The Antique Wireless Association Review

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Foreword

It is with regret that we report Bob Murray, our venerable editor of *The AWA Review* for the past ten years, had a sudden and serious medical situation arise in August 2015 that prevented him from serving as editor this year. Unfortunately, we did not learn of Bob’s medical condition until December, and we were unable to make contact with him until very recently. We have been in contact with his wife, Eileen, since December and she has been optimistic about his recovery. In a recent conversation, Bob indicated he would like to serve again in some capacity with the preparation of future issues of the *Review*. We salute Bob for his accomplishments over the past ten years, including modernizing the format, expanding the range of content, developing a peer review process, and introducing color publishing to the *Review*. We all wish Bob and Eileen well, and we hope that Bob continues to recover in the coming year.

In order to provide for continuity in the publication of *The AWA Review* for 2016, Eric Wenaas and David Bart volunteered to serve as coeditors beginning in early January 2016. We have had a particularly challenging year reviewing and editing manuscripts because of the compressed schedule. Since we have had no direct contact with Bob after July 2015, we do not have a complete picture of who contacted him with questions about *The AWA Review* or submitted papers for the 2016 *AWA Review* in 2015. In the end, a number of authors submitted excellent papers this year, and those selected for publication in the 2016 edition of *The AWA Review* are summarized below in their order of appearance:

- **Dan Howard** relates a compelling story of the early days of the U.S. Forest Service during three fire seasons from 1919 through 1921 when the Forest Service evaluated a number of technologies for communicating over its vast areas of forestland to report forest fires. Dan’s story focuses on the tests performed in Oregon by foresters using radio sets developed by the U.S. Army Signal Corps and U.S. Navy during WWI. These sets were tested at selected locations in the forests and cities, including the lookout atop Oregon’s Mount Hood.

- **David Willenborg** relates the life history of Arthur Lynch, who you may recognize as a prominent magazine editor and author for *Radio News* and *Radio Broadcast* magazines in the 1920s and 1930s. Lynch’s name appears on the masthead of many issues as the editor and in the numerous articles appearing in these publications. David was able to write a comprehensive story of Lynch’s exploits as a wireless operator, editor, author and entrepreneur after making contact with two of his relatives who had knowledge of his life story and supporting photographs, which appear in the article.
- **David and Julia Bart** review the role of the military telegraph in the American Civil War, and also include a bibliography and references that can be used for further research into this topic. The text is supplemented with images of numerous artifacts from the authors’ collection, including original documents, photographs, medals, telegraph apparatus and much more. The article traces its roots to an award-winning exhibit compiled by the authors and presented at the 2013 AWA Conference: “Lincoln’s Telegraphers: The 150th Anniversary of Gettysburg and the Emancipation Proclamation.”

- **John Dilks** came across a farewell letter from Amory H. “Bud” Waite, Polar explorer and radio operator, which unknowingly came into his possession in the late 1990s or early 2000s with a number of other documents he obtained. John discovered this letter in 2010 and is now sharing this previously unpublished document with all of us. Bud wrote this farewell letter to his friends and relatives after receiving radiation treatments that nearly took his life in 1983. This letter recounts his many exploits with Admiral Byrd and other Polar explorers and is reproduced verbatim. The letter is supplemented by a number of images from John’s own Polar collection that correlate with subjects described in the letter.

- **Eric Wenaas** continues his tradition of reviewing historical accounts of great inventors to report inconsistencies between the accounts recorded by the inventor and contemporaneous documents that chronicle the inventor’s activities. This year it is Lee De Forest and his wireless telegraph companies that are under the microscope. Eric makes the case that Lee De Forest’s autobiography is hopelessly flawed with errors and omissions that have been repeated by many historians over the years. In correcting the account, De Forest emerges as something of a scoundrel.

- **William Hopkins** informs us that June 15, 2016 marks the 100th anniversary of the Second German Reich’s high-powered wireless transmitter site at Königs Wusterhausen (i.e., KW) near Berlin. Bill describes the activities of this station and its changing status over the past 100 years. He has included interesting drawings of the antennas and photographs of the site, and a photograph of German vacuum tubes on display in the museum that now stands at the site.

- **Olin Shuler** builds on his paper from last year dealing with his participation in the development of FM car radios while he was employed at Motorola. This year Olin provides a first-hand account of his participation as a production engineer in the introduction of the first successful 8-track tape player designed specifically for use in automobiles. Olin takes the reader through the unique
problems and design solutions associated with the operation of the 8-track player in the thermal and mechanical vibration environments unique to the automobile as opposed to the home.

- **Norman Braithwaite** collects high-quality superheterodyne radios manufactured by the Lincoln Radio Corporation between 1928 and 1936. He points out that for all the advertising and articles, there are very few Lincoln receivers known to exist today. This disparity between publicity and product has been an enigma for the radio collecting community, and Norman unravels the mysteries of the Lincoln Radio Corporation in his report on the history, products and outcome of the company.

We extend our sincere thanks to the authors for their excellent articles, and to the reviewers for their able assistance in reviewing the articles and making suggestions that improved the manuscript. The anonymous reviewers will remain anonymous this year. *The AWA Review* once again used the services of book designer Fiona Raven to layout each page of *The AWA Review*, which she designed for us several years ago. Her help this year was invaluable. We thank Fiona once again for her contributions and creative spirit.

The cumulative index of the Table of Contents has been updated this year and is now current through Vol. 29 dated 2016. This index can be accessed on the AWA website at http://www.antiquewireless.org/awa-review.html.

We have both enjoyed serving as coeditors of *The AWA Review* this year. This has been a new experience for us, and we now realize just how much work Bob Murray put into editing the manuscripts and assembling *The AWA Review* over the past ten years. We will continue to serve as editors of *The AWA Review* until a new editor has been appointed by the AWA.

Eric P. Wenaas  
Coeditor  
San Diego, California

David P. Bart  
Coeditor  
Chicago, Illinois
Tips for Authors

*The AWA Review* invites previously unpublished papers with a focus on antique wireless communication history and associated artifacts. Papers will be peer reviewed to verify factual content by reviewers whose identity will remain anonymous. This process gives *The AWA Review* credibility as a source of correct historical information. The papers will be edited to provide a degree of uniformity in style and layout among the articles. In general, shorter articles of six to eight pages or less should be directed toward the *AWA Journal* published quarterly.

*The AWA Review* will also publish Letters to the Editor as deemed appropriate. The letters should comment on articles published in the previous issue of *The AWA Review* or make brief comments on wireless history as it relates to one of the articles. Letters will not be peer reviewed, but they may be edited. Text is limited to 400 words and no more than 10 references. The editor reserves the right to publish responses to letters.

It is strongly recommended that authors planning to prepare an article for *The AWA Review* send an abstract of approximately 200 words to the editor describing the subject and scope of the paper, including an estimate of the number of words or pages of text before writing the article. It is never too early to submit an abstract. Space in *The AWA Review* is not unlimited, so it is important to for both editors and authors alike to have an estimate of the expected number of articles and number of pages for each article as soon as possible. The deadline for submissions is March 1.

Authors with an interesting story to tell should not be discouraged by a lack of writing experience or lack of knowledge about writing styles. *The AWA Review* will accept manuscripts in any clearly prepared writing style. Editors will help inexperienced authors with paper organization, writing style, reference citations and improving image quality. *The AWA Review* has prepared a short style manual that will be given to authors who either request a copy or who submit an abstract.

Articles submitted to *The AWA Review* will be laid out on the page in a style made consistent for all papers in the entire publication. Please do not integrate illustrations or tables into the manuscript. Manuscripts, tables, illustrations and captions should be submitted as separate files. Also, a short biography and a photograph of the author should be submitted. Text files can be prepared on any word processing software, but Microsoft Word is preferred. Manuscripts should be single spaced including a single space between paragraphs and between headings and paragraphs. Please do not include any idiosyncratic text styles (such as small caps) as they will be stripped out when the article is prepared for publication. If they are absolutely needed, please alert the editor in a cover email. Illustrations should be sent as JPG or TIF files with a resolution of approximately 300 dpi. Resolutions much less than 300 dpi produce poor images and will be
reduced in size accordingly or may not be accepted. A short Style Manual with examples is available to advise authors on the preferred format. It is available to all prospective authors and can be downloaded from The AWA Review page of the AWA's website.

Edited manuscripts will be returned to the author along with comments from the editor and anonymous reviewers, as appropriate, for the author’s review and comment. The manuscript will then be set in its final form and sent back for one final review by the author. Normally, only one review of the layout will be allowed.

Completed manuscripts with figures, tables, captions, and abstracts intended for publication in The AWA Review must be submitted by March 1 of the year it is to be published. This deadline is necessary in order for the editors to perform their own final editing and to layout the issue in order to meet our May 1 deadline for submitting the completed volume to the printer. Articles submitted after March 1 become candidates for the next year’s volume. Despite the deadline of March 1, I urge authors to submit the final manuscript as soon as possible to permit additional time for editing, layout and other preparations needed before publication. For more information contact:

Eric P. Wenaas, Acting Editor
The AWA Review
P.O. Box 676028
Rancho Santa Fe, CA 92067
E-mail: eric@chezwenaas.com
Mount Hood Calling
The Western Forest Wireless Tests

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Abstract
In the early days of the U.S. Forest Service, the agency explored a number of technologies for communicating over vast areas of forestland. The telephone soon became the favored means of communication, and the Service installed a vast telephone network with thousands of miles of wire strung on trees. In 1912, employees of the Service in the Northwest, often referred to as foresters, began to discuss the use of aircraft and radios to detect and report forest fires and coordinate firefighting efforts. Finally, at the end of World War I, radiotelephone technology and manpower became available to test some of these ideas. In 1919, the foresters in the Northwest began testing Signal Corps radiophones developed during WWI to see if they could replace wired telephones. During three fire seasons from 1919 through 1921, wireless sets were tested at selected locations in the forests and cities, including the lookout cabin atop Oregon’s Mount Hood. Radio pioneers throughout the West partnered with the Forest Service to conduct the wireless tests and analyze the results. While the results were promising, decision makers concluded that the technology had not yet been developed to the point where it was practical for deployment. The radio would not come into regular use for forest communications until the 1930s. Recounted here are the stories of the foresters and radio amateurs who conducted the Western Forest Wireless Tests.

Introduction
During its first fifteen years, the U.S. Forest Service built and relied on a vast telephone network for communications in the forest (Figure 1). The telephone system had obvious shortcomings associated with cost, reliability, availability, and maintenance. For example, the cost of installing telephone wires was about $100 per mile, and the lines required constant patrolling and maintenance. Although they were placed high to avoid damage from wildlife and minimize hazards to hikers, wires were constantly damaged by falling tree limbs. And, of course, a wired system was impractical for communication along a rapidly moving fire line.
In December 1912, C. B. Cooper of the Marconi Wireless Telegraph Company’s Seattle office spoke about radio at the Western Forestry and Conservation Association’s annual Forest Fire Conference. Officials of the U.S. Forest Service listened with interest as Cooper extolled the possibility of using wireless telegraphy in the forests to replace the thousands of miles of telephone lines then in use. The technical realities of the time were far less promising because transmitters were bulky and required substantial power supplies. Cooper described a yet-to-be-designed modular wireless telegraphy system that would be transported by mules—and was effectively limited to code transmission only.

Following the conference, Coert DuBois, who was with San Francisco office of the Forest Service (Figure 2), wrote that in theory, the wireless telephone held promise for replacing the wired telephone network. But he also believed a code-based system, using the bulky and sensitive equipment then available, was simply not practical:

“The telegraph, both wireless and metallic circuit, obviously fails to meet the essentials of a protection communication system. It requires delicate, specialized, and expensive instruments and equipment; a continuous supply of chemicals not generally obtainable, or else an engine and motor

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Fig. 1. Forest Service Lookout Lige Coalman (left) atop Mount Hood with an Osborne fire-spotting device. Reports of smoke were reported using the portable phone at his feet. (U.S. Forest Service Photo; courtesy of Mount Hood National Forest)

Fig. 2. Lt. Colonel Coert DuBois in his uniform from World War I. (American Lumberman, Nov. 1, 1919, p. 85)
to generate the sending power; it requires special training on the part of everyone who uses it, and has a wide possibility of error. In theory the wireless telephone most nearly meets the essentials of the ideal forest communication system."

J. R. Irwin appeared on behalf of Marconi a year later at the 1913 Forest Fire Conference in Vancouver, British Columbia, to provide an update. In the years that followed, sporadic tests and demonstrations were conducted. For example, in 1916, Dubois brought Dr. H. Barringer Cox (Figure 3) to the Forest Service’s San Francisco offices to demonstrate and further develop an invention that he claimed was a practical portable wireless telegraph. Although early tests were widely touted in the media, the Cox system was not deployed commercially. During the summer of 1916, Ranger William R. Warner who was stationed near Clifton, Arizona, became interested in the potential of wireless communications. With the help of Ray Potter, a local high school student and radio amateur, the necessary equipment was purchased and installed. The first test message was sent from the Baseline Ranger Station on November 26, 1916.

That fall, bids were solicited for radiophone equipment by L. V. Slonaker, the telephone engineer for District 3. One of the respondents was William Hanscom, the chief engineer for the National Radio Company, a manufacturer of receivers and damped-wave wireless telephone transmitters. Though National would eventually have a chance to demonstrate its equipment for the Forest Service as part of the Forest Wireless Tests, the District 3 bids apparently did not result in purchase. A few other wireless trials have been

Fig. 3. Dr. H. Barringer Cox demonstrates his vest-pocket wireless telegraph system. A ground connection is made through a spur attached to a shoe. His cane contains the antenna which is raised for better reception. (The Oregonian, Oct. 5, 1915, p. 3)
documented from the prewar period, but nothing was widely implemented by the Forest Service.

The war in Europe necessitated substantial investments in military radio technologies, which included practical portable radiotelephone sets. After the war ended in 1918, there was a temporary surplus of equipment and manpower. Recognizing an opportunity for further testing of wireless equipment, foresters went to Washington D.C. seeking to borrow radiotelephones from the military. On March 3, 1919, representatives of the Forest Service and the Army Air Service met to discuss using airplanes for fire detection. Ultimately, the Army provided planes and pilots during the summer months for fire patrol work and also provided wireless telephones for testing. The phones were to provide not only point-to-point communication, but also to serve as ground receiving stations for the Army planes that carried transmitters. Implementation of the plan fell to forester Col. DuBois, who had recently returned from Army service, and Col. Henry H. “Hap” Arnold, who supervised the expansion of the U.S. Army Air Service during the war. Forest Service telephone engineers in the Northwest and Intermountain Region were selected to conduct the radio tests.

Part 1 describes the tests made in Oregon by Clay Allen’s team from 1919 to 1921. Part 2 covers the tests made by R. B. “Ring Bell” Adams and his team in the Intermountain Region during the same period.

**Part 1 The Oregon Tests**

**1919 Fire Season**

In 1915, the Forest Service established a fire lookout station on the 11,250-foot summit of Mount Hood, the highest point in Oregon. The first lookout station was a Russian-style arctic tent tied down to a wooden platform in a hollow a few yards from the summit. Elijah “Lige” Coalman (1881–1970) built a permanent wooden cabin that he began in 1915 and finished in 1916 (Figure 4). An external alidade (fire spotting device) remained operational on the summit even after the lookout was finished to provide visibility into the Bull Run Reserve, Portland’s main source of drinking water (Figure 1). Lige manned it during the summers of 1916 to 1918 to watch for fires. He also performed search and rescue missions, served as a telephone lineman, a mountaintop host for cold and weary climbers, a weatherman and any number of other roles. After suffering several climbing injuries, he finally resigned in September 1918, but continued to guide climbers occasionally.

During the summer fire seasons from high summer until the fall rains—usually July through September—the lookout communicated observation reports by telephone down the south side of the mountain to Government Camp, about eight miles below. A second telephone line ran down the north side to Cloud Cap Inn. The Forest Service used a single-wire system in which the ground was used as the “return” (second conductor). Because of the weight of the #9 galvanized iron
wire, and for ease of maintenance, telephone wire came in lengths of 250 feet. Incredible as it may seem, the wire lines to the lookout were installed each summer and then rolled back up by hand each September and stored for the winter. In the forest, trees and animals frequently damaged the lines. And on the snowfields of Mount Hood, falling rocks, chunks of ice, and snow slides regularly broke the telephone wires. Using this method it sometimes took two or three days to report a fire, because “one or both of the lines were more often out of commission than in working order.”

The Mount Hood lookout was selected as a site for the 1919 wireless tests in order to evaluate the operation of radios at high altitudes and to determine if they would be an efficient alternative to telephones, with all the attendant problems of installing and maintaining wires to the lookout. The year 1919 also marked the inauguration of fire patrol flights over California and Western Oregon using Army aircraft. The Forest Service used these tests as an opportunity to see how a network of ground receiving stations could be utilized as a means of relaying reports from the planes. At the time, only a few Army planes were equipped with telegraph or telephone transmitters. Those planes without radios conveyed their reports by releasing carrier pigeons, dropping weighted messages, or by landing the plane and finding a telephone.

Clay M. Allen, the Pacific Northwest District Telephone Engineer was selected to lead the test team for the radio tests on Mount Hood between 1919 and 1921. Allen began his telephone career at the Chicago Telephone Company and later worked at Pacific Telephone and Telegraph. He started working for the Forest Service in 1916.
where he developed innovative new devices and techniques to improve communications in the forest. He shared his knowledge at speaking engagements throughout the west and in the many essays and manuals he wrote.

Because Allen had little radio experience, he solicited help from several local amateur radio operators to help conduct tests in various Portland locations, including the basement of his own home. Chas. L. “Charlie” Austin (1890–1980), one of Oregon’s true radio pioneers helped Allen with the tests. As a boy of 13, Austin reportedly built his first receiver using a coherer detector and a transmitter using an induction spark coil. During the summer of 1905, he exhibited a wireless receiver at the Lewis and Clark Exposition in Portland. Newspaper accounts dating back to January 1908 describe wireless demonstrations at local libraries with Austin and amateurs Charles Fine, Rigland Savage and Lee James operating under the auspices of the “Portland Boys’ Wireless Telegraph Club.” Austin’s earliest known call sign circa 1908 was “SN.” Later calls included 7DK, 7ZI, and 7ZK. Austin had a lengthy and varied career in radio. Prior to World War I, he served as a ship’s radio officer on the steamer Rose City.

After enlisting in the U.S. Navy, he was put in charge of the Federal station in Lents, Oregon, located on the southeast edge of Portland. Later, he was appointed Naval Radio Inspector in Portland and recruited ship wireless operators. Following the war, Austin returned to his amateur and commercial radio interests. He organized local amateurs as the Northwest Radio Association and built and installed commercial broadcast stations. In the 1920s, Austin built home receivers under the name Northwestern Radio Manufacturing Company or “Norco.” When the City of Portland organized a radio shop, he was hired as a radio technician, retiring in 1955.

The tests in 1919 were performed with a pair of SCR-67-A radiotelephone/telegraph sets that R. B. Adams had obtained from the Signal Corps. Adams shipped one pair to the Forest Service’s District 6 headquarters in Portland, Oregon, for use on Mt. Hood, and retained the other pair for tests in Montana and Idaho, which are described in Part 2. Although District 6 received permission to begin wireless tests from the Navy around July 1, 1919, initial tests were performed in semi-secrecy until concerns about the right to use the sets without licenses or permits from state and local authorities were addressed. These tests were conducted between two Portland-area locations throughout the month of

Fig. 5. Radio testing in C. M. Allen’s basement showing the BC-13-A. Sixteen-year-old Buford Allen is at the microphone. (Illustrated World, Dec., 1919, p. 559)
July. On the evening of July 17, Austin operated one of the sets from his home station and broadcast a concert of phonograph music to an audience at Allen’s residence between 8:00 pm and midnight (Figure 5). Twelve local hams responded to Allen’s invitation to call him with signal reports.

The SCR-67-A / BC-13-A

The SCR-67-A was a two-way radiotelephone/telegraph set developed by Western Electric during World War I (Figures 6–9). The complete radio kit includes the BC-13-A “set box” and its BD-1-A powerboard, cables, batteries, antennas, etc. In addition to communicating with compatible ground equipment, the sets were intended for use with airplane radiotelephone sets such as SCR-59 or SCR-68. The BC-13-A can transmit between 250 and 450 meters and receive from 200 to 800 meters. VT-2 tubes are used for the transmitter’s modulator and amplifier and the receiver uses three VT-1 tubes. The receiver’s detector tube is also used in the transmitter’s input circuit. (When viewing the photos, consider what it would have been like to transport, set up, and operate this bulky and heavy equipment with all the accompanying batteries in the woods in an emergency.)

![SCR-67-A cording diagram](Radio Pamphlet No. 22, April 20, 1919, p.11)
Fig. 7. BC-13-A set box and power board. The long extension cord in the foreground is useful when it is desired to locate the power board remotely. (*Radio Pamphlet No. 22*, p.15)

Fig. 8. Interior view of the BC-13-A set box. The three VT-1 receiving tubes are visible at the top center, with the VT-2 transmitting tubes on the right. (*Radio Pamphlet No. 22*, p.18)
Installing the Radio in the Lookout Station

Despite Lige Coalman’s September 1918 resignation, he and his assistant, George C. Maroney, returned to the Mount Hood lookout cabin in early July 1919 to reopen it. This required them to tunnel to the door through the snow, which at the time buried the lookout to the top (Figure 10)!

Shortly after the Portland demonstration tests were finished, Allen’s team arranged to transport the radio from Portland to Mt. Hood. The antennas and masts were taken down and hauled by truck to the Zigzag ranger station at the base of Mount Hood. Prior to packing the equipment to the summit, Allen’s team assembled and tested the sets at Government Camp and also at Camp Blossom near where the historic Timberline Lodge sits today (Figure 11). In those days, Camp Blossom, situated at an elevation of about 6,000 feet, was little more than a place for prospective climbers to set up camp prior to ascending to the 11,250-foot summit. As such, it made an ideal place to test, stage, and pack the equipment. Packhorses were used to carry the equipment from Camp Blossom up to Triangle Moraine (Figure 12). At that point, foresters divided the equipment into small loads and used pack boards to carry it the last two miles to the summit (Figure 13). A description of how the antenna was set up at the top appeared in *Radio Amateur News*:

“Two and a half inch bamboo, in 6-½ ft. lengths, was used in the construction of the long mast [Figure 14]. Each piece was reinforced by wrapping bands of...
Fig. 11. Supplies being loaded on pack horses. (*The Southern Lumberman*, Dec. 23, 1922, p. 157)

Fig. 12. Foresters packing mast sections and other components of the SCR-67-A from Government Camp to Triangle Moraine July 1919. (*The Oregon Journal*, Aug. 17, 1919, p. 16)

Fig. 13. Coalman and Maroney packing radio materials to the lookout. The jointed bamboo mast weighed “only” 80 pounds. (*The Oregonian*, Aug. 17, 1919, p. 14)
No. 19 spring brass wire about 1-1/2-in. wide between joints. The lengths of bamboo—eight in number—were joined by fitting oak pieces inside of the ends; and the mast was held rigid by four ½-in. special steel airplane cordage truss guys, from top to bottom, these being spread about 36 in. at the center by ½-in. oak spreader arms. The use of oak pins for spreader arms was a mistake, as the first sleet storm coated them to a thickness of about 3 in. which snapped two of them off and almost allowed the mast to crumple up. One-half inch iron pipe was substituted for the oak pins and proved very satisfactory.

“After making a careful examination of the conditions on top of the mountain, it was decided to erect an inverted L shaped antenna 250 feet long, supported at one end by a 50 foot mast erected by the side of the lookout cabin, and the other end attached through strain insulators to wires extending some 50 feet farther southwest to a short mast set in a point of rock sticking up beyond the small glacier.

“A four-wire antenna was used at first, each wire being a No. 10 stranded copper wire 250 feet long, with a spread of 3-½ feet between wires. As it was impossible, due to glacier ice, to make an ordinary earth ground, a counterpoise was used with fair results.”

The completed antenna installation is shown in Figures 15 and 16.
Fig. 15. Mount Hood lookout cabin. The mast and the inverted-L antenna show in the background over the roof of the cabin. Note the backstay tied off to a rock outcropping. The main floor of the cabin had a single door, visible in this view, with windows on the other three sides. The post to the right of the cabin was used to mount a second Osborne fire-spotting device (alidade). (USFS photograph, Perham Collection image 2003-33-147; courtesy of History San Jose)

Fig. 16. Mount Hood lookout with antenna mast. The inverted-L antenna was supplemented with counterpoise wires stretched along the ground beneath it. Extra lines hanging down from the cabin walls may be telephone lines or climbing aids. (USFS photograph, Perham Collection image 2003-33-148; courtesy of History San Jose)
**The First Tests**

Preparatory testing at Mount Hood began in early August 1919.12 As the summit radio installation was being readied, Allen’s entire family, including his eight-year-old son, Jack, made an “inspection visit” to the lookout, making Jack one of the youngest people to reach the top of Mount Hood.13 The second radio was located at the Government Camp Hotel (Figure 17) eight miles from the lookout at an elevation of about 4,000 feet.14 At Government Camp, a four-wire inverted L antenna 250 feet long and 50 feet high was installed.15

![Fig. 17. The Government Camp Hotel in early August 1919. The wireless mast is in front and the four-wire antenna stretches back over the roof. (Radio Amateur News, Jan. 1920, p. 336)](image)

The first test from the lookout occurred on Saturday, August 9. Coalmann and Maroney operated the set at the summit while Clay Allen operated the set at the Government Camp Hotel. During the Saturday test, the lookout spotted smoke from a forest fire on the reservation of the Confederated Tribes of Warm Springs and reported it by wireless, putting the set into productive use on its first day of trials.

Tests from the lookout continued for three weeks. While the station at the summit remained in place throughout the tests, the set from Government Camp was moved to various locations, including the Forest Service headquarters in Portland. During the initial tests, Allen reported that the expected static interference was not bad, but the BC-13-A sets did experience interference from other stations. Although the BC-13-As had a nominal range of only 12 miles, on August 14 signals were picked up at the lookout from Portland, almost 60 miles away. A few days later, reports were received that transmissions from the Mount Hood station had been heard in San Francisco. It was reported that the lookout station received radiotelegraph signals from stations all over the country at various times.

**The National Radio Company Tests**

As mentioned previously, the successful radio experiments in Arizona prompted the Forest Service to request bids for a wireless telephone system in late 1916. The National Radio Company based in San Francisco, which owned various patents related to damped-wave arc
transmitters, continued to seek opportunities to market these transmitters commercially despite the emergence of the more modern tube-based technologies. Consequently, William W. “W.W.” Hanscom (1869–1956) (Figure 18), the chief engineer for the National Radio Company, responded to a request for bids with a proposal featuring the company’s arc transmitters. Hanscom had succeeded Doc Herrold as the company’s chief engineer in 1913 after he left the National Wireless Telephone Co.,16 which became the National Telegraph Company in 1916. Hanscom held an experimental special land station license (6XB) issued in 1914.

There is no record that the 1916 bid led to a sale, but during the intervening war years, Hanscom remained in touch with the Forest Service telephone engineers. After the war, arc transmitters were widely acknowledged as obsolete and inferior to tube transmitters. Nonetheless, in June 1919, Allen rented two sets of National Wireless Telephone transmitters and receivers for testing in conjunction with the SCR-67-As. Hanscom agreed to apply the $50 rental fee toward the purchase price if the Forest Service decided to keep them.

The National wireless telephones (Figures 19–22) were shipped to Portland on July 28, but Hanscom himself experienced several delays and did not arrive until August 20. Allen and Austin installed one of the National sets at Austin’s home for testing using his existing antenna. Plans to test the second set at Mount Hood were foiled because the necessary 220-volt power source was not available. Allen considered hauling a gasoline-powered generator to the summit, but decided against it because of the ruggedness of the climb.

After Hanscom arrived in Portland, he operated the National transmitter at Austin’s home for two nights for about two-hours each time. Buford Allen listened for the test transmissions from the Mount Hood lookout using the BC-13-A telephone set. Over the course of two nights, he reported receiving one partial message “Hello, hello Allen” and some indistinct words from the National Wireless Telephone. Listening to the tests from the homes of various Portland-area amateurs, Clay Allen was able to understand only about 20% of the words sent from the National transmitter.17 An assistant to Hanscom who was operating the National Radio Company station 6XO on the

Fig. 18. William Hanscom circa 1902. (Electrical World and Engineer, Vol. 39, Mar. 29, 1902, p 540)
Fig. 19. A National Radio Company Wireless Telephone station similar to the ones brought to Portland. The motor-generator sits on the floor with the power panel on the desk above it. The transmitter sits in the center of the desk with the arc chamber to its left. The receiver sits atop the transmitter with a panel-style tuned circuit and a mineral detector in the foreground. (Perham Collection image 2003-33-137; courtesy of History San Jose)

Fig. 20. Close-up view of the arc tank. On the right a solenoid is used so that the arc distance can be maintained as the electrodes erode away during use. The five-point arc is immersed in an alcohol-filled chamber that is encased in a water jacket through which coolant flows. (Perham Collection image 2003-33-141; courtesy of History San Jose)
Fig. 21. Close-up view of the transmitter panel showing a voltmeter, two ammeters, the water-cooled microphone, and the regulator and transmit/receive switches. (Perham Collection image 2003-33-140; courtesy of History San Jose)

Fig. 22. The National transmitter with the side cover removed to expose the helix. The primary coil is mounted to the inside back of the cabinet. Slots through the back panel are provided for adjusting the taps. The angled secondary coil must be adjusted with the cabinet open. The microphone is water-cooled and the supply pipes can be seen in this view. An external condenser is mounted at the top center of the back. (Perham Collection image 2003-33-142; courtesy of History San Jose)

roof of the Fairmount Hotel in San Francisco reported hearing a conversation between Hanscom in Portland and Buford Allen at the summit, but no such conformation appeared in Forest Service reports.\textsuperscript{18}

Hanscom hiked to the Mount Hood lookout on August 26 to examine the installation of the SCR-67-A and participate in some tests. However, interference from intense static during his visit made it impossible to receive signals from Portland on a consistent basis. He returned to San Francisco on August 29, still aching from his climb to the summit.

The antennas and radio at the Mount Hood lookout were disassembled at the end of August as the season came to a close and crevasses began to open, making climbing dangerous. Packing the equipment down the mountain turned out to be a very complicated affair due to an unusually heavy snowstorm. The task was accomplished without mishap by means of an ingenious arrangement consisting of a brake attached to a toboggan.\textsuperscript{19}

**The Result of the 1919 Tests**

In October 1919, the Western Forestry and Conservation Association held its annual convention in Portland at which Allen spoke about the Mount Hood tests. During his talk, a BC-13-A was situated in the convention room on the 2\textsuperscript{nd} floor of the Multnomah Hotel with its antenna strung between 30-foot flagpoles on the 8\textsuperscript{th} floor roof. Using the other BC-13-A located several miles away, Austin sent messages and
phonograph music that were played loud enough to be heard throughout the conference room. Amateurs all over Portland picked up the broadcast of Allen’s speech.\textsuperscript{20}

The official evaluation of the 1919 wireless tests and forest air patrol by the Oregon State Forester was cautiously optimistic:

“The United States Forest Service has been successfully experimenting in the use of wireless telephones on Mt. Hood and other lookout points. It is expected that by next season such progress will have been made in the experiments as to make their use practical. However, should it be found impossible to obtain the necessary wireless equipment, message dropping from planes can be successfully developed.”\textsuperscript{21}

“Carrier pigeons will also be used as a means of communication. Experiments were carried on this season and the Signal Corps has detailed an officer and three men to raise and care for forty-eight carriers which are now at Eugene.”\textsuperscript{22}

During his speech at the forester’s conference, Allen summed up the tests:

“It is not desired to convey the impression that wireless telephone apparatus in its present stage of development is simple. While tremendous strides have been made in its development, it is still complicated, and requires for its use some training and ability on the part of an operator. However, it is not believed that this is beyond the employees of the Forest Service or kindred organizations who would ordinarily have to do this part of the work.

“There are some problems in considering the general use of wireless that are not so easily solved. For instance, it has been necessary for the Navy Department to refuse many requests for permission to operate wireless apparatus on account of the danger of ‘jamming the air’ . . .

“Taking a very conservative view of the wireless possibilities . . . it is believed that the benefits derived through its use justify giving it serious consideration.”\textsuperscript{23}

\textbf{Winter 1919–1920—The Portland Tests}

District 6 was allowed to keep its pair of SCR-67-As and the National Wireless Telephones after the 1919 fire season ended. Allen and his team envisioned testing the sets throughout the fall and winter and training additional operators for the coming season.

Plans were made to construct a semi-permanent station at the Forest Service headquarters in the new Portland post office building in hopes that they could maintain direct communications with the summit lookout in coming seasons. While designing the rooftop antenna system, Allen mailed perspective photos to Hanscom for his consideration (Figures 23 and 24).
After first being denied permission to install an antenna on the roof, Allen’s crew was allowed to install the masts on February 15, 1920. Using two 54-foot masts and the building’s flagpole to support it, the crew erected a triangular four-wire center-fed antenna. The Forest Service, operating at the pleasure of the Navy, had first asked to conduct tests at 900 meters, but this request was denied. Consequently, the rooftop antenna was cut to resonate at about 300 meters, but it was designed so that it could be extended if and when permission was granted to test at longer wavelengths. The radio station was installed in the mimeograph room of the Forest Service offices.

Although the Mount Hood lookout would remain inaccessible until the summer due to snow, the foresters installed and used the equipment from various other locations through the winter and spring. In March 1920, Horace G. Whitney, the District 6 chief of maintenance, erected an antenna between two 100-foot bamboo masts at his Portland home and installed one of the BC-13-As in his basement where he made contacts with local amateurs. Whitney used the radiophone to read test messages, but most amateurs were limited to reply by code.

Allen continued directing tests of the National equipment from the post office station. One such test took place on the evening of Saturday April 3, 1920, when John Pearson (7GD) operated the station at the post office. Ralph T. Galyean (7CR) was joined by Austin (7ZI) and other amateurs at his station in Sellwood, a neighborhood of Portland located about 6 miles away (Figure 25). In a typical test, the equipment was operated from 8 p.m. to 11 p.m., alternating the National Wireless Telephone and a BC-13-A with one-minute readings. On average, only one in three words sent over the arc transmitter was understood by the receiving stations. In contrast, text read over the BC-13-A was consistently clear and distinctly audible.
On the evening of Tuesday, April 13, the BC-13-As were tested between the homes of Galyean and John B. Herts (7ZB) eighteen miles away in Vancouver, Washington. Two nights later, Galyean’s signals were picked up at the station of Olfan DeGuire (7CW) in Silverton, Oregon, forty miles to the south using a one-tube regenerative receiver. In early May, one of the BC-13-As was installed at DeGuire’s Silverton station for a week of two-way phone testing. Reportedly, plans were even made to install and test the equipment on a riverboat plying the Willamette and Columbia rivers. Those tests, if any, were not documented.

Allen hoped to interest and employ local amateurs in the coming season to receive and relay wireless telegraph messages from air patrol planes by broadcasting practice code messages from the post office station. He also made plans to start a training school to teach rangers about wireless. Although the antennas had only been in place on the roof of the Post Office for two months, the Forest Service was asked to remove them in early April 1919. The National wireless telephones were boxed and shipped back to San Francisco on April 14.

In Allen’s report back to Hanscom, he said that they had experienced great difficulty controlling the arc, which caused inconsistent results. At times some voice transmissions were received clearly. On the whole though, only about 30% of the words of the test messages were received correctly. Allen suggested that Galyean, an officer of the Northwest Radio Association who helped him conduct the tests, could provide a more complete and detailed report on the tests and the results. In an internal memo, Allen concluded:

"... the principle of the set is wrong as I do not believe that it will be possible to make an electric arc steady enough for voice transmission. Assuming that the arc could be regulated, the quantity of energy required for operation of the set is too great ..."

The Northwestern Radio Association

The Northwestern Radio Association was organized by Portland amateurs in December 1916 under the name Northwestern Audion Association. Membership grew until the stations were closed...
when the United States entered World War I. After the war, the club became the Northwestern Radio Association. Members met on Friday nights at the Oregon Journal newspaper building in downtown Portland. In 1920, Charlie Austin (7ZI) was the President and Chief Inspector responsible for ensuring that members operated their stations within the law. Elmer Berk was the first vice president and chief justice, John N. Hurtt (7JH) was second vice president, Percy W. Dann (7JP), secretary, Ralph Galyean (7CR), treasurer, and B.A. Montgomery, sergeant at arms.

Correspondence continued throughout 1920 and into 1921 as Galyean, Allen, and Hanscom exchanged letters. Galyean and Allen detailed the tests and the results; Hanscom refuted their procedures and placed blame for the failures on issues beyond his control. In the end, the Forest Service did not purchase any of National’s wireless telephones.

The 1920 and 1921 Fire Seasons
The Mount Hood lookout station was reestablished August 15, 1920. Clay and Buford Allen and Austin used pack horses to carry the SCR-67-A as far as Turtle’s Neck, and then packed it the rest of the way themselves (Figure 26). William C. Kelly, a Forest Service lookout, and Alfred T. Maas operated the station. This season a two-cycle gasoline engine was used at the lookout to keep the batteries charged. However, the lookout was only operated on alternate days during the 1920 fire season to save power and fuel.

After radio operations were reestablished at the lookout, Buford Allen stayed behind at the lower reaches of the mountain. Along with John A. Calvary, Allen operated the second BC-13-A from the Summit Ranger Station east of Government Camp, only about 10 miles from the lookout and well within the set’s nominal range (Figure 27). During the 1920 fire season, fires spotted from the lookout were reported by radio to...
the ranger station, and the reports were relayed to the Portland headquarters by telephone. Even though the Forest Service did not push for distance during the 1920 tests, Galyean reported communicating directly with the stations by radio during the summer from his Sellwood station. The Mount Hood lookout was closed for the season in October 1920 and the equipment was removed.

In 1921, the Forest Service established radio-equipped air bases at several Oregon locations and additional patrol planes were equipped with transmitters for spotting and reporting fires. During the patrol season, a station was established at Zigzag for the purposes of receiving reports from the air patrol, which were then relayed by telephone to locations throughout the forest. F. S. Flesher (7NI, later W7ESA) was the assigned operator at Zigzag. Unfortunately, local interference blamed on Portland-area amateurs caused so much frustration that pilots had to rely on the Forest Service air base in Eugene to receive and relay reports by telephone and telegraph. There is no record of the radio being reinstalled at the summit lookout; presumably, fires were reported once again by wired telephone.

**Part 2 The Intermountain Region Tests 1919 Fire Season**

Wireless telegraphy had the potential to do away with the necessity for maintaining forest telephone lines, but for most foresters, sending and receiving code was a barrier. Thus the Forest Service was understandably eager to experiment with the Army’s telephony-capable SCR-67-A radios, which they hoped to use literally as telephones without wires. Ralph B. “Ring Bell” Adams, who was responsible for performing the radio test described in Part II, was the telephone engineer for both District 1 based in Missoula, Montana, and District 4 headquartered in Salt Lake City, Utah. These two districts covered the Intermountain Region of the United States, including the states of Idaho, Montana, Utah, and parts of Wyoming, Nevada, and Arizona. Adams describes how he made arrangements to obtain these sets:

“Early in the winter of 1919 I discussed briefly with the Forester the possibilities of obtaining some of the wireless telephone equipment which had been manufactured for other government departments during the war. The Forester called me to Washington, where I was able to get in touch with offices of the Signal...”
Corps and the Navy Department and through the courtesy of the United States Signal Corps, I was able to borrow four wireless telephone sets for experimental use. Two of these I shipped to the telephone engineer of District 6, and two I sent to Missoula. This was done with the idea of testing out this equipment under two entirely different conditions.”

Adams, former superintendent of construction for the Intermountain Telegraph Co., and H. Everett Cutting (7LY), builder and operator of the Beaver Ridge station, installed and tested a pair of SCR-67-As along the Montana/Idaho border in July 1919. Cutting, who held amateur licenses (7HC, 7LY), an experimental license (7XL), and a commercial broadcasting license (KFDO), brought his radio experience into the test program. In the teens Cutting studied electrical engineering at Montana State College in Bozeman and was teaching wireless telegraphy there at the time of the 1919 tests. In the 1930s he was licensed as W7EXG and working as the chief technician at KVI in Tacoma, Washington.

One radio was set up first at the Mud Creek Ranger Station about 30 miles west of Missoula in Montana’s Lolo National Forest (Figures 28 and 29). Cutting packed the other set on horseback to the Beaver Ridge fire lookout in Idaho about 13 miles away. Vic Miller helped install the 100-foot high antennas. The Bitterroot Divide, a 9,000-foot high ridge, separated the two

Fig. 28. R. B. Adams shown July 15, 1919 with a BC-13A at the Mud Creek Ranger Station in the Lolo National Forest, Montana. (U.S. Forest Service Photo 45520-A; courtesy of National Archives Online Public Access)

Fig. 29. A second view of R.B. Adams at Mud Creek with the power panel showing at left. (U.S. Forest Service photo; courtesy Bud Moore Papers, University of Montana)
Cutting’s pack train left Mud Creek on July 8 but the radio batteries were lost along the way when the horses repeatedly fell. Replacement batteries arrived at Beaver Ridge on July 14 and communications were established on the morning of July 15. R. B. Adams described the accident:

“One pack horse (the last one) started pulling back. She kept pulling until she pulled the rest of the horses over and all rolled down the mountain about 100 feet to where a tree stopped them. Finally righted them again and started up. In a short time the horse repeated the performance, and this roll completely put the storage batteries out of service, the electrolyte having completely run out.”

In late August 1919, a forest fire threatened the Beaver Ridge lookout. Before fleeing to a nearby lake for protection, the operator disconnected the BC-13-A and took it with him. Upon arriving at the lake the operator loaded the radio on a raft and paddled out from shore. When the danger had passed, the set was returned to the lookout and put back into operation. The fire had destroyed the telephone lines in the area and they were not rebuilt for several days. Adams seized on this dramatic story and mentioned it frequently when describing the successes of the Montana tests.

Among the several locations Adams used for testing was the Bitterroot Valley ranch of Ashley C. Dixon (Figure 30). According to Dixon’s 1948 autobiography, the Forest Service tests at his home inspired him and his son, Ashley Jr. (Figure 31), to begin studying radio. Dixon (7ACP) and his son (7IT) held amateur, experimental (7XAF), and broadcast licenses. On September 23, 1923, Dixon’s station KFJR began broadcasting two nights a week.
Mount Hood Calling

on 1160 kHz using a transmitter assembled from RCA parts. Dixon explained his methods in his article “How to Build a Good Low-Power Transmitter” which appeared in the July 1924 issue of Radio Broadcast. Dixon brought the station to Portland in 1925, where it was installed for a time at his Eastmoreland home. (Later, professional studios were constructed in an office building downtown and the transmitter was moved to a local mountaintop). Although the KFJR call sign is no longer active, its successor station (KKPZ, 1330 kHz) is still on the air in Portland.

The Montana field tests ran for about six weeks from mid-July through late August 1919. Adams appeared at the Montana State Fair in Helena during the week of September 8 demonstrating the SCR-67-As and publicizing their achievements (Figure 32). Fairgoers listened in as messages were exchanged between the two sets and a third unit exhibited by another branch of the U.S. Government. The sets were exhibited again a month later at the Utah State Fair in Salt Lake City October 6–11. Following the Utah fair, Adams installed them temporarily at the Forest Service building in Ogden.

The Montana tests were intended to evaluate the effectiveness of the SCR-67-A sets when they were separated...
by mountains and operated in areas with significant metallic mineral deposits. Although the SCR-67-As proved successful over short distances, Adams ultimately concluded that they were underpowered for his needs, and that wired telephones would be cheaper and easier for short distance communication.

The Power Problem

Clay Adams recognized the power problem from the outset:

“Am not sure yet about getting a gasoline engine and generator to the top but am very much in hopes. Last 1,000 ft. up is 80% grade—about 150’—right up the glacier . . .”

Whether in the mountains, woods, or other locations without available power, batteries proved to be one of the biggest challenges to using the BC-13-As for forest work. Power at the Mount Hood lookout was provided by a combination of storage batteries and a hand-cranked dynamotor. And packing heavy replacement batteries up the mountain was a real problem. Various alternatives were considered with a wind charger seeming to have the most promise for the wind-whipped summit. To that end, Allen reached out to the Aeromotor Company for a solution, but nothing panned out. For areas that were accessible by horse, Adams requested some gasoline-powered charging plants weighing 115 pounds each. Of course those were heavy to pack and required supplies of fuel (Figure 33).

In Montana, the power consumed by the dynamotor was also an issue. S. R. Winters described a solution to the vexatious power problem:

“Temporarily, the Forest Service solved the problem by using 270 No. 2 Burgess dry cells, connecting these in series and using them on the plate circuits. By this makeshift arrangement, the motor generator was eliminated and the storage battery employed in heating filaments only. The discharge from the storage batteries was decreased from 12 to 3.6 amperes. Likewise by the use of dry batteries the transmission values on the wireless equipment were enhanced 25 percent. The No. 2 dry batteries were in use for four weeks, or until the radio equipment was dismantled for the summer, at which time they

![Fig. 33. Radio batteries being recharged at a portable gasoline-powered charging plant. (The Southern Lumberman, Dec. 23, 1922 p. 155)](image)
evidenced a slight deterioration. Storage-battery ‘deaths’ at Beaver Ridge were averted by providing a bank of 48 super-six Burgess dry batteries. These were connected in series parallel, in six different banks of eight, which were used to heat the filaments or drive the motor generator, in the event of an accident, to the storage or high-voltage battery.”

Harry Kylie and the Denver Trials

Following the 1919 fire season, Harry R. Kylie, the telephone engineer at the Forest Service’s Denver office, also ran radiophone trials utilizing a BC-13-A with the output boosted by an amplifier of his own design (Figure 34). One demonstration took place on the evening of February 18, 1920, when more than a dozen musical selections ranging from jazz to classical were broadcast. Stations from as far away as Colorado Springs reported listening to the concert. Following the concert, Kylie used a second BC-13-A to conduct distance trials, moving it from place to place by truck to test the signal strength from the Federal Building base station.

Winter 1919-1920—The SE-1370 and SE-1414 Navy Sets

Adams returned to Washington D.C. in December 1919, and based on the successes of the tests that summer, requested the loan of 24 additional radiophones from the Signal Corps for the 1920 fire season with plans to distribute them throughout the region. The Signal Corps denied his request but the Navy provided Adams with five SE-1370 transmitters and five SE-1414 receivers that were modified by General Electric for 800-1000 meter use. However, the Navy sets were not used until the end of the year. The chief problem proved to be the improper wiring of the SE sets. Pressed for time, Adams was unable to identify the cause of the problem until the fire season was well underway.

General Electric designed and manufactured the SE-1370 transmitter (Figures 35 and 36). The companion SE-1414 receiver (Figures 37 and 38) was designed at the Washington Navy Yard’s Radio Test Shop and was manufactured by Westinghouse Electric and Manufacturing Company. Both sets were intended for use on the Navy’s World War I era flying boats, but their designs also made them useful as field radios.

Fig. 34. William P “Paul” Pagett broadcasts using a BC-13-A at the Forest Service’s Denver office. The output is boosted by an amplifier designed by Harry Kylie, the district Telephone Engineer (inset). (Rocky Mountain (Denver) News, February 2, 1920, p. 8)
The SE-1370 was a two-tube transmitter capable of about 100 watts output (telegraph mode) and 50 watts output (telephone mode). Like the SCR-67-As, the transmitter ran on batteries but also required an outboard dynamotor.

Fig. 35. The SE-1370 transmitter measures 15” high and wide by 8.25” deep and weighs 17.6 pounds. The external dynamotor adds another 17 pounds. (Proc. of the IRE, April 1920, p. 95)

Fig. 36. Interior view of the SE-1370 transmitter showing the two fifty-watt CG-1144 (VT-18) tubes, one for the oscillator and one for the modulator. (Proceedings of the IRE, April 1920, p. 95)

Fig. 37. Front view of the SE-1414. The cabinet measures 11” wide by 10” high by 5.13” deep and the receiver weighs 10.75 pounds. The entire receiver hangs from the unusual rubber suspension shown on the sides of the cabinet. (Proceedings of the IRE, April, 1920 p.116)

Fig. 38. Interior view of the three-tube SE-1414 receiver, which used Moorehead type SE-1444 tubes. (Proceedings of the IRE, April, 1920 p.116)
The 1920 Tests
Since Adams needed time to resolve the technical issues with the Navy sets, he used the SCR-67-As he had borrowed in 1919 to establish stations for the 1920 fire season in the Payette National Forest near the Oregon border. In late July, one station was set up at National Forest headquarters in McCall, Idaho, and the other was packed to Thunder Mountain about forty miles east. The radiophones provided a key link from the Thunder Mountain lookout, which looked out over 1.2 million acres of virgin timber, to McCall from which firefighting resources could be dispatched. Despite the BC-13-A's low power and minimal range, conversations were picked up 100 miles away in Kuna, Idaho, southwest of Boise. The set on Thunder Mountain took a beating while being transported and needed repairs by the end of the summer. Following the fire season, Adams had the station from McCall relocated to Salt Lake City, and the station from Thunder Mountain was repaired and returned to the Forest Service building in Ogden.

Adams made several wireless demonstrations for students and various civilian leaders over the winter of 1920-1921 in Utah and Nevada that received positive reviews. At different times, two-way communications were established between the airmail field at Salt Lake City and Ogden, a distance of 35 miles, and between Salt Lake City and Elko, Nevada, a distance of 200 miles. Setting up the demonstrations also provided the opportunity to address the issues with the Navy equipment and prepare for the 1921 summer fire season.

The 1921 Idaho Tests
During the 1921 fire season, the Navy sets used in the forests of Idaho handled 200 official messages during 6–8 weeks of operation. Stations began service July 15 at Moore’s Ranger Station (on Buffalo Hump) in the Nez Perce National Forest (Figure 39), and at Warren, Idaho, 35 miles away. A station was also established briefly at Edwardsburg, Idaho, but was put out of commission due to equipment mishaps. Mr. Ira Kaar (6ZA) assisted Adams with building the stations. The more powerful sets “made it possible to maintain regular communication 205 miles overland by telephone . . .” and sometimes up to 450 miles.

At the end of the fire season, one of the radiophones was loaned to the Boise High School Radio Club (7YA/7XT), and the students used it to converse with Nampa, Idaho, 20 miles away. The students also reported receiving broadcasts from cities across the west, including Denver, Sacramento, and from the National Radio Company station 6XO at the Fairmount Hotel in San Francisco.

In 1921 the more powerful Navy equipment gave impressive and encouraging fire reporting results. However, these achievements were not given much value, as they were perceived as merely an extension of the forest wireless tests. Adams was still relying on borrowed equipment, and the upper management of the Forest Service made
no long-term commitment to the program. Every year the very existence of the wireless and air patrol programs were at the mercy of budgets and appropriations.

Conclusions

After three seasons, the formal wireless tests and regular forest air patrols were discontinued. Reasons cited were technology issues, costs, and other challenges. However, the Western Forest Wireless Tests did answer several questions for the foresters. They clearly showed that radio would work in mineral zones and at high altitudes. They also showed that radio could penetrate heavily forested areas. Although the wireless sets were not tethered by expensive wire lines like telephones, they were not exactly “portable” either—essentially requiring a mule train or truck to carry the radios, batteries, and the accessories. The foresters embraced the concept of wireless telephone communications, but freely admitted that the technology was still not practical for their use in the forest.

Gary Craven Gray, who wrote the classic, Radio for the Fireline, published by the Forest Service in 1982 summed it up this way:

“The main lesson learned by the Washington office during the 1919, 1920, and 1921 fire seasons was that radio as a communications tool was expensive—at least on the limited Forest Service budget. . . . Similarly, radio air patrols were of no benefit if, after 3 years, they were not found to produce results in first discoveries of fire great enough to justify the burden of keeping it up.”

By the 1922 Oregon fire season, the use of radio and routine airplane fire patrols were abandoned. According to Gray, “Instead, special flights were made during periods of high fire hazard.
State and Forest Service observers rode in planes, obtained firsthand knowledge of the fires, and made direct reports after landing.57

Today we know that a few more years both radio and airplane technology development would allow these tools to realize their potential to manage forest resources.

Epilog
In a July 1921 letter to one of National’s shareholders, Hanscom continued to assert that the company’s arc wireless telephone could have performed reliably in a commercial setting. And he continued to blame the failure of the Portland tests on inexperienced operators who did not operate the set according to his instructions. But, tellingly, he concluded the letter by acknowledging that tube transmitters held the most promise for the future.

“I have had a chance to gain considerable information during the past year which has been released from war work, and to hear the results obtained by experimenters working with the tubes now available for radio telephony and telegraphy, and I have come to the conclusion that the NR [National Radio] apparatus will have a very difficult time to make any headway in competition with them.”58

Notes
4. In addition to the ground tests described in this article, the use of aircraft for forest fire patrols necessitated the development of airbases across the west and the installation of many receiving and transmitting stations. A future article is planned that will tell that fascinating story.
5. Major Arnold went on to enjoy a storied career as a military aviator and leader.
6. After his death in California at age 88, Lige Coalman’s ashes were returned to Mount Hood. The Coalman Glacier, just below the summit on the southerly climbing route, was named in his honor. A veteran of hundreds of ascents, Coalman’s exploits are legendary. For more information on Lige Coalman and the history of the Mount Hood lookout see the list of additional sources.
9. Permission to operate these sets was required by the U.S. Navy even though they were manufactured for the U.S. Army Signal Corps. As Michale Marinaro explains in his recent AWA Journal article, the Navy had been placed in charge of all U.S. radio licensing and regulation at the time. This authority lasted through World War I and beyond. On September 26, 1919, authority shifted back to the Department of Commerce - Bureau of Navigation. Michael W. Marinaro, “Tracing the Birth of RCA,” The AWA Journal, January 2016, pp. 45–48.
12. Ibid.
14. (Oregon Dept of Forestry) p. 36.
16. Gordon Greb and Mike Adams, Charles

17. In responding to the disappointing reception reports for the National Radiophone, Hanscom said that the antenna at Charlie Austin’s house was too long and was mismatched to the operating wavelength of the transmitter. Ironically, Hanscom later asserted that his transmitter performed better at longer wavelengths. (W. W. Hanscom letter to C. M. Allen Nov 18, 1919). In subsequent correspondence, the Forest Service replied that the National Radiophones were impractical for their needs because they required antennas that were too long to deploy practically in the forest. (A. O. Waha, Asst. District Forester, USFS District 6 by Shirley Buck (acting) letter to James H. Boyer, Attorney for National Radio, June, 1920). (Letters courtesy of History San Jose).


20. Ibid.


22. (Oregon Dept of Forestry) p. 28.

23. Ibid., p. 73.


33. “Wireless Station in Operation,” The Oregonian, July 1, 1921, p. 11.

34. “Flesher is at Forest Station,” QST, Sept. 1921, p. 39.


36. The lookout cabin at the summit of Mount Hood continued to be staffed during fire season for many years. Finally abandoned at the end of the 1933, the lookout fell into disrepair and tumbled over a cliff in the early 1940’s.


40. Versions of the story were also retold in contemporary children’s fiction such as “The Radio Boys with the Forest Rangers” by Allen Chapman.


47. No rent was charged. However, the Navy asked Adams to report the results of his testing.


50. (R. B. Adams) p. 5.

51. R. T. Galyean, “The Operating Department—Northwestern Division,” QST, Oct., 1921, p. 40. Ira Johnston Kaar (b. 1902) was licensed as 6ZA in 1919. In the next few years, he
Mount Hood Calling

built several broadcast stations in Salt Lake City: KFOO—Latter Day Saints University, KDYL (KFNZ)—Salt Lake Telegram, KFUT (KUTE)—University of Utah. In the mid-1920s he began a 31-year career at General Electric during which time he was granted several patents for radio technology. Later he was Engineering Director and Vice President at Hoffman Electronics in Los Angeles.

52. “100-Watt Radiophone Works 450 Miles in Daylight,” The Wireless Age, June, 1921, p. 12.
53. The Boise High School Radio club was initially licensed only to perform amateur and experimental communications. Harry E. Redeker, the school’s chemistry teacher, was granted a commercial broadcasting license (KFAU) in 1922. Using a home-built 2-kW transmitter and a De Forest unit panel receiver, the club produced radio broadcasts several nights a week that were received coast-to-coast. Redeker moved on in 1927. In 1928, the Boise school district sold KFAU and the call letters were changed to KIDO. Today, KIDO is generally acknowledged to be Boise’s first broadcast station.

56. Ibid., p. 29.
57. Ibid., p. 23.

About the Author
Dan Howard lives just outside of Portland, Oregon.

Today, few Oregonians realize that there was ever a lookout cabin on top of Mount Hood. And the story of the wireless tests has been all but lost. Researching this story has not only given me the chance to learn and share a little about local history, but also to draw together several different story lines from Oregon’s radio past.

My interests in ham radio and radio collecting date from the 1970s. I became interested in the history of Forest Service radios about ten years ago after realizing that many were manufactured here in Oregon. In fact, the Forest Service Radio Lab was located in Portland until the 1950s.

The accompanying photograph shows the Mount Hood summit as seen from Timberline Lodge in late October. Not far from here, in 1919, Camp Blossom was used as a staging area as the radios were being packed to the summit. As you can see, 2015 was a very dry year. In contrast, the foresters were fighting summer snow and ice storms as they sought to put the lookout on the air.

Thanks to my family for their assistance (and indulgence) with this project.

Dan Howard
Abstract

Born at the dawn of wireless communication, Arthur H. Lynch would become one of radio’s leading advocates. His interest in radio started as a child after he constructed his first crystal radio. It grew into a fascination that would remain with him for life. Arthur was one of those blessed individuals who turned their passion into a successful career. He was a wireless pioneer who explored all facets of this emerging field. He worked as a wireless operator on merchant ships, served America in two world wars, and was a prominent magazine editor and author for Radio News and Radio Broadcast magazines. Using his pen name A. Henry, he wrote a series of articles detailing real life experiences that provided insight into what it was like to be a wireless operator at sea before World War I. As an amateur radio operator, he pioneered the five-meter band and conducted the first two-way amateur television contacts at the 1939–1940 World’s Fair. Arthur managed his own business, Arthur H. Lynch, Inc., a radio parts manufacturing company that supplied parts to early radio enthusiasts and the amateur radio community. However, his most important contribution to communications was through his writing. His young audience became the generation that pushed communications to the next level, ushering in the age of computers and the exploration of space.

Gates Avenue Home

Arthur Lynch was born on July 2, 1894 in a row house on Gates Avenue in Brooklyn, New York at the close of the Gilded Age.1 His father was Thomas Emmet Lynch, his mother was Catherine O’Conner Lynch, and he was the oldest of five children. Arthur had one brother, Emmet, and three sisters, Marie, Helen and Kathleen. Two years separated Arthur and Emmet, and there was a ten-year difference in age between Arthur and his youngest sister, Kathleen, who was born in 1904.2 Catherine’s father, Michael O’Conner, who lived nearby in Richmond Hill, had a successful business trading horses, which during the 1890s was still the primary means of transportation.3

During a visit to Jamaica Long Island, which Arthur referred to as “the town where my childhood was spent,” Arthur and his father happened upon a kite-flying contest. The contest sparked his interest in kites, and he and
his father built them in the basement of their home. Arthur found enjoyment in building and flying kites, and he put them to good use after he became interested in amateur radio by using one to suspend an antenna at his home.\textsuperscript{4}

Exactly how and when radio entered Arthur’s life is not known. He could have been introduced to radio by reading, schoolmates or perhaps friends. We do know that Arthur had a younger friend, Alfred H. Grebe, who was deeply interested in the wonders of radio. Arthur spent a great deal time at the Grebe home building crystal sets in a backyard toolshed. An article in the \textit{Daily Eagle} mentioned their relationship: “When he and Alfred H. Grebe, who also became a radio manufacturer, were schoolboys they experimented with wireless telegraphy, making their own sending and receiving sets. They learned the code and obtained ship operators’ licenses.”\textsuperscript{5}

There is another reference in Alan Douglas’ book, \textit{Radio Manufacturers of the 1920’s}, to Arthur Lynch and A. H. Grebe: “While he [Grebe] was away, his younger friends Ralph Sayres and Arthur Lynch ran the ‘ham station and crystal detector factory.’”\textsuperscript{6} Several references agree with the Douglas account in which Grebe and Lynch made early Grebe products together at the Grebe home. However, this account is not completely correct since it portrays a younger Arthur remaining behind to take care of Grebe’s affairs while Grebe was absent at sea. In fact, both Grebe and Arthur were both shipboard wireless operators, and Arthur was almost a year older than Alfred Grebe, who was born on April 14, 1895.\textsuperscript{7}

Written accounts claim that Arthur Lynch was an amateur radio operator as early as 1908, but a review of call books and other amateur radio licensing documents fails to show that anyone by the name of Arthur Lynch was assigned a license in District 2, which encompassed his home state of New York. Since a government license was not required to operate as an amateur until 1912, it is possible that he stopped operating for a long period of time after the license requirement went into effect (Fig. 1). A second possibility is that he operated from another licensed operator’s station, perhaps that of A. H. Grebe, who was licensed.

Little is known about Arthur’s education beyond the fact that he attended prep school in 1910 at Brooklyn College, a Catholic school for men, and that he was a member of St. Ignatius Church.\textsuperscript{8} The 1940 U.S. Census shows that the highest grade Arthur completed was his second year of high school. Arthur was a good student, but his grades began

![Fig. 1. Young Arthur Lynch operating his home wireless station in 1912. (Short Wave Craft, August 1933, p. 249)](image-url)
to suffer once he got an itch to see the world. He devoted more and more time reading about travel, and as a result he neglected his studies. He wanted to quit school, but did not quite know how to obtain the necessary permission from his parents. He found an opportunity after his mother lost the money she had inherited from her father as a result of some bad housing investments. Catherine had purchased a row of houses, which she was forced to sell at auction. With the family finances in disarray, Arthur was able to convince his parents that he should quit school and get a job to help support the family.\(^9\)

It took only one day for Arthur to find employment because businesses were staffing up for the holiday season. He took a job at a large department store where he received a salary of five dollars a week. After a few days of training he was assigned to the book department where he checked receipts and wrapped packages. After paying for transportation and lunch, Arthur discovered that he was clearing only a dollar and forty cents a week. The combination of poor pay and the store’s requirement that Arthur work late without compensation caused him to rebel, and he was fired after only two weeks on the job. He found a second job at another department store as a stock boy, and was paid seven dollars a week plus an additional 50 cents for dinner money when he worked evenings. Once the holidays had passed, Arthur had expected to be laid off, but instead he was kept on. However, there was a problem. Arthur wanted for more—he still wanted to see the world but had no funds to do so.\(^10\)

Arthur decided that the best way for him to travel was to become a shipboard wireless operator. He had been an amateur radio operator for a few years and had taught himself how to send code using a practice set he made from an old car horn, batteries and a Morse key. His parents approved of him going to the radio school run by Marconi, but the school rejected him because he was too young. Arthur was persistent and did not take no for an answer. In time, the school allowed him to take an entrance examination, after which he enrolled. It only took Arthur ten days to complete his training, and he was then offered his first assignment as the wireless operator of the Standard Oil Company sea-going tug, Astral (Fig. 2).\(^11\)

Arthur’s parents were not keen on seeing him leave home, and were even less so on seeing him going to sea. His father, whom Arthur liked to call “The Governor,” had assumed incorrectly that his son was going to be sailing on a steamer. Arthur never told him otherwise. He did tell them that his berth was beside the captain’s quarters and that he was going to be Chief Operator—but

\(\text{Fig. 2. The Standard Oil Tug Astral. (Radio Broadcast, April 1923, p. 479)}\)
failed to tell him that he was also the only wireless operator. Thomas Lynch accompanied his son on the trip to Communipaw, New Jersey, located near Jersey City where the Astral was taking on coal. They had some difficulty finding the tug in the cold February night but they did find her before her midnight departure. Thomas boarded the Astral with Arthur and was able to see the radio room and the berthing arrangements before departing. The mooring lines were soon removed from the Astral, and Arthur’s quest for adventure began.

Arthur’s First Voyage

Now 18 years old, Arthur had learned the skills needed to be a wireless operator. Not only did operators have to send and receive messages via code, they also had to operate, repair, and in some cases, install communication equipment and antennas. While Arthur had been educated, school does not prepare one for all aspects of the job. He had not been tested to see if he had the personality and temperament to live at sea, to endure the harsh elements, and to cope with his first separation from his family.

The tugboat Astral was a sea-going vessel that was used to tow barges along the East Coast and the Gulf of Mexico. The captain was a good-natured man who gave Arthur the nickname “Sparks.” Arthur described the crew as, “Norwegians and Danes and Englishmen and Skyhoovians who made up our crew.” The term Skyhoovian was probably interchangeable with Scandihoovian, a slang term used to express contempt towards people of Scandinavian origin. The crew was a rough bunch that liked to harass young Arthur. During one hazing episode, Arthur was hoisted nearly ninety feet up the mast in a Boatswain’s chair to watch for the Diamond Shoals Lighthouse. Young Arthur willingly participated in the hazing, and before the excursion was over he found himself hanging in the heavy black smoke from the stacks that covered him in black soot.\(^\text{13}\)

After leaving the coaling pier in New Jersey, the Astral picked up a barge off Staten Island and then traveled south with the barge along the east coast. She made an overnight stop in Wilmington, North Carolina, and then continued to tow the barge south towards her final destination, but she never arrived. Young Arthur’s first adventure as a wireless operator ended tragically when the Astral ran aground during the night on a Florida beach within sight of the Jupiter Inlet Lighthouse. The Astral broke her rudder during the grounding and the waves were driving the hull “against the bottom with a sickening thud.”\(^\text{14}\) The barge in tow nearly hit the Astral but instead it grounded.

Arthur tried to establish communications with the grounded barge but he could not contact it by radio. His next option was to use a flashing light, but unfortunately all of the flashlights were being used in the damage control efforts, so Arthur rigged up a switch to signal using the masthead light. This worked, although it turned
out that the barge could receive radio signals but could not transmit them. There was also trouble in establishing communications with the Jupiter Inlet Naval Radio Station, or anyone else, for that matter. Arthur continued to send out his SOS messages for almost four hours with no reply. The Naval Radio Station had received the Astral’s SOS but was unable to respond due to power generator failure. The Revenue Cutter Yamacraw was dispatched to the grounding and stood by until morning light, when it successfully towed both the Astral and the barge off the beach, and then to Jacksonville, Florida for repairs. Once the Astral was placed into dry dock it was determined that the damage was extensive, so Arthur was released from his position and headed back home to New York without a job.15

The story of the grounding of the Astral was brought to my attention by Arthur’s Niece, Virginia Duffy, and nephew, Gaylord Worstell, who recalled, “As a teenager before World War I, he was a wireless operator on an ESSO tug that was battered in a hurricane and washed ashore in Jupiter, Florida.”16 The accounts differ in that the family said the Astral grounded due to weather, but Arthur’s written account made no reference to bad weather on the night of the grounding.

