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# WILLIAM J. CLARKE AND THE FIRST AMERICAN RADIO COMPANY

—H.L. Chadbourne
4/25/82

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*Setting the Stage*

In 1897, who could have imagined the age of electronics we know today? Yet there were signs it might come to be. One branch, "wireless" [wireless telegraphy] — the original name for radio — was already beginning to extend man's reach and his capabilities.

1897 was the year in which Guglielmo Marconi communicated wireless code messages 9 miles over land in England and 12 miles between warships at sea, the triumphant outcome of two years of experimentation. That year too Sir Oliver Lodge filed for several wireless patents, including a landmark one on tuned circuits. Sir Joseph Thomson proved the electron exists and is the smallest particle of the atom. Karl Braun in Germany devised the first electron-beam cathode-ray oscilloscope. Another German, Adolph Slaby, set up a wireless system of his own after he had witnessed a test conducted by Marconi. Augusto Righi in Italy, one of Marconi's teachers, published a treatise on the optics of electrical oscillations. Alexander Popoff, sometimes called Russia's Marconi, established wireless stations at the port of Kronstadt and aboard a cruiser. And in mid-1897 the Wireless Telegraphy and Signal Co., Ltd. was incorporated in England to put Marconi's patents to commercial use.

The year 1897 found awakening interest in wireless in the United States as well as in Europe. No breakthroughs perhaps, but diverse creative activity.

For example, that year the brilliant Professor Reginald Fessenden, down from Canada, collaborated with two of his students at Western University of Pennsylvania* on a study of different types of receivers for electromagnetic-wave signals. He went on to secure over 500 patents, mostly in the field of radio, and including major ones for radiotelephony, improved detectors, and the heterodyne method of reception.

*Now known as the University of Pittsburgh. The study referred to was reported in a thesis that unfortunately has been lost.

Another prolific inventor, John Stone Stone, received a patent in 1897 on a method of matching impedances so as to increase the efficiency of long-haul telephone lines. This work related to radio; in fact Stone at the time was studying resonant circuits at the American Bell Laboratories in Boston and lecturing on the subject at MIT, with emphasis on wireless telegraphy. His career included important contributions to tuned-circuit design and the mathematics of circuit analysis*

In 1897 the American Bell Telephone Co. received a patent for transmission of speech over a beam of light, and Bell and Hayes showed that a direct-current arc could be modulated so as to make the sounds of speech as it also varied in intensity. These events were prelude to the use of radio to carry voice as well as code — even to carry (as Emil Simon put it) "homeless waves of song."

Off on another tangent, the colorful Nikola Tesla filed in 1897 for a patent on a method of transmitting electric power by conduction through the atmosphere and ground, using elevated terminals and many megavolts at the radiator. Earlier Tesla had drawn public attention to this approach. He liked to generate and demonstrate canopies of electric sparks that ranged up to 23 feet in length and that "roared like Niagara," thus anticipating the spectacular effects seen in some science fiction films today. No practical application has been found for this form of wireless power transmission, but it still has enthusiastic advocates.

Many of the future pioneers of U.S. electronics technology were youths or in college in 1897. Lee de Forest was two years from his doctorate at Yale and nine years from his monumental invention of the three-electrode vacuum tube. A. Hoyt Taylor, who was to lead the way in radar, had one year to go for a BS at Northwestern. Edwin Armstrong, perhaps the greatest of the radio inventors, with the super-heterodyne, frequency modulation, and much more to his credit, was a boy of but 7 years.

Alan Hazeltine, inventor of the neutrodyne and an early advocate of the mathematical approach to radio design, was only 11. Roy Weagant, Fred Kolster, Albert Hull, and Vladimir Zworykin, all important engineers-to-be, were teenagers. Other fine future engineers were in their twenties but had yet to make their mark; two examples are Greenleaf Whittier Pickard, later famed for the crystal detector, and Fritz Lowenstein, who applied grid bias to a triode and made AT&T pay $150,000 for a dollar battery in the process.

In 1897 one hundred automobiles were manufactured in the United States. A U.S. submarine operated for the first time in open waters. President McKinley was inaugurated. Hawaii was annexed. Comic strip buffs met the Katzenjammer Kids. War with Spain lay months away. Alternating current had become the preferred power; incandescent lamps were standard. Klondike gold yielded $22 million. The nation's Gross National Product was $14.6 billion; it would double in a decade. The U.S. was on the threshold of becoming a major world power.

1897 was the year Frank Sprague installed his multiple-unit control system on Chicago's elevated electric-lines passenger cars with their own motors and controls, doing away with the separate locomotive. That year Boston got the first American subway and its own marathon. Boston lit up too; soon it would boast it had more electric lights per capita than any city in the world. New York got Steeplechase Park and a trolley across Brooklyn Bridge. The *New York Sun* verified that there was a Santa Claus. And the company that was to become IBM sold computers to the Russians for use in their census — but these were mechanical marvels, not electronic.

Few things were electronic in 1897. There were no radio stations, no ships with even emergency radio, no hams, no stores selling radio gear, no journals exclusively in the field. Nor was it taught; electronics engineering was unknown, and wireless was not a permissible major. And wireless formed no part of the $50 million U.S. defense budget. But this situation would soon change.

*An Industry Starts*

1897 was a year of getting under way, of setting the stage. One event of 1897 has long gone unnoticed. The first American radio company was established. Soon it started to make the first radio communications apparatus to be built in the U.S. for general sale.

It was not the best of beginnings. The first transmitters and receivers produced were patterned after early Marconi design and were quite limited in performance. The innovative genius so evident in later years had yet to appear. And the company responsible did not long survive. So history has forgotten the man behind this first equipment.

He deserves better. He had imagination, enthusiasm, and generosity. To a background in electrical engineering he added lecturing skill; he could explain wireless to a lay audience. He was also a bit of a showman, with a flair for the dramatic. Most important, he launched a key industry in which American technology led the world for a high percentage of the time.

*William Joseph Clarke* was his name. He and two associates, Charles P. Sheridan and T. Channon Press, incorporated the United States Electrical Supply Co. (USESCO) in New York State on July 19, 1897. (1) [See references]. This was one day before Marconi incorporated his first firm in England. Capitalization of USESCO was $10,000. On the record Sheridan is listed as president — most likely he had supplied a good part of the capital. Press is shown as secretary. Clarke was treasurer. Despite these titles, Clarke was the company engineer, functioned as general manager, and maintained liaison with prospective customers, the scientific community, and the technical press. The firm could be and often was called Clarke’s company. Of the other two, no information can be located on Charles P. Sheridan. T. Channon Press was a lawyer.

USESCO started with a showroom and office at the wonderfully appropriate site of 120 liberty Street, New York City. Liberty is one block south of Cortlandt and parallels it. Dey, Fulton and Vesey Streets are nearby, to the north.

Mr. W. J. Clarke.

William Joseph Clarke in New York in 1897. Age 36, he'd run a Canadian electric utility for 9 years and he'd had the fun of experimenting with things electrical since boyhood. Now he was busy establishing and promoting America's first radio manufacturing firm: United States Electrical Supply Co.

— photo from *The Electrical Age*, Dec. 25, 1897

This area of lower Manhattan — particularly Cortlandt Street — was famed as Radio Row in the 1920s and 1930s because of the vast array of radio components and assemblies displayed there to be admired and bought. It was long the Mecca for hams and experimenters, including this writer. So Clarke not only started things; he began where the action would eventually be.

Clarke was also responsible for the first public demonstration of wireless in the U.S. (2) It took place on Thanksgiving Eve, 1897. The scene was the New York mansion of the distinguished banker Jacob Schiff.* Twenty-four guests were present. A spark transmitter installed in the picture gallery was used to send out electromagnetic-wave signals. A receiver located in the adjacent drawing room responded by closing a relay. It was a simple on-off response; code was not attempted. Still, the test was judged "very pretty and successful."

The transmitter and receiver demonstrated at the Schiff residence had been built to Clarke's specification by the J.H. Bunnell Co. of New York, a well-known supplier of telegraph apparatus. A few weeks later was shown at a meeting of the American Institute of Electrical Engineers held in New York on December 15, 1897. Clarke explained that the receiver adjustments were not "sufficiently under control" to allow it to follow Morse code transmissions. So like the receiver shown to Schiff's guests, it served as a sort of space relay. It was more of a remote-control device than an intelligence collector. But Clarke assured the AIEE audience that the set could be adjusted to receive code.

After the demonstration Clarke held a question-and-answer session. His responses indicated that although he had made a beginning by producing radio equipment that worked, he was still uncertain of many aspects of operation. He was in uncharted waters.

Despite the limitations of the demonstration and talk, the electrical engineers applauded Clarke. The event was a success.

*Jacob Schiff, a partner of Kuhn, Loeb & Co., was an investment banker second only to J.P. Morgan in stature. It is not known whether Schiff provided any financial support to Clarke.

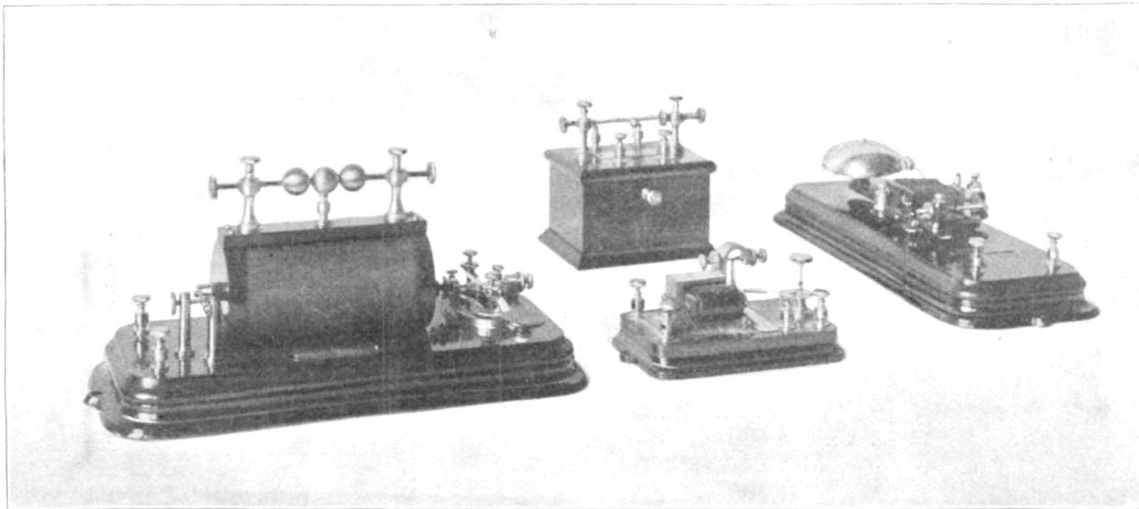

U.S. Electrical Supply started on the 11th floor of this lean building at 120 Liberty Street, in the area that would later become New York's famed Radio Row. When Clarke found that the journal *The Electrical World* was across the hall, he promptly rigged a wireless signaling system between his office and theirs·

— photo courtesy Museum of the City of New York

Marconi had founded his first company in England. Now the United States also had an operating private wireless enterprise, the U.S. Electrical Supply Co. Before long the firm had expanded into laboratory and plant facilities at 141 East 25th Street, New York — better known as the Lexington Building. The original space at 120 Liberty Street was retained as a showroom for about a year, then given up.

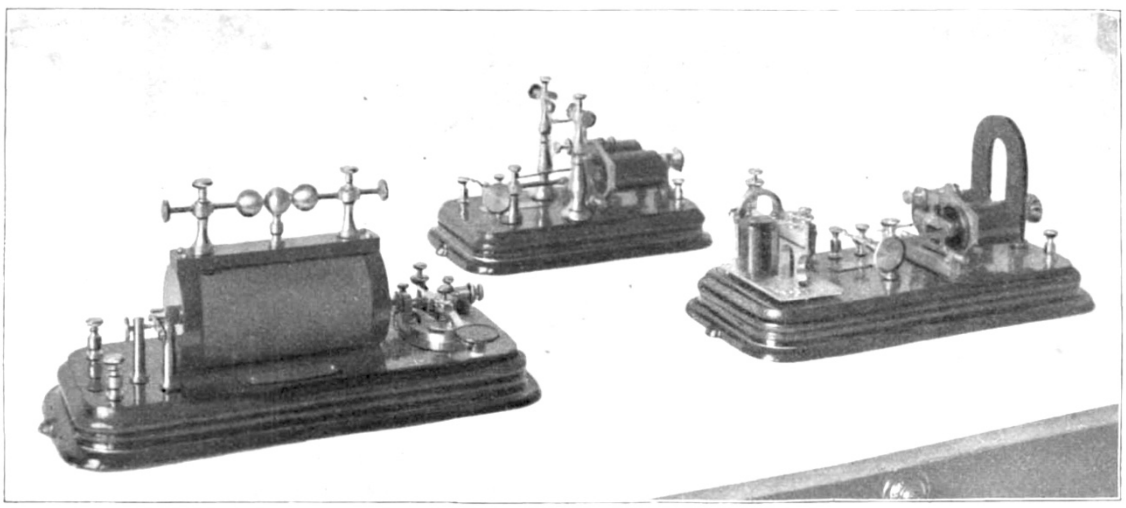
Soon after the AIEE gathering Clarke had improved wireless equipment in production. It included a basic spark transmitter design and two types of receivers. All units were mounted on highly polished mahogany bases. Bottoms of the bases were recessed to provide room for the wiring and for small components such as resistors, capacitors, and chokes. Truly an advanced construction technique for the day! Separate components were also marketed.

