THE FIRST CENTURY
WIRELESS AND AMATEUR RADIO HISTORY

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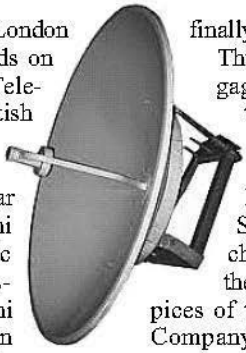
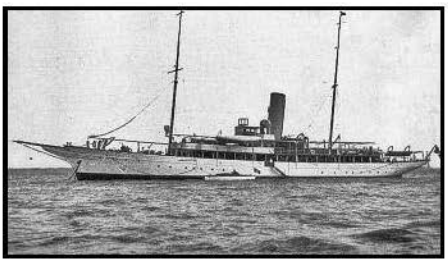
Marconi Introduces the Microwave Era

A plaque is affixed to the London building that now stands on the former site of the Telegraph Office building of the British General Post Office. It was in this long-gone facility, in 1896, that the twenty-one year old inventor, Guglielmo Marconi conducted the first public demonstration of the transmission of wireless signals. Marconi was disappointed that the Italian government was not interested in his newly-developed wireless communications system, and accordingly had brought his equipment to England. He demonstrated to the Postal authorities that a spark coil could generate signals which then could be received by a carbon granular coherer. The Postal authorities were sufficiently impressed to entertain further demonstrations, culminating in a transmission spanning 3.7 miles across the grasslands of southern England's Salisbury Plain. Subsequent demonstrations consecutively spanned the Bristol Channel, the Atlantic Ocean and finally, the globe.



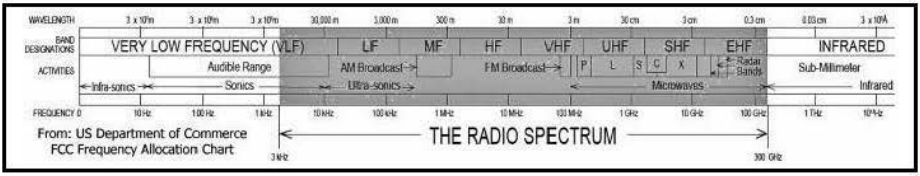
GPO telegraph office building plaque.

Thus commenced the practical engagement of the Wireless Age and the initial Spark Gap Era, which extended for two decades before progressing into the Short Wave Era. In late 1919, early into the Short Wave Era, Marconi purchased a 700-ton steam yacht from the British Navy through the auspices of the Marconi Wireless Telegraph Company. The craft was refurbished to serve as both a luxury accommodation and a floating laboratory. This 220-foot coal-fueled steam-powered vessal was capable of achieving a cruising speed of 10 knots.



SY Elettra.

With a staff and crew of thirty it could sail to anywhere in the world, although it most frequent cruised in Italian waters or between Italy and England. This sailing yacht was christened the *Elettra,* registered in Italy, and flew the Italian flag. The floating radio laboratory was fully equipped for research and experimentation, augmenting the Company's Chelmsford facilities in Wessex. The shipboard environment of the SY *Elettra* was the ideal work place for Marconi, giving him both independence and seclusion. He could perform experiments at any hour of the day or night with-



Frequency spectrum chart.

out interruption as he began to understand the propagation effects of short wave transmission. It also had suufficient room to accommodate the Marconi Company engineers who often assisted the inventor.

In 1923 the SY *Elettra* sailed the waters around the Cape Verdi islands of the South Atlantic, listening for transmissions from the central station at Poldhu, in Cornwall. Progressively shorter wavelengths were tried. It was determined that the shorter the wave length (Marconi utilized 32 meters), the greater the distance traversed during both daylight and night time hours, and at lower power. Shortly thereafter, these experiments were repeated, with the *Elettra* cruising the Mediterranean off the Levant. Marconi had discovered the practical characteristics of the F2 layer of the ionosphere surrounding the earth but at that time was not able to scientifically define it.