**Operating as a Career**

Even after experiencing seasickness, bed bugs, hazing and the grounding of his vessel, Arthur was not deterred from continuing in his pursuit of adventure on the high seas.17 His follow-on assignment as a junior operator was aboard a Clyde Line passenger steamer that operated between New York and Jacksonville, Florida. Arthur did not make a good impression on the captain of the steamer because he fraternized with the female passengers, had no uniform and was not professional. One of the altercations he had with the captain involved a party with passengers in the radio shack. Their singing had awaked the captain, who told Arthur that he was a young fool, a pest and an insubordinate jackass—behavior that is not unusual for an eighteen year old. Upon returning to New York, Arthur was surprised that his supervisor turned in a good report except for mentioning the lack of a uniform. Arthur made two other trips on the Clyde Line steamer before he was reassigned.18

One of the greatest sins a sailor can commit at sea is falling asleep on watch. There are two accounts of Arthur doing just that, and in both cases it was deliberate. One incident was on the passenger steamer Carlos. Arthur relieved the senior wireless operator at 1:00 AM, and after doing some chores he decided that the Carlos was safe because she was at anchor off San Juan. Even though the law requires a wireless operator to always be on duty on a passenger ship with fifty or more passengers, Arthur disregarded the law and went to bed. When his alarm clock went off, Arthur thought it was a ship alarm and that the Carlos had been hit by another ship or some other calamity. He knew he was negligent and later wrote, “I saw my boyhood and the succeeding years,
Remembering Uncle Arthur

some of my pleasant moments and all my faults. And here was the end—on a sinking vessel—a disgrace to my family and myself.” Arthur grew up that day and finally understood the huge responsibility that came with his position as wireless operator. The lives of the passengers and crew could be at risk if he failed to stand his watch properly. He never slept on watch again.19

Assignments were rather short and Arthur served on a wide range of boats and ships. One assignment put him on the American Yacht Wakiva I that was anchored in the Pánuco River as a communication station just a short distance from Tampico, Mexico. Due to poor relations between the United States and Mexico at the time, the Mexican government would not allow the construction of a shore station. The solution was a floating communication station, and the task was to construct a radio shack on the Wakiva and install the two-kilowatt transmitter, receiver and other equipment. A telephone line was then connected between the yacht and the shore. The setup provided communication between an office for an oil company and the shipping they controlled. This arrangement worked well, and Arthur used it to check in with oil steamers as they arrived in port. He also assisted the American Consul in Tampico by relaying messages to the battleship USS Connecticut, which was anchored at the mouth of the Pánuco River to protect American interests.20

Using the pen name A. Henry, Arthur wrote about how glamorous life can be for a wireless operator in his article “A Millionaire’s Cruise on an Operator’s Pay,” which appeared in the July 1923 issue of Radio Broadcast. He gets a cherry assignment, and departs New York in February 1914 for the warmth of Key West, Florida where he boards the Yacht Catania, which was owned by the Duke and Duchess of Sutherland. They had chartered the yacht to Count and Countess Széchenyi. During Arthur’s time on the Catania, it visited Grenada, Trinidad, Curacao, Martinique, Saint Lucia, Saint Vincent, Saint Kitts, Venezuela, Haiti, Jamaica, Cuba, and Panama. Arthur had dreamed of a trip like this since high school. It was no wonder that he considered his time on the Catania a millionaire’s cruise. His good assignments continued, and on June 8, 1914, he found himself on the Allianca, which made history when she became the first ocean liner to pass through the Gatun Locks of the Panama Canal.21

By August of 1914, Arthur was a crewmember of the S.S. Atlantic City, operating her half-kilowatt transmitter, and by September 1914 he moved to the Wakiva II, which was heading for Europe.22 Somewhere in this timeline, Arthur served as a junior operator with fellow New Yorker, Elmo N. Pickerill, on the Ward Line steamship Havana.23 Pickerill secured his place in communications history when he established the first successful airplane-to-ground radio communication on August 4, 1910.24 The last two records associating Arthur to ships was his rotation to a new boat, the Hawick Hall, in January.
1915, and his transfer to the Brazos to relieve Sam Schneider as the senior operator in July of the same year.\textsuperscript{25}

Arthur grew up quickly due to circumstances in the home. He was earning a good wage, which may have been magnified in importance by the fact that Arthur’s father was not carrying his own weight. With money tight and her son risking his life pursuing a dangerous career at sea to support the family, Catherine asked her husband, Thomas, to leave. Arthur Lynch’s niece, Virginia Duffy, said, “I guess it was felt that his father didn’t contribute much financially to the household, so he was asked to move out.”\textsuperscript{26} With Thomas gone, life did not improve for the Lynch family. Tragically, Catherine became sick with tuberculosis and passed away in 1914. Fortunately for Arthur and the children, their mother’s brother Charles and her sister Mary came to their rescue.

\textbf{118 St. James Place}

With the passing of Catherine, Uncle Charlie O’Conner and his sister Mary O’Conner welcomed the younger Lynch children into their home and accepted the challenge of raising them. Uncle Charlie and his sister Aunt Mary shared the house at 118 St. James Place before the Lynch children arrived.\textsuperscript{27} Uncle Charlie was a kind and good man who provided a strong male role model for Arthur and Emmet. The O’Conner home was large, with a street-level basement and three additional stories. To assist in caring for the home they employed a young Irish maid named Nellie. During the period that Arthur lived there, the brick faced row house had wide striped window and door awnings that appear to have been made of canvas.\textsuperscript{28} The St. James Place home still stands today, located in Brooklyn within walking distance of Fort Greene Park (Fig. 3).

Uncle Charlie was employed by the railroad and made a good wage. Like his sisters, Mary and Catherine,
he had received an inheritance, which helped him to purchase 118 St. James Place. At some point the money ran out, and there was not much money left for extras. Arthur’s niece, Virginia Duffy, recalled hearing her mother saying that Mary and Catherine “were glad when the money was finally gone.”

While living at St. James Place, Arthur continued to work as a shipboard wireless operator. As mentioned earlier, he was transferred in July to the steamship *Brazos* owned by the Mallory and Clyde Steamship Lines (Fig. 4). What Arthur did after he completed his tour on the *Brazos* remains a mystery. He may have remained a wireless operator until America entered World War I, but no record or notice reporting his transfer from the *Brazos* to any other vessel has been found. Did Arthur get his fill of adventure, did he get assigned to a radio shore station, or did he decide to help his friend Alfred H. Grebe grow his business? Whatever he did, it almost certainly involved radio.

Charlie and Mary remained single throughout their lives, and to the end of their days they remained close to the children. The O’Conners sacrificed much to help their sister and her children, something Arthur never forgot. In their later years, Arthur provided the O’Conners with an apartment, and he looked out for them as they had done for him. He also provided for his father Thomas, and paid for his expenses when he was placed in a nursing home. Whatever Arthur’s faults were, a lack of generosity was not one of them.

**World War I**

Life at 118 St. James Place quickly changed after the United States entered the conflict in Europe in 1917. Uncle Charlie, Arthur, and Emmet all served
during World War I. Arthur was drafted in August 1917, Uncle Charlie volunteered, and the family was not sure if Emmet was drafted or decided to volunteer after Arthur was drafted. Uncle Charlie said that he joined the army in order to go to Europe so he could “watch over the boys.” Unfortunately, they were separated during the war, and the closest Uncle Charlie got to watching over them was to carry a small gold watch fob that contained a picture of Arthur and Emmet. All three had joined the Army and found themselves in France as part of the American Expeditionary Forces. Charlie was commissioned as a captain, and was stationed in Paris where he served in the Army Air Service (Fig. 5). As for Emmet, the family remembers that he was in the infantry and fought in the trenches in France. Most of the details about their activities during the Great War have been lost. A request for a copy of Arthur Lynch’s service record elicited this response from the National Archives: “The record needed to answer your inquiry is not in our files. If the record were here on July 12, 1973, it would have been in an area that suffered the most damage in the fire on that date and may have been destroyed. The fire destroyed the major portion of the records of Army personnel for the period 1912 through 1959.”

Due to the fire at the archives, all that remains is oral history from the family, Arthur's Final Pay Voucher from the army, an

Fig. 5. The World War I army identification card of Captain Charles O'Conner. (Lynch Collection of Virginia Duffy)
Remembering Uncle Arthur

index card from the U.S. Veterans Bureau and a few newspaper articles.

A letter from Corporal Arthur H. Lynch of the 501st Engineers to *The Brooklyn Daily Eagle* read more like a recruitment aid than a news letter providing information on events in Europe. Arthur tells the readers how well everyone is getting along in Europe. Lynch writes, “Everything possible is being done to make our stay over here just as pleasant as possible. We have a comfortable place to live in, plenty of good clothes, bedding and that all-important requisite—plenty of good, substantial food.” The title of the piece and the comments added by *The Brooklyn Daily Eagle* confirms that Arthur was drafted, but he did volunteer to go to France while at Camp Upton.35

Arthur's final pay voucher provided his Army Serial Number 189429. He left England with other members of the 332 Aero Squadron on December 14, 1918 and arrived in the United States on December 23, 1918. He was discharged from the army with a payment of $3417.58 in cash on January 10, 1919. Also provided with the pay voucher was a copy of an index card that indicated Arthur's address was 17 Demson Street, Garden City, N.Y. The card shows an enlistment date 9/29/17 and a discharge date of 1/10/19. It also shows Arthur as a sergeant with Company D 501 Engineers. The index card from the U.S. Veterans Bureau listed Arthur’s unit as Company D 501 Engineers, which does not match the unit name on his pay voucher. All other information on the documents was consistent. The index card provided Arthur’s middle name, which even his family could not recall.36

An obituary in the *Proceedings of the Radio Club of America* mentions that Arthur had been an instructor in the Army Officers Training Facility in Tours, France. There is also an account in the *Brooklyn Eagle* stating not only that Arthur was an instructor at the U.S. Army Radio School located in France, but also that he was an aviator operating out of Tours, and that he had been shot down but suffered no injuries.37 According to family history, Arthur flew a biplane when his commander asked for a volunteer. Arthur had little or no experience and crashed upon landing. His injuries left him with one leg longer than the other, causing him to forever have a slight limp.38 Although these stories are somewhat inconsistent, they all have a common theme, namely that Arthur was involved with aviation during World War One. Tours, France was home to the Tours Aerodrome and the Second Air Instructional Center, also known as the 2nd AIC. The 2nd AIC formed specialty schools in aerial gunnery, photography, aero observation, and radio. The radio school was established during the summer of 1918.

Welcome Home

After the First World War ended, Uncle Charlie, Emmet, and Arthur returned home, and all three remained close throughout their lives. Major changes took place in Arthur's life with his return from the war. Arthur found new
work, a new home, and within the first year married Miss Margaret Maetrich, the daughter of a Brooklyn Shoe manufacturer. The Lynchs took up residence in a two story, single family home at 17 Demson Street, Garden City, New York. They lived there for over twenty years, and never had children.

Arthur’s employment history between 1915 and 1920 is not well documented. One possible scenario is that Arthur remained with American Marconi until he enlisted in the army. After discharge, the earliest employer that has been identified is A. H. Grebe & Company. It was during this time that Arthur prepared the first Grebe catalog. Several references indicate that Arthur worked for the Radio Corporation of America (RCA) during the early 1920s. A newspaper article mentioned that Arthur was hired by RCA to conduct a series of tests to determine the nature of static. He later became RCA’s assistant advertising manager. Arthur also served as RCA’s first Director of Publicity, and has been credited with authoring RCA’s first sales catalog, *Radio Enters the Home*, which was published in June 1922.

While working at RCA, Arthur also wrote articles that were published in Hugo Gernsback’s magazines, *Radio News*, and *Science and Invention*. The name Arthur H. Lynch first appeared in the August 1920 issue of *Radio News* in a product review of a device that Arthur had designed, which he called the NOSTAT Static Eliminator. A month later, Arthur’s first article entitled “Amateur Station Operated on a Commercial Scale” appeared in *Radio News*. For nearly eighteen months, Arthur wrote articles for *Radio News* on a wide range of topics, including marine radio, construction projects, ethical business practices, product review, and happenings in the radio industry. Arthur also provided articles for the *Radio News* monthly column, “The Beginner.”

At times Arthur provided his friend, Alfred Grebe, with free advertising by using Grebe products in his articles. For example, he wrote an article entitled “High Class Workmanship in Amateur Radio Apparatus” that features a Grebe radio, most likely a CR9. The article mentions the materials, design and construction quality of American radio manufacturers, and proclaims, “The accompanying illustrations bear witness to the fact that for workmanship, design and ease of operation and control, not to mention appearance, it is now time for foreign manufacturers of radio apparatus to take off their hats to America.” Most antique radio collectors today would agree with Arthur’s assessment of the Grebe radios of this period.

One of the more interesting articles that Arthur wrote during this period was “Vacation Time Radio.” It touched on his own childhood experiences, his use of kites for antennas, and explored new ways to use radio. “Vacation Time Radio” was about utilizing a portable transmitter and receiver combination—the Grebe KT-1 underway in a canoe—to operate “maritime mobile” while using a kite to support an antenna.
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(Fig. 6). The photos used with this article were provided to *Radio News* by A. H. Grebe & Co., Inc. Arthur’s Niece provided a few pictures from the photo shoot, including one with Arthur sitting in the aft end of a canoe with a paddle in hand. The other occupant, who is wearing headphones and operating a Grebe KT-1 is thought to be Alfred Grebe (Fig. 7). While the maker of the radio equipment was not relevant to the article, and though Arthur avoided using the Grebe name, it would have been clear to the readers who the manufacturer was, and again Arthur used the opportunity to help his childhood friend.

Arthur Lynch’s pen name, A. Henry, first appeared in the May 1921 edition of *Radio News* as the author of the article entitled “Radio Experiments with Kites.” Arthur used the A. Henry pen name regularly while he worked for *Radio News*—often in issues in which Arthur’s name also appeared. Arthur’s last article to appear in *Radio News* was in the June 1922 issue. By the time the June issue was available, Arthur had already started working for a new radio publication, *Radio Broadcast*, owned by Doubleday, Page & Company, with an office located near Arthur’s home in Garden City, New York. Radio historian D. H. Moore, author of *Vintage Radio Identification Sketch-Books*, said that Arthur’s departure was caused by his dissatisfaction with Robert E. Lacault being selected to replace Pierre H. Boucheron as the Associate Editor of *Radio News*. Moore wrote, “Robert E. Lacault, my favorite radio pioneer, joined Gernsback in 1920 as senior editor, thereby causing Lynch to resign in a huff.” The flaw with Mr. Moore’s account is that Robert Lacault appears as the associate editor in the January 1921 issue of *Radio News*, and Arthur continued to contribute articles to the magazine for well over a year. Why Arthur moved on may never be known, but it is very unlikely it was due to any jealousy or a bruised ego.

**Radio Broadcast Magazine**

Several familiar names to *Radio News* readers appeared in the inaugural issue of *Radio Broadcast* published in May 1922. Arthur wrote two articles on radio receivers while Pierre Boucheron, who was Arthur’s former associate editor at *Radio News*, wrote one on adventures in radio. Arthur’s pen name, A. Henry, also appeared as the author of two non-technical articles, “Radio Personalities—Paul Godley”...
The magazine was very similar to Radio News, which targeted the hobbyist who built and experimented with radio receivers. Arthur’s role quickly shifted at the fledging magazine. He became Technical Editor as of the July 1922 issue, and then became Editor as of the October 1922 issue, replacing Roy Mason. Arthur’s move to Doubleday paid off, placing him in a leading role as a competitor of his former employer, Radio News.

The move to editor did not reduce the number of articles he wrote. Arthur covered a wide range of topics, both technical and non-technical. In an early article, “Radio Helping Us Enjoy Summer,” Arthur revisited the use of kites to support antennas, and included pictures that had been used in his Radio News article, “Vacation Time Radio” (Fig. 8). The most interesting articles from the early days at Radio Broadcast—and the most revealing of young Arthur’s life—were written under his pen name A. Henry. The usefulness of the A. Henry pen name must have run its course because it disappeared from the pages of Radio Broadcast after he completed a series of tales that told of Arthur’s sea going adventures as a wireless operator for American Marconi.
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As editor of Radio Broadcast, Arthur felt that it was his responsibility not just to entertain his readers, but also to educate them. In recognition of the third anniversary of Radio Broadcast, Arthur wrote, “Our first and perhaps most important ideal from your point of view is a desire to present to our readers the best technical information that research makes available.”

Arthur was also very keen on protecting his readership from unscrupulous radio manufacturers and retailers by challenging those who misrepresented their products. Long before Consumer Reports published their first magazine in 1936, Arthur Lynch and Radio Broadcast were providing advice on consumer protection to the radio hobbyist. The Radio Broadcast Laboratory tested products before they were seen in the magazine. Arthur established the policy, “this magazine determined to try every piece of radio equipment, in its final form, before bringing it to the attention of our readers through our text pages.”

The magazine also addressed ethics issues regarding manufacturers who compensated authors for writing construction articles that used their products. Radio Broadcast did not allow for
this practice, and when they published an article from an independent writer, both the author and Radio Broadcast would first agree upon the content of the article before it was written.\textsuperscript{56} Sometimes, however, conflicts arose when manufacturers’ claims were questioned. The March 1924 Radio Broadcast article “The Truth about Trick Circuits” was very critical of the Kaufman Circuit. The author Zeh Bouck called it the Golosh Circuit, saying that it “embodies all three methods of regeneration,” and “I combine them all and am therefore the best. So does hash, but it is hardly to be preferred to chicken or lobster”.\textsuperscript{57} As a result of the critical review of the Kaufman Circuit, the first radio libel case on record was filed, Kaufman vs. Radio Broadcast, in which Kaufman was seeking $100,000 in damages. The Federal Court in the Eastern District of New York ruled in favor of Radio Broadcast, supporting its position that Radio Broadcast had the right to challenge the claims of manufacturers and to refute them in print.\textsuperscript{58}

Arthur wrote several radio construction articles in 1925. His article entitled “Radio Broadcast’s Phonograph Receiver” in Radio Broadcast was so long that it was published in three parts over three consecutive months. Arthur saw the need to revitalize the forgotten phonograph and did so by incorporating a compact, four-tube receiver into a phonograph cabinet.\textsuperscript{59} The second construction article was a five-tube receiver called the Aristocrat,\textsuperscript{60} which had a follow up piece the next month.\textsuperscript{61} The Radio Broadcast Aristocrat utilized a Hanscom tuning control that allowed for a pair of Remler tuning condensers to turn in sync, which allowed the Aristocrat to have one-dial tuning. The receiver had a tuned RF section, a regenerative detector, and three stages of resistance-coupled audio amplification. Arthur tells his readers that the resistance-coupled amplification used in the Aristocrat, which should not be confused with other examples, promised good volume and tone quality when used with high-Mu tubes. Like some of the other construction articles in Radio Broadcast, the staff goes to work in the Radio Broadcast Laboratory and experiments with the circuit, using different components and component layouts in order to present different options to the home builder.\textsuperscript{62}

In January 1926, Arthur published his last radio construction article for Radio Broadcast entitled “Radio Broadcast’s Universal Receiver.” Arthur’s receiver design was simple—it had four tubes with a stage of tuned radio frequency amplification, a regenerative detector and two stages of audio amplification. The goal was to create an easily constructed receiver that worked on both dry cells and storage batteries, was suitable for both urban and rural areas, could provide ample audio volume from a loud speaker and, in Arthur’s own words, “a circuit for which parts could be procured in any town of any size in any part of the world; that was our notion of what the ‘Universal’ should be.” There was nothing unusual about the construction, which had been assembled on a wood baseboard with a bakelite
Fig. 9. A General Radio advertisement for the Radio Broadcast Universal Receiver. This was a very high quality radio designed by Arthur Lynch. (Radio Broadcast, February 1926, p. 412-a)
front panel. What made Arthur’s project stand out were the quality of the components and the simple layout of both components and controls. Arthur utilized General Radio components in his example, which resulted in a receiver of the highest quality. Although Arthur used General Radio parts, he advised the readers that “intelligent substitution” of parts would not harm performance. The article also presented other examples that were very similar to the Radio Broadcast project, one being a kit available from Samson. Radio Broadcast was very happy with the final radio and declared, “A more practical all-around receiver than Radio Broadcast’s Universal will be hard to find” (Fig. 9).63

Radio Broadcast instituted a format change and new graphics on the cover page starting with the November 1925 issue. Another major change came in February 1926 with Arthur’s resignation and exit from Radio Broadcast. Although Arthur departed in February, his name appeared as editor until the May 1926 issue when his name was replaced with that of associate editor Willis K. Wing. During the approximately forty-five months that Arthur wrote for Radio Broadcast, he penned his name or the name A. Henry on over thirty articles. By that time, the name Arthur H. Lynch was well known, and it was time to capitalize on it. For the next two decades, he did what he could not do at Radio Broadcast due to its ethics policy—he wrote articles to sell both his merchandise and the merchandise of companies that he worked for as a sales representative.

Arthur H. Lynch, Inc.
Arthur could be described in many ways, but what first comes to mind is a businessman. He understood that he had name recognition, and he used that recognition to sell radio components, kits, antennas, and other radio-related merchandise. Arthur turned his name into a brand recognized in magazine and newspaper advertisements for many years. He diversified his business activities by becoming a manufacturer, a retailer, and a representative for other companies in the radio field. Arthur’s published articles became a way for him to market his wares, and his positions as editors of Radio Broadcast and Radio News brought an added sense of quality and credibility to his products.

Arthur Lynch’s earliest known business venture was a company named NOSTAT that used Uncle Charlie O’Conner’s home mailing address of 118 St. James Place, Brooklyn, New York. The company ran a full-page advertisement in the August 1920 Radio News for the NOSTAT audio noise filter that claimed to eliminate static and interference. The NOSTAT, designed by Arthur Lynch, was a passive audio filter that he proclaimed to be the “conqueror of static” (Fig. 10).64 Along with this advertisement, Radio News reviewed the NONSTAT and also gave some background on sources of noise and previous failed solutions to the problem. The NOSTAT Model 4 filter was priced at $45.00, which included the filter mounted on a base, a Baldwin receiver, and an earpiece resembling a stethoscope.65 The last ad for the
NOSTAT appeared in the December 1920 issue of Radio News, offering it only as a filter for the reduced price of $10.95.66

Preparations for starting his business, Arthur H. Lynch, Inc., began in 1925 while he was the editor of Radio Broadcast. An article in the May 1926 issue of Radio Engineering mentions that Arthur Lynch had organized his own company, the purpose of which was to manufacture and distribute grid leaks. Arthur had made all the arrangements to organize his company a year before, but had delayed its opening because Radio Broadcast had asked him to stay on until the spring of 1926.67 In June 1926, the first advertisement placed by Arthur H. Lynch, Inc. appeared in Radio Broadcast for metalized resistors (Fig. 11).68 The resistors were of the cartridge type, but differed from earlier cartridge types that had a conductive coating applied to the interior of the tubular glass body. Instead, metalized resistors consisted of a resistive filament encapsulated in a glass tube with brass end caps that functioned as contacts. The process for making these resistors involved depositing a thin metal film on a thin glass rod, called a filament, by running it through a bath, then firing the glass rod in a furnace to fuse the metallic
material permanently to the glass. Once completed, the glass filaments were cut into two-foot lengths and then stored in a protective container until needed to build complete resistors. Advertisements for Lynch’s metalized resistors stated that the resistors had, “a concentrated coating of metal one-thousandth of an inch thick upon a glass core.” The Lynch resistors were warranted to be noiseless, impervious to moisture, and had a permanent resistance value.

It did not take long for Arthur to start expanding his product line. In October 1926, Arthur H. Lynch, Inc. purchased the Airgap Products Company of Newark, New Jersey. Airgap was known for their unique vacuum tube sockets that had a cutout providing an air gap between the grid and plate connections of the socket. Advertisements in 1927 documented an expanding line of resistor types and mounts that securely held the cartridge-style resistors. Arthur’s company also offered resistance-coupled amplifier kits and complete Micarta tube decks, or chassis, which included tube sockets, condensers, resistors and mounts.

In 1929, Arthur marketed the Lynch “Tubadapta,” a tube adaptor which accepted two tubes in parallel, which could then be installed in the final audio tube socket for improved audio output (Fig. 12). Writing a radio construction article was a sure-fire way to sell product. Construction articles provided the would-be builder a list of recommended components that included not only the component values, but also often suggested...
Fig. 12. The Lynch “Tubadapta” allowed running a pair of 112A or 171A tubes from a single tube socket. (Radio Engineering, March 1929, p. 54)
the brand names to purchase. Not only did Arthur suggest the components he manufactured, he also recommended CeCo brand vacuum tubes and parts from National Radio, both of which Arthur represented as a sales agent. His construction articles appeared in many magazines of the day such as Radio, Popular Radio, and Radio World. An example of this practice is the 1927 Victoreen receiver for which Lynch specified two National vernier dials and variable condensers, eight Lynch metalized resistors, and six CeCo tubes. The follow-on article for building a power supply and audio amplifier for the Victoreen receiver put more money in the pockets of National Radio, CeCo, and Arthur H. Lynch. While selling products in this fashion was the norm in the 1920s, Arthur engaged in a questionable practice when he used his pen name, A. Henry, to author a construction article describing how to build the Lynch National 5 receiver.  

The relationship between Arthur and the CeCo tube company came to an end in November 1928. Arthur stated only that it had been the wish of the CeCo Company to sever the relationship. An article appearing in the December 1928 issue of Radio Engineering stated, “In spite of rumors to the contrary, Mr. Lynch says he is not associated with any other tube company, although several have made offers to him as soon as they learned of the impending break with CeCo.” Perhaps CeCo thought Arthur was courting other offers, or perhaps he had, in fact, signed a deal with a competitor. Whatever the reason, neither CeCo nor Lynch showed any animosity towards one another publicly (Fig. 13).  

The company went through a name change as well as an organizational change in 1929 when L. R. Beardslee became president and Arthur Lynch assumed an advisory role of Lynch Manufacturing Company, Inc. Besides the metalized resistors, they were now manufacturing a resistor line formerly made by the Tobe-Deutschmann Company. Lynch resistors were being made at facilities in Cranford, New Jersey and Malden, Massachusetts. Arrangements between Arthur and his new president did not last much more than a month before Arthur’s childhood friend, Ralph Sayres, replaced Beardslee.
as president and also assumed the duties of management of sales. Ralph had previously worked for A. H. Grebe & Co., Inc., and had just resigned from General Motors before returning to the radio industry.\textsuperscript{78}

During the first half of the 1930s, Lynch Manufacturing remained in the resistor business (Fig. 14). \textit{Short Wave Craft} printed an article in 1935 about a new line of Lynch resistors which were, “carbon stick, or composition type,” but by this time Arthur was focusing his advertisements towards selling antennas and antenna components for both home and automobiles, and accessories such as spark plug and distributor noise suppressors (Fig. 15).\textsuperscript{79} He also marketed an early type of RF coax that used a twisted pair of copper conductors, which he named, “Giant Killer Cable.”\textsuperscript{80} Lynch Manufacturing advertisements appeared in several radio magazines during the 1930s, including \textit{Radio Craft}, which regularly printed Arthur’s articles. By 1936, his advertisements were no more than few lines—no longer grand, full page ads like they were just a few years before. Arthur’s business tried to adapt to a market where fewer radio enthusiasts constructed their own receivers, but advertisements by Arthur H. Lynch, Inc. ceased to appear in \textit{Radio News} after March 1936 and in \textit{Radio Craft} after January 1937. Since the company had run ad copy for a decade, its disappearance was a clear signal of the company’s demise. It appears that Arthur H. Lynch, Inc. closed in late 1936, although part of the business may have merged with L. S. Brach Manufacturing Corporation, which ran advertisements in 1937 that included the Lynch Hi-Fi logo and offered Lynch Giant Killer Cable (Fig. 16).\textsuperscript{81}

Arthur continued to represent National Radio well into the 1940s, and at one time went into manufacturing

\begin{figure}
\centering
\includegraphics[width=\textwidth]{lynch-resistors.png}
\caption{This Lynch Manufacturing Advertisement showcased a letter from James Millen of the National Company stating that National Radio, “have standardized on your resistors for many years.” (\textit{Radio Craft}, August 1933, p. 112)}
\end{figure}
when he partnered with William Cepak, one of the founders of CeCo, to form the Quartz Crystal Corporation of America sometime in 1942. Without any knowledge of crystal manufacturing, they had secured a contract to produce 8000 crystal units from Radio Marine Corporation of America, and hired Dick Nebel, who knew the business. Dick Nebel stated in a letter to the AWA Old Timer’s Bulletin, “I produced many of the crystal units for them and I believe they eventually filled the contract.”

Arthur’s nephew, Gaylord Worstell, remembers visiting his uncle’s factory with his family around 1941. The facility was a green wooden structure located just south of the intersection of Stewart Avenue and Clinton Road, Garden City, New York. He recalls that the factory was “making small electrical components,” and they were required to wear security badges when they visited the factory. Gaylord estimates that there were 20 employees present during his visit. This fits the time line, and could have been the Quartz Crystal Corporation plant. No other information has been found regarding Quartz Crystal Corporation of America, or any other manufacturing enterprise that Arthur Lynch owned thereafter.

Fig. 15. The Lynch HI-FI low noise antenna system. (Radio World, January 1936, p. 58)

Fig. 16. An example of a L. S. Brach Mfg. Co. advertisement using the Lynch Hi-Fi logo, which appears at the top center of the ad. (Radio News, February 1937, p. 504)
Return to Radio News

The strict policies that prevented Arthur from submitting construction articles to Radio Broadcast did not exist at Radio News. It was normal practice for Radio News to publish construction articles from authors that had a financial interest in the components and plans required to complete a published project. Arthur took advantage of the opportunity and reappeared in the pages of Radio News with the October 1926 issue. Although articles did not list manufacturers or parts suppliers—a practice that changed in 1926—Radio News was more than happy to allow its authors to advertise their wares in the same issue as their articles appeared. This workaround constituted a soft-sell approach for marketing parts to construct the authors’ projects. Arthur’s advertisement in the October 1926 Radio News is a good example of this practice. His article entitled “An Amplifier and ‘B’ Supply Unit,” which he co-authored with R. R. Mayo, detailed how to build an amp and power supply, and his ad copy for Arthur H. Lynch, Inc. was associated with the article by a color banner at the bottom, “Lynch Power Amplifier & ‘B’ Supply Unit” (Fig. 17). Over the next year, Arthur wrote an occasional article for Radio News. The last two appeared in June 1927, one of which he co-authored with James Millen, “The New Raytheon ‘A-B-C’ Power Unit.” His other article explained how the very popular Brownning Drake circuit could be adapted for use with lamp-socket power. The next time that the name Arthur Lynch appeared in the Radio News table of contents, he was the editor.

Hugo Gernsback lost ownership of a large group of his enterprises in early 1929, including Radio News, Science & Invention, Radio Listeners Guide and Call Book, Amazing Stories, and his radio station WRNY when his business, Experimenter Publishing Company, Inc. went into receivership. The debt was approximately $500,000, while the assets were only $182,000. The Irving Trust Company of New York was appointed receiver and announced that they had selected Arthur H. Lynch, former Director of Publicity

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Fig. 17. Running this advertisement in the same Radio News issue as the construction article Lynch authored, “Lynch Power Amplifier & “B” Supply Unit” was a clever approach to work around the magazine’s policy. (Radio News, October 1926, p. 387)
American Radiostat

October 1930 was the beginning of a year of hype, debate and controversy over a new receiver system that had been invented by a Briton, Dr. James Robinson. Robinson, who was highly respected in the radio field, once held the title of Chief of the Department for Wireless at the Royal Aircraft Establishment, Farnborough. The doctor was best known for his pioneering work in direction finding. He called his new receiver the Stenode Radiostat, the word Stenode meaning “narrow path (Fig. 18).”

Radio News introduced the Stenode Radiostat to their readers in the article, “The Stenode Radiostat,” authored by British radio engineer W. T. Cocking. The Stenode Radiostat receiver was said to provide interference-free reception with as little as one kilohertz separation between radio stations. It was also said to have first-class reproduction and a

Fig. 18. This is the American version of the Stenode Receiver. (Radio Age, April 1982, p. 1.; courtesy of the Mid-Atlantic Antique Radio Club)
total absence of heterodyne whistles. The radio was, in essence, a superheterodyne receiver with a crystal filter called a Stenode, placed just after the last intermediate frequency transformer (Fig. 19). Notes in a *Radio News* editorial stated, "Infinite selectivity is accomplished without the loss of high or low notes by using ‘sidebandless’ reception, or the reception of a carrier wave modulated in intensity only.” The article went on to explain that this selectivity allowed for an increase by ten in the number of transmitters that could occupy the existing legal band without interference.

The unique component in Dr. Robinson's new receiver was the Stenotube—a quartz crystal with a resonance of 175 KHz that was contained in what appeared to be a four-pin based vacuum tube (Fig. 20). The Stenode circuit with a stated passband of about 50 cycles prevented almost all of the sidebands to pass. The article stated that the lack of sidebands had no negative effect: “It is said, however, that they are unnecessary for the proper reproduction of modulation frequencies.” Yet, a special audio amplifier circuit was used to correct for the loss of the high tones.

Cocking pointed out a few concerns in his article, including the tonal quality of the receiver’s audio. He said that the audio was not as good as ordinary receivers “with only a small high-note loss in the tuned circuits.” Other issues were the difficulty in tuning due to the many controls it had, and the sharp nature of the tuning circuit. Lastly, he did not feel that the receiver was ready to go to market, and thought that “some considerable time must lapse before

![Fig. 19. This top-view picture of the Stenode Receiver shows the location of the Stenotube on the Stenode Receiver chassis. (Radio Age, April 1982, p. 2; courtesy of the Mid-Atlantic Antique Radio Club)](image1)

![Fig. 20. Stenode Tube drawing showing details of the 175 KHz crystal. The tube was available from Stenode Corporation of America for $15. (Vintage Radio, January 1991, p. 132)](image2)
the Stenode Radiostat was sufficiently
developed.”98

This first article on the basic theory of the Stenode Radiostat operation and its performance must have generated substantial feedback. In the November 1930 Radio News, we find Arthur Lynch defending the new receiver system in an editorial entitled “A Million Dollar Idea.” Lynch responded to the critics with, “We hear the sepulchral echo of the voice of the ultra conservatives and engineering diehards who say, ‘The system is fundamentally unsound and it will not work. This newly touted but very laughable invention is nothing but the peg on which a lot of pseudo-scientific charlatans can hang a lot of questionable publicity for the purpose of exploiting the public through the sale of stock. It is merely the annual bid for the publicity that is necessary for any of the harebrained schemes used for the periodical ‘revolutionizing’ of the radio business. We had hoped there would be no such revolution this year, but here is the old bugaboo larger and livelier than ever.’” Arthur Lynch used his editorial space to point out the applications for this new technology, and closed by saying, “We have called the Stenode a ‘Million Dollar Idea.’ After learning of its multiplicity of applications we feel sure that our estimate is conservative in the extreme. Perhaps we would be nearer the correct figure if we made it a billion.”99

Arthur and John B. Brennan Jr., the managing editor of Radio News, resigned to join American Radiostat in January 1931.100 Arthur assumed the duties as Vice President and Director of American Radiostat, which was renamed the Stenode Corporation of America later in 1931.101 The company established a research laboratory in a home on Hempstead Avenue, West Hempstead, New York. The purpose of the lab was to develop systems to eliminate interference and to extend the range of broadcast radio stations. American Radiostat also planned to work in the field of television and direction finding for aircraft. Arthur, speaking at a Hempstead Association of Commerce, told his audience that the focus of American Radiostat was primarily development, but once the experimental phase was completed, American Radiostat would build a manufacturing plant. He told the association that he expected American Radiostat would “bring large volumes of business and employ many workers in the area.”102 In June, Arthur reported that the laboratory had between 20 and 30 employees, and the corporation had invested thousands of dollars into the community.103

The Radio News organization extended an offer to make the magazine’s laboratory available to Dr. Robinson upon his visit to the United States. Dr. Robinson accepted and he was joined by British Radiostat chief engineer and general manager Percy W. Harris.104 The doctor used his visit to demonstrate his new receiver in Washington D.C. at the Mayflower Hotel to military and civilian radio experts, and afterwards to the Radio Manufacturers Association in Chicago. The public was
able to see the Stenode Radiostat at the Chicago Radio Show.\textsuperscript{105} The newspapers reported that the demonstrations in Washington and Chicago were successful, and they were either unaware of or ignored negative reviews.

Doctor Robinson made another trip to the United States around June 1931, at which time he toured the new research laboratory in Hempstead. A story covering the doctor’s visit in the \textit{Hempstead Sentinel} touches on the subject of critics questioning the theory of how the Stenode Radiostat worked. Many in the industry knew that the Stenode Radiostat had critical flaws, and yet the company continued with its development, maintaining that the future was bright for the company. The \textit{Hempstead Sentinel} reported, “Within the past month and a half, nearly every important radio manufacturer in the country has sent representatives to the Stenode Corporation’s laboratory, and none of them have any hesitation in admitting freely that the demonstrations have shown that a receiver of this nature can be made and made at a lower manufacturing costs.” Two weeks later the \textit{Hempstead Sentinel} printed, “Nearly every first rank manufacturer and a great number of smaller ones are rushing their work along this line and it has been necessary for us to remain over several days to clear up the loose ends. Within the next few weeks there will be a continuous run of these people to our laboratory at Hempstead Gardens, where we will check the work before approving any of the receivers.”\textsuperscript{106} The newspaper’s assessment of the situation was much more positive than the reality.

The former American Radiostat, now known as the Stenode Corporation was in trouble. The Stenode Corporation of America announced in October 1931 that they had “temporarily” ended activities at their Hempstead laboratories. The announcement also mentioned negotiations for “placing the development of the Stenode to telegraphic and cable systems in the hands of telegraphic interests in America.” Readers were informed that enquiries could be directed to the usual Hempstead Garden address, and that Arthur Lynch was now the president of the failing enterprise.\textsuperscript{107}

A year after the closing of the Hempstead lab, the \textit{New York Sun} reported that the British Department of Science and Industrial Research Board declared the Stenode principle of reception was “sound and in accordance with the basic law of electrical circuits.” The reporter closed by writing, “As far as is known the Stenode was never adopted for use in any standard receivers manufactured in this country.”\textsuperscript{108} The Stenode Radiostat was not successful because it was difficult to use, mostly due to the extreme sharpness of its tuning and the poor reproduction of the received programming. The big mistake was thinking that sidebands were not needed for accurate reproduction of voice. The Stenode concept was revisited again after narrowband IF crystal filters were introduced into communication receivers.

Arthur Lynch threw caution to the wind when he proclaimed the Stenode
Radiostat as the greatest advance since Morse code. His reputation as an expert in radio was apparently badly damaged by the Stenode Radiostat venture. A few years later he wrote an article about another emerging technology, Armstrong’s new Frequency Modulation (FM) system. Arthur pointed out that many UHF experimenters thought there was “no point” in the noise reduction promised by FM because atmospheric noise was not as noticeable at these higher frequencies. He was also critical of the vast number of tubes required in both FM transmitters and receivers. Arthur said that the number of tubes “would seem to be a staggering handicap.” The critical critique may have been due to his experience with the Stenode Radiostat, or could it be that FM was about to deliver what the Stenode Radiostat had failed to do?

After Stenode Radiostat and the American Stenode Corporation, Arthur focused his career in radio parts manufacturing and sales. He continued to publish articles in radio magazines, but they appeared with a decreasing frequency and with a focus on amateur radio and antenna projects. The nature of his later magazine articles may reflect that he was no longer looked upon as an expert in leading-edge technology.

The 1939/1940 World’s Fair and W2USA
The 1939–1940 World’s Fair was intended to give its visitors a look into the future. With the theme “Building the World of Tomorrow,” the Fair provided manufacturers the opportunity to have their most advanced products seen by millions. One such company, RCA, demonstrated all-electric scanning television to the American public for the first time on a large scale, and RCA’s NBC network started a regular television programming service with the opening of the Fair on October 30, 1939. Ten days before the Fair opening, David Sarnoff, President of RCA made a dedication speech at the RCA Exhibit Building where he laid out his vision of the future. He began his speech with, “Today we are on the eve of launching a new industry based on imagination, on scientific research and accomplishment.” It is very likely that Arthur Lynch, who knew David Sarnoff, was in the audience that day to witness this historic event.

Radio Club W2USA was established to setup and operate an amateur radio exhibit for the 1939–1940 World’s Fair, and Arthur had a big role to play in managing the amateur radio station. The American Radio Relay League assisted, providing legal assistance in the preparation and filing of the corporation papers. The call letters W2USA were not issued by the Federal Communications Commission until the day before the Fair opened, so the station operated before opening day under Arthur Lynch’s call sign, W2DKJ/2.

The Amateur radio station W2USA was located within the Hall of Communications, which was later renamed the Communication and Transportation Building after the Fair opened. Arthur and his team were provided a rather small space constructed of wallboard
Remembering Uncle Arthur

and without heat or ventilation. In describing the space, Arthur wrote, “Nothing but an empty shell when we moved in. It was colder inside than out.” The heat problem was resolved by borrowing a small oil stove, but proper ventilation for the space was never provided.¹¹⁴

Three sponsors including Thordarson Electric, National, and Hallicrafters manufactured most of the equipment used by W2USA.¹¹⁵ The radio equipment was arranged around the perimeter walls of the twenty by twenty-three foot space. There were separate stations to operate each amateur band from 160 to 5 meters; both CW and phone modes were available. The center of the room had two back-to-back workbenches with test equipment, making the W2USA ham shack very cramped for the operators and visitors. The station started transmitting just before Christmas 1938 using the five-meter band and signing as W2DKJ/2.¹¹⁶ By the official opening day of the Fair, there was a vast array of antennas adorning the top of the Hall of Communication Building, all needing approval by the Fair staff out of concern over their physical appearance (Fig. 21).¹¹⁷

One of the hurdles Arthur faced as he managed W2USA was how to respond to the many thousands of QSL card requests. The station’s QSL cards were given to amateurs who had communicated with W2USA, short wave listeners who had reported that they had heard W2USA on the air, and those who had signed the station visitors log.

Fig. 21. A drawing depicting the W2USA antenna setup on the roof of the Hall of Communications at the 1939 New York World’s Fair. (Radio and Television, May 1940, p. 9)
called the “Golden Book.” The 1939 QSL card featuring the Trylon and Perisphere was designed by Leonard Oehmen, son of amateur radio operator Oscar Oehmen. Due to limited finances there was a considerable delay in printing the 1939 cards, which resulted in a delay in mailing the cards to nearly ten thousand individuals around the world. Unfortunately cards were not sent until the 1940 Fair opened (Fig. 22).\textsuperscript{118}

One of the more notable activities at the Fair that Arthur participated in was operating a mobile amateur radio station that utilized a motorized chair. Arthur’s nephew, Gaylord Worstell, explained, “He also did a radio broadcast from the World’s Fair as a roving reporter from a wheelchair for the convenience of carrying the required electronics.”\textsuperscript{119} Arthur had installed a five-meter transmitter, receiver, and quarter-wave antenna on a motorized chair that looked more like a golf cart without a roof than a wheelchair.\textsuperscript{120} The motorized station was called W2USA Mobile Unit 1. On October 20, 1939, Arthur used it to ride around the fairgrounds and radioed in what he observed to the main W2USA operation, which was then relayed to the amateur radio station at the New York Institute for the Education of the Blind where 200 students listened to the broadcast in the Institute’s auditorium (Fig. 23).\textsuperscript{121}

Fig. 22. The W2USA QSL card. (Courtesy of Patrick Rigg and Thomas Roscoe K8CX)

Fig. 23. Arthur Lynch operating an amateur radio station, W2USA mobile 1, from an electric chair as he tours the New York World’s Fair. (Radio and Television, April 1940, p. 714)
During the last week of September, with just a little over a month left before the Fair closed, W2USA ensured their place in history when they completed the first two-way, all-electronic television contact via radio using duplex video and simplex audio between the Hall of Communication and amateur radio station W2DKJ, which was located in the Daily News Building about eight miles away. The video was not of the same quality as commercial systems of the time, but each television system at W2USA cost less than $500 to construct. Video was transmitted between 112 and 116 MHz, with one transmitter operating at the low end of the spectrum and the other at the high end, and both transmitting at the same time to provide duplex video. Audio was transmitted on five meters. W2USA held its first public demonstration on September 28, 1940 and continued demonstrations for the public until the close of the Fair in late October 1940 (Fig. 24).

Amateur radio station W2USA put on a good show for the public by providing emergency communications via relay operations, thus demonstrating emerging technology and educating the public. Arthur had made a huge commitment to amateur radio and the Fair that involved over two years of volunteer work. He was proud of the accomplishments of W2USA, and shared its story with a later generation of amateurs when he wrote what is believed to be his last magazine article entitled “W2USA/TV, New York World’s Fair 1940.” He closed his article with saying, “I believe the photos, with the captions, can give you a fair idea of the job, done entirely by amateurs, more than a quarter of a century ago, of which they have every reason to be proud.” I think all would agree.

The 1940s and Beyond

Ten months after the conclusion of the 1939–1940 World’s Fair, Arthur’s wife, Margaret E. Lynch, died at age of 45 from a sudden illness. Arthur remained in the home that he and Margaret had lived in for the past 21 years. Articles by Arthur greatly decreased after 1940, and most of them were published in Radio Craft.

Aviation had been one of Arthur’s passions since childhood when he and his father constructed kites. That interest continued into adulthood when he became a pilot, but the how and when of it has been lost to time. Arthur’s niece recalls stories of Uncle Arthur spending weeks at Roosevelt Field as Charles Lindbergh prepared
for his flight across the Atlantic. Photographs from Arthur’s collection, which the family believes were taken by him, record some of the scenes around the airport during the time of Lindbergh’s flight across the Atlantic (Figs. 25 & 26). Arthur’s interest in aviation was shared by other members of the family such as his sister, Marie, who was most likely photographed by Arthur as she painted a plane owned by Amelia Earhart (Figs. 27A & 27B).

During World War II, Arthur put his love of aviation and piloting skills to good use by serving in the Civil Air Patrol (CAP). Due to limited air and naval resources and a pressing need to patrol the vast waters along the East Coast for German submarines, authority was granted to the newly

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Fig. 25. The Spirit of St. Lewis at Roosevelt Field, Long Island, New York where Arthur Lynch spent much time when Lindberg prepared for his flight across the Atlantic. (Lynch Collection of Virginia Duffy)

Fig. 26. The Fokker C-2 known as “America” which made the third transatlantic flight. She is shown here at Roosevelt Field, Long Island New York. (Lynch Collection of Virginia Duffy)

Fig. 27A. Arthur’s sister, Marie Lynch, is pictured here painting a plane owned by Amelia Earhart. Photograph was taken at Mitchell Field, Long Island, New York. (Lynch Collection of Virginia Duffy)

Fig. 27B. The back inscription of the picture of Amelia Earhart’s Plane at Mitchell Field. (Lynch Collection of Virginia Duffy)
formed Civil Air Patrol to assist. On March 5, 1942, the CAP was authorized to perform coastal patrols at two locations off the East Coast of the United States for a period of 90 days. The first unarmed missions were a success and the scope of the CAP’s participation was expanded. Planes were later armed with small bombs or depth charges so that the CAP aircraft could engage the submarines instead of merely loitering on station until other military assets arrived to prosecute an attack.\textsuperscript{126}

The Civil Air Patrol suspended submarine patrol missions on August 31, 1943.\textsuperscript{127} The civilian CAP pilots had flown 86,865 missions, for a total of 244,600 flight hours during the previous 18 months. They reported spotting 173 German submarines and sank two.\textsuperscript{128} The end of search and destroy missions did not mean that the services of the CAP were no longer needed. They continued to perform search and rescue, border patrol and missions to transport cargo.\textsuperscript{129}

Arthur flew submarine patrol missions out of Zhan’s Airport in Amityville, New York, but the family has few additional details.\textsuperscript{130} A possible clue as to his unit assignment could be in an article that Arthur wrote for the amateur radio magazine \textit{CQ}. His antenna construction article, “A Good Point-To-Point Antenna,” described an eight-element directional antenna to be used by the Civil Air Patrol Wing Group 11 based in Hempstead, Long Island. The article identified McArthur Field as being the airfield used by Group 11.\textsuperscript{131}

Arthur married his second wife, Marge, who was his bookkeeper in 1944. They remained in Garden City, Long Island, but relocated to a two-story home on Transverse Blvd. Arthur’s nephew remembers the home, which had a pool table with scoring beads hanging overhead on the second floor. He also recalled that the Lynches had a television that had “the screen facing the ceiling, and a sloping mirror reflecting the screen in order that the show could be viewed from a chair.” Both Marge and Arthur smoked Lucky Strikes, and you could find an ashtray on every table.\textsuperscript{132}

In 1946, Arthur Lynch and J. Alan Biggs formed Lybig Sales Corp, which was based in New York City. Arthur Lynch was named president. Their company was created for domestic and foreign sales of radio equipment for radio manufacturers. Arthur still continued to represent National Radio Company as their New York Sales Manager.\textsuperscript{133}

Arthur and Marge said goodbye to New York, and moved to Fort Myers, Florida in 1947 and then on to Cape Coral, Florida in 1959.\textsuperscript{134} Exactly when Arthur left National Radio Company is not known, but it is reasonable to assume that Arthur resigned from his position when he relocated to Florida. After settling in Fort Myers, he established Arthur Lynch Associates with a partner. The company had two aircraft, which they kept at Page Field (Fig. 28). Arthur and his partner were the sales representatives for Hewlett Packard, covering the entire state of Florida. They also were sales representatives...
for other businesses, such as H. H. Scott for whom Arthur sold disc noise suppressing equipment. The majority of Arthur’s sales were Nucleonic, X-Ray, and laboratory equipment. Arthur closed his business after Hewlett Packard switched to a direct sales force. Retirement had arrived.

Retirement in Fort Myers Florida

Marge and Arthur enjoyed their retirement years in Florida. They had a waterfront home on the Caloosahatchee River with their two Boston Terriers, Ding and Dong (Fig. 29). Arthur’s sisters, Marie and Kathleen, both lived in the Cape Coral area. Marge and Arthur were both involved with the local theater. Arthur was a member of the local Veterans of Foreign Wars VFW Post 8463, San Carlos Knights of Columbus No. 2596, St. Andrews Catholic Church, and the Fort Myers Amateur Radio Club. He was also a member of the Amateur Radio Relay League, DeForest Pioneers, Radio Club of America, OX5 Aviation Pioneers, Veteran Wireless Operators Association and many other professional and civic organizations. Marge passed away in 1975 and is buried in the Coral Ridge Cemetery.

Until his death on March 1, 1980, Arthur remained active in amateur radio. Arthur could not speak during his last years due to a medical condition,
Remembering Uncle Arthur

and so he communicated on the air by tapping out Morse code. He replied to his friends that were using phone with his CW key. The Fort Myers Amateur Radio Club was contacted but today’s membership did not recall Arthur.

Arthur died from cancer at a nursing home in Cape Coral, Florida at 85 years of age. A mass and funeral was held at the St. Andrews Catholic Church, and he was interred with his wife at the Coral Ridge Cemetery. A small flat cemetery marker made of granite and bronze, missing its vase, marks their resting place (Fig. 30).

Conclusion

The life of Arthur Lynch demonstrates the one key ingredient for success—namely, loving what you do. He turned his hobby into a lifelong career. His life is an amazing story of a high school dropout that, through his writing, became a leading voice in the radio

Fig. 29. Arthur never lost his love of flying kites. It is interesting to see that the style of kite he holds here is the same type that he built in the 1920’s for his articles in Radio News and Radio Broadcast. (Lynch Collection of Virginia Duffy)

Fig. 30. The Gravestone of Marge and Arthur Lynch, which is located in the Coral Ridge Cemetery, Cape Coral Florida. (Courtesy of Lydia A. Harris)
industry. He was a prolific writer and his work can be found in many of the U.S. radio periodicals of the day.

He was also a visionary, having founded a company named Airnews, Inc. in the early 1930s for the purpose of providing aerial photography imagery for news services with the capability of developing photos in the air and transmitting the images via a “tele-photo” process. This process allowed images to be delivered while the aircraft stayed on station.\textsuperscript{139} This concept, combined with the capability of a two-way TV link as demonstrated at the 1939–1940 World’s Fair, is being realized today for military applications to provide real time video from aircraft to ground stations.

Arthur was a daredevil who loved travel and adventure. This was evident when, as a young man, he headed to sea as a shipboard wireless operator, or when he tried to fly an airplane in a combat zone with no training. This same sense of adventure lured him into a thirty-mile automobile road race with Silver Marshal, which Arthur proudly won—and with an average speed of 90 miles per hour.\textsuperscript{140} These acts clearly show that Arthur was a risk taker, but he usually managed to come out on top. That would change in 1931.

Like all of us, Arthur had his flaws and made a number of missteps in life. His resignation from \textit{Radio News} at the zenith of his career to join American Radiostat is puzzling. The Radiostat technology had many skeptics, although Arthur thought otherwise. Was he blinded by the prospect of great wealth, or was he a technical writer and editor that did not have a clear understanding as to how radio worked? We do not know all of the factors that entered into his decision, but he took a huge risk and lost—just as our country was trying to cope with the effects of the Great Depression.

As the editor of \textit{Radio Broadcast} he championed consumer protection, and defended in court the right to challenge misleading claims by radio manufacturers. Arthur’s most important contribution to the radio industry was spreading the interest in the art of radio to others. Surely, a number of his readers that constructed their own receivers went on to become technicians and engineers.

The young man, who along with Alfred Grebe and Ralph Sayres, had started his career assembling radio apparatus in a tool shed, succeeded in doing what we all would like to do—living our lives doing what we love. Few can make that claim, but Arthur can. He not only taught us about the miracles of radio, but also showed us how to live life to its fullest.

\textbf{Notes}

Remembering Uncle Arthur

7. Ibid.
10. Ibid.
11. Ibid.
12. Ibid.
15. Ibid.


Remembering Uncle Arthur

93. Ibid.
94. Ibid., p. 298.
97. Ibid., p. 298.
98. Ibid., p. 360.
114. Ibid.
118. Ibid.
126. *Introduction to the Civil Air Patrol* (National Headquarters Civil Air Patrol, 2002) p. 8–9.
127. Ibid., p. 10.
128. Ibid.
129. Ibid., p. 11–12.
Acknowledgements

This paper began with a question posted on the Antique Radio Forum: Did anyone know of an article about Arthur Lynch? There was only one response, a short discussion followed, and the answer was no. The forum member that responded was the late Alan Douglas, author of Radio Manufacturers of the 1920’s. Alan had been told by either John Dreyer, a former Atwater Kent engineer, or James Millen that Arthur used the pen name A. Henry. This revelation proved to be true, and it enabled me to learn much about Arthur Lynch’s younger years through the stories penned by A. Henry. It was four months later before someone responded, and the person who did, Virginia Duffy, started by saying, “Arthur Lynch was my uncle.” This started the communication between Virginia Duffy, her brother, Gaylord Worstell, and me. Without their help and the help of Alan Douglas, it would not have been possible to reconstruct so much of Arthur’s life history before he started writing at Radio News, and I would never have had any clue to his personality. Thank you Virginia Duffy and Gaylord Worstell for sharing your memories of Uncle Arthur.

I also would like to thank the owner of the Antique Radio Forum, Alan Voorhees, for providing this amazing website. Thank you also to forum member, Michael Feldt, who shared his knowledge regarding the Stenode Radiostat Receiver. I am also thankful for the help I received from Peter Lankshear, author of “Doctor Robinson’s ‘Stenode Radiostat,’” and to Lydia A. Harris, who documented the location of the Lynch’s gravesite and provided a photo. Thomas Roscoe, K8CX, who has the website “hamgallery.com,” managed to find an image of the W2USA 1939–1940 World’s Fair QSL card from the QSL collection of Patrick Rigg. To my friend Richard Ammon, a subject matter expert on pre-1930s superhet- erodynes, I thank you for sharing your knowledge and materials from your library. My friend and co-worker, Hilton Garcia, came to my rescue to work his magic so the photos from Arthur Lynch’s collection could be shared in this article.

Most importantly, I am very grateful to my family for their help and support while I worked on this article—especially to my bride of seven months, Lisa Marie Willenborg, who did the editing of my first draft and allowed me to spend countless hours working on this project.

About The Author

David L. Willenborg was born and raised in St. Mary’s County, Maryland. After graduation from Great Mills High School, he joined the U.S. Navy. Upon completing his required electronics training and graduating from Basic Submarine School he was assigned to the diesel submarine USS Grayback (SS-574). While serving on the Grayback, he successfully qualified in submarines and was responsible for operating, and maintaining the subs MKI06 Fire Control system. In 1984, the Grayback was decommissioned and David was
transferred to the nuclear powered fast attack submarine USS Shark (SSN-591). He served as the Fire Control Leading Petty Officer until he was transferred to the Naval Radio Receiving Facility, Kami Seya, Japan. After a two-year duty assignment, he was transferred to Norfolk to finish ten years of service aboard the Los Angeles class fast attack submarine USS Memphis (SSN-691). Returning home, David found employment at the Patuxent River Naval Air Station, first as a defense contractor, and now as a navy civilian employee.

David’s interest in electronics and antique radios began as a child. His collection includes early superheterodynes, communication receivers, consoles with a large tube count, and a wide variety of plastic table radios. He holds an amateur radio Extra Class License, with the call of N3UX.

David has been active in his community. He is a member of the St. Mary’s County Ethics Commission, and was recently appointed by Maryland Governor Larry Hogan to the Governor’s Emergency Management Advisory Council. In 2010 and 2014, David was elected to the St. Mary’s Republican Central Committee, on which he presently serves as vice chairman. He is a member of the Mid-Atlantic Radio Club, Southern Maryland Mustang Club, Veterans of Foreign War, and the American Legion.

Any comments you may have regarding this article, or his previous article, “Robert Lacault and the Invention of the Ultradyne,” which appears in Vol. 26 of The AWA Review published in 2013, can be sent to his email address, david.willenborg@verizon.net.
Telegraph in the American Civil War
Dawn of a New Era in Military Communications

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Abstract

The wide-scale use of telegraph in the American Civil War directly impacted the outcome of the War. The Union's early adoption and rapid expansion of telegraph services was also an historic development in the field of military communications. The telegraph not only affected tactical, operational and strategic battlefield communications, it also permitted civilian government officials to maintain control over the military in wartime. The telegraphers who served were never recognized by the U.S. government for the risks they endured and the contributions they made. Yet, they forged a newly defined trade craft with proud traditions that had lasting effects on the country, and they laid the foundation for a modern telecommunications society. This article outlines the role of the military telegraph in the Civil War and introduces historical resources that can be used for further research into this topic.

Introduction

One hundred fifty years ago in 1865, the American nation emerged from a great Civil War. The cataclysm encompassed nearly every aspect of American society. Virtually no one in the population was left untouched by the sacrifices of those who perished or suffered debilitating wounds, or those who lost their homes, possessions or livelihoods. The outcome of this titanic struggle depended on the use of transformative new technologies and differences in manufacturing capacity, population size, the role of former slaves, economic wealth and mobility. Vastly superior telegraph networks gave the Union significant advantages in managing its military and economic resources and in coordinating the logistics necessary for victory. This article outlines the scope of Union and Confederate military telegraph operations and the development of their respective signal corps. It also introduces critical firsthand historical resources that can be used for further research into this topic.¹
Lincoln and New Technology

President Abraham Lincoln maintained a lifelong personal interest in cutting edge technology. He is the only president to hold a patent, a device to lift riverboats over shoals. He also took an active interest in new technologies as they became available. He personally witnessed demonstrations and supported development of aerial reconnaissance by balloon, organization of the Army ambulance corps, new long-range weapons, rifling and the Minie bullet, the Gatling gun, ironclad warships, rockets and projectiles, naval mines and torpedoes.\(^2\)

Lincoln was fascinated by mechanical devices and scientific advancements throughout his life. In 1858, when shown a copy of the *Annals of Science*, he purchased and read all the back issues.\(^3\) One of Lincoln’s former law partners recalled, “[He had] a faculty for comprehending and understanding machinery.”\(^4\) After losing the 1858 U.S. Senate election to Stephen A. Douglas, Lincoln finalized a lecture on *Discoveries and Inventions*. He delivered the lecture six times, contemplating the origins of man’s most significant discoveries and inventions. He noted that the development of a functioning patent law system “added the fuel of interest to the fire of genius in the discovery and production of new and useful things.”\(^5\)

Three years later, he recognized the military importance of contributions from new science and emerging technology. Consider that in his first six months in office as president, Lincoln took unprecedented control of Northern railroads and telegraph lines. He also introduced aerial surveillance by balloon, urged the production of advanced weaponry, ordered the building of ironclad ships, and began a full naval blockade of the South. He had an interest in and a facility for learning on the job and quickly understood the potential applications for new technologies.\(^6\)

As president, Lincoln broadly fostered and encouraged invention. In 1863, he signed a bill creating the National Academy of Sciences whose stated mission is to “investigate, examine, experiment, and report upon any subject of science or art” whenever called upon to do so by any department of the government.\(^7\) Throughout, Lincoln exhibited insatiable technical curiosity, frequently visiting the U.S. Patent Office, and visiting the U.S. Navy Yard every week for the first two years of the War.\(^8\) Joseph Henry, then Secretary to the Smithsonian Institution, became his informal scientific advisor, often arranging or participating in experiments or demonstrations with the president at the White House.\(^9\)

Incredibly, Lincoln first saw a telegraph in operation during 1857, just three years before South Carolina seceded from the Union. Lincoln inquired about its operation in the Tazwell House Hotel telegraph
office in Pekin, Illinois. He received a demonstration from telegraph operator Charles Tinker, later a member of the U.S. Military Telegraph Corps (USMTC) and eventually superintendent of the Eastern Division of Western Union. Tinker recalled that Lincoln was curious about the telegraph and wanted a full explanation while he waited for dinner. Tinker spent 30 minutes explaining the batteries, connections, instruments, wires and procedures. Tinker recalled how Lincoln quickly grasped all the intricacies stating, “How simple it is when you know it all!”

The Transcontinental Telegraph
As Lincoln entered office, significant political and commercial interests continued to seek government funding for building the nation’s first transcontinental telegraph. Lincoln maintained an ongoing interest in the project. He recognized the critical political necessity of keeping California and western U.S. territories involved in the Union through faster communications. The idea of a transcontinental telegraph linking Missouri to California dated to 1849, but it remained mired in political and financial speculation. Competing U.S. Congressional and California State bills and multiple telegraph companies vied for control and funding, all while in the midst of growing sectional wrangling between Northern and Southern politicians. By April 1861, a Northern Free State route had been selected for construction by a consortium of companies led by Western Union. The final route ran from San Francisco to Salt Lake City to Omaha then on to Chicago and the eastern cities. Construction began July 4, 1862, the same day that Congress and President Lincoln enacted legislation to raise a Union army.

The length of the transcontinental telegraph was unprecedented. It extended over 1,700 miles across the rugged terrain of the western U.S. from San Francisco to Omaha. Messages were then relayed another 470 miles to Chicago and then onto the eastern cities, an additional 800 miles; making this the longest telegraph route in the world at that time.

Development and construction of the transcontinental telegraph spanned five years. The project was endorsed and supported by Samuel F.B. Morse.
and Cyrus Field. Hiram Sibley managed the political and business dealings that eventually unified dozens of independent companies into Western Union. He forged arrangements among the companies to build the line and obtained Congressional support and government funding for the project. Various California telegraph companies merged together to form the Overland Telegraph Company, which constructed the line from California to Salt Lake City. Western Union built the line from Salt Lake City eastward. Western Union’s Edward Creighton, Superintendent of the Pacific Telegraph Company, directed the construction, which took only 14 months to plan and execute. He obtained manpower and supplies from Mormon leader Brigham Young, negotiated treaties with numerous Indian tribes, coordinated services with the Pony Express, overcame engineering difficulties due to distance and mountainous terrain, and finally rerouted the terminus from St. Louis to Omaha due to the outbreak of the Civil War.13

Stephen Field, Chief Justice of the California Supreme Court, sent the first official message on the new telegraph line to President Lincoln. Stephen was the brother of Cyrus Field, who promoted and developed the first transatlantic telegraph cable across the Atlantic Ocean from 1858 to 1866.14 Stephen’s message to the President assured Lincoln of California’s loyalty to the Union and promised that the new telegraph line would “be the means of strengthening the attachment which binds both the East and the West to the Union.”

October 24, 1861
President Abraham Lincoln,
The White House,
Washington, D.C.

In the temporary absence of the governor of the state I am requested to send you the first message which will be transmitted over the wires of the telegraph line which connects the Pacific with the Atlantic states.

The people of California desire to congratulate you upon the completion of the great work. They believe that it will be the means of strengthening the attachment which binds both the East and the West to the Union, and they desire in this—the first message across the continent—to express their loyalty to the union and their determination to stand by its government on
this its day of trial. They regard that government with affection and will adhere to it under all fortunes.

Stephen J. Field, Chief Justice of California

The original transcontinental telegraph line operated from October 1861 to May 1869. It was replaced by a multi wire system also constructed by Western Union that ran alongside the route of the first transcontinental railroad. The transcontinental telegraph dramatically shortened communication times, forever linking the continent,
especially during the Civil War. In less than one hour, the new telegraph line could transmit a message that formerly required Pony Express riders 10 days to hand deliver across the 1,966 miles from St. Joseph, Missouri to Sacramento, California. The Pony Express declared bankruptcy only two days after the telegraph line commenced operations, signaling the arrival of a new era in communications.17

Transcontinental Railroad and the Telegraph
Lincoln followed the success of the transcontinental telegraph with the Pacific Railroad Act on July 1, 1862, the first of five Pacific Railroad Acts in 1862, 1863, 1864, 1865 and 1866. These Acts provided funding for construction of the transcontinental railroad. Lincoln signed the first four of them. The Pacific Railroad Act of 1862 authorized land grants that would “aid in the construction of a railroad and telegraph line from the Missouri river to the Pacific Ocean.” Under the acts, the Union Pacific Railroad would build westward from Omaha, and the Central Pacific Railroad would build eastward from Sacramento. Again, Lincoln hoped this would keep the western territories and California firmly bound to the Union.18

Six years after the groundbreaking, laborers of the Central Pacific and the Union Pacific met at Promontory Summit, Utah, driving the last spike on May 10, 1869.19 In the world’s first live mass media event, the hammers and spike were wired to the telegraph line so that each hammer stroke could be heard as a click at telegraph stations nationwide. Unfortunately, the concept failed, so a telegraph operator manually sent the signals. After removing the ceremonial spike and replacing it with an ordinary iron spike, the telegrapher sent a simple message to both the East Coast and West Coast stating, “DONE.”20

Lincoln in the Telegraph Office
The telegraph was still relatively new in March 1861 as President Lincoln entered office. Samuel Morse’s demonstration of the telegraph between Washington and Baltimore had occurred only 17 years earlier. Many people in America’s heavily rural population had very limited contact with new technology and had never seen a telegraph. Yet, although the industry was less than twenty years old, it had already undergone considerable consolidation. At the time of Lincoln’s inauguration, three major telegraph companies dominated operations: the American Telegraph Company, the Western Union Telegraph Company and the Southwestern Telegraph Company.21 Nationwide,
approximately 50,000 miles of telegraph had been installed.\textsuperscript{22}

Railroads, many with their own telegraph systems, were also rapidly expanding across the continent.\textsuperscript{23} Those railroads became essential for the movement of men and material over vast battle lines that spanned distances equivalent to the later two world wars in Europe. In fact, the Civil War was the first large-scale war to be supplied by rail over such long distances and over such a long period of time. Coordination of railroad transport for troop and supply movements heavily depended upon the expanded use of the telegraph.\textsuperscript{24}

Fig. 5. Carte-de-Visite photograph of a typical Civil War era telegrapher showing the operation of a paper tape telegraph register. Photo by C.L. Lochman’s Photograph Gallery, Carlisle, Pennsylvania. (Author’s Collection)

Fig. 6. Ambrotype photograph of a typical Civil War era telegrapher showing the operation of a key, relay and sounder. (Author’s Collection)

Fig. 7. Ambrotype photograph of a typical Civil War era telegraph lineman with his pole climbing spurs and wire cutting tools. (Author’s Collection)
Following the bombardment of Fort Sumter, the southern systems of Southwestern Telegraph Company and American Telegraph Company each split off from their northern operations by cutting their north/south lines. The southern portion of the American Telegraph Company then changed its name to the Southern Telegraph Company.

Rioting broke out in Baltimore and mobs destroyed railroads, bridges, and telegraphs, initially leaving Washington itself isolated. Southern sympathizers also interrupted military lines by installing cross connections made with fine copper wire that could not be seen from the ground. Farther south, whole sections of wire would sometimes be torn down at night by raiders and carried into the woods.

In Washington, Secretary of War Cameron quickly proceeded to mobilize Northern railroads and telegraphs at the direction of President Lincoln. He first turned to the Pennsylvania Railroad for help. The railroad selected Andrew Carnegie, a young superintendent of the Pittsburgh Division, to oversee the coordination and organization of northern rail and telegraph operations. President E. S. Sanford of the American Telegraph Company immediately directed his own company to link key government facilities at the War Department and Washington Navy Yard. American Telegraph installed and initially operated these lines for seven months at the company’s own expense.

Communications in the opening days of the war were chaotic. William Bender Wilson recalled that “on the afternoon of the 17th of April 1861, I ran telegraph wires into the Executive Chamber and there with a key and a relay, established on a window sill the first electric telegraph offices for military purposes on this continent.” Wilson later served as a secret service telegraph scout in the future U.S. Military Telegraph Corps operating in the Shenandoah and Cumberland valleys. Five days later, Carnegie arrived in Washington bleeding from lacerations received while repairing a telegraph line. He called for four telegraph operators (in addition to Wilson) to report from his Pennsylvania Railroad office. The famous “first four” included David Homer Bates, Samuel Brown, Richard O’Brien and David Strouse. Carnegie considered them the best telegraph operators the railroad could provide.

Other volunteers quickly followed. In fairly short order, railroad lines were repaired or re-laid, bridges were rebuilt and telegraph wires restrung.

A new telegraph office was soon installed in the War Department across the street from the White House. During the next four years Lincoln spent many hours in the War Department’s telegraph office where he received all of his telegrams. Lincoln visited the small office at all hours of the day and in the middle of the night to receive the latest news directly from the front. He often personally delivered his own urgent or sensitive handwritten telegrams for transmission. Lincoln once remarked, “When you want a thing done right, go do it yourself.”
Fig. 8. Letter from A.S. Scott to the “principal officer” of the USMTC volunteering services and requesting an appointment, June 4, 1862. Scott notes his eight years of “practical experience” in “all matters relating to telegraphy” including telegraph construction in England and Ireland. (Author’s Collection)
Bates recalled that Lincoln spent more time in the War Department telegraph office than in any other place, except the White House. He frequently wore a gray plaid shawl in the evenings and often spent the night there. When he did not fill the idle time telling stories to the operators, he read aloud humorous articles from a newspaper. By late 1862, Lincoln energetically dictated and wrote his own telegrams to his top Union generals and colonels in the field. He interacted with “ten or twelve day and two or three night operators” in a “large suite of library and rare book rooms adjacent to the Secretary of War’s office.”