By early 1898 the manufacture of radio receivers, transmitters, and components in America was under way:



INSTRUMENTS FOR TRANSMITTING ELECTRIC SIGNALS BY MEANS OF WIRELESS TELEGRAPHY

(A)



INSTRUMENTS FOR TRANSMITTING MORSE SIGNALS BY MEANS OF WIRELESS TELEGRAPHY.

(B)

— photos from *Scientific American,* April 2, 1898
[pps. 213 ff]

1898 saw the start of wireless (radio) equipment production by the U.S. Electrical Supply Co. The early compact spark transmitter is shown to the left of both photographs. In (A) above, the space-relay type receiver is on three mahogany bases: coherer/decoherer (upper center), sensitive relay (lower center), and sounding bell (right). (B) shows the advanced and much more expensive Morse code receiver, mounted on two bases. The coherer/decoherer assembly is at the center and the sensitive relay and Morse sounder are on the base to the right.

*The Background of W.J. Clarke*

To some extent William Joseph Clarke is a shadowy figure. Historians have ignored him, and there are periods of his life that cannot readily be traced at this late date. We do know he was not an inventor or a scientist. Although he worked as an engineer, he made no outstanding achievements in that field. He emerges rather as a devoted and skilled tinkerer. He was once called the first wireless experimenter in the U.S.; certainly he was one of the earliest to see the fun of it. He pioneered a hobby that has had enormous support since, with appeal for millions.

Clarke's book, A.B.C. OF ELECTRICAL EXPERIMENTS, (5) reflects his enthusiasm. In the manner of a fond uncle he counsels the younger generation to read "how-to" books and make all manner of electrical assemblies from commonly available parts. "If you do this," Clarke tells his readers, "you will soon find that what you have learned at home will help you greatly to advancement, and in reality, will be worth a great deal more to you than even a college education, which in many cases is not at all a practical one, and consequently of little value to you." Modern educators might rail at this philosophy.

The do-it-yourself approach is reflected in Clarke's experiences from boyhood on. He was born in Trenton, Ontario, Canada in February 1861, the son of William and Mary Ann Clarke, who had come to Canada from Ireland. He grew up in the house his father had built in 1859 at 130 Dundas Street East, Trenton. (6) He was called "Josie" as a youth after his middle name, probably to prevent confusion with his father, who shared with him the first name of William. His father died while Josie was still a boy.

The young Clarke showed an early absorption in science, especially electricity. He probably taught himself most of what he learned about the subject. It is doubtful that he went to college. His name does not appear on the registers of Queen's, the University of Toronto, or McGill, the three most likely colleges for him to have attended.

130 Dundas Street East, Trenton, Ontario. The young W.J. Clarke grew up in this house and conducted his early experiments with electrical apparatus here, including trials of the telephone and wireless. Clarke's father built the place in 1859. He built well for it is still (1982) used as a residence.

— photo courtesy
T.J. Gauthier

The *New York Herald* reported that Clarke started to experiment with wireless in Trenton when he was 20, in 1881. (7) The date seems very early indeed. Unfortunately the paper gives no details and town records cast no light on the matter. 1881 was six years before Heinrich Hertz in Germany had shown electromagnetic waves existed and could be transmitted and received, and it was fourteen years before Marconi's first successful wireless tests. It seems likely, therefore, that Josie's earliest experiments were with conduction or induction types of wireless,* which were known at the time but were useful only over very short ranges or under special operating conditions .

Although his initial wireless experiments remain a mystery, there is no doubt Clarke played an important role as Trenton's first and foremost electrician. We begin to hear of him as he installed electric doorbells and a sort of early bell-ringing intercom system for homes. This system, put in several rooms of a residence, could "also be used as an alarm bell to call the servants should they over-sleep themselves in the morning." Better testy servants than tardy ones, Trentonians must have reasoned.

In 1885, when he was 24, Clarke engineered a cable fire-alarm system for Trenton, whereby the location of a blaze could be communicated rapidly to a central fire station. This was, of course, before the widespread availability of telephones, which eliminated the need for a special fire signal line. His biggest job that year, however, was to plan Trenton's first electric light installations, and to serve as general manager of the electric lighting plant of Trenton Electric and Water Co. (9) This was one of the first hydroelectric plants in Ontario.

*Conduction wireless refers to methods that use conductors other than wires as, for example, the water in an ocean or bay, or conduction through the atmosphere by the use of extremely high voltage to create lightning-like sparks between two terminals. Induction wireless utilizes the inductive coupling that exists between two separate coils, and that allows energy to pass from one to the other provided the coil design is suitable and the coils are not too far apart.

Clarke initially planned the installation of arc street lights· He estimated cost of sixty of these at $14,000 and revenue as 40 cents per light per night.* (10) Merchants soon subscribed for sixteen and the town agreed to pay for twenty-five additional, making a total of forty-one lights at the start. The first ones went into operation in 1886. They burned from dark until midnight every night except Sunday. By 1890 many homes in Trenton were lighted by electricity, using incandescent bulbs. Streets and homes were ablaze.

T.J. Gauthier, who lived in the original Clarke home on Dundas Street East from 1912-1970, recalls that his mother told him she had known Clarke well. She said that the young man had installed a telephone line between his house and that of a friend and hooked up the instruments long before the technology was generally known. She also said that some of the townspeople thought Clarke a mite eccentric because he frequently gazed up at the power poles. The pole inspection was probably not as much eccentricity as prudent concern. Early arc lights were connected in series. This meant that the power lines had to carry the combined sum of the voltage required to fire each light. Thus the lines were high voltage and could be lethal. The young utilities manager had good reason to check them for safety.

In 1894 Clarke was replaced as general manager of the town's utility company by an S.M. Wheeler. This was done at the instigation of Brush Electric Co. of Cleveland, Ohio, the major stockholder of Trenton Electric.** Brush was unhappy at the failure of the firm to pay dividends.

*Another source puts the figure at 25 cents per light per night. This may have been actual revenue rather than estimated.

**Charles F. Brush, a noted chemist and inventor, was the pioneer of arc lighting in America. His Brush Electric Co. made dynamos, arc lamps, arc carbons and related apparatus. The firm customarily received a large stock interest in the companies it supplied with this apparatus as part of a complicated financial arrangement. Brush Electric was bought by Thomson-Houston Electric Co. in 1889 and subsequently both were absorbed into General Electric.

Clarke may not have produced profits, but he was well regarded. At the time of his ouster the *Trenton Courier* called him "a gentleman of ability, perserverance and strict integrity … an amiable, worthy citizen."

The following year Josie Clarke left Trenton and Canada for the United States. His activities in the U.S. between 1895 and the founding of USESCO in 1897 are not known. In 1900 he married, and later that same year he and his wife Ida had a son, Kenneth. They lived in a rented house at 1208 Fifth Avenue, New York City. (12)

*Transmitters: A Choice of Sparks*

The transmitters Wm. J. Clarke had shown to the AIEE in 1897 and later refined for production were of the simple untuned spark type. In fact spark transmitters were the only kind known at the time.

Operation depended on high-voltage spark discharges. These oscillated back and forth between two or more metallic electrodes at a very rapid rate — up to hundreds of millions of times a second. The frequency depended on the size and separation of the spark electrodes and the constants of the other circuit elements, including the antenna. A portion of the energy in the circuit was radiated into space. Wave trains of the oscillations were keyed on and off to form the dots and dashes of Morse code. Thus, the early transmitter.

Figure 1 shows the circuit (13,14). A storage battery furnished power. It was connected to the primary winding of the induction (spark) coil through a telegraph key and contacts on a device called an interrupter. When the key was first depressed, battery current flowed to the coil primary. The current magnetized the iron core of the coil. The magnetization attracted an iron piece mounted on the spring of the interrupter. When the iron piece moved, the battery contacts opened. The core demagnetized. This allowed the interrupter spring to return the contacts to the normally closed position, restoring battery current and starting the cycle over again. A capacitor was connected across the key and interrupter contacts to minimize undesired sparking.

The interrupter was designed to break battery current quickly, the faster the break the better. When battery current was cut off the magnetic flux field surrounding the coil primary collapsed suddenly — in about 1/10,000 second. The collapsing field induced a pulse of very high voltage in the coil secondary, with which it was linked.

The secondary had many times the number of turns of wire used in the primary (miles of fine wire in some cases) and was wound in sections over the primary. The effect of the collapsing field may be likened to striking a pendulum a hard blow.

11-A

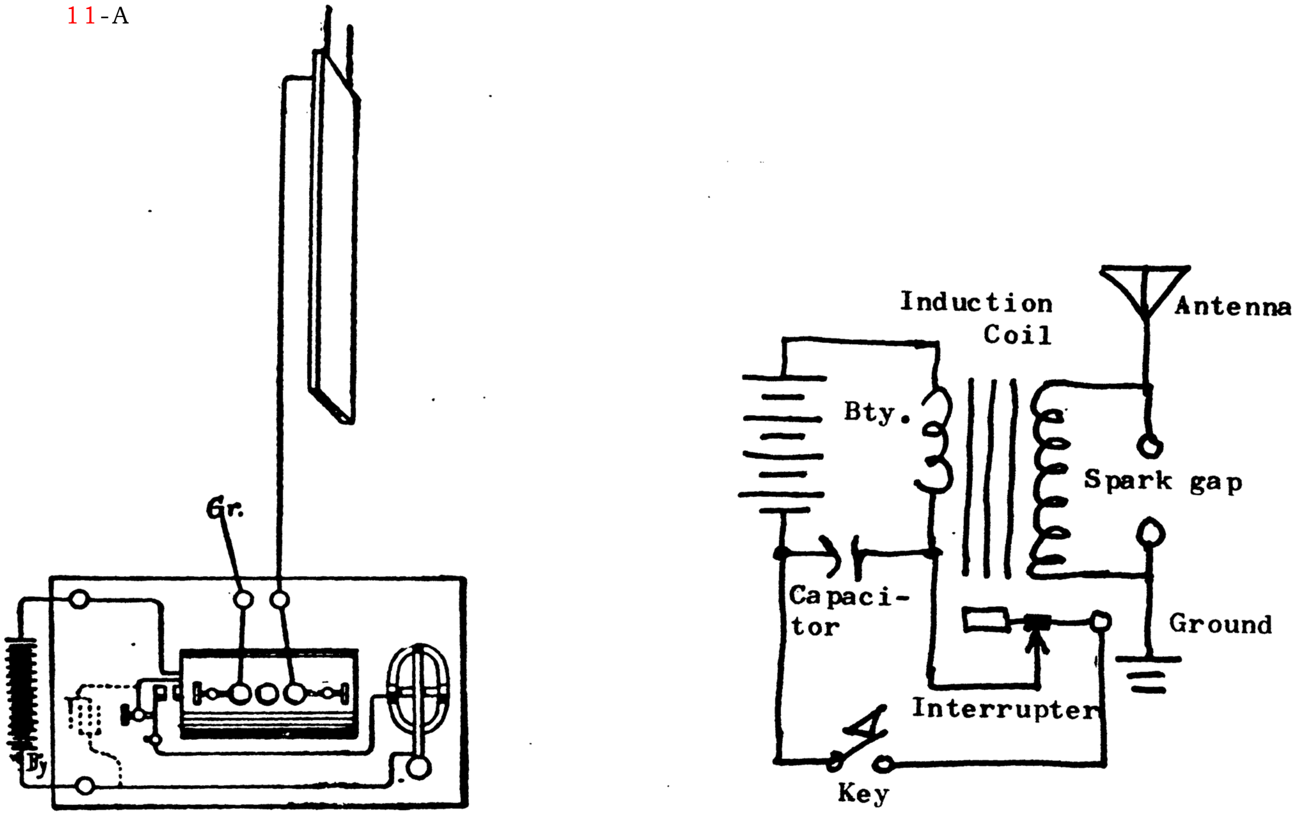



Figure 1. *Basic* circuit of United States Electrical Supply Co. *transmitters* from 1898 on. Pictorial wiring diagram left; schematic [by H.L. Chadbourne], right.