By late 1927 the results of the short wave development were manifest. Paralleling the Marconi Company's world-wide commercial wireless system, the Imperial Wireless network commissioned by the British Government now was fully functional. Marconi-designed wireless stations equipped with directional beam antennas operated 24/7 on 32 meters and linked the vast Commonwealth Nation community worldwide. Both systems were enhanced by the newly-implemented ability to impose several channels on one carrier wave, permitting multiplex transmissions of separate messages and the means to send and decipher super high speed telegraphy of thousands of words per minute. These achievements far exceeded the bounds of contemporary expectations and brought great honor to Marconi, the Marconi Wireless Telegraph Company, and their associates. In June of 1926 the world had celebrated the thirtieth anniversary of wireless telegraphy. At a public celebration in his home city of Bologna, Marconi was awarded a gold medal. In an inspired speech he summarized his past work and divided his life into periods conforming to the eras of the Wireless Age we have recognized here. However, at that time he was not aware of the fact that he had already crossed the threshold into another era—that of microwaves—which was to be equally phenomenal and of benefit to society.

After a short pause, the "Daring Genius" (as nicknamed by Dr. Lee de Forest), redirected his attention to hyper/ultra short waves. The Propagation Section of the Marconi entity had done considerable investigation of the behavior of very high and ultra high frequency waves. Consistent with his style, Marconi sought to apply this research to the practical utilization of this portion of the radio spectrum for communication. His first objective was to determine the useful communication range of the high frequency waves in comparison to the optical range, along with the effects of the earth's curvature and surface obstructions. These explorations first required the development of heretofore nonexistent equipment capable of operating at the wavelength of 50 centimeters (frequency of 600 MHz) chosen for this research. Marconi engineer Gaston Antoine Mathieu undertook the assignment. His experience from previous work on the beam-system development was ideal for this new venture. Mathieu, incorporating valves recently developed for use at high frequencies designed a radiophare (ship position locating beacon) transmitter producing a constantly pulsating, sequenced signal at 25 watts output, a sensitive receiver and a dipole antenna with a parabolic reflector. The transmitter and an antenna were initially placed at a land site,

Elettra *radio room and laboratory.*

Hotel Miramar – Santa Margherita Ligure.

and the receiver was installed aboard the *Elettra* with the receiving antenna placed atop the mast at about 16 feet above sea level, or at the stern.

Successions of practical demonstrations were undertaken commencing in October of 1931 along the Italian Mediterranean coast. The first demonstration established a link from the Hotel Miramar in the commune of Santa Margarita south to the commune of Sestri Levanti, 11 miles over open sea. This was followed by a link from Santa Margarita to the town of Levanto 11 miles further south. In early 1932 these links were equipped to transmit duplex telephony. This marked the world's introduction to communication by microwave, which today is common.

In August, 1933 another series of trials was conducted aboard the *Elettra*, utilizing improved transmitting and receiving equipment, while sailing off the Tyrrhenian coast. Signals of 57 centimeter wavelength were transmitted from atop the Hotel Miramar at a height of 40 feet, with a power of

Caption translation: "The parabola of 1.5 meters mounted on the terrrace of the Grand Hotel Miramare. On the left is a very rudimentary "herringbone" reflector."

25 watts. The receiving antenna aboard the vessel was situated at a height of 16 feet above sea level. Signals were consistently received at a distance of almost 100 miles and intermittently at a distance of 160 miles—these ranges were five and nine times beyond the respective optical ranges.

Further tests were conducted in the more southerly Tyrrhenian Sea in the straits between the port of Rome-Civitavecchia and Cape Figari, near Olbia in northern Sardinia. The transmitter, broadcasting at 57 centimeters, was first positioned at Rocca di Papa south of Rome, 15 miles inland and at an elevation of 2,460 feet. A distance of 115 miles was achieved with this arrangement. Four days later, the receiver was removed from the *Elettra* and installed on a land-based signal sta-

Northwestern Italian coast.

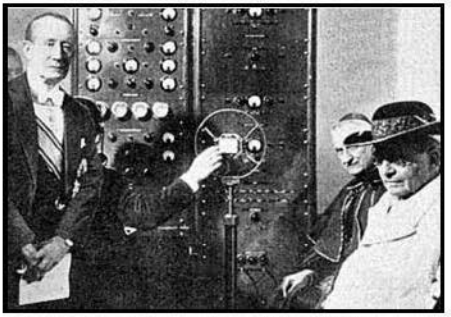
tion at Cape Figari, 1,115 feet above sea level. This land link produced strong, consistent signals over the distance of 168 miles—more than double the optical range.

These experiments established that microwaves could be propagated to distances beyond the optical range, as they were being deflected earthward to some extent, like the longer, lower frequency waves. The experimental variables were elevation, frequency, antenna configuration and power.

