetime Army could not keep them. [38]

Joseph Mauborgne was not only a good spy, he was a renaissance man: Army officer, mathematician, artist and musician. It was the British experience in the Second World War that musicians, artists and even literary types made excellent cryptologists. Perhaps their minds were quicker or more open to possibilities or patterns. The Spy in the Presidio was certainly an exemplar of such a man.

**The United States Coast Guard’s Prohibition Intercept Work**

On January 29, 1920, the Prohibition of alcoholic beverages, by the 18th Amendment to the Constitution, became the law of the land. Of course, disputes with the government about liquor went back at least to the Whiskey Rebellion
Figure 26. Prohibition Era San Francisco marine receiving station NPG. Late 1920s. [Hal Layer, CHRS, collection]

Figure 27. Prohibition Era Rumrunners' amateur radio station with QSL cards. [7]

Figure 28. Prohibition Era Rumrunners' radio station makes the headlines. [7]
Figure 29. Prohibition Era federal agents seize rumrunners' radio station. [7]

Prohibition ended the tradition until its repeal by the 21st Amendment in 1933. Beer and bathtub gin was the order of the day, but the good stuff came primarily from Europe, by way of the high seas, often via Canada. Wireless coordinated the rumrunners, as well as the Prohibition agents, foremost among whom was the United States Coast Guard. [83] The Radio Inspectors of the Radio Department of the Department of Commerce also joined the fray. [7] [Figs. 28, 29]

The rumrunners, whose vessels the Coast Guard called "Blacks," quickly realized that the Coast Guard was intercepting their shore to ship radio communications. The Coast Guard equally quickly realized its vulnerability to radio interception by the rumrunners. Both sides in this contest turned to radio codes to hide their intentions. [Fig. 25] The Coast Guard set up an intelligence center at Headquarters under Lt. Cmdr. Charles S. Root. Radio intercepts were an important facet of this intelligence operation. [46] The Coast Guard initially got its codes from the Navy, just as it got obsolete destroyers from World War One to use as Revenue Cutters. The Navy, however, feared that too much traffic in its codes left them open to decryption, and withdrew this support.

The Coast Guard used both coastal radio stations and its vessels to intercept the communications to and from the sloops full of whiskey that Americans' thirst drew to our coasts. A typical coastal station of the period, NPG in San Francisco, [Fig. 26] is illustrated nearby. The rumrunners, overseas, had access to high grade marine radio equipment for their ships. In the United States, the coordinating radio stations favored R.E.L. equipment from Long Island’s Radio Engineering Laboratories, but they also used the cover of amateur radio stations, complete with QSL cards on the wall and all. [Fig. 27] Amateur equipment easily sufficed to communicate for several hundred miles out to sea.

The rumrunners devised special codes to frustrate interception. Occasionally, Prohibition agents seized a code book. New York District Radio Inspector Arthur Batcheller did so in a raid on a major radio station on Long Island. A copy of this code book appears nearby [Fig. 25], along with official photographs and newspaper stories of the raid [Figs. 28, 29]. Without such a seized code book, decryption posed more of a challenge. The Coast Guard turned to the then nascent Signal Intelligence Service in Washington.

It was not the SIS Director William Friedman who took on the work, but rather it was his wife, Elizabeth Smith Friedman. She became the cryptanalyst for the Coast Guard. [46, 24] On the high seas, Lt. Frank M. Meals intercepted
Figure 30. Prohibition Era Coast Guard radio CGR-25A (1929). [Norm Braithwaite collection and photo]

Figure 31. Prohibition Era Coast Guard marine receiver LSR-101. (photo and collection of Norm Braithwaite, CHRS)

Figure 32. Prohibition Era Coast Guard LSR-101 inside view. (photo and collection of Norm Braithwaite, CHRS)

Figure 33. Prohibition Era Coast Guard LSR-101 name plate. (photo and collection of Norm Braithwaite, CHRS)
the rumrunners from Coast Guard Cutter 210, with special equipment. The Field Intelligence Unit was established at a fixed location on shore in December, 1930, with Lt. Meals commanding it. Four specially equipped 75 foot patrol boats with high frequency monitoring capability and experimental direction finders joined the fray. One radio which the Coast Guard employed for direction finding as well as communications, was the CGR-25A, manufactured by the Charles W. Speaker Company. It covered 69 kHz to 1.050 MHz, and dated from the 1920s. A photo appears nearby. [Fig. 30] In November of 1929, Admiral F. C. Billard, Commandant of the Coast Guard, accepted the Speaker company’s bid for 115 intermediate frequency receivers at $260 each and 50 low frequency receivers at the same price. These radios went one each to 24 destroyers, and 46 patrol boats, while 28 cutters got one or two each. [11] The Speaker company made a similar radio, the LSR 101 [Figs. 31, 32, 33], for the U.S. Lighthouse Service which was part of the Department of Commerce at the time. The Coast Guard earlier used Navy SE 1420, IP 501 receivers. [7] [Fig.22]

For code breakers of the sophistication of the Friedmans, rum-runners’ codes were child’s play. Nonetheless, history seems to be devoid of testimony from anyone who could not obtain alcoholic beverages during Prohibition. There can be little doubt, however, that the Rum Wars, radio interception and all, made good whiskey more expensive, although, on the other hand, it was free of federal tax.

As late as May, 1936, the Coast Guard still had a small seven man cryptography unit dealing with radio intercepts. At that time, the Army’s seven or eight man unit was no larger. [38] In 1941, the Navy used the Coast Guard’s collection of weather observations from all ships at sea for intelligence purposes, and Fleet Radio Unit Pacific declared that it had had “… the support of at least one organization capable of intercepting on a useful scale.” [72] George Sterling reports that the Federal Communications Commission Radio Intelligence Division intercepted “Hellscreiber” transmissions from the German High Command circa 1943, and turned the printouts over to the Coast Guard Cryptographic Laboratory in the Navy Department. (The Hellscreiber system sends a small facsimile of each letter of a message in sequence; The F.C.C. had intercept equipment for it). [92]

The Sounds of War Fill the Ether in the Late 1930s

The intercepts for the Army SIS came first from stations at Battery Cove, Virginia, Fort Monmouth, New Jersey and Fort Sam Houston, Texas. The Presidio at San Francisco, California (Monitoring Station Number Two) came on line by 1940 or so, along with the Canal Zone, Fort Shafter on Oahu in Hawaii and Fort McKinley in the Philippines. The next year, a station in New York harbor at Fort Hancock, and one at Fort Hunt, Virginia joined the network. [107] The Army in the Philippines monitored the Tokyo and Berlin, and Tokyo and Moscow circuits, while the Presidio and Bainbridge Island listened to traffic on the Tokyo and Washington circuit. [107] Panama focused on the Rome and Tokyo circuit. [5] General Mauborgne had been instrumental in setting up this intercept chain which was focused mostly on diplomatic traffic. The Army in 1940 described its operations in formal terms:

“47. SIGNAL INTELLIGENCE SERVICE — a. General. — The signal intelligence service consisting of the service chief, several officer assistants, and enlisted clerical and other assistants is charged with the
handling of all matters within the province of the army signal officer regarding signal intelligence and signal security in the entire army. Among other matters, it—(1) Recommends and supervises the employment of the radio intelligence company, assigns missions thereto, and evaluates the information obtained thereby…"

"RADIO INTELLIGENCE COMPANY"

64. COMMAND. — A radio intelligence company is an organic part of the army signal service and of the GHQ signal service…. The radio intelligence company may also be employed in coastal or other frontier defense, or in the zone of the interior…. Elements of the company are widely dispersed during operations and may be attached to units subordinate to the army.”

65. DUTIES. — The duties of the radio intelligence company include — a. The establishment, operation and maintenance of radio stations for the purpose of — (1) Obtaining signal intelligence by intercepting enemy radio transmissions, and finding positions of enemy radio stations…. (3) Obtaining information as to unauthorized radio stations by intercepting radio transmissions, and finding positions of such stations located in areas controlled by friendly forces.” [102]

By December, 1941 the Army had seven working intercept posts, known by their numbers:
1. Fort Hancock, New Jersey
2. Fort Scott, Presidio of San Francisco, California
3. Fort Sam Houston, Texas
4. Post of Corozal, Panama Canal Department
5. Fort Shafter, Territory of Hawaii
6. Fort McKinley, Philippine Islands
7. Fort Hunt, Virginia [38]

RCA receivers worked in diversity [Fig. 34] at an early Army intercept post. Diversity reception entailed hooking each receiver to a differently oriented antenna and then combining the outputs of the receivers to optimize reception of the desired signal. The Army equipment list for its first, 1939, intercept station at Fort Hunt, Virginia cites 53 receivers: ten SCR-243, twenty nine SCR-244, and fourteen diversity sets. The SCR-243 and SCR-244 equipment at work in the first Army monitoring station were Signal Corps Radios including then state-of-the-art receivers. (SCR is the designation for “Set Complete Radio” and it often includes several BC-### which is the designation for “Basic Component.”) The SCR-243 used the BC-197, an early Hammarlund Superpro receiver in military dress. It covered 100 kHz to 20 MHz. The SCR-244 was similar and used a BC-794 receiver. This, too was a Superpro model, covering 150 kHz to 400 kHz and 2.5 MHz to 20 MHz. According to contemporary documentation, some SCR-244 radio sets used variants of the Superpro such as the BC-779 (the most common [Fig. 23]), and the BC-1004. [23] Some 30 sets of recording equipment were also listed along with nine diversity antennae. [38]

The Navy had its own chain of intercept stations in the Pacific. They were identified by letters of the alphabet relating to their locations and were used for naval intelligence as well as diplomatic traffic. In Washington, D.C., the Army SIS and the Navy equivalent organization “OP-20-G” (established in 1924) shared Washington decryption duties in the period immediately before the Second World War and they cooperated well. [38] In December, 1941, OP-20-G had 730 personnel, including 75 officers. At the end of the war, it had 8,454 personnel including 1,499 officers. [73] (The Army employed comparable numbers.)

The Americans, the British and the Dutch traded intelligence information about the Japanese. In the period after the war in the Pacific began, the British had four intercept stations in Australia (one removed from Singapore) plus a Dutch station removed from Batavia in Indonesia. The Americans provided the Purple Code keys and similar high level material including two Purple Machine replicas as reconstructed by Friedman. [107] After evacuating Singapore, the British in Australia set up a naval signals intelligence center at Belconnen, and the Central Bureau near Melbourne. The Australian Special Wireless Group put up intercept stations in Darwin, Perth, Morningsby near Melbourne and in New Guinea. [86]

Tactical intercept units, including American units, moved up towards Japan as the war progressed. [86] At the Central Bureau, 4,000 personnel worked to provide General Douglas MacArthur with his own “Ultra” intelligence. [86, 32]

According to Robert Stinnett in DAY OF DECEIT, [93] the Navy in December, 1941 had eleven intercept stations in the Pacific. The main station was located at Heeia, on Oahu Island in Hawaii, and known as Station H (or “Hypo”), with 65 radiomen at eight receiving posts. [93] Others were on Corregidor Island, P.I., called Station CAST (phonetic “C”); Sitka, Alaska was Station AE and Dutch Harbor, Alaska was Station KING. Station ITEM was sited at Imperial Beach near San Diego in Southern California to monitor the Japanese Fleet, with help from three Canadian stations one at Vancouver, B.C., and two just to the North. [93] RCA Communications at KPH in Marshall, just
North of San Francisco, and Mackay Radio at KFS in Half Moon Bay, just
South of San Francisco also aided the Navy. [93] Guam hosted Station BAKER.
Samoa was the site of Station VICTOR on Pago Pago at Vaitogi. Near San
Francisco, perhaps at Scaggs Island, Station FOX supplemented the mid Pacific
stations. The Navy headquarters was Station US (now Naval Security Command
at Fort Meade, Maryland).

Before the outbreak of war in the Pacific, along with the British Hong
Kong and Singapore stations and the Dutch Batavia, Indonesia station, this
coordinated network of 22 intercept stations was known diplomatically as “The
Splendid Arrangement.” [93] [Fig. 35]

Close to Washington, Station M in Maryland was also detailed to intercept
work. [93] It was, however, the Navy intercept station at Bainbridge, station
“SAIL,” (phonetic for “S” as in Seattle), that took the communication from
Tokyo to the Japanese Ambassador in Washington, D.C. which instructed him
to break off negotiations at 1 PM Washington time, or just after dawn in
Hawaii on December 7, 1941. [5] The critical last paragraph, with the time
clearly specified, was also intercepted at San Francisco’s Presidio, at Monitoring
Station Number Two, and teletyped that evening, December 6, 1941, to Washington.
[93] Station S also took that traffic.

Intercept stations had been alerted to its importance by an unusual plain
English special request from Radio Tokyo to both RCA (for KPH) and to
Mackay Radio (for KFS) in San Francisco, to be ready to take a cable to the
Japanese Ambassador. [93] On December 6, 1941, Sergeant Howard W. Martin
was in charge of Station Two in the Presidio, and at 8 PM he complied with
Washington’s urgent request to teletype the day’s intercepts (already forwarded
by airmail). These teletype versions were received about Midnight, Washington
D.C. local time. [26] The Navy intercepts also got to Washington about midnight;
it was the Navy’s responsibility to keep the President informed.

According to DAY OF DECEIT, Washington malfeasance as well as general
military misfeasance prevented an adequate and timely warning to Hawaii on
the morning of December 7, 1941. A rash of intercepts (at least 129, duly
categorized), [93] some taken even on the SS Lurline at sea, showed hostile
intent [93] (although many in the Military code AN-1 were not in fact decrypted
until much later according to recent criticism). The Japanese shore stations
had taken to communicating with the fleet on the long distance frequency of
16.620 MHz. [93] Radio direction finding at 4 MHz placing the fleet north of
Hawaii [93 chart] had given the game away as surely as had the RADAR
detection of the Japanese air fleet attacking from the North. The interceptions
[see e.g., Fig. 52, Nov. 1941 San Francisco intercept] and decrypts, indeed
the simple traffic analysis of the unusually high number of Japanese Naval
messages [93] should have pointed to the coming of war, but dawn on December
7, 1941 was thought to be just another Sunday in Hawaii.

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[6] According to a map of “The Splendid Arrangement” of intercept stations in DAY OF
DECEIT [93] on page 68, a Midway radio station primarily used for direction finding
was identified with the nomenclature “AF” (and Sitka, Alaska was “AE”). According to
several sources, “AF” was the Japanese code term for Midway Island, decrypted by the
U.S. Navy and confirmed by a radio hoax on the Japanese before the Battle of Midway
that had been perpetrated by Navy cryptologists Jasper Holmes and Joseph Rochefort.
[73] Although “there are no coincidences...,” confusion is possible.
World War II’s Etheric Conflicts: The Setting of the Radio Wars

U.S. counter-espionage work in the ether was initially the domain of the FBI, but the Coast Guard also made a claim to jurisdiction, based, no doubt, on its Prohibition work. [5] The FBI enjoyed a brilliant success in operating a fake spy station on Long Island to communicate with the NAZI control station AOR, in Hamburg. It lead to the arrests of 33 spies in June, 1941. [92] The Coast Guard and the Army, as late as May, 1936, each had as few as seven or eight cryptologists working. [38] In short order, however, the Federal Communications Commission, under George Sterling, assumed domestic intercept responsibilities. [92] Sterling was a leading radio authority and later an F.C.C. Commissioner. At the beginning of the war, the F.C.C. formed the Radio Intelligence Division (R.I.D.) to intercept spy radio transmissions and other traffic. [92] [Figs. 36, 37, 38, 39] The R.I.D. claimed to have put many Axis spies out of business, perhaps as many as 200. Commissioner Sterling has told this story so well [92] that little of it will be repeated here. Herr Flicke, however, very much doubted the R.I.D.’s claims, because he was in a position to know that Germany never had anywhere near that number of agents in place. “Sixteen was more like it,” he wrote after the war. [35] The American
success in intercepting radio transmissions from Axis agents in South America also got all too much disclosure during the war in TIME magazine in November, 1942 and by the Pan American Union in 1943 (e.g., four agent groups in Argentina alone). [55]

Commissioner Sterling, in telling his story, kept silent about the F.C.C.'s intercepts of Soviet signals. In 1942 it monitored Russian Embassy transmissions from Maryland. It also intercepted illicit transmissions from the Russian Consulates in San Francisco and New York. The F.C.C. also cooperated with the British in targeting Soviet clandestine stations. Sterling similarly did not reveal F.C.C. interception of British Royal Navy traffic in September, 1943, with the U.S. Navy providing the stations, frequencies and schedules. [2]

As of August, 1940, after the French armistice, a French intercept operation continued working in Vichy territory as the Groupement des Controles Radioelectriques for the Duexieme Bureau. It employed several listening stations in France and direction finding stations in France and North Africa, with about 400 people working at various tasks. Its Commandant Romon suffered arrest by the NAZIs in December, 1943, and they shot him in August, 1944. [86]

The Germans excelled in technical intelligence techniques. As early as 1940 or 1941, the Germans developed a device to unscramble the radio-telephone calls between President Roosevelt and Prime Minister Churchill. It was presumably a vacuum tube analog computer-like machine, for it was "a complicated apparatus ... constructed at great cost, based on the recognized rhythm of the known distortions," according to Flick. [35] Telephone engineer Kurt Vetterlien ran an intercept post (the "research post") on the Dutch Coast. It focused only on high Allied leaders' radio-telephone communications. Knowing AT&T's system, he had been working for the German Post Office on descrambling since the mid 1930s. His success was not expected by Allied technologists. [73] Hitler read the transcripts of these calls in near real time. However, a change in the Allied scrambling system put the device out of business.

The United States used a world-wide network of at least ten radio stations. The Germans called this the KVNA-net, after the VNA call sign of the first heard station, in Karachi, now Pakistan. Station WAR in Washington acted as net control for the central station. The Cairo station was WVNV. The Germans read most traffic on this net directly: "... it afforded information on American military measures in the Far, Middle and Near East and in Africa." [35]

Perhaps the greatest success that the Germans enjoyed in interception for intelligence purposes came in North Africa in 1942. General Irwin Rommel earned his sobriquet "The Desert Fox" with his battlefield prescience. What was actually going on was more mundane: The German General Staff
(Oberkommando der Wehrmacht) military radio and cipher breaking group (OKW-Chi) intercepted and decrypted (with the help of a secretly copied code book) the communiques of the American Military Attache in Cairo on the Cairo KNVA net. He reported to the State Department in Washington every move and plan of the British. OKW-Chi at Nuremberg passed on his detailed reports to General Rommel. [35, 86]

On June 27, 1942, a German domestic station broadcast a radio drama about the war in North Africa. One of its characters was an American military attache in Cairo who sent detailed reports back home. Transmissions from the real attache, and hence intercepts, stopped two days later. A change in the American code soon deprived Rommel of the best strategic and tactical intelligence of the War. He had no advance warning of British General Montgomery's coming attack at El Alamein, which was the turning point of the war in North Africa and in the West. [86] The German thrust to the oil-rich Middle East was parried.

As of 1942, the U.S. Army Signal Intelligence Service set up its main European intercept station at Vint Hill Farms in Warrenton, Virginia. It was soon followed, for Pacific intercepts, by Two Rock Ranch in Northern California, and a much enlarged operation in Hawaii. These were Stations One, Two and Five. They employed Hammarlund Superpro receivers, favored for their two RF stages, and many highly directional rhombic antennas. [64] The network of Allied intercept stations was not just located in Europe and America but was spread worldwide throughout the war. For example, an intercept station in India, (probably in New Delhi) provided valuable intelligence to MacArthur's Combined Bureau on Japanese intentions in Indochina. [55]

The warring powers filled the ether with signals. As a result of ionospheric effects, the shortwave signals bounced around the world. Between 1938 and 1942, sunspot numbers were peaking, promoting long range high frequency propagation of both military and diplomatic transmissions as well as international broadcasting. [94] Sometimes, for example at Two Rock Ranch, one station could, and often, did monitor an entire theater of operations.

Most of these signals were encrypted Morse Code. Few were radio teletype using Baudot code, because propagation conditions made teletype reception very difficult. The U.S. did, however, use an IBM radiotype system on domestic military circuits, and a Baudot system overseas. [95] The Russians also used a radio-teletype circuit back to Moscow. [2] Some tactical communications used radio telephone which often operated on very high frequencies. Aircraft communications, including those from German bombers [Fig. 40] and Japanese Naval aircraft, frequently employed AM voice mode, and were duly intercepted. Roosevelt and Churchill spoke across the Atlantic on radio telephone, duly scrambled and initially, duly unscrambled. Of course, everyone was listening to everyone else, most of the time. The codes were regularly broken on all sides, except for high level Russian communications and most but not all of the British and American codes.

The Allies also used false radio traffic to mislead the NAZIS as to their own intentions, particularly in connection with a second landing after Normandy which was codenamed Operation Bodyguard. [82] Hitler continued to withhold forces in the summer of 1944 to meet the second landing north of Normandy that never came. The British used the "double cross system" to turn almost every NAZI spy in England. When captured, each spy was given the choice
Figure 41. Navy HRO at work. (Radio, May 1942)

Figure 42. National NC-100, father of a generation of Navy, Marine Corps and FBI intercept receivers. (Moore, Communication Receivers)

Figure 43. Navy 1930s RBA and RBC 'battleship' receivers also used for intercept work. (ex author's collection)

Figure 44. Panoramic SX-28 surveillance system by Hallicrafters in 1942. (Radio-Craft)
to work with the British, or not. Those that did not were 1) shot and 2) replaced with British agents pretending to be that German spy. Each of them then radioed the Germans false information, much of it purportedly from very high levels in the British government.

The Allies maintained false levels of traffic from the mythical First Army Group (FUSAG) to mislead the Germans who were seeking to understand allied intentions by using traffic analysis, [73] a deceptive practice begun in the North African campaigns, [86] with antecedents in World War One. The Germans ran “radio games” (funkspiel) to subvert Allied intentions. For example, they ran the entire British sabotage network in Holland, [108] even asking the British by radio for airdrops of chocolate. On the other hand, a British radio deception helped to save the Normandy invasion of June, 1944. The British convinced the NAZIs that their supposed agent CATO could obtain the highest secrets by sending a message supposedly coming from CATO to Germany reporting that the Allies would indeed invade Normandy on June 6. They sent this warning just too late to be of use. It did, however, establish CATO's credibility. CATO then sent another message on June 9, that the real invasion was not at Normandy, but farther North. Hitler believed it and held his crucial Panzer divisions in reserve. [49]

There was often little difficulty in hearing signals. Ground wave often sufficed for nearby armies. Skip propagation permitted long distance technical intelligence gathering from the ether. The transmitters ranged from broadcasting stations of up to 500,000 watts and more, to spy radios of maybe five watts on a good battery. Utility services, including radio telephone, ran five to ten or more kilowatts as did naval land-based circuits.

Military land based circuits such as WAR and WVY ran at ten kilowatts for the main transmitters. [95] The U.S. Army's main station, WAR, was located in Washington, DC. Intelligence services' spy and sabotage control stations often communicated using hundreds of watts with directional antennas providing gain. Unless a broad area was to be covered, such as by a BBC broadcast, it made good security sense to limit power and use directional antennas.

Ships at sea still used long wave as well as shortwave, with transmitters such as TAQ, TBA, and TBB, being used for frequencies from 200 kHz to 30 MHz. [59] The Navy in Hawaii put out 500 kilowatts at 26.5 kHz and 355 kHz was the primary ship to shore frequency [59] The Navy also used its shortwave capability (primarily 2.716 MHz as of 1941) at lower powers. Aircraft often conducted liaison communications at a hundred watts or less, often using much less on shortwave. Command communication among aircraft ran very low power transmissions of ten watts or so.

Figure 45. Army WW II intercept operators at work in North Africa. [33]
Figure 46. Army WW II intercept operators at work in the Pacific. [33]

Figure 47. Army WW II combat intercept post New Guinea, 1944. [33]

Figure 48. Army SCR 206 / BC 470 pre-W II RDF in Hawaii, 1940. (photo from [33], identification by Paul Thekan, MRRG)
Tactical military signals ran from one hundred watts and often much less, down to the 350 milliwatts of the Handy-Talky BC-611, which was good for maybe half a mile with ideal terrain and fresh batteries. (It has been reported that these "Walkie Talkie" sets were purposely detuned to limit their range because the foot soldiers who carried them had no training in coded transmission and their plain English communications could provide too much information for the Germans.) VHF command communications worked on FM at five watts or so. Spies in the field operated at the lowest power practicable, and for the shortest time to defeat direction finding while still permitting communications.

The receivers which were used came from the general market and primarily exemplified the designs of the 1930s. The Army Signal Corps' initial intercept efforts anticipating World War Two, circa 1939, used the early Super-pro to take the traffic.

The U.S. Navy favored National Company equipment, including the HRO series [Fig. 41] and the NC-100 series [Fig. 42]. The Navy "Battleship Receivers" were specially designed in the 1930s and manufactured by Federal Telephone and Telegraph (and others including RCA). [Fig. 43] The Navy nomenclature for these was RBA for long wave, RBB for medium wave and RBC for shortwave. Early Navy intercept work often used the RBA and RBC sets. The working receivers in many installations, including submarines, were the matched pair of tuned radio frequency (TRF) receivers with regenerative detectors, called RAK and RAL, for long wave and shortwave. Dutch Harbor, Alaska used an RAK, an RAL, a Navy National HRO-7 known as the RAS, along with a Hallicrafters S-20-R for VHF. [27] Intercept Station King (K) is identified as being sited at Dutch Harbor. The Navy also employed the National 1-10 VHF regenerative receiver for surveillance and intercepts. [Figs. 62, 63]

The F.C.C. favored Hallicrafters equipment [see, e.g. Fig. 44 the SX-28 and panoramic adaptor S-35]. The Federal Bureau of Investigation used the SX-28, and the National HRO series and there is anecdotal evidence that the FBI used National NC-100s for intercepts and feeding the signals to recording systems. An FBI photo of a NAZI spy shows his similar preference for Hallicrafters gear [Fig. 61]. The Office of Strategic Services had to make its own tactical equipment in the China-Burma-India (C-B-I) theater, and in Europe, the O.S.S. used miniaturized state-of-the-art VHF equipment (the "Joan Eleanor" system, named after developer Al Gross's wife and daughter) to avoid direction finding interception by transmitting straight upwards to high flying aircraft with VHF receivers. (The transceiver weighed four pounds and measured 6 ½ inches long by 2 ½ inches wide by 1 ½ inches deep.) [73]

Antennas in all theaters ranged from short VHF whips and short wires, through random length long wires to complex direction finding arrays and precisely aimed rhombics and log periodics. The Army at Vint Hill Farms and Two Rock Ranch put up arrays of rhombic antennas for nearly worldwide coverage.

With so many signals in the air, all World War Two belligerents employed tactical intercept units. The U.S. Army operated tactical radio intercept and intelligence units in every theater on every level. [Figs. 45, 46, 47, 48] U.S. Navy Radio Intelligence Units did shipboard tactical intercepts for task force commanders and the Fleet Admirals.
On the strategic level, the British General Communications Headquarters, G.C.-H.Q., successor to G.C. & C.S., reported to the Foreign Office. The "Y" network of receiving stations, many initially manned by amateur radio operators, became the Radio Security Service (R.S.S.) and ultimately the Composite Signals Organization (C.S.O.). The Royal Air Force, for example, posted its main intercept station at Cheadle with 100 receivers working. The British success, of which Winston Churchill was so proud [25], has been thoroughly documented by Nigel West in THE SIGINT SECRETS [107]; [see Figs. 56, 57, 58]. The British even established a research and intercept post in Antarctica. [72] [Figs. 59, 60]. It was primarily tasked with making measurements of the height of the ionosphere and radioing them back to England to help in predicting worldwide radio propagation.

American intercept operations included:
1) The Federal Communications Commission (F.C.C.) Foreign Broadcast Intelligence Service (F.B.I.S.),
2) the F.C.C.'s Radio Intelligence Division (R.I.D) covering North and South America,
3) the U.S. Navy, from California and Washington State, Hawaii and Australia, for the Pacific Theater. In Hawaii, the Fleet Radio Unit Pacific (FRUPAC) handled the Pacific Fleet's communications intelligence. FRUPAC supervised Radio Intelligence Units working for fleet and task forces commanders. [73] FRUPAC and its predecessor Station HYPO handled at least 1,460,000 Japanese messages during the war. In Australia, MacArthur's unit in Melbourne was FRUMEL in support of his Combined Bureau joint intelligence operation. [32]
4) The U.S. Army, initially by the Signal Intelligence Service, then by the Army Signal Security Agency, focused primarily on the European theater but used monitoring stations in Washington State and California. The Army's pre-war intercept stations ranged from New Jersey to Texas and Panama to California, Hawaii and the Philippine Islands. During the war, the Army also established intercept stations at:
- Amchitka, Aleutian Islands, Alaska;
- Asmara, Eritria, Africa;
- Bellmore, L.I., New York (ex-O.S.S.);
- Fairbanks, Alaska;
- Guam Island;
- Indian Creek (Miami Beach), Florida;
- New Delhi, India;
- Petaluma (Two Rock Ranch), California;
- Tarzana (Reseda), California (ex-O.S.S.);
- Warrenton (Vint Hill Farms), Virginia. [64]

In addition to these 17 major stations, hundreds of field and mobile stations supplemented the intake of enemy traffic. By 1945, the Signal Security Agency handled 380,000 foreign messages a month, but operated only 11 listening posts. [2]

In Australia, General Douglas MacArthur, Commander of the South West Pacific Area, enjoyed his own intercept network and decryption section. [32] Australia operated its own intercept stations. So, too did New Zealand. Both nations employed the Australian copy of the National HRO receiver, [Fig. 49] and also RCA AR-77s. [87]
The main German intercept operations were:

1) Seehaus "Lakeside Facility" shortwave broadcast monitoring;  
2) Military intelligence OKW/Chi [military intelligence, cypher];  
3) Internal security, the "Research Bureau" Forschungsampt (FA);  
4) Secret State Police, the Gestapo.

The Italian also developed a number of intercept receivers for tactical and intelligence work. [Figs. 53, 54, 55] Even the NAZI-allied French (Vichy regime) intercept operations continued to December, 1943, and likely into 1944, until the Allied invasions. [86]

The Japanese operated their main intercept station at Owada outside Tokyo. It was listening to broadcasts and diplomatic traffic as well as foreign armies and navies, as detailed below. The Japanese Army and Navy also did tactical intercepts in the Pacific and in China and Burma.

The Russians operated several levels of intercept service, with much tactical monitoring on what the West called the Eastern Front during the War, and with the radio section of the N.K.V.D. (the state security committee) intercepting diplomatic circuits and monitoring foreign broadcasts, along with internal security monitoring. [Figs. 50, 51]

As of 1933, the Soviet intercept agency was the best supported in the then mostly peaceful world. Work on ciphers flourished in the late 1930s and by the early 1940s the Russians also broke the Japanese Purple Code. By then the intercept service of the G.R.U., concerned with Soviet military intelligence, had separated from the similar work of the N.K.V.D., which concentrated on diplomatic traffic. (The name of the latter became N.K.G.B. in 1943. Its Eighth Directorate handled communications intelligence and later (1968) the 16th handled SIGINT.) The Soviets filed German, Italian, Japanese and Turkish intercepts. Their use of American and British radio receivers in large quantities permitted effective tactical radio interception by special purpose radio battalions on the Eastern Front. In London, the Soviets used radio interception to assess British surveillance of their illicit activities, a first in counter-counter-espionage. [3]

Towards the end of the war, the Russians targeted Allied radio circuits, and the Allies found out that they had been targeted by decrypting a Russian radio-teleprinter circuit. [2]

Radio Intelligence War Work in San Francisco: The Two-Three-Four in the Presidio and at MacKay’s Station KFS at Half Moon Bay

The Japanese attack in the Pacific on December 7, 1941, was indeed all too much of a surprise. In the six months that followed, the Japanese overran American, British and Dutch cities and bases around the Pacific’s Western shores. The British lost Singapore in late December, 1941. In the Philippines, first the Bataan Peninsula, and then the fortress of Corregidor fell by May, 1942. The Dutch lost Bandoeing and the rest of Indonesia, with all its oil, early on. By the end of 1942, the Japanese ruled from Manchuria to Australia, and from India’s border with Burma to the Western Aleutians in Alaska, Wake Island in the mid North Pacific, and the Solomon Islands in the South Pacific.