—Pictorial diagram from *Scientific American*, April 2, 1898 (above)

The shock of the blow will set it moving back and forth at a rate determined by its own natural resonance. So the sudden presence of thousands of volts induced in the secondary started the spark discharge and set it oscillating at a rate determined by the electrical resonance of the circuit.

To transmit signals, part of the energy present in the oscillations had to be radiated. Clarke accomplished this the easy way. He simply connected antenna and ground to the spark gap. In most cases a rectangular metal plate about 9 feet square served as the antenna. It was mounted vertically above the transmitter and connected to it by a length of heavy insulated wire. For long-range operation, however, much longer antennas were employed. They were generally vertical. The ground consisted of a wire connected to existing water pipes or to a buried metal plate.

When the standard plate antenna was used this apparatus must have radiated its maximum signal in the very high frequency region. But the emissions were highly damped. The oscillations started by the high-voltage pulses decayed rapidly in amplitude and ceased after a few cycles, to be restarted by the next high-voltage jolt from the induction coil secondary. Such highly damped signals take up an extremely broad band of frequencies. The sets were spectrum hogs.

The operating frequency of the interrupter limited the number of words per minute that could be transmitted. An early USESCO unit operated 800 times a minute and the coil delivered a peak secondary voltage of 10,000. Unfortunately these characteristics were not given for later models, but some were said to operate much more rapidly.

The coils were rated according to the maximum length of spark in air each could produce. The original USESCO units were for a maximum spark length of 8 inches. Later models were made available with a choice of spark lengths of 2, 8, 9, and 10 inches. This does not mean that transmitters were operated with maximum separation of electrodes. Clarke noted fine performance at moderate ranges with a spark gap of less than ½ inch, and he agreed with Marconi that a 1-inch gap was a good standard for long ranges.

The coils for the longest sparks simply produce the fattest and hottest ones at 1 inch, thus allowing high transmitter power output.

Induction coils of the type described had applications other than radio. X-ray apparatus is one example. And Clarke describes a quite different use in his A.B.C. OF ELECTRICAL EXPERIMENTS. It brings out his conviction that learning about things electrical need not be dull. He gives detailed instructions on how to build a substantial induction coil with built-in interrupter. Then he tells what to do with it: "Your coil is large enough to give a good shock to one hundred persons. The way to do this is to have them all join hands and then have the one at one end of the line touch one secondary binding post with a piece of iron held in his free hand, the one at the other end touching the other secondary binding post in the same way … Only leave them there for an instant as people cannot stand the shock for more than a very short time."

Ralph Nader, where were you then?

Clarke in his writing indicates he built some apparatus that made use of alternative methods of generating sparks for wireless. Tesla coils and several types of interrupters that were separate from the coils are examples. But he does not give enough detail to allow discussion here ·

USESCO also offered some options in oscillator assemblies. The original assembly (1897) was based on a design by Augusto Righi of Italy. It had four solid brass spheres as electrodes. The two outer ones were 1½ inches in diameter and the two inner, 4 inches. The coil secondary was connected to the outer balls. Each of these could be varied with respect to one of the inner balls, from a separation of 2 inches to direct contact.

The large inner balls were cemented to the ends of a rubber tube that had been filled with as pure a Vaseline oil as could be obtained. The balls came within 1/32-inch of touching. The oil was used in the spark gap because for a given electrode separation it required a higher voltage to break down than air, so that more power was delivered to the antenna.

Transmitting device undergoing adjustment by Mr. W. J. Clarke.

Clarke ponders the mysteries of the four-ball Righi-type spark oscillator assembly he demonstrated before the American Institute of Electrical Engineers in 1897. The induction coil and other components were on a separate base. 13–A

— photo from *The Electrical Age* (above)

The oil also had a self-cleaning effect that minimized pitting and oxidation of the brass at the gap. When the outer balls were separated from the inner, sparks had to jump the air gaps between them as well as the center oil gap. Among other effects this provided a secondary source of radiation, broadening still further the already wide band of frequencies emitted by the device. In most cases, however, the outer balls were operated while in contact with the inner.

In transmitters for 1898 and 1899 Clarke abandoned the oil interface as being not worth the added complexity. For what he called his “long-distance” unit he retained the four ball electrodes but made them all adjustable. He defined “long distance” as being between 3 and 12 miles.

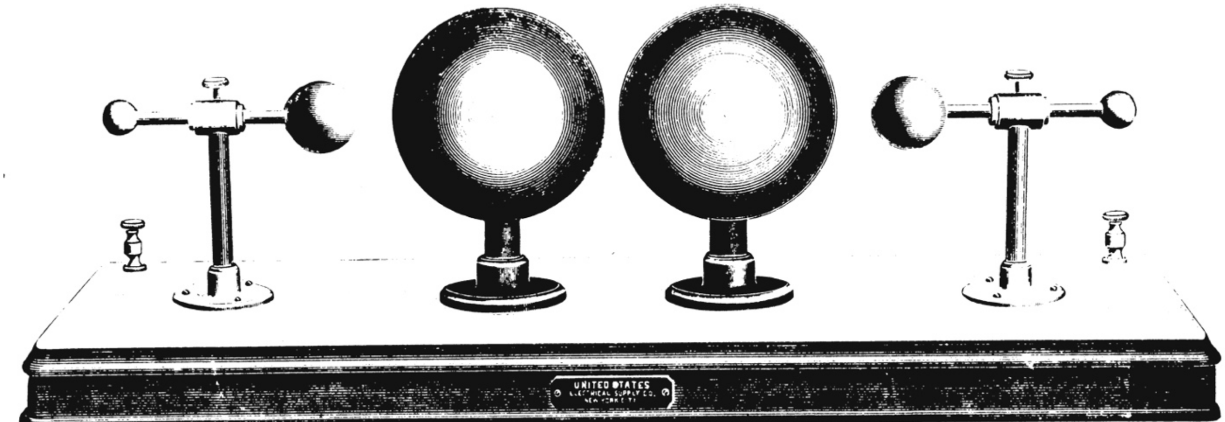
Clarke also developed a short-range transmitter for classroom demonstrations or use between stations in the same neighborhood — the CB [Citizens’ Band] set of the day, if you will. This line must have been the most popular of the two. The units that finally evolved were of compact, single-base construction and used a neat, clean layout. The same electrical circuit (Fig. 1) was used in both long- and short-range models·

A series of experiments with different sizes and configurations of spark electrodes led to the final short-range unit. An early theory was that the larger the radiating spheres were and the wider the gap between them, the greater the operating range. This came to be disproved. Clarke felt that small electrodes would do — at least for moderate ranges — if there were enough of them. So he built an experimental transmitter using six ¾-inch diameter brass ball electrodes. Then he found he could dispense with half of these with no loss in performance.* He mounted the remaining three in line atop an induction coil having a 2-inch spark capability and built-in interrupter. The center ball was on a fixed post and had no electrical connection. The other two were mounted on adjustable rods so that their distance from the center could be varied.

*Indeed he determined experimentally he could dispense with *all* of them — the gear would work after a fashion with no balls at all!

# THE “CLARKE” LONG-DISTANCE ADJUSTABLE OSCILLATOR.

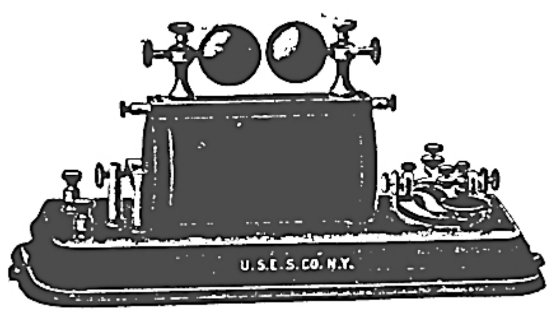
FINISHED IN GOLD LACQUER.




(A)

Four balls were again used in the “long-distance” USESCO production oscillator, although insulation in the center gap was air rather than oil. Clarke defined long distance as an operating range of between 3 and 12 miles. The drawing shows the balls in the middle as fixed but in the production version their separation could be varied.

— drawing from USESCO product brochure (figure 14A)




(B)

Showing the clean, neat, self-contained assembly of Clarke’s standard short-range spark transmitter. This model is believed to have been quite popular. The spark oscillator is conveniently mounted atop the induction coil, and the key is in a handy position to the right.

— drawing from USESCO product brochure (figure 14B)

Later in the year Clarke found that results were just as good when two 1½-inch diameter brass balls were substituted for the three ¾-inch ones. This became the standard USESCO short-range transmitter. No record can be found of design changes in later years. The spark oscillator assembly was also made available mounted on a separate mahogany base, for those who wished to use it with other circuits or induction coils.

USESCO transmitters had design flexibility. The user was given options of 2-, 8-, 9-, and 10-inch induction coils and several sizes and configurations of brass ball electrodes, all with adjustable gap spacing. Thus to some extent he could select the type of spark he wanted. There was controversy at first over which type was best. Finally fat and snappy sparks came to be most prized. Later makes of transmitters achieved fatter sparks through use of heavier wire in the induction coil secondary* and snappier sparks through interrupters with faster break characteristics. So USESCO performance was not ideal.

Still and all it must have satisfied the soul to send out some of the earliest radio signals through the agency of the bright, colorful and noisy electrical fireworks of a Josie Clarke transmitter.

*Clarke liked to use very fine wire for his coil secondaries — #36 or even #40 B&S gauge, silk covered. Much heavier wire came to be preferred.

In a lecture given in 1897 Professor W.E· Ayrton prophesied: “There is no doubt the day will come ... when a person wants to telegraph to a friend, he knows not where, he will call in an electromagnetic voice, which will be heard loud by him who has the electromagnetic ear, but will be silent to everyone else.” (16)

This great dream has yet to be realized although we have come a way toward it. By contrast, the early “electromagnetic ear” demonstrated at Jacob Schiff’s residence and before the AIEE not only was unable to receive voice, it was not even adjusted to respond properly to code. But Clarke was able to show more advanced equipment to a meeting of the New York Electrical Society on March 25, 1898. (17)

This meeting was well covered by the technical press. It included a revealing question-and-answer period that followed the presentation. In this session Clarke predicted that voice transmission by wireless would come soon. He also noted that a telephone receiver was to be preferred over a Morse sounder for reception in the presence of noise. This thinking was considerably ahead of the times. Clarke also revealed that he understood the importance of tuning circuits to resonance, but admitted he had “signally failed” to get his transmitters and receivers in tune. This may have been because of the extremely wide bandwidth of the signals he was sending out. With transmissions that broad, there may have been nothing to tune *to*!

Two receivers were shown to the Society. One was of the space-relay type. It did not have the speed and accuracy of response required to handle code. But it could switch an electrical device on or off when it received a radiated electromagnetic-wave signal.

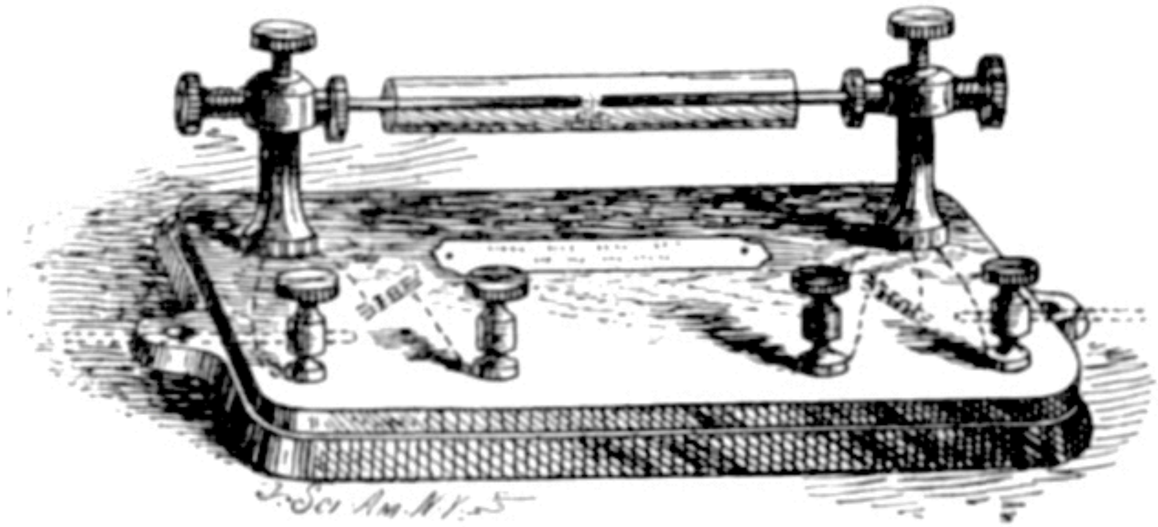
The other, more elaborate receiver was suited to slow-speed Morse reception. It could handle up to about 15 words per minute. Output was by Morse sounder, which gave a mechanical click when a signal was received. The code was read from the intervals between clicks. A long interval meant a dash; a short, a dot. The set could also operate a Morse register. The register displayed received dots and dashes on a moving band of paper tape, driven by a clock mechanism.