At times, Lincoln took direct control over ‘recommendations’ for troop movements. In a particularly memorable event in 1863, he worked with General Halleck, Thomas Eckert, Secretary of War Stanton, telegraph operators and others to directly coordinate railroad operations undertaking the largest and swiftest movement of troops in history up to that time. In eleven and one-half days, two Union Corps with 23,000 men, 3,000 mules and horses as well as cannon and supplies moved a distance of 1,233 miles by rail over mountainous terrain. They were shifted away from General Meade, who was facing Confederate General Lee near Manassas Junction in Virginia, and sent to Generals Halleck and Rosecrans south of Chattanooga in Tennessee. The move from eastern Virginia, across the Appalachian Mountains, through Kentucky and into Tennessee required four changes of trains due to the differing gauges and lack of track connections. The rapid movement of this many troops over this distance eclipsed all other such troop movements by rail up to that time, thus securing a critical Union victory at Chattanooga. Troop movements on this scale over these distances are impressive, even by today’s standards.

Fig. 9. Recommendation from A.H. Holden to Thomas Eckert for placement of John Bracken, a “first class operator,” into the War Department, June 7, 1862. (Author’s Collection)
Fig. 10. USMTC camp, Bealeton, Virginia, August 1863. (Library of Congress, Item 2013647871)

Fig. 11. USMTC construction corps hanging a telegraph wire, possibly in Virginia, 1864. (Library of Congress, Item 2007682521)
The War Department Telegraph Office also served as a refuge for Lincoln as he waited for incoming dispatches. He maintained an easy familiarity with the operators and talked to them while messages were being decoded and deciphered, often telling stories to relieve the pressures of the moment. Each day, Lincoln went immediately to the drawer with all incoming telegrams and read them, beginning at the top of the unread pile until reaching the bottom when he would state, “Well boys, I am down to the raisins.”

Lincoln often sat in the corner of the office at Thomas Eckert’s desk by the window, the same desk where he wrote the first draft of the Emancipation Proclamation. Albert Chandler, a cipher operator and later president of the Postal Telegraph Co., stated, “It was Mr. Lincoln’s habit to visit this office almost daily and sometimes oftener, and he probably spent more hours there, from the beginning of 1863 to the end of his life, than in any other one place, except the White House.”

Sadly, news of his assassination was relayed from this same location in 1865. Thirty years after his assassination, Lincoln’s former associates collaborated on a book to commemorate his life. Abraham Lincoln—Tributes from His Associates published in 1895 included tributes from three of his former War Department telegraphers. Portions of those recollections are discussed below.

Fig. 12. Reminiscences of Abraham Lincoln, 1886. (Author’s Collection)
U.S. Military Telegraph Corps

The U.S. Census of 1860 listed approximately 2,000 telegraph operators in the country. Approximately half of these operators joined President Lincoln’s cause when recruiting commenced for the newly organized U.S. Military Telegraph Corps (USMTC) in May 1861. Anson Stager was appointed Superintendent of the USMTC in October, and Thomas Eckert directed the War Department’s Telegraph Office with its 12 day operators and 3 night operators. As the USMTC became fully operational it effectively became a complete telegraph company with linemen and construction teams, repairmen, telegraph operators and encryption specialists. Although mostly male, some women were employed for work away from tactical or risky battle areas.

Every operator in the field carried a portable instrument and usually a short piece of wire with him. The Caton pocket set produced by the Caton Telegraph Instrument Shop in Ottawa, Illinois was a major telegraph instrument used during the war. Small and light, an operator could cut into a telegraph line in the field and put the set in series with a main line in only a few minutes. The set was also popular with railroad telegraph superintendents who found the set useful at the site of train accidents. These sets allowed linemen to tap into telegraph lines with a pocket-sized instrument and they were also used by the military for intercepting and sending false messages to the enemy.

The set is enclosed in an oval hard rubber case and in a thick leather protective case. The set, approximately the size of a small eyeglass case, is only five inches long, 2-¼ inches wide and 1-¼ inches thick and weighs only 10 ounces. It consists of a sensitive sounder and a very early and tiny strap key with a small ivory knob on both the key and the shorting lever. The coils are wound with 36 gauge wire. There were two versions, one with two binding posts and another with four, and the two terminal model was the most common. The four terminal set was considered a “pocket relay.” In addition to using it as described above, the sounder had a pair of contacts wired to the extra terminals that would allow the set to key another circuit. A sample of the Caton pocket set was later placed on exhibit at the Paris Universal Exposition in 1867 and designated as a “Pocket field telegraph.
apparatus.” Samuel F. B. Morse was a U. S. Commissioner at the Exposition. His report of all the telegraphic apparatus included this description of the Caton set:

“Here are all the instruments necessary for a complete telegraph office. . . . It is designed for use in the field or out of doors. . . . Mr. Caton states that during the war he supplied the government with a large number of these instruments, but was unable to fill all the orders . . . An account of their services thus rendered each year would fill a volume, and, really, no train should ever move without one . . . It was beautifully finished, and was sent to the Exposition by Judge J. D. Caton, of Ottawa, Illinois, and manufactured in Ottawa by Mr. Robert Henning, whose telegraphic instruments are among the best in the country.”

The USMTC assumed responsibility for maintaining communications between the federal government in Washington and the generals and field commanders of the far-flung units of the Union Army. By definition, the USMTC operated as a civilian authority separate from the U.S. Army and distinct from the U.S. Army Signal Corps (USASC). Given its central role in Union communications, the USMTC also found itself playing a large part in intercepting and deciphering Confederate communications.

The USMTC and USASC effectively split the responsibilities for communications. Early on the USMTC and USASC each had field telegraph units and field stations both linked to the commands. Soon however, the USMTC assumed responsibility for all telegraph communication and ran their telegraph lines up to command posts in the field. The USASC remained responsible for hilltop signalers who sent messages by wigwag flags in daylight and torches at night in areas without telegraphic outposts or operations. This combined Union network formed the world’s first highly developed integrated military communications system. In contrast, the Confederacy rarely used the telegraph for tactical communications in the field and operated with much more limited message abilities between Richmond and its military commands. One observer later described the rapidity and functionality of battlefront telegraph operations:

“In the campaign of 1864, from the Rapidan to the James, General Grant established a field telegraph line, which was of very great advantage in keeping up communication with his corps division and brigade commanders. A Telegraph Corps was organized of men and mules. The wire was in coils upon large spools, the spools placed in the frame work not unlike a sawhorse, and this placed upon the back of the mule, one mule for each brigade; whenever there was a movement of the
army, the Telegraph Corps would follow the movement somewhere upon the flank, and as the wire was unrolled, it was fastened to trees, and in the absence of trees, to poles that were carried along in teams provided for the purpose, so that within five to ten minutes after a halt, the telegraph operators were at work with their instruments between all of the various headquarters.\textsuperscript{53}

Although the USMTC played a prominent role in transmitting messages to and from commanders in the battlefield, it functioned independently from direct military control. The USMTC employed civilian operators both on the battlefield and in the War Department. Only USMTC supervisory personnel were granted military commissions from the U.S. Army’s Quartermaster Department in order to distribute funds and property, and to provide a military rank as the basis for authority. All of the orders the telegraph operators received came directly from the Secretary of War. Since no government telegraph organization existed before the war, Congress possessed no existing legal authority to appropriate funds to pay for the expenses of erecting poles, running cables or the compensation of operators. As a result, during the first six months that USMTC was in operation, Edward Sanford’s American Telegraph Company paid for all of these expenses. American Telegraph was later reimbursed through an appropriation of Congress.\textsuperscript{54}

The relationships between the USTMC and regular army or regular navy personnel were often strained. USMTC operators did not take orders

Fig. 15. USMTC operator at night work, receiving dispatches, while a mounted orderly waits in order to convey them to the division generals in Virginia. (Leslie, 1895)

Fig. 14. Light field service - stringing telegraph line. (O’Brien, 1910; Century Magazine 1889, Vol. 38, p. 789)
from theater commanders, officers or even the generals, and they did not share their code or cipher books with military personnel. They lacked official standing even though they often served in combat under conditions of extreme danger. Yet, officers “frequently regarded them with a certain contempt or hostility . . . [O]perators suffered from the natural impatience of military commanders, who resented the abnormal relations which inevitably led to distrust and contention.”

Nevertheless, USMTC operators served courageously during the War facing the same battlefield risks as regular military. Operators in the battlefield faced the constant threat of being captured, shot or killed by Confederate troops whether they were establishing communications on the battle front, sending messages behind during a retreat, or venturing out to repair a line. USMTC operators experienced a casualty rate of approximately ten percent, a rate similar to the infantry. The strained relationship between the operators and military commanders added to these dangers. Many commanders resented USMTC operators because they were not enlisted members of the armed forces, and were merely employees of the Quartermaster Department. As a result, the commanders distrusted the telegraphers and felt that they were not fit to serve. A number of personal accounts document the experiences of the USMTC, which are described below.

Fig. 16. Military telegraph operators, headquarters, Army of the Potomac from the eastern theater, Meade in Virginia, Aug.-Nov. 1863. (Library of Congress, Item LC-B8171-7358)
After the War, the U.S. government required the South’s telegraph lines to be repaired and controlled by the USMTC, which was also made responsible for reconstruction of the Confederate telegraph network. The Confederacy had never been extensively linked by wire and lacked the funds to provide adequate maintenance of its telegraph network. Wartime destruction left the South’s telegraph network in terrible condition. On February 27, 1865 the Quartermaster General transferred Union control of all telegraph lines in the South to commercial telegraph companies under the supervision of USMTC Assistant Superintendents. This order also relinquished control of all lines seized by the government in the North and sold the lines constructed by the USMTC to private telegraph companies. The USMTC then undertook extensive reconstruction efforts and, over time, transferred all remaining military lines to civilian authority. Once control of the telegraph lines were turned over to the civilian telegraph companies, the operators were discharged. The only office that remained in service was the original telegraph office situated within the War Department building.

Fig. 17. Stereocard of field telegraph station at Wilcox’s Landing near Charles City County, Virginia, 1865. “A tent-fly for shelter and a hard-tack box for a table, the resourceful operator mounted his relay, tested his wire, and brought the commanding general into direct communication with separated brigades or divisions. The field-line was built of seven twisted, rubber-coated wires which were hastily strung on trees or fences.” (Author’s Collection, Library of Congress LOT 4188, no. 200 [P&P]) (Quote from Greely, 1911a)
U.S. Army Signal Corps
The USASC originated with the appointment of Major Albert J. Myer, a former surgeon, as its first signal officer. In a June 21, 1860 letter from the War Department, Myer received orders to organize a command structure to develop signaling procedures. The USASC did not become an official U.S. Army organization until March 3, 1863. The Confederate States Army Signal Corps (CSASC), a much smaller group of officers and men, also based their initial organizational concept and techniques on Myer’s design. Both signal corps accomplished tactical and strategic communications for their armies, including the development and application of aerial telegraphy (see below) and limited early use of electromagnetic telegraphy. Both services had an implicit mission to provide battlefield observation, intelligence gathering and direct artillery fire from their elevated signal stations; however, the CSASC also had an explicit espionage function.  

Myer, while still serving as an Army surgeon, first became interested in communications when learning about sign language for the deaf. He developed his concepts for signaling over long distances by designing lightweight and simple-to-use equipment. He is best known for inventing a signaling system using a flag, or a kerosene torch.
for nighttime use, known as wigwag signaling, or aerial telegraphy. Unlike semaphore flag signaling, which used two flags held in designated positions to represent letters, numbers or abbreviated words, wigwag required only one flag and used a binary code to represent each letter of the alphabet or digit as the flag was waved left or right. It was more mobile than previous means of optical telegraphy since it only required one flag and a 6–8 feet platform for the signal corpsman. Myer initiated his tests in April 1859 at Fort Monroe in Virginia followed by tests in New York Harbor at West Point and later in Washington, D.C. Myer drafted his own code, visual techniques, administrative procedures and reporting authority. The Senate confirmed Myer’s appointment as the first signal officer on June 27, 1860, just six months before the outbreak of hostilities. Both Union and Confederate signal corps utilized the Myer codes.  

Myer quickly established an independent corps with training camps, regular training protocols and defined procedures. He also introduced the concept of mobile electrical telegraph operations and recruited telegraph operators as officers. He developed ‘flying telegraph trains’ as an important innovation. Horse-drawn wagons carried apparatus and supplies such as reels of insulated copper wire and iron lances for stringing temporary field lines as well as the aerial signaling supplies such as flags, rockets and composition night signals.  

In January 1862, Henry J. Rogers developed a new battery operated electrical instrument for the USASC that replaced
the traditional telegraph sending key and receiver with a dial mechanism.\textsuperscript{61} The mechanism, comprised of a circular index with the letters of the alphabet and a rotating pointer, was housed in a large box. A similar pointer spelled out the message at the receiving end. The new device eliminated the need for a trained telegraph operator who knew about electricity and who was fluent in Morse code. During the 1862 Peninsula Campaign, Rogers substituted the new Beardslee Patent Magneto-Electric Field Telegraph Machine, which had been invented by George W. Beardslee of New York. This instrument also used a dial indicator, but it was powered by a hand cranked generator instead of a battery. These instruments were included on the flying telegraph train and were intended to increase flexibility since anyone with limited training could replace the more specialized Morse telegraph operators.\textsuperscript{62} McClellan considered the flying telegraph useful to contact “any point within our lines not reached by the military telegraph.”\textsuperscript{63} However, the Beardslee machines had limited range and technical difficulties, soon leading Myer to convert them to Morse code and requiring Myer to use trained Morse telegraph operators.\textsuperscript{64}

Myer’s interest in expanding the application of telegraph was further demonstrated in his work with Thaddeus Lowe in the deployment of military observation balloons that used suspended telegraph lines to report on enemy movements observed from up to 1,000 feet in the air.\textsuperscript{65} Unfortunately, despite McClellan’s encouragement, balloon operations were never understood, trusted or exploited, and their cumbersome transport and employment limited their adoption. Following McClellan’s demotion, the balloon service disappeared from the army.\textsuperscript{66}

Integration and development of visual signaling versus the electric telegraph, or combinations of both, proceeded unevenly for the next two years at the command level. Some

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Fig. 22. Signal Tower at Cobb’s Hill, near New Market, Virginia, 1864. (National Archives, 165-C-571 Identifier: 533120)

Fig. 23. Albumen photograph of field telegraph battery wagon, Petersburg, Virginia, September, 1864. (Author’s Collection)
generals laid telegraph lines, others did not. Some used visual signaling, others did not. Many were indifferent. Political conflicts increasingly emerged with the USMTC over authority and control of electric telegraph operations. The USMTC and Secretary Stanton fought to possess sole authority over all electrical telegraph communications. They disputed Myer’s command over, and USASC operation of, flying telegraph trains.67

In April 1863, problems continued to persist with USASC field operations. The Union Army entered the Chancellorsville campaign with thirty of the “cumbrous magneto machines” operated by signal officers. Proving slow and inefficient, Beardslee telegraph communications were turned over to the USMTC telegraphers, who discarded the machines and worked with their Morse instruments on the short lines laid by the USASC.68

In July 1863, the USASC achieved considerable success at Gettysburg. After identifying the high ground and occupying key sites prior to the arrival of Lee’s army, the USASC, and in particular Chief Engineer and Signal Officer General Warren, occupied Cemetery Hill, Cemetery Ridge, Emmitsburg Hill, and especially Little Round Top. These locations proved critical for coordinating Union signal communications as well as securing the key lines of battle that would determine the Union victory.69 Lee’s army approached with no telegraph and had inadequate visual signal communications to facilitate its movements. As the Union army approached, its soldiers chanted “Let the telegraphers through, they’ll get us into a fight, and out of
The Union’s combination of electrical and visual communications proved instrumental in coordinating its movements. General George Sykes later stated, “The Signal Corps has been of great use to the army. During the battle of Gettysburg its services were highly important to me . . . I look upon it as a necessary part of our military establishment, and would be glad to see it placed upon a permanent foundation.”

Overall, the USASC demonstrated some success on the battlefield; however, it suffered from the ongoing political disputes in Washington over control of the country’s national military telegraph network led by the civilian USMTC. Secretary of War Stanton relieved Myer from command on November 15, 1863. In March 1864, all USASC telegraph operations and the flying telegraph trains were transferred to the USMTC, and Stanton reassigned Myer out of Washington. Myer later wrote his seminal work, the *Manual of Signals for the United States Army and Navy*, while conducting routine reconnaissance of the Mississippi River from Cairo, Illinois to Memphis, Tennessee. In June 1864, he was appointed by Major General E. R. S. Canby to be the Chief Signal Officer of the Military Division of West Mississippi. He was not restored to his former role as overall Chief Signal Officer until July 28, 1866. Congress, reacting to the influence of Lt. Gen. Ulysses S. Grant and President Andrew Johnson, authorized a reorganization of the USASC, and Myer was reappointed as Chief Signal Officer. Yet, delays persisted. He was not confirmed in the position until February 1867 and was not ordered to active duty until August 1867. His new duties now included control over the USASC telegraph service, resolving the dispute that had originally removed him from his position.

In the long run, the USASC would be remembered for its visual signaling methods and not its early telegraph operations. “In every important campaign and on every bloody ground, the red flags of the Signal Corps flaunted defiantly at the fore front, speeding stirring orders of advance, conveying warnings of impending danger, and sending sullen suggestions of defeat.”

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Fig. 26. Signal stations at Gettysburg, July 2, 1863. (Author’s Collection)
Confederate Operations

The South entered the War with far less developed telegraph and railroad networks than the North. Consequently, the Confederacy simply did not possess the wealth of management experience to improvise and handle the enormous communication and logistical operations required by the war. They had much more limited experience with developing the initial costs, operating expenses, payrolls and otherwise responding to the technical difficulties of running large enterprises. The lessons learned by Northern railroad and telegraph businesses in the 1850s proved a distinct advantage to the North. A survey performed by the American Railroad Journal in 1857 showed the Northern states had 1,467 telegraph stations versus the Southern states, which had only 107. The South simply did not appreciate the critical importance of centralized rapid communications. Even less is known about the Confederate signal services. Much of their work was shrouded in secrecy, and most of the documentary records were lost or destroyed since the Confederate government burned its records upon the fall of Richmond.

As described above, in the first month of the war, the South’s commercial telegraph lines were separated from their northern connections and consolidated into two companies: the Southern Telegraph Company and the Southwestern Telegraph Company. In April 1862 the Confederate Congress authorized the establishment of a signal corps, almost a full year before the U.S. Congress passed such legislation. President Jefferson Davis assumed control of the Confederate telegraph lines and of such officers “as will enable him to effectually supervise the communications passing through the same.” The Confederate States’ Postmaster General, John H. Reagan appointed agents to build telegraph lines, employ operators, issue instructions to agents and operators, and otherwise carry out the Congressional grant of power to the Confederate President.

Despite the quick movement on granting Congressional authority to establish a signal corps, Southern temperament did not favor centralized government or military operations. Prior to the war, Southerners...
resisted the development of telegraph and railroad lines, fearing any impact on their way of life. They resisted the development of national interconnections either through transportation or electrical communication. That cultural resistance later hampered Confederate national efforts to centralize authority and manage the war effort. Consequently, the CSASC's telegraph operations remained underdeveloped; however the CSASC's scope of responsibilities did include a Secret Service Bureau whose role focused on espionage.

A few Confederate leaders understood the potential of the telegraph. Early on, General P. G. T. Beauregard recognized the military importance of using the telegraph. He quickly built up a regularly organized signal system around Charleston with a full corps of telegraph operators. However, most of the leadership failed to recognize the potential importance of telegraph communications. The Confederacy continued to rely primarily upon commercial telegraph networks and never developed an adequate military telegraph organization.

From the outset, the Southern and the Southwestern Telegraph Companies possessed limited capabilities. The Confederacy simply did not possess the manufacturing facilities or raw materials to produce and supply communications equipment or operators. The South did not possess a single wire or glass factory when the war began. The Confederacy immediately faced shortages of telegraph wire, battery acids, and other materials as trade and transportation routes from Northern factories were severed. The construction and maintenance of telegraph lines in war torn areas constantly suffered from wartime scarcities, increasing costs of labor and materials, defective equipment, repeated destruction of telegraph lines by enemy invasion, shortages of trained and qualified telegraph operators, sporadic cases of disloyalty, misconduct by telegraph employees, and the specter of incipient trade unionism. As a result, Confederate equipment was often crudely retooled or constructed out of remnants or scraps. Since the delivery of telegraph services depended on local civilian offices rather than the military, they were often subject to limited or unpredictable business hours, and dispatches were often inaccurately routed or inaccurately transmitted. As the war progressed, telegraph service across the South steadily worsened due to “rotten and indifferent post[s] and the careless manner in which the wires are attached over about one half the lines,” which caused ongoing interruptions in the service.

By the time Sherman left Atlanta in November 1864, the Southern Telegraph Company had almost exhausted its supply of telegraph materials. Nearly all the telegraph wire in the Confederacy was already on poles, and much of that was virtually useless due to rust. In one raid, nearly 100 miles of critical telegraph lines were destroyed, leaving Richmond entirely cut off from Savannah, Macon and Mobile for more than two weeks by any route. Union
soldiers also removed Confederate telegraph wires from the poles to be used as trip lines:

“Telegraph wires that had been taken from the poles along the railroad that we had destroyed had been strung along from tree to tree in front of our [Union] lines in a way that when the charge of the enemy was made, the men [Confederate soldiers] were thrown to the ground, piling one upon another in great confusion, where they were slaughtered like sheep, from the terrific fire of our guns.”

Given the resistance to strong national organization, the CSASC never became a distinct and independent branch of the military service despite receiving recognition from its government as early as April 1862, much earlier than the USMTC or USASC. At the outset the CSASC initially consisted of 51 officers. During the War, 61 officers were commissioned and 1,500 men were detached from other branches to serve in the Confederate Signal Corps.

Throughout the conflict, General Lee and President Davis both placed a lower priority on telegraph communications. As the war progressed, Lee slightly increased his use of the telegraph, culminating in the Richmond-Petersburg telegraph exchanges with his field commander P. T. Beauregard. However, Lee generally found telegraphing so untrustworthy that
Fig. 30. Confederate House of Representatives Bill—to organize scouts and signal guards, May 3, 1864. (Author's Collection)
he ordered his officers to “send no dispatches by telegraph relative to . . . movements, or they will become known.” 94

The CSASC’s two-room office was located for most of the war in Richmond, Virginia on Bank Street across from the capitol grounds. It was situated opposite from the Old Bell Tower between the War Department on 9th Street and the President’s office in the former U.S. Customs House at 10th and Main. 95 The CSASC adopted the Myer signal system developed before the War, employing only minor modifications in Myer’s alphabet code and a reversal of the flag motions. 96 Ironically, the very first use in combat of Myer’s wigwag signaling system was by CSASC Captain Edward Porter Alexander at the First Battle of Bull Run (Manassas). Alexander had been a subordinate of Myer’s and assisted in the New York field trials. 97

The CSASC remained officially responsible for manufacture and collection of all signal apparatus and stores and the manufacture, collection and distribution of all cipher apparatus. However, the CSASC never designed truly unique new electrical systems or apparatus, although the South did develop its own ciphers and operated an expansive secret service network providing valuable espionage. 98 Despite all the shortcomings, the CSASC managed information obtained from a variety of sources, including CSASC posts in the field, telegraph operators and wire tappers, line crossing couriers, and information from Northern newspapers, Southern sympathizers and agents. 99

Unfortunately, Confederate ciphers, though initially successful, were routinely broken by Northern operators in the USMTC’s War Department Telegraph Office. David Homer Bates, Arthur B. Chandler and Charles Tinker became so adept at breaking Confederate ciphers that they were dubbed by Lincoln “The Sacred Three,” and they were given special status by the president, who ordered that they never be disturbed when working on deciphering intercepted messages. 100

PART III – RECOLLECTIONS

Recollections of the Generals
Comparatively few firsthand accounts describe the perspectives and views of the generals and commanders who had to adapt to the rapid pace of communication using the telegraph. Although the rivalries between the USMTC and USASC are better known and documented, still, little acknowledgement was made for the contributions of the civilian operated USMTC. Lincoln’s use of the telegraph to direct the war left a bitter taste for many of the early Union generals who were relieved of command. Their desire for independent decision-making and authority conflicted with the intrusions of the president and civilian leadership. News
about ongoing inaction or failures on the battlefield could not be deferred, and Lincoln responded very directly and increasingly very quickly as the war wore on. Later more successful generals communicated regularly and utilized the technology more effectively to keep the Commander-in-Chief well informed of the military developments. They accepted his ultimate authority over the military and his political strategy behind winning the war. Yet, the memoirs of those major leaders typically focus on military themes and generalship rather than the contributions of electrical communications. Nevertheless, some important examples do identify the contributions of the telegraphers.

1. General Rosecrans
Union General William Rosecrans was the victor at prominent Western Theater battles, including Iuka and Corinth. He fought against Confederate General Braxton Bragg at Stones River, and later outmaneuvered him, driving the Confederates from Middle Tennessee. His strategic movements caused Bragg to abandon Chattanooga, but Rosecrans’s pursuit of Bragg ended during the bloody Battle of Chickamauga. After Chattanooga, Rosecrans was relieved of command by General Ulysses S. Grant in 1863, effectively ending his military career.

Rosecrans realized the critical importance of establishing and managing communications over his geographically large theater. He created several unique staff positions to manage those communications. Captain Jesse Merrill, a pre-war attorney, was appointed as Chief Signal Officer with “the object of the Organization... to keep up constant communication between the different parts of the army and the different commanding generals, to closely scan and discover the movements of the enemy.” Merrill accomplished his mission through the establishment of signal flag stations located on mountain tops and high elevations. He used these in concert with, “powerful telescopes and marine glasses” to observe and report enemy movements.

Rosecrans created a separate staff department for managing telegraph...
operations. Under Major Albert J. Meyer, and later Captain John C. Van Duzer, a USMTC supervisor, Rosecrans felt the telegraph section performed excellent work. As a result, he became highly dependent on the telegraph. Normally, each corps headquarters quickly established telegraph lines to army headquarters allowing Rosecrans to quickly relay orders. During Chickamauga, Rosecrans’ headquarters had telegraph lines connected directly to his reserve corps and indirectly connected to the War Department in Washington.

After the War, Rosecrans sent a letter to Edward Bok, aged 18, who requested Rosecrans’ autograph. Bok was working at the time as a Western Union messenger. Rosecrans’ inspirational letter states:

"Dear Sir: It gives me pleasure to respond to your request for an autograph note because the summons and faithful services rendered by members of your corps serving with me during the war for the preservation of the union inspired me with a fraternal feeling towards all its members. In all my experience I never knew one of them to shrink from serving at any post however..."

Fig. 32. Letter from General Rosecrans to Edward W. Bok, Sep. 24, 1881. (Author’s Collection)
dangerous where duty called, nor to remit vigilance where the service required the most painful and prolonged watching.”

2. General Grant

General Ulysses S. Grant initially opposed the regular use of the telegraph while serving as a one-star general operating in the Western Theater. He resented General Halleck’s intrusions into his battlefield decisions. Halleck was then serving as General-In-Chief of the Armies. Grant also questioned the competence and promptness of the USMTC telegraphers. At one point, Grant cut his own telegraph lines to prevent his decisions from being countermanded. When Grant became overall commander, his views changed, and he relied heavily upon the telegraph for information, to issue command decisions, and to communicate with President Lincoln. “Grant used the military telegraph both for grand tactics and for strategy in its broadest sense.” Ultimately, General Grant paid glowing tribute to the telegraph and signal services and noted their importance to the War. He stated, “The second [thing connected with all movements of the Army of the Potomac] . . . was, the use made of the telegraph and signal corps. Nothing could be more complete than the organization and discipline of this body of brave and intelligent men. Insulated wires—insulated so that they would transmit messages in a storm, on the ground or under water—were wound upon reels, making about two hundred pounds weight of wire to each reel. . . . The moment the troops were put in position to go into

Fig. 33. Dispatch April 7, 1865 Headquarters Armies of the United States. (Author Photo, With Malice Toward None (2009), Charles F. Gunther Collection)

Head Quarters Armies of the United States, City Point, April 7, 11.am. 1865

Lieut. Gen. Grant.

Gen. Sheridan says “If the thing is pressed I think that Lee will surrender.” Let the thing be pressed.

Lincoln.

The original dispatch sent by Mr. Lincoln to me, Apl. 7th 1865.

U. S. Grant
camp all the men connected with this branch of service would proceed to put up their wires. . . . This would be done in rear of every brigade at the same time. The ends of all the wires would then be joined, making a continuous wire in the rear of the whole army. . . . Thus, in a few minutes longer time than it took a mule to walk the length of its coil, telegraphic communication would be effected between all the headquarters of the army. No orders ever had to be given to establish the telegraph.”

Lincoln communicated with Grant and the other generals through telegrams, dispatches, letters, and in personal meetings. Lincoln’s final dispatch to General Grant on April 7, 1865 responded to comments he heard from General Sheridan that the end of the War was at hand. Lincoln famously directed Grant, “Gen. Sheridan says ‘If the thing is pressed, I think Lee will surrender. Let the thing be pressed.” Two days later, on April 9, 1865, Sheridan surrounded Lee’s remaining forces near Appomattox Courthouse, and later that same day, Lee formally surrendered to Grant.

3. General Sherman

General William Tecumseh Sherman’s exploits and his famous ‘March to the Sea’ are well chronicled. His memoirs are filled with commentary about telegraph communications and dispatches. He matched the importance of destroying the Confederacy’s rail system and farming resources with orders to destroy all telegraph communications networks. Many reports
of Sherman’s actual movements had to be derived from non-telegraph sources and Southern newspaper accounts that were monitored in the North. His army’s march was so rapid that wigwag signal flags were often used. USMTC lineman frequently considered it too dangerous to string telegraph lines in enemy territory while on the move. Yet, Sherman noted the speed with which telegraph communications and rail service could be restored, which enabled his forces to remain in contact with General Grant and President Lincoln and also to remain supplied.

Sherman is responsible for one of the most famous telegrams of the War. On December 22, 1864 he sent a telegram to President Lincoln that was extensively published in newspapers:

SAVANNAH GEORGIA,
December 22, 1864.

To His Excellency President Lincoln, Washington, D.C.:

I beg to present you as a Christmas-gift the city of Savannah, with one hundred and fifty heavy guns and plenty of ammunition, also about twenty five thousand bales of cotton.

W. T. SHERMAN, Major-General.

Sherman was known for rapid movement but also for cutting his ties when necessary. Allen T. Rice, editor and publisher of the North American Review, once asked Sherman about cutting his own telegraph lines. Sherman replied, “Did he [referring to Grant]? Why, I did that! I never heard before that Grant did it.” This was ostensibly done to block interference from Washington. Nevertheless, Sherman was very supportive of the telegraph. He later offered a lengthy commentary in his memoirs:

“For the rapid transmission of orders in an army covering a large space of ground, the magnetic telegraph is by far the best, though habitually the paper and pencil, with good mounted orderlies, answer every purpose. I have little faith in the signal-service by flags and torches, though we always used them; because, almost invariably when they were most needed, the view was cut off by intervening trees, or by mists and fogs . . . but the value of the magnetic telegraph in war cannot be exaggerated, as was illustrated by the perfect concert of action between the armies in Virginia and Georgia during 1864. Hardly a day intervened when General Grant did not know the exact state of facts with me, more than fifteen hundred miles away as the wires ran. So on the field a thin insulated wire may be run on improvised stakes or from tree to tree for six or more miles in a couple of hours, and I have seen operators so skillful, that by cutting the wire they would receive a message with their tongues from a distant station. As a matter of
course, the ordinary commercial wires along the railways form the usual telegraph-lines for an army, and these are easily repaired and extended as the army advances, but each army and wing should have a small party of skilled men to put up the field-wire, and take it down when done. This is far better than the signal-flags and torches. Our commercial telegraph-lines will always supply for war enough skillful operators.”

4. General McClellan
General George B. McClellan was an early advocate of the telegraph. He witnessed its use in the Crimean War as an official observer for the U.S. Army. Between 1857 and 1861, he left military service and worked as a railroad executive. Upon his return to duty in 1861, McClellan was charged with organizing an army to defend the Union at a time when half its ranks were resigning and joining the Confederacy. Further, the remaining officers were inexperienced:

“None of the officers at my disposal had ever seen large armies or the operations of war on a grand scale. Those who came from West Point had a good education, so far as the theory of war was concerned . . . To pass suddenly from the small scale . . . to that required for an army of half a million in the midst of a desperate war, was no easy task.”

McClellan’s civilian experience with railroads and the telegraph led him to write a critical memo only eight days after assuming command on August 4, 1861. He outlined the importance of organizing the railroads and telegraph systems “for concentrating at particular positions large masses of troops from remote sections and by creating new strategic points and lines of operation.” His organization soon became federal policy. McClellan next ordered the organization of the USASC under Myer. He also enlisted Western Union’s Anson Stager to organize a telegraph operation for his new command of the Department of the Ohio. McClellan stated that Stager’s purpose was to centralize authority in the hands of one individual for “the execution of such plans as contemplate[d] employment of the telegraph wires.” Stager proceeded to organize commercial and military systems within the Department of the Ohio. Following the disaster at the First Battle of Bull Run (Manassas), McClellan assumed command of the Army of the Potomac. He quickly reorganized the Army and its communications, establishing the USMTC on November 25, 1861 with Stager appointed as Superintendent of Military Telegraphs. A separate field telegraph system was also organized under the auspices of the USASC headed by Myer.

McClellan used his original telegraph organization in a brief campaign into West Virginia in July 1861, making this the first time a mobile electric telegraph had ever been deployed in
battle. He noted the historical precedent of this action in his autobiography, “In this brief campaign the telegraph was for the first time, I think, constructed as the army advanced, and proved of very great use to us; it caused a very great saving of time and horseflesh.”

McClellan recognized the shortcomings of the blended civilian/military command structure for the telegraph operators both in the USMTC and the USASC. He stated, “The weak point in the Signal Corps as then organized, was that its officers were not trained soldiers and therefore their judgment could not always be relied upon.” In turn, “The telegraphers were hampered by the inevitable jealousy and clannishness displayed by the military towards civilian employees. Signal-corps officers thought the telegraph should be under their direction, and gave orders, which the telegraphers ignored.” This attitude pervaded the army and partially accounts for the arrogance and resistance of commanders to rely upon the telegraphers in the USMTC and USASC early in the War.

The relationships between the civilian telegrapher or the signal corps operator and other military personnel remained complex. As the war progressed and the telegraph, and telegraph operators, became more prevalent, bitter jealousies arose on the part of many staff officers, usually the captains and lieutenants. They were hostile that a noncommissioned mere citizen, often a boy, was closely associated with the commanding officer. They were jealous that the generals communicated to superiors through a civilian while military staff remained ignorant of vital facts. They observed that the telegrapher did not salute or obey military orders and frequently acted as a private secretary for generals who often interacted with the telegrapher on a first name basis. On the other hand, in addition to simply lacking military demeanor, the telegraphers themselves remained overly independent and could even be insubordinate. The telegraphers considered their frequent treatment as mere enlisted men insulting when they considered themselves highly skilled electrical technicians who deserved officer status. The mixed position of
the civilian functioning in the military provoked numerous embarrassments for the operator, and officers frequently chafed at the refusal of an operator to inform them of news even in a general way.\textsuperscript{126}

After the war, McClellan, like other commanders reached his own conclusions about the telegraphers based on his direct experiences with the USASC over the preceding four years:

“There was scarcely any action or skirmish in which the signal corps did not render important services. Often under heavy fire or artillery, and not unfrequently (sic) while exposed to musketry, the officer and men of this corps gave information of the movements of the enemy, and transmitted directions for the evolutions of our own troops. The weak point in the signal corps as then constituted was that its officers were not trained soldiers and therefore their judgment could not always be relied upon.”\textsuperscript{127}

McClellan further characterized the activities of the USMTC stating:

“The services of this corps were arduous and efficient . . . they were constantly provided with all the material for constructing new lines, which were rapidly established whenever the army changed position, and it was not unfrequently (sic) the case that the operatives worked under fire from the enemy’s guns; yet they invariably performed all the duties required of them with great alacrity and cheerfulness, and it was seldom that I was without the means of direct telegraphic communication with the War Department and with the corps commanders.”\textsuperscript{128}

Despite all of McClellan’s conflicts with Lincoln and other generals throughout the war, he remained a staunch supporter of the telegraph and not only kept a large compliment of operators and linemen in the Army of the Potomac, but encouraged similar services in all other territories.\textsuperscript{129} Members of the USTMC also respected McClellan since he understood the value of their contributions. One member later commented:

“The telegraph corps revered “Little Mac,” both in person and in military genius. Perhaps none knew better than some of its members the extent and scope of his plans or had more confidence in their success. The orders for his withdrawal from the James were reluctantly transmitted, and on his removal from the command of the Army of the Potomac, in November, his chief operator telegraphed, “We are all grieved at McClellan’s removal. The whole army, from major-generals down to foot orderlies, feel it. Old soldiers of the regulars wept like boys when he left.””\textsuperscript{130}
Unfortunately, McClellan’s own hubris led to his undoing. He withheld information that could have been sent regarding his defeat at Balls Bluff, aggravating Lincoln and setting a pattern for their relationship. Withholding information contributed in part to the establishment of civilian control over the military telegraph. Although McClellan proved to be highly skilled at building and organizing his armies, he repeatedly demonstrated a lack of strategic initiative. Lincoln eventually replaced the “Little Napoleon” for many reasons, but McClellan remained proud of his achievements with the telegraph. McClellan wrote “the first field telegraph that has ever advanced with an army in America kept pace with this one.”

5. General Greely
General Adolphus Greely’s principal contributions to the USASC post dated the Civil War and involved the establishment of a weather bureau and leading arctic explorations. Yet, in 1911, he wrote one of the earliest comprehensive accounts describing the impact of the telegraph service in the war, focusing on a general explanation of the importance of the technology to wartime operations. Without defining the USMTC and the USASC, Greely’s explanations do center upon USMTC contributions. Greely noted that “The cipher-operators with the various armies were men of rare skill, unswerving integrity, and unfailing loyalty.” He further summarized the importance of the telegraph:

“The exigencies and experiences of the Civil War demonstrated, among other theorems, the vast utility and indispensable importance of the electric telegraph, both as an administrative agent and as a tactical factor in military operations. In addition to the utilization of existing commercial systems, there were built and operated more than fifteen thousand miles of lines for military purposes only. Serving under the anomalous status of quartermaster’s employees, often under conditions of personal danger, and with no definite official standing, the operators of the military telegraph service performed work of most vital import to the army in particular and to the country in general. They fully merited the gratitude of the Nation for their efficiency, fidelity, and patriotism, yet their services have never been practically recognized by the Government or appreciated by the people.”

Recollections of the Telegraphers
During the course of the war, approximately 1,500 telegraph operators served in the USMTC. Their average ages ranged from 16 to 23 years. A number of firsthand accounts were written after the war by the telegraphers themselves. They offer the best perspective on the experiences of those directly involved with the technology.
1. John Emmet O’Brien

John Emmet O’Brien’s 1910 book *Telegraphing In Battle* recounts the exploits of John, the youngest telegraph operator in the USMTC, and his elder brother Richard, who was one of the “first four” USMTC operators. It provides comprehensive documentation of both Richard and John’s experiences. John wanted to follow in the footsteps of Richard’s coworker Andrew Carnegie. Like Carnegie, John started as a messenger but was discouraged until Richard, his brother, taught him how to operate a telegraph. At the age of ten, John became a relief operator for the Pennsylvania Railroad. Shortly after the Civil War began, Richard asked John...
to join him at Fort Monroe to serve as his assistant operator. John arrived in Baltimore in early 1862. He was 13 years old. Richard progressed to be the chief operator for the Army of the James, participating in the siege at Petersburg and the capture of Richmond.

Much of the book is filled with excerpts from Richard’s personal diary, including a firsthand account of the famous duel between the USS Monitor versus the CS Merrimack at the Battle of Hampton Roads. John was the operator on duty at Fort Monroe during the battle, and Richard set out with forces to support the wooden ships damaged by the Merrimack in the harbor. John’s book pays tribute to the “first four” operators and all the telegraph operators who served in the War.

After the War, John later became a noted surgeon and author. Richard continued in the telegraph industry. He was first named superintendent of the American District Telegraph Company following Lee’s surrender where he was responsible for reconstructing telegraph lines in an area extending from Richmond, Virginia to Wilmington and Charlotte, North Carolina. He eventually became a superintendent and traffic supervisor for Western Union. Richard was known for his work in submarine cables used under rivers and along coastlines both during and after the war. He also installed the first telephone line in Scranton, Pennsylvania during 1877, one year after Alexander Graham Bell’s invention. In July 1866, Thomas Eckert presented Richard and nine other military telegraphers with silver watches marked “U.S. Military Telegraph” by order of the Secretary of War in recognition of their “meritorious and valuable services” These watches had been purchased and used to establish uniform time in the Army of the Potomac.

John O’Brien extensively described the contributions of the USMTC as well as the Confederate experiences using the telegraph. He summarized the contributions of the wartime telegraphers as follows:

“I will close by saying, in brief, that the telegraph was a potent force, a silent intelligence, which pervaded the whole field, synchronized the movements of all our armies and contributed
very largely to the triumph of the Union. No such system was ever used in war before. Its operations were little known or noticed, except by the great commanders . . . Its influence on the strategy of the war has been little understood, and has, therefore, not been adequately credited by military critics. I believe that without the telegraph we would have had a still harder task to conquer the South, with our million [sic] of men distributed over a wider area than had ever before formed a theatre of actual war . . . Not only the unity of strategic movements, in widely separated fields, depended on the telegraph, but the prompt and adequate supply of the sinews of war—food, clothing, ammunition—depended on its efficiency as much as the civil business of the country now depends on the Western Union and the Postal systems. All these splendid systems—the military telegraph and the commercial telegraphs—owe their triumphs largely to the same head, General Thomas T. Eckert, and his former lieutenants of the military telegraph.”

2. David Homer Bates

Bates, one of the “first four” USMTC operators, became the chief chronicler of President Lincoln’s telegraph operations in the War Department. As a teenager, he moved to Altoona, Pennsylvania, and entered the telegraph service of the Pennsylvania Railroad under the supervision of Andrew Carnegie. In April 1861, Bates and three other cipher operators were ordered to Washington to form a new telegraph corps within the War Department. This was the first time a federal government department had a telegraph service. Major Thomas Eckert was appointed superintendent shortly after their arrival.

Except for two weeks of service in early 1865 as the operator for General Grant at City Point, Virginia, Bates was stationed within the telegraph room of the War Department. In addition to his telegraph skills, he became an expert in military codes and breaking Confederate ciphers. He, Arthur B. Chandler and Charles Tinker became so adept at code breaking that they were dubbed “The
Sacred Three” and were given special status by Lincoln, who ordered that they never be disturbed when deciphering intercepted messages.142

Bates rose to the position of manager by the end of the war. He published *Lincoln in the Telegraph Office* in 1907, a well-received account of his Civil War reminiscences. By the time of his death in 1926, he also completed a book of anecdotes entitled *Lincoln Stories Told by Him in the Military Office in the War Department During the Civil War*. Bates maintained a war diary from Nov. 13, 1863 through June 4, 1865. The contents of that war diary were published in 2003. The editor, Donald E. Markle, was a cryptologist at the Intelligence Service of the Department of Defense working at the U.S. National Security Agency.

Although Bates’ books are primarily intended as studies about Lincoln, they provide tremendous detail about the operations of the USMTC and telegraph services. Bates works are routinely cited (including in this article) as the basis for descriptions of Lincoln and Civil War telegraph operations. Bates notes:

“In our Civil War the Morse telegraph was for the first time employed to direct widely separated armies and move them in unison, and news of victories..."
or defeats was flashed almost instantly all over our broad land. In fact the history of our Civil War was largely recorded by the telegraph, and that branch of the service Stanton, the great War Secretary, called his ‘right arm.’”

3. John D. Billings
Billings was a veteran of the 10th Massachusetts Volunteer Artillery Battery in the Civil War. Originally published in 1888, Billings’ book Hard Tack and Coffee: The Unwritten Story of Army Life quickly became a best seller, and is now considered one of the most important books written by a Civil War veteran. The book is abundantly illustrated by the pen and ink drawings of Charles Reed, also a veteran, who served as bugler in the 9th Massachusetts Battery. Reed received the Medal of Honor for saving the life of his battery commander at Gettysburg. The book is about how the common Union soldiers of the Civil War lived in camp and on the march, and includes numerous descriptions of signaling operations by the USASC. The book covers the details of regular soldier life and as such, has become a valuable resource for Civil War reenactors. Billings summarizes, “Ho! My comrades, see the signal wagging through the sky; reinforcements now appearing, victory is nigh.”

4. Joseph Orton Kerby
Joseph Andrew (later changed to Joseph Orton) Kerby was a young telegraph operator who found himself caught up in espionage serving Union forces in Pensacola, Florida at the outbreak of the War. His book, The Boy Spy: A War, Adventure, Espionage, recounts adventure, romance and an ability to always be in the right place with the right person at the right time that raises skepticism. But his firsthand knowledge of early telegraphy, use of “sound reading” and wire tapping, and his service as a 2nd Cavalry telegrapher with General Buford and later as a commissioned officer in the USASC from 1863–1865 merit consideration. The story is stated to be “a substantially true record of secret service during the war of the rebellion, a correct account of events witnessed by a soldier: The Only Practical History of War Telegraphers in the Field—a Full
Account of the Mysteries of Signaling by Flags, Torches, and Rockets—Thrilling Scenes of Battles, Captures and Escapes.” Kerby occupies a unique place in the history of world espionage as the first documented person to wire-tap and monitor an enemy’s telegraphic communications and to utilize the information as intelligence.46

5. Charles Anderson Dana
Charles Anderson Dana was not a telegrapher, but during the Civil War found himself in constant use of the telegraph. He was a journalist, author, and a senior government official. Until 1862, he was a top aide to Horace Greeley as the managing editor of the powerful New York Tribune. During the Civil War, he served as Assistant Secretary of War, particularly serving in the role of liaison between the War Department and General Grant. Initially very skeptical of the tactical role the telegraph could play, he was present at the Battle of Chickamauga with General Rosecrans and dramatically changed his assessment. His Recollections of the Civil War states:

“That we were able to keep as well informed as we were was due to our excellent telegraphic communications. By this time the military telegraph had been so thoroughly developed that it was one of the most useful accessories of our army, even on a battle-field . . . The line was completed after the battle began on the 19th, and we were in communication not only with Chattanooga, but with Granger at Rossville and with Thomas at his headquarters. When Rosecrans removed to the Widow Glenn’s, the telegraphers went along, and in an hour had connections made and an instrument clicking away in Mrs. Glenn’s house. We thus had constant information of the way the battle was going, not only from the orderlies, but also from the wires. This excellent arrangement enabled me also to keep the Government at Washington informed of the progress of the battle.”47

He was further impressed by the rapidity of the telegraphers in action.
stating, “The boys kept at their post there until the Confederates swept them out of the house. When they had to run, they went instruments and tools in hand, and as soon as out of reach of the enemy set up shop on a stump.”

Spies and Ciphers
Joseph Kerby’s tales reflect the importance of wire tapping and intelligence gathering efforts. Both were deployed, especially as the War progressed, by the North and South as part of broader intelligence gathering efforts. For example, at Vicksburg, two Union telegraphers were ordered, at the request of General Rosecrans, to get behind the lines and tap the wires between Chattanooga and Knoxville to ascertain the movements of Confederate troops. Confederate telegraph wires were often tapped during Sherman’s March to the Sea. From the outset, both sides tapped critical telegraph lines to listen or cut them to interrupt service. However, the South never broke the North’s cipher disks, which remained secret. Those ciphers remained solely in the possession of USMTC operators, unavailable to any military personnel or even to President Lincoln. In a broader context, the Union’s overall secret services proved vastly superior to the Confederate secret services. Indeed, every Confederate plot in the North ultimately failed.

Many operators used the Caton pocket telegraph set. This tiny set (described above) provided a complete telegraph sending and receiving system consisting of a tiny telegraph key and a tiny sounder. It was small enough to fit into a spy’s pocket without being noticed. Civil War spies could tap into the enemy telegraph lines and listen in on the enemy’s messages by simply throwing a wire from this set over the un-insulated enemy telegraph wires and hooking the other wire to a bayonet stuck into the ground. Spies could also send false and misleading messages to the enemy in the same way.

Despite the use of the Caton telegraph sets, most message intercepts did not come through lone wiretaps,
but rather by the capture of enemy telegraph stations. Once in control of a station, the captors could not only intercept messages, but also send false ones.\textsuperscript{156} Because the telegraph lines were so vulnerable to wire tapping and cutting, cavalry patrols and signal guards monitored them when infantry was not available, although volunteers from the infantry were typically easy to find.\textsuperscript{157} General Joseph Hooker regarded the telegraph as so critical during the Battle of Chancellorsville that he detailed two regiments to guard the lines.\textsuperscript{158}

Despite the precautions and although both sides tapped the wires, neither side operated a totally effective intelligence organization. Most successes were primarily attributable to individual efforts. Although both sides obtained intelligence and used it for strategic thinking, transmission for rapid tactical use in the midst of battle was rare.\textsuperscript{159} Confederate efforts were further blocked by the Union’s effective use of ciphers, whereas, the Confederate ciphers were routinely broken by the Union.\textsuperscript{160} In fact, the Confederate telegraph codes were routinely deciphered by Union telegraphers and its mail and signal codes were regularly deciphered by Union signal officers.\textsuperscript{161} Expanded Confederate efforts to involve Canada in the War, to direct “Copperhead” uprisings, to conduct raids to release prisoners, or to coordinate supply and destruction raids were rendered largely abortive due to the “ciphergrammers of the War Department.”\textsuperscript{162}

**PART IV – THE BIG THREE – STAGER, ECKERT, STANTON**

**Nationalizing the Telegraph Under Anson Stager (Military Superintendent of Telegraph Lines)**

Anson Stager spent his life in the telegraph industry. By 1848, he was chief operator of the National Lines in Cincinnati. In 1852, he was promoted to superintendent. He also served as the first general superintendent of newly consolidated Western Union Company beginning in 1856.\textsuperscript{163}

In April 1861, Stager was General Superintendent of Western Union in Cleveland. Ohio’s governor asked Stager to assume military responsibility for managing the telegraphs in southern Ohio and along the Virginia Line. In May, McClellan was appointed Major General commanding the Department of the Ohio, which included western Virginia, Ohio, Indiana, Illinois, and later, Missouri. He requested authority from the state governors over each state’s telegraph lines declaring, “the telegraph is not a military organization.”\textsuperscript{164} McClellan then appointed Stager “superintendent for military purposes of all telegraphic lines” within the Department of Ohio and established the precedent that military messages should supersede all other business on the commercial
wires. By May 27, Stager had designed and transmitted the first cipher ever used in wartime telegraphy. The cipher permitted Stager to securely communicate with those who possessed the cipher key, notably the governors of Illinois and Indiana. The ‘Stager Cipher’ became the standard for Union communications, and whole word codes were used. In fact, it remained unbroken throughout the War.\textsuperscript{165}

In summer 1861, Secretary of War Cameron directed Stager to submit a general plan for a military telegraph. In October, 1861, Lincoln and Cameron accepted Stager’s plan and he assumed command of the USMTC. McClellan had already accelerated the building of telegraph lines within his regional command. After the creation of the USMTC, Stager furthered the work.\textsuperscript{166} Stager nationalized the Union’s telegraph operations, as well as the railroad lines, placing them directly under the government’s authority in 1862.\textsuperscript{167} Although time sensitive messages were often slowed by downed lines and enemy sabotage or even resistance within the military to respond, President Lincoln effectively bypassed the military’s chain of command and directly addressed regional campaign theater commanders and other officers. Both Stager and Lincoln took great personal interest in effectively managing the telegraph communications throughout the War.\textsuperscript{168}

Under Stager’s original plan, the civilian members of the USMTC did not require military ranks. However, U.S. Army Quartermaster General Meigs insisted that ranks were necessary because the Army would refuse to honor Stager’s requisitions for money and supplies since he had no military rank. Stager was therefore brevetted a colonel and assistant quartermaster. He appointed Thomas T. Eckert as his assistant, who received the rank of major. Gilmore and nine other department chiefs were made captains. The operators and cipher men had to perform their duties with no rank at all, and they had no military standing. This dual status where the leaders of a civilian telegraph service possessed a brevetted military rank continued throughout the War.\textsuperscript{169}

Stager specifically noted the contributions of the commercial telegraph companies in his Annual Report of Anson Stager to the Quarter-Master General dated February 1862, stating:

“It is but just to state, in concluding this report, that the telegraph companies have at all times evinced the most liberal and loyal spirit. They have tendered to the Government all facilities possessed by their lines. With few exceptions, they have transmitted the messages of the Government Telegraph Department regarding purchase and shipment of material, and other urgent correspondence, without charge. At telegraph stations where military lines terminate, they furnish room, light and fuel, and the labor of repeating army business without compensation.
Fig. 44. Orders announcing that Congress has authorized the President to take possession of “any or all” railroad and telegraph lines placing them under military control to suppress the rebellion, February 4, 1862. (Author’s Collection)
advice and consent of the Senate, to assess and determine the damages suffered, or the compensation to which any railroad or telegraph company may be entitled by reason of the railroad or telegraph line being seized and used under the authority conferred by this act, and their award shall be submitted to Congress for their action.

SEC. 4. And be it further enacted, That the transportation of troops, munitions of war, equipments, military property and stores, throughout the United States, shall be under the immediate control and supervision of the Secretary of War and such agents as he may appoint; and all rules, regulations, articles, usages, and laws in conflict with this provision are hereby annulled.

SEC. 5. And be it further enacted, That the compensation of each of the commissioners aforesaid, shall be eight dollars per day while in actual service; and that the provisions of this act, so far as it relates to the operating and using said railroads and telegraphs, shall not be in force any longer than is necessary for the suppression of this rebellion.

Approved, January 31, 1862.

BY COMMAND OF MAJOR GENERAL McCLELLAN:

L. THOMAS,

Adjutant General.

OFFICIAL:

Assistant Adjutant General.
No commissions are charged for the material manufactured or supplied the Government.”

Stager’s strongest comments about the telegraph were contained in his Report of Colonel A. Stager, Assistant Quarter-master And Superintendent of the United States Military Telegraph for the Fiscal Year Ending June 30, 1863 dated November 2, 1863 where he stated:

“. . . at any hour of the day or of the night, you can listen to the mysterious, yet intellectual click of the telegraph instrument amidst the strife of battle and the whistling of bullets, its swift, silent messengers pass unseen and unharmed. . . . The public mind has but a faint conception of the magnitude of the uses of the army telegraph. Its importance and utility in a military campaign is fully understood only by those who are constantly brought into contact with it as a medium for the daily transaction of their important and extensive business. . . . The military telegraph, under the general direction of Colonel Stager and Major Eckert, has been of inestimable value to the service and no corps has surpassed—few have equaled—the telegraph-operators.
in diligence and devotion to their duties . . . From the Superintendent’s report it appears that the military telegraph lines required by the Government have been constructed over an extensive and scattered territory . . .”

Stager remained in service with the USMTC until September, 1868, and was made a brevet brigadier general of volunteers for his valuable services. In 1869 Stager moved to Chicago, where he became president of Western Electric. He was also president of the Chicago Telephone Company and president of the Western Edison Company, which he consolidated. Stager died in Chicago in 1885.

**Thomas T. Eckert (Chief of the War Department Telegraph Office)**

Eckert was superintendent of the Union Telegraph Company in Ohio until 1859 when he moved to Montgomery County, North Carolina to manage a gold mine. In 1861, Eckert returned to Ohio to bring his wife and children to North Carolina. Upon arriving back in North Carolina, Eckert was accused of being a Northern spy. When his case was heard before a judge, the judge acquitted Eckert due to lack of proof. After the case, Eckert and his family escaped back north to Cleveland with the help of influential friends in 1861.72

After arriving in Cleveland, Eckert telegraphed Assistant Secretary of War Thomas A. Scott that his services were available. Eckert was ordered to Washington and was assigned to General McClellan’s headquarters as captain and aide-de-camp in charge of military telegraph operations. He accompanied McClellan on the Peninsula Campaign as superintendent of the military telegraph for the Department of the Potomac. In September 1862, he was sent to Washington to reorganize and administer the War Department’s Telegraph Office, and he was given the rank of major. Since Stager continued to function as a Western Union Superintendent in Cleveland, in addition to being Superintendent of the USMTC, Eckert actually managed most of the daily responsibilities of the USMTC’s office in the War Department. In 1864 Eckert was brevetted a lieutenant colonel and was later granted the rank of
Brigadier General of Volunteers in 1865. He was appointed Assistant Secretary of War in 1866, a position he held until 1867.¹⁷³

One of Eckert’s most notable recollections of his experiences described Lincoln’s drafting of the Emancipation Proclamation at Eckert’s desk in the War Department Telegraph Office. Eckert’s correspondence to Bates describes Lincoln and the Emancipation:

“... shortly after McClellan’s ‘Seven Days’ Fight,’ he [Lincoln] asked me for some paper, as he wanted to write something special. I procured some foolscap and handed it to him. He then sat down and began to write. I do not recall whether the sheets were loose or had been made into a pad. Lincoln would look out of the window a little and then put his pen to paper, but he did not write much at a time. He would study between times, and when he had made up his mind he would put down a line or two, and then sit quiet for a few minutes. After a time he would resume his writing, only to stop again at intervals to make some remark to me or to one of the cipher operators as a fresh despatch [sic] from the front was handed to him.” ... He didn’t write much at a time, and he didn’t write rapidly ... he made no secret about it [to the cipher operators and he asked Eckert to] please keep it locked up.” ...”He [Lincoln] said he had been able to work at my desk more quietly and command his thoughts better than at the White House.
House, where he was frequently interrupted. I still have in my possession the ink-stand which he used at that time and which, as you know, stood on my desk until after Lee’s surrender.\textsuperscript{174}

Eckert was responsible for assigning talented operators to the various theaters of War. In one exchange during July 1862, Eckert was asked if he needed a “good sound operator.” The ability to receive telegraph by sound, listening and directly translating the sounds of the receiver clicking versus reading a printed paper tape, was a highly sought skill in the early 1860s. Sound reading, also called acoustic reading, was a much faster and more efficient means of receiving Morse code. The reception by telegraph register printing on a paper tape required constant winding of the register’s clockwork motor as well as repairs to its motor, weight and cord. Imperfect transcription onto the paper tape, and mistakes by the copyist as well as retranslation for delivery caused routine delays and unnecessary labor. The telegraph companies, concerned with preserving a paper record to ensure the accuracy of the messages, were slow to accept reception solely by ear. Nevertheless, after 1850, operating by sound became prevalent.\textsuperscript{175}

The main advantage of the sound reading was speed. Morse paper tape reading methods averaged 25 words per minute.\textsuperscript{176} In comparison, Jesse Bunnell, of post-war telegraph manufacturing fame, was operating with McClellan in Yorktown at rates of 40 words per minute.\textsuperscript{177} This led to the widespread use of sounders for copying Morse code by the time of the Civil War. The

Fig. 48. Inkwell from the War Department Telegraph Office used by President Lincoln to write the first draft of the Emancipation Proclamation. (Smithsonian Institution, Author Photo)
Confederate military telegrapher James Francis Leonard of Frankfort, Kentucky is credited with being the first practical sound reader to rapidly and accurately copy Morse code by ear in 1849, using the sounds made by a register as it impressed dot and dash marks on paper tape. Leonard had won speed contests averaging 50 words per minute in the 1850s and could operate for

Fig. 49. Views of James Leonard Tombstone—Called home by the Grand “Chief Operator” To Work the “Eternal Circuit” Above. Tombstone details with telegraph key, insulators on telegraph pole and the epitaph. Frankfort Cemetery, Franklin County, Kentucky (Courtesy Perera, 2016)

Fig. 50. Correspondence to Col. Thomas Eckert requesting sound operators, July 11, 1862. (Author’s Collection)
Fig. 51. Thomas Eckert revered the scientists associated with the telegraph. This signed set of portraits was given to Eckert by Frances W. Jones with portraits of William Thomson (top center), Charles Wheatstone (center), Michael Faraday (bottom center), Ernst Werner Siemens (top left), Latimer Clark (bottom left), Charles William Siemens (top right), and David E. Hughes (bottom right). (Author’s Collection)
short periods at 60 words per minute. He later served as a telegraph operator assigned to General Beauregard’s staff in Corinth, Mississippi and died in July 1862 at 27 years of age.¹⁷⁸

After the War, Eckert managed the eastern division of Western Union, eventually becoming president of the Atlantic and Pacific Telegraph Company, the American Union Telegraph, and later Western Union. In 1900, he became chairman of the board of directors and held this position until close to his death in 1910.¹⁷⁹

**Edwin Stanton (Secretary of War)**

Edwin Stanton served as President Lincoln’s Secretary of War during most of the Civil War. His tough and autocratic, but very effective, management style and his use of telegraph communications were instrumental to organizing the Union’s extensive military resources. After Lincoln’s assassination, Stanton remained as Secretary of War under President Andrew Johnson during the first years of Reconstruction; however, he opposed President Johnson’s lenient policies towards the former Confederate States. Johnson’s attempt to dismiss Stanton ultimately led to Johnson’s impeachment by the House of Representatives. In 1869, Stanton was nominated to the U.S. Supreme Court by President Grant; however, he died four days after his nomination was confirmed by the Senate.¹⁸⁰

Stanton’s interest in the telegraph occurred as early as 1847, only three years after Morse’s demonstration of the experimental line between Washington and Baltimore. Stanton was serving as a director of the Pittsburgh, Cincinnati & Louisville Tele-
graph Company, which sought to expand telegraph service west of Pittsburgh. By 1860, Stanton, now a lawyer and politician, was experienced in managing governmental affairs and was very aware of the critical importance of communications. As Lincoln’s Secretary of War, he prioritized the creation of an effective transportation and communication network across the North based on its railroad system and telegraph network. Stanton was a primary proponent of granting the president authority to forcibly seize railroad and telegraph lines. He relocated the military’s telegraph operations from McClellan’s army headquarters to the War Department giving him closer control over the military’s communications operations.

After the fall of Richmond on April 3, 1865, Stanton stood in the War Department Telegraph Office reviewing the incoming telegrams. He exclaimed to the operators while his “tears of joy and gratitude were falling . . . Boys, I consider the telegraph my right arm and if ever I can do anything for you don’t hesitate to ask it.” In his official report Stanton later stated, “The Military Telegraph, under the general direction of Colonel Stager and Major Eckert, has been of inestimable value to the service, and no corps has surpassed it.”

**PART V – OPERATOR EXPERIENCES**

**Women in the War**

Women also played a role in both military and civilian telegraph operations. They served as operators, clerks and office managers. As male telegraphers enlisted or were drafted into the military telegraph corps, they were replaced by women. Records to verify the women’s activities are scarce, but evidence is available.

Colonel Marshal Lefferts was a major supporter of using women in telegraph operations. Lefferts was a telegraph engineer responsible for building long lines between New York, Buffalo and Boston. He was involved with American Telegraph Co. and Western Union where he designed test equipment and developed the Lefferts

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Fig. 54. Carte-de-Visite Photograph of Col. Marshal Lefferts. (Author’s Collection.)
Insulator. Lefferts hired the first female employees in the industry. In the War, Lefferts commanded the 7th NY Regiment and served as military governor of Frederick, Maryland. The regiment engaged in the Peninsula Campaign, Antietam, Fredericksburg, Chancellorsville and Gettysburg. A similar turn of events took place in 1865, when three women’s names can be found in the roster of USTMC military telegraphers compiled by William Plum in *The Military Telegraph During the Civil War*. Louisa Volker’s intelligence activities on behalf of the Union army at Mineral Point, Missouri put her at risk of capture during Sterling Price’s invasion of Missouri in 1864. Among the most famous of the Union women working in civilian offices were Elizabeth Cogley at Pennsylvania Railroad headquarters in Harrisburg and Abbie Strubel at the Baltimore & Ohio Railroad in Pittsburgh. Cogley was the Pennsylvania Railroad’s first female operator and worked for 45 years, finally retiring in 1900. Strubel was one of the earliest operators to learn to receive by sound alone. Hettie Ogle at the Western Union office in Bedford later managed the telegraph office in Johnstown where she lost her life in the Johnstown Flood of 1889. Emma Hunter in West Chester was considered to be an expert operator and sent many war-related messages, finally leaving the telegraph office in the late 1860s.

Although few records survive, women were involved in telegraph offices nationwide. On October 31, 1864, a letter to the editor from ‘Susan-nah’ appeared in the second issue of the *Telegrapher*, which stated, “we—that is, your sister operators—are rapidly growing in numbers.” The return address was the American Telegraph Company’s operating rooms in New York at 145 Broadway.

Less is known about the role of women in Confederate telegraph operations, but women did take charge of telegraph offices as the men went to war. Women are known to have worked as telegraphers and office managers in Georgia, South Carolina, Louisiana, Florida, and Alabama during the Civil War.

After the war, women continued to work in the telegraph industry with the support of the industry itself, and Western Union in particular. They also actively defended and justified their role...
as able employees and contributors to the war effort.¹⁹²

**Examples of Union Operations**

Examples of military telegrams are generally available for collectors. Rarer telegrams specifically note activities involving the telegraph. A few examples demonstrate the importance placed by the participants themselves on the telegraph.

1. **U.S. Military Telegram Reporting on Telegraph Operations at Bridgeport, Alabama in September 1864.**

Bridgeport, Alabama in the northeast corner of the state was a strategic location during the Civil War and numerous actions took place in the area. In the latter part of the war, Bridgeport was the site of a major shipyard building gunboats and transports for the Union Army.

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Fig. 56. U.S. military telegram reporting on telegraph operations at Bridgeport, Alabama, September 30, 1864. (Author’s Collection)
A U.S. Military Telegram from Brigadier General Luther Prentice Bradley reported on telegraph operations at Bridgeport in September 1864, confirming that the telegraph is “working” and that naval officers confirm that “rebel forces” were moving toward Bridgeport and Chattanooga. Bradley states he will send any additional information needed from “any quarter.”

Bradley captured Island Number Ten in New Madrid, Missouri, and later participated in the Battle of Stones River. He was severely wounded at Chickamauga where he commanded a brigade. Bradley participated in the Atlanta Campaign under General Sherman, fought in Tennessee at the Battle of Spring Hill and was again wounded. His injury prevented him from leading his brigade during the Battle of Nashville that followed. After the war, he constructed several western forts used during the Indian Wars. He also attended the Centennial Exposition in 1876 as an official attendee for the Army seeing the electrical, telephone and telegraph displays.

**2. U.S. Military Telegraph Regarding Medical Transport By Rail From Rappahannock in Oct. 1863**

Civil War medical equipment and knowledge were primitive by modern standards. Medical practices were simply not prepared for the challenges posed by deaths, wounds, infections and diseases that plagued millions of soldiers on both sides. Illnesses like dysentery, typhoid fever, pneumonia, mumps, measles and tuberculosis quickly spread among the poorly sanitized camps. Men weakened by fighting and exposure to the elements who were surviving on meager rations fell ill. Both armies initially struggled to efficiently tend to and transport their wounded, inadvertently sacrificing more lives to mere disorganization. Telegraph operations were critical to organizing relief wagons and transport by rail or riverboat.

**3. Telegraphic Orders Prohibiting The Issuing of Bounties For Soldiers in December 1863**

The Civil War was the first American war that used conscription. Both sides permitted conscripts to hire substitutes to serve in their place. In the Union, many states and cities offered bounties and bonuses to drive voluntary enlistment in order to meet the state quotas for military service. In April 1862, the Confederate Congress passed an act requiring military service for three years from all males aged eighteen to thirty-five not legally exempt; it later extended the obligation. The U.S. Congress followed in July with the Militia Act of 1862 authorizing a militia draft within a state when it could not meet its quota for volunteers. Failures in the state administered system resulted in the March 1863 Enrollment Act, the first national conscription law in the U.S., which set up an elaborate machinery for enrolling and drafting men between twenty and forty-five years of age to serve in the Union Army.

On December 23, 1863, the U.S. government issued a call for 300,000
volunteers stating at the time that after January 5, 1864 there would no longer be any extra bounties. It was hoped this announcement would cause a rush to enlist. In April 1864, extensions were terminated, and after 1864, enlistments were sought for one, two and three years with new quotas assigned in each state. Deficiencies in volunteers were required to be met by conscription. Men could still could provide substitutes, and until mid-1864 could even avoid service, by paying commutation money. The Confederacy maintained its basic conscription program throughout the war and never effectively dealt with these issues due to inequities in the exclusion rules and unresolved conflicts between state and local governments and the national government of the Confederacy. 