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7 Recordings are available from the U.S. National Archives and Records Administration made by Germans in France in 1944 of American radio telephone transmissions in England which may have been designed to deceive the enemy.
Figure 49. Australian copy of the American HRO intercept receiver. (AWA Annex)

Figure 50. Soviet 1932 shortwave receiver. (AWA Annex)

Figure 51. Soviet KV-M intercept receiver, possibly post-war. (from a 1955 British manual)

Figure 52. Intercept Nov. 1941 Presidio of San Francisco. (courtesy of Robert Stinnett [93] from NARA)
MacArthur escaped from the Philippines to Australia on a submarine. The last, heartbreaking message from the last Army radio operator on Corregidor, as the fortress surrendered, was copied helplessly by several stations.

Most of the information that follows comes from Professor Richard D. Kain’s 1998 oral history recorded by the National Park Service at the Presidio where he had served as a Sargent and intercept station “trick chief” between 1942 and 1946. [50] In the chaotic period of retreat and defeats during December, 1941, and early 1942, the ether delivered a few strange shortwave signals to state-side monitoring stations. They seemed to be Americans seeking contact with American Forces and transmitting Morse code in plain language. They could be heard most frequently in California. Perhaps they were some Japanese trick, the kind of “radio-game” of which the NAZIs were so fond. On the other hand, maybe they really were Americans in desperate straits.

The Army quickly established contact. Once communications links were working, the operators could determine that they were indeed talking to Americans. Only Americans could know cultural details, family matters and the minutia of overseas postings. These circuits, however, posed an unusual problem: the overseas radio operators had no code books, so only plain language messages had to suffice.

The Army early on decided to create a “cover” for these communications. All Army operators adopted amateur radio processes, procedures, call signs, nomenclature, and abbreviations (such as the Q signals, e.g., QRN for noise on the circuit, QRM for interference, QSO for contact or conversation, etc.). The Army thus sought to create the impression that some “hams,” willing to violate the shut-down orders of December, 1941, still talked to each other on the shortwave bands in C.W. Morse Code. Fifty years later, Prof. Kain could still remember working a Navy man, Roy Tweed, on Guam after it came under Japanese control. He recalled Hammarlund receivers (one shows in a photo [Fig. 64] in the unit’s History) as well as Mackay equipment, and that of the Hallicrafters and National Companies. These pseudo-ham QSOs used nothing but the best amateur radio equipment.

The Signal Corps created at least one dedicated radio company to communicate in this manner. The Presidio of San Francisco housed it. The Signal Corps called it the 234th Signal Operation Company. Its last commander was Captain William B. Inglis of Norman, Oklahoma. The 234th documented itself, consistent with war-time security constraints. It produced a company book, and recorded some of its stories. Some photos have also been preserved. [101] On September 21, 1945, the Army awarded the 234th its Meritorious Service Unit Plaque.

It may be that the 234th was not preceded by 233 prior companies. “Two Three Four” sounds like an arbitrary but hardly random numerical sequence. Perhaps similarly, the covert and irregular Office of Strategic Services (O.S.S.) named its only operational combat regiment in the China-Burma-India theater of operations “the 101st Detachment,” lest it ever be known that it was only the first such unit. [63]

In 1942, the Office of Strategic Services (O.S.S.) set up two intercept stations in the United States because it did not receive enough intelligence information from the Army and Navy. A front company, FBQ Corporation, established the listening posts in Reseda (Tarzana), California and in Bellmore, Long Island, New York, for foreign broadcasts. The Army soon took them over [73] and used both sites in 1944 to monitor Army transmissions for security breaches. [73]
These Army security stations monitored the work of Army radio operators such as those of the 234th. In the case of the 234th, however, the monitors did not want to hear good, secure, standard Army communications. The whole point had been to disguise the overseas contacts as amateur radio bootleg QSOs. Hence the monitors listened for any deviation from amateur radio procedures and even vocabulary. The last thing they wanted to hear on these circuits was Army talk.

In one instance, the Army disciplined an operator (then Sgt. Kain, Professor Kain admitted) for saying in his QSO with an overseas operator that he had "just gotten out of the sack." Use of an Army term like "sack" for bed could give the game away. It was hoped that enough boring ham talk, and only ham talk, would send Japanese intercept operators elsewhere for more interesting traffic.

The 234th Signal Company operated from its own radio station on the Presidio. A site inspection of the known radio buildings as of 1998 suggested to Professor Kain that the station was the former Crissy Field aeronautical radio station. This building, with its own small generator outbuilding located next to it, has long been converted into a nice house. It is at the West edge of the Crissy Field homes of "officer's row" which housed the pilots and their families. In the 1920s and into the 1930s, it housed the radio transmitters and receivers used by the Army Air Corps to communicate with the biplanes and pursuit aircraft using Crissy Field on the North shore of the Presidio. The 234th's History discloses that the unit operated at Crissy Field until October 7, 1944. [101]

The World War Two radio operators of the 234th in the Presidio referred among themselves to their radio station as "the H.O.I. P." for "House of Intelligent Persons." This station, however, did not provide the only base of radio operations for the 234th. Forty miles South, International Telephone and Telegraph's Mackay Radio Company operated a radio receiving site near Half Moon Bay for its commercial and marine station KFS. The resurrected Globe Wireless Company operates this receiving site to this day for its KFS and KPH transmitters in Palo Alto utilizing marine digital communications with ships at sea. The callsign KFS dates from the Federal Telephone and Telegraph Beach Station on Ocean Beach in San Francisco, callsign FS, which was known for its 1910 arc operations. Before Pearl Harbor, the Half Moon Bay site may have been British Station X in the Splendid Arrangement. [93] On December 7, 1941, the radiomen at KFS heard, on 500 kHz, the signal for submarine spotted (SSSS SSSS SSSS) then an S O S, then silence. Globe Wireless operators at KTK, at nearby Mussel Rock in Pacifica, also took the traffic. [68] The ether thus carried some of the first signals of America's Pacific war.

Mackay Radio (and now the resurrected Globe Wireless) had (and has) a wonderful network of antennas, rhombics and the like, for working the Pacific. The war shut off most of the KFS commercial and marine traffic. The Coast Guard took the station over, and the radiomen became Coast Guardsmen. In short order, however, the Army put some or all of the antennas to good use and the receiving station was back in business.

In August of 1942, a KFS intercept started the communications between overseas operators and the West Coast. American guerillas using the old Manila army station callsign KAA called WAR, the U.S. Army's main station in Washington. They came up on the 8 MHz marine band where they were sure
Figure 53. (left) Italian WW II intercept receiver RF2. (courtesy Mario Galasso, IKOMOZ)

Figure 54. (right) Italian WW II intercept receiver I607 targeting an American SCR-522 in Malta. (courtesy Mario Galasso, IKOMOZ)

Figure 55. (above) Italian WW II RDF in the Balkans 1942. (courtesy Mario Galasso IKOMOZ)

Figure 56. (right) British Voluntary Interceptor radio spies get unwanted publicity. [107]

SPIES TAP NAZI CODE
BY A SPECIAL CORRESPONDENT
BRITAIN'S radio spies are at work every night.
During the day they work in factories, shops and offices. Colleagues wonder why they never go to cinemas or dances.

But questions are parted with a smile—and silence. Their job isn't one to be talked about.
Home from work, a quick meal and the bush-bush men unlock the doors of a room usually at the top of the house. There, until the small hours, they sit, head-phones on ears, taking down the Morse code messages which fill the air.

To the layman these would be just a meaningless jumble of letters.
But to the hands of code experts they might produce a message of vital importance to our Intelligence Service.
No pay is given to the men who pull the air for these messages.

Their Reward

They are drawn from the radio enthusiasts who operated their own short-wave transmitters before the war.

We are glad to serve the country in this war," one of them told me. "A letter of thanks from head quarters telling us that we have been able to supply some useful information is all the reward we ask.

Naturally we have no idea of the codes used by German agents.

But it is a great thrill to feel you might be getting down a message which, decoded, might prove of supreme importance."
to be monitored. The Navy and KFS completed a circuit and verified the identity of the guerillas. The circuit stayed open until the Japanese captured the group, killing some and imprisoning the remainder of them.

Another station soon came up, using "WPI," the old U. S. Army Philippines station callsign. It, too, was vetted, and then that circuit carried considerable traffic about Japanese positions in the Islands, all in plain language. Soon a new circuit opened with a more organized group that enjoyed the benefit of an M-94 cypher machine. At this point the Army put in its own shifts of trained operators at KFS. [68]

Details of operators from the 234th at the Presidio went down to KFS for months at a time. They had no leaves or time off. The work was intense and demanding as the war progressed. More and more stations appeared in the Pacific. Soldiers and sailors left behind, especially in the Philippines, came up on jury-rigged transmitters which they had reconstructed. Philippine partisans also put radio equipment into operation. Escaped prisoners of war did the same. Civilians in the war zone came on the air, sometimes from transmitters in ships. In the South Pacific, the "coast watchers" provided intelligence about Japanese naval movements by radio. Toward the end of the war, submarines landed commandos in the Philippines who carried good, working radios and operated on pre-planned circuits with the 234th.

On December 26, 1944, notes the History of the 234th, it received a "Commendation at the conclusion of special mission at Radio Station KFS at Half Moon Bay, California. It was the relay of radio traffic in a certain net designated by the Commanding General South West Pacific Area."

Radio operators at KFS also specialized in reception of weak distress signals from survivors of torpedoed ships which were transmitted on the universal distress frequency of 500 kHz. KFS had a particularly good custom-made marine receiver available and it was able to save many lives. [68]

The 234th also got an early taste of the Cold War. Still active at the end of World War Two, the Army called upon it to set up the first teletype circuit with Moscow. The United Nations (and President Truman) came to San Francisco in June, 1945 for its formal post-war revival, The "United Nations Conference of International Organization" (the Allies had also used the term "United Nations" for themselves as they battled the Axis powers). The 234th thus played a role in the U.N.'s genesis.

There may well have been other units with equally dramatic stories. War time secrecy has, unfortunately, outlasted almost all the participants. With the ongoing declassification of World War Two documents, perhaps more of these stories will become known.

The "adventures in the ether" of the 234th emphasize that radio intelligence work knew no "front line." Getting too close to a real front line cost the lives of all too many radio intercept operators on all sides. Much of the work could be, and in many cases had to be, done thousands of miles from combat. To do it right, it often had to be done far from the dangers and distractions of the ongoing warring armies. The dedication of these intercept operators was no less intense despite their relative safety.
Figure 57. British Voluntary Interceptor post early WW II. [107]

Figure 58. British Voluntary Interceptor home listening post. [107]

Figure 59. British Antarctic WW II Station Alpha part of a possible TABARIN network. (courtesy Tom Perera, W1TP, who visited and photographed the station in 2002.)

Figure 60. British Antarctic WW II station Alpha interior with RG35 receivers used for ionosphere measurements and interception. (courtesy Tom Perera, W1TP)
Two Brothers in Two Theaters of the Radio War

Dick Secondari and the late Elliot Secondari, twin brothers from San Francisco, served in the U.S. Army Signal Corps in World War Two. Dick Secondari has generously made his personal archives available. He was drafted in 1943 as a 19 year old, as was his brother Elliot. Both had been amateur radio operators and knew the Morse Code. The Army sent them to the Signal Corps after Basic Training. They both qualified as Radio Intelligence Intercept Operators. Dick Secondari has provided the information that follows.

Dick Secondari served with the Second Signal Service Battalion (established by Gen. Maubourne in 1939) whose personnel operated all over the world. The Signal Corps assigned him as an intercept operator to stations working Japanese traffic and he was an “IO-J.” The IO-Js had to learn Japanese Kana Code, with 58 different characters and two phonetic signs. They transcribed this onto typewriter like machines, known as RIP-5s.

The Signal Corps initially posted Dick Secondari to Two Rock Ranch North West of Petaluma California and he made occasional visits to the Presidio. Later he served in Hawaii, and he had been posted to Guam as the war ended. The intercept stations moved West as the Japanese retreated. The traffic consisted of operational messages and procedural messages for radio circuit operation. The Japanese used 50 word per minute Kleinschmidt perforated tape keying systems. The intercept operators recorded the traffic on inked paper tape recorders, the BC-1016, then typed the encrypted messages out as Kana Code. Dick Secondari, still an active amateur radio operator (as K6TR), still has a paper tape recorder, and some documents and messages preserved from his IO-J days. The Waters Conley company of Rochester, Minnesota, made the tape recorder (Army BC-1016 and Navy SC-10 equipment), and an illustration of it from its manual appear nearby. [Fig. 65]

While on duty, Dick Secondari compiled a personal dictionary of Japanese radio and other terms. He used it to decipher some of the procedural circuit transmissions. For example, he could use his little-black-book dictionary to help figure out a message to change frequency. Then the IO-Js would tune the intercept receivers so they were ready and waiting for the traffic on the new frequency. The IO-Js were thus up on the new Japanese frequency before the Japanese were. A page from his circa 1944 dictionary appears nearby. [Fig. 66] He also retained some of the “end of the War” messages which he had access to and one is reproduced nearby. [Fig. 67]

The Japanese transmitted diplomatic as well as military messages via shortwave radio. The intercept operators called the diplomatic traffic “Dip.” As the Japanese conquered new territories, e.g., the Dutch East Indies (Indonesia), they incorporated surrendered radio stations into their network. They did not, however, change the call signs. They also used their own standard pre war call signs. This made circuit analysis and traffic analysis easy. The station at Bandoeng, for example, retained its pre war call letters, PLK1, as the Japanese continued to operate it after wresting it from the Dutch.

Dick Secondari’s recollection is that the Army favored Hammarlund receivers. The Army intercept stations racked three Hammarlund Superpros as a diversity receiver with a metered combiner circuit (behind a black wrinkle-painted panel) at the bottom of the stack. Dick Secondari recalled that the Army published a photo of such a diversity setup in a wartime radio magazine (without disclosing its intercept function). He still has a copy of that picture from the magazine,
Figure 61. NAZI spy Joseph Klein with his NAZI dog at his radio station in New York c. 1941. (FBI photo in [82])

Figure 62. VHF surveillance receiver RBT-2 (NC-1-10). (author's collection)

Figure 63. VHF surveillance receiver RBT-2 nameplate (1944). (author's collection)
and it appears nearby. [Fig. 68] The three meters to the right in the bottom rack each correspond to one of the BC-779A receivers, the left meter shows the final combined output. The two bottom meters monitor the power supply. Each receiver worked off a different rhombic antenna, pointing in a slightly different direction in order to eliminate fading and atmospheric distortions. The output from the combiner went directly to paper tape, not earphones. The operators read the tape visually. Operators used earphones for tuning, but almost never a loudspeaker such as the one shown on top of the rack. The nearby frequency meter (BC-221) provided accurate tuning of the system to the nearest kilocycle. As the operators read the tape from the Waters Conley machine, they typed out the Japanese Kana code characters on a RIP-5 teletypewriter. Others then re-encrypted these messages and used the land line teletypewriter circuits to send the messages to Washington for decryption of the Japanese text. The operator in the photo holds the same rank as Dick Secondari did at the time; he mustered out in 1946 as a “Spec. 5.”

The East Coast stations to which Elliot Secondari was assigned monitored Germany primarily. Army intelligence on the East Coast also targeted Argentina, because of the heavy German influence there at the time. Elliot Secondari was assigned to stations working German traffic, and he was an “IO-G.” He also served with the 3258th Signal Service Company in Europe with the U.S. 9th Army. A photo taken 50 years after this intercept work, of the two Secondari brothers (Dick on the left and Elliot on the right), as the radio operators of the SS Jeremiah O’Brien, (homeport San Francisco, callsign KXCH) appears nearby. [Fig. 74]

Tactical Intercepts

In the military battles of World War Two, all belligerents communicated by radio, intercepted radio communications, and sought to deceive by radio. The best telling of the tactical details of this intercept work is in Major Hugh Skillen’s SPIES OF THE AIRWAVES (1989) supplemented by his Enigma Symposium (one each in 1994-99). Intercept operators all too often found themselves in combat on the ground as well as in the ether. Major Skillen lays out the whole of the Second World War from the perspective of military intelligence that had been derived from radio interception. His is the definitive if relentless work, from which only slivers will be taken for this note.

As of 1940, the U.S. Army formally described its tactical radio operations:

— Tactical operations affect the operations of the radio intelligence company in varying degree. The effects of some of the more common tactical operations are indicated below:

(1) Intercept operations vary but little with the tactical situation. These operations for both long and short ranges consist of searching the workable radio spectrum rapidly and intercepting all types of transmission from both enemy and friendly stations for extended periods of time. The location of the intercept station is to a large extent independent of the terrain, and all activities can be concentrated in one room or tent without affecting the efficiency of operation.

(2) Position finding operations vary markedly with the tactical situation. These operations are governed by the distance to and power of radio transmitters employed by the enemy, the extent and frequency of movement thereof, and the tactical maneuver of our forces...
Figure 64. (left) Army 234th Signal Operations Company BC-779 radio console in the Presidio. [50]

Figure 65. (above) Papertape Recorder for Japanese Morse. [manual, courtesy K6TR]

Figure 66. (left) Intercept operator's dictionary (page) of Japanese procedural words. (made in 1944 by Dick Secondari, K6TR; his collection)

Figure 67. (below) End of Pacific War 'Beware of Treachery' message. (K6TR)

<table>
<thead>
<tr>
<th>17 AUGUST 1945</th>
<th>S-E-C-R-E-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM: CINCPAA ADV HQ</td>
<td>TO: ALPOA</td>
</tr>
<tr>
<td>INFO: COMINCH</td>
<td>1423°4/576</td>
</tr>
<tr>
<td>CEASE OFFENSIVE OPERATIONS AGAINST JAPANESE FORCES AND CONTINUE SEARCHES AND PATROL TO MAINTAIN DEFENSIVE AND INTERNAL SECURITY MEASURES AT HIGHEST LEVEL. AND BEWARE OF TREACHERY OR LAST MOMENT ATTACKS BY ENEMY FORCES OR INDIVIDUALS.</td>
<td></td>
</tr>
<tr>
<td>S-E-C-R-E-T</td>
<td></td>
</tr>
<tr>
<td>MDC 153</td>
<td>CODE PASSED TO ASP</td>
</tr>
<tr>
<td>DECIDIST: WU EESP</td>
<td></td>
</tr>
<tr>
<td>CORRIGAR</td>
<td>1423°4/576</td>
</tr>
</tbody>
</table>
Intercept and direction finding operations are interrelated to the extent that intercept stations usually first detect enemy transmitters..." [102]

The role that tactical radio interception played in military intelligence in the North African campaign was critical on both sides. Rommel had the benefit of a superb tactical intercept and decryption unit, Radio Company 621 under the command of Oberst Lt. Harold Seebohm (a veteran of the Polish and French campaigns). He lost it all, including Seebohm, in combat on July 10, 1942 to an Australian Army attack. Seebohm died of his wounds. [86]

British tactical intercept units also found themselves in combat and sustained loss of life in North Africa, in the shifting tides and fogs and sands of battle. [86] Both Rommel and the British commanders frequently had the benefit of viewing intercepted, decrypted and translated tactical traffic before the intended recipient actually received it. [86] Lax American communications security often assisted the Germans, [86] as lax British security had assisted them earlier.

Some 40 British Special Wireless Sections acted as the ears of the British Army. [Figs. 69, 70] Thirty of these worked in the field with a complementary Wireless Intelligence Section. Wireless Intelligence Section 55 trained the American 128th Radio Intelligence Company, one of the Army's first, in the North African Campaign. [86].

A typical British tactical intercept unit at Corps level employed 20 National HROs, ten Hallicrafters S-27s for VHF, and three loop direction finding vans. [86] Morse code was the order of the day except for the VHF radio telephone used by German armor and some AM air communications. Both the Australians and the Polish Army in exile assisted the British intercept efforts. The Polish success was impressive, at one point sneaking into a German combat air radio telephone net and successfully commanding the aircraft to return to base. [86] A Polish intercept unit went to Palestine to monitor the Russian Front. [86]

In June, 1944, the Normandy invasion succeeded. By 1944 "radio intercept had become the most valued source of military intelligence in the German Forces" which deployed 17 Communications Reconnaissance Battalions [86] under General Fritz Boetzel. [86] Each intercept company operated 36 receivers. The Army units used the German receivers Ln-E.a and Kw-E.a (for "shortwave - ground, model 'a'. "The Kw-E. a. set is reported to be "a high-grade superheterodyne..." [99]; see [Fig. 71]) and the R1 V. The Navy and the Abwehr intelligence service favored the KST, a copy from the late 1930s of the National HRO by the Korting Radio Company. [86] The U.S. Army characterized several other German radios as intercept receivers: the Fu. H. E. c. ground receiver, the earlier Fu. H. E. u. ("a well constructed, battery-operated 9-tube superheterodyne..."), the Torn. E. b. [Fig. 100] ("nicknamed 'Bertha,'" which is the German phonetic for the letter "b") [99].

In the latter part of the European campaign, British radio intercept crews sometimes were tasked to communicate with the German radio networks on matters of prisoner treatment and possible exchange and these unusual communications between enemies took place when necessary. [86]

The British units mostly operated National Company HROs, in their nomenclature "R-106." [Fig. 72] They wanted Hammarlund Superpro receivers badly [86] because they were band switched and this eliminated the need to plug in new coil units to change surveillance bands. The Superpro receivers also provided superior sensitivity as a result of having RF amplification. Most if not all of the American Army intercept units used the Superpro receivers and this created some envy among their British companions.
Figure 68. Army standard intercept set up with BC-779s in diversity configuration and 'combiner' underneath. (Radio News)

Figure 69. British R107 receiver used in intercept trucks. (courtesy L. Meulstee PA0PCR)

Figure 70. (left) British R206 Intercept Receiver. (courtesy L. Meulstee, PA0PCR)

Figure 71. (below) German shortwave KW E. a. intercept ground receiver. (AWA Annex)
Towards the end of the war, the British began to intercept German UHF radio telephone links from the Adriatic coast. The Germans called these the Rudolf and the Michael systems and they operated between 400 MHz and 600 MHz. Little communications security hindered the intercept work because the Germans erroneously believed that the UHF links were entirely secure by reason of their high frequency and narrow beam nature. [86] They fell prey to a clever British officer who remembered an experimental UHF link at the 1936 Olympics in Berlin.

The U.S. Navy put Radio Intelligence Units aboard the flagships of most task forces. They made combat intercepts and reported to HYPO (i.e., Station H, later called FRUPAC for Fleet Radio Unit Pacific). [Figs. 78, 80] The Navy's coordinated communications intelligence permitted the submarine USS Gudgeon to sink the Japanese submarine I-73 some 240 miles west of Midway Island in January, 1942. It was the first U.S. submarine sinking of an enemy vessel in the war. [73] The Navy had deciphered the five-number Naval Code early on. [93]

Radio intelligence won the Battle of Midway Island in June, 1942 and thus started American forces on the way to Hiroshima. The Navy radioed false information which was duly intercepted by the Japanese. It lured the Japanese into making an almost immediate radio transmission which identified their target as Midway Island. This permitted the Navy to be ready for the battle. [73] A Japanese speaking Navy officer also provided translations in near real time of AM VHF intercepts (likely made by a NC-1-10) from attacking Japanese aircraft, for great tactical advantage.

Tactical use of radio also initiated the peace. In mid August, 1945, MacArthur effected the Japanese surrender by radio traffic broadcast over the U.S. Army Air Corps Pacific meteorological radio network (500 kHz and 15 other frequencies) which was regularly monitored by the Japanese. [69] The Army then followed up with direct contacts. A message retained by Dick Secondari regarding the dangers in implementing the cessation of hostilities appears nearby. [Fig. 67]

The Japanese Intercept Service and the Exploitation of Traffic Analysis

The Japanese intercept service operated primarily from a site near Tokyo where it made military intelligence tactical intercepts in the Pacific and China and Burma theaters and performed diplomatic monitoring of foreign broadcasts. The main intercept site was in the Tokyo suburb of Owada. The Owada Receiving Site was established in connection with Japan's war on China in 1937. The Japanese had other sites in Japan which were used for monitoring Russia as well as China, and for internal security. It is not known which site or sites took the shortwave coded messages from the Japanese in South America in the beginning of the war. [89]. A sophisticated Japanese army receiver [Fig. 73], perhaps some 60 years hidden in Southern California, has been recently found by Mike Adams, so clandestine traffic into the U.S. cannot be ruled out.

As an example of Axis cooperation, the officer who was later to become the Pearl Harbor Japanese spy of December, 1941, Takeo Yoshikawa, worked in Naval Intelligence in Tokyo at the beginning of the war in Europe. He intercepted a plain language shortwave broadcast from Australia detailing a fleet of 17 transports of Australian troops passing Freetown, South Africa on its way to England. Upon forwarding this information to the German embassy,
Figure 72. (left) British R106 HRO in tactical intercept service. (courtesy L. Meulstee, PA0PCR)

Figure 73. (right) Japanese WWII army radio made by Tokyo Electric (Toshiba). (found hidden in California by Mike Adams, CHRS)

Figure 74. (left) Intercept Ops in WWII. Dick and Elliot Secondari on the SS Jeremiah O'Brien callsign KXCH c. 1990. (courtesy K6TR)

Figure 75. (right) Japanese Model 92 Receiver. The Owada site used 60 of these according to JA1FC. (photo WA7QQI from Electric Radio #95)
Hitler wrote him a thank you letter. [73] Soviet spy Richard Sorge made many radio transmissions out of Japan. He was targeted by counterintelligence, captured in 1941 and executed by the Japanese in 1944. [73] He sent out thousands of coded messages by radio from Tokyo residences. [82] Japanese domestic interception was fairly crude; it lacked mobile radio direction finders and could only get a fix on Sorge's Tokyo radio operations within a couple of kilometers, although it first noticed his traffic in 1937. [82]

Mamoru Fujimuro (JA1FC) is on the staff of the Museum of the Japanese Amateur Radio Relay League, a member of the Antique Wireless Association, and an historian of Japanese military communications with a book on Japanese military and naval receivers forthcoming. He has generously conveyed [36] the following information about Japanese World War Two intercept work (some other sources are cited as well).

The Imperial Japanese Navy used a very heavy and very stable receiver designed in 1932, and known as the 92 Toku (The "92" came from the year 2592 in the Japanese calendar). [Figs. 75, 76] It tuned 20 kHz to 1500 kHz in its long wave version. The shortwave version tuned 1300 kHz to 20 MHz. It put a single radio frequency amplification stage before its mixer and oscillator. Next came two intermediate frequency stages of amplification, a detector and an audio stage. In its "Improvement-Four" iteration, it employed two type 78 tubes in two RF stages, a type 6A7 as its mixer-oscillator, and two type 78 tubes as IF stages. A type 77 tube acted as the detector and the audio went to a type 38 tube. On long wave, the first IF acted as a radio frequency amplifier stage followed by another, then the detector and the audio stage. The top left dial on the radio on "Improvement 3" was the "regenerative adjustment capacitor" suggesting a regenerative detector, at least on long wave. These sets served on board submarines. On surface ships, at least 10 could be found in the radio room. It weighed 60 kilograms (over 130 pounds).

The Japanese Navy employed it in all types of vessels and at the main intercept station outside of Tokyo which was the Owada Receiving Site. (The Japanese Navy also sited intercept operations at Jaluit in the Marshall Islands). [32] Some Japanese references suggest that as many as 300,000 of these receivers were manufactured, but Fujimuro-san doubts this number, because the number is disproportionate to the size of the Navy itself and its war time manufacturers such as Hitachi and Oki did not keep good records, or at least such records did not survive the war. Perhaps 10,000 to 30,000 is a more accurate estimate.

![Figure 76. Japanese 92 intercept receiver (made by JRC). (from its manual, courtesy JA1FC)](image-url)
The Japan Radio Corporation is shown as the manufacturer on one of the surviving sets.

Despite the information about this receiver noted by the U.S. Army, [100] it is not the case that it was used by the Japanese Army. It may, however, have been captured in land bases of the Japanese Navy. A few of these receivers are in private U.S. collections [45], and one is on display in the Japanese Self Defense Forces’ Communications School’s museum at Kurihama, in Yokosuka. In Yokohama, Mr. Takashi Doi is opening a museum which will display two of these receivers. This receiver was still operational in 1950 on the SS Kouei-maru, formerly an auxiliary cruiser in the Japanese Navy. After the war, with a beat frequency oscillator added, the Model 92 served as a police radio. Every once in a while one shows up in the United States. [45] [Fig. 75]

The Japanese Army favored foreign receivers, mostly captured in China and Manchuokuo (the Japanese state of Manchuria). The Army ran intercept operations in the South Pacific as well as in China and Manchuokuo (occupied Manchuria). The Army plotted direction finding bearings, as well as intercepted traffic, from its site in Kitatama, Tanashi-city near Tokyo. The Japanese Army in Japan used the facilities of, among others, the Nakano Communications School for its intercept and decryption activities. The Army in Japan favored imported or captured Hallicrafters SX-28s, Hammarlund Superpros and National HROs. The National NC-100A was in use in the Kyoto communications center. The Army’s strategic intercept target was the Soviet Union.[32] The Japanese radio direction finding radios may well have been superior to those of the British as well as those used by the Americans. [55] A Japanese tactical RDF set up appears nearby. [Fig. 87]

In 1937, another receiver appeared. It was based on the 1932 version. It was designed especially for ships. Having been designed in 1937, its nomenclature was “Type 97” (based on the Japanese calendar year 2597). It employed ten vacuum tubes, including a rectifier in a full wave power supply circuit for standard shipboard 100 volt a.c. power. It appears to have bandswitched three sets of coils for full frequency coverage.

The pre-war Japanese Ministry of Foreign Affairs realized the importance of radio interception and monitoring. It established its Overseas Broadcast Receiving and Recording agency. For this purpose it used the HRO-inspired (PW dial and all) Yamada Denki superheterodyne. This radio, one of which Fujimuro-san has in his personal collection [Fig. 77], employs two stages of radio frequency amplification, two stages of intermediate frequency amplification and two audio stages. Its main range was 9 to 18 MHz. Its circuit made it the peer of any of the military radios of the day. The Japanese Ministry of Foreign Affairs also employed many U.S. commercial receivers of the day for interception.
and recording. These included four Hammarlund Superpros. The MFA operated the Ogama receiving site which was formerly that of radio station JOAK.

The Japanese government imported as many good shortwave receivers as it could, before the war. It had pending orders for both Hallicrafters and National receivers when the war broke out.

Although the Type 92 and the Type 97 were original engineering efforts, the Yamada Denki superheterodyne was a one-band copy of the National HRO. The direction finder in the Mitsubishi Zero fighter aircraft was a copy by Toshiba Corporation of an American direction finding radio. The Japanese also employed a VHF aircraft transceiver for 30 to 50 MHz AM.