Both sets had a coherer as detector, the key component. This was the only form of detector in use outside the laboratory at the time, apart from the simple wire loop resonator of Hertz. The coherer was the subject of experiments by Dr. Oliver Lodge in England in the 1880s. But the French scientist Dr. Edouard Branly first applied it to the specific task of radio-wave detection in 1890, and so is generally given credit for the device. Subsequently both Lodge and Marconi made major improvements in coherer design.

The coherer consists of a small glass tube in which a heap of metal filings is placed between two metal plugs. The plugs are connected to terminals. The loose filings normally show high electrical resistance, many thousands of ohms. But when an "electrical jerk" (as Dr. Lodge calls it) of a radio-frequency signal is applied, they stick together, or cohere. The resistance of the filings then drops dramatically, down to a few ohms. Thus the coherer responds to a received signal in a way that can be measured or used to control current flow in an external circuit. This latter property made it useful not only in wireless but also, in Clarke's words, "capable of exploding torpedoes, ringing gongs, starting motors, and many other apparently wonderful things."

A fraction of a volt may be sufficient to trigger some coherers, if provisions have been made to ensure high sensitivity. Unfortunately, however, once a standard coherer has responded to a signal it remains in the low-resistance state until it has been mechanically tapped. The filings must be jarred to restore high resistance, A vibrating hammer connected in parallel with the Morse sounder can accomplish this. It must be carefully positioned to provide the right mechanical impact.

USESCO built its own coherers. They differed in a few respects from those used by Marconi. The typical Marconi coherer had a 1½-inch long, 0.1-inch inner diameter [evacuated] glass tube, sealed airtight to prevent corrosion of the filings. The filings were in contact with snugly fitting silver plugs about 0.05 inch apart at the center of the tube. Filings were fine, and were generally a mix of 88 percent nickel and12 percent silver. Silver increased sensitivity, but too high a percentage led to unstable operation. Platinum wires connected to the plugs were led to external terminals.



W.J. Clarke's coherer detector design. A feature was the use of spring-loaded screws to control pressure of the metal plugs that were in contact with a heap of filings in the center of the glass tube. The filings responded to an applied signal by dropping sharply in electrical resistance.

— drawing from *Scientific American*, April 2, 1898

Clarke's coherer, on the other hand, used a 2-inch glass tube of 1/30-inch inner diameter, not sealed. The filings were of a special metallic mix, mainly nickel. Brass plugs at the tips of brass screws contacted the filings. Silver or platinum plugs were also sometimes used. The screws went through threaded brass caps at the ends of the tube, and were spring-loaded. This permitted adjustment of pressure.

Clarke believed that the size of the filings and the pressure exerted on them were more important than the content of the mix or the evacuation of the tube. He preferred coarse filings for short-range use and fine for long ranges, but admitted to inconsistent test results. He quotes a figure of 20,000 ohms or higher for a typical USESCO coherer in its high-resistance state, falling to between 8 and 25 ohms after it had been triggered by a signal.

Figure 2 shows the circuit of USESCO receivers. The difference between the two models was not in circuit but rather in component quality and the number of adjustments the user could make. In both cases antenna and ground were connected to opposite ends of the coherer. The coherer was effectively in series with two chokes, a dry battery, and a sensitive, polarized relay with a 1,200-ohm coil. The chokes confined radio-frequency currents to the input circuit.

When a signal of sufficient strength was received, it actuated the coherer. This caused its resistance to drop. Current flow from the battery increased and the sensitive relay became energized. Its contacts closed. This turned on the sounder, register, or other electrical output device and also started the vibrating hammer decoherer·

An unusual two-cell battery was used in the coherer circuit. It was designed for long life under the low-drain conditions of this circuit. Only one cell was used at first. When its voltage dropped after extended service, the other cell was brought into use.

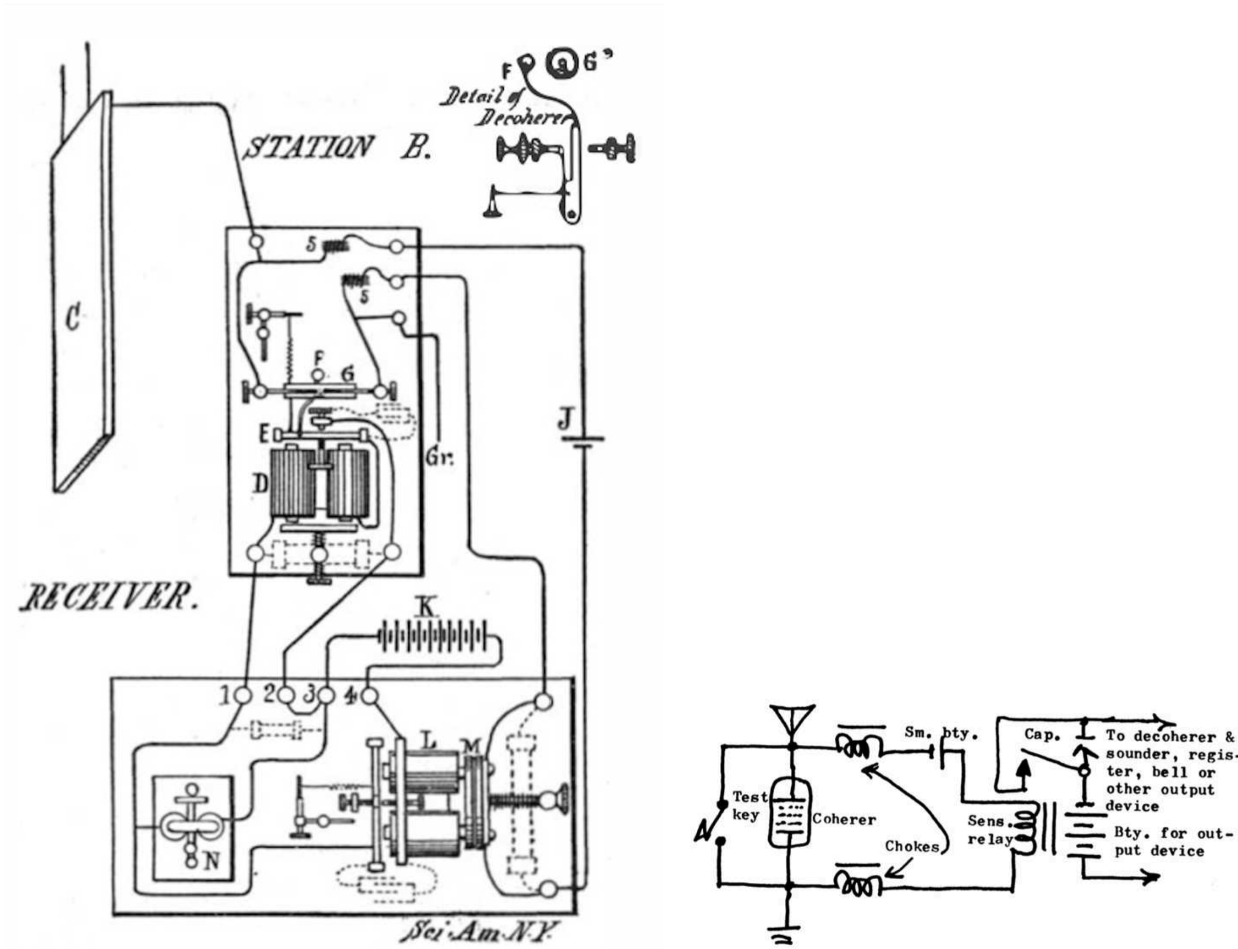



Figure 2. Basic circuit of United States Electrical Supply Co. receivers from 1898 on. A pictorial wiring diagram of the 1898 model for code reception is shown on the left; in 1899 and later models all components were mounted on a single base rather than the two shown. Similarly the space-relay unit (pictorial not shown) was originally on three bases, but was consolidated on one in 1899. The schematic on the right applies to all models.

— pictorial diagram from *Scientific American*, April 2, 1898 (above); schematic [by H.L. Chadbourne], right.

The decohering hammers in these receivers operated rapidly enough to produce a low-pitched hum. Inertia prevented the sensitive relay from opening each time the coherer was tapped, so long as a signal was present to make the filings recohere after the impact. When a tap was not followed by a signal, however, the relay opened. That, at least, was the theory. But operation must not have been perfect in this respect because Clarke complains of chatter in the sounder and states he preferred to read the code from the operating noise of the decoherer.

This kind of apparatus must have been a headache to operate. Set-up was difficult and performance, cranky. False coherer operation could be caused by a variety of electrical disturbances, including sparking across contact points in the receiver. To minimize this Clarke placed capacitors across all such points. Damping resistors were placed across some coil windings. And an unusually wide range of adjustments was provided. Thus the armature of the sensitive relay was not only made extremely light but could be adjusted for length of travel. The decoherer had adjustments for the distance between the magnets and the vibrating armature, spring tension, and distance through which the armature vibrated. All needed to be set correctly to assure that the hammer would hit the coherer with just the right impact.

Clarke early recognized the troublesome nature of the coherer. He sought alternatives and claims to have found a good one in a detector that would permit reception as fast as an operator could key. (18). Presumably this device operated in conjunction with a telephone receiver, a practice Clarke advocated. Unfortunately he does not give details and others in the field have received credit for the greatly improved detectors of the early 1900s. All known USESCO sets used coherers, and none operated with telephone receivers.

Marconi receivers of the period did not provide the wide range of adjustment of the USESCO units, but did have a lot more shielding as a safeguard against spurious operation. Clarke does not seem to have understood the function of shielding. During his 1898 presentation before the New York Electrical Society he advanced the curious view that Marconi had mounted his receivers in iron boxes to show that electromagnetic waves *could* penetrate iron. He was taken to task for this misapprehension by one of the attendees, Dr. Michael Pupin, the celebrated Columbia University professor of physics who was later to instruct Edwin Armstrong, Emil Simon, and other distinguished radio engineers. Dr. Pupin explained, "You cannot get wires into a box unless there is an opening, and the waves go through the opening. They crawl through the smallest hole, and that is the reason the box does not act as a screen." (17)

In addition to better shielding, Marconi receivers by 1898 had started to use a form of tuning known as "wings." These were long metallic strips ¼-inch wide, one of which was attached to each end of the coherer. The strips were cut in length to resonate with the transmitter in use.

In a later version Marconi used what he called a "jigger" in conjunction with an elevated antenna. The circuit is shown in figure 3. The antenna voltage applied to the input coil primary was stepped up by the tuned secondary and fed to the coherer. Because the coherer was a voltage-operated device, the circuit responded to weaker signals [better] than when it was directly connected to the antenna, and the tuning provided some rejection of signals on other frequencies.

There is no indication that Clarke ever made use of wings or jiggers, although in 1899 models he provided terminals to which they could be connected. Another change in 1899 was in basing. The 1898 space-relay type set had three interconnected bases: coherer/decoherer, sensitive relay, and bell. All these components were mounted on a single mahogany base in the later version.

Similarly, the 1898 set for Morse code reception had the coherer and decoherer on one base and the sensitive relay and sounder on another. These elements were assembled together in a single unit in 1899 to form Clarke's "standard" receiver. He sometimes also called it his "high-class" receiver. It did indeed have class, with its highly polished wood, gold trim, concealed wiring and clean layout. It was the top of the line. And the last. Although the company struggled along for some years after 1899, the record does not show that any improved models were designed or built.

20-A

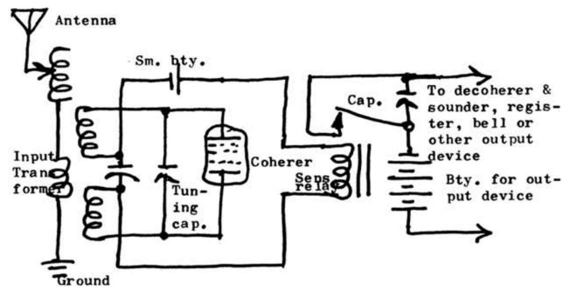
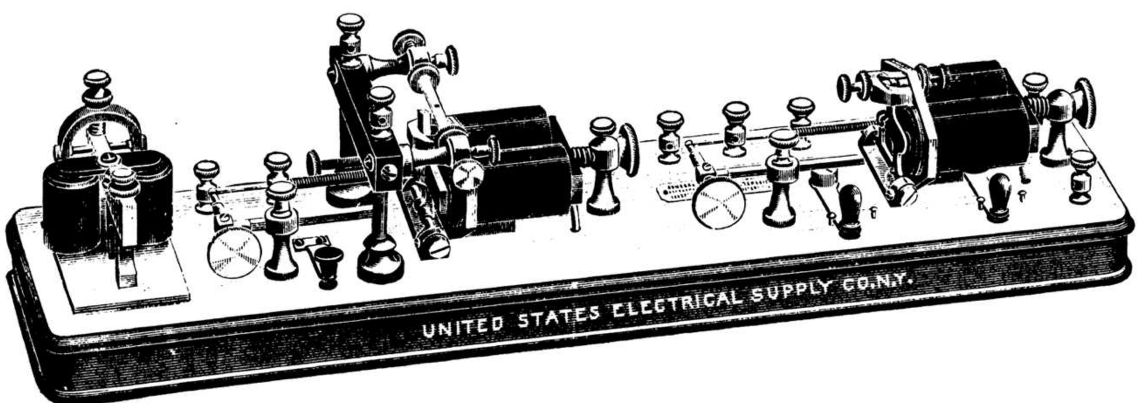



Figure 3. Simplified schematic of Marconi’s improved receiver with input transformer “jigger” to step up signal voltage to the coherer [drawn by H.L. Chadbourne].