In the time between these series of tests, Marconi demonstrated his remarkable abilities by engaging in other related activities. During the 1929-1931 period, Marconi installed an elaborate short wave station at the Vatican in Rome. This system was capable of broadcasting to the world and brought the Roman Catholic Church into the modern era. Subsequently, in 1932, he and his associates installed a microwave telephone channel between the Vatican and the Pope's palace at Castel Gandolfo. Traversing a span of 15 miles, this was the first commercial link on a wavelength shorter than one meter. In the course of operation this link produced an ultra-wave phenomenon that would prove to have enormous consequences.

While these activities were occurring Marconi took time off to participate in a ceremony in his honor. He and his wife Marchesa Marconi landed in New York aboard the SS *Conte di Savola*. During a *New York Times* interview, reported in the

Map showing Marconi's Tyrrhenian Sea test area.



Marconi and Pope Pius XI – 1931 inauguration of the Vatican radio station.

September 29, 1933 edition, he is quoted as saying: "*There is a great vista opening up in the micro-wave spectrum. We have discovered that the tiny waves are not limited to optical distances, as originally believed, that is, the curvature of the earth is no barrier.* He went on to say… "*As prior experience has proven, it is dangerous to put limits on wireless. Now, if we succeed in sending micro-waves over long distances, we may revolutionize the whole art of radio.*" The Marconis' next destination was Chicago and the Century of Progress Exposition—the World's Fair. The following Monday, October 1, 1933 had been designated "Marconi Day" at the Fair.

Marconi and his associates initiated a navigation system utilizing radio-phares transmitting ultra-wave signals. This concept involved the employment of beams of high frequency waves in direction-finding systems, with the transmitter and receiver situated separately. A receiver equipped with a directional antenna aboard a ship or aircraft homed in on signals which were emitted by a specifically located radio-phare beacon, thereby establishing the vessel's direction relative to the beacon. Tuning to several separate navigation beams would enable calculation to establish the ship or aircraft's exact position. This concept was demonstrated in June, 1934 in the waters off Santa Margherita. The *Elettra* repeatedly navigated blind between buoys using only the guiding beam of a beacon placed on a hill on shore. This methodology evolved into today's elaborate and sophisticated com-

puter-assisted navigation systems.

An inadvertent discovery at Castel Gandolfo revealed that the microwave beams were reflected off solid objects in their path. This was fundamentally the mirror or RADAR effect. Other than a few brief tests using an aircraft as a target, other research commitments and health issues prevented Marconi from exploring this marvel prior to his death on July 20, 1937. Marconi and his assocates would be the first to admit that they were not the sole parents of Radio Direction Finding (R.D.F) or RAdio Detection and Ranging (RADAR). They were, however, leaders in establishing the fundamentals, and were among the early applicators of microwaves. Many scientists and engineers came before and afterward to contribute to the development of the system which became a major factor in the outcome of the Battle of Britain and World War II—known as RADAR—which is so significant in today's world.

Chicago World's Fair 1933 – "A Century of Progress."

MEMBERSHIP NEWS, *continued from p. 12*

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• Vintage Radio and Phonograph Society (VRPS) — Meets monthly on the third Saturday. Located in the Dallas, Fort Worth Metroplex, our current activities are annual convention, auctions, swap meets, repair training sessions and monthly programs. For details visit our website www.vrps.org, or by contacting VRPS President Jim Sargent at (817) 573-3546 or bsargent@swbell.net.

BOOKS AND LITERATURE, *continued from p. 30*

for the military, *Stars and Stripes*, also credited Phelps with the invention, although the paper misspelled his name.

The remainder of the book covers virtually everything you would want to know about foxhole radios. It even starts out with a chapter on how to dig a foxhole for your radio according to military specifications, complete with two drawings. Clearly, the author has a sense of humor. According to the author, the foxhole as described in 1940 was a simple affair—a hole three feet wide at the top and a depth illustrated in three stages of digging for prone, crouching, and standing positions.

There are drawings, schematics, sketches, photographs, and other memorabilia associated with various radio designs, including detailed instructions on how to build a foxhole radio. To determine how well some of the razor blades worked, the author actually tested selected razor blades by various manufacturers in a foxhole radio similar to the one Elton Phelps designed, and he used both safely pins and pencil lead as a cat whisker. There is an impressive four-page layout with photographs of his collection of razor blades by various manufacturers of the day.

This book is extremely well researched with many original sources. There are 140 clear images in black and white, 38 pages of endnotes, and a 12-page chronology of foxhole radio sources. If you have any interest in foxhole radios, this book is a must-read. It is a real bargain at $12.95.