The Navy supplemented the work of the Owada and Jaluit sites. Japanese Naval Intelligence worked from the Third Department of the Japanese Naval General Staff. [73] The Japanese Navy sent light cruisers on pre-war radio reconnaissance voyages to waters off Hawaii or the West Coast during U.S. Navy exercises and training missions. One such was HIMJS Yuhara off Hawaii in 1923. [32] The use of cruisers for radio reconnaissance before World War Two is reminiscent of the HIMJS Asama incident off Baja California in 1915. In 1932 the tanker SS Erimo, equipped with intercept gear, plied Hawaii’s waters during a U.S. naval exercise. [73] Japanese “fishing ships” carried special radio equipment and intelligence officers to the waters off the West Coast as well. [73] The Japanese had a five-man radio intercept team in Mexico in 1940 tasked to listen to the U.S. Navy on the West Coast. [32] The Japanese found decyphering U.S. Navy coded messages a formidable task, but they had some success. According to Fujimuro-san, their Navy used hundreds of reserve officers, and employed an IBM punch card tabulating machine (as did General MacArthur in Australia).

The Third Department emphasized traffic analysis because it had so little success in code breaking. Traffic analysis permitted the Japanese to predict bombing targets with an initial 70% accuracy. [73] According to a later U.S. analysis:

"... the most lucrative sources of information available to the Japanese became (1) analysis of Allied Communications transmissions and (2) Allied short and medium wave radio broadcasts... [73]

According to Fujimuro-san, some 50,000 people worked on communications interception, broadcasting monitoring, and intelligence analysis of the intercepts and recordings. Different groups of people did the radio work and the analytic work. The Naval General Headquarters worked on wireless telephone interception. The paucity of English speaking Japanese personnel made this a challenge. Copying Morse code was relatively easy but dealing with spoken English was very hard. A post war Japanese analysis notes:

"Our navy was not able to break the American military’s code(s); our intelligence appreciations and strategic estimates were primarily based on call-sign identification, direction finding bearings, and the interception of plain-language transmissions [aviators’]. As an example, we could estimate when a strong American force sortied from port or was operating, because their air patrols in that area became intensified and expanded and many patrol planes’ messages then came up on the air; we could also ascertain the general area of the enemy’s attack because of their custom of stationing submarines in that general area, in advance of the planned attack." [55]
Figure 78. Japanese coded message intercept (partial). (courtesy of Robert Stinnett [93] from NARA)

Figure 79. Shortwave Listener in WWII by Norman Rockwell. (by paid permission, Saturday Evening Post)

Figure 80. Navy version RBG of the SuperPro. (From its manual)
The Japanese government restricted domestic wireless and radio from the beginning by enforcing the 1915 Law of Radio Telegraphy. Only the Army Military police were permitted to do "research" with shortwave radios that could receive foreign broadcasts. It was not until after the war that Japanese could freely tune the world bands (a novel circumstance of which SONY Corporation soon took advantage). As early as 1924, a few radio enthusiasts put amateur radio stations on the air, much to the displeasure of the government. The Army Shimoshizhu Aviation School amateur station used the callsign J1SK. The Navy Yokosuzh Torpedo School's Communications Section took to the air on the ham bands as J2BB. When the Japanese Minister of Posts and telecommunications found out from the American Radio Relay League (A.R.R.L.):s QST magazine in August, 1926 about the new Japanese Radio Relay League, he was surprised and angered and called official hearings into the matter. Official licensing of amateur radio stations began in 1927.

Before the amateur licensing, only licensing-fees-paid receivers for the broadcast band were permitted to listen to the first station JOAK (1924) and then some others between 550 kHz and 1500 kHz. The use of transmitters was strictly regulated, but marine and private commercial radio telegraphy and telephony was permitted. Popular demand fueled the growth of broadcasting in the 1920s but it did not have the support of the government.

The government insisted on type-acceptance of receiving equipment after inspection and testing. One can speculate that had the Japanese government been less hostile to radio knowledge in its population, it would have had more resources available to it in time of war. The Japanese militaristic regime was, however, dedicated not to technical initiative but rather to "thought control" policed by, among others, the "Thought Section of the Criminal Affairs Bureau" in the Ministry of Justice. [73]

**Shortwave Broadcasting Goes to War**

Shortwave propaganda broadcasts first flourished in the Spanish Civil War in 1936 with the advent of the technology a few years earlier. [Figs. 79, 81, 82] This gave rise to increasingly more organized monitoring of governmental broadcasts.

"It was in the 1930s that shortwave was first used as a propaganda weapon. 'Since the outbreak of the Spanish rebellion,' reported the New York Times, 'new stations have appeared on various shortwaves, sending music and speech from both Nationalist and Rebel headquarters. Stations in the Canary Islands, Spanish Morocco, the Balearic Islands, and new stations in Spain itself may be tuned almost daily by shortwave listeners who know when and where to locate these transmitters..." [10]

The NAZIs in Germany employed the Zeesen shortwave broadcasting station for propaganda from 1934 forward, having specially built it for that purpose. Its image appears on a 1930s QSL card, reproduced nearby. [Fig. 83] German stations D JA through DJE broadcast in the 49, 31 and 25 meter bands as of 1933.[78] The Fascists in Italy broadcast propaganda on shortwave as well. It went out on station C2RO on 11.810 MHz in the 25 meter band at up to 10 kilowatts. [Fig. 84] In 1936, news of the Fascist colonial wars in Ethiopia and
Figure 81. (above) Shortwave monitoring post of Radio News in New York in 1934. (Radio News)

Figure 82. (right) European shortwave stations 1933. [78]

Figure 83. (left) NAZI Zeessen (Berlin) shortwave station 1934 QSL. (author's collection)

Figure 84. (right) Italian shortwave station 2RO E AIR 1936 QSL. (author's collection)

Figure 85. (left) Japanese Nasaki shortwave station 1936 QSL. (author's collection)
elsewhere in North Africa provided fodder for the Italian broadcasters. Japan put its shortwave facilities at Nazaki to work broadcasting the virtues of the coming “Greater East Asia Co-Prosperity Sphere.” This station’s equipment also appeared on a QSL card, reproduced nearby. [Fig. 85] This prolonged propaganda broadcasting of the “Co-Prosperity Sphere” began with the invasion of Manchuria in 1931, and extended through the overrunning of Nanking in 1937 and into the world wide war of 1941-1945.

Early on, the Russians recognized the power of shortwave radio for propaganda and established Radio Moscow in October, 1929 at Moscow Centre. [79] Perhaps it commenced broadcasting for the furtherance of the communist revolution in October in order to commemorate the “October Revolution” of 1917 which had occurred only 12 years prior. A photo of Joseph Stalin making a shortwave radio broadcast in the mid 1930s appears nearby. [Fig. 86, cf. Fig. 50] During the Spanish Civil War, Russia is reported to have targeted Spain with four 100 kilowatt shortwave transmitters employing directive antennas and “radiating communist propaganda.” [40] In a decade, it broadcast for the defense of Mother Russia using its station RV49 which broadcast on 6.0 MHz at between 10 and 25 kilowatts. [78]

The English used the British Broadcasting Corporation (BBC) from Daventry, England. [Fig. 88] It transmitted on shortwave extensively in the 1930s on radio stations GSA through GSH in the 49, 25, 31, 19, 13 and 16 meter bands at up to 25 kilowatts. [78] The fact that the English always told the truth on the radio made it the only trusted broadcaster on the airwaves [35] in wartime in which “truth is the first casualty.” [Fig. 91] By 1938, the impact of shortwave radio propaganda was widely recognized. [110]

The Americans created the Office of War Information and broadcast from transmitters primarily on the East Coast. Their main station, WRUL (which had its own pre-Pearl Harbor anti-NAZI programming) eventually became the Voice of America. [18] The O.W.I. broadcast operations devoted themselves to truth, on the British model, to the dismay of the Office of Strategic Services (O.S.S.), which wanted to use broadcasting as a weapon of subversion. [89] The first U.S. interval music, “Yankee Doodle Dandy” is still the Voice of America signature on the air nearly 60 years later.

During the war, shortwave radio built and maintained the morale of the troops. Many civilian radios, usually with a shortwave band as well as the medium wave AM band, were transformed by the manufacturers into “morale receivers.” Some were specially designed as such. A 1944 Associated Press wirephoto of a Hallicrafters S-29 hard at work presenting a baseball game to American soldiers in Panama [Fig. 89] appears nearby. 8 The German receiver WR 1 played the same role, covering 0.15 to 15.8 MHz. The Germans adapted a pre-war commercial shortwave set for morale use, but warned:

“Use of this radio for foreign station reception is a crime against the national safety. By order of Our Leader (der fuhrer) such use will be punished with the severest penalty. Soldiers, beware!”

This warning is noted in the U.S. Army Field Manual description of this set. [99]

8 The F.C.C. also used the S-29 as a close-in mobile surveillance receiver, according to George Sterling. [92] Compare it with the disguised RDF set [Fig. 92 ].
Figure 86. Joseph Stalin making a shortwave broadcast c. 1938. (Radio News & Shortwave [110])

Figure 87. Japanese RDF radio of the sort that triangulated the OSS in Burma and other U.S. troops. (Radio News)

Figure 88. BBC 1930s QSL from their Daventry Station. (author's collection)
Monitoring Shortwave Broadcasting for Intelligence in the Early Years of the Second World War

In 1939, U.S. news organizations begin shortwave monitoring of the war in Europe. CBS, working in the New York area, was perhaps the first to do this. [Fig. 90] In 1940, the Federal Communications Commission created the United States Foreign Broadcast Information Service to gather intelligence from foreign shortwave government broadcasting. [80, 54]

Listening to Second World War shortwave broadcasts can send chills up the spine, fifty years later. It was a nightmare world that the NAZIs had in mind, and before the Allies won that war, 70 million people had died in the conflagration. Intelligence as well as armaments prevailed. The intelligence operation of the Foreign Broadcast Intelligence Service (F.B.I.S.) of the Federal Communications Commission played a role. [Figs. 93, 94, 95] These shortwave listeners, for example, brought Americans the first news of the surrender of France. In the darkest moments of the Pacific war in April, 1942, they monitored the first news of the success of General James Doolittle’s air raids on Tokyo and other Japanese cities. They were the first to know that the strains of war had provoked the resignations of Japanese Chiefs of Staff.9

Shortwave radio had become a major source of international information around the civilized world in the 1930s. The radio fad that flourished with the rise of broadcasting in the 1920s, revived again in the 1930s with the coming of long distance shortwave broadcasting. Where it had once been a triumph to get a nearby city on the broadcast band, by 1934 distant foreign capitals were calling loud and clear. [Figs. 79, 81, 82] Holland started in 1927 and Moscow in 1929. The British Broadcasting Corporation’s early experiments with shortwave had grown into the Empire Service by 1935. The NAZIs took to the air from the specially built Zeesen propaganda station in 1934, and the Japanese militarists did their own propaganda broadcasting in Asia. By 1939, the airwaves were full of arguments soon to be resolved by war and bloodshed.

In 1939, the first formal American monitoring began. It was sponsored by the Columbia Broadcasting System (CBS). A photo from Radio Craft showing that modest station in Queens, New York, [Fig. 90] appears nearby. [34] CBS also devoted its Studio Nine to the analysis and broadcast of war news derived from shortwave monitoring. CBS monitored broadcasts from as many as 24 countries and provided linguists for translations. At its 10 by 12 foot radio “shack” in Forest Hills (Queens, New York), CBS employed commercial receivers whose performance had been enhanced by CBS engineers. (It was also CBS, in San Francisco, that took the first Japanese acknowledgment of surrender in August, 1945, by shortwave monitoring of the Domei News Agency’s Morse code press broadcast, which announced: “Flash – Emperor Accepts Potsdam Declaration” and then went off the air. CBS carried the story on this basis for 16 hours before an official announcement.) [20]

Although the war had started in 1939, it was at first “the phoney war,” until 1940 when Europe felt the blitzkreig (although the Japanese had been on the march in China since 1937). All of the combatant nations intensified their shortwave broadcasting and, propaganda broadcasts became a weapon of total war.

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9 The National Archives and Records Administration (NARA) in Washington, D.C., has preserved many of the recordings and cassette tape copies are available.
Figure 89. Hallicrafters S-29 at work raising morale, Panama, 1942. (AP wirephoto for San Francisco Chronicle)

Figure 90. CBS shortwave monitoring post in Queens, New York c. 1939. (Radio-Craft)

Figure 91. Clandestine listening in occupied Europe WW II. (collection of Jerry Simkin, AWA)

Figure 92. Counterspy WW II U.S. portable disguised RDF set. [82]
After Pearl Harbor, the Office of War Information (O.W.I.) quickly put nearly 30 shortwave stations on the air in the United States. They were directed toward other nations as well as American service personnel. By 1942, the National Broadcasting Company (NBC) had established an elaborate monitoring post at Bellmore, Long Island, New York, to log the broadcasts of other nations. This station in operation, with obvious wartime dramatization is shown nearby [Figs. 96, 97]. These theatrical scenes come from an article about official monitoring in the Mechanics Illustrated Radio Manual dating from the first year or so of the war and intended for home front morale boosting purposes. [104] NBC apparently favored Hammarlund Superpro receivers.

Overseas, the British Broadcasting Corporation also operated its own listening posts. The Political Intelligence Department of the British Foreign Office sifted through whatever emanated from Germany. A German then-refugee working for the English as a young lady, summarized it:

“We analyzed what came out of Germany — press agency stuff and broadcasts. We all knew that Goebbels [propaganda chief] lied, but one could learn a lot about German thinking by watching the daily news releases.” [41]

Princeton University in November of 1939 had set up the Princeton Listening Center in its School of Public Affairs. Lloyd Free of Princeton became the first Director of the Foreign Broadcast Monitoring Service in 1941 after the Federal Communications Commission set up that official agency. Harold Graves of Princeton was its Assistant Director. The agency’s second Director was President Robert D. Leigh of Bennington College. After Pearl Harbor, the F.C.C. changed the name of the agency to the Foreign Broadcast Intelligence Service. With initially four posts in Oregon, Texas, Maryland and Puerto Rico, this Service set out to record significant broadcasts and to analyze enemy broadcasting for useful intelligence. The nature of its work can be gathered from the sorts of reports that it issued:

- Underground Movements and Morale in Japan
- Berlin’s Claims of United Nations’ Shipping Losses
- Reactions to the First Bombing of Japan
- New NAZI portrait of the American Soldier

Despite the importance of its work, the F.B.I.S. earned the enmity of powerful forces in Congress. Some of them thought it to be the “Nastiest nest of Reds.” The House Un-American Activities Committee went after its chief analyst, Goodwin Watson, and the assistant news editor, William E. Dodd, Jr. A rider on the war appropriations bill cut their salaries. It was all just an attack on the F.C.C.’s Chairman, Lawrence Fly. He would not knuckle under to Congressional potentates. As it happened, a new F.C.C. Commissioner, Clifford J. Durr from Alabama, was Supreme Court Justice Hugo L. Black’s brother-in-law. When the attack on the F.B.I.S. personnel reached the Supreme Court, Justice Black ruled against the Congress and in favor of the F.C.C. men. He wrote a ringing opinion for the court in which he applied the Constitutional prohibition of Bills of Attaint passed by Congress against individuals. [103]

During the war, the F.B.I.S. monitored millions of words a day which were received at listening posts in the United States at San Francisco, Portland and Silver Hill, Maryland, and in London, Stockholm and Algiers. Additional stations monitored the airwaves from the island of Kauai in Hawaii, and eventually
Figure 93. FCC FBIS (NDA) listening and recording post. (supplied by George Sterling to the OOTC Spark-Gap Times 1963)

Figure 94. FCC FBIS shortwave monitoring post. (courtesy W6CF from Radio News [80])

Figure 95. (left) FCC FBIS surveillance console. (from a 1943 Radio News ad)

Figure 96. (right) NBC gets a shortwave scoop at its Bellmore, LI, N.Y. post. [104]
Guam and Iwo Jima. The U.S. posts took in 1.2 million words a day, and the foreign posts received another million more. The recordings were made on site, or in Washington, D.C., from land-line audio from Silver Hill. The analysis was done in Washington. Information went out by teletype to 19 Government agencies, the O.W.I., the British Ministry of Information, and to the Army Provost Marshall with prisoner of war information. The teletype circuits handled some 150,000 words a day of analysis and information.

The recordings were mostly made on wax cylinders and retained for only 48 hours. They were then shaved and reused. Important broadcasts, however, were recorded on plastic Presto Disks, or on paper disks, and archived. The translators worked in Washington and got their material from disks or directly from audio over telephone lines connected to the receiving stations.

The West Coast stations teletyped their Japanese code transcriptions to Washington for translation. This material included press broadcasts to Japanese stations which were monitored in Portland. These broadcasts first disclosed the resignations of the two Japanese Chiefs of Staff in the middle of the war. The news of the surrender of France was buried in speeches broadcast from France at the time. An F.B.I.S. monitor had to listen to the recordings over and over in order to tease out their meaning. The success of Doolittle’s Raid was detected by the appearance of unusual words in Japanese newscasts which provided the needed clues. During the war, one analysis declared:

“Today almost every political, diplomatic and even military move is presaged by shifts in propaganda treatment. It is often possible for experts to predict such moves. A new course in policy can be reflected in broadcasts long before it is announced officially, or rumored in the press. The altered tone of certain foreign broadcasts, for example, gave the first indication of the German invasion of Russia, and that Japan intended to occupy Indo-China.” [77]

All F.B.I.S. posts and stations employed a similar set of sequential procedures:
First: Scheduling, Interception, Monitoring and Recording;
Secondly: Translating, Editing, Teletyping;
Thirdly: Reports and Analysis;
Lastly, on demand: Special Services.

During the course of the war, Special Services included a live hookup of Hitler’s speech after the Italian surrender which was provided to President Roosevelt, Prime Minister Churchill, General Marshall and others. It also included expert testimony about enemy propaganda at a sedition trial. All speeches by enemy leaders were recorded on permanent disks and furnished to O.W.I. and the British for use in broadcasting and then they were archived. Much of this detail was laid out by Oliver Read in Radio News towards the end of the war. [80, 16]

Figure 97. NBC shortwave monitoring console, LI, N.Y. 1941. [104]
The Hallicrafters SX-28 was the favorite receiver of the F.C.C. [Fig. 39] It was used almost exclusively in F.C.C. Radio Intelligence Division (R.I.D.) counter-espionage work, as reported by George Sterling. A R.I.D. listening and recording post appears in a nearby illustration from Sterling’s article in Spark Gap Times (1963). [Fig. 93] Sterling reports that a section of the Radio Intelligence Division known administratively as “NDA” did foreign broadcast interception for the F.B.I.S. [92] (This may refer to Non-Directional Activity). The SX-28 appears to have been the exclusive high frequency receiver of the F.B.I.S. as well. Engineers set them up in banks of as many as 24 with each tuned to a specific station. Rhombic antennas pointed everywhere in the world. From Silver Spring, the audio went through routing consoles and then out over landlines which were carefully matched for impedance, to the translating and recording center in Washington. End users included the U.S. State, War and Navy Departments, the Foreign Economic Administration, The Department of Justice and the Federal Reserve Board, Allies, and the United Nations Refugee Relief Agency.

Several SX-28s were used as surveillance receivers to search for new frequencies and stations. This was a shortwave listener’s dream job. Many of the F.B.I.S. monitors had been amateur radio operators before the war. The manager of the Silver Spring station was Frank X. Green who had been the former engineer of at least five pre-war broadcasting stations. He got to do the tuning around, along with his assistant, James G. Wedewer. A supervisor and assistant appear in the war time Hallicrafters advertisement from Radio News reproduced nearby. [Fig. 95] To their left was a full bank of SX-28s tuned to programs destined for recording. Their console is a search and surveillance set up.

The Office of Strategic Services (O.S.S.) briefly operated two listening posts, at Tarzana (Reseda), California and at Bellmore (Long Island), New York. The O.S.S. Bellmore post may well have been the NBC receiving station there at the beginning of the war. The O.S.S. also ran a ‘round-the-clock’ monitoring operation of Japanese Broadcasts in April, 1945 in Kunming, China. [89]

After World War Two, the Cold War quickly came to occupy the attention of intelligence agencies. The F.B.I.S. had enjoyed a $1.5 million budget in the war but it was downsized, lost most of its 350 employees, and had its
budget cut by nearly two thirds. The Foreign Broadcast Intelligence Service went over to the Central Intelligence Agency, where presumably its work continues to this day. Perhaps now it receives information ranging from European long wave broadcasting, through medium wave AM, FM, TV such as the new Arab networks, to UHF and SHF satellite links.

**World War II’s Home Front Monitors:**

Thousands of American shortwave listeners followed every move in the Second World War. Many were “Armchair Generals” such as Norman Rockwell painted for the Saturday Evening Post, [Fig. 79] reproduced nearby. Others listened more casually. Many American shortwave listeners kept a record of prisoner of war names. This monitoring was formalized by at least one nationwide club. This supplemented the F.B.I.S. information conveyed to the Army Provost Marshall who passed it on to families. The bureaucratic process of the F.C.C. and the Army often delayed notification. The cards (and sometimes telephone calls) of concerned shortwave listeners [Fig. 98] sometimes contained the first news to reach the families of captured soldiers, sailors and airmen informing them that their loved ones were safe, albeit prisoners of war. [10]

Moreover, as a result of variable high frequency propagation or local conditions, or priorities, it is likely that the F.B.I.S. did not catch all the names broadcast. Thus, some families may have come to know the fate of a son or brother only from the good work of a patient and dedicated shortwave listener.

A typical story is told by noted shortwave hobby writer Hank Bennett:

“During World War Two, one of my SWL friends, who (to the best of my knowledge) never held a ham radio license ... did a magnificent job of tuning in the foreign shortwave broadcasts from the capitals and chief cities of the Axis countries; he used several receivers so that he could tune in two or more stations at any one time. He faithfully monitored every possible transmission in an effort to learn the names of Americans who had been taken prisoner of war. Reportedly, he was often able to notify military authorities or family members of the general whereabouts of missing servicemen before the military officials themselves were even able to get the information. I often wonder what happened to this fine gentleman who so ably served his country in a nonmilitary manner. He lived in one of the southern states and certainly should have received some sort of commendation from his appreciative government.” [9]

An advertisement from Midwest Radio in the February, 1944 Radio News tells a similar story. Mr. Alex Gordon [Fig. 98] used his 16-tube Midwest to monitor the war, and heard prisoners’ names broadcast by the NAZIs. He notified the families with post cards, and organized others to do the same. Reportedly, many such listeners spent a considerable amount on postage and related expenses during the course of the war, which they considered as personal contributions to victory. Both Popular Communications and Monitoring Times magazines have run stories on this home front effort. [12, 17] According to a later interview with the source for the Popular Communications story, Mr. Frank Davis, some 469 shortwave listeners are now known, so many years later, to have communicated news to families of prisoners of war. In his own case, his mother heard from 38 listeners writing her to tell her that her son was safe as a prisoner. [29]
Listening to the Allies

As busy as the F.B.I.S. was, listening to Axis broadcasts, the Axis powers were listening to American, British and Russian programing as well. Once the BBC implemented its truth-in-propaganda policy, its broadcasts to Germany were well regarded by those brave enough to listen to them. Despite the penalty of death for listening to BBC and other foreign broadcasts, many did. The NAZIs jammed what they could but could not jam all transmissions. The then-new Voice of America was hard to hear in Germany, being quite distant. Its programing was not much favored by Germans, except the programming that featured the noted writer Thomas Mann, "... inspired by a glowing hatred of National Socialism." [35] Two Allied (British) clandestine stations were popular in Germany, the "Atlantic Sender" and the "German Freedom Station." At least one clandestine station in England, Gustave Siegfried Eins, used so many obscenities that it became known as the Scheissensender. Germans did not respect it or listen to it much. [35] It was carefully designed to create suspicion among NAZIs about each other, and to offend Germany’s ally, Italy. It operated in the 31 meter band on 9482, 9548, 9625, 9635 and 9649 kHz. [15] Deutscher Kurzwellensender Atlantic operated on 6145, 6212, 7020 and 9760 kHz. [15] The British believed that their clandestine broadcasting worked well. It was done by the Political Warfare Executive and ultimately employed an American-made 600 kilowatt transmitter which stayed in service with the BBC after the war. [88]

Shortwave broadcasting into Germany (and certainly that transmitted by the Americans) did not have much effect on the outcome of the war. Similarly, NAZI propaganda had little or no effect, and perhaps only served to strengthen Allied resolve. Wilhelm Flicke, in his history of radio interception in the war, concluded:

"The importance of the English, Russian and other broadcasts seems to me to lie in another quarter [not propaganda]; they helped the German people in its search for truth, in its efforts to learn the real relations of things, in its search for a way out of the labyrinth of aberrations. If, after the outward collapse of the National Socialist reign of terror—a collapse which was inevitable—the German people showed that a vast majority had long since broken with that negative system and created conditions favorable to a positive course, then a good part of this cure may be ascribed to the critical searching of the
broadcast frequencies. Broadcasting showed that it can only be an effective weapon if it uses the truth.”

To extract intelligence from foreign broadcasts, the NAZIs set up a central monitoring bureau. Foreign Secretary Joachim von Ribbontrop, a polyglot former salesman of champagne, reported directly to Hitler as Chancellor. According to noted historian David Kahn in his definitive book, HITLER’S SPIES, he established a monitoring organization comparable to the F.B.I.S. A series of high NAZI officials ran it.

Inasmuch as it had a lakeside site outside of Berlin, it was known as “Seehaus” or more formally, Sonderdeinst Seehaus, the Special Service Lake Facility. It was much smaller than the F.C.C.’s operation, and not as well organized. Ribbontrop used it primarily as a personal intelligence gathering asset. He had to share the take, however, with NAZI propaganda minister Joseph Goebbels. In 1933, NAZI air minister Herman Goering also set up his “Research Department,” the Forschungsamt, (FA) which was dedicated in part to interception of foreign broadcasts as well as increasing internal security by telephone tapping and domestic radio interception.

The Seehaus went into operation in July, 1940. Before that several other organizations monitored shortwave broadcasts [Fig. 99] and especially press transmissions. These included the Reich Radio Corporation in Berlin, and the DNB (roughly: German News Bureau), the official wire service. The Foreign Ministry itself monitored international broadcasts, and received the first news of the Japanese attack on Pearl Harbor. [49] By October, 1941, Ribbontrop and Goebbels had agreed to set up the German Foreign Broadcast Company Interradio Inc. It was used mostly for broadcasting abroad, but it also did monitoring, primarily at Seehaus. External posts were set up in Denmark, France, Hungary, Italy and Poland. During the war, Seehaus grew to the capability of monitoring 37 languages from more than 40 countries with its 700 and more workers. Monitors had to know foreign languages and translate for themselves.

Each monitor listened to the same program on two receivers on different frequencies. This dual diversity technique compensated for adverse propagation and atmospheric conditions. Seehaus employed radio frequency amplifiers and signal splitters, all from one omni-directional antenna. In any given year it picked up thousands of broadcasts and hundreds of speeches by Allied leaders. All British broadcasts and most American broadcasts were heard. Seehaus recorded the important ones. The reports from Seehaus were generally fastest to reach the NAZI hierarchy (after the press summaries of the DNB) but they were not necessarily regarded as the best. [49]

German military intelligence (part of the General Staff: OKW) also manned at least four major listening posts using military receivers. [Figs. 100, 71] A department of its Cypher Branch (OKW-Chi-Nachrichten [news]) put out reports on broadcasts. Some 3,000 workers monitored and processed radio intelligence for OKW-Chi, primarily at sites near Berlin and Nuremberg. There, at Lauf, Herr Flicke, who opposed NAZI policies, supervised a six tower antenna farm and 150 monitors. [35] The two main monitoring stations backed each other up in their target areas, such as British or Russian transmissions. OKW-Chi devoted itself primarily to interception of point to point diplomatic and military traffic, and decryption. [49]
The German Navy and Air Force also ran monitoring and intercept posts and stations at all levels. They often served for more than just tactical purposes. The Army intercept service was run by General Erich Fellgiebel until Hitler had him executed after the failed 1944 assassination plot. Shortwave broadcasting, it was thought, could sap the morale of the enemy; hence Hitler forbade listening to any other country’s broadcasts. This prohibition was clearly stated, on the label on the German army morale receiver type WR 1.

General Fellgiebel’s subordinate, Herr Flicke, noted after the war that the German radio intercept service was entirely too fragmented because it consisted of almost a dozen organizations. He concluded that, except for tactical intercepts by each of the ground, air and sea forces:

"... all other facilities for monitoring radio traffic of foreign countries should unquestionably be combined in one central organization."

This conclusion is no doubt one of the reasons the U.S. National Security Agency, in 1954, published his works since the N.S.A. is, itself, so centralized. Congress had learned hard lessons from the overall inadequacy of signals intelligence processing at all levels of the chain of command that had resulted in the loss of so many American lives at Pearl Harbor. It also learned from observing the German failures.

Radio in Shanghai and China Before and During the War

Shanghai’s radio station XMHA, a Blue Network (NBC) overseas affiliate, played an important role in the Asian radio wars. After 1938, its technical
The side was run by the late Alex Cattell, a Russian refugee and later Chief Engineer at San Francisco's KRON-TV, according to his family in San Francisco. The Shanghai Dollar Directory for January, 1941 lists Alex Catell as the Chief Engineer along with the six other staff members, and notes the XMHA motto: "The Call of the Orient." It operated on 600 kHz and it was one of several stations in Shanghai's International Settlement. A reproduction of its QSL card [Fig. 101] is nearby. XMHA operated on shortwave at 11.860 MHz and 11.910 MHz. XMHA's programming is remembered as entertaining and dramatic in its work of raking the Axis powers over the coals three times a day. Cattell built XMHA's five kilowatt shortwave transmitter. Upon the Japanese invasion, he escaped first to the Philippines, and then to Australia, according to his family. The Chinese government took over the station in 1946.

Shanghai, China, before, during and after World War II was the proverbial hotbed of international intrigue. [105] An important aspect of Shanghai's role was its radio industry which was full of propagandists for every cause and nation. A good many of them were outright traitors and spies. Before the war, the British owned XMHA and XCDN; the Japanese ran XQHA; the Russian station was XRVN, and the Italians operated XIRS. The French station had French-sounding call letters FFZ. Its engineer was Vladimir N. "Gus" Gercke, later K6BIJ in California. [46]

Inasmuch as the German radio station got the call letters XGRS, one wonders if the call signs were abbreviations, e.g., "Italian Radio Station" and "German Radio Station." At this remove, there is no way to know who assigned call signs or how. Perhaps, station operators simply chose their own. In any event, there were fully 40 Shanghai radio stations broadcasting often at high power and in many languages. [105] After 1941, the British financed in Shanghai a Soviet radio station broadcasting propaganda inimical to the German war effort which continued even after the Japanese occupation. [105].