## THE “CLARKE” WIRELESS TELEGRAPHY RECEIVER.

PROVIDED WITH ALL NECESSARY ADJUSTMENTS.

20-B




(20-B)

The top-of-the-line USESCO set for 1899. It was a beginning; in years to come American-built communication receivers would establish a magnificent tradition. The sounder is to the left and the sensitive relay is at the other end of the base. The decoherer is near the center, and the coherer is elevated above it on pillars. The key to the left of the front pillar shorts the coherer to test operation of the rest of the receiver. Wiring and small components are concealed in the recessed base.

Regardless of their relative merits, both the Marconi and the USESCO receivers had performance characteristics that seem intolerable today. Reception was limited to slow-speed code from nearby spark transmitters. Sensitivity was poor. Selectivity? It was almost nonexistent. The sets were extremely susceptible to interference from atmospherics and electrical equipment. A user could not distinguish one transmitter from another by its sound--or even distinguish a desired signal from interference — because the output was the same for all. This also meant they could not be used for quantitative measurements of signal strength. They were go/no-go devices. And they were so troublesome to set up that a USESCO instruction sheet cautions, “Please remember that as Wireless Telegraphy apparatus is something entirely new, it takes some time to master the details of the adjustment. Therefore, do not be discouraged if you do not succeed very well during the first few weeks.” ·

Patience was the word. But despite their limitations under the right conditions these earliest sets could pick up invisible and inaudible radio waves from miles away and translate them into meaningful form. Years later a radio firm suggested the waves were transported by magic carpet to the receiver. Indeed there has always been something magical and inherently exciting about “electromagnetic ears.”

Josie Clarke saw this excitement and even added to it. He demonstrated his product with a fine flair for the dramatic — and nearly blew up Thomas A. Edison in the process.

*Bombs and Bells*

The scene was an electrical show held at Madison Square Garden, New York, in May 1898. For his part Wm. J. Clarke contrived an exhibit that mixed radio technology, fireworks, and the Spanish-American war, which had just started. *The New York Times* reported: "By touching an instrument placed in the southern gallery a miniature Spanish cruiser anchored in the fountain lake on the lower floor, 90 feet away, was blown into the air, together with a considerable quantity of water, which fell on those who were not quick enough in getting out of the way … The first movement of the machine and the explosion were simultaneous. There was no connection between the transmitter and the vessel in the lake." (19)

This technique was heralded as a new way to fire mines. In addition, Clarke rigged a 6-inch bell in the receiver case. At times when the model warship was not being blown up and bystanders drenched, signals from the remote transmitter were sent out to actuate the bell so that it sounded out repeatedly the Morse signals for NY NY NY.

An insensitive receiver was used in these demonstrations. The coherer had 40 to 60 small nickel filings rather than the fine nickel-silver mix of the sensitive set. The explosive charge was a mixture of gun-powder and fulminate of mercury sealed by a special cement in a one-ounce bottle. The rationale behind the mixture was that it would completely pulverize the glass container on explosion, whereas gun-powder alone might result in dangerous shards of glass being thrown out of the tank. (20)

Wiring to the charge was led through a side of the seal on the bottle, and the bottle wars secured upright a few inches below the hull of the miniature warship. The charge was set off by voltage from an auxiliary battery, switched on by contacts on the coherer-operated relay in the receiver. A safety switch was provided in the detonator lead so the apparatus could be adjusted without setting off an unwanted explosion.

During the exhibition, the mock warship was blown up four times a day. These explosions and the coded clangs of the bell gave Garden visitors dramatic glimpses of some of the potentials of wireless. The imaginative Clarke, however, was not content. He wanted to provide a New York - Chicago communications link by means of a series of wireless relay stations. The scheme was not practical at the time. But *The New York Times* mentions a more immediate and practical plan the man had, namely: "One day next week … a transmitter placed on the roof of Madison Square Garden is to blow up a vessel five miles away in New Jersey."

The *Times* did not follow up on the story. So we don't know if New Yorkers found it was really that safe and easy to blow up something in New Jersey. Clarke did, however, nearly manage to blow up by accident no less a personage than Thomas A. Edison, America's most distinguished inventor.

At some point the USESCO Garden exhibit of 1898 was changed from a tank having a single model warship to one in which a string of miniature gunboats floated, each with a tiny mine positioned below it. Originally whenever Clarke actuated his remote transmitter, all the submerged charges would go off at once, and all the gunboats would be tossed in the air simultaneously by the explosions. Clarke, working with Edison, sought to modify this action so that the charges could be selectively exploded by wireless, one at a time. The implications of this were important and way ahead of the times. But neither Edison nor Clarke came up with a solution. Instead during one of the experiments a mine was left in Edison's desk, adjacent to the tank. It exploded along with the other mines during the test, "reducing the desk to kindling wood." Edison was at the desk at the time. Fortunately he was not hurt, except for the shock to his nerves. (21)

Clarke's Garden demonstrations may have been the first use of radio-controlled explosives. A few months later he staged a similar show in New England. (22) The occasion was the big all-electric Twentieth Tri-ennial Exhibition of the Massachusetts Charitable Mechanic Association, held in Boston from October 10 to December 3, 1898. Again, the action consisted of blowing up a miniature warship by remote radio control four times a day. But in the Boston scene the event became a lesson in contrasts. Picture it: The target vessel is floating in the artificial lake of the Japanese tea garden section of the exhibition. Visitors in the area are being served light refreshment by charming daughters of Japan. Then suddenly a muffled explosion!

The ship flies, water sloshes, people jump. Josie Clarke is working his rig.

This was the first time wireless had been shown to the public in a New England state. It was a sizeable audience; an estimated 10,000 people a day attended.

In addition to wireless, Clarke gave many visitors to the Massachusetts Charitable Mechanic Association exhibition the first glimpses they had had of what lay under their skins. X-ray apparatus had not yet come into widespread use. So USESCO built a fluoroscope and installed it in a viewing booth. Large crowds of people passed through the booth, viewing their bones the while. A Cox thermo-electric generator was still another advanced technology device USESCO had built and put on display.

A snag developed at the Boston show. A few hundred feet away from USESCO headquarters D. McFarlan Moore was showing his “artificial day-light” display. Moore had found the incandescent lamp “too small, too hot and too red.” So he developed an early version of fluorescent lighting. It consisted of a long gas-filled tube that was ionized by the application of high voltage. When it was fired sufficient energy was radiated to trigger Clarke’s set-up. Josie, however, had a PR man’s knack of turning obstacle to advantage. He let it be known that not only had he perfected means of blowing up a model warship by remote wireless control — he could even blow one up by remote artificial daylight. And, with Moore’s help, he proceeded to do so.

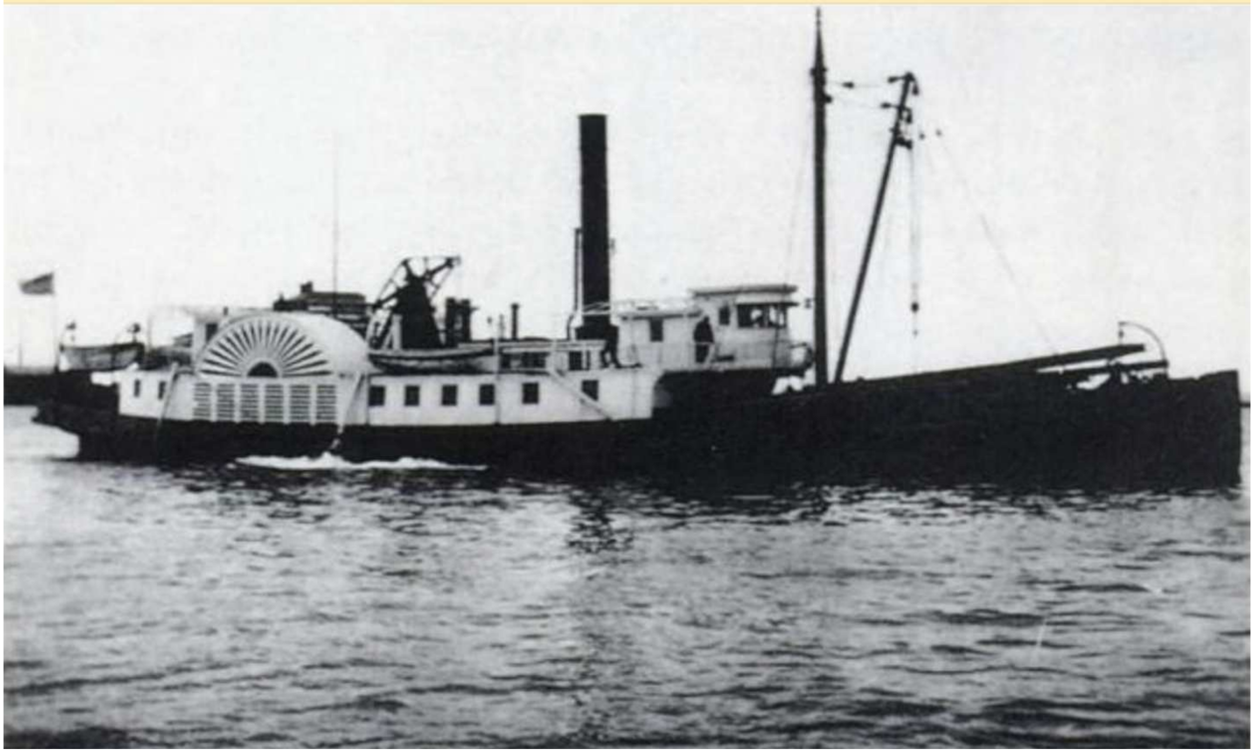
Clarke also pioneered in another aspect of remote control. He tells us he succeeded in directing by spark transmissions the movements of a large model automobile, weighing about 50 pounds. No other details are available.

In May 1899 USESCO apparatus was again at Madison Square Garden. It was a feature of the big electrical show held there that year. (23). The gear was set up on a plate of glass about 10 feet long and 2 feet wide. The spark transmitter, controlled by a telegraph key, was at one end and the receiver at the other. These were of the single-unit construction type. The receiver included a Morse register to provide a printout of signals. When demonstrated, according to the *Electrical World and Engineer*, this exhibit "attracted much attention and general admiration." Adjacent booths set up by other companies at the Garden contained strange machines advertised to cure human afflictions by shock or mysterious ethereal waves. The journal cited also mentions an intriguing "exhibit of electricity under water in a big plate glass tank with a real woman diver assisted by experts." The reader can let his imagination run wild on this one — no further information is given.

About the time of the 1899 Garden show Clarke advanced an interesting plan to use radio waves for detecting the presence of ships, icebergs, and other hazards at sea. (25) According to the idea, when two suitably equipped ships approached each other, a large gong would sound in each. The gong would also operate when an iceberg loomed. Clarke apparently envisioned a form of radar long before its time. But he must have had trouble in implementation because no more is heard of the proposal.

Soon after the 1899 Garden exhibit Clarke managed to persuade the Lighthouse Board, then affiliated with the U.S. Army, to sponsor a demonstration. General Greely, Chief of the Signal Corps, and others foresaw that lighthouse and lightship service would be greatly improved by wireless, especially because spark transmissions could be picked up through fogs and storms that blocked the brightest light. (26)

The tests were run in July 1899. Clarke installed a powerful transmitter in the lighthouse at Tompkinsville, Staten Island, New York. (27) He put one of his simple space-relay receivers aboard the lighthouse tender *Mistletoe*. This craft was built in 1871. She was 137 feet long and had a squared-off hull design, with a high center stack for escaping steam and large side wheels for propulsion. The quaint and homely *Mistletoe* was herself an early experiment in a new technology; it seems appropriate that she should have been the first U.S. vessel equipped to receive electromagnetic-wave radio signals.



**Wood hulled side wheel** steamship *Mistletoe*. **Courtesy** Steamship Historical Society **Collection,** University of Baltimore Library.