Fig. 57. U.S. military telegraph regarding medical transport by rail from Rappahannock to Washington, Oct. 12, 1863. (Author’s Collection)
Telegraph in the American Civil War

4. Signal Corps Letter Dated March 1865
Life on the front line was difficult with exposure to the elements, warfare, and daily living among large masses of men under poor sanitary conditions. A letter from Union Reserve Signal Corps Headquarters written by Volunteer Private Lewis A. Egolf describes “pretty hard times” in the infantry and cavalry. He outlines lonely camp life, rain, lack of privacy and aggravations with army regulations. Egolf was from Minneapolis. This rare letter is written on U.S. Signal Corps letterhead.

Fig. 58. Telegram orders dated Dec. 24, 1863 prohibiting the payment of bounties after Jan. 5, 1864 for the Army of the Potomac. (Author’s Collection)
In 1861, the United States was the most newspaper-rich nation in the world with over 3,000 newspapers constituting one-third of all newspapers published in the world. The public was hungry for news throughout the war. The Associated Press wire service, founded in 1846, shared the cost of transmitting common news. Over 300 special war correspondents also travelled with the troops. Telegraph bulletins, telegraph updates, news by telegraph, and other postings and broadsides issued by the newspapers brought the public an unprecedented up-to-date awareness of the battles and leaders of the war. Throughout the North, crowds hung about the bulletin

5. **Telegraphic Broadside**

General Nathan Banks noted the importance of the telegraph in sustaining morale during the War. He stated:

“...the Telegraph performed [an] important and patriotic part. It was the constant telegraph communications from the Government, and army, that re-assured the people, bound the loyal States together and stimulated civil and military authorities to greater exertion... It was in truth, an electric nerve that united them, consolidated their power, inspired them with courage and hope and finally led them to victory.”

In 1865, the United States was the most newspaper-rich nation in the world with over 3,000 newspapers constituting one-third of all newspapers published in the world. The public was hungry for news throughout the war. The Associated Press wire service, founded in 1846, shared the cost of transmitting common news. Over 300 special war correspondents also travelled with the troops. Telegraph bulletins, telegraph updates, news by telegraph, and other postings and broadsides issued by the newspapers brought the public an unprecedented up-to-date awareness of the battles and leaders of the war. “Throughout the North, crowds hung about the bulletin

Fig. 59. Signal Corps letter from Private Lewis A. Egolf, March 3, 1865. (Author’s Collection)
Fig. 60. Telegraph broadside, June 5, 1861, announcing a naval engagement, anticipating the First Battle of Bull Run (Manassas), the execution of a spy and the construction of a military telegraph line to Manassas, Virginia. (Author’s Collection)
boards and telegraph offices, eagerly devouring the latest news.”

Yet, the public was not aware that the news by telegraph was, in fact, being censored. In April 1861, Ohio’s governor William Dennison agreed with General McClellan that military supervision of the state’s telegraph lines was necessary “to stop all messages of a disloyal character,” especially “orders for munitions and provisions for the South.” By early 1862, Secretary of War Stanton ordered that no military information was to be sent over the telegraph except by order of the War Department or a commanding general in the field. Newspapers that printed restricted content were to be excluded from receiving any news and from sending their papers over the railroads. A military telegraph supervisor, E. S. Sanford, was appointed to oversee all official telegraph dispatches, acting in effect as a censor.

Throughout the war, Lincoln and his staff and his generals tried to proactively manage breaking news or to offset news of disasters with success stories to limit the negative impact on morale in the North. The Associated Press was given preferential access to news as well as access to restricted telegraph lines with the understanding it would report the news as presented by the Lincoln Administration. The President’s team, with Lincoln’s support, continued to manage public relations and spin the news throughout the war to promote its war aims and boost morale.

Confederate Examples
Confederate records are incomplete and few documents record the use of the telegraph by the Confederacy. Despite its underutilization, a number of examples can be found that demonstrate the use of the telegraph by the South.

1. Confederate Telegraphic Dispatch Regarding Cavalry For General Johnson’s Defense of Jackson
The war in the West was not proceeding well for the Confederates in 1863. General Johnson defended Jackson, Mississippi and received communications from Mississippi Governor John Pettus and Colonel James H. Rives in May 1863. Rives was the aide-de-camp to Pettus. After the election of President Lincoln in 1860, South Carolina seceded from the Union and invited other Southern states to join in forming a Southern nation. Mississippi, under the leadership of Pettus, followed in January 1861, and along with five other slave states established the Confederate States of America in February 1861 at Montgomery, Alabama.

In 1862, during the early stages of Grant’s Vicksburg campaign, Pettus was forced to move the state capital first to Enterprise and then back to Jackson. When his second term expired in October 1863, Pettus joined the Confederate Army. After Lee’s surrender at Appomattox, Pettus refused to surrender and settled in Arkansas where he continued to resist federal military authorities until his death in January 1867. Rives and his artillery would eventually be
one of the last to leave Richmond before it fell to the Union and Lee surrendered at Appomattox.

2. Morgan’s Raid and Capture of a Telegraph Instrument

John Morgan was a Confederate general and cavalry officer best known for Morgan’s Raid in June and July 1863. He and his men rode over 1,000 miles in 46 days from Tennessee, up through Kentucky, into Indiana and onto southern Ohio. This was the farthest north any uniformed Confederate troops penetrated during the War. The raid coincided with the Vicksburg and Gettysburg Campaigns, although it was not directly related to either. Morgan and his men captured and paroled about 6,000 Union soldiers and militia, destroyed 34 bridges, disrupted the railroads at more than 60 places, destroyed telegraph lines and diverted tens of thousands of troops from other duties as well as striking fear in the civilian population of several Northern states. In Ohio alone, approximately 2,500 horses were stolen and nearly 4,375 homes and businesses were raided. Repeatedly thwarted in his attempts to return south by hastily positioned Union forces and state militia, Morgan eventually surrendered in northeastern Ohio. The general and six officers famously escaped by tunneling from an air shaft beneath their cells into the prison yard and scaling the walls. Only two of Morgan’s men were recaptured. He and the rest returned to the South. Morgan was killed less than a year later in Tennessee by a Union cavalryman after refusing to halt while attempting to escape during a Union raid.205

Morgan was very aware of the importance of the telegraph and took “great delight in becoming the chief antagonist of the Union military telegraph system in the West.”206 He recruited George “Lightning” Ellsworth, a Canadian telegrapher who served in the Confederate cavalry under Morgan, to telegraph false or misleading information on Union telegraph lines or on Confederate lines that were known to be monitored by the Union. He earned the nickname “Lightning Ellsworth” in Morgan’s first Kentucky Raid in July 1862 after sending a telegram in knee-high water...
during a thunderstorm.\(^{207}\) Morgan used Ellsworth to “milk the wires” for intelligence and disrupted and sowed confusion by sending misinformation in all directions while posing as Union telegraphers.\(^{208}\) Ellsworth developed the ability to imitate the distinctive style, or “fist,” of other telegraphers,

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*Fig. 62. Letter announcing Morgan’s Raid and the capture of a telegraph instrument from Morgan’s forces. The telegraph instrument was likely used by Morgan’s telegrapher, George Ellsworth. Letter dated July 28, 1863. (Author’s Collection)*
including several Union telegraphers based in Kentucky and Tennessee. The Times in England later declared the use of the telegraph to spread disinformation as the greatest innovation to come out of the war.

3. Reminiscences of a Mosby Guerrilla

John Munson was 15 years old and a native of Richmond, Virginia when he first heard about Confederate John S. Mosby and his band of partisan rangers operating in northern central Virginia. Munson’s firsthand accounts provide an amazing description of life in a detached cavalry unit that was not a part of the regular army. The ‘43rd Battalion’ operated in small groups of no more than 50, or as few as two or three for scouting assignments. Mosby, known as the Gray Ghost, and his rangers engaged in raids, stole supplies, captured horses and mules, burned bridges, wrecked railroad tracks, and even kidnapped a Union general from his bed one night in Fairfax County. Mosby, like Morgan, targeted the Union telegraph lines either by tearing them down or cutting them. Munson was in Mosby’s outfit from its early days of operation until the very end. Mosby learned about Lee’s surrender at Appomattox and chose to disband his unit rather than surrender to Union forces. Mosby did not receive parole until early 1866, nearly a year after war’s end, ironically by then President Grant. Mosby lived until 1916. Munson recorded his experiences in his book Reminiscences of a Mosby Guerrilla.

PART VI – PRESERVATION

Old Time Telegraphers Association and Society of U.S. Military Telegraphers

In 1880, Western Union’s Vice President and General Manager and former Superintendent of the USMTC, General Anson Stager, along with his Western Union stalwarts Charles Taylor, F. A. Armstrong, and J. C. Matoon, proposed a reunion of all old time telegraphers. The first reunion took place in Cincinnati in September 1880 with about one hundred former telegraphers in attendance. The Old Time Telegraphers’ Association (the ‘Association’) formed and elected James Reid as Chairman. Any person who served at least five years in the telegraph service during the past 25 years could join.

No reunion took place in 1881 due to the assassination of President Garfield. At the 1882 reunion, the Society of the United States Military Telegraph Corps (the ‘Society’) formed, and former USMTC telegrapher Col. William R. Plum of Chicago was unanimously elected as the first President. Any former member of the Corps and their male descendants were eligible for membership.

Since so many telegraphers were eligible for membership in both the
Association and the Society, the two organizations held joint reunions after 1882, with each organization presenting their own business reports at the combined meetings. The 25th annual reunion at the Waldorf-Astoria Hotel in New York City was the largest. From August 29 through September 1, 1905 more than one thousand people filled the Waldorf to capacity. Thomas Edison, Clarence Makay (President of Postal Telegraph), Colonel Robert C. Clowry (President of Western Union) and many other industry leaders were among the notable attendees. Side trips were even provided, including a visit to Grant’s Tomb in Riverside Park by Morning-side Heights (Grant’s tomb was modeled after Napoleon’s Tomb in Paris).  

Over the years, former USMTC telegraphers grew increasingly bitter about the lack of official acknowledgement for their contributions to the war effort, and the lack of governmental support for widows and children of the deceased.

“No provision was ever made for his wife and little ones; no slab ever erected at Government expense; no military salute was fired over his [the telegrapher’s] grave . . . Indeed, some who pretended to write up the history of the Civil War, seem to have been strangely ignorant of the fact that there ever was a Military Telegraph Corps; much less did they ever hear of the repairer, who dared and died for his country.”

“During the war there occurred in the line of duty more than three hundred casualties among the operators by disease, killed in battle, wounded or made prisoners. Scores of these unfortunate victims left families dependent on charity, for the Government of the United States neither extended aid to their destitute families, nor admitted needy survivors to a pensionable status.”

Congress finally gave some formal recognition to the contributions of the civilian USMTC in 1897, although no military pensions were ever paid. The
issue arose because the USMTC was, technically speaking, composed exclusively of civilian military leaders in the Cabinet responsible to the Secretary of War. Technically, the USMTC was a civilian bureau of the U.S. Army Quartermaster Department. The managers, operators, and linemen were civilians only, although they were required to perform strictly military duties, frequently at or near the actual lines of battle.\textsuperscript{217} Congress passed Senate Bill 319 in 1897, \textit{An Act for the Relief of Telegraph Operators who Served in the War of the Rebellion}.\textsuperscript{218} However, “The act was carefully drawn . . . to exclude us from receiving pensions.”\textsuperscript{219} Nevertheless, former military telegraphers, including women, did achieve some recognition by this act as honorably discharged members of the United States Army.

During the War, over 300 casualties were suffered by the USMTC from disease, capture and enemy fire. This rate of approximately one death for every four members of the USMTC (depending on the estimates of the total number of people who served in the USMTC) is similar to the Union’s casualty rate.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image1.png}
\caption{Convention medals for Old Time Telegraph & Historical Association: 1896 (left), 1905 (right). (Author’s Collection)}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image2.png}
\caption{Miniature souvenir telegraph key given to all the guests attending the 1905 convention of the Old Time Telegraph & Historical Association. (Courtesy Casale, 2007)}
\end{figure}
Fig. 66. Civil War veterans service medals: Grand Army of the Republic (center), U.S. Signal Corps (top center two) and Old Time Telegraphers/U.S. Military Telegraph Corps Conventions (two outside). (Author’s Collection)

Fig. 67. Society of U.S. Military Telegraphers Certificate signed by David Homer Bates and William Bender Wilson, 1913 with a portrait of Samuel Morse at the top. (Author’s Collection)
for infantry.\textsuperscript{220} Even so, the Federal government never considered the telegraph service a true military corps, and the operators were never given pensions. The philanthropist Andrew Carnegie, a former telegrapher himself, stepped in 42 years after the surrender at Appomattox. At the symbolic age of 73 (noting that “73” was the telegraphers’ own private shorthand for “best wishes” or “warmest regards”), Mr. Carnegie “instituted an honor pension for the needy survivors of the 1860s military telegraph service at the same rate as private Union soldiers, or thirteen dollars a month.”\textsuperscript{221}

The 38\textsuperscript{th} reunion was held in Chicago in 1921. Bates, then Secretary of the Society, reported only 101 members of the USMTC were still alive. By 1927, Bates and others had passed away, and only 17 of the original Civil War telegraphers were still alive. In 1930, the Association still had 2,300 members, but four years later in 1934 the organization was finally disbanded. Parts of the collection had been initially given to the Smithsonian Institution in 1901. The Association continued to receive donations, and the telegraph collection of over 54 years was eventually donated to the Edison Institute Museum in Dearborn, Michigan, now known as The Henry Ford Museum.\textsuperscript{222}

![Fig. 68. Watch Fob Old Time Telegraph & Historical Association Convention 1928. (Author’s Collection)](image)

![Fig. 69. Old Time Telegraphers Association & Society of U.S. Military Telegraphers 28th Reunion 1909. (Author’s Collection)](image)
Post War Technical and Pictorial Histories

After the War, several efforts were made to carefully document the technical achievements of the wartime telegraphers. Two key technical histories are available for the researcher. Col. William R. Plum’s 1882 *The Military Telegraph During the Civil War in the United States* is widely considered the most comprehensive treatment, including descriptions and illustrations of apparatus, signals and codes as well as lengthy treatise detailing military procedures and history. Plum volunteered for service as a telegrapher for the Union Army in February 1862 at age 16. He was eventually assigned to General George H. Thomas, commander of the Department of the Cumberland, and served with him until the end of the War. Plum was one of the few operators who had access to all nine Union ciphers. He took notes of his wartime experiences and in 1882 published his book. He also wrote a novel about the War, *The Sword and the Soul*. He became and lawyer in Chicago and advocated vociferously on behalf of the telegraph operators. He was unanimously elected the first President of the Society and was unanimously re-elected for the next 14 years.\(^{223}\)

Joseph Willard Brown’s 1896 *The Signal Corps, U.S.A. in the War of the Rebellion* offers similar topics.

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Fig. 70. Col. William R. Plum’s Old Time Telegraphers Association Certificate. (Courtesy Helen Plum Library, Lombard, Illinois.)
with additional detail. Two other key contemporary texts provide additional information on the equipment available, including the 1866 edition of the *History, Theory and Practice of the Electric Telegraph* by George Prescott and 1870 edition of *The Modern Practice of the Electric Telegraph* by Frank Pope.

The Civil War was one of the first wars to be actively photographed, and portraits were taken of generals and civilian leaders on both sides of the conflict. These photographs, and the books where they were republished, continue to be cited today as critical resources. Several of the postwar photographic histories contained photos and illustrations of the USMTC and USASC telegraph operations and signal corps stations. They each reprinted

Fig. 71. A selection of reunion ribbons from Col. William R. Plum. (Courtesy Helen Plum Library, Lombard, Illinois.)

Fig. 72. The Signal Corps of the United States Army, drawn by A.R. Waud, Harper’s Weekly, June 28, 1862. (Author’s Collection)
many of the photographic negatives initially taken by Mathew Brady or Samuel Gardner. Brady was one of the first American photographers who studied the methods of daguerreotype photography with Samuel Morse. Alexander Gardner was a Scottish photographer who emigrated to the U.S. in 1856. Gardner later worked for Brady and then opened his own studio in 1862. He is best known for his photographs of the Civil War, President Abraham Lincoln, and photographs of Lincoln’s assassination conspirators at their execution.

Two primary books contain many of the most well known photographs as well as many engravings of signal corps and telegraph operations. Much of the text in both books is written by former Union and Confederate leaders, officers and soldiers as well as photographers and historians who directly participated in the Civil War. Frances Trevelyan Martin’s 1911 *The Photographic History of the Civil War in Ten Volumes* contains specific articles on the signal corps and telegraph services along with many classic rare photos. Many of Brady’s well known and wide ranging pictures and portraits from the Civil War are included. Gardner’s *Photographic Sketch Book of the War* published in 1865 and 1866 contains two volumes with fifty albumen print photographs, each with a descriptive caption, generally believed to have been written by Gardner himself.

Fig. 73. The Army telegraph, setting up the wire during an action, drawn by A.R. Waud, *Harper’s Weekly*, Jan. 24, 1863. (Author’s Collection)
Harper’s Weekly, Leslie’s Illustrated Weekly and other pictorial newspapers covered the War extensively. Yet, despite the presence of such famous artists as Winslow Homer, who worked for Harper’s Weekly, relatively few illustrations were produced that show the operations of the telegraph or signal corps. Most illustrations focus on the more dramatic battle scenes, soldiers, naval battles, wartime destruction, camp life and portraits of the military and civilian leaders. Several postwar commemorative editions published by Harpers contain reprints of the original articles and illustrations. Unfortunately, relatively few images or articles relate to signal corps or telegraph operations. Some examples of the Harpers illustrations have been included in this article.

Concerted Preservation Efforts

The political wrangling between the military USASC and civilian USMTC had an unexpected benefit for historians. Stager’s order dated November 4, 1862, strictly required all USMTC operators to retain “the original copy of every telegram sent by any military or other Government officer . . . and mailed to the War Department.”

This order was intended to keep the president’s administration informed of all developments in the War. By following the order, the USMTC compiled a complete record of the telegraphic history of the war, leaving a treasure trove of detailed information for future historians. Much of that archive formed part of the official government record of the war.

Concerted efforts to preserve war records began almost immediately. Both sides wanted to tell their story to succeeding generations. The “Lost Cause” themes adopted by Southern historians focused on the bravery of Confederate soldiers amidst a torrent of superior manpower and supplies that poured in from the North. Union historians focused on the ideals of preserving the Union, freeing the slaves and the heroism of Union forces.

The Office of the Chief Signal Officer issued circulars in 1867 soliciting photographs of all who had served in the Signal Corps during the late war. Former battlefields were set up as monuments and parks by local, state and national authorities. Veterans of the former Confederacy and their families established their own museums. Confederate Memorial Hall opened its doors in New Orleans in 1891, and the former ‘White House of the Confederacy’ in Richmond reopened in 1896 as the Museum of the Confederacy. The Chicago Historical Society, New York Historical Society and Atlanta Historical Society each assembled significant and historically important collections of Civil War documents and artifacts at the beginning of the twentieth century.

Early on, General Adolphus Greely collected and contributed his own original documents and historical materials for preservation. Greely compiled documents regarding the Battle of Chickamauga in which telegraph played a key role. The Battle of Chickamauga, fought September 19–20, 1863, marked the end of a Union offensive in southeastern
Tennessee and northwestern Georgia called the Chickamauga Campaign. The battle was the most significant Union defeat in the Western Theater of the American Civil War and involved the second highest number of casualties in the War following the Battle of Gettysburg. Greely was wounded three times in the Civil War and promoted to major. After the War he was put in charge of the U.S. Signal Corps. During his tenure as Chief Signal Officer (1887–1906), Greely introduced the radio, automobile and airplane into military use. He wrote that his most important peacetime act was convincing Samuel P. Langley to produce a flying machine for the military. Although Langley was unsuccessful, his work encouraged the Wright brothers. Greely was instrumental in the survival of the Signal Corps in an era when Congress almost abolished it. Greely’s contributions included arctic exploration and overseeing the construction of thousands of miles of telegraph lines in the American southwest.226

Preservation efforts eventually expanded from general military history to specifically focus on U.S. telegraph history. The 1880 invitation to the first national “Old Timer’s” reunion of the Association requested, “We desire that each one will secure any relics of old-time telegraphy [italics original], and send them or bring them for temporary exhibition.”227 The preamble to the newly formed Constitution of the Old Time Telegraphers Association dated September 17, 1880 opens with “The science and art of telegraphy, which continue as the wonder and admiration of the world, have, in the United States, become of such paramount consequence as to justify, if not require, organized effort to preserve early memories incident to the

Fig. 74. Receipt issued to General Adolphus Greely regarding Chickamauga documents. (Author’s Collection)
unfolding thereof.” And the Secretary was charged with the “preservation of all exhibits, pictures, instruments, relics and other mementos or reminders which shall be purchased or presented to this Association...” Thus, the Association began to play an active role in preservation efforts.

The 1890 joint reunion of the Association and Society in Kansas City, Missouri brought an announcement from the Association about the loss of all its records due to a fire at Western Union in New York City. Association President George C. Maynard made an urgent appeal at the next reunion in 1891 asking members, “to collect everything that would perpetuate the history of telegraphy. If the Old Time Telegraphers’ failed to do this, much of the early history of telegraphy would be lost.”

Three years later, the Telegraphic Historical Society of North America formed “for the [express] purpose of collecting, preserving and publishing historical information relating to the establishment and development of the Telegraph in North America.” By September 1901, that organization merged into the Association which, undertaking a renewed focus on preserving history, modified its name to become the Old Time Telegraphers’ and Historical Association. Maynard, a former Civil War telegrapher, later became a curator at the United States National Museum (later part of the Smithsonian) in Washington, D.C. After the two organizations combined, their relics were deposited in the Smithsonian. The Association also continued to receive items from its members, and eventually its remaining collection was transferred to the Henry Ford Museum at Dearborn, Michigan.

J. Elfrith Watkins, a former Pennsylvania Railroad employee and museum curator for the United States National Museum and the World’s Columbian Exposition in Chicago as well as the Field Columbian Museum, authored an early and important work outlining the necessity for historical preservation. The Importance of Collecting and Preserving the Relics of the Beginnings of the Telegraph was delivered in 1891 to the Association’s and Society’s joint convention in Washington, D.C. He stated:

“I believe it to be true that he who helps perpetuate history, by preserving things, does more valuable work than he who attempts to record history in only words . . . Ere it is too late, I beg you to make an effort to obtain such a collection as shall be a worthy monument to the members of your Associations . . .”

The last decade of the 19th century and first decade of the 20th century would see the remaining members of the Association and Society record numerous memoirs, historical accounts, autobiographies and testimonials. They also made donations of equipment, medals, documents and memorabilia to a range of museums and libraries to preserve that history.
On April 28, 1911, the fiftieth anniversary of the establishment of the USMTC, a bronze tablet was unveiled at the Soldiers and Sailors Memorial Hall in Pittsburgh to commemorate the volunteers from Allegheny County, Pennsylvania who served in the USMTC.\textsuperscript{235} Wilson, Bates, Carnegie, Kerby, Munson, O’Neill and others were listed on the memorial tablet, the first such memorial recognition of the USMTC in the country. Bates, Richard O’Brien and Plum gave speeches in which they highlighted key dates and the historic achievements of the USMTC. Bates noted that the first, Andrew Carnegie in 1861, and the last, Bennett Bates in 1869, members of the USMTC both came from Allegheny County as well as many of the other notable telegraph operators of the war. Plum described the many individual operators. He noted that Jesse H. Bunnell, of later telegraph manufacturing fame, was one of McClellan’s three operators on
the Peninsula and at Antietam, was with Rosecrans at Chickamauga, and was with Thomas at Missionary Ridge and on the Atlanta campaign. Bates proudly noted that “In the Civil War the Morse telegraph was for the first time employed to direct widely separated armies and move them in unison, and the history of that war was largely recorded by the telegraph.”

In the recent 10–15 years, comprehensive public displays of telegraph artifacts and documents have succumbed to broader trends and changes in priorities for museum design. At most institutions, those considerations now minimize artifact presentation in favor of interactive activities and videos or live conversations with character actors. For example, notable and comprehensive displays at the Smithsonian Institution and Henry Ford Museum, among others, have been dismantled. The Antique Wireless Association has dedicated itself to preserve and share the history of technology used to communicate and entertain, from the first telegram to today’s wireless text messaging. AWA’s preservation of telegraph history and display of telegraph artifacts are central to its primary mission. Since 1952, the AWA has been assembling a comprehensive collection of equipment, artifacts and documents relating to telegraph history. Many of its members are internationally recognized for their preservation efforts, noteworthy research, publications and important private collections. AWA’s internationally renowned leadership in this field led the Sherman Wolfe family to select AWA as the recipient of its very significant artifact collections in 2013. The AWA’s Antique Wireless Museum now holds the majority of the National Telegraph Museum’s famous Western Union collection. AWA now exhibits the largest collection of early telegraph apparatus in the world, making it available for historians, educators and the general public. Yes, the Smithsonian Institution does hold more items in their storage buildings and the Smithsonian has incredibly significant items, but AWA has, by far, the largest public display, including numerous unique and historically important documents and artifacts.

**PART VII – FEATS AND LEGACIES**

**Unprecedented Achievements**

There was no precedent for a war the size or magnitude of the Civil War. Many solutions were improvised as leaders dealt with an unprecedented massive mobilization and coordination of huge forces over vast terrain. Andrew Carnegie later recalled:

Quite simply, there were no prewar plans for industrial mobilization or a centralized War Department procurement and administration, which resulted in absolute chaos in the first year of the war.
“The general confusion which reigned in Washington at this time [the beginning months of the war] had to be seen to be understood. No description can convey my initial impression of it.”240 He also looked back and recognized the “unsparing use . . . and the important part played by the railway and telegraph department of the Government from the very beginning of the war.”241

The Union Army expanded from 16,402 men located in widely scattered garrisons before the war to over one million men in thousands of units undergoing mobile operations spread across a vast country. Military operations correspondingly increased to “unprecedented levels of scale, scope, dispersion and complexity” as “large formations engaged in complex active operations on a continental scale.”242

The scope of new electrical communications in the Civil War was enormous. Never in the history of previous warfare had the commander in chief been separated from his generals by so great a distance operating with so great a mobility of forces. Carnegie immediately recognized the critical role of the telegraph and railroads when he organized “a force of railway men” that included the telegraphers.243 He stated, “It was one of the most important departments of all at the beginning of the war.”244 A modern Central Intelligence Agency (CIA) assessment states, “The Union particularly saw the value of the telegraph and used it as the key component in what would be the first modern military communication system.”245

The presence of massive armies waged in combat was not new. Consider that the Battle of Gettysburg (166,000 combatants and 46,000 casualties) was nearly as large as the Battle of Waterloo (191,000 combatants and 65,000 casualties) in the Napoleonic Wars.246 But, “the introduction of the telegraph underlay the first clear technical transformation of the general’s role since the beginning of organized warfare.”247

At the time Grant assumed overall command of the Union forces in 1864 and began his three pronged strategy to defeat the Confederacy, his territory of operation spanned over 800,000 square miles. The battle lines were highly fluid, and the armies were widely distributed, placing tremendous strains on the shifting supply lines. The Union’s better developed railroad network and communications systems and their flexibility and adaptability would prove critical. Grant coordinated and closely directed over half a million men operating under Generals Meade, Sherman, Crook, Sigel and Butler on a daily and even hourly basis with General Halleck as Chief of Staff, and, of course, all of them answered to President Lincoln as Commander in Chief. Grant’s coordination of military actions took place while he resided with the Army of the Potomac that was battling Lee in Virginia. Grant did not command from a desk in Washington, yet he did keep Lincoln closely and regularly informed. Grant’s accomplishment and the overall
achievement in military communications are all the more remarkable since they demonstrate effective control of large forces over far reaching terrain while the military commanders and their staffs were themselves on the move. President Lincoln reportedly stated, “Grant is the first General I have had . . . that can go ahead without me.” A visitor to Grant’s headquarters in Nashville in 1863 recalled that Grant “had a telegraph in his office and spent much of his time talking by wire with all parts of his command.”

The Tremendous Scale of the War

On January 1, 1861, the Union Army totaled 16,402 regular soldiers and volunteers. Seven months later, the Union Army had grown to 186,751, and by March 31, 1865 the Union Army totaled 980,086. By the end of the American Civil War, more than 2.8 million Union and 1.6 million Confederate soldiers were enlisted, out of a combined population of 22 million people, nearly 20% of the total population. The casualties included 620,000 killed, 476,000 wounded and 400,000 captured or missing. Approximately one in four soldiers that went to war never returned home. It is estimated that one in three Southern households lost at least one family member. Medical practices were also primitive. Estimates state that for every thirteen surviving Civil War soldiers returning home, one was missing one or more limbs.

The immediate arc of the battlefront spanned approximately 1,300 miles from Washington, D.C. to St. Louis, Missouri, to New Orleans, Louisiana. Consider that Napoleon’s famous march to Moscow was over a distance of approximately 1,000 miles. Civil War battles were fought beyond the immediate battlefront and fighting stretched across Louisiana, Missouri, Texas and the Western territories, and even California was involved. Telegraph communications lines extended across the entire continental U.S., a distance of approximately 2,800 miles from New York to Los Angeles, and were deemed critical to keeping California in the Union. Intense warfare over these distances with rapid electrical communications and swift large-scale troop movements had never before been encountered. And, the American continent had never witnessed or managed warfare on this scale. Neither the Union nor the Confederacy had prior

Fig. 77. Telegraph key and receiver used to relay the news of Lee’s surrender, railroad depot, Appomattox Court House, Virginia. James Clark, Philadelphia. (Courtesy Chicago History Museum, Charles F. Gunther Collection, ICHi-85659, Assess. No. 1920.905ab)
experience with this type of protracted large-scale military conflict.

“Not until Grant, a master of telegraphic method, took command of the Union armies in 1864 would the telegram come to dominate the management of armies; and, even then, it remained a strategic, not tactical instrument, again because of the rigidity of the network and the infeasibility of pushing the cable head forward into the maelstrom of battle.”

It was the telegraph that enabled the Union to strategically coordinate its railroads, manufacturing, supplies, men and armies to win the ultimate victory. During the course of the war, an estimated 6.5 million military telegrams were sent by the Union, averaging approximately 4,500 telegrams per day during the four years of the War. In essence, “The [telegraph] corps was the very nerves of the army during the war, and was so considered by all those that came in contact with it.”

**Legacies**

Although tactical mobility was ultimately limited to the pace of the foot soldier or cavalry rider, and battlefield communications in many cases were still limited to line of sight and range of sound, the Union's widespread use of the telegraph dramatically improved its overall control of armies in the field. But, the Union's large scale use of the telegraph in the War had a broader impact than just exploiting...
better tactical, operational and strategic communications. The telegraph enabled civilian government officials to maintain control over military operations and to control the flow of news, further anchoring a uniquely American style of divided government. In addition, the shared wartime experiences of the telegraphers helped them to forge a new identity in a specialized trade craft with proud traditions. This led to a sense of increased professionalism and helped spur national union organizing movements that sought to protect wages and jobs as the industry continued to consolidate. 268

The immediate costs of the War were high in blood and treasure, but the return on that investment by the Union was tremendous. The total cost of the War to the North in 1860 dollars has been estimated at approximately $3.4 billion, plus another $3.3 billion for the South. 269 For the North, the capital investment in the telegraph lines operated by the USMTC was approximately $3.2 million, less than 0.1% of total wartime expenditures. Comparable figures are not available for the South. The Union’s investments in this new technology reaped significant rewards for all since the war may have been shorted by two years through its use. 270

Following the war, the Union was left with thousands of miles of new communications lines that bound the nation together financially and economically. Western Union and other telegraph companies would further expand the reach of the telegraph, ultimately permitting telephone communications on this network. The telegraph revolutionized the flow of information from and into the battlefield and permanently changed the way the government operated and people communicated. In sum, this transformative technology critically shaped the outcome of the war as it propelled the nation into the last quarter of the nineteenth century with lightning speed.

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Notes
1. Note, a number of historically important telegraph industry people are mentioned in this article. Additional biographical information for many of them can be found in Taltavall (1893). See also Reid (1879); Thompson (1947) and Wilson (1900).
11. Based on Thompson (1947), Chpt. XXIII-XXV; Reid (1879), Chpt. XXXVII; Gamble (1881); Harlow (1936), p. 310-314.
12. Based on Thompson (1947), Chpt. XXIII-XXV; Reid (1879), Chpt. XXXVII; Gamble (1881); Harlow (1936), p. 310-314.
13. Based on Thompson (1947), Chpt. XXIII-XXV; Reid (1879), Chpt. XXXVII; Gamble (1881); Harlow (1936), p. 310-314.
14. Based on Thompson (1947), Chpt. XXIII-XXV; Reid (1879), Chpt. XXXVII; Gamble (1881); Harlow (1936), p. 310-314.
15. Obtained from the estate sale of a former Western Union employee who found it filed in the attic of the old Western Union Offices in Omaha where he was an employee in the 1920s. Western Union’s Omaha office was the relay station at the eastern terminus of the transcontinental telegraph.
17. Based on Thompson (1947), Chpt. XXIII-XXV; Reid (1879), Chpt. XXXVII; Gamble (1881); Harlow (1936), p. 310–314.
18. First Transcontinental Railroad at Wikipedia.
19. First Transcontinental Railroad at Wikipedia.
23. At the beginning of the War, the Union’s rail network was far more developed with 22,385
miles of railroads versus the Confederacy, which had only 8,783 miles of rail. Allen (2009), p. 111.

24. Plum (1882), p. 26; Wheeler (2006), p. 38, 188 note 4; Kriedberg (1955), p. 126; Newall and Shadrer (2011), p. 156. According to Plum, the Crimean War (1854–1855) witnessed the first use of the electric telegraph in war; however, it was not used for “tactical purposes”, but merely for intercommunication between the principal headquarters or between the capitals of the allied besieging countries. See also Raines (1996), p. 4 and Newall and Shrader (2011), p. 157 regarding the Quartermaster Department’s authority over railroads.


29. For biographical information on Wilson see Taltavall (1893), p. 296–297.


32. O’Brien (1889).


42. Chandler (1895).

43. Tinker (1895); Chandler (1895); Bates (1895).


48. For more discussion about the Caton pocket telegraph and its inventor John Caton, see Casale (2001, 2009) and Perera (2016), Item 7. John D. Caton eventually sold his telegraph business to Western Union and served as the Chief Justice of the Supreme Court of Illinois.

49. Reports (1870), Class 64 Apparatus and Methods of Telegraphing, p. 301.

50. Comprehensive historical discussions about the USMTC are included in Plum (1882); Brown (1896); Raines (1996). See Bates (1907), Wilson (1889) and O’Brien (1910) for firsthand accounts.


55. Greely (1911a).


60. For complete discussion of Myer’s signaling system and the Beardslee telegraph, see Brown (1896), Chpt. I; Plum (1882), Vol. II, p. 38–39; Scheips (1963); Raines (1996), Chpt. I; Allen (2013); Markle (2003), p. 108 notes 3-4; VanDeusen (1929), Chpt. II; Greely (1911b).

61. Rogers, a New York telegraph engineer, had worked with Samuel Morse to build the first commercial telegraph line between Washington and Baltimore in 1844.

62. For Myer’s own discussion, see Myer (1872), p. 355–388.


64. See prior footnotes about the Beardslee telegraph.
Telegraph in the American Civil War

67. Scheips (1963); Raines (1996), Chpt. I; Greely (1911b).
68. O’Brien (1910), p. 124; Plum (1882), Vol. I, p. 363. Myer recognized the issues with the Beardslee telegraph. He later stated “There were advantages to attaching to this instrument, that it was portable and compact, could be set a work anywhere, required no batteries, acids, or fluids; and, what was thought of importance in the early days of the late war, and while the corps was a temporary organization, it could be worked by soldiers without skill as operators. The defects were, that messages could not be sent as rapidly or as far as by some other instruments. Nor could several instruments work easily upon a single circuit. For some uses on the field of battle, or under fire, where the attention of the reader is disturbed, it is, perhaps, as good an instrument as has been devised. With a permanent corps, or at secure stations it gives place to some of the forms of signal or of sound instruments.” (Myer, 1872), p. 358.
73. Scheips (1963); Raines (1996), Chpt. I; Greely (1911a); Newall and Shrader (2011), p. 298.
74. Greely (1911b).
78. Andrews (1964); Raines (1996), p. 26; Brown (1896), Chpt. XI.
82. Gaddy (1975); Cummins (1897); Brown (1896), Chpt. XI.
87. For information about this item, see Hopkins (2014).
98. Gaddy (1975); Cummins (1897); Brown (1896), Chpt. XI.
99. Gaddy (1975); Cummins (1895); Headley (1911).
105. At 13, Bok quit school and went to work as an office boy for Western Union. He eventually became a manager at *Scribner’s Magazine* and then editor of *Ladies’ Home Journal*. He wrote 12 books and received the Pulitzer Prize. Bok coined the term “living room” replacing the earlier terms for the parlor or drawing room. He also created Bok Tower Gardens in central Florida. See [Edward Bok](https://en.wikipedia.org/wiki/Edward_Bok) at Wikipedia.
106. See Plum (1886), p. 265–270 and Newall and Shrader (2011), p. 82–83 regarding a well documented dispute between Grant and Stager over John C. Van Duzer’s conflict with Grant regarding the independence of the USMTC and use of USMTC lines for private dispatches, which ultimately resulted in USMTC receiving copies of all dispatches passing over military lines. Hochfelder (2012), Chpt. 1 also discusses Van Duzer as an example of conflicting lines of authority as well as possible conflicts of interest since many USMTC managers were also managers of Western Union or other commercial telegraph companies.
108. Greely (1911a).
121. Sherman (1891), p. 231.
131. Fuller (1888).
135. Greely (1911a).
139. Ibid.
142. For biographical information on Bates see Taltavall (1893), p. 224-226; Markle (2003).
145. For additional information about Kerby and other spies see Markle (1994).
151. Greely (1911a).
154. Headley (1911); Casamajor (1911).
158. Fuller (1888).
167. Although the government exercised some control over the volume and content of telegraph traffic, in general, the civilian telegraph companies in the North were left to
operate independently. The War Department also generally opted to guide and instruct the railroads regarding military movements rather than actually seizing them and operating them. The U.S. government concentrated on taking control and operating telegraph and rail lines nearest the Union Army as it advanced in the South. See Newall and Shrader (2011), p. 157 and 159; Pickenpaugh (1998), p. 21.

168. Clark (2011); Fuller (1888); Plum (1882), Vol. I, p. 36; Reid (1879), p. 483.
178. Townsend (1909), p. vi, 34, 37, 42. See also Perera (2016), Item 90.
180. For a complete biography of Stanton see Wilson (1900) “Stanton, Edwin McMasters”; Doyle (1911); Thomas and Hyman (1962).
182. Thomas and Hyman (1962).
186. National (1900).
188. Jepsen (1997); Jepsen (2000); p. 80; Moreau (1989); Women Telegraph (2016).
189. Jepsen (2000); p. 82.
190. Ibid.
193. Luther Prentice Bradley at Wikipedia.
195. Moffat (1965); Conscription in the U.S. at Wikipedia.
196. Ibid.
205. Morgan’s Raid, Wikipedia.
211. Munson (1906); John S. Mosby at Wikipedia.
214. Ibid.
216. Greely (1911a).
226. Adolphus Greely at Wikipedia.
228. 28th Annual (1909), p. 77.
233. Ibid.
234. Watkins papers are located at the Smithsonian Institution. Biographical information is available at http://sova.si.edu/record/Record%20Unit%207268.
235. Address (1911).
237. Address (1911), p. 6, David Homer Bates.
244. Ibid.


Battle of Waterloo: Total 191,000 combatants with 65,000 casualties (34%); French-73,000 with 41,000 casualties and British Allies-118,000 with 24,000 casualties. See Wikipedia.


253. The total distance from Paris to Moscow is approximately 1,550 miles. Napoleon began his Russian Campaign from the Polish border, a distance of approximately 1,000 miles to Moscow.

255. Fuller (1888); Plum (1882), Vol. II, p. 337.
257. Bates (1907), p. 27. Scheips (1963) notes that estimates range from 1,079 to 1,500 depending on the source.

259. Stager (1863).
262. Ibid.
264. Ibid.
265. Fuller (1888); Thompson (1947), p. 393–394.
266. Fuller (1888).
268. Hochfelder (2015), Chpt. 1; Thompson (1947), p. 389–391. The first convention of the National Telegraphic Union was held September 5, 1864 in Philadelphia, and its publication, The Telegrapher, was first published in September 26, 1864.
270. Fuller (1888).

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About the Authors
David and Julia Bart reside in the Chicago area. Together, they have published numerous articles on telegraph, radio and broadcasting history.

David is the Sr. Director of Litigation Consulting for the Great Lakes Region of RSM US LLP where he specializes in corporate restructuring, business valuation and commercial litigation. He has a BA (anthropology/statistics) and MBA (finance/accounting/econometrics) from the University of Chicago. He is the lead author of A Practitioner’s Guide to Liquidation and Litigation Trusts and the Standards for Distressed Business Valuation.

David has been extensively involved in the history of electrical and electronic communications. He is a Director of the Antique Wireless Association, Chairman of the AWA Press Committee and Co-Editor of the AWA Review. He is also a Life Member and Director of the Radio Club of America where he is Chairman of the RCA Publications Committee and serves as the Editorial Director of the Proceedings of the Radio Club of America. He also authored the Centennial Index of the RCA Proceedings. David is Vice President and Treasurer of the Museum of Broadcast Communications in Chicago. He is a member of the IEEE and a member of the IEEE Historical Committee. David has published in and/or presented at: the RCA Proceedings, RCA Technical Symposium, AWA Conference, AWA Review, AWA Journal, IEEE Global History Network, IEEE History Center Newsletter, New York Historical Society and the American Association of Physics Teachers Joint AAPT/AAAS Meetings. He is a recipient of the AWA Dr. Max Bodmer Award, the AWA Curator’s Award, and the RCA Ralph Batcher Memorial Award for his work in publications, historical preservation and museum exhibit development. He is the former President of the Antique Radio Club of Illinois.

Julia received her BA (Behavioral Sciences) from the University of Chicago and MA (Reading Education) from Concordia University. Julia is an Associate Editor of the AWA Review and provides advisory services to the AWA Board of Directors. She coauthored numerous peer-reviewed articles for the AWA, RCA and IEEE and works closely with David on their collecting interests. Julia is the Editor for the Antique Radio Club of Illinois’ publications, a past Treasurer, and an advisor to the ARCI Board of Directors.

David and Julia’s work on the IEEE Edison Medal and the IEEE Medal of Honor is included on the Engineering and Technology History Website (f/k/a IEEE Global History Network).

David and Julia Bart
Amory H. “Bud” Waite, Polar Explorer

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Abstract

This article presents a biography of Amory H. “Bud” Waite, a radio operator on numerous Antarctic and Arctic explorations with Admiral Richard E. Byrd, and a hero during the D-Day invasion in World War II. Included is a transcription of a rare firsthand account written by Waite contained in a nine-page “farewell” letter he wrote to friends and relatives shortly before his death from cancer. The letter recounts many of his exploits and experiences in the Polar Regions, and mentions many of the friends he met and worked with throughout his life. The letter came into the possession of the author in one of a number of boxes that he obtained in the late 1990s or early 2000s, but it was not discovered until 2010. This article is accompanied by a number of photographs from the author’s Polar collections and other sources.

Introduction

This is a story about the life of Amory H. “Bud” Waite, inventor, Antarctic and Arctic Explorer, rescuer of Richard E. Byrd, and hero during the D-Day invasion in World War II. It is a story told primarily through a nine page “farewell letter” that Bud wrote after he completed a long series of radiation treatments in June 1983 as a result of bladder cancer. The letter, dated Christmas 1983, was addressed to his relatives, friends and especially those comrades of the second Byrd Antarctic Expedition of 1933–35 who were still alive in 1983. The letter describes his activities and accomplishments achieved over a lifetime of Arctic and Antarctic adventures, not to mention his participation in the war.

Fig.1. Amory H. “Bud” Waite, inventor and polar explorer. (Author’s collection)
Amory H. “Bud” Waite, Polar Explorer

This letter came into the possession of the author in the late 1990s or early 2000. It was buried in a boxes of material purchased at that time and packed away, undiscovered until 2010. The author now wishes to share this letter, which has never been published, with the readers of *The AWA Review*. The letter is reproduced here with only minor changes, most of which are indicated in italics. The letter he sent was accompanied by other material referenced in the letter, which is not in the possession of the author. The author’s supplement to the letter includes images that were collected over the years based on an ongoing interest in Bud Waite, Admiral Robert Peary, arctic explorer Donald MacMillan, the schooner *Bowdoin*, and a very talented amateur radio operator Don Mix, who was selected by the Amateur Radio Relay League (ARRL) to be MacMillan’s radioman on the *Bowdoin*.

The remainder of this paper is divided into three parts. The first part, entitled a “Synopsis of Bud Waite’s Biographical Background,” provides the necessary background for understanding the events described in the letter. The second part, entitled “Bud Waite’s Farewell Letter,” is a reproduction of the letter Waite wrote in 1983, which constitutes by far the largest portion of the paper. The third part, entitled “Obituary by Charles R. Bentley,” is a copy of the obituary for Bud Waite written at his death by Charles R. Bentley, an American glaciologist and geophysicist and a professor emeritus at the University of Wisconsin in Madison. Mount Bentley and the Bentley Subglacial Trench in Antarctica are named after Bentley.

**Synopsis of Bud Waite’s Biographical Background**

Born near Boston, Bud Waite became interested in radio at age 12 when he joined the Boy Scouts, where he obtained his first ham radio license. Like most hams back then, he experimented while in high school. Upon graduation, he joined the U.S. Navy and went to the U.S. Naval Radio School at the Great Lakes Naval Station in 1919. His first assigned duty station was aboard the USS *Florida*, a battleship in the Atlantic Fleet. Waite was later reassigned to the USS *Arkansas* as the “Flag Radio Operator for the fleet.” He furthered his education at the Lowell Institute, now known as Massachusetts Institute of Technology. He graduated in 1926 with a degree in radio and electrical engineering.

As the U.S. was entering the Great Depression in 1929, he became the Assistant Electrical Officer aboard the first electrically driven cargo vessel, the M.S. *Triumph*, on its eight-month maiden voyage. Returning to Boston he joined New England’s first television station, owned by the Shortwave and Television Corporation. At the same time he joined the Massachusetts National Guard as a Master Sergeant developing some of the military’s first mobile radio stations.

Waite was an active amateur radio operator in the 1920s. He became interested in listening to broadcasts by various polar explorers. This is where he
first heard U.S. Navy Lieutenant Richard E. Byrd finishing his first Antarctic Expedition in 1933. When Byrd asked for volunteers for his second expedition to Antarctica, Waite did not hesitate to apply. He was accepted and assigned to the USS Bear of Oakland.¹

Waite immediately began to wire running lights and performed other electrical duties, and became a valued member of the crew. He became the ships radio operator during the voyage. Recognized for his resourcefulness, he was invited by Byrd to leave the Bear of Oakland when they reached Antarctica, and he became a member of Byrd’s shore party there. At this time, Byrd had no idea how good a decision this would become.

In later years, Waite became a great friend of Antique Wireless Association’s founder Bruce Kelley. Kelley invited Bud to attend his early “Old Timers” gatherings to speak. Bud would eventually donate much of his prized radio collection to the AWA, where it is on display in the AWA’s Antique Wireless Museum.

Waite retired in Sarasota, Florida in 1965, and was diagnosed with cancer in 1983. He died on 15 January 1985 in Sarasota. He was buried at the Walnut Grove Cemetery North Brookfield, Worcester County, Massachusetts. Few can say they did as much with their lives as Amory H. “Bud” Waite did.

Before he died, Waite wrote a detailed farewell letter to all of his family and friends. As you read this letter detailing his life, you will learn that this man was a giant among men. Images of actual letterhead and salutation of the letter are shown below. The content of the letter with this salutation is reproduced in the next section of this article with a few explanatory footnotes inserted as part of this transcription. The dashed lines appearing in the letter are section breaks that Bud placed in his letter to segue between sections.

Fig. 2. The cutter Bear, renamed the USS Bear of Oakland by Admiral Byrd circa 1933, was probably the most famous polar exploration ship of all time. (Courtesy of the Boston Public Library, Leslie Jones Collection)
Christmas Bulletin... 1983

To all my dear relatives and friends and especially those Comrades of the 1933/35 Second Byrd Antarctic Expedition who still survive.

This is being written hurriedly to get it finished before the final bell tolls, since I have just completed a long series of radiation treatments after bladder cancer in June, the 50th Anniversary Trip to Washington (See Below), and no sooner got home than was in sick bay again because of heart problems. Three days in ‘intensive’ care, and four days ‘progressive’ I was home again on new medication that regulated the beat of the tired old pump, and then back in again on the night before Thanksgiving. The medics say it is all caused by the artery that failed back in 1977 and was supposedly completely healed. At least they say it will not stop yet if I obey the rules. Those interminable hours waiting for the “misses” are hard to live with. The fact that so many of my dear relatives and friends are beginning to leave ever more frequently does not help either . . . Ok! So much for me. I’m still alive and this to get copies of some of the later events in my life to all concerned; Not least my friends in the Antarctican Society, the Royal Geographical Society, and dear Alison Wilson in the Polar and Technical Records Center of the National Archives, where most of my important Antarctic papers and artifacts are emplaced for posterity’s perusal.
Recent happenings that have been very dear to me are as follows:

1. The Reunion of the 12 Ice Party members of BAE II [Byrd's Second Antarctic Expedition] in Washington brought about by the agencies of RADM Dick Black and Stevie Corey.

2. A brief publication of some of my lifetime radio activities in the national magazine of the U.S. Power Squadrons, the Ensign (Oct issue). This was written by a non-radio man and several embarrassing mistakes have been corrected in the copy [not] enclosed herewith.

3. A brief resume of my radio activities in the weekly bulletin of the Tamiami Radio Club of which I am a member. This is in Venice and Englewood, Florida. No copies enclosed but it did have the pix of the radio set-up at the Advanced Base so long ago.

4. Steve Corey’s presentation to me at the Anderson House banquet on October 22nd of a beautiful picture of the Admiral (Byrd), that he had taken for his Mother, Eleanor Bolling Byrd, before they both left us for Sunnyland. This was furnished by Senator Harry Byrd, the Admiral’s nephew, and signed by him and his brother and sister. Copy [not] enclosed. I was called on first because they knew I had to leave early because of poor health. It had been engineered by Dr. Paul Dalrymple and Ruth Siple, my dear friends in the Antarctican Society, Lo! These many years. I am very grateful.

5. An article in the Washington Post by a girl named Betty Kastor, which covered the wreath-laying ceremony at the memorial monument to Byrd on the Avenue of Heroes in Arlington, and associated photographs, copy [not] enclosed. This article made me think that the subject should be more fully covered, as probably the rest of the group did, so I wrote a long billet-doux [sweet note] to Ms. Kastor, as the rest of you have also probably done, setting forth some thoughts that I had on each of you for history’s sake. My only excuse is that I have kept as closely as possible in touch with all Antarctic History over the 40-odd year span since 1935, having participated in a total of 23 expeditions and given over 3500 illustrated lectures to all kinds of audiences on the various Phases from the Deepfreeze Task Forces on. I am certainly hoping for rebuttals from all of you and your thoughts to Betty Kastor so that she
will have the composite view rather than that from just one individual regardless of his old age, and maybe limited out-look. No answer has as yet been received so the effort was probably wasted, but will serve as a finger-nail history of some of us for my 14 surviving grandchildren, and 13 great grand-children, years in the future. I received the shock of my life in the hospital the other night when the medical attendant, a bristling young intern, interrupted an old friend and I who were talking about Byrd and the reunion, to have him pipe up with . . . “Who was Admiral Byrd?” Believe me we’ve got to do some solid missionary work pretty soon . . . All of us! This, then, was another milestone.

6. Recent notification that although Cape Waite was named for me, near 73 S and 103 W in 1960, the naming of the Waite Islands had been confirmed. They are about 100 miles off the Cape, but I’ve been all through that area twice on ship-board, and very surprisingly discovered one island near there under 400 feet of ice with one of our early radio ice-depth sounding units that my Assistant and I were flying over the area of grounded bergs in a Helicopter. Made 64 flights over unknown areas that year, 1961/62.

7. The last item of interest is that my longtime friend Dr. Charles Bentley, Head of Polar Activities at the Univ. of Wisconsin for many years, another well-known scientist named Gudmansen from Denmark, and the world renowned expert of glaciology from Russia, Dr. V. Bogorodskii, had just finished a book on Radio Glaciology, which I discovered and made practicable with the help of John Dyer’s Airborne Instruments Company in Long Island, way back in the late ’50s and early ’60s, so that aircraft are now sounding up to three miles of ice as fast as they can fly. I gave Charles all the notes he needed on the early days (nine nations are now using this technique to measure the large ice masses of the world) and a copy of the book was received just after I got home from Washington, dedicated to the Russians who worked out of Mirny (where I have visited) for 25 years and to me! Boy! That made an old man happy. Of course, I’m waiting for a translation, but the book is like so much gold to me . . . precious!

8. So with my various awards and medals, having just finished 25 pages of info in exchange with the British Antarctic Survey in Cambridge, and a similar amount a few months ago with the famous Roland Huntford
who had the guts to write the truth about Amundsen and Scott in his great book, I now rest serene in my little nook, thinking of all of you, and knowing that at least some of my ashes will blow across the Antarctic wastes and the rest mingle with the sweet grass on the Waite cemetery lot in North Brookfield, Massachusetts where my ancestors are already sleeping.

Now to get the rest of the story I want to broadcast here, before the lights go out . . . I want to record here the things I had planned to say at the reunion, and was unable to get out because of the emotional situation brought on by the presentation of the Senator Byrd Award . . . when I got up there in the darkened room to accept the beautifully mounted plaque I was blubbering allover the place and couldn’t think . . .

Now dear friends and comrades, what I had planned was first to lead a toast to the President of the United States, who has done so much to save us all from ignominy, and then, as I once heard the famous Montgomery, at an international banquet of military people at Fort Churchill, Canada, way back in 1946, “And here’s to the Governor of Texas!”

Then, I had planned a five minute review of some of the things that I had seen happen to dear old Little America II, where we spent so many months together so long ago on and under the ice of Ver Sur Mer Inlet in the southeastern corner of the Bay of Whales, which incidentally has broken out, at least once since we left, to leave behind a Vee-shaped opening, the same old ten miles long, North and South, as it used to be, and over forty miles wide at East Cape. As far as I know, and I was last there in 1963, the steel towers of Little America are still there, though completely lost to sight by late 1962.

Now, however, I don’t have to stick to the five minute limit as I have you at my mercy, so will be a bit more explicit, if this old mill keeps going.

First, I must tell you how wonderful it was to see you all again after half a century, except for Dickie Black, Lindsey, and Olin Stancliff, & John whom I have seen either on later expeditions in the case of Dick, or visits to my home. We didn’t have much time to yak, but my bad ear, which stopped my beloved boating and very much talking, three years ago, dictated brevity in that direction, anyway. It was especially nice to meet the girls I had been hearing about, here and there over the years, partly from Ruthie Siple and partly through correspondence. Jane and Ruth, Mimi, Wilma Jo, Betty Swan, and Betty Innes-Taylor, and her son, Priscilla Dyer,
whom I have met before, often as I visited John from time to time, Bram's wife, Marion, Walter's Florence, Eddie Moody's Dorothy, Sylvia Robinson (one of our family names) and last but not least Dick Black’s Aviza, whom we have met many times, and Betty, who insists on being called “Elizabeth” Lindsey. I sat [by the] side of Walter’s wife and learned more about him than I ever knew, and really enjoyed all of them . . . I hope they’ll take every chance to visit us when near this part of Florida, remembering always as REB [Richard E. Byrd] insisted on often repeating towards the end of the Expedition, and after the Bolling Advanced Base two months on that freezing floor, “Don’t forget, the latch-string is always hanging on the outside of the door! You are always welcome!” It was nice to meet up with Paul Swan’s boy, the first time I had heard of him, and wish him all the best along with the others, as time goes on. It was too bad Dusty and Clay and Hutch, and Doc Perkins, and Ike and John Herrmann couldn’t make it, and Dick Russell, of course, but Dick has been out of it for many years as I learned in Salem’s Peabody Institute some years ago, when I met up with friends of his, as I placed quite a few artifacts in that Institution. I had seen Ike often, even before he was in his present rest home, of course, and helped make the tapes that we now have on his life and adventures. I had seen Dusty several times since 1935, as he worked along with Dickie, Jr. on things at 9 Brimmer Street, but no contact there for years. John H. is just too much older than this old hulk to make it, but he’ll get a copy of this and we wish him all the best. I’ve been in touch with Clay and Hutch frequently and missed them, too. I had not seen Smitty or Arthur Zuhn, but again, will mail this to them with hopes it arrives . . . Eddie Roos, formerly of the Bear and now a retired Sea-Captain, lives near Canaveral, where I put in the first radio in 1949 so have been in touch with him often. Guess that ends that list.

As Dickie Black would say, with tankard in hand, “Skoal!” and “Vest Over Sea!” My life has been better for knowing all of you, but I sure missed Gil, and June and Stu Paine and Duke, and Rip Skinner, who fell out of a boat near Dunedin, years ago, leaving a wife and five kids behind. I also miss Quin, and Jimmy Sterret last seen near Minneapolis, the same year I climbed aboard “Doc” Poulter’s Snow Cruiser, as they headed towards Boston through Ohio, and I was lecturing for the Admiral. We’ll all remember “Doc” Potaka and Joe Pelter, and dear old Major “Buck” Boyd, and Von der Wall, and all the others . . . They are in our memories forever.

My only regret, that night, was that the Byrd children, Kathy, and Bolling and Dick, Jr. along with Helen Poulter could not have been there,
and, we must never forget those Marine Corps pancakes Carbone used to dish out that you could snap and kill a man with at twenty paces!!!! And old “Perk” with his beautiful movies of opening flowers; Now in Maine.

All of you wherever you are, “Hail! And Fare-well!” Cox, who died in WW II along with Petersen, Tinglof and Eilefson, and Davey Paige, and Ronne, whom I’ve met “way down South” several times since ’35, again “Skoal!” And now on to other matters . . . Never forgetting Petie Demas!

I still have the remaining Byrd Sun-Compass, but Smithsonian has one so it will probably go to the archives along with the mass of other stuff I have already sent. I also have 8 copies of the original Barrier Bull, with specimen’s of Walter’s poetry still intact therein, How ‘bout that? And the diary you all signed so kindly so long ago . . . still very dear to me. The original MAS [Mutual Admiration Society] Flag is in the Museum at Fort Monmouth. I carried it always!

Now for a very brief progress report, mostly for my three surviving children, Pat Malone at Delta in Atlanta, Jackie Bigelow, housewife in Westwood, Massachusetts, and Susan, my youngest, a Lab Tech in Oceanport, NJ, where Betty and I lived so many years while I was roaming around the world on 23 expeditions, three wars, and 14 “A” Bomb tests. My second daughter, Barbara, died in 1963, and my only son, Dr. Richard, and two of his four beautiful girls, was wiped out by a drunk 19-year old in 1982 and Bet and I are still in shock. None of the three regained consciousness, which may be a blessing in disguise. They were hit by a truck in the wrong lane at 80 miles per hour, as they were on a fishing trip, in Missouri. People wonder why my memories won’t let me sleep nights, sometimes. There is good reason! Together, this crew left us 14 grandchildren, oldest now near forty, and they have produced, and are still producing thirteen ‘greats’. Some times I have [to] call ’em by numbers to remember them all, and some still write me, “Believe it or not!”

My four years Navy, 1919–23, left a few memories: I won the Atlantic Fleet swimming Championship in 1922, I was Capt. of the Team on the “Arkie” (I saw her sunk at Bikini, later), and played football on both the Florida and the Arkie. By 1921 I was Flag Radio Operator Atlantic Battle Fleet and, among others, sent the commands for Billy Mitchell to fly out each of his three attempts to sink the great German ship Osfriesland off the Virginia capes.

Then came 1923–29, working in shipyards as a radio electrician, going to school nights at Lowell Institute at MIT, getting married and having our first three children, and spending eight years in the Massachusetts
National Guard, part of the time in charge of half the communications in the old Yankee Division, nights and weekends. Night work and the Guard got me divorced in ’32.

In 1929 I went to China for a year on the first all electric-drive cargo ship, the M.S. *Triumph*, and learned a lot there. Then, when we got back to Boston, after the depression had started, I signed up with the famous Hollis Baird at Shortwave and Television Corp in Boston, helping build the four transmitters that soon were sending New England’s first TV signals every night until 1933, and BAE II came along just as the Company was folding because of lack of funds. During this period there were three items of interest . . . I helped send all the traffic to Byrd on MacMillan’s Expedition of 1925 and later knew Mac well . . . I helped build the first State Police Radio Station in Massachusetts in 1927, and got a job on the “Bear”!

Old “Doc” Shirey, in the Boston office, gave me a “sea-going banjo” and sent me down into the hold to shovel coal, three days before she sailed, but the electrical stuff wasn’t working and Connie Royster and I ran in running lights, steering gear, gyro compasses, and when she sailed Monday

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Fig. 4. The Bear of Oakland prepares to leave for an Antarctic mission. (Courtesy of the Boston Public Library, Leslie Jones Collection)
I was one of the famous 39. You all know the rest of that story! We almost sank off Wilmington, Delaware, because my life-long friend, and later Vice Admiral Robert A. J. English, wouldn’t let me send an SOS, but a little old Chesapeake tug pulled us in and we were saved. Later, the late Dickie Watson and I conned her down the coast 1000 miles in solid fog with the Radio Compass, and narrowly missing the “bad part” of a hurricane we got to Panama, eventually Tahiti, and Napier, NZ, for badly needed coal. On to Dunedin, and the ice . . . then eastward until we were stuck in pack ten feet above the rails for three days but Old Bendik Yohansen saved our necks and we were safe again, taking 2 tons of water an hour. At Bolling Bight they called on the Bear to repair a burned-out generator and starter from one of the three Citroens, and having special wire aboard I was able to do just that. Down came a wire from REB, “Get that man on the ice fast!” So I was one of the glorious 56 . . . A little late, and not knowing any of you, but there, at Little America! Hurrah!
You all know the rest of that chapter . . . When June wanted to go inland to set the Advanced Base at the Mountains, I was the radio op, and later . . . pride myself on making the first long successful tractor-trip in history, and all but two of the longer trips until 1956 when the big cats of the IGY came down. I helped teach some of you code in the winter and overhauled those derned (sic) Koehler generators many times (during the winter) especially when we tried to burn half gas and half kerosene to save the gas for the Tractors. Then the three coldest vehicular trips in history to the Advanced Base in mid-winter, where we found REB 55 pounds lighter from fumes and lack of proper food, lived with him two months and 18 days and then back to camp for the Eastern Plateau Party with Gil and Bram, Petiep and Joe. I don’t suppose anybody cares at this late date, but we made 815 miles, and missed or almost missed over 700 valleys of death (crevasses), met Siple and Al Wade and Stevie and Stancliff at the 150 mile mark where Ronne soon joined us with needed spares, and so on into all the detailed pages of Charlie Murphy’s great book, “Discovery.” I still read it nights to be sure I remember correctly. Jane and Ruth there’s a picture of the three of us at that 150 mile rendezvous when Al was very weak from not eating his oatmeal, and his face had barely healed from the frostbite in the winter.

When the Bear came back for us, I left early, so left my mattress in my bunk in the Radio Shack, and believe it or not, Lincoln Ellsworth slept in that bunk when they finished up there on foot after the “First Successful Crossing of the Antarctic by Air.” We met the Wyatt Earp in NZ on the way home got a good look at chubby Berndt Balchen whom I met many times later after the War in Greenland and other places. So after coaling,
we on the Bear took off immediately for Easter Island and Panama, then the Marine Barracks overnight at Quantico and finally the reception by Madame Byrd and President Roosevelt in Washington. Later the banquet in Boston and then I unloaded most of the stuff left on the Bear in the Boston Navy Yard for REB because I lived nearby . . . always without salary . . . but he saved my neck on sundry occasions and was closer to me than my own father for 25 years.

At his request, I spent the next several years lecturing in between spells at my old job in the TV company, one of whose four transmitters became part of the Voice of America, later on.

I soon met Betty at a Camp in Maine and we were married that October 47 years ago . . . Dick came along in ’37 and then Susie in Nov 1945 just as I got home from Japan.

When the war came, in early ’41, we were living in New Jersey, so I immediately, with 8 years National Guard and 4 years Naval Radio plus the Byrd Expedition experiences, signed up at the Signal Corps Research Labs as a Junior Radio Engineer in June . . . 25 years later, at age 62, having
been pulled under a sled by a Cat in 1956, so that I had and have a painful hiatal hernia (Like the one that helped kill Paul) and a couple of broken ribs, I retired as the Coordinator of the U.S. Army Signal Corps Arctic and Antarctic Research Teams, having led teams of from one to forty on various research endeavors from the Alaskan Highway, where I first Met Wilkins with Paul Siple, by the way (they were Quartermaster Corps) in 1943, to Fort Churchill on Hudson’s Bay three winters, ten more journeys to the Antarctic and eight sojourns in Greenland, one of which saw us aboard the Westwind taken especially to Devon Island from Thule just to test our Radio Ice Depth Measuring Gear where some Canadians needed help and got it, and two summers were spent with us organizing and leading the 1962 and 1963 “International Experiments on Glacial Sounding in which the Signal Corps paid for the travel to Greenland of scientists from 7 countries to make sure we all knew which method of sounding ice was the best . . . . The seismologists still have value where the ice is warm but in ice colder than 30 degrees F radio waves work quite well . . . . to depths of 14,000 feet and over.

After the early years (1946–55) were spent in determining the electrical characteristics of thick ice, and setting up the boundaries of the technique, and having made our first successful sounding through 540 feet of ice at Wilkes in Jan 1958, Dyer and his famous Airborne Instruments came

Fig. 8. Amateur radio calls held by Bud Waite were W2ZK, W1TR, and W3HKO. (Author’s collection)
into the scene on Signal Corps contracts to build the special pulsing gear we needed and those models are still operative, though I’ve been retired 20 years.

The “International Experiments” proved the Radio Technique and I am now a Fellow of the Radio Club of America, The Royal Geographical Society of England and the American Geographic Society, and 28 other groups . . . There are several awards, including a Bronze Star as a Civilian in Combat in WW II, the Marconi Gold Medal, Veteran Wireless Operators Association of NY, and the highest they can give a civilian, The “Exceptional Meritorious Award for Civilian Service.” Which I wore while in Washington . . . I, with two others, received the first research awards ever issued by the Army in 1961 and have over fifty other commendations and letters of thanks. It’s been a long and interesting life, but nothing can go on forever.

Of course, I’ve been an active Radio Amateur Operator through all the years, and set up the original communications plan for the Antarctic in the IGY, ad infinitum . . . In 1970 a partner [Dr. Marcel J.E. Golay] and I invented and later patented an ice-breaking sub that would come apart in four segments for getting oil out of the Arctic much cheaper than the
pipeline . . . See *Popular Mechanics* Magazine, March 1970, and so on . . . All the time I was away my precious Betty was teaching school to get Dick his Doctorate in Neuro-Physiology, from Lehigh, Duke and Texas, where he was high up in the bio-med group of NASA during the Moon-Flights. Such a waste . . .

Last but not least, my experiences in the War, when Dyer was so vital to the “big picture” in Allied HQ London, included a lot of work on perfecting the antennas and insulating mounts that all tanks carried from then on, later building the first remote control systems for vehicles working in areas of high radioactivity, participation in 14 “A” bomb tests in Nevada and the South Pacific, including Bikini and Johnston Island (“53), but in 1942 the probably most important activity saw me as one of a group of 8 civilians in the Radio Branch rushing through the first of the well-renowned Radio Relay Equipments now used by every telephone company in the country . . . In 1943, we tested them from every hill and valley along the East Coast, and in early 1944 another “ham,” Victor Colaguori, W2VC, and I took eight of these to First Army in Bristol, England, for participation in the D-Day invasion of Normandy . . . We kept in the first multi-channel telephone circuits from France to HQ in London, sometimes the only ones, for the vital 38 days, and then with a small team of enlisted men, sporting our new “simulated grades of Captains in shiny new uniforms, installed over 100 radio-relay circuits across France before the Bulge when they sent us back to Paris to set up a school. From eight sets on D-day we then had thousands all over Europe and the Pacific Theatre and were busier than you know what keeping them all working. Our teams put the first American gear on the Eiffel Tower and the Arc de Triomphe where I was when they paraded down the Champs d’Elysees on 23 August . . . from First to Third Army HQ’s ending up travelling across France 100 feet from Georgie Patton’s tent, after the break-through at St. Lo. Yes! We were under fire frequently! So what?

From Paris, Vic, W2VC, went to Tinian to oversee the circuits there that led to Hiro and Nagasaki later, and our gear carried all the “stuff” running both voice and teletype and facsimile as it did . . . and I went
first to Luzon while MacArthur invaded and then put in circuits to the mountains in early '45, until VJ day, when I immediately went to Japan and put in a system that hit every large city and mountain peak the length of Honshu. It was VHF FM so we needed height and got it! Later I was assigned to studying enemy equipment, and got into lots of interesting places, even Hiro and Mac’s presence in Tokyo, where I also met Dickie Black having lunch one day, me in dirty field uniform in the officer’s mess in the Daiichi (Brothel) Hotel!!!