The German propaganda radio station, XGRS, was the most powerful in the Far East. [105]. Upon the German surrender in 1945, the Japanese took it (and a companion station with call letters XGOO) over for more propaganda broadcasting by turncoats and traitors [105]. The Japanese Navy took over XMHA during the war. [105]

The British, Japanese and Chinese all listened to each other's wireless traffic. [105] The American Navy had operated one of its main listening posts in the Shanghai consulate. [61] During the war, German intercept stations operated from Shanghai copied and decrypted enormous amounts of American military traffic, sometimes as many as 2,000 messages a day. Many of these messages were sent in the clear, posing no challenge at all beyond tuning the dials. [105] The NAZI Abwehr spies were pleased with the take. The NAZIs in the Far East also intercepted the wireless traffic of their ally, Japan. [105]

At least one wireless spy, James H. Smart, worked for the British as the head of their monitoring and intercept operations in Shanghai. After the occupation, but with British connivance, he set up the same system for the conquering Japanese. [105] He then left his 17 year old Russian stepson in charge, as a British agent, and the lad later went to work for the Japanese in the Philippines. [105]

The real hero of the whole war in Shanghai was the British radio operator Petty Officer Jim Cuming, on the captured gunboat HMS Peterel. Cuming managed to escape capture and stay at large in occupied Shanghai. He then, on
his own initiative, set up a secret communications spy and sabotage network in occupied China for the duration of the war. [105] By 1943 the British had at least one other clandestine radio network of some 20 stations operating in the service of espionage and sabotage. [105] American Marines manned an intercept station in Outer Mongolia. The Sino-American Cooperative Organization put together an intercept station near Chunking which controlled the Mongolia operation. It used National Company NC-100s and Hallicrafters SX-28s. [86]

Any self-respecting spy in Shanghai had to be up before dawn to listen to his shortwave set for news from Moscow, Honolulu, San Francisco and London, before heading off for the usual day of conspiracy, betrayal and often murder. [105] The ether rang with the sounds of war in Shanghai from the Japanese invasions of Manchuria in 1931, to the destruction of nearby Nanking in 1937, to the end of the Chinese Revolution in 1949. The communists cleaned out the old Shanghai following the success of the People’s Revolution. Oddly enough, Shanghai is once again becoming a cosmopolitan center in China, 50 years later.

The O.S.S. in Burma: Jury-Rigged Shortwave Radio at War

General William “Wild Bill” Donovan, a Wall Street lawyer by trade, ran the Office of Strategic Services (predecessor to the Central Intelligence Agency) at President Roosevelt’s behest during World War Two. The O.S.S. worked wonders (when other Generals let it) in China and Burma, in North Africa and in Europe. Standard O.S.S. spy radios had nomenclature such as SSTR-1 and contained miniaturized versions of much larger circuits. [21]

The O.S.S. in Burma faced special problems of mountains and moisture. Late thirties radios designed for temperate climates rarely worked well. [63] Detachment 101’s commander in Burma, Col. Carl Eiffler, (who died just this year) directed that his radiomen build their own radios. They did. The radios had to be receivers and transmitters powerful enough to do the job but small enough to be carried and weighing less than forty pounds including batteries. Lt. Phillip S. “Gob” Huston ran the radio section which was tasked with the creation of these radios. Sgts. Alan Richter, Don Eng and Fima Haimson [Fig. 102] did the actual work.

“The sets were built from scratch and hunger. The commercial sets they had brought with them didn’t work. The monsoons flooded them out. Also, they operated from AC current, which was unavailable in the jungle…. The men scrounged around trying to find components. Nothing would work….

“After three or four weeks of improving the

Figure 102. OSS field radio in Burma being operated by Sg t. Fima Haimson, its designer. [82]
design, they came up with a transmitter that had a single tube. They also made a ‘home brew’ receiver that contained three tubes. They couldn’t standardize on the transmitter or receiver because when they ran out of one type of tube they would have to use another.... They fabricated their own variable capacitors out of C-ration cans. The resistors proved to be a real problem. Finally, they took some flashlight cells and removed the carbon rods to make their own resistors. When the first set was completed, it was taken one hundred miles away to be tested. It worked fine. The transmitter and receiver weighed ten pounds apiece. .... one final test was made.... to lower India, a distance of about two thousand miles. From Mysore, a regular schedule was maintained .... Eventually, there were seventy-two of these sets working all over Burma. They were crystal controlled, and the men had to find calibration crystals to get night and day operation out of them. They got them from old Signal Corps equipment. The crystal was on 3,500 kc., and daytime doubled the frequency. The antenna was a piece of insulated wire thrown over the limbs of a tree or bush. The lower the aerial, the better the distance.” [63]

It is likely that the receiver had a regenerative detector isolated from the antenna by one or two stages of radio frequency amplification. Otherwise, letting the detector slip into oscillation would broadcast the location of the site to any enemy RDF operator within range.10 [Fig. 87] So, too, would the transmitter, of course, but its operation would be disciplined with exactly that risk in mind.

Any field transmitter should suppress harmonic and parasitic radiation for the same reasons. The Burma designers of this equipment likely concerned themselves with these risks, inasmuch as it was they who were at risk. It may also be the case that the 1940 or 1941 A.R.R.L. Handbook provided the basic circuits, if only from memory, especially since the design called for operation in the 80 meter and 40 meter amateur radio bands. A photo of that sort of equipment operated in the field by Sgt. Haimson, one of its designers, [Fig. 102] appears nearby.

The O.S.S. also inserted false broadcast feeds into a Japanese puppet broadcasting system in Thailand. This plan (JN-27) employed a transmitter in Chittagong, Burma. [89] Although the O.S.S. engaged in radio deceptions, its role in this theater was more combat-oriented, using Burmese troops, than directed toward covert action.

Radio For, and Against, Sabotage

Inasmuch as broadcasting covered large areas, a common method of control of spies, saboteurs and partisans was to hide coded messages or sequences in regularly scheduled shortwave broadcasts. The high power of the broadcasts (often several hundred thousand watts and as high as one half million watts or

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10Shipboard equipment including even morale receivers, was also built with low radiation in mind. Designed by Marvin Hobbs, complete copper shielding of the outer cabinet and isolation of a well-shielded local oscillator stage with one or more RF stages did the trick. There is, however, no record of a submarine actually finding a ship from receiver radiation (at least in World War Two) and only an anecdotal instance in World War One involved an oscillating regenerative circuit. “Better safe than sorry” is no doubt what E.H. Scott told the Navy when he asked for the contract for the RBO and the end-of-the-war SLR (Special Low Radiation) series. [84]

81
more for the British Broadcasting Corporation) permitted reception by primitive radios with one tube circuits. Saboteurs and partisans on the ground often had little else, but they were only one ionospheric skip away. Churchill set out to use the saboteurs of the Special Operations Executive (S.O.E.) to “set Europe ablaze.” These operatives were regarded by the Germans as terrorists and illegal combatants. However they may have been characterized by the Germans, they still needed coordination and orders from England. Coded messages on the BBC and elsewhere provided this direction.

The British broadcasting Corporation (BBC), for example, recited various verses of French poetry to alert and control French resistance elements. Radio Moscow, on the other hand, played different folk tunes to control field agents. Many of the agents sent into France were women who functioned as radio operators as part of their duties. Many died at the hands of their captors who executed them as terrorists and spies. Leo Marks, who died on January 15, 2001, wrote much of the poetry for the agents to use after it was determined that known poems posed a risk. [58] He knew personally many of the women agents to whom he taught his poems before sending them to France and all too often, to their deaths. [88] The technique of the BBC using simple prearranged phrases in the clear to instruct agents originated with an agent in France in 1941. It minimized his own need to transmit to the S.O.E. to be able to receive his instructions. [88] The coded messages created by spy-master Vera Atkins came at the end of the BBC news broadcasts. [4] Coded broadcast messages simply obviated the effectiveness of the German intercept services, at least for one half of the operational circuit.

Very simple receivers like one tube triode circuits sufficed to listen in to these very powerful shortwave broadcasting stations. Regeneration, although it increased sensitivity markedly, was, however, to be carefully avoided. The re-radiation of a regenerative circuit could mark a path for the Gestapo directly to the radio operator’s door. The same was true for any shortwave listener.
with a regenerative set. [Fig. 91] Many of the clandestine miniature radios have survived. [62] The British designed a particularly elegant little receiver [Fig. 103], the Miniature Communication Receiver MCR-1 for its S.O.E. agents. [43] On the receiving end of the circuit, the British wireless station at Sevenoaks handled the incoming traffic from S.O.E. agents, and other receiving sites came into play. [81]

The Special Operations Executive, the O.S.S. European operations, and the like, conflicted with intelligence gathering in the theater. The last things a spy needed were saboteurs, however well intentioned, blowing up nearby bridges or otherwise antagonizing security forces. Spies like things quiet and unremarkable. If sabotage is even a possibility, defensive forces are likely to intensify monitoring, and spies prefer to avoid such risks that could lead to mission failure, capture, torture and execution. Sabotage operations can diminish the amount of intelligence transmitted by spies in the field. The weighing of objectives between intelligence and sabotage is, no doubt, a policy matter, but the British MI-6 (Secret Intelligence Service) did not approve of the price paid in lost intelligence for showy sabotage. The balance likely shifted near D-Day, as sabotage created important and direct military advantages. Cutting telephone and telegraph wires forced the Germans to use radio and it was often interceptable and decipherable. Well over a million pounds of explosives went into France with the S.O.E. [81], along with many thousands of operational messages.

In August, 1944, the S.O.E. traffic into France peaked at 360,000 code groups a week. [57] The sheer volume of pre-D-Day radio traffic in and out of France overwhelmed the German intercept services. The NAZIs had state of the art intercept equipment, including mobile direction finding vans [Fig. 104], and well trained as well as experienced counter-espionage personnel. Despite this edge, intercept activities put only about 10% of the French stations out of business. [57] In the earlier years of the war, S.O.E. did fear the NAZI intercept service for its efficiency. It was so good that the especially at risk radio operators had a field life-expectancy of three months before capture and worse. [91] They used radio sets hidden in ordinary suitcases. [Figs. 92, 105] According to the German head of the counter-intelligence service for western Europe, Hubertus Freyer, his agents and operatives had to disguise themselves to hone in on the S.O.E. radio operations. [Fig. 92] Their vans, disguised as bakery trucks, could only get so close. Then agents dressed as French civilians did the final direction finding with disguised devices [cf. Fig. 92] in suitcases or in their clothes. [91] One German direction finding receiver used a loop antenna sewn into an overcoat lining and a field strength meter disguised as a wrist watch.
How the Second World War was Won; Etheric Intelligence at Work

The British interception and cryptanalysis won the war in the European Theater, according to Winston Churchill. RADAR may have saved England in 1940-41, and the radio proximity fuse made a difference, but radio intelligence provided the edge for a victory as early as 1945. The NAZIs arrogantly believed that their codes could not be decrypted, hence they relied on radio rather than silencing their radios. As a result of the work of the intercept operators and with the cryptanalysis that permitted the reading of much Enigma traffic, the Allies knew many of the Germans' intentions. Technical approaches were successfully applied to cryptanalysis but it was German operator error and sloppy operating procedures, all duly copied by intercept operators, that provided the "cribs" that permitted the British to decrypt even the complex Enigma traffic (with help from spies and a few captured Enigma machines). The same factor had been true in the First World War. The Admiralty's Room 40 succeeded because of poor radio operating procedures and discipline by the enemy, all duly copied by the intercept operators.

The Japanese believed that their own codes were good enough especially given the difficulty of the Japanese language, and they attributed their losses to conventional spies. This complacency cost them dearly. In the Pacific, the U.S. Navy had the benefit of many of the Japanese codes from the earliest days of the war. That was a theater of intelligence, especially signals intelligence, at work eliminating so much of the "fog of war." [75]

As historian David Kahn has pointed out, the NAZIs lost their initial military advantage in the Second World War precisely because they were unable to coordinate their military intelligence, especially signals intelligence. Wilhelm Flicke anticipated this conclusion, from a German perspective. Failures in signals intelligence and security played a similar role in the early stalemate of the Germans in the First World War as well.

In the end, the causes of the Allied victory in the Second World War are multiple but by taking better advantage of emerging technologies such as radio interception, especially in their coordination, the Allies were able to fight smarter and harder. To be sure, it was Russia committing herself, at the cost of 20 million lives, to defeat the fascist invaders, that turned the tide in the East. The Western Allies did, however, supply the Russians with enormous amounts of war materials including critical intercept receivers, and they were flexible enough to be willing to work with Stalin toward bringing an end to the war.

Fighting smarter in the ether was first and foremost a matter of intercept operators receiving the traffic followed by the discovery that enemy operator error could become the key to successful cryptanalysis. Defensively, American and British forces were thus able to make and maintain for themselves largely secure encrypted communications that prevented most strategic blunders and tactical surprises despite constant enemy interception. The Russians on the Eastern Front also maintained very strict operator discipline, frustrating German efforts to read much of their traffic. The Allies took advantage of the arrogance and errors of the Axis powers, by coordinating the intelligence derived from taking so much of their traffic as intercepts, and then by decrypting it so successfully. The rest, as they say, is History.
Acknowledgements

Many dedicated amateur and professional historians of radio have helped me over the years that I have been doing the research for this paper. Will Jensby (W00EM) of the California Historical Radio Society in particular deserves my thanks, especially for introducing me to Herr Flicke and for much more help. So, too, Steven A. Haller, Historian of the Presidio, National Park Service, has been invaluable with respect to radio in the Presidio of San Francisco. Dick Secondari (K6TR) was extraordinarily generous with his personal archives and materials about his intercept operator experiences. Mamuro Fujimuro (JA1FC) opened up the world of Japanese SIGINT in several interviews. Jerry Berg contributed pre-publication information from his Shortwave Radio history. The specific references try to acknowledge particular assistance, but I fear inadequately.

This is necessarily a meta-history, often selecting technical aspects of much more general publications, to bring them together in one place. It has, however, been a pleasure to make some original contributions in telling these stories. With respect to the illustrations, it is hoped that the wide range of sources makes the reproduction of the images an effort of scholarship.

Many people, knowing of my quest, would simply mail me wonderful things, in hope they might be useful. They all have been, and I am grateful for the assistance of so many enthusiasts. We share a deep community of history, technology, and scholarship, ranging as I have come to know it, from Japan to California, to New York and to Europe. Thank you all.

-- 73 de Bart Lee, KV6LEE, San Francisco.

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early circa 1905 amateur radio operator, for the loan of her copy of this book.

David Kahn is the most authoritative American writer on intelligence subjects. 
His work is the foundation for all who have followed. Mr. Kahn does not, 
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the Bean Counters, continues to this day, vide the recently disavowed Office of Strategic Influence which was to do no more than unify existing operations.


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  Nigel West is the nom de plume of Rupert Allason, writing with the “guidance” of British intelligence officers [73]. His several books overflow with authoritative detail. A work of “fiction,” his THE BLUE LIST (1989), suggests that H.A.R. Kim Philby defected to the Soviets in 1963 as a British triple agent. The fact that the British permitted at least two clandestine Soviet or Comintern wireless circuits to operate between England and Russia between 1930 and 1945 is consistent with this view (see text footnote 4 above and sources [3] and [13]). The British did continue to read Comintern traffic after 1930: Alvarez [2] p. 201. But then, in what James Jesus Angleton called “a wilderness of mirrors,’ who knows?

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On September 11, 2001, the New York Red Cross enlisted Bart as the night shift radio supervisor where he operated the Red Cross and occasionally the RACES amateur radio communications networks, coordinating disaster recovery work after the terrorist attacks on the World Trade Center.
The Marconi Wireless Telegraph Apparatus in R.M.S. Titanic Confirmed by Observations of the Wreck

Parks Stephenson

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Figure 1. Titanic alongside in Southampton. Note the spacing between the two inner antenna wires, as opposed to that of the outer wires, at the forward spreader and the strop insulators between the third and fourth funnels. (Harland & Wolff archives)

Introduction

A system-level description of the Marconi apparatus on board the White Star liner Titanic was previously presented in a two-part article published in the AWA quarterly newsletter, the Old Timer’s Bulletin in November 2001 and February 2002. For this article, that description will be expanded to include component-level detail.

In September 2001, film director James Cameron explored the remains of the Marconi suite during his expedition to film the wreck of the Titanic for his upcoming documentary Ghosts of the Abyss. One of Cameron’s uniquely-designed remotely operated vehicles (ROVs) was able to penetrate farther than any previous attempt into the portion of the Officers’ Quarters that housed the Marconi suite, where it disclosed the remains of the transmitting apparatus. Based on Cameron’s discovery, it appears that, although the Marconi Room was completely destroyed by hydrodynamic forces acting inside the superstructure as the ship plunged to the ocean floor, the more substantial walls of the adjacent room that housed the transmitting apparatus provided a measure of protection for the equipment therein. This room was called the “Silent Room,” because its walls were heavily insulated with asbestos to prevent the loud noise of the electric motors and spark generating equipment of the transmitting set from distracting the operator while he attempted to receive faint signals through his headphones. Organisms that have taken residence within the wreck have eaten
Figure 2. Olympic’s Marconi Room, as seen during her maiden voyage in June 1911. (Marconi plc archives)

Cameron’s thorough exploration of the Silent Room yielded a gold mine of information. Although pictures of operating rooms or Marconi rooms are relatively common (Figs. 2 and 3), contemporary pictures of the interiors of Silent Cabins aboard ships during the spark era are rare. Of the three Olympic-class liners, of which Titanic was the second, the only known photograph of the interior of a Silent Room was taken around 1924 and shows Continuous Wave equipment. Therefore, even though the configuration of a Marconi transmitter could be postulated by studying contemporary literature concerning the subject, there was little direct evidence prior to Cameron’s expedition to corroborate such speculation. But there, illuminated in the lights of Cameron’s ROV, was an almost-complete 5-kW Marconi transmitting set, arguably the most famous one in the history of marine wireless telegraphy, still connected together by the original circuit wiring. A study of this apparatus is therefore illuminating for students of both Titanic and Marconi history.

Background

Marconi’s Wireless Telegraph Company, Ltd. (hereafter referred to as the Marconi Co.), had an exclusive financial arrangement with the major British-flagged shipping lines among which was the White Star Line. These companies paid the Marconi Co. for the use of their equipment and for the salaries of the operators who manned the shipboard installations. The Marconi Company was responsible for the training of the operators as well as the installation and maintenance of the leased equipment.

Figure 3. Titanic’s Marconi Room, as seen during her maiden voyage in April 1912. Double-image photo, the only surviving photograph of Titanic’s Marconi Room. (Fr. F. Browne collection)
The major incentive to the steamship lines for installing a wireless telegraph apparatus was revenue generated by passenger traffic. Use of the apparatus for navigational purposes was also understood, but not fully appreciated, across the industry. Not all ships plying the North Atlantic were equipped with wireless, and of those that were, only a relatively few were manned around the clock. This changed as an immediate result of the Titanic disaster, but the signals for change were already in the air just prior to 1912. The differences in the physical placement of the wireless controls between the White Star sisters Olympic (1911) and Titanic (1912) demonstrate an increasing dependence on having more than one operator man the station. On board Olympic, it only took one operator to control the entire apparatus from the Marconi Room should the occasion require it (Olympic was nonetheless staffed with two operators, because of the expected passenger traffic load). On board Titanic, the controls for the transmitting equipment were moved into the Silent Room, which meant that two operators were required to work in tandem to adjust the equipment.

The wireless apparatus was housed on board Titanic in a series of interconnecting rooms — the sound-proof “Silent Room,” in which noisy transmitting equipment was located; the Marconi Room, an office which contained the operators’ work stations, manipulation keys, and receiving equipment; and the Bed Room, which contained the operators’ spartan berthing. This suite was located inboard on the centreline of the Boat Deck within the Officers’ Quarters deckhouse. A six-pane skylight overhead in the Marconi Room provided natural light to the space.

As mentioned above, the wireless apparatus was operated and cared for by Marconi Co. employees, who were by routine assigned to Titanic for the duration of one voyage and, therefore, not considered part of the normal White Star Line crew. The uniforms worn by the two Marconi operators aboard Titanic were made distinguishable by Marconi emblems on the buttons, sleeves, and cap. Marconi employees were not directly responsible to any of the ship’s crew, except the ship’s Master, and even then, only in certain instances. Most of their time was spent within the Marconi suite, with the exception of meals, which were taken in the dining saloon reserved jointly for Marconi and postal employees on C Deck.

Originally, the standard 1.5-kW marine wireless apparatus was intended for the two newest additions to White Star’s transatlantic service, the sister ships Olympic and Titanic. As events happened, though, wireless technology progressed so rapidly between 1909 and 1911 that a 5-kW plain spark apparatus was now available to be installed on board Olympic just prior to her maiden voyage in June, 1911. Titanic would receive the additional benefit of a synchronous rotary spark discharger the following year.

Titanic’s wireless apparatus had a nominal working range of 250 nautical miles, but signalling more distant stations was possible. At night, ranges of up to 2,000 miles were attained with sets of similar architecture. The use of the “T” type aerial afforded greater power and sensitivity in both fore and aft directions so optimised performance could be expected when the ship was pointed either toward or away from a distant station.

**Details of the Wireless Installation**

The Marconi wireless apparatus consisted of both transmitting and receiving equipment sets. The transmitting set consisted of five distinct circuits that
converted direct current from the ship’s electrical mains into regulated, high-
power, radio-frequent oscillations that were then transmitted into the atmosphere
by way of the ship’s aerial. Much of this equipment was located in the Silent
Room, the walls of which were heavily insulated with asbestos to quench the
noise and reduce interference generated by the transmitting apparatus. The
receiving set, located on or adjacent to the aft-facing operators’ desk in the
Marconi Room, was connected into a single circuit that converted radio-frequent
oscillations collected by the aerial into audible signals that could be heard by
the operator. An emergency transmitting set, also located in the Marconi Room
and capable of producing a plain spark in the event of a casualty to the main
transmitting set, was also provided.

Transmitting Set

The Direct Current transmitting circuit carried the 100-volt direct current
(D.C.) from the ship’s lighting circuit via a local electrical distribution box to
the main switch for the Marconi equipment. This circuit included the main
switch, a starter, two field regulators, the D.C. switchboard, four protecting
shunts and the motor. The function of each of these components is described
below.

Main Switch — The Main Switch was used to allow D.C. from the ship’s
mains to flow to the motor. To start up the motor, the operator first had to
close the double pole (D.P.) knife main switch, then place the starter handle
over the first or second contact.

Starter — (see A, Fig. 4) The full and sudden application of direct current
to the motor could burn out the armature windings, so a series of resistance
coils was used to slowly bring the motor up to operating speed. The manual
motor starter consisted of a series of brass contact studs on a slate face. Each
stud was connected to a resistance coil within the starter’s cast-iron casing.
The starter incorporated an overload release electro-magnet, which caused the
electrical flow to the motor to be cut out whenever the current exceeded a pre-
determined value. As the handle of the starter was slowly moved across the
contact studs, resistance was taken out of the circuit and current was thereby
admitted to the motor armature in small increments. The motor’s speed steadily
increased as the handle was moved toward the final or full running position.
The handle was held in the full running position by a no-volt release, which was essentially another electro-magnet. Upon loss of power, a break in the current flowing through the motor windings or the activation of the overload release, the handle was released and brought back to the full open position by a spring held in tension.

Field Regulators (see B, Fig. 4) - Two field regulators - one to regulate the frequency of the alternator, another to regulate the voltage of the armature - connected in series with the motor generator allowed the operator the means to adjust the discharged spark. Each field regulator consisted of a number of turns of resistance wire wound on a slate base, in much the same fashion as the starter. As the operator moved the starter handle across each sequential tap to bring the motor up to its steady operating speed, resistance in the motor’s armature circuit was steadily decreased until it reached a minimum value. As resistance was being cut out of the armature circuit, it was introduced in proportional quantities into the field-magnet circuit. This was designed to keep the motor armature from overheating during the starting process. When the starting handle was brought to rest on the final contact stud and the armature was running at a constant speed, this protection was no longer necessary and all resistance was then cut out of the field circuit. If a greater speed was desired after the motor had been brought to its constant steady speed, then an application of extra field resistance would decrease resistance in the armature circuit, thereby allowing the motor armature to rotate at a faster rate. In the alternator, the part that revolved was the field, so an increase in the resistance of the exciting field (alternator) regulator reduced the current flowing through the alternator field and the voltage across the alternator terminals subsequently dropped. The difference in the effect of applied resistance by the two field regulators was due to the fact that in the motor, the armature rotated; in the alternator, it was the field that rotated. Close regulation of the voltage and frequency produced by the motor generator was necessary to achieve a properly quenched spark. No spring return was fitted on the handle of the regulators, as the handle had to be capable of being left on any selected contact stud.

The settings observed for the field regulators in the wreck of the Titanic show that an extra amount of field resistance had been applied to increase the speed of the motor and thereby raise the alternating voltage, while the alternator had a bit more resistance than normal applied to lower the frequency of the transmitted spark to compensate for the increased speed of the motor without affecting the voltage output. Basically, the observed positions of the settings support the supposition that the Marconi operators were trying to wring more power for the transmitted spark from the fading shipboard power supply moments before the ship foundered.

Double Panel Switchboard (see C, Fig. 4) — The switchboard had a slate panel for direct current (DC), and another for alternating current (AC), both of which were mounted on a common cast-iron frame. Each panel included a double pole (D.P.) knife switch that allowed for control of current flow into the working circuits and cartridge fuses to provide for circuit protection against sudden differences in potential. A shaded pilot lamp on each panel illuminated when power was being supplied to that particular panel, no matter if the respective D.P. switch was open or closed. An illuminated pilot lamp on the DC panel indicated that ship’s direct current was being supplied to the switchboard
from the mains, while an illuminated lamp on the AC panel indicated that alternating current was being supplied to the switchboard by the alternator. The DC circuit was protected by 100-ampère cartridge fuses; the AC, by 30-ampère fuses. Each fuse consisted of a fuse wire surrounded by asbestos or sand, the whole of which was contained within a cardboard cylinder capped with brass terminal lugs at either end. The strength of the voltage or electro-motive force (E.M.F.) in either circuit could be measured by pressing the voltmeter key momentarily and observing the needle deflection in the voltmeter on the respective panel. The operator could also monitor the performance of the motor generator by observing the values measured by the ammeter on each panel, which measured the current flowing inductively through the stationary windings of the motor field (DC) or armature (AC).

Protecting Shunts — Four graphite sticks, in tubular form, were connected in shunt (parallel) across the alternator and motor terminals for the purpose of preventing spikes created by the oscillating discharges in the transmitting circuit from damaging the windings of the motor and alternator. The resistance supplied by these sticks absorbed excessive oscillations in voltage. Each of the two sets of protective shunts was mounted between two pairs of brass springs, fixed on a baseboard supplied with electrical terminals.

Motor Generator (Fig. 5) — A source of alternating current was required for the generation of radio-frequent oscillations. The Motor Generator supplied 300-volt, 60-cycle AC from the 100-volt DC ship’s supply. Radio transmission required that the generator provide constant speed and AC voltage under variable load. For this reason, the motor was rated at a larger output than the alternator so as to provide a suitable margin of power to compensate for the load placed on the alternator each time the transmitter key was depressed. The set (see D-E, Fig. 4) consisted of a drum-wound motor and a simple alternator coupled together on a common cast iron base. The motor armature was on the same shaft as the alternator rotor field, separated by a coupling. Rotation of the motor armature caused rotation of the drum-wound alternator armature by way of the common shaft. As the alternator field revolved past stationary coils situated around the interior of the framework, alternating current was induced in the windings. Mechanical power was thus converted to electrical current. The AC taken from the stationary windings at the alternator end of the shaft was sent to the AC panel of the switchboard.
Low Frequency Primary Circuit

The Low Frequency primary circuit carried the low potential alternating current generated by the alternator to the primary winding of the transformer. This circuit included the AC switchboard, a regulating inductance, a manipulating key, a magnetic key and the primary winding of the transformer.

Low Frequency Inductance (Fig. 6) — In the DC circuit, self-inductance effects were only produced at times of switching the circuit on or off, or when the current was increased or decreased. With alternating current, self-inductance effects continually rose and fell as the current switched direction. In order to establish a state of resonance (i.e., where the potentials across the inductance and the capacity balanced one another) in the low frequency primary circuit so that the condenser could be efficiently charged, a variable inductance was provided. The low frequency inductance consisted of a coil of insulated copper wire wound on a laminated iron core. Adjustment of the inductance value was performed by moving a brass spring brush over a series of brass stops. Both the speed of the motor and the amount of inductance were adjusted to achieve the state of resonance. When both current and voltages were in phase, the alternator delivered energy to the transformer at maximum efficiency.

Manipulating Key (Fig. 7) — The Manipulating Key was connected to the low potential side of the transformer by way of a magnetic relay key. The function of the key was to form the dots and dashes of the Morse code by allowing the alternating current to flow from the alternator to the transformer whenever the operator depressed the key. The Marconi Morse transmitter key had platinum contacts to resist the corrosive effects of switching the circuit to the magnetic key. An ebonite knob and protecting disc on the end of the brass bar of the key protected the operator from electric shock. Because there was
no aerial change-over switch to protect the receiving headphones from the sending spark, the Marconi key had small auxiliary spring contacts on the side, which were pressed together by a small ebonite bar projecting from the side of the brass bar each time the key was depressed. These contacts were joined across the receiver headphones, short-circuiting them whenever the key closed the circuit. In this manner, the ears of the operator were protected from the loud discharge of his own transmitter. A brass lever with an ebonite knob at the left side of the base broke the circuit completely if required in an emergency situation, effectively isolating the transmitter key.

**Double Magnetic Key (Fig. 8)** — The relay key utilised electro-magnetically operated switches to interrupt the 100-300-volt primary circuit, in order to protect the expensive platinum contacts of the manipulating key from the corrosive effects of the high voltage spark. Use of a double magnetic key relay also allowed the manipulating key to be worked on a lower voltage. As the name implies, two electro-magnets of similar construction were utilised, one in the DC circuit, the other in the AC low-frequency primary circuit. Each one consisted of two coils of wire wound on boxwood bobbins, which were then mounted in parallel on two slotted soft iron cores fixed to an iron yoke in the wood base. The windings on the D.C. coils were of much finer wire and of greater numbers of turns than those of the AC coils as the current used was much smaller. A soft-iron armature was mounted above each set of coils on a brass arm by means of a flexible spring. Each armature carried a platinum contact stud on its underside, directly across a small air gap from a like contact mounted atop a brass support pillar extending upwards from the base. The first electro-magnet was energised from the DC mains whenever the manipulating key was closed, attracting the armature and thereby closing the contacts. This in turn closed the circuit from the alternator through the AC coils. The flow of current through the coils created a magnetic field that attracted the armature in the AC electro-magnet, closing the low-frequency primary circuit which allowed current to flow from the alternator through the primary winding of the spark transformer. When the key was released, the transformer circuit was opened and the armature was released and forced back to its original position by the spring. The current had an alternate path to follow along the brass strip of the manipulating key and through the pillars of the DC electro-magnet in order to rejoin the original circuit; therefore, very little sparking occurred at the breaking of the manipulating key contacts. As alternating current comes to a zero value 100 to 120 times per second, it follows that a zero value would be reached shortly after the release of the manipulating key, which resulted in very little sparking at the magnetic key contacts. In this manner, the circuit could be interrupted without dirtying.
or burning out the contacts. This ensured that the operator would be able to use the key to send the Morse code as fast as the hand can work without worrying about developing intermittent contact operation.

