# Abstracts

## The First Century of Microwaves - 1886 to 1986

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The first century of microwaves began with the historic experiments of Heinrich Hertz, between 1886 and 1889, using what are now called microwave circuits and techniques. His remarkably thorough investigations validated the Faraday-Maxwell theory of electromagnetism, opened up the electromagnetic spectrum between dc and light for scientific and practical uses, and opened up a new line of investigation in the ultraviolet. Even so, his was a step-by-step learning process, alternating between experiments and analytical work. Although Hertz's papers are a model of excellence in technical writing, they are extensive and are difficult to understand, due in part to the hazards of being a pioneer. Nomenclature and ideas that had meaning to him can create unforgiving pitfalls. Hertz's work and his outlook were that of pure scientific inquiry. He never considered patents or products, yet the results of his work form the basis for a wide range of products and services represented in diverse industries and institutions today. Hertz's immediate successors in at least nine different countries made advances in techniques and technology, scaling their apparatus to shorter (millimeter) wavelengths in scientific investigations. The first practical use of Hertz's work in electromagnetic was the wireless telegraphy system. The high-power pulses of RF energy from the Hertzian oscillator could quite readily be formed into dots and dashes of Morse code for the transmitted signal in Marconi's wireless telegraph system (1896). With the need for transmitting increasing amounts of data and information to distant places not accessible to wire or cable, wireless telegraphy experienced rapid growth. The advent of the triode electron tube, the DeForest audion (1906), led to continuous wave (CW) sources, amplifiers, and detectors by about 1914. This made voice communications possible and, equally important, far better use of the RF spectrum. Radio broadcasting started to replace wireless telegraphy. Early microwave system applications, centered in communications and early radar experiments, were stimulated by the advent of CW microwave signal sources in the 1920's. Examples of some of the ensuing advances described in this article are drawn from a search of historical records and from personal correspondence and interviews with some pioneers in microwave devices and applications. This paper is in two parts. Two of the objectives of Part I are (1) to identify, and establish a uniform nomenclature

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for, the apparatus used by Hertz in his experiments, and (2) to serve as a guide to the understanding of the work of Hertz in electromagnetic, especially his experiments. Part II covers succeeding work to the early 1940's in outline, with some detail.

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