I flew home in a B-17 alone with Ty Power and enjoyed every minute . . . It was something to remember . . . just in time for Suse’s arrival. She now has a 19 year old boy and a 14 year old daughter. Those were hectic times . . . I no sooner got in the house on 30 Nov 1945 when Bet had to rush off to the Hospital and I was immediately put into writing reams of reports, all published in Signal Corps archives . . . and Vic and I got mentioned 47 times in the Signal Corps History of WW II. Not bad for an old ice-worm!

Reports over, off I went to test a lot a stuff in cold weather because of things revealed by the suffering of troops and equipments in the cold of the “Bulge,” and so again got close to Siple who was controlling all this stuff for higher headquarters. It thus came about that I got to the American part of Ft. Churchill on Hudson’s Bay just to take out every then existent radio set the troops were using and test them in actual 50 below zero cold . . . Then I ran an equipment quality control section for a couple years coupled with cold weather testing of everything from tubes, and porcelains, to men and sleeping bags and even Weasels.

It also came about that studying the frozen terrain in Northern Canada and later Greenland and the Antarctic to find out how radio waves behaved in the new medium . . . we already knew about travel in air, ground and water . . . all our years of studies were published in the Convention Record of the Institute of Radio Engineers in NY in 1961 and those data still hold. This would take books to detail . . . suffice it for me to say I went to the Antarctic or Arctic in aircraft, every US icebreaker, and even some MSTS cargo ships, flying both oceans both ways (as a passenger) ten times before my retirement and a few afterwards.

I wrote the Report of the Signal Corps Observer of “The Cruise of the Atka” in 1955, after a long treatise on things we learned in Op Highjump, 14 ships and 4000 men, in 1946 and 47, just after I got back from Bikini. I returned from the South via Peter the First, Deception and even St Peter and Paul’s rocks, around the horn, studying radio, logging worldwide
signals and even static discharges, and reflections from bergs to improve our knowledge, and it all paid off when our first little reflections came back in 1958 and we had a new tool. I helped set up a five mile antenna in Greenland one year, the operation of the portable “A” power station, and other things, leading my own research teams across the 9000 foot thick cap and my gear (built by John) was first to sound Greenland from the air in 1965 as I retired. . . I sounded Ferrar Glacier first with radio ice-depth measuring gear, with me and my instruments in one chopper and the Skipper of the USS Glacier in the other, over 80 miles that day. We always travelled as guests of the Navy and on two journeys I actually was the half-owner of the Flag Mess on the Glacier. On that flight we stopped at Button Point and some other interesting places in the history books. I also had a hand in helping the New Zealanders, under Griffiths, dig out and rehabilitate Scott’s old house at Cape Evans, Shackelton’s old hut at Cape Royds, and the Discovery Hut on Hut Point, over the years. My pix are now in the archives of the Scott Polar Institute at Cambridge, as well as in 20 volumes here in Florida. I have visited Cambridge, Paris and Switzerland, of course, on several trips in addition to my wartime travels.

I was lucky, and like Ruthie, got to the Pole itself for a few hours back in 1961, and also measured the ice around Black and White Islands, Hut Point, the Ninnes Glacier, the Ross Barrier near Erebus, and also near the Little Americas I thru V. This included resounding some of the paths sounded by Poulter and Morgan back in ’35 and they always checked out very closely.

The stories and the hundreds of friends from the various Task Groups, and the pilots of both fixed-wing and rotary-wing flights in the Antarctic and around Thule . . . 200 miles inland and 300 miles north, thereof, are not forgotten. We owe those guys plenty, both Navy in the Antarctic and the Engineer Corps fellows in the Arctic, They helped us make history. They know who they are.

When I retired in 1965, there were 300 at my retirement dinner in the “O” Club at Fort Monmouth, and ten of those great Engineers came all the way from Belvoir to see me off; I’m sure you know Dickie Black was the leading speaker that night along with the MC who was the Chief Scientist of the Labs. What a night . . . more tears !!! I still wear my Red Engineer Corps tie whenever in khaki with great pride, in spite of the orange one dictated by my Alma Mater the Signal Corps! Thank you all wherever you are!

To make this short . . . I was asked to give a report on our ice techniques
to an international group in Obergurgl, Austria, in 1962 and did so, finding that there were six different means proposed for measuring ice and so innocently suggested that the whole group should meet just East of Thule, where we had already known depth areas established, to prove the best of the lot. It thus came about that they bought my idea and the two “International Experiments” were born, as noted above. The rest in the scientific papers, and now Bentley’s, Bogorodsky, and Gudmansen’s book, which makes it solid . . . Enough!

After retirement I was still kept busy for years getting people up to date on my old projects, writing a summary of every action over the 25 year period, and teaching Safe Boating in the U.S. Power Squadron, always with small boats and having my kids out fishing and learning as much as possible around Sandy Hook and New York Harbor, and always running a modern “ham” station with world-wide capabilities.

When the [Trans-Alaska] Pipeline came into the media and the problems with shallow water in Prudhoe, a friend and I drew 49 24×36 detailed
drawings of a sub that would break ice, assemble and disassemble for use in Prudhoe, and the shallow rivers of East Coast United States, and then we got a patent. You can find it in March 1970 *Popular Mechanics* Magazine and the May *Science Digest*. We were both too old to fight it through but it’s a workable idea. Love’s labor lost! Then, when OPSAIL 76 came to New York, I had part of the radio network to handle in New York Harbor for Squadron interests and Safety, and at 75 fell and broke my hip putting up an antenna. They put it back an inch too short, so I am still on crutches, and my arthritis doesn’t help. I still manage to swim and scuba dive down here for the fossils for which Venice is famous. That’s why we are here! Have some beauties. Of course, if you haven’t noticed I’m an amateur geologist and archeologist, in my spare time!

And so my dear friends, my precious wife and children, grand-children and great-grandchildren, wherever you are, read and save the other enclosures I have put with this brief summary of my work-a-day life, and remember above all that copies of all my important papers, movies, pix, and other items are in four places. Some are here at the house and will be sent to Bentley at U. of Wisconsin when the time comes; some are in the Fort Monmouth Museum in New Jersey with the clothes and skis I wore

![Fig. 12. Bud Waite retired in 1965 and lived in this home in Sarasota, Florida. (Author’s collection)](image-url)
on the ‘rescue’ trips to save Byrd in 1934; Some are in the Center for Polar and Scientific Records in the Nat’l Archives in Washington, carefully assembled from all Antarctic wanderers by the Late Major Gerry Pagano and now under the careful eye of my dear friend Alison Wilson, and many items plus a very complete Polar library have been given to the Peabody Marine Museum in Salem, Massachusetts, when our father’s ancestors did such great work in the Revolution . . . I still have a fairly complete and valuable Polar library here, so don’t let it go to waste. Salem also has the coffee grinder I recovered from Kane’s old camp (1856) way north of Thule and other items.

Also remember Betty and I gave our beautiful south sea shell collection, several valuable old family documents, and our 3500 piece collection of high grade Indian artifacts to Seton Hall University in Orange, NJ, before we sailed South. We now have a few newer ones. The large collection of antique radio parts will go to the Antique Wireless Association in Holcomb, NY, where I am an honorary member of that Society. The ancient letters from which I compiled the family’s genealogy last year are still here and must be properly taken care of, presumably Susie, and so also are the early 19th century bibles . . . Remember we have 37 ancestors who fought in the Revolution, and twenty in the Civil War. There are two generals on our father’s side and one on our mother’s (See Blue Book), and one Colonel and three officers in 1861–65. Don’t let them down.

And so farewell! Everything I have ever done has been for my family and my country, and I continue to abhor the misuse of drugs and alcohol. Please keep the flag flying. I am a Mason, a Knights Templar, and a Shriner and believe in things associated with those groups, but regardless of whatever religion you profess if you live up to it, it’s OK with me! The Golden Rule is far the best. I used to smoke, too, but in later years cigarette smoke became very bad for me, so that too is a No No!

I can easily wax sentimental since you are all so far away, but let’s say once more... To all, my warmest love and Yawr Son Dics.

P.S. There are some of my paintings here, but I hope there’ll be others before the Black Camel gets me! Cheerio! 73 88 and 30.

Fig. 13. Bud Waite closes his letter, signs his name and adds a postscript. (Author’s collection)
Bud closes his letter with the following words: “I can easily wax sentimental since you are all so far away, but let’s say once more . . . To all, my warmest love and Vaya Con Dios!” He then signs his names and adds the following postscript: “There are some of my painting here, but I hope there’ll be others before the Black Camel gets me.”

Obituary of Amory H. Waite by Charles R. Bentley

Amory H. (‘Bud’) Waite, the pioneer in radar sounding of ice sheets, died on 15 January 1985 at the age of 82. Born 14 February 1902 in Newton, Massachusetts, he was married to Betty (nee Massey) in 1936. He graduated from the Naval Radio School at Great Lakes Naval Station in 1919 and received his degree in electrical engineering from the Lowell Technological Institute in 1926. Most of his career was spent with the Institute of Exploratory Research of the U.S. Army Signal Corps (later the U.S. Army Electronics Command), in which he was the Chief of the Communications Research Group. He was one of the last survivors of the Second Byrd Antarctic Expedition during which he was the radio engineer/operator, and a member of a small tractor party that rescued Admiral Byrd from Boiling Advance Base during the winter night of 1934. His interest in Polar Regions lasted all his life; twenty times he led Signal Corps research teams in the Arctic or Antarctic. Bud Waite was best known for his important contributions to the early development of radar sounding. He made the first recorded long-distance transmission of radio waves through ice at Little America Station on the Ross Ice Shelf in the summer of 1955–56, when he recorded signals that had traveled one mile between snow pits. He also recorded the first bottom echo from the base of the Ross Ice Shelf in January 1957, although he did not recognize it as such until looking back later at his records. His first deliberate attempt at measuring ice thickness, at Little America Station in December 1957, was a discouraging failure. Only a month later, however, he successfully sounded ice up to 600 m thick south of Wilkes Station (now Casey Station). He also made the first airborne survey in Antarctica in December 1961. In the summers of 1963 and 1964 he organized and coordinated the International Cooperative Field Experiment in Glacier Sounding, a unique venture in which the results of radar, seismic, gravimetric, and electrical measurements of ice thickness were compared directly along the same sounding lines. He retired from the U.S. Army Electronics Command in 1965. Bud Waite was a man of great enthusiasm and boundless generosity. For several of the early years he persisted with his belief in radar sounding in the face of widespread skepticism on the part of glaciologists and geophysicists. His generous help was instrumental in establishing programs in radar sounding in several US institutions. He took great and justifiable pride in his accomplishments which eventually, if slowly,
brought him the international recognition he deserved.

—Charles R. Bentley

Notes

1. For information about the USS Bear of Oakland see http://www.hazegray.org/features/bear/.
2. The Tamiami Amateur Radio Club, an affiliate of the ARRL, was organized circa 1960 to serve the Venice, FL area with emergency communications.
3. The Antarctican Society was founded in 1960 as a not-for-profit educational society by devoted Antarciticans in the District of Columbia. Nearly all the members had been in Antarctica during the International Geophysical Year, 1957–58, and wished to continue reuniting socially.
5. Little America II was one of a series of Antarctic exploration bases named Little America I, II, etc. from 1929 to 1958, located on the Ross Ice Shelf south of the Bay of Whales. See Wikipedia at https://en.wikipedia.org/wiki/Little_America_%28exploration_base%29.
6. A “mill” is a special “Caps only” typewriter used by early wireless/radio operators in copying messages.
8. USS Arkansas, a U.S. battleship.
9. The well-renowned “Radio Relay Equipment” referred to in the letter was commonly used by the Signal Corps and was known by the acronym ANTRAC, which was derived from its nomenclature, AN/TRC-1, 3, or 4.
10. Tinian is one of the three principal islands of the Commonwealth of the Northern Mariana Islands.
11. OPSAIL, or Operation Sail, refers to a series of sailing events held to celebrate special occasions and features sailing vessels from around the world. See Wikipedia at https://en.wikipedia.org/wiki/Operation_Sail.

ABOUT THE AUTHOR

John Dilks, K2TQN, has been an amateur radio operator since high school (1956). Dilks first became interested in radio history in the 1970s. Having seen some of the great “ham radio” stations of the past in his youth, he began to collect early radio equipment and historical documents. Much of his collection came from the owners of older ham stations as they were downsizing and shutting down.

In the mid 1990s Dilks built a mobile radio museum in a 27-foot RV-like vehicle that had been a mobile office. The purpose of the mobile museum was to travel to radio events giving demonstrations for enthusiastic audiences. Traveling up and down the east coast to these events, he eventually came to the attention of the American Radio Relay League in Connecticut. ARRL publishes QST, the popular amateur radio magazine. Dilks was invited to write a monthly column about radio history starting in the January 2000 issue. Since that time, Dilks has penned more than 130 columns. As a member of the Antique Wireless Association since the 1990s, Dilks regularly travelled to participate in the AWA Conference in Rochester with his mobile museum.
Amory H. “Bud” Waite, Polar Explorer

In 2001, after a 38-year career with the telephone companies, he joined the Egg Harbor Township School District where he was the Distance Learning Coordinator at the Fernwood Avenue Middle School. He also ran a computer lab and maintained the computers in the building until recently. Now retired from the school district and QST magazine, he enjoys speaking at radio events and writing articles.

John Dilks
The Rise and Fall of the De Forest Companies

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Abstract

Much has been written about Lee De Forest and the various companies he helped to create, most of which focuses on the man, his radio apparatus and his accomplishments. This paper is a review of how and when his many companies were formed, how they transitioned from one to another, and how and why they failed—often spectacularly. It details how De Forest, whose goal was to achieve success and fame in the field of radio telegraphy and telephony, was willingly duped into forming a number of companies by conspiring with known stockjobbers whose goal was to sell as much stock and pocket as much of the proceeds as possible. As a result, De Forest was left with precious few resources for developing the necessary apparatus, much less for assembling the necessary infrastructure consisting of stations and operating personnel required to provide reliable communication services. Interspersed among interesting facts and figures about the rise and fall of each company, with their attendant accomplishments and failures, are stories of the shenanigans of colorful but deceitful cohorts of De Forest.

Introduction

It is not known for certain how many De Forest-related radio companies were created in the years between 1902 when the first De Forest company was organized (Wireless Telegraph Company of America), and 1924 when the last De Forest radio company was formed (De Forest Radio Company). The better known De Forest-related companies listed in Table 1 were selected for chronicling because each succeeding company in the table was created just as the preceding company began to fade or fail, so that the stories of these companies result in a rather seamless account of the rise and fall of Lee De Forest and his companies. Other lesser-known radio companies such as the De Forest Great Lakes Wireless Co., Atlantic De Forest Wireless Co., and Occidental and Oriental Wireless Co. were subsidiaries of one or more of the companies listed. These lesser-known companies will be mentioned as appropriate but not accorded the status of sections denoted by Roman numerals.
The De Forest companies in this table are divided into two categories. The first three companies focused on wireless telegraphy while the remainder focused on wireless telephony, that is to say, communication by voice for applications to radiotelephony and/or broadcast radio. This article addresses the first three De Forest companies appearing in the table, while a subsequent article will address the remaining companies.

It should be noted that the spelling of the De Forest company name in the filing papers of all De Forest companies listed in this table appear as “De Forest,” spelled with a capital “D” and a space between “De” and “F.” While alternate forms of the De Forest spelling have been used for the De Forest company names—often quite indiscriminately—the De Forest form is used here because it is the most common form and because the De Forest spelling appears in most of the filing papers, providing an indication of intent. The De Forest spelling will also be used for Lee’s surname in the general narrative for reasons indicated in the first reference. The spelling of Lee’s surname used in cited references, quotations, and reproductions of historical documents is reproduced here exactly as it appears in the cited material, a practice that is recommended by most style manuals.

While much has been written about the De Forest-related companies, little has been written about how and why the companies were created, how one company transitioned to the next, and how and why they failed. More to the point, much of the information written about this topic is either inconsistent

**Table 1. De Forest-related Companies Chronicled in Titled Paragraphs.**

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<thead>
<tr>
<th>De Forest-Related Wireless Telegraph and Radio Companies</th>
<th>Incorporation</th>
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<td>Wireless Telegraph Company of America</td>
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</tr>
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<td>De Forest Wireless Telegraph Co.</td>
<td>ME 2/19/1902</td>
</tr>
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<td>American De Forest Wireless Telegraph Co.</td>
<td>ME 12/3/1902</td>
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<tr>
<td>De Forest Radio Telephone Co.</td>
<td>NY 3/7/1907²</td>
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<td>Radio Telephone Co.</td>
<td>NJ 5/17/1907³</td>
</tr>
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<td>North American Wireless Corp.</td>
<td>ME 11/4/1909</td>
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<td>Radio Telephone &amp; Telegraph Co.</td>
<td>DE 12/10/1913</td>
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<tr>
<td>De Forest Radio Telephone &amp; Telegraph Co.</td>
<td>DE 9/26/1914</td>
</tr>
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<td>Lee De Forest Inc.</td>
<td>CA 3/27/1920</td>
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<td>De Forest Radio Co.</td>
<td>DE 9/27/1924</td>
</tr>
</tbody>
</table>

¹Dates taken from state incorporation documents unless otherwise noted
³*New York Times*, May 18, 1907, p. 11.
with original documents describing these events or has never been chronicled. Accounts of the De Forest-related companies given here were generated from original documents found in the following sources: documents from the Lee and Marie de Forest Papers at History San Jose Research Library, George Clark’s Radioana Collection held by the Museum of American History, the “Lee De Forest papers, 1884–1955” held by the Manuscript Division of the Library of Congress. Citations from De Forest’s diaries held by the Library of Congress are referenced hereinafter as “De Forest Diaries” followed by the date of entry.\(^2\) Also included are incorporation documents from the respective secretaries of state in which each company was incorporated, electrical magazines and newspapers of the day that chronicled activities of the wireless telegraph companies, and documents from the author’s collection chronicling the sworn testimony of De Forest employees and other witnesses in two different litigations, the principal one being the National Electric Signaling Co. (NESCO) suit against the American De Forest Wireless Co. alleging infringement of Reginald Fessenden’s electrolytic detector patent.\(^3\)

Finally, both versions of De Forest’s autobiography were used including *Father of Radio* that was published in 1950,\(^4\) and the original unpublished 1186-page draft version of De Forest’s autobiography dated 1949 held by History of San Jose.\(^5\) The unpublished version of his autobiography was found to be significantly more accurate than the published version, which is fatally flawed by numerous errors and omissions that were created by the publisher during the editing process. For example, 1) two of the more relevant companies are not even mentioned—the Wireless Telegraph Co. of America and Lee De Forest, Inc., 2) the American De Forest Wireless Telegraph Company is misidentified as the De Forest Wireless Telegraph Company in several places, and as a result, activities of the De Forest Wireless Telegraph Company do not appear anywhere in the book,\(^6\) and 3) many vignettes have errors in dates and time intervals.\(^7\)

**Organization**

This article is organized according to the roadmap outlined in Fig. 1 in which each of the four shaded boxes corresponds to one of the four major titled sections. The first section covers the activities of the first company, the Wireless Telegraph Company of America, which was organized on September 21, 1901. The second section covers the activities of the De Forest Wireless Telegraph Company organized on February 19, 1902, the first company to use the De Forest surname. The dashed line indicates that this company was not a successor to the Wireless Telegraph company—instead its assets were transferred to the new De Forest Wireless company by means of a 99-year lease executed on May 5, 1902, almost three months after the new company was organized.

The third section covers the activities of the American De Forest Wireless
The Rise and Fall of the De Forest Companies

Fig. 1. This roadmap represents the organization of the article, in which the four major divisions are indicated by the shaded boxes designating the three major De Forest-related telegraph companies; companies in the first column were either organized as subsidiaries of, or merged into, the indicated parent companies appearing in the middle column, while companies appearing in the third column were foreign affiliates. The American De Forest Wireless Telegraph Company was organized as a subsidiary and later became the parent.
Telegraph Company, which was organized as a subsidiary of the parent De Forest Wireless Telegraph Company on Dec. 3, 1902. The parent and subsidiary actually operated as if they were a single company with the same assets, the same president, the same business offices, and a majority of the same directors. Since the activities of both companies were indistinguishable, they are treated together as one entity until March 14, 1904 when the parent De Forest Wireless company and the International Wireless Telegraph Company were merged into the then-subsidiary, the American De Forest company. The stock in the Canadian affiliate owned by De Forest Wireless was also transferred to American De Forest. The affiliates in this roadmap are distinguished from the subsidiaries in that they were not under the control of the De Forest companies whereas the subsidiaries were.

The fourth and last section covers the exploits the American De Forest company from the time it became the parent on March 14, 1904, until the time it and its three subsidiaries were merged into the United Wireless Telegraph Co. on November 17 1906. The financial interests in the two foreign affiliates were also transferred to United Wireless at that time. Lee De Forest’s employment at the American De Forest company was terminated on November 28, 1906, eleven days after formation of United Wireless, so all connections between Lee De Forest and his wireless companies ended with his termination, as does this article.

I. The Wireless Telegraph Company of America (1901–1902)
The story of the Wireless Telegraph Company of America begins with a newspaper article in the July 20, 1901 issue of the Chicago Tribune reporting the successful test of a new wireless telegraph system invented by Dr. Lee De Forest, E. H. Smythe, a young Western Electric engineer, and Professor Clarence E. Freeman, a professor of electrical engineering at the Armour Institute of Technology. Artistic sketches of the new system of telegraphy accompanying the article (Fig. 2) made an impression on many readers, and this article propelled the young De Forest into the spotlight. The reporter used the De Forest spelling for the first time in print—the spelling that was repeated in newspapers for years to come. Over a two-year period, De Forest and Smythe collaborated on the design of the receiver, often referred to as a “responder,” while Freeman designed a unique transmitter. The term “responder” describing a radio receiver was actually coined by the Electrician of London in October 1900. The three participants filed four patents between September 1, 1900 and July 5, 1901 on apparatus that collectively became known as the De Forest-Smythe System: U.S. patents No. 716,203 and No. 716,000 covering the receiver, which were filed jointly by L. De Forest and E. H. Smythe on September 1, 1900, and July 5, 1901, respectively; U.S. patent No. 773,069 covering the transmitter, which was filed on January 14, 1901 by C. E. Freeman; and U.S. patent No.
720,568, also covering the receiver, which was filed on March 6, 1901, by L. De Forest. The Freeman sending apparatus and De Forest-Smythe receiver or responder covered by these patents are shown in Fig. 3 and described in the *Western Electrician*.10

The new De Forest–Smythe responder was a form of an electrolytic detector that was used in conjunction with headphones as an indicating device. The responder shown in his patent consisted of two opposing conducting cylinders (see Fig. 4) in which the space between the two was filled with an electrolyte or “electrically-decomposable” liquid containing metal particles—a paste which De Forest often referred to as “goo.” In this regard, De Forest’s electrolytic goo detector was distinctly different from the electrolytic detector chronicled by Pupin and patented later by Fessenden.11

The principal novelties of De Forest’s responder were the fact that the detector was self-restoring (as opposed to Marconi’s coherer, which required tapping back to restore sensitivity), and it used earphones rather than the Morse inker used by Marconi. These differences made possible a much higher word rate than the coherer used by Marconi and others. De Forest’s new receiver was often described in the press as an anti-coherer because the resistance of the device increased rather than decreased when responding to electromagnetic waves. While the De Forest-Smythe System would achieve a degree of acceptance in the U.S., De Forest’s new responder was relatively insensitive and also subject to clogging, which would...
ultimately cause De Forest to discard it in favor of other detector technologies.

After his initial success in Chicago, De Forest felt it was time to challenge Marconi, who was planning to report on the America’s Cup races to be held off the coast of Sandy Hook, New Jersey, between September 28 and October 4, 1901. De Forest believed that he could overshadow Marconi by transmitting information farther and faster, thereby attracting the attention of the public and investors alike. In his autobiography he states: “From the start, I had the one aim in view, to make my name at least rank with that of Marconi.” He continued with, “Efficiency shall be the key to success and fame . . .” His visions of grandeur dictated that he move his operation east—against the wishes of his partners Smythe and Freeman. Over their protests, he came to the New York City area circa August 7, 1901, where he roomed with his Yale classmate Manning (Max) F. Stires, Jr. in his Jersey City home.

Max Stires found that Marconi had already contracted with the Associated
Press and New York Herald to report the races, so Stires introduced De Forest to representatives of the Publishers’ Press Association, with whom De Forest was able to arrange a competing contract for reporting the races. Stires also introduced De Forest to Charles Seidler, a former mayor of Jersey City and willing investor, who advanced $1,000 to De Forest, thereby allowing him to construct a copy of the Freeman transmitter. Seidler would later be elected the first president of the Wireless Telegraph Company of America at its first shareholder meeting on Dec. 14, 1902.14

The Wireless Telegraph Company of America is Incorporated

While De Forest was busy fabricating the needed apparatus, Max Styles, a practicing attorney in New York City, was busy incorporating the Wireless Telegraphy Company of America in New Jersey on behalf of the five incorporators and subscribers (shareholders) listed on the Certificate of Incorporation (Table 2). According to the minutes of the company, the Certificate of Incorporation was recorded on September 23, 1901, just five days before the yacht races were to begin on September 28. Only 60 shares were authorized at a par value of $50 per share, resulting in a total capitalization of a mere $3,000. De Forest, Freeman and Smythe paid for their shares by assigning three of the four patents mentioned previously to the Wireless Telegraphy company. According to the Minute Book of the Wireless Telegraph Co. of America held by History San Jose,15 the fourth patent mentioned previously, No. 716,203 was not included in the assignment. Seidler had already advanced $1,000 prior to the formation of the company, which De Forest used to fabricate the Freeman transmitter, leaving a capital contribution at the time of incorporation of only $150—and that is assuming that Stires paid for his stock with cash. Clearly the company had no financial resources at the time of the races.

While Lee De Forest was able to assemble a working system by the time the yacht races began, it is known only too well that the coverage of the yacht races by both Marconi and De Forest was a complete fiasco, not only because the two systems interfered with each other, but also because employees of the American Wireless Telephone & Telegraph Co. (formed in 1899), who were also attempting to report the races but without a sponsor, took great delight in interfering with the two companies with contracts.16 De Forest’s hopes for fame and fortune were instantly dashed, leaving him and the Wireless Telegraph company with no resources and no

<table>
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<tr>
<th>Subscriber</th>
<th>No. Shares</th>
<th>Par Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee De Forest</td>
<td>16</td>
<td>$800</td>
</tr>
<tr>
<td>Clarence E. Freeman</td>
<td>16</td>
<td>$800</td>
</tr>
<tr>
<td>Edwin H. Smythe</td>
<td>16</td>
<td>$800</td>
</tr>
<tr>
<td>Charles Seidler</td>
<td>9</td>
<td>$450</td>
</tr>
<tr>
<td>Manning F. Stires, Jr.</td>
<td>3</td>
<td>$150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>$3000.00</strong></td>
</tr>
</tbody>
</table>
immediate prospects for improving its financial situation. Charles Seidler, who had advanced De Forest $1000 before the race, refused to provide any additional financial support.

Lee De Forest Seeks Financing
In the months immediately following the races, De Forest claimed he visited no less than 25 offices of investment bankers to solicit financing for the fledgling company, but with no tangible results. De Forest wrote in his autobiography that his “financial affairs were in desperate straights.” Indeed, the entire enterprise was in such dire straights that De Forest also wrote he had contemplated asking Marconi for a job. Between his visits to Wall Street asking for financial support, he worked in White’s machine shop in New Jersey to develop a new transmitter to replace the Freeman transmitter, which De Forest felt was worthless. Sometime in late 1901, De Forest met John Firth, who was working in the same machine shop, and the two struck up a conversation. The upshot was that Firth introduced him to E. R. Holden & Co., a group of questionable financial agents that raised capital for various types of enterprises, particularly those that were not financially sound.

While the E. R. Holden Company initially made a proposal to obtain financing for De Forest’s new company, even the Holden company, which was accused of various stock swindles over time, had its limits. The E. R. Holden Company soon withdrew the offer and referred De Forest to Henry B. Snyder, the owner of H. B. Snyder & Company, a group of bankers and brokers specializing in speculative stocks that were sold “on the curb.” Snyder made an offer involving upfront payments of $5,000 at a rate of $1,000 per month that De Forest could not refuse. De Forest desperately needed the cash for his salary and for developing the new transmitter, and wanted to engage Snyder’s company to access the minimal upfront cash, notwithstanding the huge stock commission that the offer entailed. Snyder proposed to create a company with a capital stock at a par value of $100,000 to be distributed as follows: 35% to the original owners of the Wireless Telegraph company, 30% to the treasury of the new company for sale to the public, and a whopping 35% to H. B. Snyder & Company as a commission.

Seidler, Smythe and Freeman objected to the terms of the financing, which they felt were highly unfavorable to the proposed new company. According to a letter by Seidler, he voted against the contract but advised Smythe that the proposed contract could be voided if Snyder could not make good on the offer, which included the upfront cash payments amounting to $5,000 and the sale of 35% of the stock for the benefit of the company. Further, the directors would have to vote on the transfer assets of the existing Wireless Telegraph company to the new company that Snyder was committed to form. Despite these safeguards, Seidler was sufficiently upset with both De Forest and the Snyder proposal that
he resigned as president of the Wireless Telegraph company circa Dec. 18, 1901, at which time De Forest became interim president.

Shortly after De Forest became president, De Forest signed the contract with Snyder, although there is no record in the Minute Book of the Wireless Telegraph company that such a contract was ever signed or ratified. That the contract was in fact signed is apparent from this entry dated Dec. 22, 1901 in De Forest’s diary:

“Now, at last, a contract is signed—by me, as President of the Wireless Telegraph Co. of America. Seidler resigned the post to sell 10% (of his stock) to Bourbon for the magnificent $1,000 he has sunk in it—and because he was not satisfied with the terms of the Snyder agreement, he would, forsooth, ‘when convenient look further into Snyder’s references.’ . . . Enough of the ‘fatherly interest’—and blocking my steps.” He goes on to write, “Never was one so handicapped, bound up & tied down with such complications of ‘friends, partners, collaborators, patrons, sponsor, etc. as I have been from the start.”

Apparently, Snyder, who had no substantive financial resources of his own, could not meet the terms of the contract, because sometime before January 6, 1902, he would introduce De Forest to Abraham White, president of the Greater New York Security Co. located at 90 Wall Street. (Indeed, White’s office was located less than a block from Snyder’s office on Wall Street, and the two were well acquainted with each other as Freemasons of the same order in New York City.) Abraham White would form a new company for De Forest in February 1902—the De Forest Wireless Telegraph Company. The previously unchronicled story of how the new company was formed is addressed in the next section, along with the exploits of the new company after it was formed. Suffice it to say that White acquired the assets with an imaginative lease arrangement—as opposed to traditional methods of acquiring a company and/or its assets. Two traditional methods were mergers involving an exchange and/or a purchase of stock, and an asset purchase agreement, which was often used to avoid assuming liabilities of acquired companies. A lease arrangement is unique in that it leaves the two companies intact as separate entities after the lease is signed.

The Wireless Telegraph Co. of America Ceases Operations

Even after the lease was signed on May 5, 1902, the Wireless Telegraph Co. of America continued to exist, at least on paper. According to the Minute Book, a new slate of directors consisting of Smythe, Freeman and Stires was elected at the annual shareholders’ meeting held on May 5, 1902 to serve for the following 12 months. The last shareholder meeting was held on July 2, 1903, although the meeting was
adjourned because a quorum was not present. There are no more entries in the company’s Minute Book following the entry for the July 2, 1903 meeting; thus it appears that the company was essentially abandoned at that time. It is likely that the company’s charter lapsed several years later for failure to file the required annual documents with the state of New Jersey and/or for nonpayment of taxes—a very efficient way to dissolve a defunct company.

In its short lifetime, the Wire-less Telegraph Company of America failed to produce any tangible results. The only public demonstration of its technology at the yacht races held in 1901 was a complete disaster. Worse yet, the Navy concluded that the difficulties with interference at the yacht races could never be overcome with the apparatus used by the Wireless Telegraph company in the yacht races. The Freeman transmitter turned out to be worthless and the De Forest-Smythe goo responder would soon turn out to be unsuitable for practical wireless telegraphy because of its tendency to clog and its lack of sensitivity—despite public claims by De Forest to the contrary. With no operating capital, no prospects for raising capital as a result of the interference at the yacht races, and patents covering technologies of marginal value, the directors of the company had no alternative but to agree to the asset purchase contract offered by White. They abandoned the Wire-less Telegraph Company of America altogether, a story that is detailed in the next section.

II. The De Forest Wireless Telegraph Company (1902–1904)

This account of the De Forest Wire-less Telegraph Co. begins on January 3, 1902, the date when noted author Samuel Lubell claims that Lee De Forest first met Abraham White at lunch. Lubell describes how White impressed De Forest with a lavish meal and the gift of a $100 gold certificate (i.e., a $100 bill), undoubtedly accompanied by a glowing description of how he could make De Forest’s wildest dreams come true by creating and financing a new wireless telegraph company. Whether or not the date or description of their first meeting provided by Lubell is entirely accurate, an entry in Lee De Forest’s diary dated Jan 13, 1902 makes it clear that he had met with White prior to that date: “The prospects of getting money from Snyder & White about as fast as we will need it are encouraging.” As an aside, the reference here to both White and Snyder in the same sentence provides further evidence that Snyder introduced De Forest to White.

White and De Forest soon agreed to form a new company, and they also agreed that the name of the new company would be the De Forest Wireless Telegraph Company. Both the name of the new company and the position of Scientific Director that White offered De Forest were memorialized on a business card De Forest pasted into his personal diary on a page dated February 9, 1902. The business card, which is reproduced as Fig. 5, was accompanied by the following entry: “As this card, long coveted, discloses, I have at last
found my place—at least nominally. It has been a long, long time of groping in the dark, seeing few lights, small glow in the East—and feeling perhaps but one hand held out for sympathy & encouragement.”²⁴ Assuming the card was printed on or before February 9, 1902, the date in De Forest’s diary entry, this card was printed before the new company was incorporated, and was most likely presented to De Forest by White as some sort of inducement for De Forest to proceed with their plan to create a new company. How that plan was executed is presented next.

De Forest Wireless Telegraph Company is Incorporated

Abraham White engaged Millard W. Baldwin and a host of other bankers and brokers to create and incorporate the De Forest Wireless Telegraph Co. with a capitalization value of $3,000,000 in the State of Maine—three times as much as Snyder had proposed.²⁵ White decided to register the new enterprise in the state of Maine, most likely because the tax laws made it more attractive to register the stock there. The incorporation costs and franchise tax rates in Maine were the lowest in the nation. For example, the annual franchise tax for a company capitalized at $3,000,000 was $150 in Maine versus $3,000 in New Jersey and $1,500 in Delaware.²⁶ The incorporation papers were prepared and signed on February 7, 1902, just one month after the two first met. The papers were subsequently filed with the Attorney General’s Office of Maine on February 17, 1902 and recorded by the Secretary of State of Maine on February 19, 1902 (Fig. 6).²⁷

The names of the incorporators and the initial subscription of stock among the incorporators are shown in Table 3. It was not unusual to list the incorporators of a public company as the only subscribers (i.e., shareholders) at the time of filing, and to name the directors who would be responsible for operating the company at a later date. While the company was initially capitalized at $3 million dollars with each share having a par value of $1, only 1,000 shares were subscribed at the time of filing. The remaining shares were presumably available for sale to the public to fund the growth of the company. At a meeting of the incorporators the next month, the capital structure of the company was altered slightly by a reverse split in which the number of shares was reduced by a factor of 10 to 300,000 shares, and the share price was increased from $1 to $10.00 per share, thereby leaving the
total market capitalization remained unchanged.

It will become clear from the Minute Book and subsequent events that Abraham White filed the incorporation papers for the De Forest Wireless Telegraph Company with the State of Maine on February 17, 1902, without the consent or vote of the directors of the Wireless Telegraph Company of America. How the directors of the Wireless Telegraph company learned of the incorporation of the De Forest Wireless company and how White eventually persuaded the directors to approve the transfer the assets of the Wireless Telegraph Company of America to the new De Forest Wireless Telegraph Company are addressed next.

### Directors of the Old Company React to Incorporation of the New Company

It is clear from De Forest’s diary that Smythe and Freeman were unaware of the incorporation of the De Forest Wireless Telegraph Company until just before it occurred. The account in his diary begins with an entry dated February 18, 1902, one day before the incorporation papers were filed for the new company. De Forest received a telegram from Smythe that day—a very bad day for De Forest even before he received

### Table 3. Incorporators and Subscribers of the De Forest Wireless Telegraph Co. at the Time of Filing.

<table>
<thead>
<tr>
<th>Initial Subscribers</th>
<th>No. Shares</th>
<th>Par Value</th>
</tr>
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<tbody>
<tr>
<td>Millard W. Baldwin</td>
<td>992</td>
<td>$992</td>
</tr>
<tr>
<td>Ernest L. Chaney</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Herman R. Paul</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Edward P. McLaughlin</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>J. Lewis Shortridge</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Hartley Sagar</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Frank Stanton</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Louis H. Trosk</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Millard Damren</td>
<td>1</td>
<td>S1</td>
</tr>
<tr>
<td>Unsubscribed</td>
<td>2,999,000</td>
<td>$2,999,000</td>
</tr>
<tr>
<td>Totals</td>
<td>3,000,000</td>
<td>$3,000,000</td>
</tr>
</tbody>
</table>

Fig. 6. The De Forest Wireless Telegraph Co. was incorporated on Feb. 19, 1902, almost three months before the directors of the Wireless Telegraph Company of America voted on May 5, 1902 to lease its assets to the De Forest Wireless Telegraph Company created three months before. (Office of the Secretary of State, Maine)
the telegram. He had been working on a new transmitter to replace Freeman’s hapless transmitter, and his experiments on the new transmitter were not going well. Beginning with a reference to the intermittent performance of his new transmitter, De Forest wrote in his diary somewhat facetiously:

“But not a dot or dash could I receive! To add to my joy and peace of mind comes a telegram from Smythe demanding the name of the new company!”

It is clear that Smythe and Freeman were unaware of the name of the new company, which means they had not seen the incorporation papers nor had they assigned the assets of the old company to the new company. Second, there is no record in the Minute Book of the company about any vote or discussion by the directors about the incorporation of a new company or transfer of assets prior to the recording of the new company. De Forest was clearly angry and agitated by the telegram, and continued by writing:

“At last! I replied, it is also deemed wise and eminently fitting that my name be used in this connection. A hyphenated title with the ‘Wireless Telegraph Company’ would be unwieldy and cumbersome, and in as much as I have been from the first, & by long odds, the main factor in this enterprise, it is just that my name should be used.”

The words “At last” appearing at the beginning of the citation in his diary is clearly an indication of his long-standing frustration with Smythe and Freeman, and that he was ready to make his frustrations known to them. Indeed, he made his frustrations known to Smythe in a six-page letter dated February 18, 1902—the very same day. He began by stating his position on the company name: “It is also deemed wise, and eminently fitting that my name be used in this connection.” He then goes on to assert that nothing would have come of “the scheme” if it were not for him, that he had “sacrificed position, chance of promotion, with years of grubbing thereto . . .” and that he had done “nine-tenths of the work in the laboratory and practically all of it in interesting capital and launching the business.” He then rails against the injustices he has suffered under the yoke of Smythe and Freeman. He closes the letter by stating that: “It is important also, from every consideration, that we assign those patents to the new company.”

According to the next entry in De Forest’s diary dated March 21, 1902, there was a turbulent period following the incorporation in which Smythe and Freeman traveled to New York City to have very frank discussions with De Forest and White about the name and organization of the new company. Freeman and Smythe wanted to have their names added to the name of the new company, or in the alternative, to have De Forest’s name deleted. Smythe and Freeman were also insistent on becoming directors and employees of the new
company. However, De Forest would not agree to any of their demands. White put pressure on De Forest to acquiesce to their demands, but De Forest would not hear of it. According to his diary, he threatened to resign if White were to include their names in the company name or allowed them to remain as directors or employees.

Smythe and Freeman initially refused to assign their patents to the new company, believing that the assets of the Wireless Telegraph Company of America could not be transferred to the new company without a vote of the directors. Smythe and Freeman by themselves had 32 of the 60 votes needed to pass such a resolution. De Forest made it abundantly clear that he would not tolerate the presence of Smythe and Freeman in the new company as employees or directors, or allow their names to appear in the name of the company, lest he resign. To avoid the need for director approval, White prepared an imaginative lease agreement that would allow De Forest as President to sign an agreement on behalf of the Wireless Telegraph company to lease its assets to the De Forest Wireless Telegraph company for a period of 99 years. The following language appears in the 2nd paragraph of this agreement, the first page of which appears in Fig. 7:

“WHEREAS, the second party [Wireless Telegraph Co. of America] has leased unto the first party [De Forest Wireless Telegraph Co.] for a period of ninety-nine (99) years, that is to say until the 28th day of February, in the year Two Thousand and One (2001), all its rights title and interest in and to certain patents, patent rights, and assets, to wit . . . [three patents listed plus a Mechanical Syntony Device]; also similar inventions for the purpose of Wireless Telegraphy which may be hereinafter acquired by second party, foreign rights to the same, and all assets of second party consisting of machinery and instruments; . . .”

This was a bodacious clause because it allowed for the Wireless Telegraph Company of America to continue in business and continue to develop and patent new wireless technology that the De Forest Wireless Telegraph Company would have the right to use for the next 99 years. Best of all, there was nothing in the bylaws of the company preventing the president to sign such a lease.

However, by the time of the next shareholder meeting of the Wireless Telegraph Co. of America held on March 28, 1902, both Smythe and Freeman must have become aware of this draft agreement and realized that the bylaws did not preclude De Forest, who had previously been appointed President, from signing the licensing agreement without approval of the majority of directors or shareholders. As a result, Smythe and Freeman requested that another shareholder meeting be held on March 31, 1902 to consider several amendments to the by-laws of the company, the most important one being an amendment that would preclude
ARTICLES OF AGREEMENT entered into this______day of June, Nineteen Hundred and Two (1902), between the DeForest Wireless Telegraph Co., a corporation of the State of Maine, hereinafter called first party; the Wireless Telegraph Company of America, a corporation of the State of New Jersey, hereinafter called second party, and the Greater New York Security Company, a corporation of the State of New York, hereinafter called third party; WITNESSETH:

WHEREAS, the second party has leased unto the first party for a period of ninety-nine (99) years, that is to say until the 28th day of February, in the year Two Thousand and One (2001), all its right, title and interest in and to certain patents, patent rights, and assets, to-wit, U.S. Patent Application #50,078; U.S. Patent Application #67,136; U.S. Patent Application # 43,096; a Mechanical Syntax Device; also similar inventions for the purposes of Wireless Telegraphy which may be hereinafter required by second party, foreign rights to the same, and all assets of second party, foreign rights to the same, and all assets of second party consisting of machinery and instruments; which lease is dated the 28th day of February, 1902; and,

WHEREAS, the total authorized capital stock of the first party, amounting to $3,000,000.00 divided into 300,000 shares of the par value of $10.00 each, has been issued or is about to be issued in the name of and for the second party in payment for aforesaid patents, patent rights, and assets; and,

WHEREAS, of the said 300,000 shares of the capital stock of the first party, the second party has agreed to return into the treasury of the first party 90,000 shares, to be held as treasury stock, and to be disposed

Fig. 7. This page is the first of a seven-page lease agreement in which the De Forest Wireless Telegraph Company leased the assets of the Wireless Telegraph Company of America for 99 years.
any encumbrance or transfer of patent rights without a vote of the majority of shareholders. The wording of the amendment appearing in the *Minute Book* of the company is as follows:

“The board of directors in this corporation shall not have the authority to bargain, sell, assign, mortgage, lease, convey, transfer, or otherwise dispose of any letters patents, patent rights or invention, or any interest therein or right thereunder belonging to this company without the assent in writing of the majority of stockholders of the corporation.”

This amendment was easily adopted because Smythe and Freeman had a majority of the votes. White was left with the task of negotiating a severance agreement with Smythe and Freeman whereby they received an undisclosed amount of cash and/or stock in the new company in return for an agreement to vote for ratification of the lease agreement, which was required by the recently-modified bylaws. White also agreed to buy the stock of Smythe, Freeman and Seidler in the Wireless Telegraph Co. of America, although none of the three was offered any position in the new company. The lease agreement was put to a vote by the directors of the company at a special meeting held on May 5, 1902, at which time the agreement was unanimously affirmed and ratified by all directors. The contract was signed by Lee De Forest as president of the Wireless Telegraph Co. of America and Abraham White as the president of both the De Forest Wireless Telegraph Company and the Greater New York Securities Company, the latter company also being a party to the agreement.

The nine directors listed in Table 4 were elected at a shareholder meeting held on May 20, 1902. Abraham White was named president, Manning Stires was named Secretary, and James Stewart was named Treasurer. It is notable that Smyth, Freeman and Seidler, who had an adversarial relationship with De Forest in the old Wireless Telegraph Company of America, were no longer directors. The three that had helped De Forest secure funding for the new company were named directors in the new company—namely Stires, Firth, and Snyder, who are shown in bold font in the table. White appointed four of his friends and associates as directors (Galbraith, Stewart, Avery, and Dexter) to make sure he had a voting majority. None of the nine incorporators originally listed as directors on the Certificate of Organization remained as a director.

There is no record of how much stock each director listed in the table was initially granted, but the distribution of much of the remaining stock was

<table>
<thead>
<tr>
<th>Names of Directors</th>
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<tbody>
<tr>
<td>Abraham White, President</td>
<td></td>
</tr>
<tr>
<td>Charles C. Galbraith</td>
<td>James Stewart</td>
</tr>
<tr>
<td>Lee De Forest</td>
<td>George W. Avery</td>
</tr>
<tr>
<td>Manning F. Stires</td>
<td>Henry B. Snyder</td>
</tr>
<tr>
<td>John Firth</td>
<td>Henry B. Dexter</td>
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Table 4. Directors of De Forest Wireless Telegraph Co. as of May 20, 1902.
specified in the lease. The language of the agreement is an amazing exercise in obfuscation. One thing is clear, namely that one third of the stock (100,000 shares) was to be sold to the Greater New York Securities Co., which had an option to purchase 75,000 shares with a par value of $10 per share for 8 1/3¢ on the par dollar. It is not likely that much of the proceeds of this stock found its way into the company treasury.

That the transfer of assets from the Wireless Telegraph company to the De Forest Wireless company was, in fact, accomplished by means of a 99-year lease can be confirmed by a later lawsuit over the subsequent transfer of this lease from De Forest Wireless to American De Forest, which purportedly occurred on January 1, 1904. Henry Snyder brought a suit in an attempt to block the transfer of this 99-year lease to the American De Forest company that would have diluted his stock.

De Forest Wireless Telegraph Company Objectives

White and De Forest got along very well because their technology goals were the same despite the vast difference in their strategic goals. De Forest’s strategic goal was to achieve fame and fortune by developing superior wireless technology exceeding that of Marconi in particular and other competitors in general. White’s strategic goal was to amass a fortune by selling as much stock as possible in the fledgling field of wireless telegraphy, and retaining as much of the proceeds as reasonably possible. Neither one displayed any genuine interest in building an extensive wireless communication system. The technology goals of both were aligned: 1) improving transmitter and receiver technology resulting in better performance (longer ranges, higher word rates and improved reliability) to provide better demonstrations for prospective investors; 2) building station pairs to test and evaluate receiver and transmitter technologies and to demonstrate communication capabilities to potential investors and customers (military, government and commercial), and 3) selling wireless communication components, systems and services to major customers in order to gain an competitive edge over Marconi and to elicit testimonials from customers for purposes of selling stock.

The fledgling De Forest Wireless company made progress in all three technological categories during the last half of 1902. The major accomplishments of Lee De Forest and De Forest Wireless during this period were as follows: 1) Lee De Forest improved the De Forest System by completing the development of his new transmitter that replaced the hapless Freeman transmitter used in the yacht races in 1901, 2) De Forest reported developing an improved goo responder in August 1902, and filed a patent for a new “needle responder” with a filing date of December 24, 1902, 3) the company erected three wireless stations for purposes of testing its equipment and demonstrating its capabilities to potential investors, and 4) the company received two government contracts,
the first from the U.S. Signal Corps to support Army/Navy Maneuvers taking place circa August 1902, and a second from the Navy to demonstrate the capability to communicate between Navy stations at Annapolis and the Navy Yard in Washington circa December 1902. Progress in these four areas is summarized below.

**De Forest Improves the De Forest System Transmitter**

Lee De Forest actually began to develop the new transmitter in late 1901 immediately following the disastrous yacht races. The new transmitter consisted of a motor-generator set delivering 500 volts at 60 Hz, which was interrupted by a Morse key and then stepped up to 25,000 volts by a special transformer, the output of which was applied to a double spark gap shunted by 6 or 8 quart Leyden jars in parallel (Fig. 8). The transmitter could also be operated from an AC power main when available. De Forest began by developing a 1 kW transmitter, which was later followed by 2 kW, 5 kW, 25 kW and 40 kW versions. (It should be noted that it was the custom at the time to characterize the power of a transmitter by the rating of the power source rather than the radiated power.) A simplified diagram of the transmitter is shown in Fig. 9.36

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Fig. 8. This De Forest transmitter first appearing circa June 1902 consisted of a motor-generator set delivering 500 volts at 60 Hz, which was interrupted by a Morse key and then stepped up to 25,000 volts by a special transformer, the output of which was applied to a double spark gap shunted by 6 or 8 quart Leyden jars in parallel. (*Electrician*, Oct. 3, 1902, p. 943)
The Army was indeed impressed with new transmitter De Forest had developed, a fact that is evident from the following quote taken from the *Annual Report of the Chief Signal Officer* published in 1902: “The De Forest system gave very good results, and it is believed this system of transmission, utilizing an alternating current with a step-up transformer in oil insulation, is theoretically the best as well as the one giving the most promising practical results.”\(^{37}\) Beginning in 1903, both De Forest company ads crafted by White began to misquote this statement by omitting the words appearing in italics, thereby making it sound like the De Forest “system” was “the best”—as opposed to the “system of transmission” being “theoretically the best.”\(^{38}\) The De Forest companies also ascribed the quotation directly to Brig. Gen. A. W. Greely, Chief Signal Officer of the Army, as if he stated it, when in fact the statement was written by his staff in the *Annual Report of the Chief Signal Officer for the Fiscal Year Ending June 30, 1902*. When asked about this testimonial, Gen. Greely wrote a tongue-in-cheek response to the query, which appeared in the March 17, 1903 issue of the *Washington Post* (Fig. 10). In this letter, he

\[\text{HELPLESS TO REMEDY EVIL}\]

Gen. Greely Indignant at Use of His Name by Wireless Company.

“That is what I call an outrage,” remarked Gen. Greely of the Signal Corps, the other day. “Here is a letter from a man asking me what I know about a certain system of wireless telegraphy, and he encloses a circular of the company, in which it is stated that I endorse this system. As a matter of fact I never endorsed any system of wireless telegraphy. I would be glad to do so, and put it in operation for the government as soon as a satisfactory kind is presented to me. I don’t even know much about this particular system which I am said to have endorsed. Now, what is a man to do in a case of that kind? That circular has been sent everywhere, and there is no way for me to reach the men who might be deceived by it. Probably some men are wondering how much stock I have in the concern. All this is what makes it annoying.”

(Washington Post, March 17, 1903, p. E7)

Fig. 9. The following components appear in this simplified schematic diagram of De Forest’s new transmitter: an alternating current generator (1), a telegraph key (2), a high-voltage oil transformer (3), a spark gap (6) with one side connected to a radiating antenna (4) and the other side connected to ground (5), and a bank of Leyden jar capacitors (7 & 8) placed across the spark gap. (R. G. Blaine, *Engineering Magazine*, Aug. 5, 1904, p. 201)

Fig. 10. This article placed in the *Washington Post* by General Greely, U. S. Signal Corps, was provoked by distortions in ads placed by Abraham White in early 1903, which ended with the quip: “Probably some men are wondering how much stock I have in the concern.”
denied any personal knowledge of the system and the endorsement, closing his letter with this classic quip: “Probably some men are wondering how much stock I have in the concern.”

De Forest Improves the Goo Responder
De Forest, who was well aware from the outset that his original goo responder was unreliable and not very sensitive, set out to improve his responder in early 1902. An article appearing in the August 16, 1902 issue of Scientific American chronicled his wireless system with an emphasis on the receiver with an improved responder he had supposedly just developed. The article stated: “During the past year De Forest has greatly increased the sensitivity of the responder, while maintaining its simplicity.” The article goes on to say, “the receiver will respond with absolute certainty and regularity to a spark of one sixty-fourth of an inch length from a spark coil forty feet distant driven by one cell of a storage battery . . .”

Ominously, De Forest never quantified how the sensitivity of the old responder compared with the improved responder. A photograph of the receiver with his improved goo responder appeared in the article (Fig. 11), but there was no image of the detector itself. Consequently, there is no way to know how, or even if, the responder was actually improved.

De Forest Wireless Telegraph Co. Erects its First Three Commercial Stations (1902)
The De Forest company erected three stations in 1902 that were known to be operational by the end of 1902—all located in and around New York City. The three stations were located at: the Cheesebrough Building at 17 State Street in NYC, the Hotel Castleton in Staten Island, and Steeplechase Park at Coney Island. An article in the July 19, 1902 Western Electrician described the Coney Island station, which was opened on June 14, 1902, as the premier station: “The most important land
station yet established by the De Forest company is that at Steeplechase Park, Coney Island (Fig. 12). This enjoys the distinction of having the tallest mast in America, a fine stick of four pieces [of wood], standing 210 feet high.”41

The three stations were used primarily for test and evaluation of new designs and for demonstrations staged for potential customers. The locations were chosen because they were in close proximity to each other, to company offices, and to company laboratories. They were also conveniently located for demonstrations to potential customers. There were allusions in the press to the erection of other commercial stations during the last half of 1902, but a check of the literature clearly indicates that only the three stations mentioned above were actually operational by the end of 1902. It is notable that the maximum distance between any of these stations was approximately six miles.

**De Forest Wireless Co. is Awarded Its First Two Contracts from the Government**

The De Forest Wireless Telegraph Co. was awarded two government contracts in 1902, the first from the U.S. Signal Corps and the second from the U.S. Navy.42 The first contract from the Signal Corps was awarded in August 1902 to supply two systems for test and evaluation during the course of the Joint War Maneuvers with the Navy.43 The original contract called for one system to be installed at Fort Wadsworth, New Jersey, and the other at Fort Hancock, New Jersey, located 10 miles away. According to a later article, the contract was modified such that the set planned for Fort Wadsworth was actually installed in the scout-boat “Unique” (Fig. 13).44 Wireless systems from two additional manufacturers were also tested during the maneuvers, namely those from Marconi and Fessenden. According to an article appearing in the *Western Electrician*, the Signal Corps was impressed with the De Forest System.45

According to De Forest press releases, the Navy was sufficiently im-
pressed with the operation of the De Forest System during the Joint War Maneuvers in August that they purchased two systems for tests and evaluation in late 1902 and early 1903, installing one at the Annapolis Academy, Maryland, and the other at the Washington Navy Yard in Washington, D.C., 36 miles distant from the station at Annapolis. While the De Forest press release may have been true, in reality the Navy purchased wireless systems from five different companies for test and evaluation and to compare capabilities. Wireless systems were also purchased from Messrs. Ducretet and Rochefort of Paris, Braun-Siemens-Halske and Slaby-Arco of Berlin, and Lodge-Muirhead of London. Initial tests were also carried out with the Marconi system, but that company refused to sell its system outright to the Navy for additional testing, so the Marconi system was dropped from further consideration.

The Navy made no statements about the results of these tests pending completion of the ship-to-ship and ship-to-shore transmissions planned for 1903. Nevertheless, the De Forest Wireless company took a very aggressive stance by sending a press release to the newspapers the day after the tests between the two land stations had been completed on January 14, 1903, which stated in part: “Washington, January 14, 1903—The Navy Department has practically accepted the De Forest wireless telegraph system, after final tests between the Navy Yard here and the Naval Academy at Annapolis to-day.” This statement was used in many display ads appearing in 1903 to bolster sales of De Forest company stock. However, according to the Navy Report for 1903, the De Forest System was not chosen by the Navy: “The report of the [Navy] board was received by the Bureau September 23, 1903; it finds that, under the varying conditions of the tests above outlined, the Slaby-Arco apparatus is superior to the other systems. On March 27, 1903 after consultation with the president of the wireless board, the Bureau ordered 20 sets of wireless telegraph apparatus of the Slaby-Arco pattern, the Department being desirous of testing this system of transmitting signals during the summer maneuvers.”

De Forest Replaces the Goo Responder with the Steel Needle Responder (1902–03)

Despite reports in the press about how well the goo responder worked, De Forest employees would later testify in the NESCO vs. De Forest litigation that...
none of the goo responders worked well, and that they often clogged during demonstrations to potential customers. De Forest, clearly aware that the original responder did not work well, had already been thinking about developing an entirely different oscillation detector as early as May of 1902. A sketch from his notebook dated May 19, 1902 reveals a detector formed by a carbon pencil lying across two steel wires (Fig. 14). Apparently he thought this configuration was a coherer requiring restoration to sensitivity with a mechanical shock because there is a solenoid in this figure that is intended to jar the contacts.49

The configuration in De Forest’s notebook is strikingly similar to the design used by David Hughes in his wireless experiments performed in 1879, which was first published in 1899 (Fig. 15).50 The Hughes figure was accompanied with the following description: “A microphone which is both sensitive and self-restoring, that is to say, does not cohere, is made with a carbon contact resting lightly on bright steel. Such a receiver is shown in fig. 3, where C is a carbon pencil touching a needle, N, and S an adjustable spring of brass by which the pressure of the contact can be regulated by the disc, D.” Note that De Forest annotated his drawing with “carbon pencil,” the same unusual words that Hughes used to describe his detector (see italicized words in the above paragraph). Also note that De Forest would refer to his detector as a “needle” detector, the same word Hughes used above for his bright steel contact.”
The main difference between the two sketches is that De Forest placed an electromagnet against the contacts to provide a mechanical shock to restore sensitivity, whereas Hughes states quite plainly that his microphonic contact is self-restoring. However, when De Forest went to the laboratory, he too found the contacts to be self-restoring. His discovery is plainly stated in the pre-amble to patent No. 770,228 he filed on or about Dec. 4, 1902 for a very similar configuration: “I have found that if two or more members consisting alternately of material which are unlike—such as, for instance, as steel and aluminum—be placed in series in the aerial circuit a strong autocoherer effect is produced.”51 This patent shows a drawing of slightly different version consisting of two aluminum needles (“C”) lying across two steel rods or pins (“D”) held in place by spring (“F”) with its tension adjusted by the knob (“G”—but without a solenoid (Fig. 16). While the drawing shows steel and aluminum contacts, the claims do not restrict the materials to these elements. In fact, documentation is cited next showing that De Forest actually made and used three different versions of this configuration—steel and aluminum, steel and copper, and steel and a carbon lamp filament.

All three versions of this self-restoring “needle” detector were used in the tests between Fort Schuyler and Fort Wright sponsored by the U.S. Signal Corps at the end of 1902 and the beginning of 1903. Captain Wildman, U.S. Signal Corps, testified in the NESCO vs. De Forest company litigation that he was present during tests of the De Forest System between Fort Schuyler and Fort Wright on Long Island in the fall of 1903 where three different forms of the needle responder were used. He asserted that one version (designated responder No. 1) was an imperfect contact consisting of a steel needle held against two terminals by a spring, another version (designated responder No. 2) was an imperfect contact consisting of steel and copper, and a third version (designated responder No. 3) was an imperfect contact consisting of carbon filaments resting on steel edges.52

De Forest’s General Manager C. G. Tompkins, employed by the De Forest
company from July 1902 to April 1903, testified in the NESCO vs. De Forest litigation that responder No. 3 had replaced the goo responders in all De Forest ship and land stations in the U.S. by December 1902, and that it remained in use until early 1904 when it was replaced by the liquid barretter electrolytic responder, which will be addressed later.

While there can be no doubt that the No. 3 needle responder replaced the goo responder in the entire De Forest System by December of 1902, there is conflicting testimony about whether the No. 3 responder consisted of aluminum rods or carbon filaments resting on steel needles. Captain Wildman testified that the No. 3 Responder consisted of carbon filaments resting on steel edges, but De Forest engineer J. P. Copland testified the No. 3 responder was the steel-aluminum version: “. . . defendants use the No. 3 Responder, the steel aluminum microphone of De Forest patent 770,228 . . .” 53 In testimony taken in a different lawsuit in 1915, De Forest confirms that the needle responder was used in 1903 but he sheds no light on which version was No. 3. 54

“[Fig. 4] illustrates the receiving circuit used in 1903, in which for the first time . . . I substituted for the old form of electrolytic detector [goo responder] an auto-coherer shown at X, which was built in various forms, one of the most practical being an incandescent light filament of carbon resting lightly upon two steel edges, forming a microphonic auto-cohering contact, which was automatically self-restoring. In shunt around this detector was connected a telephone receiver Y and the battery B.” 54

Note that De Forest uses the term “microphonic” when referring to the contact—the same term that Hughes introduced when describing the configuration he used, which was shown previously in Fig. 15. Unfortunately, the figure X cited by De Forest in the above testimony did not appear in the referenced document. Regardless of which version De Forest used in 1903, both versions actually form a relatively crude form of a crystal detector, not a self-restoring coherer as De Forest asserts. Thus, there can be no doubt that De Forest was one of the first to use a crystal detector in a wireless telegraph station—preceded only by Greenleaf W. Pickard, who documented the fact that he was using a carbon-steel form of a crystal detector on May 22, 1902 at the Cape May Station of the American Wireless Telephone & Telegraph Co. 55

H. E. Athearn, engineer and De Forest company operator at the Coney Island station in 1903, testified that he observed both the land station and the steam-ship Erin outfitted with the steel and aluminum version of the needle responder in 1903. 56 One of the better photographs appeared in Electrical World and Engineer on July 4, 1903 (Fig. 17), although the article is silent as to the type of responder. 57

The only reference to the needle coherer found in the literature...
appears in *Maver’s Wireless Telegraphy* published in 1904.58 Maver shows a sketch of the entire De Forest shipboard outfit using this needle coherer and states: “This figure (see Fig. 18) illustrates the arrangement of the De Forest apparatus in the cabin of the steam-yacht *Erin* [at the time of] the international races of 1903.” The layout of the De Forest System in the sketch is virtually identical to the previous photograph, and can be used to identify many of the main components of the transmitter and receiver on the *Erin*. Maver also shows a drawing of the details of the receiver and responder itself, which is reproduced here as Fig. 19. It is notable that Maver informs the reader that he was given much of this information by Lee De Forest himself: “The author is under obligations to Dr. De Forest for his courtesy in supplying many of the foregoing details of his system.”59

Actually, it is astonishing that De Forest never mentioned the needle coherer in his autobiography or other

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**Fig. 17.** One of the best photographs of the wireless equipment aboard the *Erin* was published in the *Electrical World and Engineer*; the needle responder appears at the far right. (July 4, 1903, p. 34)

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**Fig. 18.** William Maver, Jr. identified the main components of De Forest’s wireless equipment on the *Erin*. From left to right: the spark gap enclosure with Leyden jars, the antenna, the switch connecting the high-voltage transformer (not shown) to the spark gap, the key on a box enclosing circuit breakers, and the needle responder with protruding terminals holding the needle electrodes. (Maver’s Wireless Telegraphy, 1904, p. 114)
of his known writings, and he never chronicled the fact that any form of his needle detector was used in virtually all stations in the De Forest System during all of 1903. If it were not for the testimony of De Forest employees and Capt. Wildman of the U.S. Signal Corps in the NESCO v. De Forest litigation, the extensive use of the needle coherer in the De Forest stations may never have come to light. This is all the more surprising when one considers that the needle responder was used more widely and for a much longer period of time than De Forest’s goo responder, which he praised so extensively.

III. American De Forest Wireless Telegraph Co. as a Subsidiary (1903)
In late 1902, Abraham White decided to operate the De Forest Wireless Telegraph Co. by creating a number of different subsidiaries, each of which would be assigned well-defined geographical areas in which to operate. The stated reason for creating the subsidiaries was to better compete in foreign countries, but the real reason was to capitalize each subsidiary separately, thereby creating more stock for sale. The first subsidiary he created was the American De Forest Wireless Telegraph Company, which was incorporated on Dec. 3, 1902, in the State of Maine with rights to operate the De Forest System in America and its possessions. Smith was also the driving force for creating the De Forest Wireless Telegraph Company of Canada, Ltd., which was incorporated in Canada circa March 11, 1903, as an affiliate. Rights to operate the De Forest System in Canada were granted in return for a minority stock position in the Canadian-owned company, making it an affiliate of the De Forest company rather than a subsidiary. The function of the parent De Forest Wireless company was to develop and manufacture the wireless hardware needed to operate the De Forest System and provide the hardware to each subsidiary or affiliate.

This whole subsidiary approach was something of a farce because there were no foreign subsidiaries created, and only one foreign affiliate, which was a failure almost from the outset. The incorporation of the Canadian company was announced in an article appearing in newspapers circa March 11, 1903: "The De Forest Wireless Telegraph Company of Canada (Limited) has been incorporated with a

![Fig. 19. William Maver, Jr. produced this sketch of the receiver including the needle responder: 1) two aluminum rods (a) of the responder are attached to terminals (R) and (R') mounted on the receiver box, 2) a steel needle (n) is held against the rods (a) by the spring (s) whose tension is adjusted by the winding screw (S'), 3) the telephone (t) used as the sensing device and the battery (b) are placed in series with the responder to complete the circuit, and 4) the terminals of the responder are connected to the antenna (A) and the ground though capacitor (C). (Maver's Wireless Telegraphy, 1904, p. 113)
capital of $2,500,000. The company will acquire the present and future inventions of Lee De Forest . . . and enter into agreements with cities and municipalities to establish the new system. The head offices of the new company will be in Toronto.”60 A second article then appeared in the March 1903 issue of the Canadian Electrical News stating that experiments “are now being conducted for transmitting messages between Toronto and Hamilton,”61 cities which are located 40 miles apart across Lake Erie. Five months later, a third article appeared in the Canadian Electrical News indicating the entire enterprise was in trouble: “The De Forest Wireless Telegraph Company is removing its instruments from the station on Point Hill. The experiments were successful, but commercially it has not been profitable.”62

Little else appeared in the contemporaneous press after this announcement. However, testimony by De Forest employee J. P. Copland in the NESCO v. De Forest suit contradicted this statement about the experiments being successful. Copland testified that the stations never worked successfully: “At Toronto, Canada, a Mr. Thompson was trying to organize a Canadian De Forest company, and to induce Canadians to purchase stock in same; had erected through the New York office a couple of stations, one of which I think was at Hamilton. These two stations never did, within my knowledge, work successfully. These stations caused a great deal of trouble at the New York end, inasmuch as they were all the time bothering the New York office . . . They use a No. 3 responder, and Dr. De Forest and operators from this point were in charge of the stations.”63 Nothing more can be said here about the Canadian De Forest company, the only known foreign enterprise created as an affiliate of the parent De Forest Wireless Telegraph Co.64

The distinction between the activities of the American De Forest Wireless company operating as a subsidiary and the De Forest Wireless Telegraph Company operating as a parent would become blurred. The names of the two companies were often used interchangeably and indiscriminately in announcements and ads offering stock for sale in the press. Both the parent and the subsidiary made identical claims for the same achievements, and the majority of directors for both companies were the same. The remainder of this section addresses the activities of both.

American De Forest Wireless Telegraph Co. is Incorporated

The incorporation papers for the American De Forest Wireless Telegraphy Company were recorded in the office of the Secretary of State of Maine on Dec. 3, 1902. In choosing a market capitalization for this new subsidiary, White was undoubtedly influenced by the capitalization of the competing International Wireless Telegraph Company, which was $7,500,000 at that time. Somewhat arbitrarily, he selected a market capitalization of $5,000,000 for the American De Forest Wireless subsidiary, thereby giving the parent
company a market capitalization of $8,000,000—only $500,000 greater than that of International Wireless. Who could argue with that? With this ploy he was able to increase the capitalization of the parent De Forest Wireless Telegraph Co. from $3,000,000 to $8,000,000, and without appearing to dilute the exiting shareholders. White claimed other subsidiaries with operating rights in foreign countries were sure to follow. Such a scheme would allow for a seemingly endless stream of subsidiaries, each with its own stock and market capitalization.

Here is how White explained the scheme in his own words, which appeared in one of his many display ads placed in various publications beginning in 1903 for purposes of generating interest in the stock of both the parent company and the new subsidiary:

“The relation of the American De Forest Wireless Telegraph Co. to the De Forest Telegraph Co. is that of a subsidiary company. The American company was organized to operate the De Forest System in American territory. The De Forest, or parent company, is capitalized at $3,000,000, and will eventually hold in its treasury, more than the amount of its own capital stock, [namely] the stocks of active sub companies, such as the American, English, Canadian, Mexican, etc. Stockholders, therefore, in the parent company, will derive profits from businesses of the entire world field. The parent company also furnishes all instruments at a profit, and receives substantial royalties in addition, so that her revenues will be steady and absolute, whether the sub-companies yield large or small dividends.”