Transformer (see F, Fig. 4) — A high voltage step-up transformer raised the voltage of the AC supplied by the alternator for charging the main condenser. The transformer was an iron-core type. Two transformer windings were superposed on a middle limb, with the entire limb assembly immersed in high-flash insulating oil within a galvanised steel tank to prevent arcing. The primary consisted of thick copper wire wound over a soft iron core, with two ends of the winding brought through heavy ebonite bushes to standard lugs on the outboard side of the galvanised container. The secondary was in two parts, each part consisting of fine wire wound in a great number of turns over the primary (which was separated by a stout ebonite tube), thereby forming a continuous circuit. The greater number of turns in the secondary winding ensured that the voltage tapped off the secondary would be greater than what was introduced into the primary. The four ends of the secondary windings were connected to plug sockets on the inboard side of the galvanised container. The secondary terminals were fitted with two brass strips which allowed the two windings to be arranged in either series or parallel. The output voltage from the secondary could thus be adjusted to provide 5 kilo-volt-ampères at either 10,000 (parallel) or 20,000 (series) volts to charge the condenser. The necessary changes of wavelength were obtained by variation of the capacity of the condenser in the closed circuit and the amount of inductance in the aerial circuit.

High Tension Circuit

The High Tension circuit carried the high voltage current stepped up by induction through the secondary winding of the transformer to the condenser. This circuit included the transformer secondary windings, two choking coils, the main condenser and the condenser commutator.

High Frequency Air Core Choke Coils (see G, Fig. 4) — The flow of current through the AC transformer was regulated by two “choking” coils of potentially high impedance. The coils consisted of a few turns of heavily insulated copper wire wound over an air-filled porcelain cylinder contained in a teak box. Being without an iron core, these coils had practically no effect on the low-frequency current from the transformer to the condenser. The frequency of the transformer charging current was so low that the current passed through the coils to the condenser with minimal resistance. However, owing to the fact that impedance effects increase as the frequency increases, high frequency oscillations were prevented from flowing back through the chokes. In this manner, the choking coils prevented the condenser discharge currents from flowing back into the secondary of the high voltage

Figure 9. Condenser Cell and Cradle.
(Handbook of Technical Instruction for Wireless Telegraphists, modified)
transformer, where they could have caused a difference in potential in the winding strong enough to puncture the insulation and short-circuit adjacent layers.

**Main Condenser (Fig. 9)** — The purpose of the condenser was to store the high-voltage charge until it built up to the point where it reached the breakdown voltage of the spark gap. Upon discharge, the condenser charged again. This cycle would repeat itself numerous times as long as the key was down, completing the circuit. The main condenser used in Titanic was of the “double plate, whole plate” type and consisted of four cells, each mounted on a teak stand. Each cell contained 17 sheets of zinc — acting as conductors — interspaced with 36 flint glass plates — acting as dielectrics — supported by a galvanised iron cradle. Each cradle was suspended within a galvanised iron tank, which was packed with sheet and block cork and then filled with transformer oil to prevent direct arcing. The terminal bolts, which were fitted through the lid of each tank had heavy ebonite bushings where they passed through to the exterior. The whole system of zinc and glass plates could be lifted easily out of the case for the purpose of renewing any glass plate that had broken down. The condenser was protected from heavy loads by a pair of spark points of flat brass fitted to the terminals. The noise made by any discharge at these points served as notice to the operator to adjust his circuit. Due to the effect of dielectric hysteresis in the glass plates, the condensers could become very hot during operation.

**Swiss Commutator (Fig. 10)** — A controlling device was mounted on top of a wooden framework around the condenser tanks and used to vary the configuration of condenser cells in the circuit according to the length of the wave desired for transmission. The four condenser cells were connected to five hollow copper bars of square cross-section mounted on a baseboard and arranged in two parts of two cells each. Two additional hollow copper bars were mounted on ebonite standards such that they lay two inches above, and perpendicular to, the five bars on the baseboard. Electrical terminals on the upper bars were connected to the leads from the choking coils and the closed oscillatory circuit. Split brass plugs were inserted in various holes in the bars, depending on the configuration desired, to connect the upper bars to the lower. For the normal 600-meter (500-kHz) wavelength, the two parts of the condenser were connected in parallel; for the 300-meter (1000-kHz) wavelength, they were placed in series. Thick copper strips were used to connect the condensers to the terminals mounted on the lower commutator bars.

**High Frequency Primary or Closed Oscillating Circuit (Fig. 11)**

The High Frequency Primary or Closed Oscillating circuit set up an oscillating current of high potential for transmission. This circuit included the main condenser, rotary spark discharger, a variable inductance and the primary of the oscillation transformer, or “jigger.”

**Rotary Spark Discharger (Fig. 12)** — The function of the spark gap was to keep the closed oscillation circuit idle until the condenser was fully charged; to discharge the energy stored up in the condenser in the form of radio-frequent oscillations; and to restore the gap to its non-conductive state (known as “quenching the spark”) when the energy had been transferred to the aerial. A 10-inch circular steel disc was mounted on an independent shaft running in ball bearings, which was then directly coupled to the aft end of the motor-generator shaft through an insulating rubber coupling. This arrangement permitted the discharge of the condenser to be accurately timed with the alterations of the charging
Figure 10. (left) Swiss Commutator. To place the condenser cells in parallel, the brass plugs would be placed through the holes marked 1, 7, 9, and 5, or through 6, 2, 8, 4, and 10. To place all four cells in series, two plugs would be inserted in the holes marked 1 and 10. (Handbook of Technical Instruction for Wireless Telegraphists, modified)

Figure 11. (right) High Tension and Closed Oscillatory Circuits. (Handbook of Technical Instruction for Wireless Telegraphists)

Figure 12. (left) Disc Discharger. This disc has holes for 8 contact studs, Titanic's had 16. In addition, Titanic's discharger shared an extended bed plate with the motor generator. (Courtesy of Louise Weymouth, Marconi plc Archivist)

Figure 13. (right) High Frequency Tuning Inductance. (Handbook of Technical Instruction for Wireless Telegraphists, modified)
current; hence, this system was also known as a Disc Discharger. The disc was fitted with 16 transversely-mounted copper discharge studs, each of which protruded 1 inch from either face. The discharge studs revolved between two stationary electrodes on ebonite pillars, which could then be adjusted in order to maintain the shortest possible discharge gap without actually touching the revolving disc.

When the stationary electrodes were connected in series with the closed oscillation circuit of the transmitter, the spark would discharge whenever an electrode on the disc came opposite the stationary electrodes. At the charging current of 60 cycles, the condenser was charged and discharged 120 times a second. In actuality, the spark discharge began long before the electrodes were directly opposite, which was a consideration when adjusting the discharge gap. In order to muffle to sound of the spark discharge, a heavy teak box was positioned and hinged so that it could be lowered over the disc and the two stationary electrodes. This discharger box contained a semi-circular cut-out on the side closest to the motor to allow the box to be lowered over the shaft. When lowered, the discharger box enclosed only the upper portion of the discharger apparatus. The lower half was left open to the atmosphere so that noxious gases resulting from the spark discharges could be dissipated by the spinning disc.

The operator adjusted the spark primarily by adjusting the speed of the motor until the discharges were synchronous (i.e., regular sparking without misses), resulting in a clear, musical spark note. The note of the spark was dependent on the speed of the disc; therefore, the speed of the motor was adjusted to obtain a spark frequency of between 400 and 700 sparks per second. This range had been determined through practice to give best results, as operators complained of fatigue brought on by having to listen continuously to notes of too high a pitch. Ultimately, the adjustment obtained depended on the ear of the operator, so the discharge box was lifted in order to clearly hear the spark during adjustments. The desired spark produced a high-pitched note that was crisp and clear in order to make it easier to discern over the interference of atmospherics at the receiver than the “Shhhh” sound emitted by plain spark dischargers.

The discharger box was found locked open in the remains of Titanic’s Silent Room. This would seem to reinforce the scenario wherein one of the Marconi operators, most likely junior operator Harold Bride, took station in the Silent Room towards the end to adjust the spark in response to the failing ship’s power. The reason for lifting the box would have been to hear the spark clearly as the motor was adjusted to provide more output from less power.

**High Frequency Tuning Inductance (Fig. 13)** — The condenser was only capable of adjustment for two values of capacitance. An additional inductance in the closed circuit was required to provide a final adjustment to tune the oscillation frequency to the wavelength of the aerial circuit. A heavy brass spindle with ebonite handle allowed the operator to move a spring brush up or down the inner surface of a heavy copper spiral. The length of the spiral in the circuit affected the amount of H.F. inductance inserted into the circuit. The busbar connectors from the condenser bank were bent around the spiral in order to increase the effective value of inductance.

**High Frequency Variable Coupling Jigger (See N, Fig. 4)** — In the Marconi system, coupling transformers were termed “jiggers”. A variable jigger was
used to roughly couple the wave-generating and wave-radiating circuits together. When the condenser discharged, the resultant oscillations set up in the jigger primary coil were transferred by induction to the jigger secondary coil. The primary of the jigger consisted of four turns of a heavy insulated copper-stranded cable wound on edge as a square-shaped spiral and mounted on an ebonite support which was held in a wooden frame with metal supporting legs. The ebonite end plate of the primary supported five solid brass lugs which were connected to taps on the coil. Behind them ran an insulated horizontal copper bar onto which either one or other of the lugs could be plug connected. One terminal was connected to the high frequency tuning inductance, the other to the main condenser.

The secondary consisted of an insulated copper-stranded cable which was wound seven times around a square teak box with an ebonite top. Eight tappings were brought from the secondary winding to brass sockets mounted on the ebonite top. One end of the secondary was joined to the earth-lead, the other to the aerial by way of the aerial tuning inductance; the number of turns (i.e., amount of inductance effect) of the secondary in use could be altered, depending on which socket the lead plug was inserted into. For the purpose of adjusting the coupling between the wave-generating and wave-radiating circuits, the secondary was made to slide laterally over the primary by means of a handle and screw fitting. When the primary coil was positioned almost directly over the secondary coil, the two circuits were considered to be closely coupled, and if the distance between them was relatively large, they were said then to be loosely coupled. Two closely coupled circuits resulted in the maximum amount of radiating signal strength, but the oscillations set up in each circuit could interfere with one another. By loosening the coupling, greater selectivity could be gained to reduce interference, at some cost to radiating strength. The degree of coupling was usually determined by the station erecting engineer, with the optimum position marked on the primary casing. The operator seldom was required to change this setting.

**Radiating or Open Oscillating Circuit**

The oscillating current set up in the closed circuit was inductively transferred to a circuit open to the aerial. The Radiating, or Open, Oscillating circuit included the secondary winding of the jigger, an aerial tuning inductance, an earth-arrester spark gap and a tuning lamp.
Aerial Tuning Inductance (Fig. 14) — For maximum efficiency, the effective length of the aerial had to be adjusted to match the exact frequency required; however, practical shipboard considerations precluded having a separate aerial of the exact physical wavelength required for each of the international frequencies. The variable jigger, while providing for the proper degree of coupling between the radiating and aerial circuits, was unable to tune the aerial to a specific wavelength. An additional inductance was therefore provided to adjust the wavelength of the aerial circuit to the desired frequency and bring it into resonance with the oscillating circuit. The Aerial Tuning Inductance consisted of two similar units, each made of stranded cable well insulated and braided, wound twenty times in one layer on a wooden form contained in a square teak box, in a manner similar to that of the jigger secondary. Tappings were brought from various points through ebonite bushings to eight brass plug-sockets arranged on the face of each containing-box. Because of the length of Titanic’s aerial, two separate units, providing a total inductance of 300 microhenrys, were required to produce the long wave.

Tuning Lamp (Fig. 15) — The tuning lamp was a small, 4-volt carbon filament lamp which was wired in series with an adjustable inductance coil of wound copper wire and mounted on a teak base. The lamp was shunted between the jigger secondary and earth so that it could take a small fraction of the oscillating current induced in the earth-lead of the transmitter. The amount of glow produced in this lamp acted as an indicator of the total amount of current in the earth-lead, and as this depended upon the accuracy of syntonisation between the jigger primary and secondary, the lamp could be used for tuning these circuits (i.e., the lamp was most brightly lit when the two circuits were in tune). The operator could add an additional amount of inductance into the circuit by moving a pivoted brass arm across the inductance coil.

Earth Arrester (Fig. 16) — A terminal was needed to protect the receiving apparatus from the high potential of the transmitting apparatus while also providing protection for the aerial against lightning. The earth arrester was actually two round brass plates separated by thin discs of mica. The wires to the ship’s earth connected with the bottom plate. The top plate was connected to the earth of the oscillation transformer and the aerial terminal of the tuner. A circular groove was cut in each brass disc, coinciding with the edge of the mica, to ensure that no sparking would take place at the mica edge and thereby burn it; the sparking then took place across the outer edge of the upper plate. The gap was short, so that transmitting currents (and lightning) would flow in sparks across it, but wide enough to act as an insulator to the tiny received currents which found their way to earth through the tuner. Use of this protective spark gap was unique to apparatus manufactured by the Marconi Co. and alleviated the requirement for a change-over switch.

Extra Condenser and Earth Arrester — Titanic used an extraordinarily long aerial, the natural frequency of which was such that an unacceptable number of turns would have to have been taken out of the jigger secondary in order to obtain the 300-meter, or “short,” wave. Therefore, an extra, or Short Wave, condenser was supplied to reduce the total capacity of the aerial and thereby render it suitable for the production of the shorter wave. A separate arrester was also provided so that received currents of the same frequency as was being transmitted would pass through to earth, rather than oscillate in the closed oscillating circuit.
Aerial

Aerial (Fig. 17) — Titanic was fitted with a Marconi twin “T” type aerial, rising vertically from the roof of the Marconi Silent Room and connecting with four horizontal wires strung between the ship’s two masts, which were stepped approximately 600 feet apart. Positive electrical connection was made between each vertical lead-in and its corresponding wire in the horizontal flat top by means of a “T” Joint that was designed in such a manner that strain was not collected at the junction. Two 20-foot spreaders at either end of the flat top portion spaced the two inner wires 8 feet apart and the two outer wires 6 feet from the inner wires. The aerial spreaders were supported by bridles of tarred hemp rope (ratline), which in turn could be raised or lowered by rope halyards run through reef blocks attached to the top of their respective masts. The
forward spreader had four eyebolts, each of which took a 5-ft. flexible strop insulator with a working strain of 30 cwt, from which an individual aerial wire was run.

The fundamental wavelength of the aerial was 325 meters, which provided a good value of aerial current at the 600-meter adjustment and a fair value at the 300-meter wave adjustment. Because the natural wavelength of an aerial was approximately four or five times its physical length, the working length of Titanic’s aerial had to be much shorter than the distance between the two masts. The length of the horizontal wires was therefore limited to keep both standard radiated waves within limits. This resulted in the strain insulators for the after portion of the aerial being suspended over the space between the 3rd and 4th funnels, instead of attached directly to the aft spreader. The remaining wire aft of the insulators served only as support. Also note that the lead-ins had to be taken from the exact centre of the flat top; otherwise, each branch of the “T” would have a different wavelength, making accurate tuning impossible.

Leading-in Insulator (Fig. 18) — A Bradfield type deck insulator, rated for the 5-kW marine generator set and able to withstand a minimum of 30,000 volts, was used to insulate the aerial from the steel structure of the ship. The insulator was elevated on an approximately 6-foot-high wooden trunk, square in cross-section, to keep it clear of a canvas awning that was part of the design for the roof of the Officers’ Quarters but never utilised during the ship’s short career. In order to protect the Bradfield insulator from the strain of the aerial being pulled by the wind, the lead-ins were firmly attached to a screw eye in the roof of the Officers’ Quarters and electrically isolated by a single strop insulator. Electromagnetic energy was transferred between the aerial and the Bradfield insulator by way of two flexible wires that ran from the terminus of the lead-in wires to the insulator’s shackle head. The brass terminal socket on the lower end of the insulator rod inside the Silent Room secured the wire connection to the Aerial Tuning Inductance as well as to the two plug sockets mounted on the aft bulkhead of the Marconi Room.

Partition Insulators (Fig. 19) — Two partition insulators were provided to feed the high voltage aerial wires through the soundproofed wall of the Silent Room. Each consisted of a steel rod encased in an ebonite tube, with brass terminals on both ends.

Aerial Plug Sockets — Two plug sockets were provided to feed high voltage through the wall of the Marconi Room to the aerial. One socket was connected to the earth arrester terminal in the aerial circuit; the other, to the induction coil secondary in the emergency set. Each socket consisted of a large electrose insulator, moulded over a 27-in. brass rod. Connecting lugs on either end were used to connect the leads. The outside of the insulator was threaded, so that a collar could be used to draw the socket up tight in the hole through the cabin wall. The plug sockets were designed to withstand a minimum of 30,000 volts.

Receiving Set (Fig. 20)

The Receiving circuit was considered a secondary circuit in a loosely coupled oscillation transformer, of which the transmitting circuit was the primary. This circuit included the magnetic detector, multiple tuner, a pair of headphones and a headphone condenser. A stand-by receiver, with associated power supply, could be inserted into the circuit by means of a two-way switch, when required.
Figure 18. (left) Bradfield Leading-in Insulator, mounted atop an aerial trunk. (Author's modification of the illustration for an aerial trunk in Handbook of Technical Instruction for Wireless Telegraphists)

Figure 19. (above) Partition Insulator. (Handbook of Technical Instruction for Wireless Telegraphists, modified)

Figure 20. (right) Receiving Circuit Connections. (Handbook of Technical Instruction for Wireless Telegraphists)

Figure 21. (above) Magnetic Detector. (Marconi: Receiving and Measuring Instruments)
Magnetic Detector (Fig. 21) — This instrument, colloquially known as “Maggie,” was used to convert the received electro-magnetic waves into a form of energy that could be heard by the operator. A continuous band of soft iron wire revolved on ebony grooved wheels, which were turned by clockwork. The band passed through a glass tube that was wound with a fine wire, through which radio-frequent oscillations flowed on their way from aerial to earth. Two horseshoe-shaped permanent magnets were mounted above the tube. When the iron band passed underneath the two magnets, it underwent a cyclic change in magnetism and became extremely sensitive to the magnetic field generated by the current flowing through the primary coil wound around the glass tube. It may be mentioned that for the greatest intensity of received signals, the two permanent magnets could be placed with like poles together over the coils. This arrangement, however, introduced a low noise in the telephone termed “breathing”. Adjustment of the position of the magnets could reduce the unwanted noise effect, but at a slight decrease in the intensity of the received signals. A wire bobbin inserted in the path of the magnetic flux was acted upon inductively by the magnetized regions of the iron band, sending a current to the receiving headphone diaphragms via a secondary circuit. In this way, a single sound was generated for each group of incoming oscillations. A brass key was provided on the side of the instrument's base to allow the operator to wind the internal clockwork. The primary terminals of the detector were connected to the tuner, the secondary terminals to the receiving headphones via the phone condenser.

Marconi Multiple Tuner (Fig. 22) — The Multiple Tuner was used in conjunction with the Magnetic Detector to provide a reliable receiving apparatus that required no adjustments when once set. A means of tuning it to the incoming signals of one given wavelength, and eliminating the signals of all other wavelengths, was provided by three inductively-coupled adjustable circuits. The full range of 100 to 2,500 metres was obtained in four steps by a triple four-way Tuning Switch located on the front of the instrument case. This switch simultaneously altered the amount of fixed inductance and capacity in the primary, intermediate and secondary circuits for a progressive increase or decrease in wavelength. The intermediate circuit was used to filter the received signals, so that the detector circuit would be actuated only by signals of the desired wavelength. This decreased the effect of atmospheric discharges (known colloquially as “Xs”) on the detector circuit. Finer adjustments of tuning were made by means of the variable condensers located on top of the case.

A small double-pole, double-break detector switch on the top of the case could be placed in either the “Std. Bi” or “Tune” position. In the “Std. Bi” (Stand-by) position, the Magnetic Detector was connected directly into the aerial circuit and the necessary tuning adjustments could be made with the Aerial Tuning Inductance multiple-contact switch (located on the left front of the case) and a variable adjustment of the Aerial Tuning Condenser (AK). The “Std. Bi” position was often used for reception, as it was specifically devised to pick up incoming signals of widely different wavelengths. A high induction coil across AK prevented static charges from accumulating in the aerial circuit. When it was desired to operate the tuner in a highly-tuned condition, the detector switch was thrown over to the “Tune” position, which removed the Magnetic Detector from the aerial circuit and coupled the detector circuit to the intermediate circuit, where accurate tuning could be accomplished. A multiple-contact switch on the side of the instrument case allowed for a simultaneous adjustment of the
inductance couplings in the primary and secondary circuits. The particular wavelength adjustment corresponding to any position of the Tuning Switch was clearly marked on the face of the operating handle. For the normal operating wavelengths of 300 and 600 meters, Switch S-1 was placed in the second position, which placed AK in series with the aerial, shunted the Intermediate Condenser (IK) to the intermediate circuit and placed the Detector Tuning Condenser (DK) in series with the Magnetic Detector. As the Marconi system did not use an aerial change-over switch, injury to the receiving equipment from the heavy inductive effects of transmitter oscillations was prevented by the micrometer spark gap, which automatically shunted the aerial terminal to earth during transmission.

Head Telephones or Headphones (Fig. 23) — The operator received the incoming train of signals through head telephone receivers, which converted the feeble electrical current impulses to a discernible sound. As the action in the headphones was electro-magnetic, and therefore unable to keep pace with extremely rapid changes in direction of an oscillating current, the current had to first be converted by the detector into an intermittent uni-directional current.
This current effect acted on the diaphragm, which was a thin disc of special iron, causing it to vibrate in and out in response to the impulses of the current flowing through the coils. The vibration of the diaphragm created the sounds in the operator’s ear. The working parts of the headphones were enclosed in ebonite casings, so as to isolate the interior components from dust and dampness. Two sets of headphones were provided, each wound to a resistance that equalled the resistance in the secondary of the associated detector. The headphones connected to the Magnetic Detector were wound to a relatively low resistance (150 ohms); those connected to the valve receiver, relatively high (8000 ohms).

**Headphone Condenser** (Fig. 24) — The train of oscillations set up by the magnetic detector included not only the fundamental note, but also the associated harmonics. In order to prohibit the harmonic oscillations from creating their own sounds in the telephone receivers, a condenser was shunted across the telephones to suppress some harmonics while strengthening others. It did this by compressing the small irregular currents with the main impulses before charging the condenser; once the current flowed from the condenser to the telephone receivers, the “note frequency” was clarified, which made the sounds heard in the telephones clearer and stronger.

**Marconi Valve Receiver** (Fig. 25) — The valve receiver was used as a stand-by detector/tuner even though it had been already proven to be more sensitive than the Magnetic Detector. The valve receiver took its name from the Fleming Oscillation Valve, which was used to convert alternating electric current oscillations created by spark gap discharges into direct current. The two 4-volt “valves” were essentially tungsten filament lamps with a cylinder of copper gauze surrounding the filament. These cylinders were capable of adjusting the current flow, hence the name “valves”. Received radio-frequency oscillations induced oscillating voltages in the secondary circuit so that the copper cylinder gauze around the filament alternated between positive and negative potentials. The heated filament released electrons, which flowed through the vacuum to the copper gauze. At positive potential, electrons flowed across the cylinder and therefore through the entire circuit; at negative potential, the electrons were repelled and no current ensued. The rectified current continued through the circuit to the head telephones, where it was converted into audible sounds. This provided for increased sensitivity without impairment by strong atmospherics or interfering signals.

The aerial and intermediate circuits operated in a similar fashion to those described for the Multiple Tuner. The “Std. Bi” position on the small D.P.D.B. detector switch magnetically coupled the valve circuit to the aerial circuit, while the “Tune” position coupled both circuits through an intermediate circuit. The potentiometer and series resistance were located on the left side of the case and were used to vary the amount of voltage impressed on the valve filaments, which in turn affected the strength of the rectified current. The intermediate circuit coupling coil adjustment was on the right side and was used to decouple the intermediate circuit, which had the effect of cutting out interfering signals. After such adjustment of coupling, fine-tuning could be accomplished by manipulating the adjustable condensers (high-capacity ebonite disc condensers for the Aerial and Intermediate circuits and a sliding variable condenser of very small capacity (“Billi” type) for the valve circuit). The aerial tuning inductance adjustment, located on the front of the case, operated in the usual Marconi pattern. A platinum wire around the glass bulbs of the
valves was connected to the positive terminal of the battery in order to prevent the glass from becoming statically charged and thereby interfering with the sensitivity of the detector. The operator could select between the two valves as he saw fit. As there was some variance in the manufactured quality of the Fleming valves, the potentiometer and series resistance had to be readjusted for maximum sensitivity whenever a new valve was selected or replaced. Each valve had an average life of 1,000 hours.

**Valve Accumulator Battery Box** (Fig. 26) — The Marconi Valve Receiver required a 6-volt source in series with a voltage regulating resistance to raise the filaments to incandescence. This was provided by a dedicated battery-accumulator, which was charged by the ship’s mains. Two battery boxes were provided, so that one could be charged while the other was in use. Each battery was rated at a 40 ampère-hour capacity and consisted of three cells in celluloid containers, all fitted in a polished teak box.

**Valve Accumulator Charging Switchboard** (Fig. 27) — A small switchboard was used to facilitate the charging of the valve accumulators off the ship’s mains. Two 50 c.p. lamps were provided to regulate the normal charging current of 2.5 amperes. To power the receiver, the charging plug was removed from the accumulator socket and a plug from the receiver inserted in its place.
A voltmeter, activated by a push button, indicated to the operator when the accumulators are charged.

Two-way Switch — A standard two-way toggle switch, linked at the switch lever, allowed the operator to select either the Magnetic Detector/Multiple Tuner or the Valve Receiver for use as a receiver.

Emergency Set (Fig. 28)
In the event of a loss of power to, or a breakdown of, the main transmitting set, a Plain Aerial Coil Set, capable of producing a plain spark and operating continuously for at least 6 hours, was provided. It was not capable of producing the power or pleasing tones of the main set but it was kept ready for emergency use. The Plain Aerial Coil Set could be quickly connected to the aerial for the production of a plain aerial spark. It had the additional advantage of producing highly damped waves, which would affect receiving circuits of stations within a normal working range of at least 80 nautical miles, even if they were not strictly in tune. The set included an accumulator battery, a suitable charging switchboard, a 10" induction coil and a separate manipulating key.

Accumulators — A battery of 8 chloride accumulators stored direct current from the ship's mains for use by the wireless set in the event of a shipboard electrical casualty. During normal operation, the accumulators were charged by the ship's dynamos and required little attention. Upon loss of power from the ship's mains, the operator could discharge the accumulators through a 10" induction coil by using the Emergency Key. Eight accumulators were provided in order to provide the necessary E.M.F. to work the emergency spark coil. The cells in each battery were arranged in series, with positive connected to negative, leaving a positive terminal at one end and a negative at the other. Cells were deep enough to allow the lead plates to be covered with dilute sulphuric acid at all ordinary angles of heel. Iron shelving, covered with paraffined hardwood as an insulator, was used to accommodate the accumulators. Hardwood fittings held the batteries secure within the shelving to prevent shifting due to the movement of the ship. The movement of the ship actually helped the accumulators keep the electrolyte at a uniform specific gravity, as it kept the acid from settling in layers of varying densities. The acid would boil toward the ends of
charging, but spraying was prevented by covers. The operator had to ensure that no naked-flame lights were used near the cells when the accumulators were fully charged, because the amount of hydrogen released during the process could be ignited by contact with a light source. The operator monitored the voltmeter mounted on the Charging Switchboard during operation of the emergency set to guard against the occurrence of sulphating in the accumulator cells, a condition where the lead plates were coated with a white insulating skin of sulphate of lead which rendered the plates electrolytically inert and gave the cell a high resistance and low capacity. Normal (non-emergency) discharging of the cells had to be terminated when a reading of 14.5-15 volts was indicated; otherwise, permanent sulphating of the cells would occur.

**Charging Switchboard** (Fig. 29) — The switchboard used for the emergency set was a Marine Type Switchboard, No. 1. The operator could control the discharging and charging of the accumulators through use of multi-point switches on the switchboard. The position of the double pole three-way switch connected the ship’s dynamos to the accumulators and determined the direction of the charging current through the battery. Two 50 c.p. carbon filament lamps provided a visual indication that the proper connection had been made for charging the batteries. The position of the D.P. switch that provided proper charging would cause the lamps to glow least brightly. The single pole three-way switch was used to connect the induction coil into the circuit. A 15-ampere fuse inserted between the coil and accumulator terminals along the bottom of the switchboard protected the coil when working off the accumulators; the two connected to the fuse terminals protected the coil from the main charging and working circuits. Because the accumulators were not used in normal operation, a series of twelve 4-ohm charging resistance coils were inserted into the charging circuit to slow the charging rate. The filament lamps were wired in series with the charging circuit and allowed a charging current.

**Figure 29. Charging Switchboard.** (Handbook of Technical Instruction for Wireless Telegraphists, *modified*)
of 4-ampères to pass. Since the charging rate of the battery was nominally 12-ampères, long charges were required to fully refresh a depleted battery. When the battery of accumulators was fully charged and charging current still passing, the operator would read approximately 20.8 volts on the supplied voltmeter. At that point, gas would be freely bubbling from both positive and negative plates. With the charging current removed, the reading fell to around 17-volts, or 2.1-volts per cell. Because permanent sulphating would occur when the voltage in any individual cell in the battery fell below 1.85, the operator took care not to allow the total voltage as shown on the voltmeter to fall below 14.5-15 volts, which equated to 1.17 specific gravity of the acid.

10" Induction Coil (Fig. 30) — To power the emergency spark transmitter key, 16-volt, 8-ampère direct current supplied by the accumulators was changed to a high-voltage alternating current by the Induction Coil. The primary winding consisted of 360 turns of No. 12 insulated copper wire wound over a core of stranded soft iron wire. An ebonite tube covered this winding and supported the secondary winding, which consisted of 54,000 turns of No. 34 silk-covered wire wound in 116 sections, which were connected in series. The size of the coil was predicated on the number of turns in the secondary winding, and gave an indication as to the magnitude of increase in the output voltage. The direct current in the primary winding was interrupted by a “hammer break”, which was effectively an armature on a spring that alternately created and collapsed the magnetic fields around the windings at about 25 interruptions a second. In so doing, a rapid change in flux affected the secondary winding, inducing an alternating current. The voltage was stepped up high enough to jump the air gap between two discharge rods connected to the secondary terminals, thus forming an electric spark.

Coil Condenser — In order to prevent unwanted sparking at the induction coil hammer break contacts, an extra coil condenser was provided. This condenser, which had a capacity of 2-microfarads, consisted of alternate layers of tin foil and varnished paper. Because the tin sheets and dielectric paper were very thin, a fairly large capacity could be realised in a relatively small container. In all, 140 sheets of foil were utilised. The condenser was charged by counter E.M.F. created by the breaking of the primary circuit, thereby absorbing the current that would otherwise discharge at the hammer break contacts. The condenser subsequently discharged back into the primary circuit through the accumulators, increasing their effect in the coil secondary. In summary, the coil condenser helped to eliminate sparking at the induction coil hammer break contacts, accelerate the “break” of the primary circuit, and retard the current at the “make.”

Emergency Key — This key was similar in function to the main transmitter key, with the exception that it was wired to the induction coil primary, rather than to the magnetic relay key which keyed the main transformer. This separate key was required in Marconi installations because of the lack of a changeover switch.