The lighthouse tender *Mistletoe* served as the platform for the historic wireless tests run in 1890 between Staten Island and New York City. (25A)

During the tests the coherer receiver on the tender was connected to a bell· The Staten Island transmitter sent out two signals every half minute while *Mistletoe* cruised the five miles between Staten Island and East River Pier 5, New York City. Operation was perfect. The bell rang loud and clear each time a signal was transmitted. Observers included members of the U.S. Lighthouse Board and the Assistant Secretary of the Treasury. Results were called "perhaps the best so far attained in this country." Encouraged, Clarke announced his goal to extend the range to 50 miles. But if this goal was achieved, it was not reported. And, as happened so often to this unlucky entrepreneur, the large sales of wireless equipment for lighthouse and lightship installation that were hoped for did not happen. In fact the Lighthouse Board had budgeted no funds at all for wireless.

1899 continued as perhaps Josie Clarke's busiest year. Shortly after the *Mistletoe* tests he left for Canada to demonstrate USESCO apparatus at the big exposition and industrial fair held in Toronto from August 28 to September 9, 1899. This fair was first held in Toronto in 1879 and has been an annual event ever since. Clarke's part in the 1899 show was announced in the official program under "Advance of Electrical Science," and the exhibit was said to include "Wireless Telegraphy, Wireless Telephoning, High Tension Effects, Improved X-Rays, Etc., Etc." (28) It must have pleased Clarke to have been able to demonstrate such up-to-the-minute technology in his native Canada. The inclusion of "Wireless Telephoning" is particularly intriguing because almost nothing had been done in that field at the time. What sort of apparatus could he have shown?

Clarke's demonstrations of wireless and other aspects of electrical technology should have constituted a more than ample contribution to the 1899 Toronto exhibition. Yet he was so absorbed in new scientific wonders he went beyond this. He staged exciting grandstand displays of liquid air. (29) The crowds were so large he had to use a megaphone to explain the nature of this curious substance. He demonstrated how liquid air could be poured; how it would freeze butter instantly; how a sample of mercury could be used as a hammer after it had been dipped in liquid air; and how a rubber ball, an onion, and a piece of iron could be easily broken into pieces after the treatment. Finally, being fond of ending with a bang, he demonstrated the explosive properties of liquid air.

*Reporting a Yacht Race*

The America's Cup yacht races were a major international sporting event in 1899, as they are today. The 1899 competition had the doughty Englishman Sir Thomas Lipton as challenger, sailing his first *Shamrock*.* The American yacht *Columbia* was cup defender. Races were held October 16th, 17th, and 20th. All started and ended at Sandy Hook Lightship at the entrance to New York Bay, about 35 miles from New York City proper. A straight 30-mile course, 15 miles out and return, was used on the first and third days, and a triangular 30-mile course (10 miles each leg) was used on the second day.

Naturally these colorful races have never failed to bring out the world press in force. But a unique feature of the 1899 event was that for the first time wireless was used to provide a running account of the competition as it took place.

The *New York Herald* was responsible. The paper had originally asked the distinguished Professor Reginald Fessenden to provide means for reporting the races by wireless. Fessenden was a top expert in the field. But he was busy with other research. So he referred the *Herald* to Marconi, who was in England at the time. (18) Marconi was interested, but believed commitments abroad would prevent his participation. So the paper contracted with Wm. J. Clarke for his services and equipment. As it turned out, Marconi was able to come after all, and both he and Clarke shared in providing the desired radio coverage. (31)

Marconi was placed in overall charge. His was much the bigger name and he supplied the bulk of the apparatus. Therefore in many accounts Clarke's participation is overlooked. In fact several contradictory versions of the event have appeared in print.

*This was the first of the five tries Lipton made at the cup over the course of 31 years. He lost each time. he did so with such gallantry he became known as the world's finest loser. The writer witnessed his last attempt (*Shamrock* V vs. Harold Vanderbilt's *Enterprise*, 1930). Sir Thomas cut a magnificent figure. Many (including Americans) were saddened to see him come in far behind. He died the following year.

Fortunately for the historical record, however, Clarke was assisted by the prominent electrical engineer and technical author William Maver, Jr. (32) From the separate accounts of Maver and Clarke, together with the articles in the *New York Herald*, (33) we can learn how the work was divided. These references carry weight because they come from people who were on the scene, rather than impressions garnered from second- or third-hand sources.

A Marconi transmitter and receiver were placed aboard the new and fine 17-knot, 3200-gross-ton steamship *Ponce*, where Marconi himself presided. Clarke, Maver, and a telegraph operator named Rickard (a Marconi employee) were in the captain's cabin of another medium-sized steamship, *La Grande Duchesse*, along with USESCO transmitting and receiving equipment. An antenna of 115 feet was employed.

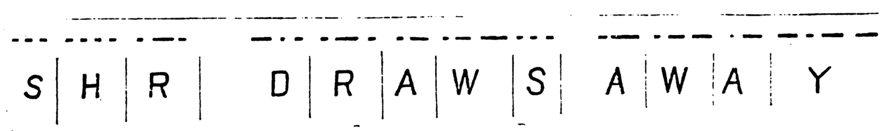
On at least one race day, over 500 visitors were aboard *La Grande Duchesse* for a front-row view of the races. Many jammed into Clarke's limited work area to see the wonders of reporting by wireless telegraphy at first hand.

Both ships followed the yachts as they raced. The original plan was to divide transmission times according to flag signals passed between *Ponce* and *La Grande Duchesse*. But vision between these ships was often blocked by the many other vessels along the course. So *Ponce* transmitted exclusively the first day. On the second and third days the ships transmitted alternately according to a previously agreed time schedule.

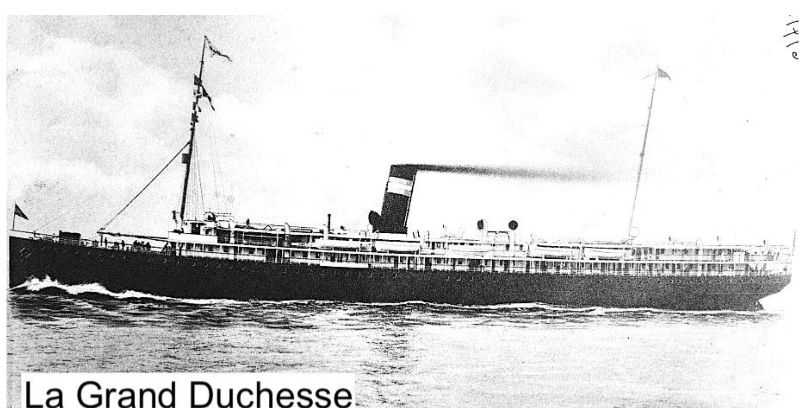
Signals from whichever ship was transmitting were picked up at two receiving stations. One, using a Marconi receiver, was aboard the cable ship *Mackay Bennett*, which had anchored at Sandy Kook in order to tap into the transatlantic cable and thus allow race news to be relayed to Europe without delay. The other Marconi receiving station was installed 9 miles away at Navesink Highlands, New Jersey, where an antenna 150 feet high had been erected. The *Mackay Bennett* relayed the news by cable both abroad and to the *Herald* offices in New York. Navesink also relayed the news to the *Herald* offices by land wire. The two sets of messages could be compared for agreement, providing a check on accuracy.

Both the USESCO and the Marconi apparatus performed in exemplary fashion. Abbreviations were used to speed information flow, such as SHR for *Shamrock*. A signaling speed between 12 and 15 words per minute was attained. Tireless communication was maintained up to 15 miles range. The *New York Herald* received about 2500 words of race news as it happened, virtually error-free. European papers that received cables from the *Mackay Bennett* also had fine coverage.

The experiment was a success. The way had been paved for the Ted Husings and Howard Cosells of generations to come.




The line of dots and dashes above shows the form the New York Herald received news of the America's Cup yacht races as they were being run. The pattern illustrated appeared on the register tape aboard *La Grande Duchesse* while transmissions from *Ponce* were being picked up. Identifying letters were added later. (Drawing from page 568, *Electrical World and Engineer*, Oct. 14, 1899 [one of the earliest recorded wireless messages]


La Grand Duchesse

*La Grande Duchesse*. W.J. Clarke and associates reported the 1899 America's Cup races from this steamship. USESCO transmitting and receiving apparatus was installed in the captain’s cabin. The ship was packed with passengers eager to view this great sporting event and incidentally to observe the new wonder of wireless at work.

*Pictures by Wire and by Wireless*

The successful use of wireless to report the 1899 America's Cup yacht races prompted Wm. J. Clarke to propose an even more ambitious scheme for the next race series, scheduled for the fall of 1901. He would again transmit race news in code from the scene. In addition he would transmit the scene itself! His plan was to radio pictures of the racing yachts under way to a New York newspaper. (34)

The idea must have seemed at the time like something out of Jules Verne. Clarke was confident he could pull it off, however. The reason was that he had adapted the recently developed Hummel method of sending pictures by wire to transmitting and receiving them over the air. His experiments with the technique may have been the first application of facsimile by radio.

The basic apparatus was the brainchild of Ernest A. Hummel, an expert clockmaker of St. Paul, Minnesota. (35) Hummel used two clockwork-driven synchronized revolving cylinders of equal size, one for sending and one for receiving. The picture to be sent was drawn with an insulating ink on a sheet of tinfoil. The foil with inscribed picture was then wrapped around the cylinder of the sender. A platinum stylus mounted on a lathe carriage travelled slowly along the length of the cylinder as it revolved, so that in time it traversed all the lines of the picture. The stylus and the foil were connected together electrically. Each time the stylus reached one of the insulating ink lines the circuit was broken, to be reestablished when the line was crossed and contact with the foil was again made.

The receiving cylinder was wrapped with a sheet of white paper topped by carbon paper, marking side down. Relays at the ends of the link were connected so that whenever the sending stylus encountered insulating ink, a solenoid at the receiver was energized. It pressed the receiving stylus against the carbon paper backing. The carbon marked the white sheet. Gradually a replica of the original picture took form.

The cylinders revolved at about 14 rpm. On each revolution the receiving stylus was made to start at the top of the paper sheet at the same instant the sending stylus started at the top of the tinfoil. This was done by running the receiver cylinder slightly —1 or 2 percent —

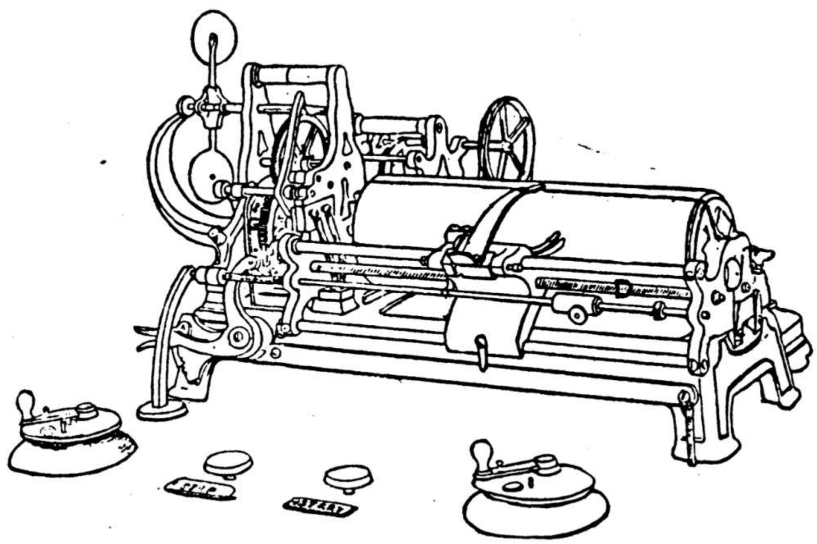
faster than the sender, then holding it at the end of each revolution until the sender caught up. The hold mechanism was actuated by the gap that separated the ends of the foil after it had been secured to the cylinder of the sender. This method of synchronization was a special feature of the Hummel design. Another feature was an automatic stop that shut the device down after a picture had been sent.

Clarke demonstrated this facsimile equipment in operation over telegraph lines at the Canadian National Exhibition of 1901.* The first showing was on August 23, 1901. Sender and receiver were set up in the Great North Western telegraph offices in Toronto. A drawing of President McKinley was sent over the wires to Hamilton, Ontario and back, a distance of 80 miles. Twenty minutes were required to complete the picture. The test went well. Praise was unrestrained; the Toronto *Daily Star* went so far as to headline the results as a "Triumph of the Telegraph in the Field of Art." (36)

We do not know exactly how Clarke adapted this facsimile apparatus to wireless. Most likely he altered the relay circuits to permit the Hummel sender to be used in place of the telegraph key in the USESCO transmitter, and the Hummel receiver to be substituted for the Morse sounder at the other end of the link. In any event, Clarke stated the adaptation worked well. Unfortunately if it was tried at the 1901 races — and this is in doubt — it was fated not for triumph but for almost certain defeat.