In this display ad, White made it clear that the role of the parent De Forest company was to develop and manufacture wireless equipment for subsidiary companies, while the role of subsidiary companies such as the American De Forest company was to operate the “De Forest System” in those geographical areas assigned to each.

White Introduces Misleading Ads and Articles
Armed with another 500,000 shares of American De Forest stock to sell at $10 a share, Abraham White began an advertising blitz to hawk the remaining stock of the De Forest Wireless company and the newly minted stock of the American De Forest company. For the first time, many display ads were placed in magazines and newspapers specifically hawking stock of both De Forest companies. Many ads containing misleading information on the number of stations erected, and false assertions that the De Forest System had somehow been adopted by the government. Other display ads compared the De Forest System and/or the two De Forest companies to the Bell Telephone System and company, implying that the profits to be made from investing in De Forest stock were comparable profits that
had been made by investors in the Bell Telephone Company (Fig. 20). These misleading ads appeared not only in the New York Times, the Wall Street Journal and the American Investor magazine where one might expect to find them, but also in daily newspapers circulated in cities throughout the country.

Typically, White would pick a city where he believed he could sell stock, erect a new wireless station for purposes of attracting local investors, and create an advertising blitz to sell stock in that geographical region. About half the ads promoted stock of the American De Forest company and the other half promoted stock of the De Forest Wireless company. A few of the ads promoted the stock of both by being intentionally vague, referring only to the “De Forest Wireless System” and the “Company” without actually referring to either company by name.

Perhaps the most interesting feature of these ads published in 1903, of which Fig. 21 is representative, was that they gave credit to the American De Forest company in 1903 for the accomplishments made by the De Forest Wireless company in 1902. Worse yet, credit was also given to De Forest Wireless company in its ads for exactly the same accomplishments. Thus, while the total capitalization of the two companies had increased from $3,000,000 to $8,000,000, there was no commensurate increase in assets, achievements, prospects or value of the combined companies. The companies not only shared the same achievements and prospects, they also shared the same address at 100 Broadway in New York City, the same President (Abraham White), and a majority of the same directors (Table 5). As a practical matter, the only real differences between the two companies were the different names on their stock certificates and separate listings on the stock exchange.
The Rise and Fall of the De Forest Companies

The American De Forest Wireless Telegraph Co.

Is prepared to furnish estimates for the equipment of yachts and steamers, also the establishing of PRIVATE wireless telegraph service between cities or other points.

The De Forest system has been accepted by the United States Navy after many severe competitive tests. The following is the report of the Chief Signal Officer, U. S. A. War Department Signal Office:

Washington, October 1, 1903.

Sir,—In connection with the army and navy maneuvers it was deemed advisable to test all available systems—namely, the De Forest, the Fessenden and the Marconi. The De Forest system gave very good results, and it is believed that this system of transmission, utilizing an alternating current with step-up transformers in oil insulation, is theoretically the best, as well as giving the most promising practical results.

The Secretary of War,

A. W. GREELY, Brigadier General,
Chief Signal Officer of the Army.

Stations have already been erected by the Company at 17 State Street, New York City; Coney Island, Staten Island, Fort Mansfield, Point Judith, R. I.; Block Island, R. I.; Cape Hatteras, N. Y.; Newburg, N. Y.; Poughkeepsie, N. Y.; S. S. "Warden" (N. Y. Harbor); Fort San Cristobal, Porto Rico.

DE FOREST WIRELESS AUTO No. 1. (Stationed before No. 25 Broad St., New York City, from which curb market quotations are transmitted by wireless to the brokers’ offices.)

The company has a capital of $5,000,000, $500,000 of which is 7 per cent. preferred, cumulative and participating stock, and $4,500,000 common stock. Par value $10 per share. For complete information regarding equipment or stock, address

American De Forest Wireless Telegraph Company,
100 Broadway, NEW YORK.

Fig. 21. Immediately following the incorporation of the American De Forest Wireless Telegraph Co. in 1903 as a subsidiary of the De Forest Wireless Company, Abraham White began to place ads giving credit to the American De Forest subsidiary for the all the accomplishments made by the De Forest Wireless Company in 1902—while at the same time, he also placed ads giving credit to the De Forest Wireless Telegraph Company for exactly the same accomplishments. (Electrical Age, April 1903, Vol. 30, p. 15)

Table 5. Directors of the Two De Forest Telegraph Companies.

<table>
<thead>
<tr>
<th>Directors* as of the Dates Indicated</th>
<th>American De Forest Wireless Telegraph Company (2/7/03)</th>
<th>De Forest Wireless Telegraph Company (5/29/03)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abraham White</td>
<td>Abraham White</td>
<td>Abraham White</td>
</tr>
<tr>
<td>Lee De Forest</td>
<td>Lee De Forest</td>
<td>Lee De Forest</td>
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<tr>
<td>C. G. Galbraith</td>
<td>C. G. Galbraith</td>
<td>C. G. Galbraith</td>
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<tr>
<td>Henry Doscher</td>
<td>Henry Doscher</td>
<td>Henry Doscher</td>
</tr>
<tr>
<td>Clarence G. Tompkins</td>
<td>Clarence G. Tompkins</td>
<td>Clarence G. Tompkins</td>
</tr>
<tr>
<td>Ferdinand Peck</td>
<td>John Firth</td>
<td>John Firth</td>
</tr>
<tr>
<td>W. N. Harte</td>
<td>James Stewart</td>
<td>James Stewart</td>
</tr>
<tr>
<td>M. M. MacRae</td>
<td>Harry E. Wise</td>
<td>Harry E. Wise</td>
</tr>
<tr>
<td>Dr. Samuel Abel</td>
<td>Francis Butler</td>
<td>Francis Butler</td>
</tr>
</tbody>
</table>

*Bold print indicates directors common to both companies
White Exaggerates Earnings Projections

White also placed ads in publications such as the *Wall Street Journal* dated February 19, 1903, in which he exaggerated the potential yearly earnings that could be expected from the operations of the two De Forest companies. White projected annual earnings of $5,000,000, although he did not specify whether he meant “gross profit” (revenue), or “net profit” (revenue less expenses, interest, taxes and depreciation). To give White the benefit of the doubt, it is assumed that White’s predictions of $5,000,000 referred to revenue. White broke down projected revenue into the four categories listed in Table 6 as follows: 1) telegraph messages from ships, 2) ship-to-shore messages and reverse, 3) transatlantic and transpacific messages, and 4) inter-insular messages (meaning between islands or between an island and the mainland). These four categories were generally conceded to be the ones where wireless telegraphy had the best chance of competing favorably with cable telegraphy and the fledgling telephone system, which was being assembled by the Bell Telephone Company through acquisitions. Note that White made no revenue projections from wireless communication between cities within the U.S.

A closer look at these projections show that of the $5M of projected revenues, $4M or 80% was to be derived from tolls for transoceanic messages. However, the technology was simply not available at that time to support this mission. The De Forest Wireless company had demonstrated a capability for transmitting messages for a distance of only 50 to 60 miles. Further, the international laws and agreements were not in place to support the mission, and the De Forest Wireless company had no plans to make the necessary agreements with foreign countries and companies. To be fair, history would show that White’s revenue projections of $4,000,000 for transoceanic communications was essentially correct, but it would take a quantum leap in technology and another 25 years before it happened. The Radio Corporation of America initiated commercial transoceanic communication service in June of 1920 using the Alexanderson alternator as a source for CW transmissions, and it took another seven-and-a-half years after that before RCA revenues from transoceanic communications reached $3.9 M in 1927, the level projected by White for the De Forest companies in 1903. By that time, RCA was using De

Table 6. Projected Yearly Earnings by the American De Forest Wireless Telegraph Co. Published in Early 1903. (*Wall Street Journal*, Feb. 19, 1903, p. 8)

<table>
<thead>
<tr>
<th>Projected Yearly Earnings for American De Forest Wireless Telegraph Co.</th>
<th>Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telegaphing from ships (50 @ $5,000 ea.)</td>
<td>$250,000</td>
</tr>
<tr>
<td>Messages from ship to shore and reverse</td>
<td>$250,000</td>
</tr>
<tr>
<td>Transatlantic and transpacific messages</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>Inter-insular communications</td>
<td>$500,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$5,000,000</strong></td>
</tr>
</tbody>
</table>
Forest’s three-element vacuum tubes in its transmitters and receivers, something that was not available in 1903.

The Rise and Fall of the De Forest Companies

The Transoceanic Initiative Fails

White's bold projections for transoceanic revenues were undoubtedly influenced by reports of Marconi's success in communicating between England and Canada that appeared in publications such as *Electrical World* at the end of December 1902, just a few weeks earlier. In making these projections, White ignored the fact that the maximum demonstrated range for stations of the De Forest Wireless company as of early 1903 was less than 50 miles—far less than that required for reliable transoceanic wireless telegraphy. White hatched a plan with Lee De Forest in January of 1903 to erect two stations hundreds of miles apart for a demonstration of the long-range capabilities of the De Forest System. De Forest himself announced the project, which was reported in a newspaper article dated January 15, 1903: “Dr. De Forest tonight said that his company had begun construction of two long-distance stations at Cape Hatteras and Block Island, three hundred miles apart.”

The nexus between the Marconi announcement and the De Forest initiative is evident in the title of the De Forest article announcing the initiative: “Marconi Not Quite the Whole Thing.”

If one examines the chronology of the Cape Hatteras initiative, it becomes obvious that the highly publicized initiative was nothing but an exercise in exaggeration and misinformation by way of press releases to bolster the purchase of De Forest stock in the face of the Marconi achievement. Two weeks after the first announcement of this initiative, the American De Forest Wireless company placed a number of display ads hawking stock in which the Cape Hatteras station appeared in a list of commercial stations that the company claimed had already been erected. The day following this ad, an announcement by the American De Forest company appeared in a local newspaper contradicting the assertion that the Cape Hatteras station had been competed: “A station is being erected at Cape Hatteras by the American De Forest Wireless Telegraph Company. G. H. Barbour, executive engineer left here this morning with a cargo of building material and the work is to be pushed to an early completion.”

Three months later, White arranged to have an article placed in the *American Inventor* with the overt title “Spanning the Pacific by Wireless Telegraphy” that likened the De Forest initiative to the Marconi achievement: “While Marconi has made the Atlantic his chief scene of operations the American system of wireless telegraphy will be put to the practical test on the Pacific and Gulf of Mexico. The first long-distance stations of the De Forest system . . .have, however, been located at Block Island and Cape Hatteras, three hundred miles apart . . .”

Further announcements describing the progress of the long-distance initiative all but ceased until September of 1903 when an article featuring the
steam Yacht Erin appeared in Marine Engineering with the following sentence buried on the seventh page of the article: “A large station is nearing completion at Cape Hatteras . . . to transmit messages to the Coney Island and Block Island Station, 360 and 460 miles distance respectively.” Clearly, the station was still under construction nine months after the project was first announced. According to yet another article appearing on November 5, 1903, the Hatteras station was still under construction: “Stations are being constructed by the De Forest company at Cape Hatteras and Block Island, 300 miles apart.”

The final article in the press dealing with the Cape Hatteras station appeared on March 29, 1904 informing the public that the Cape Hatteras station was finally completed, but that the American De Forest company was out of money and the Cape Hatteras station had been attached by creditors and was up for sale: “The American De Forest Wireless Telegraph Company, which has recently completed a station at Hatteras, this company seems to have experienced a shortage of funds for the transaction of its business. The plant at Hatteras has been attached and an execution has been issued in accordance with the judgments, and the property will be sold. Whether the project is a failure or not is not known, but it is known that money is becoming scarce.” The article concluded by stating that the judge refused a request for a stay of execution on the sale of the property.

Other De Forest Wireless System Failures of 1903

The long-distance wireless initiative involving Cape Hatteras was not the only blatant failure of the De Forest System in 1903. Key De Forest employees testified in the NESCO v. De Forest suit that most of the De Forest company initiatives during the year were a failure. The testimony of crack De Forest company telegraph operators H. E. Athearn, Harry Brown, and Mac Horton showed what small measure of success was attained by the De Forest needle responder No. 3 used in most if not all De Forest stations in 1903—just prior to the introduction of copies of Fessenden’s electrolytic detectors in early 1904. All of the blatant failures occurred at stations operating at ranges of less than 50–60 miles, three of which are described next.

The first example of a failed project occurred in early 1903 when White arranged to have a wireless telegraph system placed in several automobiles to transmit stock quotes to business offices in the financial district from a curb location on Broad Street selected by brokers who sold stock there (Fig. 22). The automobile station was a publicity stunt that was a total failure because the operator could not actually send messages. According to J. P. Copland, De Forest company engineer who testified at the NESCO v. De Forest trial, the operator was sitting there pretending to send messages:

“While I was in the employ of the company, I was given charge
Fig. 22. This wireless automobile was one of two that were assembled by the De Forest Company as a publicity stunt to send stock reports from the curb to offices in the Wall Street area of New York, but in fact there was only the pretense of sending messages because the system did not work. (*Electrical Age*, Mar. 1903, p. 178)
of their automobiles which contained wireless sending sets, and which were supposed to be operative to receive the curb market reports, and send them into various brokers offices. It was a failure. They used entirely the No. 3 responder. . . . I had orders, while I was in charge of the automobile, to have an operator every morning in the week, except Sundays, by nine o’clock in front of the Empire Building, on Broadway, and an operator inside sending messages, or just making and breaking the spark as though he were actually sending messages, to just advertise the De Forest stock. There was, however, no receiving done while the automobile stayed there sending the fake messages.”

When asked what became of the attempt to send market quotations by automobile, he testified, “They were entirely discontinued, one automobile having been sent to Chicago, I believe, and the one which I had been using was placed by me on a steamer, and to the best of my recollection, think it was going to Providence, R. I.” Indeed, the automobile sent to Chicago would be put on display at the De Forest pavilion at the St. Louis World’s Fair in 1904 where it was touted as being highly successful. An old adage comes to mind: “The more the lie is repeated, the more it will be believed.”

The second example of a failed project, which has already been mentioned briefly, was Abraham White’s attempt to have Canadians organize a new company for the purpose of introducing the De Forest System into Canada. Shortly after the De Forest Wireless Telegraph Co. of Canada, Ltd. was organized in early March 1903, the De Forest Wireless company planned to sponsor a series of tests to demonstrate the feasibility of transmitting messages between Hamilton and Toronto, a distance of only 19 miles across Lake Erie. An article appearing in the August 1903 issue of Canadian Electric News reported, “The De Forest Wireless Telegraph Co. is removing its instruments from the station on Point Hill, Hamilton. The experiments were successful, but commercially it has not been profitable.” The problems that Lee De Forest had with the equipment used in this test is almost certainly the main reason the experiment was discontinued, and also the main reason that the fledgling De Forest Wireless Telegraph Co. of Canada, Ltd. soon disappeared from the pages of all future publications. The fate of this company is not known, but books of the American De Forest company reported $700,000 worth of stock of the “Canadian De Forest Wireless Telegraph Company” on its books as of January 16, 1904.

The third example of a failed project was the attempt by the De Forest company to build a circuit between New York City and Albany through the Hudson Valley, the first link of which was to be between Newburgh and Poughkeepsie, a distance of only 35 miles. In the fall of 1902, an article
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appeared in the Poughkeepsie Daily Eagle announcing a De Forest station was to be erected in Poughkeepsie for purposes of communicating between Albany and New York City. Copland testified that the company was never able to communicate between the two stations. C. G. Tompkins testified that the two stations were never completed, and indeed, little or nothing was heard about this project in the press again. Nevertheless, De Forest company display ads hawking stock continued to list stations in Poughkeepsie and Newburgh as completed, and while they may indeed have been completed, they were not operational. It should be noted that both De Forest employees testified that the needle responder No. 3 was used during the attempts to establish communications between these two stations.

**De Forest Detectors Were Insensitive**

In the “Statement of Facts” prepared by the plaintiff’s attorney in the NESCO vs. De Forest suit, it was stated the De Forest detectors “were never able to work at a distance of 250 miles and there is no testimony that they ever actually covered one fourth that distance.” This statement is borne out by the evidence presented in the literature. De Forest alluded to the existence of nineteen De Forest Wireless company stations at the end of 1903 in his testimony, and indeed, seventeen land stations and three stations on vessels have been identified from the literature, which are listed in Table 7. The land stations are paired with the corresponding distances between them listed in the right-hand column. Three shipboard stations are paired with the lands stations they used.

<table>
<thead>
<tr>
<th>De Forest Station Pairs Through 1903</th>
<th>Distance (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 State Street, NYC</td>
<td>Hotel Castleton, Staten Isl. 6</td>
</tr>
<tr>
<td>Ft. Wadsworth, Staten Isl.</td>
<td>Ft. Hancock, Sandy Hook 10</td>
</tr>
<tr>
<td>Point Judith, R. I.</td>
<td>Block Island, R. I. 10</td>
</tr>
<tr>
<td>Poughkeepsie</td>
<td>Newburgh 14^1</td>
</tr>
<tr>
<td>Yonkers</td>
<td>Newburgh 35^1</td>
</tr>
<tr>
<td>Navy Yard, Wash., D. C.</td>
<td>Naval Academy, Annapolis 36</td>
</tr>
<tr>
<td>Toronto, Canada</td>
<td>Hamilton, Canada 40</td>
</tr>
<tr>
<td>Cape Hatteras</td>
<td>Block Island, R.I 300^2</td>
</tr>
<tr>
<td><strong>Unique</strong> (tug boat)</td>
<td>Fort Mansfield 30^3</td>
</tr>
<tr>
<td><strong>Erin</strong> (steam yacht)</td>
<td>Coney Island 50^4</td>
</tr>
<tr>
<td><strong>Coamo</strong> (passenger ship)</td>
<td>Coney Island 63^4</td>
</tr>
</tbody>
</table>

^1Never completed due to lack of connectivity.

^2Cape Hatteras station abandoned in 1904 before opening.

^3Testimony by operator H. E. Atcham during NESCO vs. De Forest trial, p. 289.

^4Communication obtained only by dropping word rate to a few words per minute.
maximum distance between land station pairs listed in the table is 40 miles—with the exception of the Cape Hatteras to Block Island link, which never completed despite assertions to the contrary in ads placed by White.

An examination of the actual distances between the ship and shore stations was made during the trial in the NESCO vs. De Forest Wireless Telegraph Company litigation. There were no data provided from the ship or stations logs as to the times of the communications. It became clear that the defendants carefully refrained from measuring the distances they alleged to have achieved between ship and shore stations. In essence, the distances provided by the defendants were all guesses. Data introduced in the trial showed the maximum distance achieved for communications between ship and shore was 50 miles with normal word speeds, and in the case of the Coamo passenger ship, 63 miles for slow word speeds due to low signal levels—not withstanding unsubstantiated claims by the De Forest company that messages were received at distances of up to 120 miles or more. This exaggeration was a relatively safe distortion of the facts because there was no way for the public, press, or even individual wireless operators to determine the actual distances between ship and shore stations at the exact time communications took place. It should also be noted that the De Forest needle responder No. 3 was used for all communications in the ship stations in 1903, and that the distance achieved in 1903 were no greater than those achieved in 1902 using the goo responders.

Stock salesman Melvin G. Lathrop testified about flagging stock sales that resulted in financial troubles. Indeed, the De Forest companies were in deep financial trouble by the end of 1903. Investors had lost interest in purchasing stock—the main source of its revenues—because the companies were unable to demonstrate increased performance or point to any substantive contracts awarded during the year. The revenues of the two companies from message tolls were insufficient to cover cost of operations—much less the overhead—and stock sales were insufficient to cover the deficit. The De Forest Wireless Telegraph Co. and its subsidiary, the American De Forest Wireless Telegraph Co., were almost out of working capital by the end of 1903.

Both companies would have been out of business by early 1904 for a lack of capital had it not been for two unrelated events that occurred at the end of 1903. The first event was the merging of the International Wireless Telegraph Co. and the De Forest Wireless Telegraph Co. into the American De Forest Wireless Telegraph Co.—thereby making American De Forest Wireless Telegraph Company the new parent company. As a result, the American De Forest Wireless Telegraph Co. and the American Marconi company were the only two substantive wireless companies operating in America. The second event was the introduction of Fessenden’s Wollaston wire electrolytic detector into the De Forest System,
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occurred in early 1904 immediately following a very successful demonstration at Holyhead in England during December of 1903. Both of these events soon rekindled the fire under the sale of stock, a story that is addressed in the next section covering the three-year period in which the American De Forest Wireless Telegraph Company operated as the parent.

IV. American De Forest Wireless Telegraph Co. as the Parent (1904–6)

On paper, the American De Forest Wireless Telegraph Co. had been operating as a subsidiary of the parent De Forest Wireless Telegraphy Co. since Dec. 3, 1902, but in reality, the two companies had been operating as if they were one. White had originally created the subsidiary concept to extend the De Forest System into foreign countries, but according to testimony by Lee De Forest, since no foreign subsidiaries had materialized in 1903 and no prospects were on the horizon, White decided to dispense with the subsidiary concept and merge the two De Forest companies. The timing of this decision was undoubtedly influenced by White’s acquisition of the International Wireless Telegraph Co. in early 1904. Logic would dictate that the American De Forest and International Wireless companies would be merged into the then existing parent, the De Forest Wireless Telegraph Company. However, White elected to make American De Forest the parent by merging both the International and De Forest Wireless companies into the American De Forest Wireless Telegraph Company.

The second event that propelled the American De Forest company into the forefront of wireless telegraphy in the U.S. was the introduction of Fessenden’s liquid barretter into the De Forest System. This single event dramatically increased the range of the De Forest wireless system and renewed interest of government and commercial customers in the American De Forest company, not to mention renewed investor interest in the company’s stock. However, the introduction of the liquid barretter would ultimately be the downfall of Lee De Forest as result of the NESCO lawsuit against the Lee De Forest and the American De Forest company alleging infringement of Fessenden’s liquid barretter electrode patent. White would fire De Forest for introducing this device into the De Forest System that would be found by the courts to infringe Fessenden’s patent and caused no end of legal problems for White and the American De Forest company.

White Acquires International Wireless & Merges the De Forest Company

While no specific date has been found for the merger of the International Wireless and De Forest Wireless companies into the American De Forest company, an announcement appeared in the January 16, 1904, issue of The Chronicle stating that “negotiations have been completed” whereby control of these two entities will be acquired by the American De Forest Wireless Telegraph Company. The International
company was made up of the amalgamation of five companies—the Consolidated, American, New England, Atlantic, and Northwestern Wireless Telephone & Telegraph companies. Exactly how White convinced the directors of the International company to merge with the American De Forest company has never been chronicled, but it was reported that the directors voted unanimously to do so on January 6, 1904. The International company had no real alternative because there were only a few paying customers, and with no more authorized stock available for sale, their operating capital evaporated.

The consolidation of both the International and De Forest Wireless companies was effected by issuing shares of the American De Forest Wireless Telegraph Company for shares of both merged companies on a one-for-one basis. According to documents from the State of Maine, the necessary papers required to issue the stock to effect the merger were not recorded with the State of Maine until March 14, 1904. For want of a better date, March 14, 1904, will be used in this document as the effective date of the consolidation.

The market capital for the International and De Forest Wireless companies at the time of the merger was $7,500,000 and $3,000,000 respectively, so to effect the merger, American De Forest increased its common stock from $7,000,000 to $11,500,000 and its preferred stock from $500,000 to $3,500,000. The par value of all stock was $10 per share. The Chronicle pointed out that there was an unresolved discrepancy between the authorized capitalization of $11,500,000 and the amount required to effect the merger, which the publication asserted was $15,000,000.

As for the disposition of the De Forest Wireless Telegraph Company, according to papers filed with the State of Maine, the last shareholder meeting for the parent company was held on June 25, 1904, six months after the merger. Parenthetically, White apparently did not file dissolution papers for the De Forest Wireless Telegraph Company after the merger because the Marvyn Scudder Manual of Extinct Obsolete Companies reported that the State of Maine revoked it charter in 1907 for failure to pay taxes for several previous years. Indeed, the annual report of the Board of State Assessors for Maine, which contains entries for the taxes owed by all companies registered in Maine, has entries for the De Forest company from inception in 1902 through 1907, but no entries in 1908 or thereafter. Of course, White had transferred the assets of the De Forest Wireless Telegraph Company to the American De Forest Wireless Telegraph Company and left its debts to creditors of the De Forest Wireless Telegraph Co., which had no assets.

De Forest Introduces the Liquid Barretter Responder
Reginald Fessenden filed a patent on his liquid barretter electrolytic detector on May 5, 1903, which was as reissued as No. 12,115. It was given a priority date
of the original patent No. 727,331 that Fessenden had filed on April 9, 1903. De Forest reported in his autobiography that he visited Fessenden's laboratory in March 1903 and met with Fessenden assistant, Frederick K. Vreeland, who first introduced him to the hot liquid barretter detector that he and Fessenden were developing. Vreeland told De Forest at that time that it was he and not Fessenden who had invented the liquid barretter.

Subsequent to this meeting, De Forest discovered that M. I. Pupin had published articles on electrolytic detectors in several journals in 1899–1900 that showed a sketch of an electrolytic detector and described how alternating current is rectified. Pupin ended his description of the rectification process with the following sentence: "The author [Pupin] succeeded in rectifying electric oscillations of Hertzian frequency and producing electrolytic effects in them; the wire for this purpose was .025 mm in diameter." De Forest reasoned that the electrolytic detector was in the public domain and that Fessenden's patent would not survive a challenge in court. Consequently, he decided to use Fessenden's electrolytic detector in the De Forest System.

De Forest employed Vreeland later in 1903 after he had been discharged by Fessenden. Vreeland testified that he brought a copy of the Fessenden's liquid barretter detector with him to the De Forest company in the fall of 1903. According to testimony by De Forest employees, Lee De Forest directed company engineer Dr. J. E. Ives to manufacture several “Chinese copies” of the detector Vreeland had supplied in late 1903, which were then used by the American De Forest company for demonstrations that took place simultaneously in late 1903 and early 1904. This testimony is in direct conflict with De Forest's account in his autobiography where he claims that he assigned his able assistant, Clifford Babcock, the problem of designing a practical form of the electrolytic rectifier, and that after several weeks he produced the spade form of the detector. Documents will be presented to prove that the spade detector was not designed until late 1905—two years later than De Forest implies in his autobiography.

The two De Forest company demonstrations in which exact copies of Fessenden’s rectifying electrolytic detector were used are described next. The first demonstration was between Ft. Wright and Ft. Schuyler in New York State in late fall of 1903 that took place under the auspices of the U.S. Signal Corps, and second between Holyhead and Howth, Ireland, that took place in December 1903 under the auspices of the British General Post Office (GPO).

i. Ft. Wright to Ft. Schuyler Demonstrations: One of the earliest but lesser known demonstrations of the De Forest System using the liquid barretter responder occurred at the end of a series of tests sponsored by the U.S. Signal Corps beginning in the fall of 1903, which took place between stations at Ft. Wright, New London, and Ft. Schuyler, NY, separated by a distance
of 105 miles over water. These tests were performed at the direction of General Greely, Chief Signal Officer of the Signal Corps, to determine which, if any, wireless systems might be capable of communicating at a distance of 100 miles over Norton Sound between installations at St. Michael and Safe Harbor near Nome, Alaska. American De Forest and Slaby-Arco were two of several companies requested to participate in the tests.

All of the participating companies initially failed, including the American De Forest company, which initially used both De Forest’s needle detector and his “goo” responder. However, by all accounts, the American De Forest company using its new liquid barretter detector succeeded in communicating between the two stations on Dec. 5, 1903. Line drawings of the De Forest liquid barretter responder used in these tests were introduced in the NESCO vs. De Forest litigation (Fig. 23). The detector represented by these line drawings is similar, but not identical to the production model made by the De Forest company, which is shown later in this article.

The Signal Corps subsequently purchased two of the De Forest liquid barretter detectors from American De Forest, which were then used in a wireless system designed by the U.S. Signal Corps for the Alaskan link. Since the system was designed and patented by Capt. L. D. Wildman of the Signal Corps using components from several different companies, all companies were proscribed by the Signal Corps from attaching their names to the Alaskan system, although De Forest often alluded to the fact that the De Forest responder was used in Alaska. Of course, De Forest never mentioned that it was actually Fessenden’s electrolytic detector.

**ii. Holyhead to Howth Demonstrations:**

The first public demonstration of the new electrolytic responder took place across the Irish Channel during December 1903 between Holyhead and

![Fig. 23. These line drawings of the De Forest liquid barretter used in tests between Ft. Wright and Ft. Schuyler, which was sponsored by the U.S. Signal Corps in late 1903, are very close to the appearance of a De Forest production model that appears later in this article. (Fessenden v. De Forest litigation)](image-url)
Howth (a suburb of Dublin) at a distance of 64 miles under the auspices of John Gavey, Engineer-in-Chief of the British General Post Office. De Forest was circumspect in his description of the responder used for these tests. He wrote in an article appearing in the *Electrician*: “Unfortunately the patent rights relating to the responder are not yet secure, but Dr. de Forest informs us that it works upon an electrolytic principle, the resistance becoming decreased upon the reception of Hertzian waves. Moreover, it requires no “tapping back.””100 De Forest was cautious because he was well aware that he had copied the Fessenden design and did not want to openly reveal that fact. There is a photograph of the receiver and transmitter apparatus that was purportedly used during the test (Fig. 24). The receiving apparatus in the image is clearly not the De Forest electrolytic responder that was actually used in these tests. Instead, it appears to be a version of the needle responder. That De Forest actually used the electrolytic responder in these tests is revealed in the schematic diagram that also appeared in the article (Fig. 25). The symbol represented by the letter F in the schematic, which is a concave semi-circle with a short line extended downward into the concave semicircle, is identified as “responder.” The semi-circle represented a cup holding an electrolytic liquid, and the solid line represented a Wollaston wire dipping into the cup of an electrolytic liquid.

By all accounts, the Holyhead to Howth tests were highly successful, and as a result De Forest was hopeful.
that the GPO would purchase De Forest company equipment. To that end, De Forest remained in England for a month trying to interest Gavey and the GPO in purchasing the De Forest System. In the end, the GPO elected to pursue wireless systems manufactured by European companies. While De Forest was unable to interest Gavey and the GPO in the De Forest System with the new liquid barretter, an event even more propitious soon presented itself as De Forest was travelling back to the U.S. from London, England, namely an invitation to De Forest to cover the impending Russo-Japanese War.

iii. Russo-Japanese War Coverage: As serendipity would have it, Captain Lionel James, a famous correspondent for The Times of London, was on the same mail steamer Majestic that De Forest took on the first leg of his trip home from London to Liverpool. Captain James was travelling from London via Liverpool to the Far East to report on a conflict that was expected to break out between Russia and Japan at any time. It turns out that James had been thinking about the potential use of wireless in reporting back to London and was aware of De Forest and his wireless system.\(^1\)

The two met on the steamer and the upshot of this meeting was a plan whereby De Forest agreed to supply two complete wireless systems and expert wireless operators for a wireless link between a ship and a shore station to be located near a marine cable head in Wei-hai-wei, a leased territory of the UK on the coast of China. The ship was to operate in the waters in the vicinity of Wei-hai-wei where a naval battle was expected to take place. De Forest promised a wireless range of 160 miles if James would arrange to have an antenna of 180 feet in height erected at Wei-hai-wei, and an exposed wire of 120 feet suspended on a ship’s mast to be used as an antenna.

The deal was quickly sealed between De Forest and Capt. James, and a contract between the American De Forest company and the Times was approved and signed. Captain James arranged to have an antenna erected at Wei-hai-wei, leased the dispatch ship Haimun, and also arranged to have an antenna suspended vertically on the Haimun using its mast as a support. However, according to Capt. James, “. . . we were never able to raise more than 165 [feet] on the shore and 105 [feet] on the boat.”\(^2\) Since De Forest had no time to fabricate a transmitter and receiver for the contract, he arranged to have the equipment used in the Holyhead to Howth tests shipped to the U.S. for refurbishment and then reshipped to Wei-hai-wei via Yokohama along with two De Forest telegraph operators, H. E. (Pop) Athearn and Harry Brown, both with extensive prior experience as Western Union operators. The equipment and operators arrived in Wei-hai-wei aboard the Haimun on Feb 17, 1904, more than a week after hostilities broke out on February 6, 1904. The first messages between Haimun and Wei-hai-wei were sent and received almost a month later on March 14, 1904.
Capt. James reported the war very effectively and accurately using the De Forest System with a maximum range of 125 “sea” miles, according to James, which corresponds to 143 statute miles—close to what De Forest had promised with longer antennas than were provided. The De Forest System operated for a period of three months before ship-to-shore link was discontinued for several good reasons. First, the Russian navy threatened to capture and confiscate the Haimun and treat the crew as spies. Second, the Japanese increasingly restricted movements of the Haimun, and third, the Japanese released numerous sea mines in the waters where the Haimun operated, making navigation dangerous. Nevertheless, by all accounts, the De Forest System was a huge success. The Times of London scooped competing war correspondents, and the use of the De Forest System was widely lauded by the press. Wireless telegraphy as a new means of communication had finally proved its worth. However, it has never been stated that the reason the De Forest System was so successful was because De Forest used two “Chinese copies” of Fessenden’s detector in its system.

Fig. 26. A particularly interesting account of the war appeared in the Sunday edition of the New York Times featuring photographs taken in the theater of the Russo-Japanese war, this one of Captain Lionel James (seated, center) and his staff taken aboard his ship the S.S. Haiman; two notable members of his staff include H. J. Brown, De Forest wireless operator aboard the Haiman (standing, upper right) and H. E. Athearn (inset, lower left), who was the De Forest operator at the Wei-hai-wei land station. (New York Times, June 5, 1904, p. 11)
It should be noted that Capt. James was also a war correspondent for the *New York Times*, which published almost daily accounts of the Russo-Japanese war. A particularly interesting account of the war appeared in the Sunday edition of the *New York Times* on June 5, 1904, with a date line “Steamship Haimun, (at sea) March 27,” which has pictures of the S.S. *Haiman*, the De Forest station at Wei-hai-wei, and a portrait of the members of Capt. James entire staff of nine including himself (Fig. 26). While this image is not particularly good, it is exactly what the readers saw in the *New York Times* that day. Abraham White, taking advantage of the public’s fascination with the reports, placed large announcements in various newspapers lauding the success of the De Forest System with the headline “American De Forest Wireless reports the Russo-Japanese War,” the main purpose of which was to offer American De Forest stock for sale, albeit the sales pitch appeared in fine print at the bottom of the announcement (Fig. 27).

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Fig. 27. To take advantage of the public’s fascination with the Russo-Japanese war reports, Abraham White placed large announcements in various newspapers lauding the success of the De Forest system with the headline “American De Forest Wireless reports the Russo-Japanese War,” the main purpose of which was to offer American De Forest stock for sale. (*United States Investor*, April 2, 1904, p. 519)
After the success of the De Forest System in the Russo-Japanese war, American De Forest Wireless quickly changed out all No. 3 needle responders for the De Forest version of the Fessenden electrolytic detector. From that point on, the American De Forest Wireless Telegraph Company had many successes—in fact as opposed to fiction. The De Forest System scored two of its major successes using the Fessenden electrolytic responder in 1904 and 1905. The first and perhaps the most publicized success was wireless demonstrations held in the 300-foot De Forest observation tower erected at the Louisiana Purchase Exposition, more popularly known as the St. Louis World’s Fair, which was held from April 30 to December 1, 1904. One of the first published photographs of the liquid barretter responder De Forest used appeared in photographs of the American De Forest apparatus taken at the De Forest tower. The image shown here in Fig. 28 is the clearest of the known photographs, which was published circa September 1904. An enlargement of the responder itself is pictured Fig. 29. This responder is virtually identical to the one in the collection of History San Jose, which was manufactured in late 1903 or early 1904 (Fig. 30).

The story of De Forest’s success at the World’s Fair is so well known that it need not be repeated here. Suffice it to say that American De Forest was able to demonstrate communication between cities at much longer distances than ever before with the liquid barretter responder and a 2 kW power source. American De Forest recorded its great successes in a brochure with the American De Forest tower pictured on the cover, a brochure that was circulated at the Fair (Fig. 31). The De Forest System set an overland record of 300 miles by communicating between the tower in

Fig. 28. One of the first published photographs of De Forest’s liquid barretter responder appeared in photographs of the De Forest apparatus taken at the St. Louis Exposition in 1904. (*Electrical Age*, Sept. 1904, p. 163)

Fig. 29. The De Forest liquid barretter responder appearing in the previous figure is enlarged to show more detail.
St. Louis and a station in Chicago. The official test was held on September 14, 1904, when a host of “electrical jurors in charge of the test” located at both stations witnessed the event.\(^{108}\)

A second notable success for the American De Forest company was a Navy contract it received on June 29, 1904, to supply wireless instruments to maintain reliable communications on the following circuits in the Caribbean: Key West to Panama: 1000 miles; Puerto Rico to Key West: 1,000 miles; south Cuban coast to Panama: 720 miles; Pensacola to Key West: 450 miles; south Cuba to Puerto Rico: 600 miles.\(^{109}\) The contract for four stations at a fixed price of $315,000 was initially awarded to NESCO, but Fessenden insisted on contract terms that would prohibit the Navy from sending commercial messages in competition with Fessenden stations.\(^{110}\) The Navy did not wish to purchase equipment with terms restricting it usage, so instead they awarded the contract to De Forest for $65,666, which included not only the four 35 kW stations bid by NESCO, but also an additional 10 kW stations.\(^{111}\) The American De Forest contract also called for a performance bond of $16,416, not only to guarantee performance, but also to assure that the Navy would be protected from claims for infringement for the use of apparatus supplied under the contract. The Navy must have been aware of the
patent infringement litigation between the Fessenden and American De Forest companies over the liquid barretter responder, a topic addressed in the next section. That American De Forest used the liquid barretter responder in the Caribbean stations is evident not only from the schematic diagram of the equipment appearing in Captain Linwood S. Howeth’s book, but also from a photograph of the operating room of the Cuban station at Guantanamo (Fig. 32).

While the award of the Navy contract to American De Forest was something of a coup that provided fodder for Abraham White’s ads hawking stock, it was also something of a financial disaster for the company. The contract called for completing the contract within a
year at a fixed price with payment to occur only after completing the contract and demonstrating the ability to communicate reliably between all specified circuits. The contract was successfully completed at the end of March 1906, albeit almost a year late, for which American De Forest received a total payment of $65,000.\textsuperscript{114} With the American De Forest contract almost certainly underbid to begin with, and with the actual contract period more than doubled, the difference between the cost and the final payment must have been staggering. Clearly, whatever the difference in cost, it was covered by the investors who bought American De Forest stock during the two-year period of the contract. Fortunately for American De Forest, the successes of the company using the Fessenden detector coupled with the acquisition of the International Wireless Telegraph Co. had created significant new investor interest.

The American De Forest company continued to erect wireless stations throughout the United States and attempted to generate revenues from message transmissions between selected major population centers, but with little success. Lee De Forest testified that the real problem was the American De Forest company did not have messengers such as those used by cable companies to exchange messages between wireless stations and customers. The Postal Telegraph-Cable Company, for example, employed a large number of messenger boys and the Western Union Telegraph Company contracted with various messenger services. Data published in 1909 reveal that the Postal Telegraph-Cable Co. employed 1473 messenger boys in 24 of the larger cities.\textsuperscript{115} For example, there were 612 messenger boys in New York City, 210 in Chicago, 62 in St. Louis, and 51 in Washington, D.C. Lee De Forest also testified that at some point he and Harry Shoemaker tried to convince Abraham White to develop stations along coastal areas to communicate with ships at sea where there was no competition from the cable companies. However, White and his stockbroker advisors were focused on placing stations to enhance stock sales and would not listen.

**NESCO Sues American De Forest for Infringement**

Reginald Fessenden did not stand idly by while the American De Forest company flaunted its success stories in the press with its wireless system using Fessenden’s patented liquid barretter detector technology. According to Fessenden, his National Electric Signaling Company filed suit against American De Forest after he discovered the Army Signal Corps had purchased two De Forest liquid barretter detectors pursuant to the Fort Wright to Fort Schuyler tests. The NESCO suit was announced in the press on March 5, 1904,\textsuperscript{116} three months after the successful demonstration of the De Forest System using the liquid barretter detector on December 5, 1903. The filings contained a request for a temporary injunction to prevent American De Forest from selling any more barretter detectors prior to trial.
However, at the first hearing held on March 30, 1904, Judge Lacombe in the U.S. Circuit Court, New York City, denied the request pending a full trial. Fessenden, aware that litigation would take a very long time, felt compelled to make a public announcement in the May 1904 issues of several electrical magazines to inform readers that NESCO had filed suit against the American De Forest company for infringement of his liquid barretter patent. Clearly, he intended to discourage potential customers—in particular, the Navy—from purchasing De Forest’s electrolytic responder. One such announcement that appeared in the American Electrician is reproduced here as Fig. 33.

The litigation lasted for a considerable time, and the suit was finally decided in Fessenden’s favor on October 16, 1905 when Judge Wheeler ruled that the American De Forest company, Lee De Forest, Abraham White, et al. had infringed on the Fessenden patent and ordered an accounting for damages. On November 18, 1905, the judge issued an order restraining the defendants from using, manufacturing or selling the liquid barretter. Lee De Forest, believing that he could circumvent the decree by simply tweaking the design, replaced the round Wollaston wire making contact with the electrolytic liquid with a flat spade-like electrode that he developed in short order. This form of the electrode, which was actually designed by Clifford Babcock, was named the “spade electrode.” De Forest filed a patent on the new electrode on December 21, 1905, which was issued later as patent No. 894,317. The patent contains line drawings of several versions of the spade electrode (Fig. 34.)

Reginald Fessenden soon discovered that the American De Forest company was continuing to use some form of the liquid barretter detector,

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**THE FESSENDEN WIRELESS TELEGRAPH SYSTEM**

The National Electric Signalling Company has brought suit in the United States Circuit Court, Southern Dist. of New York, U. S. A., against the DeForest Wireless Telegraph Company, the American DeForest Company, Abraham White, President of said companies, and Lee DeForest, Scientific Director, for infringement of Letters Patent of the United States of America Reissue, No. 12,115 of May 26, 1903, to Reginald A. Fessenden. This patent is for the well known Fessenden liquid barretter or receiver for wireless telegraphy, the monopoly of which is controlled by the National Electric Signalling Company, Washington, D. C., U. S. A.

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Fig. 33. Fessenden, aware that the litigation with De Forest over the liquid barretter would take a very long time, felt compelled to make a public announcement in May 1904 that NESCO had filed suit against the American De Forest Company for infringement—most likely with the intent of discouraging potential customers from purchasing De Forest’s electrolytic responder. (*American Electrician*, May 1904, p. 90)
Fig. 34. Two versions of De Forest’s spade detector were illustrated in his Patent No. 894,317 filed circa December 21, 1905.
and promptly filed a motion of attachment for contempt in Judge Wheeler’s court. The hearing on this motion would not take place until April 7, 1906, and in the meantime Abraham White dispatched De Forest to Glengarriff Harbour, County of Cork, Ireland to perform a transatlantic communication experiment, primarily to generate grist for stock sales. De Forest was sufficiently concerned about the possibility of another unfavorable ruling by Judge Wheeler while he was away that, before he sailed, he arranged to have Babcock replace the electrolytic detectors in the entire American De Forest System with the two-element audions he had recently developed. According to an entry in his diary, Lee De Forest then sailed for England on February 17, 1906, arriving in Glengarriff on or about March 11, 1906.

The story of Lee De Forest’s transatlantic experiment, which took place between mid-March and mid-April of 1906 is summarized later. The key point here is that while he was performing experiments in Ireland, Judge Wheeler found the defendants guilty of infringement on April 7, 1906, as well as contempt of court, and ordered an accounting of damages. The defendants testified that they did not believe the new spade detector infringed Fessenden’s patent and therefore were not willingly disobeying Judge Wheeler’s order of October 16, 1905. The petition was denied by Judge Ray on May 1, 1906, and Judge Wheeler’s judgment for $15,922.04 in damages to NESCO went into effect. The judge also issued an arrest warrant for De Forest and White in lieu of a bond for $10,000 for each. Clearly, Judge Wheeler did not think the new spade electrode was substantively different from the previous circular electrode, and decided that they were in contempt of court despite the defendant’s claim that the new electrode was substantively different from the original one.

When Lee De Forest returned from England on May 6, 1906, he not only found that the injunction had been issued, but also that Judge Wheeler had found him and Abraham White guilty of contempt effective May 1, 1906, and had issued an arrest warrant and set bail at $10,000. Since White had not posted the bond on De Forest’s behalf, and since De Forest did not have the money to post the bond, he decided to depart for Canada until he could arrange for a bond. According to his diary, De Forest stayed in Canada for approximately four weeks until Judge Wheeler agreed to reduce his bond to
$5,000, at which time White posted De Forest’s bond and he returned to the U.S. without fear of being incarcerated.

De Forest also learned upon his return that his directive to Babcock to replace the electrolytic detector with his two-element audions had been countermanded by a directive from American De Forest management to replace them with a new carborundum detector that General Dunwoody had recently discovered. The early form of the carborundum crystal detector first used in the De Forest System, known as the “firecracker,” did not work well until Greenleaf W. Pickard, at the request of the De Forest company, redesigned the contacts by replacing wires wrapped around the crystal with a cat’s whisker version.125

It was mentioned previously that De Forest’s account of how he developed the electrolytic detector with a Wollaston wire detector in his autobiography is highly inaccurate. According to De Forest, he visited Fessenden at his home in the spring of 1903, met with Vreeland who told him about the detector, found that Pupin had published an article in 1899, assumed the Fessenden’s detector patent was invalid because it was already in the public domain, and set his assistant Babcock to design a practical form of the detector “using a minute insulated end . . . which had not been patented.” De Forest then says: “In the meantime a patent suit was brought by Professor Fessenden against our recent deployment of the Wollaston-wire form of electrolytic detector, or rectifier. After some weeks of experimentation Babcock produced what we call a spade electrode . . .”126 De Forest omits the fact that Vreeland gave him a version of Fessenden’s Wollaston wire detector in August 1903, and that he ordered “two Chinese copies” be made on October 1, 1903. De Forest took one to Howeth/Holyhead, Ireland in late October 1903 for a demonstration to the GPO, and sent the other one to the U.S. Signal Corps for a demonstration between Forts Schuyler and Wright across Long Island Sound. De Forest’s first Wollaston wire electrodes were virtually identical to Fessenden’s patented electrode.127 De Forest says that Fessenden filed suit against De Forest while Babcock was designing the spade detector, but Fessenden filed his first suit in mid-1904 for De Forest’s infringement of his circular form of the electrode, while Babcock did not begin to work on the spade form until after the suit was adjudicated in favor of Fessenden on October 6, 1905. De Forest’s account makes it sound like the first and only detector he developed was the spade detector, a factual error stated by many historians.

Was De Forest’s Transatlantic Experiment a Success or a Failure?

As stated previously, Abraham White sent Lee De Forest to Glengarriff, Ireland, to set up an ad hoc station (using a kite as an antenna) from late March to early April 1906 for the express purpose of demonstrating that the De Forest System could receive transatlantic signals sent from the company’s 40 kW station situated at Manhattan Beach, Long Island. Abraham White
placed a large display ad in the *New York Times* appearing on April 8, 1906, with the bold announcement: “TRANSATLANTIC WIRELESS” followed by a portion of the message he claimed De Forest had sent him on April 6: “Messages Being Received Clearly. Transatlantic Wireless Now Assured. —De Forest (Fig. 35).” If one compares the accounts in the press in 1906 with the account De Forest gave in his autobiography in 1950, one will find startling differences that cannot be reconciled, some of which are summarized below. It will become clear once again that White, who controlled all press releases for the De Forest companies, was not particularly concerned with the truth.

First, White had stated that De Forest confirmed to him that messages were sent on or before April 6,
whereas De Forest writes that his very first contact with the New York station occurred on April 11, not on or before April 6 as White reported. Second, De Forest states that he had no luck in receiving any signals at Glengarriff, and moved his ad-hoc station some 30 miles west to Cahmore, where he claims to have made contact—not at Glengarriff as White stated. Third, De Forest wrote that he sent Mac Horton, his crack telegraph operator, back to London when he departed Glengarriff on April 1, and there was no longer anyone with him who could receive messages after April 1. De Forest admitted that he could not read the code, which he estimated to be between 20 and 25 words per minute (wpm). He stated he heard messages but could not copy them, while White claims De Forest received an 800-word message.

De Forest claimed that instead of receiving a message, he recognized the sign-off signal “DF” used by the Manhattan Beach station. De Forest also wrote, “The speed of ‘DF’s’ sending was far too fast for my fist to follow.” The letters DF (· · ·  ·· ·· · ·) have 18 dot-equivalent spaces, which constitute approximately one-third of a word (a standard Morse word has 60 dot equivalents including spaces). At 20 to 25 wpm, the seven characters of Morse code plus spaces constituting the letters DF would have been transmitted in approximately one second. It would be something of a stretch for the untrained ear to pick out the station call letters DF at 20–25 words per minute, particularly if the DF was sent in a train of pulses interspersed somewhat arbitrarily with the letter “D,” as Frank Butler claims he did.

De Forest’s own words in his autobiography speak volumes about his ability to understand the letters DF when he writes: “But I, not foreseeing the long wind delays and Horton’s too early departure, erred in the other direction [by sending whole messages] . . . with no simple succession of dots at all.” De Forest is saying here that he wished he had planned to have a simple pattern transmitted that could be easily recognized by anyone (e.g., the triple dots transmitted by Marconi). De Forest concluded that his test was “equally as convincing as was the succession of triple dots which Marconi pulled in from a kite string four years ago.” That sounds about right. Neither Marconi nor De Forest had neutral observers or any documentation to prove they heard the signals, nor did either attempt to repeat their respective experiment.

Regardless of what De Forest may have said or heard, it is obvious that White’s account was a total fabrication. White says that De Forest received a complete message of 800 words on April 6, while De Forest writes: “Had Horton been able to remain one week longer, he would undoubtedly been able to copy that night (April 11) the first wireless messages ever transmitted across the Atlantic; certainly the first from West to East.” De Forest has his own credibility problem with regard to receiving messages. While he clearly stated in his autobiography that neither he nor Horton, his crack
telegrapher, ever received any messages, he claims that he did receive messages flashed across the ocean in an interview with an *Electrical World* correspondent upon his return:

“ATLANTIC WIRELESS.—Dr. Lee De Forest, on his return from the other side, asserts that actual transmission of signals with the system has occurred across the Atlantic. ‘My Irish experiments,’ he says, ‘were very satisfactory. They were conducted with the Bell kites and elevated conductors, and I am able to vouch absolutely for the truth of the story that messages were flashed across the ocean from Manhattan Beach to Bantry Bay, Ireland, where the receiving station was located. The distance over which the message traveled was a little more than 3,000 miles.’”

The highly controversial results of this De Forest’s transatlantic experiment are best summed up by an article appearing in the *Washington Times* on the one-year anniversary of the heavily advertised event:

“White did not intend to be beaten by the Marconi people. So he sent De Forest to Glengarriff Harbor, County Cork, Ireland, to receive a transatlantic message from the De Forest Manhattan Beach station. It would be unkind to suggest that the 800-word history of wireless telegraphy, which White says he sent through the ether to Glengarriff Harbor, was in De Forest’s pocket before he set sail for Ireland. This great achievement in aerography was recorded more than a year ago. Since then nothing has been heard of the art in connection with the De Forest companies, and it may be that transatlantic aerography is one of the lost arts. It certainly does seem strange to a layman that, after sending an 800-word message across the Atlantic, nothing more was heard of transatlantic messages. The cable companies still continue to do business, and the owners of the cable securities do not seem to be lying awake nights worrying over aerograms.”

*Lee De Forest is Terminated*

After De Forest returned to the U.S. from his failed transatlantic experiment and his four-week stay in Canada to avoid incarceration, he sensed a great deal of antagonism coming from Abraham White and C. C. Wilson, then the Vice President of the American De Forest company and a close associate of White. They were both upset with De Forest, blaming him not only for the litigation with Fessenden, but also the many lawsuits involving De Forest companies that had taken place over the past four years—not to mention the arrest warrant issued for White and the contempt finding against White and the company. Further, Dunwoody had discovered the carborundum crystal detector that had
finally provided the company with a non-infringing, inexpensive, reliable and sensitive detector—something that had eluded Lee De Forest since the inception of the De Forest companies. The cold-shoulder treatment that White gave De Forest in the summer and fall of 1906 soured him on his onetime mentor and close confidant. De Forest’s four-page entry in his diary dated September 30, 1906 reads like a soliloquy from a Shakespearean play in which he relates the slings and arrows of outrageous fortune that have beset him. The following three sentences from his diary give a sense of his thoughts that presaged the outcome: “I am daily more disgusted with the man [Abraham White] and this newly-revealed side of his character. I will never be intimately connected with the metamorphosed ‘Schwartz’ again. . . . I am done with White. While the Co. floats I will work for it, but I will search for another man of vision and honest common sense, who can sanely finance my further institutions; that I be not always the mendicant, the ‘Tramp of Fortune,’ which White has delighted to make of me.”  

By November, the die had been cast, and De Forest wrote his often-chronicled letter of resignation to Abraham White dated November 28, 1906. De Forest claims in his autobiography that he decided to resign when he heard White had created the United Wireless Telegraph Company for the purpose of consolidating the American Marconi company with the American De Forest company:

“When I learned of this situation, I indignantly resigned and offered to turn back into the stock-empty treasury of the American De Forest company all of my stock, amounting to some 20% of the entire capitalization. In exchange I demanded only the full rights to any pending audion and Aerophone patents, $1000 in cash, and a general release and quitclaim. Saurian-eyed C. C. Wilson greedily grabbed at this quixotic offer on my outraged part . . . and Farnsworth advised the company to accept my proposition stating that the patent applications in question had no value, that my contributions had been negligible from the start of the enterprise!”

The first sentence of the paragraph on the next page of his diary begins with: “Even before being booted out the company . . . ,” which indicates that he was forced to resign. Whether or not he resigned of his own volition or was forced to resign is a matter of conjecture. A much more important issue is what De Forest received in exchange for his considerable stock. In the paragraph cited above, De Forest states that he received “full rights to any pending audion and Aerophone patents, $1,000 and a general release and quitclaim.” Indeed, virtually all historians have interpreted this statement to mean De Forest received only $1,000 and full rights to his audion patents pending, ignoring the words “general release and quitclaim”—most likely assuming
they were merely “boiler plate” that often appears in such agreements. However, an entry in his diary dated November 29, 1906, hints at something entirely different. He offers to surrender all of his stock in exchange for a “quit-claim” for all his patent rights and inventions—not just those limited to audion or pending patents—and license rights back to other patents previously assigned to the American De Forest company:

“As for myself I have offered to surrender all of my stock for a quit-claim to my patent rights and inventions (if necessary the Am. DeF Co. to operate under the 'loop patent' as a license). ‘The Company,’ i.e., White claims to use nothing of my origination now . . . , so that it is more than a fair trade on my part—a pitiable reward for those years! I ask only the chance to again begin with a free hand, in a field not free but now crowded; to interest new (and honorable and genuine capital), to develop my ideas, to follow by best, to vindicate myself. The use of the alternating current, telephone receiver, the tuning arrangements, a host of necessary mechanical arrangements, the loop antenna—all these, albeit many unpatentable, are my productions, at least independently and early conceived, and many other some-day-to-be most valuable ideas, justify the faith in me.”

In the first two sentences, De Forest offers to exchange all his stock in the American De Forest company for ownership of his patent portfolio, with an option for the American De Forest company to lease back his patent rights. De Forest cites the “loop patent” as an example of such a lease. De Forest’s loop patent, No. 749,131, was assigned to the original Wireless Telegraph Co. of America, and subsequently leased to the De Forest Wireless Telegraph Co. for 99 years, a lease that was later transferred to the American De Forest Wireless Telegraph Co. In the last two sentences, De Forest made a case that he needed access to his patents for “alternating current, telephone receiver, the tuning arrangements, a host of necessary mechanical arrangements, the loop antenna” to continue in the wireless business.

The bold assertion here that De Forest retained an interest in all of his patents is supported by an article De Forest wrote in June 1907 explaining what he received in exchange for his stock. He begins by stating that he voluntarily returned all of his stock with a par value of $1,250,000 (125,000 shares) back to the depleted treasury of the American De Forest company. He then writes:

“In exchange I received a license to use all patents which I had assigned the American De Forest Wireless Telegraph Co., and a promise of $1,000.”

The interpretation that he received a quitclaim for many of his patents is contrary to conventional wisdom, but it is fully supported by the contract De Forest signed in 1917 transferring rights and ownership of his entire
Wenaas

patent portfolio to Western Electric for $250,000. The contract with Western Electric dated March 14, 1917 lists virtually all De Forest patents in two schedules, Schedule A and B. In Schedule A De Forest warranted that he owned all the rights to patents listed, free and clear of any encumbrances:

“And the De Forest Company covenants with a warrant to the Western Company, its successors and assigns that it owns and controls the entire right, title and interest in, to and under each and all of the patents, applications of patents and inventions listed or intended to be listed in said schedule A, free and clear of any adverse assignment, grant, mortgage, license and every other encumbrance . . .”

Included in Schedule A were listed all of De Forest’s patents issued after October 31, 1904 with the exception of single patent 806,966 issued on Dec 12, 1905, which was on Schedule B as described in the next paragraph. These patents covered the non-obsolete technologies that De Forest would need in the future.

It seems clear that De Forest received the equivalent of a quitclaim deed to his these patents. If not, how was De Forest able to guarantee ownership without encumbrance to Western Electric? If United Wireless had retained the rights to De Forest patents, those rights would have been transferred to American Marconi when it purchased the assets of the bankrupt United Wireless in 1912, but that did not happen.

Included on Schedule B were the De Forest patents beginning with his first patent No. 716,000 issued on Dec. 16, 1902 up to his patent No. 802,981 issued on October 31, 1904—plus patent 806,966 issued on Dec. 12, 1905—for a total of 27 patents. According to the agreement with Western Electric, De Forest warranted that he had transferable rights or interests in these patents, but in this case the warrantee did not preclude encumbrances. Thus, the language characterizing patents in List B was consistent with De Forest receiving transferable lease rights but not unencumbered ownership. The assertion that De Forest received quitclaims and licenses for his patents is supported by a letter from De Forest to Frank Butler dated Dec 15, 1906, which states in part, “I have now got all my quitclaims, licenses, and contracts signed and hope to begin again on the ‘Telephone’ in a few days.”

**United Wireless Co. Absorbs American De Forest Wireless Tel. Co.**

By all accounts, the American De Forest Wireless Telegraph Co. was in dire financial straights by the end of 1906. The available stock for sale to potential investors was oversubscribed, and the income from operations did not come close to covering the overhead. The dire situation prompted White to invite American and foreign scientist and industrialists to his estate known as White Park to discuss potential solutions to the problem. Conferences were said to take place over a period of several months, ultimately resulting in the implementation of the grandest scheme of all—the consolidation of the
American De Forest Wireless Telegraph Company and its subsidiaries with the Marconi Wireless Telegraph companies of both America and England. The resulting company would be a monopoly of wireless telegraph companies in all English speaking counties.

Hints of a grand scheme to merge the two Marconi Wireless Telegraph companies into the new United Wireless Telegraph Company reached the press as early as November 7, 1906, by way of ads placed by stockjobbers before any official announcements appeared in the press (Fig. 36). Details of the proposed consolidation first appeared in major newspapers and financial publications circa November 16, 1902. Many publications stated that White had begun the process of consolidating the American De Forest and Marconi wireless telegraph companies by forming the United Wireless Telegraph Co., a new company with a market capitalization of $20,000,000, and with White as president of the new company.

Many different versions of the proposed merger appeared in the press—Marconi officials had agreed to the merger, they were opposed to the merger, or they were unaware of the merger. American De Forest officials

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Fig. 36. Hints of a grand scheme to merge the two Marconi Wireless Telegraph Companies into a new United Wireless company reached the press as early as Nov. 7, 1906 by way of ads placed by stockjobbers before any official announcements appeared in the press. (Syracuse Standard, Nov. 7, 1906, p. 14)
claimed that the new company had acquired a large or even a controlling interest in the stocks of the American Marconi company and/or the parent English Marconi company, but officials of both Marconi companies denied these reports. The two Marconi companies also claimed there was no deal between the Marconi and United Wireless companies, and they had no interest in any deal with United Wireless.\textsuperscript{147}

According to newspaper reports, White used the Amalgamated Wireless Securities Company, a holding company created on Dec. 8, 1904,\textsuperscript{148} to effect this merger. White had originally organized Amalgamated Wireless to secure ownership of the American De Forest company and its subsidiaries with a broad charter covering the entire field of wireless telegraphy in America and all foreign countries.\textsuperscript{149} The real reason for creating the company, which was incorporated in the State of Maine with a market capitalization of $10,000,000, was to create an additional 1,000,000 shares of stock to sell. The additional dilution of the American De Forest stock was too much for even White’s cronies, and they had forced him to abandon his plan to sell securities under the Amalgamated Wireless name back in 1904.\textsuperscript{150}

Since the Amalgamated Wireless company was already incorporated and already owned the American De Forest Wireless Telegraph Co., it was a simple matter to change the name to United Wireless Telegraph Company and recapitalize the company at $20,000,000. According to both the incorporation papers filed with the state of Maine and an article in the \textit{Oakland Tribune}, the name was changed to United Wireless Telegraph Company effective November 17, 1906.\textsuperscript{151} According to the \textit{Wall Street Journal}, stock quotations appeared on the “Curb” market beginning on November 24, 1906.\textsuperscript{152} The change in name clearly occurred before Lee De Forest submitted his resignation letter on November 28, 1906, so that it can be said the American De Forest Wireless Telegraph Company ceased to exist as an operating entity when Lee De Forest resigned from the company effective November 28, 1906. It was not long after that the assets of the American De Forest company and its subsidiaries were transferred to United Wireless, and the stock in those companies was exchanged for United Wireless stock.

Thus ends the story of Lee De Forest and the wireless telegraph companies with which he had been associated up to November 28, 1906. Suffice it to say that White was unable to consolidate the Marconi companies with the American De Forest company and its subsidiaries into United Wireless. Lee De Forest and the United Wireless Co. parted ways after November 28, and the history of United Wireless Co. from that point became essentially independent Lee De Forest and his future De Forest companies. The story of the American De Forest Wireless Company is concluded here by identifying the subsidiary companies and the assets of foreign affiliates of American De Forest that were consolidated into United Wireless along with American De Forest itself.

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Subsidiaries and Foreign Affiliate Assets Consolidated with United Wireless

The American De Forest Wireless Telegraph Company had three known domestic subsidiaries and two foreign affiliates that were created between March 14, 1904 (when it became the parent De Forest company) and November 17, 1906 (when it was merged into the United Wireless company). At the time of the merger, its subsidiaries were also merged into United Wireless, and the financial interests in its foreign affiliates were transferred to United Wireless. The subsidiaries and foreign affiliates identified in the course of this study are listed in Table 8 along with the approximate dates of incorporation, capital stock issued or owned, and the percentage of issued stock initially owned by the American De Forest company. A short paragraph describing each entry follows.

The Atlantic De Forest Wireless Company was organized as a subsidiary of American De Forest Wireless Telegraph Co. on November 21, 1904 in the state of Maine with an authorized capital of $500,000, which was raised to $1,000,000 in 1905. The American De Forest Wireless Company owned 55% of the capital stock of the Atlantic company, and Abraham White and his associates owned the other 45%. The stock of this subsidiary, which is the only De Forest entity said to make a profit from operations, was never offered to the public. The Atlantic De Forest Wireless Co. focused on ship-to-shore communications using land stations located on the Atlantic, Pacific and Gulf Coasts. It controlled the De Forest Marine Service Company located on the Atlantic Coast. There was also a British branch of the Atlantic De Forest Wireless Co.

The De Forest Great Lakes Wireless Company was incorporated as a subsidiary of the American De Forest Wireless Telegraph Co. in the state of Maine on Dec. 30, 1905, with an authorized capitalization of $500,000. By

Table 8. American De Forest Wireless Co. Domestic Subsidiaries and Foreign Holdings.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Date of Incorp.</th>
<th>Initial Capitalization</th>
<th>Holding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidiary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic De Forest WTC</td>
<td>11/21/1904</td>
<td>$500,000(^1)</td>
<td>55%(^2)</td>
</tr>
<tr>
<td>De Forest Great Lakes WTC</td>
<td>12/30/1905</td>
<td>$500,000</td>
<td>100%</td>
</tr>
<tr>
<td>De Forest Occidental and Oriental WTC</td>
<td>02/09/1906</td>
<td>$2,000,000</td>
<td>100%</td>
</tr>
<tr>
<td>Foreign Holding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominion De Forest Wireless Telegraph Co., Ltd</td>
<td>~03/1905</td>
<td>$1,200,000</td>
<td>50%</td>
</tr>
<tr>
<td>De Forest Wireless Telegraph Syndicate, Ltd. of London</td>
<td>07/18/1905</td>
<td>£120,000</td>
<td>21%</td>
</tr>
</tbody>
</table>

\(^1\)Capitalization was raised to $1M on Dec. 9, 1905. \(^2\)White and associates owned the remaining 45%.
that time American De Forest already had more than five stations on the Great Lakes, so the creation of this subsidiary in 1906 must have been either a ploy to create more stock for sale and/or to better position itself to compete with the Clark Wireless Telephone and Telegraph Co., which was expanding its wireless activities on the Great Lakes at the time.

The De Forest Occidental and Oriental Wireless Company was incorporated as a subsidiary of the American De Forest Wireless Telegraph Co. in the state of Maine on February 9, 1906, with an authorized capitalization of $2,000,000. The subsidiary was granted “all the rights on the Pacific Coast and Nevada, extending as far north as Alaska, and taking in the Pacific Ocean, Hawaii, Guam, China and Japan together with the right to manufacture on the Pacific Coast all instruments needed in the establishment of stations.”

The Dominion De Forest Wireless Telegraph Company, Ltd. was organized as a Canadian affiliate circa March 1905 in Ontario, Canada, with an authorized capitalization of $1,200,000. The Dominion Wireless company had a contract with the American De Forest company that granted it rights to all patents owned by American De Forest (or that it might have an interest in) for use in the Dominion of Canada and Newfoundland. American De Forest owned 50% of Dominion’s stock, but only three of the seven directors were American De Forest employees—Abraham White, Francis Butler, and Lee De Forest, which means that American De Forest did not control the Dominion Wireless company. Thus, American De Forest’s interests in this company were transferred to the Untied Wireless company but there was no merger. De Forest Dominion had ambitious plans to erect approximately eighty stations in a number of provinces throughout Canada as well as a transatlantic and transpacific station on either coast. However, by the end of 1907, the Dominion Wireless company had run into serious financial problems, and by the end of 1908 it was taken over by the Northern Commercial Telegraph Company.

The De Forest Wireless Telegraph Syndicate, Ltd. was registered on July 18, 1905. It was a British affiliate with a capitalization of £120,000 at £1 per share for a total of 120,000 shares “to carry on the business of owners of wireless and other telegraph systems, patents and concessions, etc.” There were initially six subscribers—most notably Lord William Armstrong, the first scientist and engineer to join the House of Lords—each with one share; no shares were initially offered to the public. According to the Chronicle, the American De Forest company received 25,000 shares of stock, which amounted to 21% of the authorized shares. Prior to its registration in 1905, Syndicate announced an agreement to pay the American De Forest company £125,000 for rights to use the De Forest patents in the UK.

On September 16, 1906, the De Forest Syndicate registered a new
company—the Amalgamated Radio-Telegraph Co., Ltd.—which it had created to amalgamate and operate the interests of the Poulson Wireless Telegraph Co. patents, as well as the De Forest and Maskelyne patents, and others unnamed. Lord Armstrong was chairman of this entity with a share capital of £500,000 that was partially subscribed with private capital from British industrialists. No public money was invested in this undertaking. American De Forest’s interest in this company was transferred to the United Wireless company, but again there was no merger. In July of 1907, the De Forest Wireless Telegraph Co., Ltd. voluntarily wound up its affairs, and the De Forest Syndicate ceased to exist as a separate entity.

Summary

The key takeaway from this paper is that the conventional histories of the first three De Forest companies written by most historians are incorrect or incomplete in many details, some of which are particularly relevant. For example, most historians are confused about the creation of the American De Forest Wireless Telegraph Company, most likely because De Forest’s published autobiography mistakenly referred to the creation of the American De Forest Wireless Telegraph Company when it was actually referring to the creation of the De Forest Wireless Telegraph Company. De Forest had corrected the draft of the manuscript by hand but the corrections were never included in the final manuscript. As a result, most authors state the name of the De Forest Wireless Telegraph Company was changed to the American De Forest Wireless Telegraph Company in late 1902, or in some cases state it was merged into the newly created American De Forest Wireless Telegraph Company. In fact, the American De Forest Wireless Telegraph Company was created as a subsidiary of the De Forest Wireless Telegraph Company on December 3, 1902, and operated as a subsidiary in parallel with the parent De Forest Wireless company for approximately one year until March 14, 1904, at which time the parent De Forest Wireless company was actually merged into the American De Forest subsidiary and the American De Forest Wireless Telegraph finally became the parent. Confusing? Blame it on Abraham White, who created the American De Forest company as a subsidiary primarily to create more stock to sell.