Ancillary Equipment

Other equipment was supplied by the Marconi Company for the purposes of fault isolation, circuit tuning and system maintenance by shipboard operators. This equipment included a shunted buzzer, portable wavemeter and a tool box.
Shunted Buzzer (Fig. 31) — To test the receiving circuit or allow for short-range transmissions, a battery-powered high-note buzzer was placed in series with the tuner in the transmitting aerial circuit. The buzzer itself operated under the principle that a current, provided by a dry cell, passing through two coils would attract an armature, which normally was at rest against an adjustable contact where it closed the aerial circuit. Once the armature was attracted away from the adjustable contact, the circuit was opened and the current flow through the buzzer coils ceased. The spring contact was released and the circuit closed once again, repeating the process. The intermittent spark thus created generated a “buzzing” sound, hence the name. The buzzer utilised in Titanic had a non-inductive resistance shunted across the coils, so that the buzzer could be used to tune the radiating circuit. During normal operation, this device was switched out of the circuit and isolated. However, the normal discharge output of the transmitter prohibited clear transmission with stations located within a few miles of the sending station. In order to communicate over a short distance, then, the buzzer could be connected to the aerial and earth; the necessary capacity and inductive effects being in the wires, the wavelength being that of the aerial circuit, while a simple spark key functioned as the make and break for the buzzer. The multiple tuner could then be calibrated using the buzzer by first setting the intermediate circuit to a certain value, then adjusting the aerial and detector circuits until they were in tune with the oscillations produced by the buzzer. The musical frequency of the buzzer could be varied from 200 to 1,000 cycles per second.

Pneumatic Conveyor — A pneumatic conveyor system was provided to transport Marconigram forms between the Enquiry office, located on C Deck, and the Marconi Room. The suction in the brass conveyor tubes was created by an air pump rated at 1/2 B.H.P.
Clocks — Two clocks were provided for time-of-receipt reference. One clock was driven by an electric pulse transmitted from a master clock on the bridge and continually displayed local ship’s time. The other was mechanical and set to the time at destination; during Titanic’s maiden voyage, the clock was set to New York time.

Wavemeter (Fig. 32) — A portable wavemeter was provided to allow the Marconi operator to measure the natural wavelength in a given circuit. The Marconi Wavemeter consisted of a square wooden frame wound with 25 turns of silk-covered wire, with this coil connected across a variable condenser. A high-resistance carborundum crystal detector in series with a pair of headphone receivers was shunted across the terminals of the condenser. The entire apparatus was mounted in a wooden box 9"x 6"x 4 1/2" deep. The operator measured a circuit by holding the coil of the wavemeter near enough to the circuit to be loosely coupled. The variable condenser was adjusted until signals were loudest in the headphones. The condenser reading was compared to a card affixed to the lid of the wavemeter, which translated the reading into wavelength.

Tool Box — A complete electrician’s repair kit was provided. It included special tools, a galvanometer with dry cell and spare parts required to service Marconi marine sets.

Summary

Prior to James Cameron’s 2001 exploration of the wreck of Titanic, there didn’t appear to be much remaining of the liner’s wireless apparatus. The aerial was swept away when the ship’s two masts were dislodged during the sinking. A bent aerial insulator connecting rod protruding from the roof over the Silent Room was the only apparent equipment remaining until that too was trampled by submersibles touching down on that part of the deckhouse. The first probe inside the Marconi Room revealed only an electrical distribution box, incorrectly identified at the time as the Marconi tuner, that was mounted on the forward wall, still hanging by the heavy wires that carried power from the ship’s lighting circuit to the Marconi switchboard. The interior of the Marconi Room, briefly glimpsed during that 1993 expedition sponsored by RMS Titanic, Inc., appeared to be nothing more than a featureless wasteland. As far as anyone knew, any surviving equipment was either buried underneath piles of debris or torn loose and scattered by the destructive forces acting upon the liner as she plunged to the bottom of the ocean.

That assumption was dispelled when Cameron sent one of his ROVs into the after portion of the Officer’s Quarters in 2001. Evidently shielded from the brunt of the hydrodynamic forces by its thick insulated walls, the Silent Room lay undisturbed for close to a century. The transmitting set was still intact with each of its components located in or near its original location. Switches and plugs could even be seen in their final settings. The preserved contents of the Silent Room provided a sharp contrast to the almost total lack of artefacts in the adjacent Marconi Room.

Cameron’s find sheds new light on our understanding of the Marconi apparatus aboard Titanic. Prior to this, archival photographs taken aboard Olympic were used as the ultimate reference when reconstructing Titanic’s configuration. It was therefore a surprise to find the double-panel switchboard, field regulators, tuning lamp, and earth arrester – all of which appear in photographs of Olympic’s Marconi Room – in Titanic’s Silent Room. Evidently, the Marconi equipment
layout in Titanic was radically different from Olympic's. Similar differences with the elder sister ship were found elsewhere in the ship, which came as a surprise to historians who have always used the extensively-photographed Olympic as a template for understanding how Titanic appeared internally.

The discovery of the transmitting set is even more significant when considered in context of the history of the disaster. Had there been no wireless telegraph apparatus to send distress calls across the æther, Titanic's lifeboats might have drifted for days before being spotted. Because of Carpathia's rapid response to Titanic's CQD, the majority of survivors who found their way into (or onto) a lifeboat were saved. Cameron discovered in the wreck the very instrument that Titanic used to alert the world to her plight. It is fitting that the transmitting portion of the apparatus that was directly responsible for saving the lives of over 700 souls has itself survived the sinking and subsequent decay of the ship. Hopefully, the equipment can someday be recovered and restored to operating condition. Failing that, though, at least we can now tell the complete story of this vital apparatus.

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material on Marconi marine sets; Barbara Goldberg, who searched the New York Public Library for copies of relevant Marconigraph articles; Louise Weymouth, the Company Archivist at Marconi plc, who graciously took pictures of Marconi wireless equipment for my use; Gordon Bussey, historian for Marconi plc, with whom I had a most productive conversation about both Marconi and his equipment; and Neal McEwen, webmaster for The Telegraph Office website, who provided additional technical comment. Above all, it was James Cameron who explored the Marconi spaces in the Titanic wreck, discovered the transmitting apparatus and provided copies of the relevant unedited footage through his documentarian, Ed Marsh of Earthship Productions, to me for analysis. Without their contributions, I could never have come close to understanding Titanic’s true Marconi configuration.

Parks E. Stephenson

Parks E. Stephenson was born in Richmond, Virginia in 1957. A graduate of the U.S. Naval Academy and retired naval officer, Parks has spent a career at sea, much of it dealing with marine communications and data links. He works today as a Principal Systems Engineer at Raytheon (previously Hughes Aircraft) Naval & Maritime Integrated Systems in San Diego, California. With his background in communications, a modest tube-radio collection and an active interest in the history of the Titanic disaster, it seemed only natural for him to turn his attention toward the famous liner’s Marconi apparatus.

Today, Parks is a contributing member of the Marine Forensic Panel (SD-7), chartered by the Society of Naval Architects and Marine Engineers (SNAME) to evaluate the forensic evidence from shipwrecks, like Titanic, in order to learn lessons that might be applied to improve modern shipbuilding techniques. Most recently, Parks was an advisor to director James Cameron for his documentary, Ghosts of the Abyss. Cameron’s exploration of the Marconi spaces inside the Titanic wreck provides the first public glimpse into those rooms since the ship sailed from Southampton on her maiden voyage. Parks was fortunate enough to be the first to analyse Cameron’s findings and will never forget the sense of being one of the first to visit the room where so much drama took place some 90 years ago.

Parks and his wife Tamara have two children, Connor and Zoe. Connor has already picked up a bit of Morse Code, which helped earn him the Cub Scout Communications badge. Now that Zoe has learned the letters that spell her name, it won’t be long before she learns the Morse equivalent.
Sowing Seeds: Growing America’s Broadcasting System

George A. Freeman
Edited by Janet Dell Freeman

I. Germination

Most early radio stations were created in order to sell their licensees' products and services. Most failed.

This is the story of three early radio station operators and their respective seed companies, who learned to make radio grow substantial revenues at a time when most radio station operators questioned whether their stations could pay operating costs.

Less than a decade before these seed company stations were finding their stride, Lee DeForest wrote, “My company has amplifiers to sell, and we have announced the fact several times on our nightly (WJX, Bronx, New York) wireless concerts”. (1)

In the early 1920's, Shenandoah, Iowa radio listeners jiggled their cat whiskers to hear WFAV 75 miles away in Lincoln, NE. The station was operated by the University of Nebraska and the school offered mail order courses on their radio station for $12.50 each.

Doctors also utilized radio in the early years. Two hundred fifty miles east of Shenandoah, B. J. Palmer promoted his school of Chiropractic on WOC, a radio station he bought from radio manufacturer Tresco at Davenport, IA.

One hundred miles southwest of Shenandoah at Milford, Kansas, that state's first radio station, signed on in 1923 as KFKB, “Kansas First, Kansas’ Best”. It was operated by Dr. John R. Brinkley. On his airwaves he urged male listeners to come to Milford and have their libidos lifted—by means of the good doctor sewing on replacement billy goat testicles!

In Shenandoah, Iowa, seed man Henry Field listened to these radio stations and pondered whether he too might have the “right stuff” to employ radio as a house organ for his mail order seed catalogs. The key to success in propagating the life blood of seed companies of the day was the direct mail list. (See Figure 1.)
Figure 1: “Please Mister” Sending this imaginary little boy to ask a customer to give up the names of his friends and family is a classic sales management ploy. The goal was to increase the size of a qualified direct mail list of sales prospects. Its pervasiveness was to be greatly enhanced with the employment of radio.

“Henry Field was one of the most remarkable men we ever knew. He was a man who never failed to speak his mind regardless of where he was or who happened to be present. He never seemed to care whether the other fellow liked him and his ideas or not. Anything he thought was right was right, and everyone should see it that way.” (2)

II. Sprouts

During the winter of 1924, Henry’s “Seed House Gang” built his radio station. The station was issued sequentially allocated call letters: KFNF. Henry Field’s daughter, Frances Hope Field writes in “The Story of Henry Field”, “The broadcasting unit (500 watt transmitter) was an inexpensive homemade rig. Harley Bartles, the Seed House handyman, (See Figure 2.) chose parts from different manufacturers, then, with the help of other Seed House employees, he put them together.” (3) Power for broadcasting was supplied by series connected 6 volt wet-cell Willard Storage Batteries, 2000 volts in one block, “and smaller units for special parts besides. The use of these batteries is expected to give clearer transmission, steadier power, and to do away with the objectionable generator hum”. (4) “Batteries were in great rows on the top floor of the Seed House and had to be tended daily by station personnel.” (5) The late Glenn Baird of Ottumwa, IA recalled traveling 70 miles to Shenandoah to play in a small orchestra on KFNF. He remembered the batteries; “Talk about pure DC, that was it. You could smell the fumes from those batteries a block away”. He added, the station “soon converted to a motor-generator”. (6)

When Henry Field signed on in February, 1924 (seed ordering time) in shirt sleeves and wide suspenders, seated before the round carbon microphone hanging from the ceiling, he began in a friendly, informal over-the-fence manner; “This is Henry Field, himself!” The small burlap-lined wallboard studio was located on the fourth floor of Henry’s Seed House #1. Above the

Figure 2. (Harley Bartles) The accompanying text, probably written by Henry Field, shows that Harley, like most KFNF employees, was first of all a seedhouse employee. Harley also operated the KFNF gas station across from Seedhouse #1, Radio Station KFNF, and the shopping center.
building was a T-type antenna system fabricated from old windmill parts. (7) (See Figure 3.) It worked. Henry called the homebrew radio station “the darnedest rig you ever saw”. He said, “On a good clear night we would pour on the kilowatts and really tear a hole across the Midwest”. (8)

Like every successful sales person, the first thing Henry Field sold was Henry Field. “...the thing Henry Field really sold was personality. (See Figure 4.) People liked him. His company prospered, boomed! ...he infused his company with his personality. He (built) a run down radio station in Shenandoah, and talked over it. He told the conditions of the roads, who was sick, what his grandchildren were doing. The people in this section would turn off the biggest (radio) star on the air to listen to Henry Field”. (9)

Henry Field selected particular varieties of programming. He would not permit classical, as he called it “high and flighty” music on his radio station. “There will be no heavy lectures, no heavy classic music, and no jazz”. (See Figure 5.) (10) “Old fashioned music is to predominate.” (11) He meant country music, gospel, blue grass, square dance music, and hymns.

Henry sold seeds on KFNF (Known For Neighborly Folks, as he referred to his call letters). He also peddled live baby chicks, Henry Field Tires (“double guaranteed for 15,000 miles and 15 months”), Henry Field house paint, and Henry Field barn paint. KFNF and his catalogs offered Henry Field Famous coffee, Field’s Famous Overalls priced at $1.75 a pair, Field’s Famous farm fence (“We guarantee our fencing and posts to be the best quality made. If we don’t suit, ship it right back and we’ll pay the freight both ways”), and Henry Field roofing.
Figure 5. (above) KFNF Applause Card. Studio photos suggest the large support ring for the carbon microphone is home brew.

Figure 6. (right) KFNF “B” batteries.

Figures 7 (left) and 7-B. (below) Henry’s sisters. Three of Henry Field’s sisters who were heard regularly on KFNF. Leanna Field Driftmier was invited by her older sister, Helen, to make guest appearances on Helen’s woman’s program. At first Leanna only sang. It was when she talked that she began to find her place in broadcasting. Her broadcasting career spanned several decades on KFNF, KMA. Helen Field Fischer, the oldest of five Field sisters, was “the KFNF Flower Lady”, commenting on shrubs, flower gardening, arranging, and landscaping. She served on the board of directors of the Henry Field Seed and Nursery Company which was at its peak beginning in 1927. Jessie Field Shambaugh was a teacher, school superintendent and a founder of the national 4-H program.
Henry Field battery powered radios were also marketed. There were two models, the Shenandoah Five and Shenandoah Super Six, which could be purchased in table or console versions. At least one model is said to have been manufactured by Sleeper. His Catalogs also offered KFNF “B” batteries, (See Figure 6.) and “Shenandoha” (catalog misspelling) Radio “A” batteries for cars and radios. Writing in his catalog about radio tubes, Henry said, “We guarantee our Radio Tubes for a full year (unless you actually break them). I don’t know what I could say that would be as strong as this. It means a whole year’s service for the price of one set of tubes.”

KFNF programming was heavily mulched with “hillbilly” and gospel music woven between what later became forbidden by the Federal Communications Commission, a sign-on to sign-off “program length commercial”. Long before marketing guru Marshall McLuhan coined the phrase “the medium is the message”, Henry Field understood the concept. KFNF WAS “The Henry Field Seed and Nursery Company” of Shenandoah, IA. Henry pulled regular on-air shifts six days a week for years. “…the most compelling factor was his complete belief in what he said. The hearer was compelled to believe, too. Every word he wrote and spoke, the command in his voice, the piercing intelligence in his deep-set brown eyes, all expressed his extraordinary personality”. (12)

Henry Field’s sisters, his eleven children, and his grandchildren appeared on KFNF for years. (See Figure 7.)

III. Growing Season

The commercial power of KFNF (another slogan was Keep Friendly—Never Erown) was eye popping. After one year, KFNF had made Henry Field the largest mail order seed business in the world. The future appeared secure because the radio station listeners had added two million names to Henry Field’s all-important mailing lists, which had been gathered from KFNF fans’ ground cover of letters and telegrams. Henry’s seed company business DOUBLED in the first year of radio broadcasting.

“Well, it isn’t going to rain in Iowa today. Kansas may have showers. Nebraska, probably not. I’m going to take a ride in my new Studebaker this afternoon. That hill-hold on it is sure a dandy.” (Henry owned, sequentially, at least six Studebakers). “This is KFNF, the Friendly Farmer Station, Henry Field speaking”. A “Sigurney, Nebraska farmer decided, ‘I’ll go to town after all—Henry said it wouldn’t rain—and I guess I’ll take a look at them new Studeys while I’m in town!”. (13)

Sunday newspaper listings showed programming for the up coming week for about two dozen stations under the title, “Best Radio Features of the Week”. Listed along with more than a dozen heritage call letters like WEAF, the AT&T station in New York, WBAP, Fort Worth, TX, KDKA, Pittsburgh, PA, KFI, Los Angeles, CA was an early bloomer, KFNF, Shenandoah, IA. (14)

On KFNF and in his 1925 Fall Catalog, Henry Field said, “At noon, there isn’t any static...If you have trouble getting us, use a shorter aerial. Also try hooking a small fixed condenser of about .0005 capacity between the ground wire and the set. Remember I am in the contest for the most popular announcer. This contest is put on each year by the Radio Digest, and a Gold Cup is given the winner. In each issue of the Radio Digest is a coupon, and I would appreciate it very much if you would send them to me, as I am going to
need every one I can possibly scare up to win.” The September 14, 1925 Radio Digest announced that Henry Field from Shendoah, Iowa, population 5,000, was the second most popular announcer in America, second only to legendary sports announcer, Graham McNamee of WEA, New York City.

KFNF would emerge again among Radio Digest readers, in 1930, as “most popular station in the Midwest”.

In February, 1927, Field announced construction of his KFNF auditorium complete with kitchen and dining room. It would be built in a Spanish Mission style by the Seedhouse gang and local contractors. It would contain church pews, a piano, an organ and be named (See Figure 8.) the “Crystal Studio” because of its shimmering curtains surrounding the huge studio.

In 1927 Henry Field sold 55 railroad car loads of Shenandoah Brand tires (more than 1,000 tires a day), 60 railroad car loads of Henry Field paint, 490,000 pounds of Field’s Famous Coffee, “Radio Hardy Alfalfa..better than 99% pure and dodder free”, 44 railroad cars of Field’s seeds, 20 railroad cars of dried fruit, 51,000 radio tubes, 204,000 yards of dress goods, 60,000 pairs of “HenriSilk” ladies hosiery, and 21,000 suits for total sales of over two and a half million dollars! (15) (See Figure 9.)

It will help our readers at this time to compare the relative signal strength and power of KFNF with other heritage radio stations of the time. KFNF was operating with an authorized power of 2,000 watts. (And KFNF is known to have exceeded authorized power). KFNF was authorized for twice the power of WSB, Atlanta, GA, WBBM, Chicago, IL, WIOD, Miami Beach, FL, WTMJ, Milwaukee, WI. KFNF

![Figure 8.](image1.jpg)

Figure 8. (above) The New KFNF Building was squeezed in between Seed House #1 and Henry Field’s home. Figures 8, 9 and 10 are from a 25-cent souvenir 32 page booklet entitled, “STUDIO and broadcasting station K-F-N-F The Friendly Farmer Station”.

![Figure 9.](image2.jpg)

Figure 9: (right) KFNF auditorium. Interior photographs had to be exposed from three to 10 minutes. Because of this we see no people in the building. The doorway to the left leads to other studios. The door on the right hides a large storage area.
power was four times that authorized for WRC, Washington, DC, WTAR, Norfolk, VA, WKBW, Buffalo, NY, WSYR, Syracuse, NY, WBT, Charlotte, NC, WCAU, Philadelphia, PA, WHAS, Louisville, KY, WRR, WFAA and KRLD, all three in Dallas, TX, KFRC, San Francisco, CA, WDRC, Hartford, CT, WHK, Cleveland, OH, and WJAS and KQV both at Pittsburgh, PA. (See Figure 10.) KFNF was authorized for eight times as much power as that for WMAS, Washington, DC, WKRC, Cincinnati, OH, WFBM, Indianapolis, IN, or WIL, St. Louis, MO. KFNF was authorized to operate at 20 times the power authorized for a budding WWL, New Orleans, LA. (16)

Part of the strategy for success of the seed companies was enticing listeners to visit Shenandoah late each winter and early spring to stock up on their seed and nursery needs for the upcoming growing season. Today this is termed stealing market share from competitors. (See Figure 11.) Listeners were urged to visit Shenandoah for “Jubilee” and have fun, see the free live radio shows at KFNF’s “Crystal Studio”, stay at the KFNF cabins, and fill their tanks at the KFNF gasoline station (with gas discounts based on the amount of purchase). Listeners came by the thousands to see live-on-the-air radio shows, the KFNF circus, (See Figure 12.) “Henry’s Zoo”, the beautiful trial flower gardens, beautiful landscaping ideas, to examine the colorful seed packages, ride the miniature steam train and the ferris wheel, see the flag pole sitter, enter or watch egg throwing contests, the milking contest, fruit and vegetable contests, and the flower competition. (See Figure 13.) If it rained, Henry Field sold raincoats.

Many Shenandoah retailers saw their businesses flourish when KFNF listeners came to town. Shenandoans credit Henry Field with creating the

Figure 11. (below) (left to right) Seedhouse #1 (the towers have been removed from the top of the building. New 218’ tall towers were constructed, each set in 80 tons of concrete buried 12’ deep). The shopping center, KFNF studios, and Henry Field’s home are on the right. The KFNF gas station is on the left (west) across the street from this complex. One of the cars is probably Henry Field’s Studebaker.

Figure 10. (above) KFNF operating room. Paragraph two is not literally true. It can be translated to mean: “Mr. Field said we should buy some factory-made equipment.”
shopping center concept. Henry built an arcade between Seed House #1 and the KFNF building to the south. In this location, visitors to the seed house and the radio station had to pass through the arcade. Among the retailers could be found a Gambles hardware store, a pet store with fish and birds, a grocery store and a ladies dress shop on the second floor, Ross Jewelry Store, the Cortner Fur Shop, a beauty shop, Hallie Johnson’s clothing store, and a soda fountain.

By 1926 the station slogan became “From Iowa and Proud of It”. In the first six years of operation the Henry Field Seed Company sales increased from $700,000 to $3,000,000 annually. During one of these years Field sold 100 carloads of paint.

As radio took over the minds and hearts of America, listeners began to compete for bragging rights regarding the number of stations they could receive. This led to some tall tales. Tall tales led to a system that would weed out the liars. The listener had to describe the sequence of programming he/she had heard. The description was mailed to the station being monitored. The station checked its program logs and staff persons. If the information provided by the listener was reasonably accurate, the station provided “applause cards” and/or an EKKO stamp (See Figure 14) certifying that the listener had indeed tuned in the station.

“Nearing 60 years old (Henry) was distinguished looking and resplendent in his big muskrat fur coat as he judged a corn husking contest”. Henry dropped a bombshell on his crew in January, 1928: “For 40 long years I have put the business ahead of everything else—home, family, personal comfort, and a lot of other things which men desire. As my brother Sol expressed it, ‘I am 25 years behind with my fishing’. I am getting old and tired and beginning to lose faith in my own judgment. I am by nature a ‘small-time’ man. I have never been happy as a big man and have always had the feeling that I was parading in borrowed finery which someone would come and claim. I want to beat them to it by retiring in plenty of time”. (17) His employees pledged to carry more of the load and talked him out of going to pasture.

By 1931, with the depression worsening, Henry Field opened branch retail stores in Nebraska, Iowa and Kansas. Many were placed under the supervision of his first born son, Frank Field.

But Henry’s business was dying on the vine. With business volume at two and a half million dollars a year, and with Henry Field catalogs going into every State and nearly every post office in America, Henry was becoming insolvent. He began paying his employees with “Field Bucks” (paper vouchers) rather than money. The company was reorganized and as the depression deepened, Henry Field lost control of his company.

Henry was retained by the new principals and remained a front man, but now as an employee. (More about Henry Field later.)

Listening in on Henry’s 1924 broadcasts was another Shenandoah seed and nursery man, Earl May. (See Figure 15.) He watched Henry’s operation flourish. Earl put his station KMA on the air in 1925. It was equipped with a Western Electric Class B transmitter. The station proved to be “a boomer” and was DX’ed from as far away as Australia. (See Figure 16.)

Figure 16 shows the postcard which was sent out to confirm reception of the station.
Figure 12: (right) Visitor button. The staff pinned a half million of these badges on visitors in one late winter/early spring and during “Jubilee” season. In order to best show the writing on the ribbon our scanner has obfuscated the picture on the metal button of Henry F. holding the carbon microphone ring.

Figure 13. (below) KFNF gas station. Over 70 “KFNF cabins” were located behind the gas station. This is where many visitors stayed when they visited Shenandoah.

Figure 14. (above right) KFNF EKKO stamp. The provenance of heritage call letters.

Figure 15. (left) Earl E. May with bare root shrub and Shenandoah feed sack.
Figure 16. (left) KMA postcard from very early in the stations' history. The composition emphasizes the ability of the station to reach listeners long distances from Shenandoah.

Figure 17. (right) 1929 Earl E. May seed catalog cover. Earl, like Henry Field, understood that he had to sell himself before he could sell his products. The Mayfair auditorium was a focal point for excitement. The odd shaped article on the left is a rose trellis.

Figures 18 and 19. (below, left and right) Mayola radios from 1929 Earl E. May catalog. Seldom did the word “Mayola” appear on the radio or its escutcheon.
Unlike KFNF, where most of the radio staff also worked in the seed houses, KMA’s first music director, Elsie Farnham, was a Northwestern University music graduate.

In retrospect, Shenandoahns say “Henry Field was the innovator. Earl May was the refiner”. (18) KMA programming was less earthy, less country and more professional than KFNF. For example, the station employed Ike Everly, his wife and his two sons, who later became known throughout America as the Everly Brothers. The Blackwood Brothers were also frequently heard on KMA and made Shenandoah their winter headquarters for 10 years.

May Seed & Nursery catalogs went out to an ever increasing number of KMA listeners. (See Figure 17.) They listened to such programs as the “May Tire Orchestra” and the “Mayola Orchestra”, which was perhaps the same group but re-named for another program time slot. The house name for the radios May Seed sold were “Mayola”. Other offerings included Earl E. May’s Farm Belt paint and varnishes, “Mayway” chicken brooders, baby chicks from Earl May’s Laying House, “Mayworth” hay and pasture seed mixture, “May’s Beets”, “Earl May’s KMA Blend Coffee”, “Mrs. May’s Gladiolus” seeds, “Earl May’s Shade and Flowering Trees”, “May’s Finest Everblooming Roses”, “Earl May’s Winter Hardy Hedges”, and “May’s Super-Hardy Flowering Shrubs”.

As late as the early 1930’s the catalogs offered “Mayola” radios reportedly made by Clago Radio Corp. (19), and by Ozarka. (See Figures 18. and 19.) Catalogs offered KMA radio tubes. Earl’s version of the one year guarantee: “If any KMA radio tube fails to give good reception for one year, I will
replace it if not burned out or short circuited accidentally.” There were also K-M-A “B” batteries, and KMA automobile batteries. (See Figure 20.)

The Earl May radio venture proved to be a powerful nutrient. KMA spawned a 425% increase in business between 1925 and 1926.

Radio Digest magazine announced in August, 1926 the results of its reader poll: KMA’s Earl May was “The Worlds Most Popular Radio Announcer”! Henry Field had withdrawn from the competition urging his listeners to cast his considerable block of votes for his “trusted friend” (20) and competitor, Earl May. The total vote count for Earl: 452,901. (See Figure 21.)

May announced in 1927 that the KMA architect-designed Moorish style “Mayfair Auditorium” would seat 1,000 people including 900 on the main floor and 100 in the balcony. (See Figure 22.) A three ton plate glass window 24 feet long and six feet high separated performers from the audience. (See Figure 23.) Embedded lights twinkled like stars in a blue painted ceiling.

The KFNF and KMA “Jubilees” plus regular seasonal travelers brought 100,000 visitors a year to Shenandoah during the height of the era. Usually one seed company would have it’s Jubilee followed in the adjacent week by a Jubilee for the other seed company. (See Figure 24.) At Jubilee, Earl May personally flipped pancakes. In 1926, 53,000 Jubilee pancakes were consumed. World War II gas rationing dried up the annual pilgrimages.

By 1930 the Earl May Seed Company had achieved financial parity with the Henry Field Seed Company. (21) The depression was also difficult for The May Seed Company. With banks closed at seed-ordering-time, Earl May told his customers to order, send their checks, and he would hold them until the banks opened their doors. It was a good gamble as 98% of the checks turned out to be valid. (See Figure 25.)

Figure 22. "Mayfair" Auditorium. The Moorish design impressed visitors. Earl May was a frequent performer on the stage. For years Earl played the school teacher in a vaudeville type routine depicting a school room and one line jokes were abundant. The role was familiar to him since May had been a pedagogue as a young man right out of college.
able is crowding around this "unseen friend" who now has become a living and walking and talking individual, just like the rest of us. He shakes hands with two people at a time and is carrying on conversation with those two and a half a dozen more folks, all at once. Broadcasting must be simple as compared with this pleasant occupation of renewing old acquaintances and making new ones.

So I flocked over with the rest of the crowd and got my handshake. And then when the folks quieted down a little, Earl May drew my companion and I to one side to tell us that in a few minutes he would personally conduct us through the whole plant to give us a closeup view of the things that he had so often referred to us over the air. This trip took us from basement to attic, the high spots of which have been pictured in this souvenir of KMA in order that you may see for yourself what is going on down there.

**Figure 23. KMA operating room.** Figures 21, 22 and 23 are from a 1928, 16 page publication called *Mayfair.*

**Figure 24. (right)** KMA "Jubilee" circus elephants. The interdependence of the two seed companies is manifest here. On the left (west) is "Mayfair", and straight ahead (north) is Henry Field's Building #3.

**Figure 25. KMA "Hall of Fame"** In this room are displayed pictures of broadcasters and a few vintage radio artifacts collected by AWA silent key, Ed May, Jr.
In 1924, in Yankton, South Dakota John Chandler Gurney also listened closely to KFNF. As early as 1925 Chan Gurney had appeared on the local radio station, WNAX, as a spokesperson. He journeyed to Shenandoah to see the Henry Field radio station and seed company operation for himself. Gurney’s grandfather had founded “The House of Gurney” offering “SEEDS AND TREES THAT GROW AND SATISFY”. The trip changed Chan and his company. Chan returned home and urged his father, D. B. Gurney, to buy the struggling WNAX seedling which had been put on the air in Yankton three years earlier by a Crosley radio dealer. (22) In 1926, for $2,000, the Gurneys made the deal. Chan, known as “Radio Chan” and Secretary of The House of Gurney, became the station’s general manager. (See Figure 26.) By 1937 the station was upgraded to 5,000 watts, beaming its power from a 449 foot free standing tower. D. B. Gurney wrote that the cost of the improvements: “look like the figures in the World War Debt.” (A subsequent owner upgraded once more with a guyed tower, described as “the tallest radio tower in the United States”.)

With the purchase of WNAX, the House of Gurney prospered. The Spring and Fall, 1929 catalog offered Gurney’s Sunshine State Heavy Duty “B” Radio Batteries, WNAX chicken brooders, Gurney’s Winter Watermelon, WNAX chicken water fountains, WNAX Poultry Feeders, Gurney’s Model Globe Beet, and WNAX Sunshine State house paint. (See Figure 27.) A 1932 catalog offered a six month guarantee on WNAX Radio Tubes and WNAX Gurney’s Sunshine Radio “B” Batteries. (See Figure 28.) The cost for 201 tubes was 65 cents; 226’s were priced at 90 cents; 227’s at $1.00 and good old WD 11’s and 12’s sold for $1.40 each. Gurney’s 1936 catalog shows Radio Chan and D. B. eating “Gurney’s Mastodon Radio Watermelon”. It also listed the WNAX orchard collection along with the “W.N.A.X. (evergreen tree) SPECIAL” offer.

Mirroring the KFNF and KMA “Jubilees”, the Gurneys had their “Fall Festival” luring thousands to Yankton to visit WNAX and order their seeds and nursery stock for the upcoming fall and spring seasons. (See Figure 29.) Yankton residents were introduced to the shopping center concept at “The House of Gurney”.

Figure 26. 1928 WNAX staff. In addition to those identified as Gurneys, several of the staff members who are identified by first name only are also Gurneys. Like KFNF and KMA, WNAX was a family affair.
Figure 27: WNAX Sunshine paint. "Sunshine State" was the House of Gurney brand name used for tires, batteries, and other goods. Another house brand was "WNAX" radio tubes, chicken brooders, WNAX chicken feeders, etc.