Three organizations competed to report the 1901 races (*Columbia vs. Shamrock* II) by wireless. (37) Little was known about the selectivity afforded by tuned circuits at the time, so it was inevitable the competitors would interfere with each other whenever they were on the air at the same time.

*As early as 1899 Hummel facsimile apparatus linked by wire newspaper offices in St. Louis, Chicago, Philadelphia, New York, and Boston.



(Top) Half-scale unretouched reproduction of picture transmitted and received by Hummel facsimile apparatus over 1500 miles of telegraph line, with one repeater in circuit. Trade name for the apparatus was “Telediagraph.”

(Bottom) The sending unit of the Hummel Telediagraph, part of the equipment successfully demonstrated by Clarke over a Toronto-Hamilton link in 1901.

—drawings from *Electrical Review*

To make matters worse one of the organizations, American Wireless Telegraph and Telephone Co. (AWT&T), deliberately tried to jam the other two. These were Marconi's company and de Forest’s Wireless Telegraph Co. of America. AWT&T made use of a 20-inch induction coil to create blockbuster code signals. These signals, according to Marconi people on the scene, largely spelled out “vulgar and meaningless words.” Vulgarity and gibberish were supplemented by dashes that had a dual purpose: (l) they were long enough to obliterate signals from other transmitters, and (2) they carried race information.

One long dash meant that *Columbia* was ahead and two signified that *Shamrock* II was in the lead.

Toward the end of the races a time-sharing plan was worked out, but on the whole wireless coverage of the event was a fiasco. (38)

The delicate and intricate tapestry of picture signals sent out by the Hummel-Clarke apparatus stood no chance in the electromagnetic environment of the 1901 America’s Cup races. So it doesn't matter whether or not Clarke actually tried to follow through with his plan to radio pictures of the racing yachts. The point is moot.

*The Business Side*

Prospects for wireless equipment sales in the U.S. at the close of the 19th century seemed bright indeed. The technology promised greater safety at sea at a time when maritime trade was increasing and ships in distress were all too common. It offered a means for control and coordination of widely dispersed Navy and Army forces just as the U.S. was establishing itself as a major world power. And it extended communication beyond land lines to areas important to an expanding nation — the jungle plantation, the remote mine, the explorer's camp.

Wireless should have boomed. It did not. Its failure to catch on rapidly was probably caused by such factors as inadequacies of available gear; the slowness with which a bureaucracy such as government or big business adopts anything new; unscrupulous stock promoters who gave the field a bad name; and restrictive patent practices which discouraged open competition. When U.S. Electrical Supply Co. started in 1897, there were no other radio companies in this country. There were none in 1898. In the period 1899-1902 a number of firms entered the field, but mainly as utilities rather than set manufacturers. (39,40) At various times during this period some notable pioneers designed transmitters and receivers to be built in the U.S. These pioneers included Lee de Forest, Robert Marriott, John Stone Stone, Reginald Fessenden, Walter Massie, G.W. Pickard, and Harry Shoemaker. But the combined output of the companies with which these men were associated was tiny in terms of hardware. And the little momentum that had developed by 1902 was too late to affect Clarke's company, for its fortunes had already failed into a decline.

Nonetheless USESCO had an impact. The *Scientific American* refers to Clarke as a "well-known maker of wireless telegraph instruments." A USESCO spark transmitter is pictured as a good example of its kind in an early wireless text. (41) The publicity resulting from Clarke's promotional activities must have attracted wide interest in wireless and increased public understanding of its potential. Unfortunately this did not translate into a large volume of business.

Records can be located only for scattered, random USESCO sales. Here are those we know about today.Early in 1899the Army Signal Corps bought two USESCO long-distance transmitters and two standard "high-class" receivers. (42) This equipment proved to be hard to adjust and the instructions shipped with it could not be located. Throughout history, apparently, technical manuals can never be found when needed! Clarke responded by journeying to Washington, D.C. to make the adjustments himself. Thus he became in effect the first American electronics field engineer.

By May 1899 one USESCO transmitter was in operation in the War and Navy Building in Washington. The flagpole was used to hold the vertical antenna wire. The receiver was first placed about ¾ of a mile distant, at the old Naval Observatory. Later it was moved further away to the Signal Corps station at Ft. Myer, Virginia. (44) Although letters and words were successfully communicated in code between the two points, message service was "unreliable and uncertain." The receiver was temperamental. Another factor was the shielding effect of metal in buildings along the transmission path. The unsatisfactory performance must have damped Clarke's hope for large wireless sales to the Signal Corps. Subsequently he apparently sold some induction coils to the service, but not complete equipment.

In September 1899 the Corps established a successful 10-mile wireless communication link between Fire Island (N.Y.) and the Fire Island Lightship. (45) This path, being over water, was more favorable than the city environment of Washington - Ft. Myer. The transmitters and receivers used were credited to Signal Corps engineers. It is not known if the equipment was completely new or modified USESCO units.

Another potentially big purchaser of USESCO wireless equipment was the U.S. Navy. But so far as is known, there were no sales to this service ·Colleges with science departments were natural customers for early wireless apparatus. Clarke undoubtedly sold to this market. For example, on April 4, 1900 Ohio State University bought a USESCO coherer receiver for use in its physics laboratory. (46) The price paid was $26. It was the simple or space-relay model, with an integral bell as output device. It impressed Robert H. Marriott, then a student at the college. The set helped him with his study program, a unique one for the day — a major in physics with a specialty of wireless. (47) Marriott went on to become one of the most illustrious of American radio engineers, and he was the first president of the Institute of Radio Engineers (now known as the Institute of Electrical and Electronics Engineers [IEEE]).

Other apparatus ended up in homes. A correspondent of the *Electrical Review,* Wm. J. Hammer, reveals that he used wireless to "fire a small cannon in my parlor while entertaining a party of friends in my home." Clearly this bears the imprint of William Joseph Clarke. Hammer states he did indeed buy the outfit from him. (48)

Hammer also rigged a USESCO transmitter and receiver to summon the family's maid. This calls to mind the wired intercoms Josie had installed in Trenton twenty years earlier to rouse maids who "overslept themselves." Dr. Lee de Forest saw Hammer's servant alert and praised it as the first application of wireless to domestic needs. Installations of this type did not catch on, however, perhaps because few homeowners had Hammer's talent for rationalization. He claimed the wireless system avoided the wear and tear on the carpet of a floor pushbutton and the "considerable expense, annoyance and dirt" of a bell connected by wire.

In April 1899 the U.S. Weather Bureau, then under the Department of Agriculture, began to plan the establishment of wireless stations to transmit weather information to ships and shore stations. Willis L. Moore, Chief of the Weather Bureau, asked the Signal Corps to recommend a supplier of suitable equipment. Brigadier General A.W. Greely, the Chief Signal Officer, duly furnished Clarke's name and business address.

In subsequent correspondence Clarke quoted the Weather Bureau a price of $460 per station for apparatus similar to that previously sold to the Signal Corps. (49) To put this in perspective, the Consumer Price Index in 1899 was 25, as referred to a CPI of 100 in1967. At this writing the latest CPI — that for January 1982 — is 282.5. Therefore, the station price now [1982] would be $5198 [and $14,500 in 2021].

The quotation called for furnishing the following:

| | Quoted Price |
|---|---|
| One "Clarke" complete receiver | $100 |
| large oscillator | 100 |
| 8-inch specially wound induction coil | 150 |
| 4-cell portable storage battery | 40 |
| special Morse key | 10 |
| specially wound self-starting, self-stopping Morse register | 60 |
| | $460 |

The complete receiver included both a sounder and a vibrating bell.

The Weather Bureau purchased at least one of the receivers and some separate components, such as coherers at $10 each. The receiver (possibly after modification) was successfully tested over a communication range of 11½ miles. This was done under the supervision of Reginald Fessenden, who at the time was in charge of the Weather Bureau's experimental wireless studies. The site was the Bureaus station at Cobb Island, Rocky Point, Maryland, some 50 miles south of Washington, D.C.

Fessenden's technician F.W. Very also conducted a number of tests with the coherers, although at the time he was concentrating on an entirely different type of detector (the "ring" detector, a form of. galvanometer). In addition, there were negotiations over the purchase of an open-core oil-filled transformer with a 25-ampere, 110-volt primary and a 15- to 20-thousand-volt secondary. Clarke wanted $180 for this transformer [~$2,000 in 1982; ~ $5,700 in 2021]. It was sold complete with mahogany box and carrying handles. A real Rodeo Drive item.

Fortunately a number of letters written by Clarke to Fessenden in 1900 and 1901 have been preserved. They reveal the turning fortunes of United States Electrical Supply Co. and show why Clarke switched careers in midstream. (50)

[F.W. Very Notes]

Tuesday May 22

The yawl as rigged in accordance with description of preceding day was then anchored about 30 yards from the sending station. The sending station was equipped in this instance with a 6 in spark induction coil. A motor for running break-and-make machine, which machine was used only for purpose of breaking circuit in the primary. A spark gap in air was used. Under these conditions it was found that the coherer responded from the original distance up to an estimated distance of 300 yards. It may be said that the coherer was the Clarke pattern made by the U.S. Electric Co., and was provided with platinum terminals adjoining the filings.

In 1900 Reginald Fessenden's technician F.W. Very tested some USESCO equipment at the experimental Weather Bureau station at Cobb Island, Rocky Point, Maryland. Here Very mentions a Clarke coherer in his handwritten engineering notebook. He's a bit confused about the company name, however.

The letters dated early in 1900 reflect high optimism. Business was good. Influential people were interested in the company. New capital had been promised. Several contracts seemed assured for large communication system installations in foreign countries. It was expansion time. The company needed room to grow. So Clarke made the same decision as many executives have since his time : move to the suburbs. He even selected the same area many of them would, Westchester County. He chose Mt. Vernon, N.Y., a short train ride from the Big Apple.

By mid-1900 the United States Electrical Supply Co. laboratory had moved from the Lexington Building in New York City to 331 South First Avenue, Mt. Vernon. This address also became the Clarke family home. A separate plant was planned. Clarke consulted with Mayor Fiske of Mt. Vernon on the subject. The concern was expected to give "profitable employment to a large number of skilled mechanics." (51)

It never happened. The prospective clients had in mind communication nets that extended over many hundreds and even thousands of miles. Such nets would require far too many relay stations, considering the 15-mile maximum separation of a USESCO transmitter and its associated receiver. The customers also looked for faster signaling than the 15 words per minute the gear could handle. Major technological improvements were needed in the equipment. Clarke did not feel he could make them. So he turned to Fessenden for help.

One prospect wanted a guarantee of effective wireless communication between several stations 50 miles apart, located at high sites in a mountainous area. Clarke promised Fessenden an engineering fee of $100 per station for this job.

A more demanding assignment called for transmitters and receivers to cover 1000 miles without intervening relay stations. The engineering fee was vaguely expressed as being "between $5000 and $10,000."

The third job was the most promising. Clarke was certain he could land the contract. It was for a wireless system that extended over 800 miles. Relay stations, manned if necessary, would be allowed, provided they were at least 50 miles apart. Engineering fee: $12,500. [~$394,000 in 2021] Not bad! Out of it Fessenden would have to pay his own travel expenses, but USESCO in Mt. Vernon would buy the needed material and do all fabrication. Like the other jobs up for bid, the installation was to be in a foreign country. Clarke felt this was an advantage because Fessenden could do the engineering without being in competition with his efforts in the U.S. for the Weather Bureau.

None of the plans materialized. Fessenden was interested. But he turned the offers down. Perhaps he felt his own inventions and developmental work had not progressed far enough for him to guarantee the desired system performance. Another complication may have been Clarke's insistence that none of the designs infringe Marconi's patents. Clarke held a high opinion of Marconi and wished to maintain the good relations he had had with him in the America's Cup days. Indeed the patent situation may well have stalled Clarke's own efforts to engineer better apparatus. Marconi refused to license others to use his designs.

In any event, U.S. Electrical Supply built no factory in Mt. Vernon. Nor can the firm be credited with any large wireless system installations. In fact available information suggests that USESCO turned out little or nothing after 1902, although the laboratory was maintained, and the company name continues to appear on Mt. Vernon records until 1909.

There were shining business prospects on Clarke's horizon when the 20th century began. They turned out to be mirages.

*Drawing the Curtain*

Disappointments in the marketplace caused Wm. J. Clarke to shift from entrepreneurship to the role of science lecturer in the early 1900s. The press soon started to refer to him as "Professor." Perhaps this was more his forte. He lacked the arrogance of the successful entrepreneur. For example, he once told the American Institute of Electrical Engineers: "I must accord to Mr. Marconi the credit for having by far the best (wireless) apparatus, better than any I have seen in America, including my own." Such a gracious remark about a competitor would never be uttered by a hard-bitten businessman, or for that matter by very many radio engineers.