As a second example, despite the many successes reported in the press by the De Forest Wireless and American De Forest companies during 1902 and 1903, they were both actually abject failures because the De Forest System was limited to a nominal range of 50 miles due to the lack of a sensitive and reliable detector. Virtually all of the successes reported by Lee De Forest and Abraham White during 1902 and 1903 were vastly overstated or falsified. Only after Lee De Forest introduced Fessenden’s electrolytic detector into the De Forest System in early 1904 did American De Forest actually begin to have substantive successes. In fact, sworn testimony by several De Forest employees reveals
that De Forest actually made “Chinese” copies of Fessenden’s detectors from one of two prototypes that Frederick Vreeland brought with him when he joined the De Forest company in late 1903 after leaving the employ of Fessenden. Many historians believe De Forest’s account that De Forest assistant Clifford Babcock developed an improved version of the electrolytic detector in late 1903, and they fail to give Fessenden sufficient credit for the successes of the De Forest System in 1904 and beyond.

An example of an omission in the historical accounts of De Forest exploits is the lack of any reference to the needle detector that Lee De Forest designed and patented in late 1902 and used throughout the entire De Forest System during all of 1903. De Forest developed this new needle detector most likely because the goo detector was so unreliable, not because it was much more sensitive. Even more astonishing is the fact there is no mention of a needle detector in his autobiography or any other of his writings. In fact, De Forest stated quite erroneously on page 162 of his autobiography that he replaced the goo detector by the his “spade” electrolytic detector (based on Fessenden’s design) circa 1904, when in fact he replaced the goo detector with his new needle detector in early 1903. The startling discovery that he developed and deployed a needle detector in the De Forest System for almost a year has never been chronicled.

The errors, omissions, and distortions found in De Forest’s book, three of which are summarized in the above paragraphs, correlate well with those appearing in historical accounts by many historians. Clearly, authors and historians have been misled by De Forest’s accounts that aggrandized his own accomplishments and those of the early De Forest Wireless companies. Authors and historians would be well advised to quote his autobiography only after checking the veracity of the material with other sources.

The second and last installment of this story begins in 1907 with De Forest’s discovery of the three-element vacuum tube with an intervening grid, something he discovered after leaving the employ of the American De Forest company. While De Forest copied Fleming’s two-element valve when he was employed by American De Forest, it was deemed to be worthless, and it never had any impact on the performance of the American De Forest company or its successor, United Wireless. Hence, it was not addressed in this installment.

Author’s Note
In the course of researching for this paper, I was struck with the complicity of Lee De Forest in Abraham White’s many stock schemes. While White misrepresented the value of the stock and the accomplishments of the De Forest companies, it was De Forest who enabled White to do this by misrepresenting the value and capabilities of his technologies in his many writings and interviews. De Forest regularly participated in outright fraud such as
arranging to send fake stock reports from the wireless Auto No. 1 from the curb to offices in the financial district of New York, and making false statements to the press such as his claim that he received transatlantic messages in Ireland from the Manhattan Beach Station in 1906, when in fact he admitted in his autobiography 40 years later that he did not receive any messages. In the NESCO vs. De Forest litigation, De Forest employees testified to many more misstatements and frauds of a technical nature in which De Forest was complicit. As a result, a number of his failures were actually reported in the press and in his autobiography as successes.

Perhaps the greatest fraud of all chronicled here was De Forest’s claim that he developed and implemented an alternate form of Fessenden’s electrolytic detector, when in fact several former De Forest employees testified under oath that Lee De Forest ordered Chinese copies of Fessenden’s detector be made from copies Vreeland brought to Lee De Forest when he entered his employ in the late summer or early fall of 1903. De Forest then directed they be used in demonstrations between Holyhead and Howth, Ireland, at the demonstrations at Ft. Wright, New London, and Ft. Schuyler sponsored by the Army Signal Corps, in the reporting of the Russo-Japanese War, and at the St. Louis exposition. The real fraud was not that De Forest’s detector infringed on Fessenden’s patent, which it did, but that De Forest claimed he developed a form of the detector that he believed did not infringe when, in fact, he simply made Chinese copies of detectors in Vreeland’s possession—and he then advertised the detector as his own. As a result, De Forest received accolades for what he described as the De Forest System, when in fact, the most important part was a detector pirated from Fessenden.

In the end, De Forest blamed Abraham White and his lavish life style for all the ills that befell the De Forest companies. He wrote in his diary that he would search for another man of vision and honest common sense, who could sanely finance his further institutions. De Forest seemed to be blind to the fact that the financial problems of the De Forest companies were due to a business model in which stock sales were used to finance and operate the company without any plan to make a profit. To finance company operations from the sale of stock without any intent to reach breakeven is clearly a pyramid scheme, if not a Ponzi scheme. The increase in the market capitalization of the stock offered by the two De Forest companies over the five-year period from 1902 to 1906 from $3M to $20M (see Table 9) are way out of line with increase in revenues or market value.

<table>
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<tbody>
<tr>
<td>Initial Cap. De Forest Wireless</td>
<td>02-19-02</td>
<td>$3M</td>
<td>$3M</td>
</tr>
<tr>
<td>Initial Cap. American De Forest</td>
<td>03-03-02</td>
<td>$5M</td>
<td>$8M</td>
</tr>
<tr>
<td>Acquisition of Intersat Wireless</td>
<td>04-14-04</td>
<td>~$7M</td>
<td>$15M</td>
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<tr>
<td>Initial Cap. United Wireless</td>
<td>11-17-06</td>
<td>$5M</td>
<td>$20M</td>
</tr>
</tbody>
</table>

Table 9. Market Capitalization of De Forest Companies by Event and Date.
of the two companies during the same period. Clearly, even the honest financier that De Forest wished for would not have helped the De Forest companies. De Forest was upset with White only because he, De Forest, did not receive a greater portion of the largess from White’s scheme to sell worthless stock.

Notes
1. E. P. Wenaas, What’s “de” Story on the Spelling of Lee De Forest?, AWA Journal, Vol. 56, No. 1, Winter 2015, p. 40–47; Vol. 57, No. 2, Summer 2015, pp. 50–58. While Lee De Forest generally signed his private letters with the surname “de Forest,” he and the press used the De Forest form most often in his publications. For example, the De Forest spelling was used in virtually all of the references cited here. As discussed in this reference, the single sentence and footnote appearing in his autobiography that is often cited to prove that he preferred the de Forest spelling is specious. In fact, there is no factual evidence that Lee preferred the de Forest form over any other of the three forms he used somewhat indiscriminately.
3. NESCO vs. De Forest will be used hereinafter as the title for the following reference: Wm. Houston Kenyon (of council for Complainant), National Electric Signaling Company vs. DeForest Wireless Telegraph co., et al., Defendants, in Equity No. 8649, (C. G. Burgonye, N.Y, Aug. 5, 1905).
5. Lee and Marie de Forest Papers, History San Jose, Box 37, Folder 2: Lee de Forest, Father of Radio, unpublished version of De forest’s autobiography dated 1949.
6. Ibid. p. 130–131; There are two separate but related vignettes in which the activities of the De Forest Wireless Telegraph Co. are described, but the company is incorrectly identified in both cases as the American De Forest Wireless Telegraph Co.; consequently, the discussion makes no sense.
7. On page 125 of De Forest’s autobiography, he states: “the assassination of President McKinley caused the postponement of the International Races (in 1901) for five weeks.” He goes on to say that this delay enabled him to complete the apparatus and install it the day before the races. In fact, by all accounts, the assassination delayed the races by only five days, which means his description of the timing of events in August and September is in error. See American Monthly Review of Reviews, Vol. 24, Oct. 1901, p. 412 for the planned and actual dates of the International Races in 1901.
9. “Notes,” The Electrician, Oct 5, 1900, Vol. 45, p. 878. When referring to wireless receivers, the article states: “May they not be called ‘responders’? Distinctly, when we remember the entire action that goes on, we see the apparatus does more than receiver radiation—it responds to it.”
13. Father of Radio, p. 124; De Forest writes: “Three weeks after I came out east, and only a month before the International Yacht Races, the actual work of construction began.” Since the races began on Sept. 28 1901, one month before that would correspond to Aug. 28. He wrote that he came out east three weeks before that date, which would correspond to Aug. 7, 1901.
14. Minute Book of “Wireless Telegraph Company of America, History San Jose, De Forest Collection, Box 10, Folder 1, p. 25, ‘The minutes state that Seidler was elected “Chairman,” but letters from Seidler to Smythe dated Dec. 18, 1901 and Dec. 24, 1901 make it clear that he was also elected president (History San Jose, De Forest Collection, Box 2, Folder 3).
15. Ibid., p. 27.
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18. Letter from Seidler to Smythe dated Dec. 11, 1902, History San Jose, De Forest Collection, Box 2, Folder 3.

19. Ibid.

20. Seidler was elected Chairman at a shareholder meeting on December 14, 1901, but it is not clear from the minutes who the president was at that time.


22. *Minute Book*, Box 10, Folder 1, p. 53.


24. De Forest Diary Feb. 9, 1902.

25. The capitalization value of $3,000,000 in the company White formed provides definitive proof that the Snyder contract with a capitalization value of only $1,000,000 was somehow set aside in favor of the new agreement with White.


28. De Forest Diary, February 18, 1902.

29. Ibid.

30. The significance of the Feb. 28, 1902 date here is uncertain, given that the draft agreement was apparently prepared for signature sometime in June 1902 (as indicated in the 1st and 2nd line), and the agreement was actually approved by a majority vote of directors on May 5, 1902.

31. De Forest Perham Collection, Box 2, Folder 3.

32. *Minute Book*, p. 44.

33. De Forest Perham Collection, Box 2, Folder 3: “Articles of Agreement.”

34. “Order, Supreme Court of the State of New York, Henry B. Snyder v. DeForest Wireless Telegraph Co., American De Forest Wireless Telegraph Co. Abraham White, Lee De Forest, et al.,” (Stillman Appellate Printing Co., New York, 1906) p. 5–6. Among Snyder’s pleadings in this document was the following demand: “…(2) the cancellation of a paper purporting to have been executed in the name of the said DeForest Wireless Telegraph Company on January 4th, 1904, which purported to grant to the said American DeForest Wireless Telegraph Company the right to use the franchises and assets and profits for the period of ninety-nine years from the 1st day of January 1904, at a nominal rental of no more than $500 a year.”


47. The complete news release consisting of one additional sentence appeared in a number of
newspapers the next day. See for example: “Test Wireless System,” Norwalk Daily Reflector, Jan 15, 1903, p. 5.


49. De Forest Perham Collection.


52. NESCO vs. De Forest, testimony by Captain Wildman, U.S. Signal Corps, p. 279.

53. Ibid., p. 294.


56. NESCO vs. De Forest; testimony by H. E. Ahearn pp. 87, 291.


59. Ibid., p. 120.


63. Copland Testimony, NESCO v. De Forest, p. 298.

64. Other foreign De Forest companies were formed later as subsidiaries of the American De Forest Wireless Telegraph Co. after it became the parent company in March 1904.


70. “Station at Hatteras,” Charlotte News, Jan 30, 1903, p. 3.


76. NESCO vs. De Forest, J.P Copland testimony, p. 296; also see bottom of p. 299.

77. Ibid, p. 299.


81. Commercial & Financial Chronicle, 1904 Vol. 78, Part 1, Jan. 16, 1904, p. 230; note that the title of the company appearing in this notice is slightly different than the one appearing in all other publications referenced.


83. NESCO vs. De Forest, p. 302.

84. Ibid., p. 301.

85. Ibid., p. 303.

86. Ibid., p. 288.

87. Ibid., testimony by De Forest employee Mr. Lathrop, p. 284–5.

88. The Webster definition of a Wollaston wire is “an extremely fine wire formed by a process (Wollaston process) in which the metal, drawn as an ordinary wire, is encased in another metal and the two drawn together, after which the outer metal is stripped off or dissolved.”

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93. NESCO vs. De Forest, p. 269. The context of “Chinese copy” is clear; Ives duplicated the Fessenden electrolytic detector in every detail, both good and bad.


95. Annual Report of the Chief Officer, U.S.A., for the Fiscal Year Ending June 30, 1904, (Government Printing Office, Washington, 1904) pp. 12–13, 38–41. This is the best and most complete description of these tests.


97. NESCO vs. De Forest: Testimony on pages 278–280 supports the assertion that the goo detector was not successful in the test between the two forts, but the De Forest liquid barretter, which was used at the end of these tests, was successful.


101. Ibid., p. 206.


103. See for example, Display Ad, United States Investor, Vol. 15, April 2, 1904, p. 519.

104. Ibid., p. 94.

105. Ibid., p. 95.

106. Ibid., p. 93.

107. Ibid., p. 95.


1010. Ibid., p. 94.

111. Ibid., p. 95.

112. Ibid., p. 93.


127. According to the testimony in the litigation, as well as Judge Wheeler’s published findings, the only version of the De Forest detector that was in use before Judge Wheeler’s October 16, 1905 decision was a circular Wollaston wire with a diameter of .000038 of an inch—almost identical in diameter to the circular electrode used by Fessenden with a diameter of .0004 of an inch. Only after Judge Wheeler’s decision was the spade type electrode introduced into the De Forest system. According to Judge Wheeler’s findings published on April 7, 1906, De Forest replaced the circular Wollaston wire contact having a diameter of .000038” with a flat metal contact having a width of 1/32” (.03125”).
130. Ibid., p. 206.
131. Ibid.
132. Ibid.
133. Ibid.
139. De Forest Diaries, Nov. 29, 1906 entry.
141. De Forest – Western Electric Agreement of March 15, 1917, p. 3.
142. One notable patent issued before Oct. 31, 1904 of great importance to De Forest was No. 730,247 issued on Jun 9, 1903, which covered the Letcher antenna system producing a marked resonance used for tuning. This patent was the only one issued before Oct. 31, 1904 that ended up on Schedule A, indicating that De Forest was allowed to pick and choose the patents for which he received a quitclaim from the American De Forest company. For the importance of the Lecher system to De Forest, see: "Dr. Lee De Forest, Inventor of the de Forest System of Wireless Telegraphy,” *Pages Weekly*, Vol. 3, Dec. 1903, p. 508.
151. Ibid., *Oakland Tribune*, June 24, 1911, p. 4.
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About the Author
Eric P. Wenaas has had a lifelong passion for antique radios beginning with his first Radiola and crystal set given to him as a young man growing up in Chicago by family friends. He experimented with radio devices and repaired radios and televisions as a hobby while in high school, and went on to study electrical engineering at Purdue University, graduating with B.S. and M.S. degrees in Electrical Engineering. He then went to the State University of New York (SUNY) at Buffalo where he earned a Ph.D. degree in Interdisciplinary Studies in the School of Engineering. After graduating, he spent most of his career at Jaycor, a defense company in Southern California—first as an engineer and later as the President and Chief Executive Officer.

Upon his retirement in 2002, he set out to research the early days of wireless and document interesting historical vignettes based on original documents of the era. One of his areas of specialty is the early coherer and crystal detector. He has assembled an extensive collection of early coherers and detectors, and performed many experiments on both types of early wireless detection devices. He has tested most types of early coherers, including metal filing tubes, point-contact electrodes of various metals, and a mercury coherer of the type used by Marconi in his transatlantic experiment. He published three articles on the coherer and crystal detector in previous issues of the AWA Review, and two articles on Oliver Lodge and his involvement with wireless telegraphy in the AWA Journal.

Eric P. Wenaas
After 100 Years
The Königs Wusterhausen Wireless in War and Peace

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Abstract
June 15, 2016 marks the 100th anniversary of the Second German Reich’s high-powered wireless transmitter site at Königs Wusterhausen (i.e., KW) near Berlin. In recognition of the historic accomplishments of KW’s historic accomplishments and excellence as Germany’s first broadcast transmission site in 1920, the IEEE has awarded the Transmitter and Radio-Technology Museum at KW the honor, “Milestone in the History of Technology.” This study reviews the history of the station from its beginnings in the First World War through the end of the Cold War. The study then focuses on station activities between 1916 and 1918 and the early post-war years leading up to the period of statutory broadcasting in Germany that began in 1923.

Introduction
On Saturday, July 16, 2016, one hundred years and one month after the first permanent transmitter went on the air at the site of the military post in Königs Wusterhausen, Germany, the Sender- und Funktechnikmuseum, together with the town, marked the centennial in a formal ceremony and the unveiling of the coveted IEEE “Milestone in the History of Technology.” Upon announcing the event, Mr. Wolf-Dieter Säuberlich (Dipl. Ing.), General Manager of the Museum, noted that this accolade was indeed “a great thing” for the Museum.

The Transmitter and Radio-Technology Museum in Königs Wusterhausen offers a rare collection of many high power transmitters. Some equipment can still be seen in situ that was in service for many years, such as the Lorenz shortwave transmitter (20/5 kilowatts), which operated from 1930 to 1975. The Museum also features an extensive collection of rare high power vacuum tubes and table model receivers from former East and West Germany. A three-dimensional panorama covering most of a large room provides the visitor a bird’s-eye view of the station and its tower farm the way it looked at its zenith in the 1930s. With transmitting halls Senderhaus 1, 2, and 3 still intact, the Museum offers a firsthand look at these old giants of the air. Several transmitters now at the site have been restored; others will need the painstaking work necessary to return them to their former condition.
The history of the transmitter site at Königs Wusterhausen may be divided into five periods: Great War (World War I, or WWI) and early (pre-) broadcast years (1911–1923); Weimar Republic years (1919–1933); National Socialism (1933–1945); Soviet Occupation and DDR—German Democratic Republic—era (1945–1989); German Reunification, station decommissioning, and founding of the Museum (1990–present). This paper investigates primarily the first period concerning what can be known about some of the station’s activities during WWI and in the first four years of the Weimar Republic. Accounts in the Museum publication, *Hier Königs Wusterhausen auf Welle 2700* have contributed significantly to this study as well as the works of Hans Bredow, Joseph Gerlach and others from the early years.

**Historical Overview**

Almost two years into the “Great War,” a radio transmitter system at Königs Wusterhausen, Germany, first began transmitting signals for the German Supreme Army Command (*Oberste Heeresleitung–OHL*) and Supreme Naval Command (*Oberkommando der Kriegsmarine–OKM*) to the Eastern and Western Fronts and at sea. It also served other government constituents, mainly the Foreign Office (i.e., *Auswärtiges Amt*, or A.A.) and even the interests of other nations.
The place where the transmitter site was established lies above the lowland Teltower region on the northern outskirts of Königs Wusterhausen. Early wireless specialists concluded that the flat-topped Windmill Hill, at 220 feet above sea level, provided one of the best high points outside Berlin to establish a major military transmitting station. In 1911, a unit of the Airship and Telegraph Battalion in Berlin rode up to the 321-acre expanse with its teams of horses and wagons, bringing several cigar-shaped balloons that would support the first wireless aerials. The unit also brought one mobile transmitter mounted atop a hefty wagon. Orders from the Supreme Army Command were to “conduct site studies and telegraphic radio tests as well as distance determinations.” Finally, on June 15, 1916, under the leadership of Captain von Lepel, the permanent KW station went officially on the air.

KW began as a strictly military post. After the war it made Germany’s first (unofficial) peacetime broadcast on December 22, 1920. In the early 1920s it became a telegraph hub and transmitter site of the Reichspostministerium. The Ministry’s motto under Hans Bredow, the first post-war Ministerial Director of the Reichspostministerium for telegraph, telephone and radio, was to transmit public information to all listeners. Bredow asserted that, “radio stands and falls with its non-partisanship.” However, at the catastrophic end of the Weimar Republic in 1933 and for twelve years...
thereafter, the station became a propaganda arm of Joseph Goebbels and the Third Reich. Hans Bredow resigned his post the day of Hitler’s accession to the chancellorship.

The transmitters at KW and its three main buildings were in danger of being destroyed at the end of the Second World War. A group of engineers and employees at the station, disillusioned by the National Socialist system, refused to participate. The entire station with its inventory of parts was also spared Allied bombing, as was the nearby Zeesen transmitter site, built in 1926–1927. After the post-World War II Soviet occupation of the region, the Zeesen station was disassembled for use in the USSR, and its transmitter center was demolished by Soviet troops.\(^5\) (A separate Telefunken-Olympia-Senderhaus 5 had been built at Zeesen for the broadcast of events at the 1936 Summer Olympics. This included early television transmissions.)\(^6\)

On the night of April 24, 1945, the upper part of the main building, Senderhaus 1, burned. The exact cause of the fire remains unknown. (Later, it was rebuilt in a slightly different architecture.) In the summer of 1945, Soviet forces took over the station, and several transmitters and parts inventory were also removed to the Soviet Union as war reparations, since the site was located in the Soviet zone. In February 1946, as Berlin was being divided up by the four Allied Powers, a contract for a replacement 100-kilowatt long wave transmitter was given to Telefunken in West Berlin!

One yet untold story is of the transmitter now sitting in Senderhaus 2, awaiting restoration. It dates to 1933 and was originally located in Tegel on the northwest edge of Berlin. The site remained untouched during the Second World War, and the station survived intact. Joseph Stalin ordered the station to begin transmitting on May 13, 1945, to the civilian population of Gross-Berlin. The transmitter building was indeed in the new Soviet Sector, but the commanding French and American Generals—Jean Ganeval and Lucius Clay—determined that the antenna tower was in the French Sector. When the French required a large area to construct its airport for the “Berlin Airlift” (June 24, 1948–May 12, 1949), a French commando unit was sent to destroy the tower. Thereafter the site became useless, and it took a work crew only three days to disassemble the transmitter and transport it to the KW station. After six months it was back in service, broadcasting music and culture, once again giving a Soviet perspective.\(^7\)

From the end of the war and throughout the years of the German Democratic Republic (i.e., East Germany), programs in German (such as the Deutschlandsender program) and Russian (the “Volga” program and Soviet TASS News) were sent from the KW station under the aegis of the (East) German Post Office. During this time more transmitters were added in the three large buildings.\(^8\)

Finally, after 1989—with the fall of the Berlin Wall—the diminished station briefly came under the management
of Deutsche Telekom. In addition, the West German world broadcast system, Deutsche Welle, temporarily used the transmission systems on the hill.

Between 1992 and 1995, the station began shutting down its service that had been provided by four shortwave transmitters of 100 kilowatts each. Then in 1997, the last of the many transmitters on site, the 100-kilowatt long wave back-up transmitter, was finally turned off. The expansive complex on the hill, together with its original Senderhäuser 1, 2, and 3 and former military barracks and equestrian hall, presently serves as a cell tower site and is home to the local FM station Sender KW on 105.1 MHz.

And yet, the Funkerberg has been anything but quiet. On October 18, 1993, at the seventieth anniversary of the beginning of statutory radio broadcasting in Germany, the not-for-profit Support Association of the Transmitter at Königs Wusterhausen (Förderverein Sender Königs Wusterhausen e.V.) was formed, and history-minded engineers and townspeople—virtually all from the former German Democratic Republic—went to work. They committed themselves to preserving the station as a “technological monument,” and in early 1994 they made the decision to construct a lasting exhibit in Senderhaus 1. Finally, on September 10, 1995,

Fig. 3. Example of an exhibit case showing German tubes. Here, (foreground, beginning 3rd from left) 3N.F.W early multiple-tube, integrated circuit modules (1929–1933) by Radio AG D. S. Loewe (Berlin).
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at the nationwide annual event celebrating “Monuments Day,” the Museum on the Funkerberg opened its doors. Four months later, visitors could take regular tours of the Museum.

The small town of Königs Wusterhausen now has a world-class Museum. On its grounds sits a new private home community next to the old red brick water tower overlooking the town. The main Senderhaus 1 is home to the Sender- und Funktechnikmuseum. The WWI-barracks building is being renovated for upscale housing, and Senderhaus 3 is now home to the “Radio Exchange,” a place for events and, of course, regular radio flea markets. It also houses the 70-kilowatt long wave transmitter Number 36, which was famously built in the ’60s from spare parts. Senderhaus 2 holds the old “Tegel” transmitter. What catches the eye is Tower (Mast) number 17, erected in 1925 and now the last of the twenty-two former towers. Topping out at 689 feet, it sports fresh coats of red and white paint and is the costliest item on the property to maintain. Absent the many trees at the edge of the expansive property, one could almost get a glimpse of the air traffic control tower and terminals of the new “Willy Brandt” Berlin International Airport toward the northwest, located at the site of the former Soviet military airport from the Cold War years.

This large transmitter installation was officially in service for eighty-one years. Other high power wireless stations in Germany at Nauen, Eilvese, and Norddeich played significant roles before and during World War I, including regular message and business traffic, naval communications, war propaganda, and secret dispatches. Still, it was the Königs Wusterhausen station upon which Bredow bestowed the honor, “cradle” of German broadcast radio (or rather Rundfunk) in the new Weimar Republic.

The Early Equipment

The first transmitter in 1916 used a rotating spark system with a long wire antenna attached directly from the transmitter to the top of a newly constructed 490-foot high steel tower. Not long after operations commenced, the 5th Radio Battalion of Berlin began using four transmitters: a 70 and a 5-kilowatt spark transmitter from Telefunken; and a 32 and a 5-kilowatt arc transmitter from C. Lorenz AG. The station used the call sign “LP,” which was derived from von Lepel’s name. The 70-kilowatt transmitter began sending messages to land and sea-based services as well as to neutral countries, such as Spain, and to its allies, including Turkey.

The original Telefunken receivers were of two kinds: first, the “secondary” type “with two tuned circuits [i.e., tank circuits], known as the intermediate circuit receiver, which, in addition to the antenna and detector circuits, featured one more sharply tunable intermediary circuit.” The other was most likely the Naval-Universal-Cell-Receiver, nicknamed the Muze (i.e., /mootze/) and designed for naval operations. The Muze had a third, additional
tunable detector circuit. “In the hands of well trained operational personnel,” an old Telefunken magazine of the day reported, this receiver met “the highest requirements for tuning sharpness and freedom from interference.”\(^{13}\)

The antenna layout was soon enlarged to include five towers, all having identical construction, from which a long flattop antenna system could be mounted. Two hundred ground rods were placed two feet beneath the ground and radiated away from the transmitter building.

For a considerable period, only one transmitter could be in use at any given time. No system for simultaneous receiving and transmitting had been developed. By the end of the war, the receiving station was moved into Zehlendorf, a suburb in the south of Berlin to avoid interference.

**KW’s Wartime Roles, 1916–1918**

The records reveal that much of the message traffic from KW was directed southward, toward Turkey and in support of Germany’s interests in the Black Sea, the Near East, North Africa, and India. The station was used to communicate with the military ally, Turkey, and possibly to transmit the German interpretation of world events.

Hans Bredow’s two-volume memoir of German radio history has but one brief, yet significant reference to KW:
“[I]n 1915 a specific military station for [wireless] traffic had been established at Königswusterhausen near Berlin. The transport of the station [for] Osmaniye through Rumania was a particularly difficult problem and could only be solved in a way, such that the [wireless] equipment and machines were hidden in the tower parts, which made up most of the train-car load. The entire matter turned out to be a circus. Special handlers had been sent along, who could take care of any difficulties on the Rumanian border in the local customary manner.”

At one point, Bredow traveled to Turkey for the third time to help get a new high-powered station on the air in the interior at Konya. Its purpose was to relay (German) news to the Arabic world and to India, in part, “to counteract English propaganda effects on the population along the important sections of the Red Sea.”

H. Schlee, a German officer in WWI, who wrote a brief account of early German radio in the Great War, lists additional Turkish wireless installations in support of Bredow’s account. During the war, stations were established at Panderma, Smyrna, Aidin (Turkey), along the Turkish coast on the Black Sea at Songuldak and Sinop, at Damaskus (for Palestine), and Bagdad (Iraq). Toward the end of the war, stations were built in Georgia at the port of Poti and in Tiflis. Schlee’s account adds the powerful stations in Austria-Hungary (Vienna and Budapest) and Bulgaria (Sofia), the other allies, which together with Germany formed the Middle Powers.

By his account, Bredow creates a close relationship between KW and the Turkey’s main military site at Osmaniye. His additional task, he writes, was to work out a plan with the Turkish War Ministry to establish a chain of wireless installations and thereby secure the military routes to the Bagdad front and through Palestine and on toward the Suez Canal (i.e., part of the Red Sea Project). He took along a special wireless station for the German General Colmar von der Goltz (dubbed “Pascha”), stationed in Bagdad. The additional project to establish wireless stations in Mecca and Medina failed for reasons of personnel incompetence and religious interests.

It may be assumed that Germany supplied much of the funding and engineering for the construction of the wireless stations in Turkey and in the Middle East.

From Bredow’s account it becomes clear that whatever the War Ministry (Kriegsministerium) and the OHL had originally intended for the wireless station at KW, going into 1916, the primary focus would turn to the military communication link toward the southeast.

While messages and dispatches sent from KW certainly must have impacted the conduct of the war on the Western Front, to date no such reports have been uncovered. Given what is known so far about the station’s Turkish connections,
it is understandable that the Entente powers would be less interested in dedicating manpower to intercept messages from KW with the call sign “LP,” when the pressure for them was in Western Europe.

Writing several decades after the war, Hermann Stützel, a former cryptanalyst at the OHL, provides rare and valuable information about the role of the wireless station at Königs Wusterhausen. His comments are confined to the context of his code-breaking work on the German side. He writes about one of the cryptanalytical posts (i.e., E-Stellen) at the OHL to which he was attached. The post’s major tasks were code breaking, ongoing development of trench codes for the front, and diplomatic traffic. He names four traffic channels that his unit, “Diplomatic Traffic,” monitored and which he lists: Rome (Italy) to St. Petersburg (Russia); Malta; foreign embassies in Berlin; and Königs Wusterhausen with Madrid.

Stützel gives clear evidence that the wireless services of KW were made available by the War Ministry to a German ally. He specifically notes that he decrypted messages of “foreign missions in Berlin” (i.e., more than one) and briefly describes one case from Turkey’s authorized representative in Berlin as well as the replies. At first, the messages of the Turkish representative were quite impossible to read, even though their structure seemed straightforward enough. A Turkish translator aided him, but he was still unsuccessful. It soon occurred to him that the messages were not in Turkish but in French! At that point, the code was quickly cracked.

Stützel also refers to encoded message traffic between Berlin and Madrid that originated at the War Ministry, the General Staff, the Naval Command, and the Foreign Office. What Stützel says about the diplomatic Berlin-Madrid connection via KW may be compared to the account given by Herbert Yardley, Chief of the Cipher Bureau in the U.S. War Department.

In Yardley’s case, it all began when a wireless station in Maine intercepted “hundreds of Spanish diplomatic code telegrams passing between the Spanish Ambassador at Berlin and the Spanish Foreign Office in Madrid.” The U.S. State Department suspected that Spain—an officially neutral country—was aiding Germany’s espionage activities. Yardley employed the charming Miss Abbott to infiltrate the Spanish Embassy in Washington and sent a Mr. Boyd to Latin America. Boyd traveled first to the Panama Canal Zone and then to Bogota to photocopy Spanish codebooks in their consulates or embassies. He furnished a very limited photographed copy of the Spanish “Cifra 74” codebook from Panama. Ms. Abbott learned that the Spanish used twenty-five different codes, which comprised only nine families with slight variations in each family. The German station in question for these transmissions was not Königs Wusterhausen (with the call sign “LP”) but Nauen, having station call “POZ.”

These intercepts had code structures that were strikingly similar to
those copied by Stützel’s unit at OHL. The only substantive difference in the two accounts was the station of origin: Königs Wusterhausen for Stützel; Nauen in Yardley’s account. The messages copied in the U.S. were certainly not the same as those that Stützel’s unit intercepted between KW and Madrid (call sign EGC). And yet, all of the parameters characterizing the codes themselves were almost identical.24

This high number of diplomatic messages between Nauen and Madrid strongly suggests a modest if not active communication stream that Stützel likewise intercepted from KW, especially later in the war. Nauen was primarily a commercial station, while KW served the war effort, militarily and diplomatically. Until the summer of 1916, the Spanish ambassador in Berlin regularly used Nauen to communicate with Madrid, but later—in 1917—it seems that he obtained permission to use the German military wireless facility at KW (a neutral country using another’s military facility!). Even as the Spanish government continued its so-called neutral relationship, it sometimes remained dangerously close to the German side. This comes through in a diplomatic dispatch from the A.A. to the German ambassador in Madrid that Stützel decrypted: “To the [German] Ambassador. Please inform His Majesty [the king of Spain], that we will

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attack on the . . . of July at . . .” The reasons why Germany offered Spain the use of its wireless station at KW, remain unknown.

The German A.A. often sent messages via KW. Stützel read them and decided to crack the A.A.’s own code, an idea, it seemed, no German cryptanalyst had taken the trouble to do. It used five position number groups then distributed into groups of four non-alphabetic number sequences. The A.A. code proved to be much better than codes of the War and Naval Ministries between Berlin and the German Embassy in Madrid, but it but could still be cracked after eight to ten days of work. Stützel showed the case to his Chief of Communications, and soon it landed on von Hindenburg’s desk, who summarily dispatched the results to the Reichs-Chancellor. Several weeks passed, and Hindenburg pressed the A.A. once again. He was finally informed that the A.A.’s diplomatic cryptanalysis office was hard at work to reorganize. If Stützel could break the code, so could the enemy.

At one point, Stützel went to Berlin to confer with the code unit of the German A.A.; he was most likely quite concerned and/or had been sent to take care of the matter. The personnel at the A.A. remained unconvinced that its messages through KW (and Nauen as well?) could be or were being decrypted, until he proved it to them in a dramatic demonstration.

The literature on code warfare in the war has little to say about interception of messages sent toward the Eastern Front in the direction of Russia and to Bulgaria (the latter, a German ally). Moreover, information is scarce concerning the use of wireless by the German Secret Service or the running of spies abroad. One such incident is found in Bredow’s account that relates to the use of wireless in the Arabic world. The swashbuckling Paul Freiherr von Todewarth (a counter-image to Britain’s Laurence “of Arabia”), who worked among the Senussis in Sudan and Libya, used wireless to receive instructions. An Arabic wireless operator in possession of a receiver accompanied Todewarth. In this case, the communications link from Germany was conceivably KW via Osmaniye to North Africa. Bredow’s recording of Todewarth’s activities may suggest the use of long-distance wireless for other agents.

Although nothing is known about whether the German Supreme Army Command (OHL) communicated via KW, it may well have been the case. (The OHL comprised a very sizable mobile unit that resided at several locations in German and Belgium during the war.) On the other hand, the bulk of the most important coded messages between the War Ministry in Berlin, the OHL, and the Divisions at the front could have been sent via more secure land telegraph connections or by personal courier. William Friedman, an American cryptanalyst who served on the Western Front, suggests the first possibility.

A question may be asked whether the OHL wasn’t in fact reluctant to
communicate with Berlin via wireless. There are indications to suggest that wireless was still not a completely tested and trustworthy means of communication in the eyes of the OHL, in both its technical and security aspects. Bredow writes about the great difficulties he encountered with the “home agencies” in Berlin and the great caution exhibited by the army at the Divisional level, when he tried to introduce portable tube transmitters into the field in 1916 and 1917.29

In the end, Bredow’s modest explanation, that KW was built to serve communications with Osmaniye, Turkey, must be accepted as a reliable summary statement. That is, wireless communications from Königs Wusterhausen did serve general military, naval, and some diplomatic purposes, but its main task was to support Germany’s vital interests in the Southeast. It must not be forgotten that this theater of the war was a critical part of Germany’s effort to achieve superiority on the Continent. Writing about the British code breakers, John Ferris remarks that at one point, the British army in the Middle East sent up to 400 messages per week.30 This high number strongly suggests that German message traffic was likewise not insignificant, which would mean that wireless operators at KW were kept rather busy.

Fig. 6. View of the Lorenz 50 kilowatt alternator transmitter in Senderhaus 2, operational in 1923, with four 20 to 40-kilowatt telegraph transmitters for international traffic. The transmitters were: two tube; one alternator; one arc. The installation had its own power facility. (Jannack, p. 15)
Civilian Use of the Airwaves at KW

Together with Hans Bredow’s history of radio in Germany, Thomas Gerlach’s article in the *Rundfunk-Jahrbuch* (1930) also offers a rare, detailed account of the beginning of peacetime use of the station at Königs Wusterhausen.\(^{31}\)

Radio broadcasting to the public was an idea Hans Bredow had considered even before the war. One incident while he was at the Western Front illustrates his insight. While experimenting on the new tube sets, Bredow did the unthinkable for any military mind intent on protecting wireless messages from enemy interception and interpretation. He employed a microphone to read poems by Heinrich Heine. The radiotelephonic transmissions were broadcast up and down the front, crossing Divisional—and even enemy—lines.

Bredow also obtained soldier-musicians to play the harmonica and violin into the *aether*. One radioman from the trenches later reported: “It was a usual day at the front. Suddenly, music appeared right in the middle of wireless and telephonic messages—crystal clear. Everyone took his earphones off, full of wonderment at this incomprehensible event. But [with earphones off] the music stopped. It wasn’t coming from the outside.” This was probably Bredow’s first successful radio “broadcast.” His colleague, Alexander Meissner, reported the same event in his memoirs: “After this had happened a few times and roused the wireless operators from their trench existence at many positions, Commander von Lepel received a strict order to prohibit this horseplay.”\(^{32}\) The idea of expanding the broadcasting of information and culture (i.e., music, etc.) to all of Germany was taking shape in Bredow’s mind.

In late 1919, one year after the end of the war, KW was placed under the control of the German *Reichspostministerium*, the administration at which Hans Bredow became Director.\(^{33}\) At this time, the Treaty of Versailles prohibited military communication in Germany for a period of three months. Bredow considered this limitation “insubstantial” and “transitory.”\(^{34}\) The challenge for him was to find paths toward civilian uses of the airwaves.

The information services in postwar Germany soon returned to economic news and newspaper reporting. At that time, large transmitters now included arc, alternator (i.e., machine), and lower power tube types. Zehlendorf, a borough in the south of Berlin, became the system’s receiving site, and all activity was electronically linked via the Main Telegraph Office in Berlin.

About the same time, Bredow delivered a speech at the *Urania* in Berlin, an educational center for science and culture. He spoke of the importance of telephonic radio for the public. To demonstrate the process, Bredow set up a receiver in the hall to obtain a short broadcast from a tube transmitter of the *Reichspost* located nearby on the *Schiffbauerdamm* Street. The music and speech became distorted, and the audience was disappointed. All one had to use were early carbon microphones. That day Bredow convinced no one,
but he knew the idea would eventually succeed.\textsuperscript{35}

Listening to wireless transmissions was against the law for anyone in Germany, except postal employees, located at 70 stations, who constantly monitored their frequencies. No national legislation yet permitted general use of any wireless apparatus, but there were already many illegal listeners (\textit{Schwarzhörer}).

In 1920 \textit{KW} redesigned a Lorenz transmitter to experiment with telephonic transmission. They used the 3500 and 3700 meter frequencies, and the signals were heard as far away as 1250 miles. By December 22, the station staff was far enough along to make the first effort to produce a live program; they served as the musicians. “On this day the first instrumental concert of Germany was sent from Königs Wusterhausen.” The musicians had to sit very close together, cramped against the Lorenz arc transmitter.\textsuperscript{36}

When the small group played the song “Silent Night,” it was heard by many, even beyond Germany’s borders. It was reported that radio operators on ships heard it as well.

The station engineers had improved the microphone for the event. One listener from Königsberg, 325 miles to the east, reported by telegram: “Your concert was wonderfully heard. It called forth a real Christmas spirit.” A letter soon arrived from Veendam Holland, stating: “First of all I noticed

Fig. 7. Museum panorama. Status of the \textit{KW} transmitter site, circa 1939. The central \textit{Mittelturm} (3-support tower) is just visible behind the tower in left foreground. Structures are: \textit{Senderhaus} 1, 2, 3, the main barracks and the equestrian hall. (Courtesy of \textit{Funktechnikmuseum})
that your telephony and music was very powerful, absolutely no extraneous sounds, wonderfully modulated, and the voice of the speaker was clear and well articulated. As I look forward to future presentations—the music was unforgettable—I send you greetings and wish you all success in 1921.”

One of those listening to the Easter broadcast on March 23, 1921, wrote from Luxemburg that the telephony was substantially clearer than that of the Marconi station in Chelmsford, England, which lay at about the same distance as KW.38

On June 8, 1921, “Madame Butterfly” was transmitted from the Berlin State Opera (on short notice!) by means of an electric postal connection to the arc transmitter at KW. This time, several microphones were placed to pick up the orchestra and singers. Director Gerlach reported that Germans listening from abroad and German steamers in the Atlantic picked up the program. At first, because of “strong interference from the telegraph transmitter at the Eiffel Tower [in Paris], the wavelength had to be changed several times,” until a relatively free wavelength was found at 4000 meters. On August 22, 1922, Bredow arranged for his speech in the German Reichstag (i.e., parliament) on the occasion of the International Telegraphic Competition. Shortly thereafter, on September 1, the first “Economic Radio Show” went out, also over the 4000-meter band (i.e., ca. 75 kHz).39

All the while, KW’s engineering team was at work, building their own 5-kilowatt tube “three-point” circuit based on Meissner’s concepts (Telefunken) and a modulator using a Schwarzkopf patent.40 The station’s Director, Thomas Gerlach (who was highly respected by the station’s personnel), was rebuked for permitting its construction, but when it was learned that one section of the Reich Telegraph Office had need of just such a transmitter for their own experiments, the activity not only had the permission to proceed but new materials and funding came to KW to install the home-brew transmitter in the same room as the Lorenz arc transmitter. Soon the KW station quickly became known nationwide as the “Konzertsender.”

These short programs were heard in Luxemburg, the Netherlands, England, and in Scandinavian countries. The instruments used in the solos were the piano, violin, cello, cornet, and clarinet, but more and more of the music came from recordings. A little bit of marketing crept in, as the names of the record companies sending their discs (Schallplatten) were occasionally announced: Vox, Grammaphon, Odeon, Homophon.41

The engineering team experimented further with speakers and microphones and came up with a method to couple record players directly into the transmission circuits. The sound quality from records became so good, that on one occasion a “love package” arrived from Switzerland for the woman who had sung “The Nightingale” so beautifully. The recording couldn’t eat the contents of the package, so the station personnel helped out.42 Finally,
individual microphones were placed at each instrument to provide level adjustments.

Times were hard, and Mr. Krischan Otto had run out of reeds for his clarinet. Director Thomas Gerlach permitted an on-air request for replacement reeds or even sugar cane stalks to be sent to the station; none were to be found, not even in Berlin. The very next day, clarinet reeds arrived by airmail from a listener in London.

Unofficial radio transmissions in Germany came to an end on October 24, 1923, with the statutory beginning of the broadcast era. The path was now open for an “entertainment radio service” for the “broadcasting of musical programs, etc., via wireless.” Five days later, Hans Bredow was satisfied with the quick preparations made for installing a transmitter in the VOX-Haus at Potsdamer Strasse 10 in Berlin, and the program was transmitted at a power of 250 watts: “Attention, attention, here is Berlin on 400 meters!”

The regular Sunday concerts sent from KW on 2700 and 4000 meters were allowed to continue with special permission from the Reichspostministerium. The program had simply become too well known to thousands of regular listeners from Germany and across Europe. Finally, on January 26, 1926, the final unofficial broadcast was made, featuring the favorites: Fräulein Edith

Fig. 8. A portion of the complete final amplifier tuning stage of the 250-kilowatt middle wave transmitter SM8/H1, built by the Funkwerk Köpenick. It remained in service in Köpenick-Uhlenhorst from 1959 until April 2, 1993. (Courtesy of Funktechnikmuseum)
Bach (the “nightingale” from the town) and Herr Otto.

Dr. Hans Bredow’s idea “to bring the treasures of art and knowledge into every household” had slowly taken form. Bredow, as State Secretary in the Reichspostministerium, had the responsibility for all information services. It was he who coined the German word Rundfunk, urging its use instead of the non-German word “radio.” He noted how the word indicated wireless transmission (i.e., spark or Funk) sent in a 360-degree or “circular” pattern (i.e., Rund). For his considerable service to the development of wireless before the war (at Telefunken, etc.) and his tireless work to develop the Rundfunk for the public and all services, he is known today in Germany as the Father of German radio. He introduced the concept of financing public wireless in Germany through a small monthly fee levied on each receiving apparatus (in contrast to financing through advertising, as in the United States).

The station at KW emerged from the devastating economic crisis of 1923 in Germany and began to grow. Senderhaus 2 was built and four telegraph transmitters were installed: one arc, one machine and two tube transmitters, variously 20 to 40 kilowatts. Five more towers, each at 690 feet, had to be placed beyond the Old Berlin Highway. One year later, two 50-kilowatt transmitters were added.

Senderhaus 3 was built in 1924 to serve four 10-kilowatt tube transmitters for business traffic, the press service, and for expedited telegram traffic. Two more towers at 690 feet were constructed, and five broadband T-antennas were hung.

The original central tower on the main site of KW, proved too weak to carry its increasing load, so a seventh, taller tower was constructed that would be solid enough to carry the extra weight. It came to be known as the Mittelturm and was dubbed der Dicke (“the fat guy”) by locals. It stood on three gigantic supports, each located 190 feet apart. This freestanding tower reached to 797 feet to equal a 61-floor building; the Eiffel tower was 984 feet in 1924.

The tower did not receive the 131-foot extension additionally planned for it. The Versailles Treaty still prohibited the use of short wave transmissions in Germany, and the extension had been planned for this purpose. (The Eiffel Tower in Paris stood on four supports, the Mittelturm on three.) A tube-like shaft having an internal equipment elevator extended from the ground to a small platform at 750 feet. At 690 feet, twelve masts radiated outward to support the several antennas. This tower stood through the Weimar Republic, the National Socialist years, and the East Germany (GDR) era until November 13, 1972, when the epic Quimbirga Cyclone brought it down.

Königs Wusterhausen and the Antique Wireless Association

In November 2014 contact was made between the two Museums, when the author first visited Wolf-Dieter Säuberlich, General Manager at the Sender- und Funktechnikmuseum in
After 100 Years

Königs Wusterhausen. Since these two Museums display significant artifacts from the history of wireless technology and count themselves among the most significant centers for historical preservation, research and the education of youth, it is fitting that they should be aware of each other’s legacies and collaborate.

The KW station, now celebrating its 100 years of existence, should be known not simply for the role it played in the First World War—a truly bloody chapter of the 20th century—but also for the non-partisan cultural and commercial support that it gave to the German population and the world at large through its broadcasts during the Weimar Republic. All this took place, thanks to the early guidance of Dr. Hans Bredow, to Johannes Gerlach, the station’s first peacetime Director, and to the many scientists and technicians who built and maintained the station and who believed in their mission.

In June 2015 the Antique Wireless Association Museum conveyed a Crosley 51 regenerative receiver to the Museum on the Funkenberg as an example of the sort of set a young radio enthusiast in the United States or Canada may have used to try and pick up medium wave signals from home and abroad during that historic period.

Fig. 9. Wolf-Dieter Säuberlich (Museum Gen. Mgr.) and the author. Here, Säuberlich receiving a Crosley 51 regenerative receiver, a gift from the Antique Wireless Association to the Museum on “Radio Hill” (the Funkenberg).
Notes

1. http://ieeemilestones.ethw.org/Milestones: Koenigs_Wusterhausen. (All Internet references in this paper operative at the time of its publication.)


8. The SM8/H1 transmitter, which operated in East Berlin (Köpenick) from 1959–1993, is now at KW. It transmitted on 693 Khz, 783 KHz and 1359 KHz. Its programs were “Berliner Rundfunk,” “Stimme der DDR” (Voice of the German Democratic Republic), “Radio Berlin International,” “Antenna Brandenburg,” and “Deutschlandfunk” (the latter, the name of a radio and internet broadcast system in contemporary Germany, at: www.deutschlandfunk.de). Additional German transmitters may also be found at the Deutsches Museum in Munich, such as the C. Lorenz 2 kilowatt ship transmitter from 1915.

9. Circa 1910, seven German governmental coastal stations were in service to communicate with merchant shipping and the Navy and to send support telegram traffic: Norddeich (KND); Arcona (KAR); Büll (KBK); Cuxhaven (KCK); Helgoland (KHP); Borkum (KBM); and Marienleuch (KMR). Borkum transmitted on a frequency of 1.92 MHz (using Telefunken equipment) and the Marconi system was at 821 KHz. Norddeich used the classic spark gap circuit.


15. Ibid. p. 57.

16. H. Schlee (Major), Entwicklung und Verwendung der Funktechnik bei der deutschen Armee, (c1925) s.l.: s.n., 1930, 95 pp., here, p. 16; (Photos of wireless equipment used in WWI: Abb. 38–60.) (This publication in the Library of the Hans-Bredow-Institut, Hamburg, under the call number, i.e., Signatur: : D II 1* 16.).

17. Bredow, Im Banne, p. 57.


20. Ibid.


23. Ibid. The names “Abbott” and “Boyd” were cover names. Notice Yardley’s use of A and B as a sort of code!

page from “Cifra 72” shows a four-place alphabetical code group (see photo opposite p. 195). Yardley reported that messages between Berlin and Madrid (i.e., all via Nauen) fell either into group 5 (i.e., code 167), group 9 (codes 101, 301, 303), or was the single outlier code, having the number 253. Of the four groups Madrid used to communicate with Washington, two (101, 301) were also used for Berlin. Stützel’s comment (p. 543) on the code used by the Spanish Foreign Office to Berlin: “It was a four-place alphabetical code group.”

26. Stützel, p. 544. Friedman, p. 9, referring to the U.S. practice of certain codes: “the German Naval, Diplomatic, and Colonial Code text, which was intercepted by the station at G.H.Q., … which was … sent to the proper authorities at Washington.” (Some of these messages would have required Yardley’s attention.)
27. Bredow, Im Banne, p. 58.
29. Bredow, Im Banne, pp. 33–50; p. 33: the “ponderous Communication Technology Testing Commission (Verkehrstechnische Prüfungskommission) was finally replaced by the Technical Department of the Signal Corps (Technische Abteilung der Nachrichtentruppen, or TAFUNK), which itself proved to be slow to react to the need for the new mobile tube sets at the front; also Bredow, Der Daseinskampf, pp. 373–374.
30. John Ferris, “The British Army and Signals Intelligence in the Field During the First World War,” in: Intelligence and National Security, vol. 3, no. 4, 1988, pp. 23–48, at: http://www.tandfonline.com/loi/ifnt20. Here, p. 24. Ferris notes that the British navy’s cryptanalysis center, “Room 40,” was the only British signals unit out of six to retain all its records. “[T]he British signals unit was only British signals unit out of six to retain all its records.” In general, the destruction of war documents was “particularly marked regarding signals intelligence.” Of the 3,330 files from British General Headquarters in France, only 25 survive (these were filed with Room 40).
34. Bredow, Im Banne, pp 112–113.
37. Ibid. p. 21.
38. Ibid. p. 22.
40. See the three-point circuit (Dreipunktschaltung) at: https://de.wikipedia.org/wiki/Dreipunktschaltung.
41. Bredow, Im Banne, p. 176, as reported by Walter Mehle (1953), in an article in the Technische Mitteilungen, of the Nordwestdeutscher Rundfunk. (Mehle provides much of the information Bredow reports regarding early transmission of music from KW.)
42. Jannack, p. 25.
44. Bredow, Im Banne, pp. 165–166.
45. von Weiher, p. 35.
46. Jannack, pp. 16–17. Tower photo on p. 84. Neither the German nor English language Wikipedia pages show a correct photo for the entire structure of the Mittelturm.
of ball-bearing oil and cigarette smoke. Bill thought he could never copy CW as fast as Hoppy did, but he gave it a try by earning his radio amateur Novice license in 1960 and the General ticket in 1961.

After undergraduate and graduate school (Ph.D., Univ. of Wisconsin-Madison), Bill taught at Franklin and Marshall College and more recently at Nazareth College in Rochester, New York, where he is presently Professor Emeritus of German Literature. His career has taken him to many destinations in the world, mostly to Europe (East then West).

His work with students over the years has involved taking more than 500 students to the Metropolitan Opera, accompanying 200 on summer study trips across Europe, and sending more than 150 to a semester abroad program in Berlin, which he helped create in 1999. Upon retirement from teaching, he has been engaged in research and writing on topics in sixteenth-century German culture and in translation of books on psychoanalysis into English.

In 1994, Bill decided to return to the world of amateur radio by acquiring some of the equipment built during his teenage years, and later, that he never had the money or the time to buy. With an amateur Extra Class license (AA2YV), Bill now spends some time in his small shop repairing boat anchors radios.

Bill has been a member of the AWA since 1995, having once been handed parts for a 1929 Hartley oscillator by Bruce Kelley. Since 2007, Bill has served as Secretary to the AWA Board of Directors. At present, he authors the AWA Journal series, The Item in Question.
Three ‘Radio Boys’ and the Eight-Track Tape Player

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Abstract

This article takes the reader behind the scenes, describing the birth of a new concept for automobile radios, which became an icon of the 1960s. At the time, only radio entertainment was available in the automotive world. Prior to the arrival of the Lear tape cartridge and player, several unsuccessful attempts had failed to bring recorded sound into the automobile radio system. Several showed promise, but none attracted public interest or acceptance. Bill Lear, famous for the Lear-Jet business aircraft, brought forth a solution. His model shop fabrication facilities introduced a small number of tape units for aircraft use. These early units yielded encouraging results, and upscale jet passengers were interested and accepted the idea of recorded entertainment. Possible adaptation for home and automobile applications loomed ahead. But his business was airplanes not tape machines. An experienced manufacturer was needed. Motorola was selected to redesign the product for mass production and manufacture.1 Motorola’s adaptation focused on selling tape players to the major automobile manufacturers. The timing was not favorable for a 1966 model year introduction. The 1966 dashboards and their related tools and dies were already finalized or committed. Ford Motor Company found a solution by mounting the player on the transmission hump and speakers in the door kick panels. Assembly line changes were avoided by making it a dealer-installed option. The race was on. Ford and Motorola had a year’s exclusive lead on the competition. This article is a first-hand account written by a retired Motorola production engineer who participated in the introduction of the first successful automobile radio 8-track tape player.

Introduction

Our real story begins with a true, but seemingly fictional vignette, portraying three ‘Radio Boys’ much as they appeared in boy’s adventure books of the same name in the 1920s.2 Since their early teens, radio was an almost consuming interest and passion in the lives of these real life Radio Boys: Bill, Elmer, and Parker, all from Quincy, Illinois. In the end, their dedicated relationships with radio rewarded them with
phenomenal success, fame and fortune, just like the books.

The events described have their generic equivalent in virtually all levels of radio or intricate mechanical manufacturing.

Similar to the fictional Radio Boys, this article takes the reader behind the scenes and describes how two of the three real life boyhood friends collaborated on the development and manufacture of a new addition to entertainment electronics in the 1960s, the automobile radio 8-track stereo tape player. Former Radio Boy “Bill” was none other than William Lear. Bill was searching for a high quality, simple to operate source for quality music aboard his Lear Business Jet airplanes. His choices narrowed to audio tape, but he found nothing that met his needs. Necessity being the mother of invention, he soon fathered a new invention, the Lear 8-track stereo cartridge and player. Wishing to mass produce the system, Bill reconnected with an old friend, former Radio Boy “Elmer” Wavering then president of Motorola. Since Lear’s business was building airplanes and not tape machines, Bill and Elmer arranged for Motorola to re-design the concept for mass production and to produce the product. Coincidentally in late 1964, Ford Motor Company brought urgency to the project since Ford wanted exclusive access to the product for use in its 1966 automobile line. Ford’s adoption would give the automobile manufacturer a year’s lead on its competition. Total success was the only option.

Our story describes unique events in the design cycle along with the trials and tribulations that occurred behind the scenes as an all new product with a limited time schedule for development came to life. Success yielded a profitable and rewarding life for this new product as it became an icon of the 1960s, offering a complete automobile sound system comprising AM and FM radio and 8-track tape.

And, what about our third Radio Boy “Parker”? He was Parker Gates who became president of Gates Radio

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Fig. 1. Elmer Wavering, President, Motorola Inc., 1966.

Fig. 2. William Lear, President, Lear Corporation, 1966.
Company, a pioneer and leader in radio and TV broadcast equipment. Virtually every radio or TV station in the U.S. used at least one item of Gates equipment.

This article offers a first-hand account written by a retired Motorola production engineer, one of several factory based engineers (themselves former Radio Boys), who directly participated in the problem solving and production development activities with design engineering and a skilled factory staff.

**Origins**

As the scene opens, the year is 1923 and we find “Bill” (William Lear, barely 21 years old) proprietor of Quincy Radio Laboratory in Quincy, Illinois, at work alongside his high school aged sidekick and bench technician, “Elmer” (Elmer Wavering). Later that evening they were joined by “Parker” (Parker Gates). Just like the Radio Boys series, the three boyhood friends spent many after-hours sessions experimenting and brain storming to unravel the mysteries of a practical car radio they wished to perfect. But all too soon, tragedy struck Bill and his family, causing him to leave the area. Elmer continued in the radio business. Similarly, Parker remained in town to become president of Gates Radio Company, a well-respected name in the radio broadcasting equipment field. By the mid-1960s almost every radio station in the U.S. was using at least one item of Gates equipment.

By 1930, Bill was in Chicago working with the Galvin brothers on the development of a practical car radio. They needed help. Former Radio Boy Bill sent for former Radio Boy Elmer who joined the group that later became Motorola. Bill was a visionary dreamer, and within a couple of years moved along into aircraft radio navigation, later known as avionics. He found success in aviation with his well-known Lear Jet. Elmer remained at Motorola, becoming its president in the 1960s. And so, the three Radio Boys each found their own success.

**The Challenge**

By 1964, William P. Lear, father of the famous Lear-Jet executive aircraft, was searching for a source of high quality audio entertainment for his aircraft’s passengers. In the days before satellite communications, broadcast radio, with its inherent atmospheric interference, was of limited use in flight due to the aircraft’s movement into and out of each station’s range in a relatively short time. Tape recorded music, with its added appeal of hi-fidelity stereo sound, offered the obvious answer. Reel-to-reel tape equipment was readily available, but a simple method of easily changing and threading the reels of tape needed to be developed for use by the mostly non-technical executive and celebrity passengers. Lear’s answer was to develop an enclosed tape cartridge similar to that used in the popular Muntz four track automobile player. Lear’s cartridge was different. It contained its own built-in pinch roller, and boasted twice the playing time. Design work began in the Lear engineering department.
Technical Details of the Lear Tape Cartridge and Player

The Lear cartridge played over an hour at 3 ¾ inches per second and could be changed, while blindfolded, in less than five seconds. It was easy to use and instantly ready to play. Based on sound mechanical principles and precision machined parts, the first players were fabricated in the Lear engineering model shop for design validation and passenger inflight evaluation.

Inside, was a single hub-spool containing an endless Möbius loop of quarter inch recording tape with (Radio Industry Audio Association, RIAA) tone compensation for best sound reproduction. An agreement with RCA-Victor secured Lear the rights to use the tape source; access to RCA’s vast music library; and substantial expertise in tape recording. Special tape heads were developed for Lear by Nortronics Inc., representing the cutting edge of 1960s technology with the smallest magnetic head gaps then available in commercial volumes. The upper frequency response limit was approximately 12,000 Hz. The sound of wind rush and muffled engine noise in the passenger cabin usually over-rode musical content above that frequency.

Up to 400 feet of ¼-inch tape containing 8 narrow recording tracks, each .015 inches wide, spaced .015 inches apart, ran the length of the tape. (Note, a track width of .015” equals approximately four thicknesses of copier paper). A short length of conductive foil tape was placed at the splice point creating the continuous loop and acted as a switch. It activated a solenoid, ratchet and cam, advancing the vertical position of tape head by .030” ±.003” to the next pair of tracks. Therefore, a 400-ft. tape contained an effective tape length of 1,600 feet.

- Starting at the edge of the tape, tracks 1 through 4 contained left channel sounds. Tracks 5 through 8 carried the right channel sounds.
- The magnetic poles in the Nortronics

![Fig. 3. Outside and inside view of the cartridge. The tape movement is from right to left.](image)
The programs played sequentially, advancing automatically by the foil sensing switch, or by a manual switch. The tape direction could not be reversed or rewound.

**Early Success and Lear’s Vision of Future Potential**

Eighty prototype players were originally fabricated in the Lear engineering model shop for more extensive passenger in-flight evaluation. Enthusiastic reaction and acceptance by celebrities and executive passengers convinced Lear that his invention had substantial mass market potential, beyond the aircraft industry. Wishing to further test-market the public acceptance, a limited quantity of prototype design level players were built with the Lear name and sold through independent dealers. Encouraged, Lear set about finding a manufacturer who could further refine the design for efficient mass production, delivering a high quality, reliable, profitable package for automobile or home use.

**The Challenge of Profitable Mass Production**

Bill Lear was aware of Motorola’s position and reputation in the automobile radio field. He recalled working alongside his longtime friend Elmer Waver ing, now Company President, as they developed Motorola’s first car radio in 1930. In the mid 1960s, the company was headquartered on a campus in Franklin Park, Illinois that housed design engineering for the Automotive Products Division providing Original Equipment Manufacturer (OEM) sets to Ford, Chrysler, American Motors, Jeep and North American Volkswagen. There were also design facilities for Motorola branded Consumer Products Division Radios sold through Motorola dealers. A newly expanded plant at Quincy, Illinois housed manufacturing for both divisions.
Seeing these favorable conditions, Bill approached Elmer and negotiations with Motorola began in mid-year 1964. The project was assigned to the radio engineers in Motorola’s Automotive Products Division. As a key automotive supplier, Motorola maintained a sales-engineering office in Detroit that was in constant contact with its automotive OEM customers. Lear and Motorola reached an agreement and tape player technology transfer to Motorola began in late summer of 1964.

Meeting the Challenge
Motorola executives and engineers Oscar Kusisto, Bob Wolf and others fondly recalled their meetings with Bill Lear and his design team. They witnessed his personal self confidence, energy, remarkable memory, knowledge of minute technical details, and determination to succeed. The Lear design model was a ruggedly built package on a basic functional chassis, with a direct drive capstan motor; with the armature serving as the flywheel weight. In a series of meetings, continuing for several months, details of an efficient mass production design were addressed—sometimes with colorful animated reactions between Lear and the Motorola design team. Goals included simplicity of operation, size and weight, tooling needs and related precision, reliability, ease of assembly,
cost, styling and above all, excellent sound quality.

**Ford Adds Urgency to the Challenge**

By the autumn of 1964, rumored news of the project found its way into Detroit’s auto making product planning and design departments. Space behind the dashboard was already a scarce commodity, especially with the growing demand for air conditioning. The addition of a tape deck and another speaker brought space problems that largely prevented inclusion for the 1966 model year. However, the Ford radio group showed immediate interest. They proposed mounting the tape player forward on the transmission hump when dash space was a problem, with speakers mounted in the lower door kick panels. Lear and Motorola signed an exclusive contract with the Ford Motor Company to produce 35,000 Lear 8-Track players for their 1966 models. Later, the quantity grew to 65,000 to be produced by the end of the model year. Other OEM customers now had to wait their turn.

**Motorola “Design for Manufacturing”**

1964–1965: From Laboratory Concept to Mass Production Design

The size and exterior shape were of critical importance since the player had to be an easy fit into or under an automobile dashboard. Typical size and shape limitations were understood by engineers at Motorola based on their years of car radio designs. They knew that space was at a premium.

The size and location tolerances of the recorded music tape tracks

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Fig. 8. Top cover removed showing capstan flywheel, motor and drive belt.
Three ‘Radio Boys’ and the Eight-Track Tape Player

dictated the high accuracy and precision that would be required within the player. Lear’s design model contained machined parts of impeccable dimensional control. The challenge for Motorola was how to achieve the same results using mass produced components within “commercial tolerance.” The devil was in the details. The relationship between the tape guide, tape head, capstan shaft, the pinch roller, and the movement path of the tape were all quite critical.

Motorola achieved mechanical integrity by locating the tape head vertical movement mechanism on one single die-cast part that also supported the capstan shaft and bearings. The corresponding mating part, the tape-head track position cam, was also die-cast. With their relationships controlled within die-cast molds, the requirement for precision was met with a minimum of secondary machining.

Based on car radio requirements the design provided for rugged construction capable of withstanding mechanical vibration, and repeated 5g shocks. The heavy gage stamped metal deck base plate that supported the die-cast capstan assembly, along with the tape guide, contained holes and positioning dimples that were all punched on the same stamping die stroke assuring their exact positions.

The tape was driven by a small governor-controlled DC motor, belt-driven with a 3¼-inch flywheel, which drove the capstan shaft. The motor selection presented a challenge in itself, requiring a balance between physical size and shape, torque, speed and governor control, current, projected life, cost and availability. Motorola’s most qualified supplier was located in Japan. So, a senior components quality engineer was dispatched overseas to closely liaise with the vendor in order to ensure their ongoing process control and to make certain that they had the capabilities to deliver the components. As the project unfolded, similar steps were taken with other critical components.

Loud speakers and their baffles were selected by the car company’s radio engineers who were accustomed to meeting the goals of their own product planners. The audio circuitry between the tape deck and the speakers was carefully selected using Motorola manufactured power transistors selected for best power gain.

**Early 1965: Completing the Design**

Old or new, every manufactured product has its own family of not-easily-anticipated-but-critical characteristics to be identified and ultimately
controlled. And so it was with the 8-track player. Engineering and manufacturing were well aware of critical characteristics in radio production, but here was a new mechanism in different product field. The concept and design were sound, but some design features remained intolerant of some manufacturing variations. The task was to find and eliminate them.

Lear, Ford, RCA and Motorola had an exclusive one-year lead on the competition. The quality and delivery expectations inherent in the automobile world were clearly understood. Failure to satisfy Motorola’s largest OEM radio customer was not an option. Motorola knew its competitors were watching the performance and customer acceptance of the 8-track player. Based on my own experience as a production engineer at Motorola, we all knew that from corporate management to our plant manager, and on down, the order of the day was: “Get it right, do whatever it takes, ship on time and count the cost later.”

Activities in the Motorola Automotive Engineering Department continued right into early production as experience provided information needed for continuous product and manufacturing improvements.

The next step was to prepare for the pre-production pilot run scheduled in mid-May 1965. As the design for cost effective mass production continued through the winter of 1964-65, the design and engineering teams tackled a number of problems and successfully resolved them.

- **Tape slippage**: Design validation tests disclosed a tape drive problem with 400-foot cartridges in a minus 20-degree environment. RCA assisted with the selection of a superior tape lubricant that enabled low temperature operation while meeting long term wear requirements.

- **Tape stripper**: The tape sometimes tended to stick to the capstan shaft and wrap around it, a phenomenon known as “eating the tape.” Addition of a “tape stripper,” a sharp edged barrier on the capstan housing, spaced less than two thicknesses of tape away from the capstan shaft corrected the problem.

- **Motor speed-governor life**: Early stage life testing divulged a condition in the speed governor transistor circuit that necessitated addition of a second transistor, thereby reducing governor contact current, and increasing its life.

Motorola’s use of collaborative teams to plan, design, refine, test and improve its products and manufacturing processes were far ahead of their time. Twenty five years later as
Three ‘Radio Boys’ and the Eight-Track Tape Player

an independent management systems assessor for an ISO 9001 systems registrar, your author was pleased to realize that the Motorola product design, scheduling, and quality control practices used in mid-1960s met today’s ISO Standard’s requirements 20 years before they even existed. Released in 1987, the ISO 9001 management systems standard is designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to a product along with the fundamentals of quality management systems.

Early 1965: Pre-Production Pilot (Trial) Run Preparation at the Factory

In early 1965, the Quincy plant was producing all of Motorola’s branded and OEM auto radios, home table models, and portables. At the time, it was the largest plant in the world exclusively producing radios (no TV sets). The facility was huge with an employee population that averaged 2,800 to 3,000 people.

While the 8-track player’s design improvements continued in engineering, a working prototype was delivered to the Quincy plant sometime in March 1965. Based on the prototype, Manufacturing Engineering planned the assembly line layout and the detailed sequence of assembly piece by piece, documenting each step and assigning a standardized time allocation. This document was then used by the production supervisor(s) to instruct each worker on the line.

Next, the specialized manufacturing and quality control equipment were determined and established for production. For example, special fixtures and gages were installed to ensure true vertical positioning of the capstan shaft with respect to the deck base plate. A number of other component design details were addressed along with assembly tooling, and supplier process issues. Tape player test fixtures and related equipment were readied and procedures were prepared. Much of the equipment used on the line was common to radio production, and mechanical assembly was akin to producing many radio products.