Figure 28. WNAX "Battery Boys—A and B". If you could be named for a bread, soft drink, gasoline, insect killer, or clothing brand, why not for an "A" or "B" battery?

Figure 29. WNAX auditorium during a live broadcast. We don't know how many people the WNAX auditorium could accommodate. Some of this information was lost in a fire. These folks could have been watching the "WNAX Village School", a clone of Earl May's "Distrik Skul #9".
Radio Digest magazine awarded the WNA\textsuperscript{X} "Gurney's Concert Orchestra" a plaque in recognition of its reader survey denoting "the most popular radio orchestra in America for 1927-1928". The WNA\textsuperscript{X} talent roster was topped by 24-year-old Lawrence Welk. Welk and his small novelty band were on their way from the Dakotas to New Orleans. They were nearly out of money when they stopped by WNA\textsuperscript{X}. Chan Gurney fed them at the company cafeteria and then auditioned them live, on the air. Unusually enthusiastic listener response led to a multi-year performing contract and the "wonaful, wonaful" career of Lawrence Welk was launched.

The House of Gurney took on the major petroleum companies and established a group of company-owned and affiliated "WNA\textsuperscript{X} Fair Price" gasoline stations. There were five hundred retailers in five different States by 1932. This was less than two years after the launch of the concept. (See Figure 30.) However, the Gurneys operated WNA\textsuperscript{X} for less than a dozen years. (23) Why? "Following a disagreement with his father over broadcasting policies" (Chan Gurney) left the family firm in May of 1933" (24)

In order to appreciate the weight of that disagreement the reader must know more about these two men. The father, D. B. (Deloss Butler) Gurney was "one of Yankton's most influential individuals in the first half of the 20\textsuperscript{th} century". (25) In 1919, when D. B. was president of the newly formed Meridian Highway Bridge Company, he handed out a list of proposed assessments to other members of the steering committee. The assessments were for a daunting 1.3 million dollar, 1,668 foot long toll bridge with a 250 foot lift span to accommodate shipping on the Missouri River/Nebraska border at Yankton. When some committee members complained about their large assessments, D. B. hauled out two pairs of boxing gloves and invited any dissenters to step outside. End of discussion! The complainers agreed to their assessments.

The son, John Chandler "Chan" Gurney "did perhaps more than anyone to shape the face of Yankton in the second half of the 20th Century". (26) (See Figure 31.)

Chan enlisted to serve in World War I. He was a sergeant in Company Q, 34 Engineers of the American Expeditionary Force and served in Europe from 1918 to 1919. Spinal meningitis cut short his tour of duty.

In the WNA\textsuperscript{X} "disagreement over broadcasting policies" we had the immovable object (remember D. B.'s boxing gloves) and the irresistible force (Chan, the war veteran

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{wnax.png}
\caption{From "The Story of WNA\textsuperscript{X} and WNA\textsuperscript{X} 100\% Pure Pennsylvania Motor Oil". The House of Gurney waged a large and long battle against major petroleum distributor prices. The call letters, WNA\textsuperscript{X} came to stand for: "Will Not Allow eXtortion"
}
\end{figure}
who had learned what real battle was.) Rather than agree to his father’s views, the former soldier left the House of Gurney, Yankton, and the radio station he had nurtured as though it were his own.

In 1932, at the height of the depression, Chan Gurney transplanted himself into the wholesale gasoline and oil business at Sioux Falls, SD.

IV Harvest

In 1936, Chan ran for U.S. Senate in South Dakota on the Republican ticket. FDR's coattails were too long for the first-time candidate despite Gurney’s considerable status as a WNAX celebrity. Chan turned right around less than two years later and ran for the U.S. Senate again. He defeated former South Dakota governor Tom Berry. Chan Gurney served in the Senate for 12 years. During World War II, Gurney was Chairman of the Senate Armed Services Committee, and was one of Washington’s most powerful lawmakers.

Chan Gurney became a key figure in the damming of the Missouri River and the creation of a multi-million dollar tourism/recreation industry for the Yankton region. Gurney lost his 1950 bid for re-election. A former close friend from the senate, President Harry S. Truman, named Chan to the Civil Aeronautics Board where he became its chairman.

Should you fly into Yankton today, you will land at the “Chan Gurney Airport”, one of the irresistible son’s key projects. Chan Gurney died at the age of 88 in 1985. D. B. Gurney died in 1943, ten years before retirement of the Meridian Bridge debt. The Yankton station proved to be a perennial. At this writing WNAX still bears its original call letters.

Earl May’s KMA success led to the establishment of Earl May retail stores in Nebraska, Iowa, Minnesota, Missouri, and South Dakota. It also led to the acquisition of more radio and television broadcast properties. At this writing (in 2002) these properties along with 54 seed and nursery centers are still in the possession of the third generation of the May family. A grandson controls the broadcast properties. A granddaughter controls the nursery centers. The company dropped its catalog business in 1991. Earl May died in 1946. He was returned to the soil at age 56.

In 1932, Henry Field took a plunge into political life. He ran for United States Senate on the republican ticket. (See Figure 32.) Henry personally campaigned in 100 Iowa towns in two weeks and beat an incumbent and six other candidates in the primary election! But republicans in 1932 could not stem the tide of the Franklin Delano Roosevelt landslide. Henry lost the election.
By 1940 Henry's son, Frank, transplanted himself two blocks away at KMA. Frank was on May Company radio and TV stations every day for a total broadcast career of some 50 years. He was also a columnist for the KMA Guide, a listener subscription publication that built listener loyalty and represented another revenue stream for KMA. Henry's sister, Leanna Field Driftmier moved her "Kitchen Klatter" program from KFNF to KMA the year before. (See Figure 33.)

Henry Field died at the age of 77. He was answering large volumes of mail until a month before his death in October of 1949.

Through third party acquisitions, both the Henry Field and Gurney Seed Companies were acquired in 1980 by the same modern day conglomerate, Amfac, Inc. The Shenandoah and Yankton brands were grafted and became the company's mail order division. (See Figure 34.) Amfac, Inc. declared bankruptcy in July, 2001.

Four years after KFNF signed on the air, analysts speculated whether Henry Field's success could take root and flower elsewhere. "Scientific American" magazine, in its "Strays From the Ether; A Monthly Review of the Progress Made In All Branches of Radio Communication" wrote, "What are the broadcasters getting out of broadcasting? One large operator in the field is reported to have lost $800,000 in one year. There is a reason for radio manufacturers staying in the broadcasting business, because if broadcasting stopped, the sale of receivers would cease. No one would need their product. Some seem to think that 'good will' and 'indirect advertising' are the solution, but others are beginning to wonder if there are enough returns to warrant going on the air with 'good will' broadcasts. 'We must sell direct and know what results we are getting', they say. There seems to be a growing incentive to sell direct by radio. But what will the Federal Radio Commission say about it? The Henry Field Seed Company, owners of station KFNF, Shenandoah, Iowa, went on the air in 1924. That year the gross sales of seeds and nursery stock totaled $900,000. The gross sales in 1927 went up to more than two and a half millions, of which a million and a half were general merchandise...They dispose of hams and bacon at the rate of half a carload a week. That is what direct selling over the radio has done among the farmers of the Midwest. The microphone is apparently a profitable and high-powered salesman. The question is, how would the air advertising in New York compare in results with that wafted across the corn belt?"(27)

Sixty-eight years later the answer was clear. WEAF, AT&T's New York City station (reincarnated as an all sports station, WFAN) was the top billing radio station in the United States with 1996 revenues of more than $42 million. (28)

If you can grow it in Shenandoah and Yankton, you can grow it anywhere.

References
Figure 32. H. Field political banner. The text reads: "We are 100% for Henry Field for U. S. Senator".

Figure 33. KMA Guide. September, 1947. Here we see Henry Field's sister, Leanna Field Driftmier (the one who is wearing a striped blouse and has her hand on a table microphone). Frank Field, Henry's son, is at three o'clock behind an RCA 44 microphone.

Figure 34. KMA's "Mayfair" auditorium. The minarets and turret are gone. The building was destroyed and replaced with a very functional May Seed and Nursery box.
4. Advance Programs of Station KFNF (KFNF promotional publication) 1925.
7. Lowary, M. A. The Prescott Post (Dec., 1997) pg. 1
10. Ibid. pg. 127.
11. KFNF BROADCAST PRO-FILE Pg. 1.
13. Ibid. pg. 131.
14. The Cincinnati Enquirer October 4, 1925 Radio Section pp. 1, 2) Shows on the lists included a WCTU (anti-alcohol) program, a one hour sacred song recital, “Golden Rule Circle”, “Shenandoah Christian Church services, and an “old time music concert”.
17. Field, F. Chapter 28: Crisis for the Seedhouse. GSHS pg. 143.
18. Greater Shenandoah Historical Society (GSHS) video tape on the two seed companies.
19. 6/12/95 correspondence to the author from Ken Armstrong of Storm Lake, Iowa, owner of a Mayfair Compact No. 630-A.
20. GSHS video tape on Field and May companies.
21. Ibid.
22. WNAX was established in May 1922 by Dakota Radio Apparatus Company, a distributor of Crosley radios.
24. Ibid. pg. 182.
25. “Century A Look at The Past 100 Years” Press & Dakotan (Yankton) Chapter 5; D. B. Gurney.
26. Ibid. Chapter 2; Chan Gurney.
George Freeman

George Freeman graduated from Heidelberg College, Tiffin, OH with a speech major and BA degree in 1954. He began his broadcasting career that year as a staff announcer at WKST-AM/TV, New Castle, PA. He moved through the ranks; Top-40 DJ at WHOT-AM in his hometown, Youngstown, OH, back to WKST stations as news director, news editor at WBBW-AM, Youngstown, OH, news director, WNHC-AM, New Haven, CT, news director, WNBF-TV, AM/FM, Binghamton, NY, news director, WDRC-AM/FM, Hartford, CT, news editor, WNEW-TV, New York City, NY.

In 1961 he moved into marketing as account executive, WHCT-TV, Hartford, CT, then back to WDRC AM/FM as account executive. By 1967 he was general manager, WCCC AM/FM, Hartford, CT.

Freeman bought his first station, WGON-AM, Munising, MI in 1969. He put a companion FM station on the air there (WQXO), then bought KGRI AM/FM, Henderson, TX. All four stations were sold and he bought into a major market, Louisville, KY with WDGS-AM, New Albany, IN. The station was sold and he became a regional manager for the National Association of Broadcasters. He bought his sixth and final station WIKI-FM, Carrollton, KY in the early eighties and operated it for some 17 years before selling out in 1999.

At this writing, Freeman is vice president of the Indiana Historical Radio Society, board member and charter member of the Mid-South Antique Radio Collectors. He authors articles for both those clubs' publications. He writes the quarterly column, "Mics and Men" in the AWA Old Timers Bulletin. Address: RALOGEUM, 182 East Fountain Alley, Madison, IN 47250-3411, Phone: (812) 265-6878, E-Mail: ralogeum@aol.com.
“Just plug in – then tune in” - The First Commercial Light-Socket Operated Radio Receivers with AC Tubes from Rogers Radio Ltd., Toronto, Canada.

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Editing and Figure Revisions by Robert Murray

The early nineteen-twenties saw a major domestic upheaval in most industrialized countries as radio entered the home and changed the lifestyles of thousands. By the end of 1924, however, enthusiasm was waning partly due to the expense and bother incurred in satisfying the “box’s” appetite for batteries (Radio battery sales reached $450,000 in the U.S. alone for 1924). This was especially irksome for the majority of town and city dwellers who already had an electric supply wired into their homes for lighting and cooking purposes. A ready market existed for radio receivers able to operate directly from the light socket and many companies and individuals hoped to satisfy that demand.

In the United States the Radiola Model 17 marketed by RCA in 1927 is generally considered to be that country’s first all-electric receiver although pioneer radio engineer B. F. Meissner has written that Garod’s model EA, incorporating his designs, deserves that distinction having been introduced publicly in May, 1926. The first European socket-powered receiver to gain wide acceptance was probably the Philips 2511 on sale in Holland in 1927. In Canada it is believed that one of their own, E.S. “Ted” Rogers, deserves the credit for introducing the world’s first commercial batteryless receiver and building a major electronic communication business from that success.

Roger’s Canadian biographers suggest that his accomplishments should rank him alongside such eminent scientists and inventors as Bell, Armstrong, DeForest and Marconi. However, noted vacuum-tube authority Gerald Tyne in his definitive “Saga of the Vacuum Tube” wrote “... published information pertaining to Rogers’ dates of manufacture and establishment of companies is limited and conflicting ... the brochure “Edward Samuel Rogers Collection” is a disservice to Rogers because of inaccuracies. His contributions to the industry and Canadian radio history need no embellishment”.

That last sentence gives the spirit and intent of this paper.

Edward Samuel Rogers (1900-1939)
Edward “Ted” Rogers was born on June 21, 1900 to Albert S. and Mary (Ellsworth) Rogers of Hazleton Avenue, Toronto. Both Albert and his brother Joseph were executives with the Queen City Oil Company founded by their father some years earlier. The family moved three times during Ted’s early childhood before settling in 1907 in a substantial brick home at 49 Nanton Avenue.
Unlike his father who had been educated at Pickering College, a Quaker college in which his family had played a prominent financial role, Ted attended Toronto’s public schools. A precocious child, Ted developed a passionate interest in the still comparatively new field of wireless telegraphy. He learned the Morse code so that he could decipher the messages received with his progressively more complicated home-made equipment. The Rogers family were Quakers with well defined ideas on what was and was not acceptable behavior and being able to withdraw into the private world of radio communication was probably a welcome relief for a high-spirited child. In April, 1912, during a Spring holiday at the family’s cottage on Georgian Bay, Ted set up a receiver and picked up the messages giving the names of the survivors of the Titanic disaster as they were relayed by David Sarnoff. (Considering that Sarnoff may not have relayed them,¹ the source for this bit of information would have to be regarded as dubious — Ed.) Later, in 1914, Ted’s receiving station, this time at Nanton Avenue, gained some prominence, when he was able to tell of the War Declaration in Europe before the newspapers distributed the story.

Ted was enrolled in the University of Toronto’s Electrical Engineering program but withdrew at the end of his second year probably discouraged by the small part radio communication played in the curriculum. During 1920 he enrolled in the University’s School of Practical Science and he graduated in 1922.

As soon as wartime restrictions were lifted in 1919 Ted became the licensed owner-operator of amateur radio station 3BP with a 500 watt spark transmitter at Nanton Avenue. Later he was able, because of his family’s connections, to relocate the station to an apartment he made for himself in one wing of the still empty Pickering College (the college had been used as a military hospital during World War I), at Newmarket. From here his signals were received in both the Atlantic and Pacific regions (considered a remarkable achievement at the time). In 1921 he transmitted as part of the December Trans-Atlantic Test and became the first Canadian to span the ocean when his signal was received by Paul Godley at Androssen, Scotland. Ted was able to acquire a DeForest “oscillion” radio tube and was soon transmitting C.W. in place of “spark”.

After graduating in 1922 Ted joined the staff at the Canadian Independent Telephone Co. Ltd., as a radio engineer.
The Canadian Independent Telephone Co. Ltd.

At the turn of this century, the Bell Telephone system was expanding as fast as technology and finances permitted but, naturally, it attempted to service the more highly populated areas first, where the capital cost per phone was less and the anticipated revenue greater. In the rural districts Bell could only tell potential subscribers that it might be years before a service was available to them. Many of the smaller communities, therefore, organized telephone systems of their own, with the initiative often being taken by the local doctor. By 1921, some 680 non-Bell companies were operating in Ontario.

The Canadian Independent Telephone Co. Ltd., was organized by a Hamilton businessman, William A. Woods, to manufacture and supply equipment to these small telephone-system operators. They ran advertisements in the rural press - the Farmer’s Advocate or The Country Gentleman, and usually had an exhibit at the Canadian National Exhibition held annually in Toronto. (Figure 2.)

Figure 2. Magazine ad for the Canadian Independent Telephone Company

Initially located in Toronto at 20 Duncan Street, the Company moved to larger premises on Adelaide Street. Sharing this address was a related business, The Canadian Machine Telephone Co., which had originated at Brantford, Ontario, in 1900 as a manufacturer of automatic telephone switchboards and dial “machine” telephones invented by Romaine Callender. Eventually two company employees, the Lorimer brothers, became the owners. In addition to manufacturing and selling equipment to customers across Canada, in France and in Italy, the company operated a number of small telephone systems at various rural Ontario locations. The division between these two companies blurred as facilities were shared and individuals assumed positions of responsibility on both Boards.

With an eye to the future, a spin-off company - The Canadian Radio Corporation, Ltd., was formed in 1920. It began to acquire licenses and patent rights for manufacturing radio equipment. Amongst those held were the Canadian rights to the inventions of Dr. Lee DeForest and Edwin Armstrong.
Early in the 1920’s all three companies had their registered offices and showrooms at 212-216 King St., Toronto - a building which also housed offices and showrooms of the Canadian General Electric Co. Manufacturing space was also leased from CGE at their Ward and Wallace Avenue factory. An experimental 2,000 watt radio transmitter, CKCE, was also operated by the Canadian Independent Telephone Co., from the latter address.

The Canadian Independent Telephone Co. was the first, and possibly the only, manufacturer of commercial radio equipment in Toronto around 1922, and for young men seeking a career in this field, it was the place to work. The company built CITCO brand horn-loudspeakers and assembled a range of DeForest radio receivers which were then sold under the Canadian Independent Telephone Co.’s label. (Figure 3.) (A more detailed description of CITCo radios has been published.2 – Ed.)

Toronto’s first commercial radio station, CFCA, owned by the Toronto Star newspaper, started broadcasting on March 28, 1922. The equipment for the station had been installed by the Canadian Independent Telephone Co., and one of Ted Rogers’ jobs was to work with another engineer, Dr. Charles Culver, on improving the transmitter’s performance. The Heising modulation system was adopted with a Colpitts oscillator circuit. CFCA used a Ford Model T panel truck as a radio car for publicity purposes. Ted was the operator at many of the shows and exhibitions where the station quickly (and loudly) made its presence known.

Ted Rogers was also involved with solving the problems associated with the operation of radio equipment from a home-lighting power source. He was, no doubt, keeping abreast of developments made elsewhere through reading the articles in the popular radio magazines as well as the more technical reports in the Proceedings of the Institute of Radio Engineers available through Dr. Culver.

The Batteryless Radio - Early Days

As the novelty of radio in the home diminished, owners became dissatisfied and demanded the better sound quality which led to improved loudspeakers. These loudspeakers had to be driven by more powerful amplifiers which then required still larger, more cumbersome and more expensive batteries for their operation. Most town and city dwellers already had access to an alternating current electrical supply for home lighting and power purposes and it seemed quite logical and simple to the average owner that the radio receiver, an electrical

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Figure 3. Ad for radio products of CITCo, Radio News of Canada, January, 1924, p. 51
device, should also be powered from this source. The market was ready for
the batteryless receiver - why the delay?

In order to answer this question, we need to consider a bit of technical
radio theory. A loudspeaker converts changes in electrical current into changes
in air pressure. If the current changes at an audible rate so will the air pressure
which, when heard, becomes sound. The loudness level will be proportional
to the current's intensity.

In a radio system the loudspeaker's current changes should be caused only
by the program content of the received signal. The early receivers achieved
this by having the radio signal cause changes in the otherwise steady current
produced by batteries of electrochemical cells. Three of these battery systems
were generally required: a low-voltage, high-capacity type known as the “A”
battery, which supplied the energy to raise the temperature of the filament
used in each vacuum tube to obtain a supply of liberated electrons within the
tube; a “B” battery, one of smaller capacity but much higher voltage which
provided the steady current to be varied by the signal; and a low-voltage, low-
capacity, “C” battery needed to provide the correct voltage/current relationships
for minimum distortion.

The first steps taken to electrify the radio involved replacing the “B”
supply. “B”-battery eliminators were developed. These units included a transformer
to both provide voltage step-up and ac supply isolation, a rectifier, filter, and
a divider to obtain the different voltage levels required in the receiver - a
function previously taken care of by using one or more of the taps provided on
the “B” battery.

“B”-type batteries were generally made up from a number of carbon-zinc
primary cells but lead-acid cell batteries were also available, the higher initial
cost was offset by greatly extended life as the battery was capable of being
recharged. 3

When a radio receiver was purchased in the early 1920s the vacuum tubes
had to be bought as a separate package. The customer had to choose between
those that used dry-cells for their filament supply (requiring frequent battery
replacement), or those that would operate directly from the larger, heavier,
more expensive, automobile-type storage batteries. This type of battery could,
of course, be recharged when necessary using the services of the local garage,
a home-charging unit, or by simply exchanging it for a period of time with the
one used in the family car.

To eliminate the “A”-battery with a unit similar to the one replacing the
“B”-battery was feasible but not practical since the high “A”-supply current
demand could only be met by using large, heavy, expensive and cumbersome
components. 4 The ultimate receiver of the day appeared to be one which contained
within its battery compartments a “B”-eliminator and a small storage-type
“A”-battery with a charging unit which would automatically cut-in when the
receiver was not in use. 5 The storage battery, however, with its corrosive acid
and volatile fumes was not a pleasant home companion.

An alternative to having the receiver use dry-cell type tubes was for the
interior wiring to be changed so that the tube filaments were series-connected.
This resulted in reduced “A”-supply current demand making operation from a
“B”-type eliminator feasible. A number of difficulties arose, however, with
series-filament operation so that this was not the simple solution it may, at
first glance, have appeared to be.
Instead of a modified battery-receiver, what was needed was a radio designed specifically for AC line operation. The main problem source lay in the vacuum tubes of the day so the re-think began there.

**Vacuum Tubes Using AC as a Filament Supply**

If a conventional triode tube such as, for example, a 201-A is operated with an AC supply for its filament source the tube’s plate current will have a large line-frequency ripple current even though the tube’s “B” and “C” potentials are obtained from a steady DC supply (see Figure 4).

![Figure 4. Illustration of AC ripple in a DC tube.](image)

Three factors combine to produce this effect. They are:

1. A voltage gradient exists along the length of the filament and if one end of the filament is common to the “B” and “C” supplies all these potentials will vary at the supply frequency.
2. The filaments’ *I*R heating effect is reaching its maximum and minimum values at twice the supply frequency. Electron emission, a function of temperature, will vary at the same frequency.
3. The electron flow within the tube will be affected by the varying magnetic field surrounding the filament.

The effect of the first factor is minimized by returning the tube’s input and output signal circuits to the electrical centre of the filament either with a tapped filament or to an artificial tap obtained from a tapped resistor - known as a humdinger - connected across the filament circuit. A variable resistor gave more precise results (see Figure 5).

![Figure 5. The effect of a tapped resistor across the filament.](image)

The cyclic heating factor is reduced by having an emitter with “thermal inertia” (one that will resist rapid temperature changes). The first solution was to use a thicker wire filament, its greater mass producing the desired effect. The lower resistance of the thicker wire needed a larger current intensity to produce the heat required but the voltage was smaller helping still further in offsetting the effects of the first factor mentioned above.

The hum caused by the filament current’s changing magnetic field could be reduced by cancellation if a hairpin-shaped or bifilar-wound filament was
used instead of the straight type. Although the increased rate of current flow accompanying the thicker filament should increase the magnetic problems a careful choice of filament voltage-current values could produce good hum reduction.

The larger current requirement does, however, add to the overall receiver design problems when a large number of parallel-connected-filament tubes are in use. The strong fields produced must be balanced out using magnetic shielding techniques to reduce inductive hum pickup.

The vacuum tube so far described is suitable for use as an amplifier of either radio or audio frequencies but cannot be used in the detecting stage of a radio receiver. For detection the tube must operate in a non-linear region where self-cancellation features do not apply. A number of radio receiver designs, therefore, used the AC heated tube in the amplifying stages and used either a crystal detector or a dry-cell type vacuum tube with its filament energized with DC obtained from the "B" supply.

The Indirectly Heated Vacuum Tube

Another way to avoid the voltage gradient along the emitting surface was to have an emitter heated from some separate source. The emitter might be of the Wehnelt type with a lime coating on a platinum tube. Within this cylinder was a filament wire which, when connected across a suitable supply, acted simply as a heater for the cylinder. A vacuum tube using this principle was patented by H. J. Round of the Marconi Company. After its disclosure, John Scott Taggart, a British radio authority, is quoted as saying "... the Marconi device, though experimentally successful, has no commercial value ...". The filament, incidentally, was a straight wire running axially within the cathode cylinder and had to be carefully positioned so that the two did not touch. The cathode's temperature had to be raised by radiation from the heater and time delays up to 100 seconds were not uncommon from the time of first applying heater power to obtaining adequate electron flow.

A British engineer, Alexander McLean Nicolson, working in the United States for Western Electric, had been involved with this type of equipotential cathode since 1913 and applied for a patent two years later. His cathode consisted of a cylinder of quartz or similar refractory material with a platinum layer deposited and baked onto its surface. An oxide coating was then applied over the platinum and the heating wire passed down through the center of the quartz tube. The indirectly-heated tube was effectively covered by the 23 claims of this invention.

On March 23, 1918, Hubert W. Freeman applied for a patent on an indirectly-heated vacuum tube. Assigned to Freeman's employer, Westinghouse, the idea was placed on the back burner as the company was then fully occupied with thoriated-tungsten filament development.

Samual S. Torrisi of Philadelphia also designed an indirectly-heated tube with the grid, cathode and plate electrodes supported within the tube in the conventional manner but with the heater insertable from the top of the tube so that it could be readily replaced when necessary - the heater's connections at the top of the tube gave it a double-ended form of construction.

Production samples of Freeman's tube were made by Westinghouse at their East Pittsburgh plant during 1922 and several experimental circuits were devised. The results were disclosed in an article Freeman wrote for publication in the December 1922 issue of The Electric Journal. Headed "A Practical
Alternating-Current Radio Receiving Tube”, the article itemized the reasons why alternating-current was unsuitable as an energy source for radio tubes of the emitting-filament type. It showed how an equipotential cathode eliminated the problems when used with a correctly-shaped heater, and gave full details on the experimental tubes. Also given were the diagrams for receiving circuits used in the tests, and cautionary notes on the importance of keeping all leads carrying AC away from the signal circuits, and the increased tendency for hum pickup when two or more transformer coupled audio-frequency stages were used. Freeman recommended retaining batteries for the “B” supply as “... the supply requires delicate adjustment for satisfactory operation ... and batteries are simple and comparatively inexpensive ...”.

Freeman and a co-worker, Wallace Wade, filed for a US patent in 1922, a British patent in 1923 and a Canadian patent in 1925. Although the application shows a single-ended tube with the cathode connection brought out to a fifth pin, the first Westinghouse production samples were double-ended. These were designated type UX 225.

John Morecroft in the 1921 first edition of his “Principles of Radio Communication” mentioned using an equipotential-cathode vacuum tube with AC applied to its heater. Dr. A. W. Hull of General Electric patented a circuit based on this idea in 1922 where an indirectly-heated tube was used as a combined rectifier and detector-amplifier.

Incidentally the idea of using a double-ended tube with a removable heater was revived by Dr. A. N. Lucian of the University of Pennsylvania in 1926. He also suggested that AC could be used as the heater supply.

The Canadian Independent Telephone Co. was interested in line-operated radio receiver development and in 1923 Ted Rogers visited Westinghouse’s research laboratory at East Pittsburgh, Pa. There he saw experimental tubes in various states of development and discussed with their engineers some of the problems being encountered. One of these engineers, Frederick S. McCullough, held patents in his own name on several vacuum tube developments and manufacturing processes.

Frederick S. McCullough

Preparing biographical notes on Frederick S. McCullough is difficult as very little information is available. However, the information we have would suggest that he was clever, energetic, ambitious and, probably, opportunistic.

McCullough lived in Cleveland during World War I and was employed as a radio engineer with the Glen L. Martin Company. He was mainly concerned with developing airborne radio equipment for navigational purposes and he obtained several patents which were assigned to his employer. One of these shows copper coils below the surface of a flying-field runway designed to radiate RF energy as part of a guided-approach landing system. Another shows his awareness of the problems arising from distributed capacity as he attempted to improve RF amplification in airborne radio receivers by having the coupling coils within the vacuum tubes.

The aircraft industry went into a tailspin after the war ended and, in 1920, McCullough went to work as an engineer with the Westinghouse organization at their East Pittsburgh plant. He lived, as did many other Westinghouse people, in the neighboring suburb of Wilkinsburg. He was mainly involved with vacuum-tube research and production technology, bringing additional expertise
to Westinghouse as a result of the fact that he had developed the RF induction heating method for liberating electrode impurities some years earlier. 22

Elected to the IRE as an Associate in 1919 and a Member in 1922, McCullough presented a paper at the New York meeting in September, 1922. 23 Here he spoke on the construction and characteristics of vacuum tubes, using the recently-introduced WD11 as his example. He then discussed the advantages of equipotential cathodes and, finally, he gave details of tubes he had constructed and tested at Westinghouse. Two of these used AC as a cathode heater supply - one across 110 volts the other using 5 volts at 2 amps.

A few days earlier McCullough had applied for a Canadian patent on a Cathode Device and a Circuit which employed a vacuum tube with an equipotential cathode heated inductively from a coil connected to an RF generator. This coil could be within the tube or mounted externally. The tube’s 2 plate electrode was segmented to reduce inductive heating within it. 24

Towards the end of 1922 McCullough had applied for three U.S. vacuum-tube patents on his own behalf, followed in March, 1923 by one for a multiple triode tube which was assigned to his employer, Westinghouse.

Rogers Radio

Many of the experimental tubes Ted Rogers saw at the Westinghouse plant incorporated improvements attributed to McCullough. Convinced that this tube was commercially viable and that the production difficulties could be overcome, Rogers made private arrangements to acquire the Canadian manufacturing and sales rights to McCullough’s patents and developments for a sum quoted as between ten and fifty thousand dollars. A number of Canadian patents were applied-for and assigned to Albert S. Rogers, Ted’s father. The first few do not appear to be too valuable - some being Canadian rights to inventions already patented in the U.S. and assigned to Glen Martin but they do establish the licensing agreement between McCullough and the Rogers family. Two later patents are for metal envelope tubes with the envelope acting as the plate (shades of Catkin construction), and for methods used to improve glass-to-metal seals. 25

On November 2, 1923 Ted Rogers applied for a patent on an inter-stage tuned variable-coupling system 26 and assigned it to the Canadian Radio Corporation, the CITCO subsidiary. These companies were experiencing financial problems and the Canadian Machine Telephone Co. filed under the Bankruptcy Act on the 28th of December. Its rural telephone systems were placed under trusteeship and were eventually taken over by the Bell system in 1925. A trustee was appointed over the Canadian Independent Telephone Co. Ltd. on February 2, 1924. An arrangement was made with the creditors and the company’s assets, including the Canadian Radio Corporation tradename and its all-important DeForest and Armstrong patent rights, were acquired by the Rogers family and moved into the former T. Eaton Co. warehouse at 90 Chestnut Street in downtown Toronto.27 CITCO and its subsidiaries were listed as being at this address for the remainder of the year but little telephone work was done as the new plant was readied for radio tube and receiver production. 28

The Rogers Radio Company was formed early in 1924 with A. S. Rogers as President, F. S. Rogers as V.P. and Samuel Rogers as Secretary. The registered office was Room 405 at 56 Church St., Toronto, (the private office of Albert Rogers) in the Imperial Oil building. Two limited-liability companies were registered on November 28, 1924. These were Rogers Radio Ltd., with
the same executives and offices and Heliotron Tubes Ltd., a manufacturer, importer and exporter of radio tubes.