Professor Clarke was adept at the podium. He had a gift for it. The Mt. Vernon (N.Y.) *Daily Argus* commented about a talk he gave: "The lecture was very instructive, and there was not a minute of it that was not interesting and intelligible to those in the audience who had even no knowledge of electricity." (52)

Other papers agreed with this judgment. Clarke's talks were well received not only in the largest cities but also in places like Lawrence, Mass.; Bridgeport, Conn.; Lancaster, Pa.; Richmond, Va.; Ocean Grove, N.J.; and many others. ( 53) *The Daily Argus* noted that Clarke's "first lecture tour of the season" in 1903 was for eight weeks in the west. He probably went on several such tours a year, and the paper mentions a twelve-week one in 1905. He also gave a series of talks at the big electrical show in Chicago in 1906, although — surprisingly — he missed the international electrical exposition held in St. Louis in 1904, where Lee de Forest was a star attraction.

In those days, with no movies or TV to entertain, the touring lecturer was more popular than he is today. Of course, Clarke must have put on a lively show. His were multimedia presentations. He made liberal use of pictures and he demonstrated apparatus at work, including Nernst lamps [a ceramic incandescent], the electric phonograph, X-ray devices, electric arc welders, acetylene apparatus (he called acetylene "the light of the future"), liquid air, and certainly wireless. Most likely he punctuated the proceedings with an exploding bomb or two as well, or a cannon shot.

And one cannot help but wonder — was it on a lecture tour that Clarke had his audience of one hundred hold hands, not to evoke spirits but rather to receive a good shock from his handy 8-inch induction coil? He was a strong believer in the experimental method, learning by doing.

On March 30, 1909, William Joseph Clarke died of an illness in Mt. Vernon. He was 48. This early death robbed him of the joy of seeing many of his great dreams for wireless come true. He was survived by his widow Ida (b. 1876), his son Kenneth (b. 1900), and his daughter Muriel Marjorie (b. 1906).

No more is heard of the United States Electrical Supply Co. after 1909, although the company remained on the books of New York State until 1924. Mt. Vernon records show the company laboratory was at 331 South First Avenue from 1900-1902; at 434 South Sixth Avenue from 1902-1907; and at 558 South Ninth Avenue from 1908 until Clarke’s death. In all cases the laboratory and the family address was the same. Ida, Clarke's widow, was listed in the Mt. Vernon city directory as late as 1937.

He was not a genius. But Josie Clarke made some valuable contributions. He distinguished himself as a young man by becoming the leading electrician of Trenton, Ontario, where he set several electrical “firsts” and reportedly experimented with wireless in 1881 — very early indeed, and long before Marconi.

After he left Canada to work in the United States, Clarke continued to create firsts. He became the first hobbyist-experimenter in the radio field; the first U.S. manufacturer of transmitters and receivers; the first to bring radio to the place that became Radio Row; the first to employ radio control of explosives; the first to showcase radio; and the first to provide radio coverage of an American sporting event. Moreover Professor Clarke broke new ground by giving the people of many an American city and town their first clear understanding of the mysteries of radio.

*William Joseph Clarke has been a neglected figure in radio history· He deserves better. Think of him as an advance man for the present wonderful Age of Electronics.*

## ACKNOWLEDGEMENTS

My thanks to Thomas J. Gauthier and Neva McEwan of Trenton, Ontario and to Nancy Hurn and Richard Irvine of Toronto for information on Clarke's activities in Canada. I am indebted also to Virginia Moskowitz and Byron Roff of Mt. Vernon, New York, for locating records of Clarke's life in that city. John and Martha Nagle, Alan Douglas, Charles Van Hagan, and John Purcell reviewed the manuscript or provided valuable help in other ways. And several great American institutions were most cooperative and helpful, including the Massachusetts Institute of Technology, the New York Historical Society, the Engineering Societies Library, the *Scientific American*, the Museum of the City of New York, and — especially — the National Archives.

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H. L. CHADBOURNE
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Dear Hal: 28 June 1982

Believe I sent you an early version of my paper on Wm. J. Clarke, and after reading it you wondered what happened to the man after age 41. Read the enclosed and you will find out! It contains a lot of new info, and I think is a big improvement over the earlier drafts.

Most recently I've been concentrating on very early Army (Signal Corps) gear. This isn't as well documented as it might be but the Army history people in Washington are trying to be helpful and I believe I can persuade a retired Signal Corps colonel who lives in Washington to do some checking at the National Archives for me.

Hope you find the enclosed of interest.

Regards,

Chad

P.S. Pls. don't circulate too widely - I'm investigating possibility of having ms. published.

Hope all goes well with you -

To the Archives of the California Historical Radio Society, from Hal Layer, CHRS

Bart Lee

bart.lee K6VK@gmail.com

CHRS Archivist; 29 XII '20.

# Archivist's Note

by Bart Lee, K6VK, CHRS Archivist and Fellow,
AWA Fellow.

The foregoing text is entirely the work of the late H.L. Chadbourne and bears a copyright notice of 1982. He died in 1988. He hoped to have the article published. Professor Hal Layer, CHRS, provided it to the CHRS Archives. CHRS has had it converted into a MS-Word document and then a PDF; which is posted. (The conversion and editing omitted almost nothing, and added almost nothing, and any addition appears in brackets[]).

It is the opinion of this archivist, a retired attorney with a long Intellectual Property and Copyrights practice, that Chadbourne's article is what is known as an "Orphan Work." He is long dead, and his only son Dr. Thomas Chadbourne, cannot be found and may also be deceased. This present limited, non-commercial publication is a "Fair Use" by a non-profit historical charitable organization; see:

United States Copyright Office, *Orphan Works and Mass Digitization, a report of the Register of Copyrights*, June 2015.

Anyone asserting any right in this writing should so inform CHRS by use of the DMCA "button" on the website or directly, and all issues will be resolved. We have the greatest respect for H.L. Chadbourne and his work.

The Chadbourne family association notes, by personal communication:

[He was] An extremely skilled technical writer for the US Navy, his extensive articles on antique autos and other subjects were widely published.

He was a tenth generation Chadbourne descending from an English immigrant to what is now Maine in 1634, William

Chadbourne.[1]

H. Lincoln Chadbourne attended Avon Old Farms School (Class of 1934) and wrote about some radio adventures at school, legal and otherwise, "Illegal Snakes and Radio Transmissions" by H. Lincoln Chadbourne.[2]

Chadbourne was a "writers' writer." Two of his technical books for the Navy are noted on Amazon.com (but in the $700 range!):

1) TECHNICAL REPORTS FOR QUICK READER COMPREHENSION, (Paperback – January 1, 1961), By H.L. Chadbourne (Author), U.S. Navy Electronics Laboratory.

This text is also available on the Internet.[3]

2) TITLING TECHNICAL REPORTS FOR OPTIMUM USE AND RETRIEVAL , Paperback – January 1, 1965, By H.L. Chadbourne (Author), U.S. Navy Electronics Laboratory.

H.L. Chadbourne also wrote a long article about wireless in Alaska. The IEEE has a copy:

PW-1571, Chadbourne, H. Lincoln: "Leonard D. Wildman and the First Alaskan Radio: How in in 1904 a Talented Naval Officer Put Seward Peninsula in Rapid Year Round Communication with the World" (1984)[4]

One military historian noted:

… H. L. Chadbourne in his unpublished study, "Leonard D. Wildman and the First Alaskan Radio (Safety Harbor-St. Michael)" documents the trials and tribulations of building this system that delayed its successful operation until 1904. The confusion may stem, as Chadbourne believes, from the chief signal officer's annual report of 1904. Although the report is supposed to cover the Corps' operations up to 30 June 1904, it includes the successful opening of the Norton Sound station two months later. This date

[1] http://chadbourne.org/Piedcows/Issue02.pdfn

[2] ASPIRATION AND PERSEVERANCE — THE HISTORY OF AVON OLD FARMS SCHOOL; editor: Gordon Clark Ramsey [Class of 1980], published on Mar 19, 2015. "Avon Old Farms is an all-boys private boarding high school in Connecticut" (and so notes its website).

[3] https://apps.dtic.mil/dtic/tr/fulltext/u2/624448.pdf

[4] https://ethw.org/Archives:IEEE_History_Center_Library . There is also a copy at Berkeley: https://dpg.lib.berkeley.edu/webdb/hstc/search?author=&xsubject=Radio%2e&item=7

has apparently been misinterpreted by some writers as August 1903. [5]

Chadbourne researched, extensively, early communications radio firms. This work is now lost. Chadbourne often communicated with radio historian Alan Douglas, who cited his work (as Chadbourne had cited Douglas's work as well). Douglas wrote in *Antique Radio*:

> Here's some additional information on permeability tuning, copied from a letter I received in May 1980 from H. L. Chadbourne of La Jolla, California. Chad, now deceased, was researching the development of communications receivers for a book he intended to write, and he had corresponded with engineers and company founders before changing his focus to pre-1900 wireless. He felt he would never know enough to do a really authoritative book on communications receivers, but he was wrong. I wish he had done it.[6]

So do we.

+++

As Chadbourne discusses in his text, Clarke put on an 1899 demonstration in New York of a wireless system on a large piece of plate glass. The glass ensured that no claims of hidden wires would trouble the exhibit: [7]

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[5] https://history.army.mil/books/30-17/III-100.htm

[6] https://worldradiohistory.com/hd2/IDX-Site-Early-Radio/Archive-Antique-Radio-IDX/IDX/90s/1996-04-OCR-Page-0016.pdf

[7] From *The Electrical World and Engineer*, Vol. 33, No. 22 at page 776.

## Wireless Telegraphy.

The wireless system of telegraphy which is attracting much wide attention at the present time, both in this country and in Europe, is practically illustrated at the Garden by an exhibit of wireless telegraph apparatus in actual operation.

A complete sending and receiving outfit are shown. The apparatus is all set on a plate of glass about ten feet long and two feet wide. This glass lies upon ten glass telegraph insulators, the whole resting on a light frame structure. At one end of the glass plate is the transmitting apparatus, which consists of an oscillator and a Morse transmitting key on its base. The coil of the oscillator is energized by five cells of New Standard dry battery. Rising from one of the terminals of the high tension coil is a piece of copper wire 12 or 15 inches long. A similar piece of wire is connected with the receiving apparatus at the opposite end of the glass stand. The receiving instruments, all of which are on one base, include a Morse sounder, relay and coherer. The coherer is tapped by the armature of a relay, whose action coincides with the signals received. There is also a Morse register which makes a visible record of the signals. The receiving apparatus is operated by thirteen cells of dry battery. The exhibit is in charge of Mr. M. H. Kerner, who represents the manufacturers of the apparatus, the United States Electrical Supply Company, of 141 East Twenty-fifth street, New York City.


WIRELESS TELEGRAPH APPARATUS.

Chadbourne also refers to Clark's book for boys with an interest in electricity.[8] In that turn-of-the-last century book, Clarke begins:

Preface

When I was a boy I had the good fortune to be poor. Of course at that time I thought it was a great misfortune, but when I look back I see clearly that it was my poverty that has made me what I am. If I had been rich, or even comfortably well-off, it is more than likely that I would never have troubled myself with experimenting to any extent, or if I did, I would have bought the apparatus ready made, and in this way missed all the great pleasure of making it myself; and instead of learning all about what I was doing, I would have really known very little in- deed; so that this book would probably never have been written.

I was very fond of experimenting, but I found it hard to get the materials that I wanted, and almost impossible to find some one who could advise or tell me where to go or what to do; in fact, nearly every one that I spoke to, whom I thought ought to know something about experiments, seemed to think it too much trouble to explain anything to me, and I often felt greatly discouraged. I kept on, however, although I had to walk twelve miles at times to get a little zinc for my batteries, or some other things needed, it was not long before I had learned enough to be in a position to earn my own living.

There are thousands of boys to-day trying to do just what I did, and I am writing this book to try to help them, because I know from experience that it is just the kind of help which they need. W J. CLARKE. [to page 6]

Clarke's electrical book for boys starts with making batteries and ends with a wireless telegraphy system (and a static machine, as well). He ends his text with words of practical wisdom:

When you have built all of the apparatus described in this book, and performed all of the experiments successfully, you will have obtained a good idea of electrical work in general ; but there is still a vast amount that you have yet to learn before you will be master of even one of the many branches of electrical engineering. I would therefore advise you to carefully select the branch that you feel would pay you best, and that will be most agreeable to you and then secure a position at the bottom of the ladder and work your way to the top by honesty and industry. One thing I want to impress upon you above all else, and that is, that the man who is continually studying the interests of his

[8] William Joseph Clarke, A.B.C. of Electrical Experiments A Practical Elementary Book Especially Adapted to Beginners and Students [nd, *circa* 1900+], now available as a "Scholar Select" reprint from Amazon.com.

employer is the only one that will be a success in the true sense of the word. A man of this kind can always find a position, even at times when there are thousands out of work. [Pps. 145-46]

We are grateful to H.L. Chadbourne for saving the work of William Joseph Clarke.

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