Plans called for the basic tape deck to be built as a subassembly and tested for electrical and mechanical performance. Then it moved to the player chassis line where the audio amplifiers, controls and housing were added, making up a near-complete unit. Again, adjustments and quality tests were used to ensure proper performance. Tests included tape speed, wow & flutter, cross talk, correct power levels from each channel, automatic track

Fig. 11. In another view shows the motor on-off micro-switch and the speed governor circuitry, in the upper right corner.
advancement, and a music listening test. After testing, the covers and trim housing were installed. A final listening test was performed, and the players were ready for packaging and shipment. The accepted units proceeded to the packing department. A final Quality Control technician randomly selected a specific number of the packed units as the day proceeded, and repeated critical tests to monitor and document compliance. The overall process and routine were closely adapted from radio production techniques which were well established at Motorola.

May 1965: Pre-Production Pilot Run

The Quincy plant assembled a 50-unit preproduction pilot run the week of May 17, 1965. Most of the engineering design team was present to monitor their part in the new design, and to give prompt attention to any problems. Performance measurements were made on each player with reference to all required specifications. Vibration, shock, drop, and life tests were initiated, and the statistical probability-of-acceptance at the test stations was determined.

These quality control practices were fully adopted in Quincy plant radio production as early as 1963. They formed an early beginning of the Motorola Six-Sigma Program. Back then, Three-Sigma variation versus the specification was the defined target (99.7%). At Quincy, the plant production engineering manager, Carlton Braun, led the local activity. Six-Sigma is a set of techniques and tools for process improvement where nonconformities become rare enough to be counted in “parts per million.” It was introduced by engineer Bill Smith while working at Motorola in 1986. Jack Welch made it central to his business strategy at General Electric in 1995. Today, it is used in many industrial sectors.4

- Later located at a new corporate headquarters at Schaumburg Illinois, Motorola University was known worldwide as a leading Six-Sigma training center for suppliers, customers and quality professionals.
- The same Carlton Braun who led the effort to design a quality based manufacturing program at Quincy for radio and then 8-track player production became a vice president and director of Motorola University, where he was responsible, in part, for further developing and teaching these pioneering techniques.

Pre-Production Pilot Run Problems Encountered

Motorola encountered a number of pre-production pilot run problems that had

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Fig. 12. Automotive Products General Manager Oscar Kusisto examines a Ford tape player at the Quincy plant, accompanied by veteran employee Norvill Hill.
to be resolved. The following discussion provides an example of the type of problems engineering teams had to grapple with when bringing up a production line before full manufacturing could begin.

For example, during the initial testing of pilot run tape players, test tapes were in short supply and produced conflicting results. A vital performance characteristic in stereo is “cross talk,” unwanted sound leakage from one tape track to another. The question arose: “Are cross-talk problems caused by the tape head, the test tape, or misadjustment?” Accurate, precise measurement of the tape track location versus tape head pole location formed the critical problem that needed to be solved before any further advances could be made.

The engineering team altered an Ampex reel-to-reel tape machine to accept an 8-track tape head with correctly spaced pole-pieces. Their exact vertical position was adjustable and was indicated by a micrometer. While the tape was in motion and its output was read on a meter, the micrometer was adjusted until the highest meter reading could be identified on the exact track location. Thus, the location of each or any track was accurately measurable.

As an alternative, a recorded tape loop could be dipped into a chemical product “Magna-see” and dried. This made track positions clearly visible as white lines on the brown oxide surface. A calibrated microscope was used to measure the track positions. Tape track locations vs. tape head dimensions became discernible using either means. Reliable analysis proceeded.

As production began, additional test tapes arrived from RCA with accurate track locations. Motorola performed ongoing sample testing of shipments until confidence could be established that the tapes were correctly and precisely aligned.

Production Begins

July 1965: Early Production

By mid-July, 1965, the remaining open issues with design and production planning had been resolved, and parts were being accumulated in the stockroom. Production began at a line rate of 200 units per day. The schedule indicated it would take 175 workdays to complete 35,000 units. Each unit failing to meet test specifications was promptly examined to determine the cause. Three production engineers assigned to the project identified problems and corrective actions, and modifications to production processes were launched in close liaison with design engineering. Two additional production engineers joined the effort when their day shift

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Fig. 13. Executives examine a Ford tape player installed in the dashboard.
radio duties ended at 4:00 pm. The team continued until all of the day’s problems had been identified, and at least “short term fixes” were implemented for the next day’s run. Frequently, the team’s problem solving activities stretched until 9:00-10:00pm, and sometimes later. Design engineers from the corporate engineering department in Franklin Park each spent an average of 2 to 3 days per week in the Quincy plant responding to issues.

**July 1965: Final Test Tape Accuracy Controls**

Just as all radio test equipment requires calibration control, so do the test tapes used to adjust tape head positions. Worn or damaged test cartridges could result in misadjusted players. Initial tests indicated that after about 2,000 insertions, cartridge case wear could affect the accuracy of the track versus head adjustment. An optimum change interval of 1,600 insertions (every two weeks) was chosen. Cartridges were marked with an expiration date and routinely replaced.

Shortly after production start up, RCA agreed to supply Motorola with bulk recorded test tape on 12-inch reels, new cases, pinch rollers etc. to enable in-house tape cartridge maintenance in the Test Equipment Department. Rather than discard the entire worn tape cartridge, only the case was replaced. Undamaged internal parts were reused. Tape noise and dropouts were also checked. An ink marker dot was placed inside on the tape spool at each case change. In time, experience led to discarding the entire tape after wearing out five cases (5 dots).

A number of test tapes were used for initial deck adjustments and performance tests. For example:

- Track advance foil tape used to pulse the ratchet solenoid during adjustment. (One-inch lengths of conductive foil spaced every four inches.)
- 8000 Hz tape head azimuth adjustment. (Aligns head for best pickup of high pitched notes.)
- 3000 Hz tape speed, wow and flutter test.
- 1000 Hz head position adjustment and cross talk test on all four programs.
- Four frequency tape program switching, equal output from each channel: Program one L=R 100 Hz; Program two L=R 200 Hz; Program three L=R 400 Hz; and, Program four L=R 1000 Hz.
- Listening Test. RCA music tapes were used for overall listen-ability and life test: “Sound of Music,” “Girl From Ipenema,” “Cotton Candy - Al Hirt” and many others.

Fig. 14. RCA supplied a specially produced 8-track cartridge to accompany each new 1966 player. (The Ford Family of Fine Music)
August 1965: Ford Motor Company Announcement
On August 20, 1965 the Ford Motor Company formally announced to dealers and the general public that it was exclusively offering its 8-track player for its 1966 line of automobiles. The pressure was now on at the Motorola plant to faithfully meet production schedules.

Summer and Autumn 1965: Some Early Production Problems
As production began, a number of problems arose as batch-to-batch component variations entered the assembly line. Each of these issues was resolved by the engineering teams. A number of examples are described below:

- Early shipments of motors created excessive electrical interference, heard as static-like noise in the music channels. Possible shielding and filtering techniques were to no avail. The solution was to open the motor, readjust the brush holder bracket position for minimum noise, read on a special meter, and then re-assemble the unit. This special corrective process continued at the plant until shipments of motors arrived with the proper bracket position.

- Tape slippage occurred at the capstan shaft. A very carefully chosen light sandblasting by the supplier roughened the shaft surface just enough to increase traction with the tape and corrected the problem.

- Wow and flutter problems were also occurring simultaneously. It changes in tape speed as it passes the tape head. This in turn causes an instantaneous change in pitch of a sustained note. It is most noticeable listening to reed instruments or vocalists. When the change occurs at a low speed the resulting effect is referred to as “wow” (say that 5 times fast, and you will understand). Flutter is wow at a higher speed. Think the pulsing sound of a small bird flapping its wings rapidly.

- Wow and flutter problems were also occurring simultaneously. It

Fig. 15. A production engineering work position inside a double shielded screen room to eliminate electrical interference in the test environment.
was later realized that each had a different root cause. Three corrections were eventually necessary to fully control wow and flutter problems. One source of flutter came from uneven action of the governor speed control circuits. Changes in the value of two electrical components corrected that part of the problem. In continued search for another root cause, micro-precision measurement of the capstan shaft surface using a profilometer, that measured surface variations as small as .0000001 inch, was used. It showed that lobes on the capstan surface over .0000050 inch were the root cause. Minute high or low areas on the capstan shaft resulted in corresponding changes in the tape speed, inducing the flutter. Aided by support from a second supplier, plus urgent efforts from the main supplier, ultimately improvements in process equipment corrected the condition.

- A heretofore unidentified wow condition then became noticeable, caused by drive-belt thickness variation. Seemingly innocent thickness variations were identified as the root cause. A source for belts of uniform thickness was found, correcting the problem.
- Capstan bearing lubrication became a problem. After a series of test runs, a successful Oilite bearing lubricant was quickly identified, replacing the highest grade of jet engine lubricant available with a common brand of crank case motor oil. It continued successfully in use for the balance of the model year.
- Automatic track change at the required minimum battery voltage, 10.6 volts, at -20 degrees Fahrenheit, demanded attention. Additional solenoid pull-in force was needed. Lacking sufficient space to merely add turns to the solenoid coil, a solution was found by using a higher density bifilar winding within the available space.

The average person probably does not recognize the hostile environment inside an automobile. Radio and tape player specifications typically call for storage and function in a range of at least -20 degrees to near +170 degrees Fahrenheit, resistance to humidity, and prolonged periods of shock and vibration up to 5gs of force. This performance was verified in design and samples were periodically taken from production. Reliability sample-lot testing was also part of the ongoing monitoring of car radios and tape players.

- Longer term reliability testing unveiled yet another motor problem with governor contact life. As an ongoing precaution, a special cleaning of the contacts was already being performed by the supplier immediately before the cover cap was installed. After considerable effort, it was discovered that a lubricant in the cleaning solution oxidized in the presence of seemingly small arcing of the contacts. This created oxide insulation on the contact surfaces.
- The supplier provided an immediate change in the chemical composition
of the cleaning solution. A recleaning process was established and the motor contacts were reworked. This process continued until the entire oxidized motor inventory was corrected.

July 1965: Field Repair Service For A New First-Of-Its-Kind Product

Early tape players were destined solely for dealer installation. The technicians in the Motorola National Service Department needed support until a field training program could be completed. A return-to-factory repair service was set up at the Quincy plant. Ford dealers at more distant locations shipped the unit for repair to a designated large dealership in their sales zone, where they were consolidated for priority shipment to the factory. The warranty repair department repaired the player, updated it to include current revisions, and restored it to new appearance, in a 48 hour turn-around cycle. This included complete electrical testing followed by a 16-hour operational “burn-in” period that ended with the same final test requirements as a new unit. The player received expedited shipment back to the zone dealer and original dealer. Every effort was made to ease customer inconvenience with fast effective service.

Late 1965: Success Was Achieved

Production performance problems settled down to a level typical for a product of its complexity as the hidden problems were found and corrected. The new 8-track tape player was an unqualified “hit” with dealers and customers. The production rate dramatically increased in order to satisfy the demand. Through the plant’s combined efforts, Ford’s shipping schedule was met each week, without fail, with products that met specifications. By the end of the 1966 model year, a total of 65,000 players were installed in Ford automobiles.

The 8-track tape player’s popularity caused the auto industry to “make room” and redesign the dashboard to accommodate stereo equipment, further paving the way for the future success of FM stereo auto radios. The technical lessons learned in engineering and manufacturing were applied to a new tape deck design for 1967. The improved tape deck design continued virtually trouble free and unchanged for the next ten years. With it, the Consumer Products Division introduced its own after-market player, as did a multitude of competing manufacturers. Within two years, Motorola introduced a player with the ability to reproduce FM stereo through its system using an

Fig. 16. When the 1966 Ford exclusive use period expired, Motorola (and many others) entered the 8-track stereo field. An ID label for the 1967 Motorola model is shown.
adapter connected to a conventional (non stereo) AM-FM car radio.

The idea of incorporating AM and FM with stereo, plus a tape player, led to the popular automobile “Entertainment Centers” that emerged in the early 1970s and live on as standard OEM equipment today. Tape decks with

Fig. 17. Image from a Motorola dealer’s catalog.

Fig. 18. Image from a Motorola dealer’s catalog.

Fig. 19. Announcing an 8-track player with an FM multiplex decoder built in to be coupled to an FM auto radio, via an adapter. This helped initiate the demand for AM-FM Stereo 8-track players that became known as Entertainment Centers in the 1970s.

Fig. 20. Announcing three AM-FM monaural car radios designed for the stereo adapter enabling use with the accompanying 8-track tape player.
Three ‘Radio Boys’ and the Eight-Track Tape Player

AC motors soon found their way into Motorola home stereo phonographs. Since General Motors’ OEM needs were supplied by Delco, Motorola entered the late 1960s as the exclusive OEM tape player supplier to Ford, Chrysler, American Motors, International Harvester and others.

Further System Improvements


“Get it right, do whatever it takes, ship on time and count the cost later,” defined the company culture. By the end of 1965, Motorola examined the “costs of success” related to the project and developed new innovations in its manufacturing and design processes.

Motorola introduced “simultaneous engineering” to bring manufacturing into the design loop along with a number of other system improvements. A New Products Department at the plant served as liaison with designers. Issues of plant process capability and product manufacturability, including electrical, mechanical and reliability tests, were reconciled at time of design.

A small engineering run at the factory produced the final engineering prototype using workers who usually work on production lines. This activity precedes the long established production pilot run activity, which was retained. It enabled a number of design related manufacturing problems to be identified in time for engineering to make corrections before the production pilot run. Likewise, manufacturing process problems were identified in time for early correction. Your author successfully worked with the revised system introducing hundreds of new radio related models successfully over a seven-year period.5

Four Channel Surround Sound Using a Lear Cartridge

In the early 1970s, the industry was looking forward to Quadra-line “four channel surround sound.” The Lear cartridge design contained space for a pair of Quad programs with 30 minute total playing time and offered easier tape changing. They provided a simple alternative to reel to reel tape.

Within the record industry, a system was being designed to obtain the 4-channel effect from a 2-channel stereo source using a special recording studio layout and protocol for sound mixing during the recording process.
When played back, the performance was not distinguishable from high-quality stereo material and could be broadcast normally. The received FM stereo radio signal was then decoded, by the “new” IC, recovering the Quad effect for the related amplifiers and speakers.

In 1972, Motorola Model FH 480, AM-FM Stereo Radio and Quad cartridge player, contained a receptacle on the rear cover to accept the IC decoder. Information circulating at the time indicated the IC manufacturer encountered performance difficulties and was unable develop a Technical Standard agreeable to recording industry. Lacking the ability to receive four channel programming via FM radio,
public interest waned and after a few months of low quantity production the project was discontinued. Meanwhile, “simulated” 4-channel sound was creatively obtained from a two channel source: The left channel speaker (#1) operated normally as did the right channel speaker (#3). The signal for the left speaker also went through a reverberation (echo) device and on to the front speaker (#2). Similarly, the signal for the right channel speaker also went through its own echo device and on to the rear speaker (#4). The resulting sound lacked appeal to buyers accustomed to pure discrete stereo or Quad sound from tape, and the product was discontinued.

**Conclusion**

By the 1970s, millions of decks had been produced nationwide, and the 8-track tape player was recognized as an icon of the 1960s. The AM-FM-Stereo Radio-8-Track Entertainment Center for the 1978 Ford was the last auto radio produced by Motorola in the United States.
At about the same time, Federal regulations required that all new cars have factory installed AM-FM radios to receive emergency safety information. This ended the after-market branded radio business. By then, the Quincy plant was closed, and the OEM source of choice had shifted to radios produced either in-house or off-shore. Phillips cassette decks replaced the 8-track stereo player. Ten years later, the arrival of the compact disc brought forth a new era of digital recording for home and automobile listening entertainment.

Notes
1. In its hey-day, Motorola’s Quincy, Illinois plant employed three to four thousand workers, and for a time was the world’s largest exclusive radio manufacturing facility. There, Motorola introduced many new products such as: transistor powered “hybrid” (tube and transistor) car radios; shirt pocket transistor portables; the FM car radio; solid-state car radios; “Vibra-sonic Sound”-reverb for car radio rear deck speakers; three channel stereo phonographs using a center bass channel; its’ first electronic ignition system; solid state home radios; FM stereo; the eight track stereo tape player; home Quadraline surround sound using a modified 8 track tape player; the early 1970s automobile entertainment center, a combined AM-FM stereo 8 track player, and an interlude with manufacture of the ill-fated CBS electronic video record player, the EVR.
2. Radio Boys was the title of three series of juvenile fiction books published by rival companies in the United States in the 1920s. The most popular was arguably the Stratemeyer Syndicate’s thirteen volume series by Allen Chapman from 1922 to 1930. Journalist Gerald Breckenridge wrote a 10 volume Radio Boys series that ran from 1922 to 1931, J.W. Duffield / Wayne Whipple & S.F. Aaron penned a six volume Radio Boys series from 1922 to 1923, which reprinted the two volume Bill Brown series as its final volumes. See http://series-books.info/radiob.html and also see http://www.keeline.com/Chapman/. The storylines for the popular Radio Boys books featured young boyhood friends use a mentor’s inventions and their own engineering ingenuity to propel the plot. These popular books inspired many young folks to go into the radio industry as adults.
5. Ten years later, after entertainment electronics moved off shore, I was employed by an OEM automotive supplier in a different product field. At the time, Far East quality competition was knocking on Detroit’s door. Their industry-wide competitive response was the implementation of a system for suppliers similar to that I had known at Motorola. The program continues in use today, known as PPAP, Pre-Production Analysis Program along with a similar array of analytical, statistical, and scheduling tools. Needless to say, my employer was one of the “early adopters.”

About the Author
Olin Shuler is a lifetime radio enthusiast, building his first radio at age 15. He holds current FCC commercial and amateur radio licenses dating back to the early 1950s. Olin gained decades of radio manufacturing experience at Motorola Inc. during its peak years manufacturing home and auto radio products between 1950 and 1976 at the Quincy, Illinois plant.

As a production engineer for Motorola’s Quincy Plant, and later the department manager, he and his staff served as technical interface between design engineering in Franklin Park, Illinois and Quincy, 300 miles distant. The department was responsible for technology transfer and provision of ongoing support, performing services
nowadays defined as that of a Quality Engineer. Each new project brought learning opportunities for the people in a plant producing an increasingly diversified product line.

Today, Olin Shuler is a retired Registered Professional Quality Engineer (California License 5694), and a Fellow in the American Society For Quality, (ASQ). He is the 2014 recipient of the Radio Club of America’s Fred M. Link award for his contributions to development and manufacture of Motorola’s first FM car radio. He is the immediate past-president of the Antique Radio Club of Illinois, and active in six antique radio organizations, including AWA.

Olin Shuler
Letter to the Editor

- In the fall of 2015, Chuck Porter wrote:

Ray Schulenberg and Olin Shuler’s account of developing the first FM car radios, in the 2015 AWA Review, is a most enjoyable read. It also solves a puzzle. During the summer of 1959, between college years, I helped construct a powerful new FM station near Cleveland on 107.9 MHz. Initial testing after the antenna went up showed poor signal conditions locally. But then reports came in that our station was loud and clear on car radios in Chicago! How could this be? Not only was Chicago over 300 miles from our Newbury, Ohio transmitter, but FM car radios didn’t even exist then.

Schulenberg and Shuler’s article explains part of the mystery—this is when they were driving around testing their prototype receivers near Chicago. The unusual propagation conditions were corrected when we discovered that some of the antenna elements had been installed upside down, apparently sending the signal up at an angle and experiencing tropospheric bounce.

Sincerely,

Chuck Porter, Troy, NY
Lincoln Radio Corporation
Enigmatic Manufacturer of Exceptional Receivers

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Abstract
The Lincoln Radio Corporation manufactured a line of progressive high-quality superheterodyne radios between 1928 and 1936. Their radios were designed for distance reception and competed with the products of the E. H. Scott Radio Laboratories and McMurdo Silver Corporation. Lincoln radios were known for DX reception and were advertised widely during the early 1930s. William H. Hollister, president and owner of the Lincoln Radio Corporation, authored numerous articles about Lincoln's models that were published in several contemporary magazines. Yet, despite all of the advertising and articles written, very few Lincoln receivers are known to exist today. This disparity between the extensive publicity versus the small number of remaining sets has been an ongoing enigma for the radio collecting community. Mr. Braithwaite has risen to the challenge of investigating this enigma by researching Lincoln and its products. In this article, Mr. Braithwaite unravels these mysteries and reports on the history, product lines and fate of the company. A brief biography of William Henry Hollister, Lincoln's president and owner during its golden years, is also included.

Introduction
Most radio historians and collectors have heard of Lincoln Radio Corporation (Lincoln) and associate it with a line of high performance classic radios comparable to the products of E. H. Scott Radio Laboratories (Scott) and McMurdo Silver Corporation (McMurdo). But when asked about Lincoln receivers, few ever recall seeing one in person, and even fewer are able to identify the progression of models. Lincoln was one of three competing companies that are commonly perceived as industry leaders that challenged the limits of radio performance in the 1930s. Yet, far less is known about Lincoln than the other two. Morgan McMahon’s A Flick of the Switch presents an incomplete pictorial history of a series of receivers manufactured by Lincoln. Marvin Hobbs’ E. H. Scott, Dean of DX: A History of Classic Radios provides a very brief background about Lincoln and compares some of the Lincoln receivers with those offered...
Lincoln Radio Corporation

by Scott. Little else has been published about Lincoln and their products. This article provides the first comprehensive discussion of Lincoln Radio Corporation, its history and its products.

My personal interest in the Lincoln radios goes back over 30 years when I purchased a Lincoln Deluxe SW-33 as a representative competing product to Scott radios which I had been collecting for several years. I purchased several additional chassis through the years, but I accumulated many more questions than chassis. What was the complete line of Lincoln radios through the years? What were their features and how did they compare with competitors’ offerings? How many were made? How much did they cost? Whatever became of Lincoln? We know from existing literature that Lincoln was owned by William H. Hollister at some time, and that Mr. Hollister was an avid radio amateur, but what became of William H. Hollister? Over the many years that I have been interested in Lincoln and their products, some information has come to light. I have found numerous ads and product articles as well as a few product brochures, owners and service manuals. I also compiled research on William H. Hollister. Finally, after careful examination of a limited sample of Lincoln receivers, a very interesting but still somewhat incomplete picture of the Lincoln Radio Corporation has emerged.

The model introduction dates referenced in this article are the dates the subject receivers became available to the public in the form advertised. As will be seen from the descriptions, with the exception of the last classic model offered, most named receiver models offered by Lincoln represented a single flagship model which featured a continuum of improvements. Therefore, the introduction dates of Lincoln's models have been recognized as the earliest date the improved model was advertised or featured in an article. Scott Transformer Corporation, later renamed E. H. Scott Radio Laboratories, had a habit of introducing new models based on prototypes that sometimes differed significantly from the models offered to the public. These prototype receivers were introduced up to five months before the first advertisement or article featuring the receiver as it ultimately appeared. Although prototype receivers may have been constructed, the introduction dates of Scott models have been recognized in this article as the earliest date the Scott models were advertised or featured in an article. The models were made available to the public. Introduction dates of the McMurdo receivers have been assumed to be the earliest date the McMurdo models were advertised or featured in an article. This definition of introduction dates reflects potential consumer's knowledge of available and competing products.

Early Company History and Products
The early history of Lincoln Radio Corporation is not well documented, but according to a 1931 sales brochure, the company “came into existence in
1921” and produced “correctly designed highly engineered parts” for the custom builder. An application for the Lincoln trademark was filed on July 6, 1922, and the trademark was registered on August 14, 1923 identifying John H. Newman as Lincoln’s president and treasurer. A brief article in the July 13, 1924 Los Angeles Times notes the completion of the Lincoln Radio Corporation building at 1151-1153 San- tee Street in downtown Los Angeles. Little is known about the operations at this location, but boxes containing Lincoln crystal detector units identify Los Angeles as the company’s location.

At the same time, magazine advertisements show that Lincoln offered coils, tuning capacitors, loop antennas, and 1- and 3-tube radio kits from their establishment located at 224 North Wells Street in Chicago. Based on existing examples, it appears that Lincoln was selling complete single dial tuned radio frequency (TRF) receivers during the late 1920s. By 1927, Lincoln offered couplers and transformers for 8- and 9-tube superheterodyne receivers, but no complete receiver. Today, the TRF receivers turn up on occasion, and the loop antennas turn up on a regular basis.

Fig. 1. Lincoln Radio Corporation Trade Mark. (Courtesy U.S. Patent and Trademark Office)
William Henry Hollister

William Henry Hollister was born on June 12, 1879 to Henry M. and Emma A. Hollister of Chicago, Illinois. Both parents were American citizens, and Henry was a very successful bookkeeper. William attended the near west suburban Oak Park High School and had grades described by the principal as average. Subsequently, William attended Lewis College in Romeoville, Illinois from the winter of 1899 through the winter of 1900. Although his obituary stated that he graduated from Lewis College, based on institutional records, he did not complete a degree program or graduate from Lewis College.\(^2\) Full grown, Mr. Hollister was described as 5’-11”, 140-pounds, with blue eyes and brown hair.\(^3\) A late 1928 Lincoln ad credits Hollister with demonstrating “wireless” to college professors before Marconi first bridged the Atlantic; likely meaning the year of Marconi’s first transatlantic wireless signal in 1901. From 1902 through 1907, William was the assistant electrical engineer for the Pacific Electric Interurban System in Los Angeles, during which time he allegedly transmitted modulated carrier signals from Pico Heights to Boyle Heights, a distance of 3 miles. The 1910 Census listed Mr. Hollister’s employment as “General Superintendent” for Kissel Motor Car Company in Chicago. During World War I, William joined the U.S. Army Quartermaster Corps satisfying a requirement for military duty. After WWI, Hollister worked as the sales manager at Imperial Brass Company in Chicago. According to his obituary, William was “the organizer” and president of Lincoln Radio Corporation.

Although no records have been found indicating that William Hollister was involved in the formation of Lincoln, construction of the Lincoln building in Los Angeles where William Hollister lived may indicate that he was involved with Lincoln’s operations before becoming president of the company.\(^4\) In 1928, at age 45, William purchased the Lincoln Radio Corporation and consolidated operations at 329 South Wood Street, a new address in Chicago. This likely coincided with the death of his parents and his inheritance of their estate in Oak Park. Mr. Hollister described his goals of improving radio performance using new methods for “better reception and farther...

Fig. 2. William Henry Hollister. (Short Wave Craft, Sept. 1932)
distance getting ability.” Under Mr. Hollister’s leadership, Lincoln offered superheterodyne radio kits and “Lincoln Engineering Service on Standard Kits,” including those offered by Silver Marshall, Scott Transformer Corporation, Tyrman Radio and High Frequency Laboratories, as well as offering their own superheterodyne receivers and kits. The first new model introduced under Hollister’s direction was the Lincoln 8-80 (a.k.a. the Hollister 8). Based on the most current information, it appears that the TRF receivers and non-superheterodyne parts were likely discontinued.

Superheterodyne Kits and the Lincoln 9 Receiver

Articles featuring the Lincoln 9 receiver were published in *Popular Radio* in June 1927 and in *Citizens Radio Call Book Magazine* in September and November 1927. Different versions of the receiver were featured in each article, and no two articles featured the same style intermediate frequency (IF) transformers. The latter two receivers incorporated a four-stage IF amplifier employing type 201A tubes, and both types of transformers operated at a nominal frequency of 155 kHz. A complete kit of parts for the Lincoln 9

Fig. 3. 8-tube Receiver Built Using Lincoln Superheterodyne Coil Set. (Author’s Collection)

Fig. 4. Lincoln IF and Oscillator Coupler Coils in 8-Tube Superheterodyne Receiver. (Author’s Collection)
receiver cost approximately $140. The vast majority of contemporary superheterodyne receivers operated using IF below 80 KHz. The lower IF frequencies had the advantage of knife sharp selectivity but the disadvantage of creating “images” within the broadcast band. The movement toward higher IF frequencies was, in part, to avoid images. An image frequency is an undesired input frequency (the station frequency plus twice the IF) that results in two stations being received at the same time, thus producing interference. By comparison, the Scott World’s Record Super 10 employed an IF of 35 KHz, Victoreen employed an IF of 115 KHz, and Tyrman, new on the scene, had just introduced their Model 10 employing an IF of 340 KHz.

1929 Model Year: Lincoln 8-80 (AKA Hollister 8) and Hollister AC-8
Shortly after Mr. Hollister purchased Lincoln, he introduced and promoted a superheterodyne radio kit for $92.65 offering significant new, and at least one somewhat novel, features. The Model 8-80 (Hollister 8), introduced in September of 1928, included individually shielded single tuned IF transformers that were adjustable between 350 and 550 kilohertz. The fact that they were user tunable was unusual and significant. This feature eliminated the need to match IF coil sets at the factory and allowed all sets to attain peak performance after construction and after replacing tubes. The IF transformers were made adjustable over a wide range of frequencies to allow the end-user to select a frequency with the fewest image problems. Hence, the receiver was referred to as a “one spot” receiver. The very wide range of possible intermediate frequencies, however, was somewhat novel and unnecessary, although it did create an opportunity to experiment with adjusting the IF. Further, as noted in a September 1928 article published by Radio Broadcast, the IF transformers of the Lincoln 8-80 could be detuned slightly for better fidelity reception of local stations at some expense to sensitivity. Another significant feature touted by Lincoln, as if they were the first to do so, was the fact that the IF transformers were designed to match the high plate impedance of the recently introduced type 222 screen grid tubes. Tyrman had already accomplished this in their Model 70 Amplimax receiver introduced almost a year earlier in November 1927. The Tyrman 70 used a 340 KHz IF, but it employed impedance IF couplings rather than full transformers. As a consequence of matching plate impedance, the voltage amplification of the IF transformers was very low, but much better voltage amplification was obtained from the preceding tubes, yielding a much greater overall IF gain.

At the time, Scott Transformer Corporation was offering the World’s Record Shield Grid Nine (introduced in August 1928 for $138.10) with conventional factory-matched fixed frequency IF transformers operating at 120 KHz. Both receivers, Lincoln and Scott, employed type 222 screen grid tubes in a three-stage IF amplifier. Although Scott’s World’s Record Shield Grid Nine
receiver contained a radio frequency (RF) stage that was not present in the Lincoln 8-80, from the standpoint of IF performance, the Lincoln 8-80 was superior due to its higher IF and its ability to tune the IF. The RF amplification stage in the Scott World’s Record Shield Grid Nine receiver, however, isolated the first detector from the antenna, reducing the appearance of images in the Scott receiver as well as providing some amplification of the RF signal.

When new innovations became available, Mr. Hollister often incor-
Lincoln Radio Corporation

incorporated them in his receivers, even in the middle of the formal model years. As such, Lincoln often introduced improved versions of the current model under new names mid-year. Consequently, until 1934, Lincoln introduced approximately twice the number of models as Scott Transformer Corporation, E. H. Scott Radio Laboratories or McMurdo Silver Corporation. In March 1929, while Scott was still producing their World’s Record Shield Grid Nine and four months before the next Scott model was available to the public, Lincoln changed its 8-80 tube lineup from 201As, 222s, and a 171A to the new type 227s, Shieldplate Type AC-22s, and a choice of type 210 or 250 for output. The new model was designated the Hollister AC-8 and was offered for $110.00 as a kit. Both the Scott World’s Record Shield Grid Nine and the Lincoln 8-80 could be purchased with optional AC-operated power supplies, and the optional power amplifier for the Scott World’s Record Shield Grid Nine included a type 250 output tube. Although Scott offered the optional high power amplifier well before Lincoln, Lincoln incorporated tubes with AC filaments before Scott. By the time Lincoln introduced their next new model, the company no longer advertised custom set building of competing models.

1930 Model Year: Lincoln 8-40 and Lincoln Deluxe 10

During September 1929, Lincoln introduced its Model 8-40 receiver with a circuit similar to the Hollister AC-8 but with one less stage of IF amplification, and incorporating the new RCA type 224A tubes instead of the Shieldplate type AC-22 tubes. Due to alleged significant differences in electrical characteristics between the type 224A tubes and the type AC-22 tubes, Lincoln completely redesigned the IF transformers. A prototype receiver constructed using four stages of IF amplification was found to have tremendous gain but also experienced problems with instability. Given the higher gain per stage of the new IF amplifier, two stages of IF amplification were considered sufficient by Mr. Hollister. The fundamental circuit topology of this receiver was far ahead of its time, the economical use of two well designed stages of IF amplification became very popular in the early to mid-1930s. The number of IF amplifier stages, however, was an important sales metric in 1929, therefore the efficient design was likely a detriment to sales. One additional unique and interesting feature of the 8-40 was the inclusion of a filament transformer on the Bakelite receiver chassis. Lincoln advertised that any B eliminator will do but offered a B eliminator as an accessory if the customer desired. The Model 8-40 was offered for $120.00.

In July 1929, two months prior to introduction of the Lincoln 8-40, Scott Transformer Corporation introduced the AC-10 for a price of $175.50 (with power supply and speaker) that included a 480-kilohertz adjustable (capable of being peaked) four stage IF amplifier using the RCA type 224A tubes but
now excluding the RF amplification stage. The IF amplifier of this receiver not only compared favorably with the IF amplifier of the Lincoln 8-40, with its higher frequency adjustable transformers, but it included four stages of amplification without any instability.

Scott’s AC-10 upstaged the Lincoln receivers until January 1930 when Lincoln introduced its Deluxe 10 at a price of $155.82 with power supply and speaker. Given the choice of similar circuit receivers, the Lincoln 8-40 with its two stages of IF amplification...
versus the Scott with its four stages of IF amplification, Hollister must have believed that potential customers would prefer the receiver to have four stages of IF amplification regardless of the sufficiency of the former. Hence, Lincoln introduced its Deluxe 10. The Deluxe 10 circuit was essentially the same as the 8-40 circuit but incorporated an AC power supply and two additional stages of IF amplification for a total of four circuit stages. Consequently, the Scott AC-10 and Lincoln Deluxe 10 receivers contained nearly identical circuits and were nearly identical in performance. Articles describing the Deluxe 10 receiver do not explain how the instability problem experienced with the model 8-40 prototype had been overcome, but gain per stage was likely reduced. Rather than incorporating a single rectangular IF amplifier shield with separate compartments for each transformer as employed in the Lincoln 8-40 and the Scott AC-10, the Lincoln Deluxe 10 used five separated cylindrical IF transformer shields. The similarities and differences between the Deluxe 10 and the AC-10 are summarized in Table 1.

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<th>Scott AC-10</th>
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1931 Model Year: Lincoln Deluxe 31, Lincoln Deluxe SW-31 and Lincoln DC-8

In September 1930, Lincoln introduced its Deluxe 31 for a list price of $247.60. At this time, both Scott and Lincoln were advertising their sets with a list price of approximately twice the prices identified on their order forms; therefore, the purchase price for the Lincoln Deluxe 31 was most likely $123.80. Electrically, the Deluxe 31 was nearly identical to the Deluxe 10 that it replaced. Mechanically, the Deluxe 31 differed greatly. The wood framed Bakelite baseboard construction of the Deluxe 10 was replaced by a cadmium-plated, welded steel chassis. By this time, most large manufacturers of radios had been using steel chassis for over a year. The four stages of IF amplification employed in the Deluxe 10 were retained in the Deluxe 31, as were the separate cylindrical IF transformer shields and the general chassis layout. In March 1931, Lincoln replaced the fixed broadcast band RF and oscillator coils with a socket and a set of five plug-in coils covering a frequency range of 15 to 550-meters and introduced the improved model as the Deluxe SW-31. Also, like earlier Lincoln receivers, the Deluxe SW-31 did not incorporate an RF amplification stage; therefore, changing the frequency range of the receiver entailed changing only a single plug-in coil.

The Lincoln Deluxe 31 competed with the Scott Transformer Corporation’s AC-10 until January 1931 when E. H. Scott Radio Laboratories introduced their Allwave Superheterodyne to the public for $126.72. From January 1931 through the March 1931 introduction of the Lincoln SW-31, Scott’s Allwave Superheterodyne upstaged the Deluxe

Fig. 10. Lincoln Deluxe SW-31 Receiver. (Lincoln Brochure, Author’s Collection)
31 by including the capability to receive shortwave broadcasts up to 15 meters. With the introduction of its Allwave Superheterodyne, E. H. Scott Radio Laboratories now included shortwave bands as a standard feature, added an RF amplification stage, and removed one IF amplification stage leaving a total of 3-stages of IF amplification. However, operation of the Allwave Superheterodyne for shortwave reception was not particularly straightforward. In addition to changing a pair of plug-in coils, switching bands entailed swapping grid leads, changing the antenna coupler connections, and adding or removing plug-in coil shields as appropriate. Unless the owner of an Allwave Superheterodyne receiver used the set throughout the range of available frequencies on a regular basis, they had to refer to the owner’s manual for directions on how to change the frequency range of the receiver. In comparison, changing the frequency range of the Lincoln Deluxe SW-31 by merely swapping out a single coil was simple and straightforward.

Recognizing a need for sensitive receivers in markets without electrical power service, Lincoln introduced the DC-8 “air cell” battery operated receiver in January 1931 priced at approximately $110.00, exclusive of batteries. In the rush to make and market plug-and-play receivers, many manufacturers overlooked the diminishing but still significant off-grid market (e.g., farm radios). Most large manufacturers of multiple lines of receivers did offer farm sets, but until Lincoln introduced the DC-8, the smaller manufacturers of premium performance receivers did not. Electronically, the DC-8 was similar to the Deluxe 31 but was equipped with 2-volt direct current filament tubes.

Fig. 11. Lincoln DCSW-8. (Author’s Collection)
(tube numbers 30, 31 and 32) and one less stage of IF amplification but added one RF amplification stage. However, the chassis layout and appearance were much different from the Deluxe 31. The basic version of the DC-8 included tapped RF and oscillator coils covering the broadcast band and the police band. By March 1931, Lincoln offered the DC-8 with plug-in coils to cover the short wave bands up to 15 meters. Although this receiver is referenced as a Lincoln DCSW8 in service literature available from Gernsback and Readers, the last advertising for this model appearing in March 1931 continued to identify the model simply as the DC-8. E. H. Scott Radio Laboratories did not offer a competing product.

1932 Model Year: Lincoln Deluxe SW-32, Lincoln DC SW-10

In its launch of the 1932 model year during October 1931, Lincoln introduced the Deluxe SW-32 at a price of $108.75. The only significant difference between this new model and the Deluxe SW-31 was the incorporation of a band switch for selecting the frequency range of the receiver rather than changing plug-in coils. This was not an insignificant difference. Until this point in time all other receivers capable of broadcast and short wave reception required plug-in coils or use of a short wave converter. The only other receiver on the market capable of selecting broadcast and short wave reception from the front panel was the Silver Marshall 726SW that was introduced the same month. The Silver Marshall 726SW was a broadcast receiver with an on-board short wave converter rather than a single integrated all wave receiver like the Deluxe SW-32. Similar to the operation of Scott’s Allwave Superheterodyne, switching between the broadcast band and short wave reception on the Silver Marshall 726SW was not straightforward. Throughout Lincoln’s production of the Deluxe SW-32, Scott continued to offer their Allwave Superheterodyne...
receiver with plug-in coils. Although Lincoln's Deluxe SW-32 did not include an RF amplification stage, the Deluxe SW-32 with its practical band switch arguably upstaged the Allwave Superheterodyne and the Silver Marshall 726SW, especially for ease of use. Upon the introduction of its Deluxe SW-32, Lincoln offered to update the Deluxe 31 and Deluxe SW-31 models sold the prior year to incorporate the Deluxe SW-32 improvements free of charge.

By the time Lincoln introduced its Deluxe SW-32 with all of its highly desirable premium features, other innovations were being incorporated into broadcast receivers offered by the large manufacturers, including single dial operation and automatic volume (gain) control. At this point, these new features were still not incorporated into the all-wave receivers made by Lincoln, Scott and Silver Marshall. Single dial tuning was not incorporated because of the loss of performance associated with less than perfect tracking between the antenna's RF circuit and the oscillator circuit. The available tuning capacitors tracked well enough for average broadcast receivers, most of which were being used for local reception; but, these were not considered adequate for the best possible short wave and distance reception. Scott’s Allwave Superheterodyne had two independent dials for RF and oscillator tuners. Lincoln’s Deluxe SW-32 and Silver Marshall’s 726SW both had antenna trimmers in parallel with the antenna tuning capacitor which was mechanically coupled to the oscillator tuning capacitor. Automatic volume control allowed the user of a radio to tune between weak, distant stations and strong, local stations without overloading some stage of amplification or missing the weak, distant stations. Broadcast receivers by many companies were being designed and constructed with early forms of automatic volume control. “Super Control” or variable mu amplifier tubes, designed to operate with a wider range of signal input voltages so as to minimize the potential for overloading, were just being developed. Lincoln’s Deluxe SW-32, Scott’s Allwave Superheterodyne and the Silver Marshall 726SW all employed a local-distance switch to accommodate both strong local stations and weak distant stations.

Also at this time, the Deluxe SW-32 basic circuit was almost identical to Lincoln’s 8-80. Other than incorporating an on-board power supply, the addition of shortwave reception, and the addition of a fourth stage of IF amplification, the most significant changes involved the replacement of the type 222 screen grid tubes with the more modern type 24A screen grid tubes and replacement of the single ended triode output tube (type 10 or 50) with push-pull triode output tubes (type 45s). Otherwise, the circuit was substantially the same with no RF amplifier stage, with user tunable IF transformers, and with a single audio frequency (AF) amplifier stage placed before the output stage. In spite of the relative lack of circuit changes, the Deluxe SW-32 continued to compete directly with Scott and other high end radios that incorporated
more significant changes during the same period of time.

Lincoln’s DC SW-10 was an air cell (battery) version of the Deluxe SW-32, and replaced the DC-8. Unlike the DC-8, Lincoln’s DC SW-10 was constructed using the same chassis and layout as the contemporary Deluxe SW-32. And, Scott did not offer a competing product.

1933 Model Year: Lincoln Deluxe SW-33, Lincoln DC SW-33, R9
Lincoln’s next model, introduced in July 1932 as “the greatest receiver,” was the Deluxe SW-33 offered for $138.25. This was an early introduction date for a following year product. Since discrete Lincoln flagship models represented a continuously improving chassis, it is likely the company was trying to get a jump on the competition by introducing their flagship product early as a new model. Improvements included the use of type 51 remote cutoff “super control” tubes in the IF amplifier, a Wunderlich dual grid detector, “perfect” automatic volume control, a tuning meter, and push-pull type 56 tubes for the first time.
AF stage rather than a single type 27 tube. The familiar five cylindrical IF shields remained, with knobs placed on top for easy user adjustment of the intermediate frequencies. A single large rectangular shield was added to cover the RF and oscillator coils and the tuning capacitor. Shortly after introduction, Lincoln added trimmers under the chassis, rendering the IF transformers double tuned and the user-selectable IF feature on top of the IF cans substantially obsolete. This model allowed the user to conveniently adjust IF bandwidth with very small adjustments, but the user was no longer able to conveniently select the IF frequency.

The same month, Scott introduced the Allwave Deluxe at a price of $135.50. The Allwave Deluxe was a substantially improved version of the Allwave Superheterodyne with a bandswitch, true single-dial tuning, and a frequency-calibrated dial on all bands. The type 24A RF amplifier tube previously used in the Scott Allwave Superheterodyne had been replaced with a super control type 51 tube, and all type 27 tubes had been replaced with type 56-tubes. The Allwave Deluxe initially did not include automatic volume control or a tuning meter until a revised version was introduced late in 1932. Until Scott’s introduction of the revised Allwave Deluxe, the Lincoln Deluxe SW-33 with its automatic volume control was arguably more advanced than the Allwave Deluxe. Lincoln’s Deluxe SW-33 incorporated four stages of IF amplification and one RF stage in the Scott Allwave Deluxe. The Deluxe SW-33 still retained the antenna trimmer and therefore was technically not a single dial receiver. Both Lincoln and Scott were advertising prolifically at this time.

Late in 1932, Scott revised its Allwave Deluxe to include automatic volume control and a tuning meter. The majority of the tube lineup was changed. The new type 58 pentode amplifier tubes replaced the type 51 RF amplifier tube and the three IF amplifier tubes. A new type 57 pentode amplifier tube replaced the type 24A first detector tube. The Wunderlich dual grid detector, already being used as the second detector in Lincoln’s Deluxe SW-33, replaced the type 56 detector tube. Finally, the push-pull first audio amplifier stage using a pair of type 56 tubes was modified to two stages of audio amplification using two type 56 tubes in series.

Around the same time, and without introducing a new discrete model, Lincoln modified the circuit of their Deluxe SW-33 to incorporate an RF stage and the new type 58 pentode amplifier tubes. One stage of IF amplification was sacrificed to accommodate the RF stage, and the push-pull first stage of AF amplification was changed to a parallel pair. The familiar row of Lincoln manufactured round IF transformers were now replaced with Hammarlund IF transformers located in a long, narrow rectangular shield can, and for the first time included tube shields finished in silver paint. As a
result of improvements incorporated by both companies, their receivers had become near identical from an electronic standpoint; however, the Lincoln receiver continued to retain an uncalibrated dial (0–100 scale).

Before the end of the model year, a new company was formed to introduce a product that would compete directly with Lincoln and Scott. After Silver Marshall’s failure, and recognizing Scott’s success through hard economic times, McMurdo Silver founded the McMurdo Silver Radio Corporation. The new company was formed to produce technically advanced high-quality receivers for the wealthy and for those individuals who had a special interest in radio reception who were willing to spend a considerable amount of money on such a receiver. Introduced in March 1933, McMurdo’s first model, the “Masterpiece” or “Masterpiece I,” was a 15-tube receiver chassis offered for $135.00. The Masterpiece utilized the same series of tubes employed in the revised Lincoln Deluxe SW-33 and in the revised Scott Allwave Deluxe, and was finished initially in a brushed brass, and later in chrome. The circuit consisted of a single RF stage, separate oscillator, first detector, two IF stages, a second detector, push-pull first stage of audio amplification and a push-pull audio output stage. Rounding out the count of 15 tubes were a pair of rectifier tubes, a tube dedicated to automatic volume control, a dedicated beat frequency oscillator (BFO), and a tube employed for automatic tone control. The Masterpiece I was introduced as a true single dial receiver with a band switch and a tuning meter. A new BFO, that helped locate weak stations, and an unusual automatic tone control were unique to the Masterpiece I receiver. In spite of its higher tube count and additional features, the use of only two stages of IF amplification may have been considered a significant drawback by potential customers when comparing the Masterpiece I with the revised Lincoln Deluxe SW-33 and the revised Scott Allwave Deluxe.

In the last half of the 1933 model year, the products of all three companies competed for a limited market of customers and faced few directly competing products from other radio manufacturers. From a technical perspective, the products of all three manufacturers were very similar, with
an uncanny similarity between the late Deluxe SW-33 and the revised Allwave Superheterodyne. Key features of the Deluxe SW-33, the Allwave Deluxe and the Masterpiece I are summarized in Table 2.

**“Independent” Laboratory Test**

A notorious public letter writing campaign between E. H. Scott and McMurdo Silver was precipitated by an allegedly independent laboratory evaluation of the competing receivers. Conducted in June 1933, the evaluation was financed by McMurdo Silver and performed by Clough Brengle, a company owned and operated by former McMurdo Silver employees, Kendall Clough and Ralph Brengle. Although the receivers that were considered to be competitors of the McMurdo Silver receiver were not named, the report intentionally included enough information for the public to recognize those competing receivers. Receiver A, the Scott receiver, was an Allwave Deluxe with AVC. Receiver B had no RF stage, 4 IF stages, 10 tuned circuits, 3 type 56 tubes, 5 type 51 tubes, one Wunderlich tube, one type 80 tube, two “supertriodes,” a nickel finish, one uncalibrated dial with antenna trimmer, a tuning meter, a radio-phono switch, no headphone jack, and no BFO. This was clearly the early Lincoln SW-33, but it was equipped with the very new type 2B6 tubes for audio output rather than the familiar type 45 tubes. By this time, Lincoln was certainly selling the late version of the SW-33. Apparently Lincoln submitted an older model receiver used to test or prototype the

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**Table 2. Comparison of Features for Third Quarter 1933.**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Late Lincoln Deluxe SW-33</th>
<th>Revised Scott Allwave Deluxe</th>
<th>McMurdo Silver Masterpiece I</th>
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<tr>
<td>Price</td>
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<td>Coverage</td>
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<td>15-550 meters</td>
<td>15-570 meters</td>
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<td>Meter</td>
<td>Meter</td>
<td>Meter</td>
</tr>
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<td>Nickel</td>
<td>Chrome</td>
<td>Brass/Chrome</td>
</tr>
</tbody>
</table>

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* AVC accomplished using Wunderlich tube.
2B6 output circuit for use in the new Lincoln model scheduled for introduction the following month. Receiver C was the McMurdo Silver Masterpiece I. Although the Lincoln receiver was anonymously included in the evaluation, William Hollister and Lincoln wisely did not participate in the subsequently published and highly critical letter writing campaign.

Lincoln’s DC SW-33 was an air cell (battery) version of the Deluxe SW-33, and replaced Lincoln’s DC SW-32. Like the DC SW-32, the DC SW-33 was constructed using the same chassis and layout as the contemporary Deluxe SW-33. During August 1932, Scott announced a 10-Tube Deluxe chassis that appears to be an “Allwave 6-volt” storage battery receiver. Yet, the first time an Allwave 6-volt storage battery receiver appeared in a Scott brochure is in September 1933 for the 1934 model year. The Allwave 6-volt, as a storage battery receiver, is not directly comparable to the DC SW-33; however, by March 1934, Scott included both the Allwave 6-volt and an Allwave 2-volt receiver on their order forms. The Allwave 2-volt receiver was an air cell battery version of the Allwave Fifteen that would have competed directly with the Lincoln DC SW-33 if it was still being sold.

**Lincoln R9**

In March 1933, Lincoln announced a new product, the R9 receiver, that was “designed for strictly shortwave reception” as shown on the back cover of *Shortwave Craft Magazine*. Articles describing the R9 receiver and its performance followed in the April 1933 issue of *Radio Craft*, and in the April and May 1933 issues of *Radio News*. This new superheterodyne receiver was designed around the desires of amateur radio operators and short wave listeners, familiar territory for William Hollister, at a time when many radio manufacturers catering to the amateur radio community were introducing their first generation of superheterodyne communications receivers. The R9 is an 11-tube receiver that covered a wavelength range from 9- to 200-meters and included a BFO.

Fig. 16. Lincoln R9 Communications Receiver. (Photo courtesy of Bill Bryan)
and band spread dial. The circuits and tube complement of the R9 receiver were similar to that of the late SW-33, with the exceptions that it had no RF amplifier stage, used a single ended first audio amplifier stage rather than a push-pull, and added the BFO. Both the main and band spread dials were marked with logging scales rather than any frequency calibrated scale. The chassis of the R9 receiver was painted with artificial wood grain finish on the outside exposed surfaces rather than the familiar nickel plating. A similarly finished cover was provided to serve as a cabinet. Comparably equipped (with the same speaker option), the cost of the R9 receiver was identified as $140.00 on a dealer prospectus, as compared to $135.00 for the late SW-33.

1934 Model Year: Lincoln Ultra Deluxe

In August 1933, a new type 2B6 “super-triode” tube was introduced into the industry. Lincoln timed the introduction of its SW-34, or Lincoln Deluxe receiver, to coincide with the introduction of this tube. The Lincoln Deluxe was later renamed the Ultra Deluxe in a single full page text advertisement, “An Open Letter to Intelligent Folks,” that appeared in the August 1933 issue of Radio Craft. No photos or illustrations of the receiver were included in the advertisement. This advertisement emphasized the employment of type 2B6 tubes in a bi-amplified output circuit (described as binaural in the ad) crossed over at 1000 Hz. The Ultra Deluxe receiver consisted of the same basic circuit and layout as the late SW-33 with the push-pull type 45 tubes replaced by the new type 2B6 super-triodes, the tuning meter replaced with a tune-a-lite, and the uncalibrated peephole dial replaced with a full airplane dial having a calibrated broadcast band plus logging scale. The customer could request an optional bi-amplified audio circuit with two speakers. The bi-amplified audio circuit consisted of a single type 56 tube driving a single type 2B6 tube per channel. If not the first on the consumer market, Lincoln’s use of an airplane dial and optional bi-amplified audio circuit was certainly among the first, and well ahead of similar features among Lincoln’s competitors. In stark contrast to the promotion of the Lincoln SW-33, no advertisements for the Lincoln SW-34 or Ultra Deluxe appear to have run between August 1933 and January 1934, when the address of Lincoln Radio Corporation was identified as 2222 Diversey, Chicago. The two advertisements in Radio Craft during January and February 1934 referred to the receiver as the Ultra Deluxe. The January advertising promoted the receiver as “revolutionary in every feature” including the “new Lincoln-Hutter diffusing columns,” an acoustical cabinet feature for which few details have emerged. By the end of September 1934, without identification as a new model, Lincoln replaced the type 2B6 tubes with type 2A5 tubes, discontinued the bi-amplified option, replaced the tune-a-light with a tuning meter, and added a type 56 BFO. No price reference was found for Lincoln’s
Ultra Deluxe receiver at the time of this writing.

At the time the Lincoln Ultra Deluxe was introduced, Scott Radio Laboratories was still selling its Allwave Deluxe with automatic volume control (AVC), and McMurdo Silver was still selling its Masterpiece I. In October 1933, three months after Lincoln introduced its Ultra Deluxe, McMurdo Silver introduced their Masterpiece II at a price of $145.50. The Masterpiece II differed from the Masterpiece I by replacement of the type 56 oscillator and type 58 mixer with a single type 2A7 converter, adding a third type 58 IF amplifier for a total of three stages, replacing the type 45 output tubes with type 2A3 tubes, and replacing the pair of type 80 rectifiers with a single type

![Fig. 17. Lincoln Ultra Deluxe SW-34. (Author’s Collection)](image1)

![Fig. 18. Lincoln Ultra Deluxe SW-34, Top View. (Author’s Collection)](image2)
Lincoln Radio Corporation

5Z3 rectifier. The addition of a third IF stage and of a higher power audio output stage made the Masterpiece II even more similar to Lincoln’s Ultra Deluxe and Scott’s Allwave Deluxe than the Masterpiece I. Type 2A3 tubes offer similar power as the type 2B6 tubes with less distortion but require a higher voltage input signal. Starting April 1934, well after incorporation of the type 2B6 tubes in Lincoln’s Ultra Deluxe receiver, McMurdo Silver replaced the type 2A3 tubes with type 2B6 tubes, an ironic change from a future perspective but probably a competitive edge at the time of the decision.

In April 1934, a very unusual month for the event, Scott introduced their new Allwave Fifteen for $155.00. Improvements over the Scott Allwave Deluxe with AVC included replacement of the type 57 first detector with a type 2A7 tube, the addition of an audio driver stage consisting of push-pull type 56 tubes, replacement of the type 45 output tubes with type 2A3 output tubes, replacement of the type 80 rectifier with a type 5Z3 rectifier, addition of a type 56 BFO, and retention of a calibrated dial scale for all bands.

In October 1934, during the long run of Lincoln Ultra Deluxe receivers, McMurdo Silver introduced their Masterpiece III at $159.78. The Masterpiece III differed from the Masterpiece II only in the replacement of the type 56 audio driver tube by a type 2A5 tube, replacement of the push-pull type 2B6 tubes with push-pull type 2A5 tubes, and replacement of the peep hole dial with an airplane dial. Lincoln replaced the type 2B6 tubes in their Ultra Deluxe model with type 2A5 tubes within the previous two months. By July 1935, still during the long run of the Lincoln Ultra Deluxe receiver if any remained available, McMurdo Silver introduced their Masterpiece IV receiver priced at $189.75. The Masterpiece IV included many improvements over the Masterpiece III.

In September 1935, also during the apparently very long run of the Lincoln Ultra Deluxe receivers, Scott introduced their Allwave Imperial. This model was subsequently renamed as the Full Range High Fidelity Receiver and often referred to as the Allwave 23 by collectors today. Initially offered at a price of $192.50, Scott’s Allwave 23 receiver was designed to receive programs from the new experimental high fidelity radio stations, included numerous improvements over the last version of their Allwave Fifteen receivers, and was by many measures an ideal receiver offering straightforward operation in “textbook” fashion. The new receiver included an all new tube lineup where 6.3-volt types replaced 2.5-volt types throughout, except in the power supply and output stage. The type 58 RF amplifier tube was replaced with a type 6D6, the type 56 oscillator was replaced with a type 76, the type 2A7 first detector was replaced with a type 6A7, and the three type 58 IF amplifiers were replaced with type 39/44 tubes. A type 6D6 fourth IF amplifier was added, and the Wonderlich, later type 55 second detector, and the type 56 BFO, were both
replaced with type 76 tubes. The type 56 first audio amplifier was replaced with a triode connected type 6C6. The push-pull type 56 driver was replaced with push-pull triode connected type 6C6 tubes. A type 83V rectifier tube was added to complement the type 5Z3; and, finally, the push-pull type 2A3 output stage was replaced with push-pull parallel type 2A3 tubes. The new Scott also featured continuously variable selectivity providing an IF bandwidth ranging from 2 to 32 kilohertz accommodating an audio response ranging from 1 to 16 kilohertz and optional cone tweeters.

Although initially very competitive with the contemporary Scott and McMurdo Silver offerings, some features of the early version of the Lincoln Ultra Deluxe were very short lived. The tune-a-lite was found to quickly develop emissions deposits on the inside of the glass reducing the visibility of the indicator and the type 2B6 tube was not embraced by the industry, nor were consumers enamored with bi-amplification. Replacement of these features with more popular components continued to keep the Lincoln Ultra Deluxe receiver competitive but its advantage started to fall behind when Scott introduced their Allwave Fifteen with a calibrated dial scale for all bands and really fell behind when Scott introduced their Full Range High Fidelity Receiver. By the end of the run of Lincoln Ultra Deluxe receivers sometime early in 1936, the Lincoln flagship model was well behind the competition. The Ultra Deluxe, with circuit and chassis layout designs that easily track back to the Deluxe 10 receiver of 1930 and earlier models, was the last of the series of progressive receivers directly descending from the early models. Lincoln’s next flagship model reflected unprecedented change, but this did not occur until after introduction of the successor to the R9 communications receiver.

1935 Model Year: CQ Receiver

In a single advertisement in Radio magazine for December 1934, Lincoln introduced their Model CQ receiver kit still listing the address of Lincoln Radio Corporation as 2222 Diversey Avenue in Chicago. As was always the case for Lincoln, the reader was compelled to write for a brochure and no price was listed. The CQ receiver employed eight tubes in a “radically new circuit,” was designed for the radio amateur and replaced the R9 receiver. Lacking an example, a brochure, or construction data at the time of this writing, little else is known about this offering.

Figure 19: Lincoln CQ Receiver. (Radio, December, 1934)
**1936 Model Year: Lincoln Symphonic**

Except for one unusual very late “new products” announcement by Lincoln for its “Deluxe 34” still identifying the use of type 2B6 tubes in the July 1934 issue of *Radio News*, and a single ad for the CQ receiver placed between the minor advertising efforts during February of 1934 and April 1936, Lincoln advertised very little, if at all. In April 1936, Lincoln published a single promotion for the Lincoln Symphonic, a revolutionary 20-tube high fidelity all wave receiver. This receiver was also featured in a new products listing in June 1936. The address of Lincoln Radio Corporation had again changed and was now identified as 154 E. Erie, Chicago. Although very little in the way of technical features were identified in the magazine advertisement and new product feature, the technical features of the Lincoln Symphonic are well known from the sales brochure. The Symphonic was a great departure from Lincoln’s prior products. Major changes included a completely new circuit and chassis design, abandoning the nickel plated finish for a silver painted finish and use of rivets for assembly rather than machine screws of the prior models. The identification plate on the back of the tuner chassis indicates that RCA and Hazeltine Permit Number 1731 were relied upon to manufacture the Symphonic. This is the same permit number appearing on a paper tag found within McMurdo Silver Masterpiece III receivers well known to have been manufactured by Hallicrafters albeit very possibly in the Howard Radio plant. The cabinets, promotional literature, and instructions for operation are consistent with prior models. The complete Symphonic chassis set was offered for $225.00.

Fig. 20. Lincoln Symphonic Receiver. (Author’s Collection)
The new chassis was designed using 6.3-volt tubes for nearly all applications and included two stages of RF amplification using type 78 tubes, a type 76 oscillator, a type 78 mixer, a two stage narrow band IF amplifier using type 78 tubes or a one stage wide band IF amplifier using a single type 78 tube (selectable from the front panel), a type 85 second detector and BFO, two stages of audio amplification using type 76 tubes followed by a push-pull driver stage using type 56 tubes operated from a separate 2.5 volt heater winding, and four type 45 tubes in push-pull parallel for output. The output signal was fed through two series wired output transformers feeding a 12-inch Jensen A12 woofer and a 5-inch Jensen Q4 tweeter. A type 5Z3 tube is used for the plate supply and a type 80 tube is used for a bias rectifier. Coverage now included long wave as well as 0.54 to 18 megahertz and the set featured an airplane dial that was frequency calibrated on all bands. The receiver was initially offered without a tuning indicator, but a meter was included on the Symphonic by June 1936. Lincoln clearly contracted the manufacture of this receiver from Hallicrafters/Howard.

A month after the first advertisement for the Lincoln Symphonic, McMurdo Silver introduced their Masterpiece V, with its similarly selectable IF bandwidths and an 18-inch “Super Giant” speaker priced at $219.00. Scott continued to sell their Full Range High Fidelity Receiver until May 1937 when they introduced their 30-tube Philharmonic. Since Lincoln was not advertising, and virtually no Lincoln records or correspondence are known to exist from this time period, it remains unknown whether Lincoln was still selling the Symphonic at this time.

1938 and Beyond
By September 1937, radios were being offered under the Lincoln name by Lincoln Radio and Television Corporation located at 841 Jackson Avenue, Chicago, in the same block and on the same side of the road as Allied Radio Corporation (Allied). A dealer solicitation states, “In 1921 the Lincoln Radio was originated as a custom-built set.” The letter is signed by Paul M. Hochberg, Director of Exports. Lincoln’s 1938 products brochure contains the following statements:

“From the early days of radio, the world has recognized Lincoln as a leader. The Lincoln name has always stood for custom quality in every detail. Heretofore, only a comparative few could enjoy Lincoln's supremely glorious reproduction, and Lincoln's sensational performance . . . Now, with the introduction of the new 1938 line, Lincoln quality becomes available to all.

To adhere to Lincoln standards, and yet keep the Lincoln in the moderate price range, meant new large-scale manufacturing methods, brilliant engineering, and “streamlined” production . . . With the knowledge that it is
worthy of the Lincoln name, we present the 1938 line of Lincoln radios . . . 52 different and distinct models, one for every conceivable need and purpose. Tested, checked, and approved by leading radio engineer, these new and better radios offer you unfailing performance under every condition, tone of almost unbelievable richness, and construction that safeguards these qualities against deterioration.”

With the exception of four costly floor models incorporating automatic record changers, the receivers in this brochure were priced between $30.95 and $105.00.

The sets offered in the brochure differ greatly from any product previously offered by Lincoln, and they almost certainly did not hold up to the standards described in the second statement above. These statements, the address, plus the use of the Lincoln name and trademark on a number of products offered by Allied Radio up into the 1960s indicate that Lincoln Radio was acquired by Allied and used initially as an export marketing division. Well known Allied products bearing the Lincoln name were sold in the U.S., including some table model radios produced after World War II and headphones produced into the 1960s. Radios manufactured after 1937 and before World War II do not turn up in the U.S. but occasionally turn up in foreign countries.

**Lincoln Radio Company Production**

It is well known among collectors that Lincoln radios are less common than McMurdo radios and much less common than Scott radios. No records for the Lincoln Radio Corporation have been found to identify or estimate production, and only four serial numbers have been identified along with final inspection dates on differing models. If Lincoln did not restart its serial numbers with each new model, we might be able to determine production dates and

![Fig. 21. Lincoln Radio Brochure for 1938 product line. (Author’s Collection)](image)
statistics based on those model numbers. If this was the case, the four serial numbers plotted against the inspection date should produce a relatively straight line for constant production, or a slightly parabolic line reflecting the acceleration or deceleration of production. I found that a plot of the serial numbers against date produced a relatively straight line with a sudden and substantial decrease in production which is consistent with the virtual termination of advertising. Extrapolation of the line to “0” indicates the first assignment of serial numbers occurred at approximately the same time that William Hollister purchased Lincoln and started to offer complete assembled receivers. Furthermore, when superimposing the dates of introduction of the different models of Lincoln receivers, the total production of each model can be estimated. A plot of serial numbers against date with introduction dates of the individual models identified is shown in the

Fig. 22. Lincoln Radio Inspection Stamp. (Author’s Collection)

Fig. 23. Plot of Lincoln Serial Numbers.
accompanying figure. Estimated production of each model from this plot is identified in Table 3.

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<thead>
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Conclusion

After many years of research and compiling evidence, some of which has been very difficult to find, a reasonably clear understanding of the Lincoln Radio Corporation emerges. Based on my research, the following key points can be discerned:

- Lincoln was a very small, but progressive and aggressive company that produced its products by hand in very small production runs, likely no more than five chassis at a time.
- William Hollister, although clearly a proficient electronic designer and an avid radio amateur, was foremost a salesman. This is evidenced by his job history as well as by Lincoln’s prolific advertising prior to 1934.
- The abrupt halt to Lincoln’s prolific advertising was indicative of problems within the company and foretold the future declines in business. Potential reasons for the abrupt halt to production include Lincoln’s inability to expand production to meet orders, or a change of interest on the part of Mr. Hollister.
- Lack of advertising probably contributed to the lack of sales during and after 1934.
- The internationally recognized Lincoln brand was purchased by Allied Radio sometime around the beginning of 1937 to serve as the “export division” of Allied Radio Products.
Details of the Model CQ receiver along with specific reasons why the Lincoln abruptly stopped advertising remain unknown. We also do not know why Lincoln contracted out the manufacture of its Symphonic chassis, why they sold to Allied Radio, and details of the sale to Allied. Some of these unknown historical facts may be clarified if financial or other internal records come to light, but even without these details we can now appreciate a much more comprehensive understanding of the Lincoln Radio Corporation.

Author’s Note
Space limitations have prevented inclusion of cabinet illustrations and schematics in this article. These may be found at http://pacifichydrologic.com/?q=content/lincoln-radio-corporation.

References
2. Ralph A. Pugh, Assistant University Archivist, Illinois Institute of Technology, Paul V. Galvin Library, personal communication.
3. William Jerousek, Adult and Teen Services Department, Oak Park Public Library, Oak Park, Illinois, personal communication.

This article has also relied on numerous advertisements and articles in the following publications:

*Citizens Radio Call Book*, March 1925 through March 1931.
Kansas City Radio Company, undated product catalog circa 1928.

Lincoln Radio Corporation, many brochures, order forms, solicitations, and instruction manuals.
*Popular Radio*, June 1927.
*Radio Broadcast*, September 1928 through April 1929.
*Radio Craft*, March 1931 through February 1934.
*Riders Perpetual Service Manuals*, Volumes 1, 3 and 4.
*Short Wave Craft*, March 1932 through July 1933.

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About the Author
Mr. Braithwaite is owner and principal engineer of Pacific Hydrologic Incorporated, a professional engineering firm specializing in flood studies, stream channel erosion and sedimentation, and drainage. Two days before graduating from high school in 1975, Mr. Braithwaite chose to collect radios over primitives such as bottles, insulators, and other simple collectibles reflecting technical achievement. This decision was based in part from a desire to pursue a unique interest, and in part by the technical challenges of understanding electronics. Although the former turned out to be untrue,
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the latter interest persisted, and radio collecting stuck. Mr. Braithwaite developed an interest in products from the E. H. Scott Radio Laboratories shortly after reading a library copy of Morgan McMahan’s *A Flick of the Switch*. Living in a relatively rural area, it was several years before Mr. Braithwaite procured his first complete pre-war Scott receiver, which launched his specific interest in exploring the limits of radio technology available to the public. Since these early days, Mr. Braithwaite has assembled a collection of the finest Scott receivers (including the only two known Quaranta receivers), a cross-section of McMurdo Silver receivers, and what is likely the largest collection of Lincoln chassis and literature in existence. Mr. Braithwaite has published several articles about the products of E. H. Scott Radio Laboratories and other unusual radios. He has also published several reports documenting the provenance of special ordered Scott receivers owned by wealthy individuals. Mr. Braithwaite’s current interests include collecting documentation regarding technologically advanced receivers and unraveling mysteries surrounding lesser known models. Questions or contributions of additional information on the Lincoln Radio Corporation and their products may be directed to Mr. Braithwaite by telephone at 530-515-9489, e-mail at Braithwaites@sbcglobal.net, and by mail at P.O. Box 992443, Redding, CA, 96099-2443. Additional information on Lincoln Radio Corporation and their products will be posted to http://pacifichydrologic.com/?q=content/lincoln-radio-corporation as it becomes available.

Norman S. Braithwaite