The McCullough Tube

Canadian patent 256,378 issued to McCullough in April, 1925 is of interest as it shows an early attempt to solve the problems associated with using AC as a filament supply. The tube has an emitting filament wound around a porcelain rod which acts as a heat reservoir. Two versions of filament are shown. One is bifilar wound and the other has one end of the filament brought down within the porcelain rod.

Patent 265,021 shows a device more closely resembling what is now known as the McCullough tube (Figure 6). It shows a long porcelain rod with a coated metal cathode sleeve, a grid and a plate at one end. Within the rod but at the other end is the resistive heating element. The electrical fields from the heater current are thus kept away from the tube’s signal electrodes. The heater’s lead wires are brought out at the top of the tube envelope and fitted within a cap similar to the double contact base used with automobile lamps. This allowed the tube to be quickly disconnected from its external circuits.

![Figure 6. Illustration from Canadian patent 265,021 awarded to McCullough](image)

On April 25, 1925 Earl L. Koch of Pittsburgh, applied for a U.S. patent disclosing a tube which was identical in appearance to McCulloughs' but having the heater down within the cathode sleeve. A second grid located below the signal-grid had a small negative potential applied to it and this, it was claimed, greatly reduced induced hum. This patent was assigned to McCullough.
As part of a May 6, 1925 patent application for a tube de-gassifying method, McCullough shows the heater within the cathode sleeve as in the Koch patent but the auxiliary grid is omitted.\textsuperscript{30} This grid does, however, appear in a Canadian application filed May 29, 1925.

The modifications needed in the filament circuits of existing battery operated radio receivers to accommodate the McCullough tube are detailed in one patent application.\textsuperscript{31} Numerous other patents deal with tube manufacturing methods, in baking the emitting surface, de-gassifying, and temperature compensation to obtain compatibility between tube electrodes and the internal insulators.

As readied for production, the McCullough tube had a brass, short-pin Shaw base with the name McCullough and the emblem AC with two lightning flashes on the brass skirt. The top cap was of bakelite with what would have been the two bayonet locking pins now serving as the heater connections. The tube had no type number. (Figure 7.)

![Figure 7. Characteristics of the McCullough tube](image)

Provisional electrical specifications were:

- $E_h = 3 \text{ V}$.
- $I_h = 1 \text{ A}$.
- $E_p = 90 \text{ V}$.
- $I_p = 4 \text{ mA}$.
- $E_g = -4.5 \text{ V}$.
- $Z_p = 9k5 \text{ ohms}$.
- $g_m = 870 \text{ mho}$.

**amplification factor = 8**

**McCullough Tube Sales - U.S.A.**

The license fees received from the Rogers family enabled McCullough to leave Westinghouse and become self-employed. He moved into a new home, and then formed the F. S. McCullough Company Research Laboratory in premises formerly occupied by the King Radio Manufacturing Company at 521 Penn Avenue W., in Wilkinsburg, Pa.\textsuperscript{32}

There were two distinct potential markets for the McCullough tube. They could be incorporated as original equipment into the next season’s radio receivers designed specifically for line operation or, they could be used to replace the popular 201-A used in thousands of battery-operated receivers so that the radios could be converted (with a suitable transformer and “B”-eliminator) for AC line operation. The latter promised the fastest financial returns and was the one first addressed with national advertising.
The largest circulation radio magazine, Radio News (circulation 250,000) had paid scant attention to McCullough in its news or editorial columns so the main advertising was placed with the second largest magazine, Popular Radio (circulation 95,000). Two separate full-page advertisements appeared in the May, 1925 issue. In one, Radio Foundation Inc. of 25 West Broadway, New York City, announced that they were exclusive agents for the McCullough Sales Company and invited jobbers to apply for area franchises. The second advertisement was by the McCullough Sales Company at 963 Liberty Ave., Pittsburgh. This was the address of an established jobber, the Pittsburgh Radio Supply House.

Popular Radio’s June, 1925 issue carried a two-page advertisement from McCullough Sales claiming “… an absolute elimination of alternating current hum …”. The tube illustrated now had on its base a sine waveform around the letters AC. The list price was $6. Also in this issue the tube is mentioned in an article on new tube developments and in a reader’s query on the Q and A page. Several pages are devoted to plans for constructing a receiver around the tubes.33 Amongst the advertisements, four suppliers list complete parts kits34, one manufacturer shows a heater transformer35, and four manufacturers offer complete receivers (each of these requiring an external “B”-supply).36

![Figure 8. McCullough AC tube ad from Popular Radio, June, 1925.](image)

![Figure 9. McCullough/Freshman radio ad from Popular Radio, June, 1925.](image)
Two-page advertisements for the tube were placed in the July, 1925 issues of both Popular Radio and Radio Broadcast. In the same month, Radio News had an article on the tube and Popular Mechanics published construction plans for a 5-tube receiver designed around the tubes. However, in an article on the Principles of AC Tubes appearing in the August, 1925 issue of Radio, E. R. Turner writes “In practice the hum has not been completely eliminated from such a circuit due to induction from the ac leads and capacity between the heater and the cathode.” Very little more was said about the tube in 1925 other than mentioning it in another construction article, this time for a 3-tube receiver, in the December issue of Popular Mechanics.

The demand for the tube was heavy and McCullough with limited production facilities could not meet delivery dates. Quality control was marginal and customer complaints multiplied. Possibly, in addition, McCullough may have been receiving information on Westinghouse’s progress with their indirectly heated tube. For whatever reason, McCullough sold his manufacturing rights to the tube in late 1925. The transfer to the well-established Kellogg concern was announced in January, 1926.37

In February, 1926 McCullough invited radio manufacturers to incorporate the tubes in their designs and offered to wire prototypes in a Brooklyn, New York, laboratory.38 The Cleartone Radio Company took advantage of this and claimed, in September, 1926, to be the first to produce a completely self-contained line-operated receiver with their model 110. Their claim was modified a month later to read “... the first successful low-priced set to eliminate “A” and “B” batteries”.39

This quotation from a paper delivered by Julius Aceves to the Radio Club of America is indicative of the adverse publicity being encountered: “… unfortunately these tubes are not made with any degree of uniformity, and although their life should be theoretically much longer than thoriated tubes, it may be only one month, after which the emission has been reduced to a useless value or the heater may burn out in a few weeks. If the McCullough tubes were properly made, they would unquestionably be the tubes of the future, and radio sets would be designed for them on account not only of the complete elimination of the “A”-battery but of their inherent high amplification with low resistance properties”.40

The tube now had a UX-type base and was marketed as the McCullough 401. Then, as improvements were made to the heater-cathode insulation, the name Kellogg appeared on the tube. In addition to being used in receivers manufactured by Cleartone and Kellogg the tube was fitted in Bush & Lane, Dayfan, Marti, Mohawk, Shamrock and Sparton models for the 1926-27 season. (Sparton renamed the tube “Cardon”). An output tube type 403 was also made by Kellogg, until they discontinued production in 1929. The AC Neon Co. took over manufacturing with the 401 now listing at $5 and the 403 at $7.50 (more expensive than the now more popular RCA UX-227).41

Frederick S. McCullough continued as an independent research engineer and, although he dropped his membership in the IRE, he continued to file patent applications for vacuum tube improvements into the late 1930s. An unconfirmed report had him last active in a radio venture on the West Coast.

**Early Rogers Vacuum Tubes**

In 1924 Ted Rogers and the fledgling Rogers Radio Ltd. were fully committed to setting up 90 Chestnut Street to manufacture radio tubes and receivers. The
first series of tubes produced were diodes to be used as rectifiers in “B”-power supplies. These tubes, later known as type R-100 or RX-100, are structurally similar to a 201-A with the grid removed (Figure 10). The filament was rated at 5 volts and 0.60 amps. A version with a 1.25 amp filament was labeled the RX-200 (Figure 11).

![Figure 10. Rogers R-100 rectifier](image)

![Figure 11. Rogers R-200 rectifier](image)

Samples of the McCullough tube were available, jigs were made up, vacuum pumping, flashing, aging and testing equipment was devised and set up and production samples trickled through for evaluation. Some problems were immediately apparent. The warm-up time, for example, was longer than anticipated and flaking of the emitting surface material showed the need for improved bonding. Other difficulties encountered (in some tubes showing up immediately, in others only apparent over a longer term), were control-grid emission, heater to cathode emission, heater-cathode leakage, deterioration of inter-electrode insulation, and premature heater failure.

With the technology then available, it appeared that compromise solutions to these problems were all that could be anticipated (Attempting to decrease warm-up time by increasing the heater power led to increased difficulties with grid emission and early heater failure). Reducing the diameter of the twin-bore ceramic insulating rod introduced problems if the bore was not sufficiently oversize to accommodate the expansion accompanying the heater’s temperature change and also added to leakages. Promising results were obtained when the grid and plate electrodes’ surface areas were increased to dissipate unwanted heat and when other refractory materials were used as cathode insulators. Ted Rogers worked on solving these problems practically single-handedly. A steady stream of advice was coming from McCullough together with a number of patented ideas. Most when tried, however, introduced still more problems.

**The Rogers Patents**

Three Canadian patents were applied for by Rogers during 1925. All three were granted. They were:
250,714 (Feb. 21) for a rectifying system (Figure 12). The disclosure shows a transformer-operated full-wave circuit using two thermionic diodes. In addition to the conventional low-pass filter system, RF chokes have been added in each of the "B"-supply leads together with suitable by-pass capacitors. These components were included to prevent modulation hum that could occur as the signal passed via the L.F. choke's distributed capacity to the rectifying diodes. The patent application shows this supply providing "B"-potentials to a two tube (filament type) regenerative receiver which is, incidentally, described as a three-tube in the application.

Figure 12. Rogers' rectifying system shown in patent 250,714

A two-tube receiver circuit using indirectly-heated tubes from an AC supply is shown in Patent 264,940 (March 18). The tubes act as combined amplifiers and rectifiers and the circuit appears to be very similar to one described by Dr. A. W. Hull in the April, 1923 issue of the Proceedings of the I.R.E.

Patent 269,205 for Improvements in Radio Reception and Amplification shows a three-tube receiver circuit diagram and component layout (Figure 13). Indirectly heated tubes with AC applied to their heaters are shown but the "B" and "C" potentials are obtained from batteries. The two audio-frequency coupling transformers are both contained in a sheet-metal shielding can and are located within the cabinet some distance from the tubes' AC heater wiring to minimize inductive pickup. The position of the line-operated heater transformer is not shown. Some additional Rogers tube prototypes not made in quantity are shown in Figures 14 and 15.

Standard Radio Manufacturing, Corporation Ltd.

Progress was being made with improving the first indirectly-heated tubes and many of acceptable quality were produced. These were imprinted as "Canadian McCullough AC Radio Tubes. Patented 1923-25. Other Patents Pending".
tests. A "B"-battery eliminator housed in a wooden case was also made and production samples of this unit were also sent out with some of the receivers.

The receivers were to be marketed under their designer's name, "Rogers". Coupled to this would be the registered tradename, "Batteryless". It was decided to operate the vacuum-tube and radio receiver operations as corporate entities so, on May 13, 1925, a new company, Standard Radio Manufacturing Corporation, Ltd., with an authorized capital of $500,000, was registered with the same directors and officers as Rogers Radio Ltd. The latter company concentrated on vacuum tube production. Together, the two companies had about twenty-five employees, most of them young, including a number who would later retire with over forty years service. Amongst these were J. R. (Bob) Eakins as vacuum-tube works manager, Stan Scott in the winding department, Jack Knapman in radio test, and Gordon Pipe as test engineer. The latter two were recruited from the Charles Branston company.

QRS of Canada

The QRS Music Company of Canada Ltd., a subsidiary of QRS of Chicago, was registered in 1924 and opened showrooms at 690 King St. W., Toronto, early in 1925. Active in the player-piano and phonograph business, they had flirted briefly with the radio industry and were now acting as sales agents. As manager for the Canadian operation they were able to entice Fred Trestrail away from the Musical Merchandise Company. Fred was an aggressive, accomplished salesman with a flair for promotion. It was a good thing that he had radio experience since Musical Merchandise, in addition to distributing pianos and phonographs, were handling DeForest and Radiola receivers. Later, Fred with his brother, Burdock, would play an increasingly more prominent role in Rogers company affairs. This business relationship started, however, with the appointment of QRS as the Rogers distributors for Ontario and Quebec.\(^{42}\)
The First Commercial Socket-Powered Receivers

Rogers tubes of an acceptable quality could now be made in quantity and full commercial production of the tube designated as type AC-32 started in August, 1925 (Figure 18). Some advance publicity was obtained when the radio columnist for the Toronto Star reported on August 18 being a guest in a home "... where, with the aid of a new 5-tube tuned-radio-frequency receiver operating off the lamp socket and using no aerial or batteries, was enabled to tune in well over twenty-five stations".43 Standard Radio, now with another Rogers, David, as works manager, readied receivers for display at the Canadian National Exhibition to be held in Toronto from August 29 to September 12, 1925.
Advertisements were placed in both the Toronto Star and Globe newspapers. A typical one reads — “Amazing Radio Set on Display at the EX. No batteries - No Aerial - Plugs into Any Electric Light Socket. ‘Just plug in — then tune in’ is the slogan. - A startling innovation in Radio is daily attracting crowds of Radio Fans as well as those to whom radio is more a mystery than ever. The idea of operating a radio set without batteries or aerial is almost uncanny. The new set certainly revolutionizes past ideas on radio operation, and intending purchasers of radio sets should see this one on display at the Standard Radio Mfg. Corporation’s exhibit — and hear it in actual operation at the QRS Music Co. display.”

Public interest generated by the Canadian National Exhibition exhibits was maintained with an aggressive advertising program in newspapers and magazines. Fred Trestrail of QRS was quickly able to build up a strong dealership network by offering closed territories and a rigid price maintenance structure. Three battery-operated models were among the eleven receiver types available. (Figures 20 to 28.) Prices ranged from $38.50 to $370.

Rogers 100- 110- 120 Circuit

The receiver depicted in the ad in Figure 19 was the model 110. The model 100 was the same except that it came with legs and amounted to a floor console. The model 120 excluded the internal loudspeaker (Figures 29, 30). This 3-dial 5-tube TRF receiver resembles a Freshman with its honeycomb coils wound with green cotton covered wire and fastened with string to the back of each variable capacitor.

![Figure 18. Rogers AC-32 (left) and Kellogg 401 (right)](image-url)
Figure 20. (left) Rogers model 20. A 2-tube battery-operated set with a regenerative detector and audio amplifier. Tubes and batteries were not included in the price of $38.50.

Figure 21. (right) Rogers model 30. A 3-tube battery-operated set with a regenerative detector and two audio amplifier stages. Tubes and batteries were not included in the price of $52.50.

Figure 22. (above) Rogers model 50. A 5-tube battery-operated TRF receiver. Tubes and batteries were not included in the price of $130.00.

Figure 23. (right) Rogers B-battery eliminator using two Rogers R-100 tubes.
Figure 25. (right) Rogers model 130. A 3-tube set using Rogers AC-32 tubes in a regenerative detector and two audio stages. A Rogers type B heater transformer was supplied and the “B” supply was by batteries or “B”-eliminator. The “C” battery was behind the tube socket panel. Price with tubes and transformer but less batteries was $130.00.

Figure 26. (left) Rogers models 130 and 135 schematic diagram showing “A” and “B” eliminators.

Figure 27. (right) Rogers heater transformer Type B
Figure 28. Rogers model 135 was the same as model 130 but the smaller cabinet meant that both "A" and "B" supplies were external. Price with transformer and tubes was $110.00.

Tube sockets for the Rogers AC-32 tubes were an integral part of the sub-panel. Volume control was provided by a damping rheostat across the 2nd. AF transformer secondary. A 400 ohm "stopper" resistor improved the first stage's selectivity.

The "A" and "B" power supply was enclosed in a sheet-metal box within the cabinet. The heater transformer had a multi-tapped secondary with the taps connected to positions 1, 3, 5, 7 and 9 on a selector switch (positions 2, 4, 6 and 8 were deadpoints to avoid shorting the secondary turns as the switch arm was rotated). Not shown on the schematic diagram was the 0-5 VAC voltmeter monitoring the heater voltage. The "normal" 2.8 V operating point was marked and the meter was red-lined at 3.8 V. (Adjustment was necessary because of fluctuating line voltage). A "B"-supply voltage control operated by varying the rectifier tube's heater potential. It was first set about half-way then reset to bring the receiver to just below the oscillation point.

The instruction sheet on the inside of the cabinet lid stated that the set was manufactured under the Canadian DeForest, Edward S. Rogers and F.S. McCullough patents by Standard Radio Manufacturing Corp. Ltd.

1926-27 - The Second Season

Additional manufacturing space was acquired at 858 Dupont St, Toronto,\(^{47}\) and a second shift added to cope with customer demand for the receivers - a Niagara Falls dealer reporting that his salesman was earning $50 per day in commissions on sales generated by door-to-door canvassing.

Figure 29. Rogers model 120 was a 5-tube TRF in a solid walnut cabinet that was identical to the cabinet used on the model 50. Complete with tubes and power supply it cost $260.00.
For 1926-27 the 3-tube receiver was unchanged except for its model number becoming 235 at $140 and the Model 130 was now the 230 at $150.

The R-100 rectifier tube was given a different filament construction and became the R-200. Two of these tubes were included in the new power packs used in the updated Model 120 and 110 receivers. Two “C”-potentials were available so that the below-panel “C” battery was finally eliminated to produce a true “battery-less” receiver. Additional “B+” decoupling was fitted to isolate the RF and output stages, and the 2nd. RF tube’s plate supply could now be adjusted from a panel-mounted “sensitivity” control. The Model 120 now listed at $220.

Troubles were experienced with the R-100 rectifier tubes and all Rogers tube production was changed over to making replacements issued on a “no-charge” basis. The problems were traced to defective brought-in thoriated-tungsten filament wire. A change in supplier cleared the problem but it resurfaced three months later. Industrial sabotage was strongly suspected and the Rogers plants became very security conscious. Mullard’s in England became the new supplier and no further trouble was experienced. Eventually all R-100 and R-200 tubes had the Raytheon gas rectifier as a recommended replacement.

Models 200 and 220 were introduced in the fall of 1926 (Figures 31 and 32). The 220 was a 5-tube plus rectifiers table model receiver in a solid-wood cabinet. Lifting the lid exposed three units: the RF section, the audio, and the power supply. Two AC-32 tubes acted as RF amplifiers with the three tuned circuits having their variable-capacitor pulleys ganged together with a metal belt to give single-dial control. The tubular coils, one
behind each capacitor, were mounted at the approved angle to minimize inductive interaction. A slow-motion vernier drive permitted more precise tuning.

The detector and audio stages were contained within a sheet-metal enclosure with the tops of the tubes protruding to allow for the overhead heater connections. A new type of power output tube, the AC-20 (320 mW) was fitted (Figure 33).

The power supply used two R-200 rectifier tubes and additional filtering together with higher output voltages which were provided for the new output tube. The tap-switch heater control and the rectifier filament control were eliminated and a line-adjust control was connected in series with the power transformer primary. The control knob for the line-adjust was located behind the rectifier tubes below the perforated grille (contrary to normal practice a clockwise rotation reduced the voltage). An AC voltmeter monitored the tube’s heater voltage. The meter face had been changed and has a “danger area” coded in red. The Queen Anne Console Model included a Baldwin magnetic speaker unit.

Naturally the increased sales of Rogers receivers affected the growth predictions of competing firms. They generally stressed the “more natural” reproduction available from battery operation and the advantages to be obtained from buying the products of long-established companies. On September 13, 1926, Canadian Westinghouse announced that their perfected batteryless receiver, using entirely new principles and standard Radiotron tubes, would be available for delivery on October 1. This was the Westinghouse Model 56 Desk type receiver retailing at $340. It used UV-199 tubes together with a UX-210 output tube with the filaments in series across the “B”-supply with the usual resistive-divider networks to obtain the correct operating points for the tubes.

Figure 32. Rogers model 220 receiver that cost $275.00 with tubes.

Figure 33. Rogers tubes AC-32 (left), AC-20, and AC-30 (right), all with etched tube numbers.
Canadian Radio Patents Ltd.

1926 also saw an attempt to reduce possible costly patent litigation between the major Canadian radio manufacturers, Canadian General Electric, Canadian Westinghouse, Northern Electric, Canadian Marconi and the Rogers/Standard Radio interests. Each held patent rights which potentially could be in conflict. A new company, Canadian Radio Patents, Ltd., was formed in November and owned jointly by these major companies. Their patents were “pooled” into the company which then charged a royalty fee on each receiver sold by the manufacturer. Each year the revenue accrued in this manner was shared between the owners in proportion to the value of the patents contributed.

Radio Station CFRB

In addition to being involved with the design of the season’s new receivers, Ted Rogers was realizing another ambition; to design, build and own a Toronto-based commercial radio station with a program content that would increase the demand for radio receivers, particularly those made by Rogers. Suitable equipment was built at the Rogers plant, including the transmitting tubes which used hand-blown glass envelopes. The transmitter, located north of Toronto at Aurora (on part of the original Rogers land settlement granted in the year 1800), began testing in January, 1927 on 1030 kHz. using 9RB as its call. Jack Sharpe was the engineer at the studio located in Ryan’s Art Gallery on Jarvis Street, Toronto. On February 19, 1927, with Charles Shearer as manager, the 1,000 watt station, CFRB, was capturing its first radio audience. The RB in the call letters represented Rogers Batteryless.

Ted Rogers was elected to membership in the Institute of Radio Engineers in April, 1927 although he had been present with Gordon Pipe at the October, 1925 meeting at the General Electric plant when the establishment of a Canadian chapter of the IRE was first proposed.

The Third Season - 1927-28

The Type U “B”-battery eliminator was introduced this season. Delivering 180 V. at 45 mA. It sold for $49.50 less tube. The Type 60 for 60 Hz. only, gave 135 V. at 35 mA. and retailed for $39.50 less tube.

Models 200 and 220 were retained from 1926 with some modifications to the power supply unit. A Raytheon BH rectifier was used and the filtering system was simplified. The model 220 was still $275.00 less speaker, with recommended speakers in the $25.00 to $40.00 range. A type 200 chassis was used in the new model 200-A. Originally listed at $395.00, the price of this drop-front console was increased to $420.00 in October, 1927.

The Model 90 introduced early in 1927 was a compact table model using a 5-tube TRF chassis with a two-dial tuning arrangement (Figures 37, 38 and 39). An external power supply unit was required. A console version of this receiver with built-in loud speaker, “the Cameo”, was available at $325.00. The chassis layout was very similar to the Model 120 with the detector and AF tubes in line at the back of the sub-panel chassis. The heater wiring was brought to the front of the panel. This in combination with the external power supply reduced the need for AF shielding.

The pleasing appearance of the Model 90 was not continued through to the Model 250, which was also introduced this season (Figure 40). The tube’s heater voltmeter upset the visual balance of the front panel. This two-dial
Figure 34. (left) Rogers type 32 with paper label
Figure 35. (right) Rogers type 30 with etched label

Figure 36. Tube carton used in the 1930's crediting Ted Rogers with the AC tube on one panel and with his likeness on another.

Figure 37. Rogers model 90 receiver
Figure 38. Rogers models 90 and 250 schematic diagram

Figure 39. Rogers Commander model, a metal box version of the model 90 made for the Robert Simpson department stores

Figure 40. Rogers model 250 receiver

Figure 41. Rogers "Jubilee" chassis, 32.5 inches long by 16 inches deep
receiver had a self-contained power supply with the audio section again in a sheet metal shielding container on the right hand side. In a walnut cabinet, the retail price was $215.00 less speaker.

A. "Mel" Patience had joined Standard Radio as Chief Engineer at the end of 1926. A friend of Ted Rogers from University days he had been working with Ontario Hydro and later would become Superintendent for RCA in Montreal.

The basic design of the Rogers receivers had not changed since 1925. In fact part of the appeal to dealers was the simplicity of the design. However, in 1927 the Jubilee chassis was introduced in the top-of-the-line sets which, in their Malcolm cabinets of walnut inlaid with maple, retailed for $890 (Figures 41 and 42). The receivers advertised as "... being developed by Ted Rogers over the last two years ... the utmost in radio refinement and ability..." used a 7-tube chassis plus two UX-216-B rectifiers. The audio output stage used a directly-heated triode tube which originally was to be a type 171, then plans were made to develop a Rogers filament-type tube, the R-15 (Figures 43 and 44), but finally a UX-210 was used. Choke-capacity coupling was included to keep the DC plate current from the "Symphony" magnetic speaker unit. Four RF stages were put ahead of the detector with their variable-capacitors ganged for single-dial control. A bridge-type neutralization scheme was adopted with manual gain controls on the first and fourth RF stages. Only a limited number of these sets were sold and their performance was probably a source of disappointment to dealers and owners.

1928 - A Year of Change

In 1928 Rogers Radio Ltd. became the Rogers Radio Tube Co. Ltd., and a new single-ended indirectly-heated triode radio tube, the
AC-30, was introduced (see Figures 33 and 35). The double-ended AC-32 tubes were included in the 1928-29 range of receivers. These were the Models 400, 420 and 400C which used the ‘standard’ chassis with the usual 5-tube TRF circuit, modified slightly by having self-bias on the RF tubes (Figure 45). The output stage called for the Rogers 15 tube but the 210 was used instead. The power supply used a Raytheon rectifier tube and ‘automatic’ line voltage regulation was obtained by using a Clarostat ballast unit.

The AC-32 tubes were also used in the ‘advanced’ chassis of Models 480 and 490 (Figure 46). This 6-tube plus type ‘80 rectifier receiver had three RF amplifier stages ahead of the detector and featured a complicated bridge-neutralization scheme for each stage with individual 2 k ohm variable resistors used for balancing. Both RF and AF gain controls were fitted. Also included was a phonograph input jack.
A far greater change occurred in November when an arrangement was made with U.S.A. based Grigsby-Grunow, the largest independent radio manufacturer, to consolidate the Rogers and Majestic interests in Canada. The new company, Rogers-Majestic Corp. Ltd., replaced Standard Radio Manufacturing Corp. Ltd. Grigsby-Grunow acquired substantial stock and B. J. Grigsby was appointed to the Board. Albert S. Rogers, however, remained as Chairman. Majestic had recently purchased Phanstiehl for its RCA license and now obtained access to the patents, licenses and expertise needed as it moved into line-operated receiver production in the U.S.A. In Canada, Rogers was strengthened so that it could better withstand the competitive threat posed by the major companies now that they were incorporating the newly-available Westinghouse UY-227 tube in their receiver designs.

The involvement of Majestic brings to an end this first chapter in the Rogers Company history. The AC-20 and AC-32 tubes were obsolete. Henry “Hank” Parker arrived from General Electric and became responsible for tube development. The company survived the death of Albert Rogers in 1932, the collapse of the Majestic group in the U.S.A., and the depression. They took over the DeForest-Crosley interests in 1935 and were able to boast that they manufactured over 25% of the receivers sold in Canada.

Ted Rogers died on May 6, 1939. In 1941 all Rogers-Majestic assets, including patents, plant, equipment, etc. were sold to a British cable-cast company, Rediffusion, Ltd. Rogers-Majestic (1941) Ltd. became a subsidiary of Rediffusion (Canada) Ltd. All plants were now heavily involved in manufacturing military equipment. There was, of course, no Rogers family involvement. Today, Rogers-Majestic is part of the North American Philips Organization. CFRB is the most successful independent Canadian radio station with Standard Radio Broadcasting operating facilities located internationally and the Rogers Companies, with Ted Rogers Jr. at the helm, are active in electronic communication via cable and satellite.

Conclusions

It would appear that the development work for the AC operated radio tube should be credited to Westinghouse employees Freeman and Wade. Fred McCullough apparently evolved the manufacturing methods and Ted Rogers initially solved some problems that were preventing it from becoming a commercial reality.

A practical AC tube was, however, only a component, albeit an important one, in a successful line-operated radio receiver. To Ted Rogers should go the credit for recognizing the cause and solution for each problem that arose in the design and manufacture of the first commercial AC operated receiver. This, and his other accomplishments, make him Canada’s foremost pioneer radio engineer.

Why did the Rogers company prosper while scores of others entering the field at the same time failed? First and foremost was probably Ted’s involvement with radio to the virtual exclusion of other interests. He had the self-reliance and persistence exhibited by many pioneer “ham” operators. His family background including not just their wealth and business acumen, but also their Quaker influence undoubtedly contributed to his ability, like Marconi, to inspire a band of devoted fellow engineers and employees. The product itself, its quality and performance, led to ready market acceptance. And finally, the aggressive marketing style of the QRS Organization led by the Trestrail brothers ensured a successful business outcome.
References

3. See, for example, Willard battery advertisement, Radio News, August, 1922, p. 295.
4. Such a scheme was, however, used by Stromberg-Carlson in their 1927 model 523.
6. The ‘humdinger’ was the subject of a 1919 French patent taken out by the ‘Societe Independente de TSF’.
7. The French “S” tube of the Societe Ducretet was developed for this purpose in 1922.
8. The Garod model E-A, designed by B.F. Meissner, had the “B”-supply current passing through the detector tube’s filament.
25. Cdn. Pats. 244,433; 244,434; 244,435. Granted Nov. 11, 1924. Catkin valves were introduced in Britain, first as transmitting tubes with Cooled Anode Transmitting construction. The anode was a copper cylinder completely exposed to facilitate cooling. These appeared following World War I and some receiving tubes of similar construction were introduced in May, 1933. See J. W. Stokes, 70 Years of Radio Tubes and Valves, Vestal, NY: Vestal Press, 1982, Chapter 13.
27. Premises were the National Carbon ‘Ever Ready’ plant during World War I, then the T. Eaton Co. warehouse. Now a parking lot for Toronto’s downtown Holiday Inn.
28. Canadian Independent Telephone Co. headsets were still advertised by the T. Eaton Co. (for $2.98 a pair), September 3, 1925.

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32. Named after its President, G.W. King. Premises now demolished and the site of a Service Station.
35. Dongan Electric.
36. Amplex, Freshman, PRS.
41. Barawik Co. Summer Catalog. 1929.
42. QRS stayed as distributors until Majestic involvement in 1928. Fred Trestrail acquired control in 1930. Company became QRS Neon Corporation, Ltd. with David P. Rogers as V.P. Became Outdoor Neon Display, Ltd. with Rogers as Pres. in 1937.
43. The home at 37 Grenadier Road was that of Maurice Fiegehen, a draftsman, later listed as a Rogers employee.
44. The Globe. September 9, 1925.

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Line drawings are the originals supplied by Maurice Chaplin. Schematics and advertising are from Rogers company originals. Patents were searched by Maurice Chaplin.

Figures
2, 16, 17, 18, 21, 22, 25, 27, 32, 33, 34, 36, 40, 45. Robert Murray, Winnipeg, Manitoba.
15, 43, 44. Doug Brighton, Hanover, Ontario
20, 28, 37, 46. Brian Darby, Oakville, Ontario.
Maurice Chaplin

Maurice Chaplin first became interested in radio in the '30s. Employed in England in the cinema industry as a technician, he served in the military during WWII and then operated a radio service business until moving to Canada in 1951. He taught night school for several years before becoming a secondary-school teacher specializing in electronics. Since his retirement in 1986 he has maintained an interest in all aspects of technology, particularly radio both ancient and modern.
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