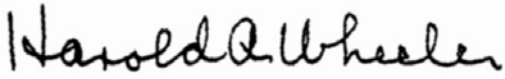

HAROLD ALDEN WHEELER

1903-1996

BY SIDNEY METZGER

IN 1984, AT A SYMPOSIUM celebrating the centennial of the Institute of Electrical and Electronics Engineers (IEEE), Professor Edward C. Jordan, head of the Electrical Engineering Department of the University of Illinois introduced Harold Wheeler as "Mr. Radio." Professor Jordan called Wheeler, "without a doubt the most distinguished living pioneer in the field once called radio, a field which now has developed and broadened into the modern fields of electronics, computers, and communications." Harold Alden Wheeler died on April 25, 1996, in Ventura, California.

He was born in St. Paul, Minnesota, on May 10, 1903, to William Archibald Wheeler and Harriet Marie Alden Wheeler, (a descendant of John and Priscilla Alden, made famous by Longfellow). In 1916 the family moved to Washington, D.C., where his father accepted a position with the U.S. Department of Agriculture. At age thirteen, Wheeler decided on radio engineering as a career. He set up a workshop in his home where he built simple electrical devices, including a crystal detector radio receiver. In April 1920 he received a license for his amateur station 3QK. In 1921 he won a scholarship by competitive exam at George Washington University and majored in physics. His father had advised him to study physics rather than electrical engineering on the grounds that an electrical engineering education at that time was superficial in its treatment of the relevant

science. In later years, Wheeler's papers played an important part in transforming radio art into radio science. While an undergraduate, Wheeler continued working in his basement laboratory. He said that he spent more time there than he did studying.

In 1922 Wheeler met Alan Hazeltine, professor of electrical engineering at Stevens Institute of Technology, who was an inventor and pioneer in applying mathematical analysis to the design of radio equipment. Hazeltine had used these methods in his design of a World War I radio receiver for the U.S. Navy, the SE-1420 which they characterized as “the best receiver for general radio reception that the service and probably the world has ever seen.”

Wheeler told Hazeltine that he had successfully built a radio receiver, in his home lab, incorporating a novel circuit that provided a significant improvement over current designs. Hazeltine was greatly surprised and then showed Wheeler a pending patent application for the same invention, which he had made three years earlier but had never built a model. Hazeltine later remarked that, “Wheeler took it very well.” Wheeler was then nineteen years old and had just completed his freshman year at George Washington. They arranged a patent agreement, and it was decided that Wheeler would work for Professor Hazeltine during the summer of 1923. This was the start of a long and fruitful collaboration.

Professor Hazeltine's invention, which he named the “Neutrodyne” went into large-scale production by fourteen manufacturers in 1923, at which time more than 500 stations were broadcasting to about two million listeners. In early 1924 Professor Hazeltine established the Hazeltine Corporation to manage his Neutrodyne patent as well as other patents, and to provide engineering services, mainly advice on product design to licensees. That year, Wheeler became the first employee of the new firm, but on a part-time basis because he was still an undergraduate. After graduation in 1925 with a B.S. degree in physics, he continued studying physics as a graduate student at the Johns Hopkins University. In 1928 he left Johns Hopkins without completing the requirements for a Ph.D. to work full-time for

Hazeltine. The Neutrodyne, with its distinctive three tuning dials, was the dominant receiver for most of the 1920s. In 1928 the introduction of the screen grid tube made the Neutrodyne technically obsolete, but made possible the application of an automatic volume control (AVC) in AM receiver design. This was an invention made by Wheeler in 1925, which maintained a constant sound level from a radio receiver while tuning to various broadcasting signals of differing strengths. AM radio receivers incorporating this AVC circuit came into use about 1930, and it has been included in every set since then. The AVC replaced the Neutrodyne as the key invention in Hazeltine's licensing portfolio.

The decade of the 1930s was a most productive period in Wheeler's career. He was awarded patents for 126 inventions made before World War II. His inventions and papers during that period covered circuits, test equipment, acoustics, antennas, transmission lines, methods of calculation for inductance of coils (included in all relevant textbooks and handbooks since the mid-1930s), skin effect, coupled circuit theory, television scanning theory (analysis of distortions in TV amplifiers using his concept of “paired echoes”), and the analysis and design of wide-band amplifiers for TV. In 1940 he received the Morris N. Liebmann Award of the Institute of Radio Engineers (IRE) “For his contribution to the analysis of wide-band high-frequency circuits particularly suitable for television.”

In the early 1940s, Hazeltine Corporation switched to military projects. Wheeler led a group of engineers in designing an antitank mine detector, replacing an element critical to the operation of previous designs. Models were rushed into service for the North African campaign of 1942, and later production models saw wide use in World War II and in the Korean War. Another project under his direction involved the design of an extensive series of Identification Friend or Foe (IFF) antennas for aircraft, surface vessels, submarines, and ground stations. By the end of World War II, the so-called lifesaver antennas had been placed on all Allied ships. Of his work on IFF Wheeler said, “Antenna design became a new field of expertise which I embraced immediately.”

Accordingly, in 1947 Wheeler left Hazeltine and formed his own company, Wheeler Laboratories. Most of their work was for Bell Labs, designing microwave circuits and antennas for guided missiles. Antenna design and microwave circuits remained an area of special interest to Wheeler for two-thirds of his career: two decades on receivers from 1920 to 1940 and four decades on antennas from 1940 to 1980. He carried on a theoretical investigation of "small antennas," i.e., antennas of dimensions much less than the operating wavelengths. He published several papers on this subject and the theoretical results were applied to practical problems, including submarines, satellites, rocket nose cones, and, surprisingly, the world's largest antenna. Wheeler consulted for the U.S. Navy on this antenna, which consisted of a dozen fanlike arrays of wires covering an area of two square miles and supported by twenty-six towers, each about 1,000 feet tall. Its effective height was approximately 1 percent of its operating wavelength of 20,000 meters (15,000 Hertz), and therefore it was considered a "small antenna" electrically. Wheeler became interested in array radar and phased-array antennas and published several papers on these subjects. His results were applied to the design of antennas then under development by Wheeler Labs for Bell Labs. In 1959 Hazeltine acquired Wheeler Labs, and Harold Wheeler returned to Hazeltine as a director and chief consulting engineer. Later, he became chairman and then chairman emeritus. He worked full-time until he was eighty years old and then worked three days a week until his eighty-fourth birthday. He filed for his 182nd patent at age eighty-four and published his last paper, the hundredth, at age eighty-two.

Wheeler always argued for understanding design principles and practices and objected to carrying out computations by the use of canned programs or tables. He sought instead a perspicuous symbolic or graphical presentation of the quantitative relationships, expressed as simply as possible.

In 1984 the IEEE celebrated its 100th anniversary by reprinting the classic papers it had published during the past century. These included papers by Alexanderson on alternators, Armstrong on FM, Steinmetz on hysteresis, Barrow on waveguides, and Wheeler on wide-band amplifiers for television.

Professor J.S. Brittain, who edited the collection, noted that Wheeler's paper was the first classic paper by an author who was still living and still publishing. He wrote several important papers on the analysis of strip line (microstrip), with emphasis on their use by the design engineer. The Microwave Theory and Techniques Society of the IEEE published a widely used paper on this subject, written when Wheeler was seventy-four years old. He wrote two historical books, *Hazeltine the Professor* in 1978 and *The Early Days of Wheeler and Hazeltine Corporation-Profiles in Radio and Electronics* in 1982. He published two books of monographs that included nineteen articles he had written in the years 1948 to 1954. In 1964 Wheeler received the most prestigious award of the IEEE, the Medal of Honor, "For his analysis of the fundamental limitations on the resolution of television systems and on wide-band amplifiers and for his basic contributions to the theory and development of antennas, microwave elements, circuits, and receivers." Wheeler received the Microwave Career Award of the Microwave Theory and Techniques Society of the IEEE. In all, he received over fifty awards. He was an adviser to the Department of Defense and served on the Guided Missile Committee from 1950 to 1953 and on the Defense Science Board from 1961 to 1964. He served on several committees of the IRE and was the chairman of the Radio Receiver Committee, which issued a *Standard Guide for Testing Radio Receivers,* used in many countries. Wheeler was a member of the National Academy of Engineering, a fellow of the IRE, American Institute of Electrical Engineers, the IEEE, and a director of the IRE from 1940 to 1945. In 1985 the Antenna and Propagation Society of the IEEE established the Harold A. Wheeler Applications Paper Award.

Dr. George Brown of RCA, former vice-president of engineering and a distinguished antenna designer who received a hundred patents and knew Harold Wheeler and his work for nearly fifty years, said, "Wheeler's publications and patents are profuse and cover such a broad field as to be overwhelming. He is one of the giants of the industry."

I would like to express my gratitude to Dr. Frederik Nebeker, senior research historian of the IEEE History Center of Rutgers University, who interviewed Wheeler for several days as part of

the IEEE's Oral History Program. Nebeker published the material in a paper, "Harold Alden Wheeler: a Lifetime of Applied Electronics" in the Proceedings of the IEEE, August 1992.

Additional material was kindly provided by Henry L. Bachmann, vice-president (retired), now with BAE Systems, formerly Hazeltine Corporation and a colleague of Harold Wheeler for more than forty years.