ARTHUR W. WARNER, JR.
1915-1996

Thomas A. McClelland
Frequency Electronics, Inc.
55 Charles Lindbergh Blvd.
Mitchel Field, NY 11553
July 2, 1996

Arthur Woodward Warner, one of the giants of the frequency control field, died on June 27, 1996, at the age of eighty. He had been one of the first recipients of the Sawyer Award, in 1969, and of the Cady Award, in 1984. In 1995, he was also awarded the UFFC Society's Lifetime Achievement Award.

Art Warner was born on December 11, 1915. He received a BA degree in physics and mathematics from the University of Delaware in 1940, and an MA degree in physics from the University of Maryland in 1942. He began study towards a Ph.D. in physics at Lehigh University in the fall of 1941, where he was simultaneously employed as an instructor in the Physics Department.

He spent one year at Lehigh University. During this year a representative from Western Electric visited the campus to interview undergraduate students for jobs after graduation. This representative showed interest in several of Mr. Warner's students. Mr. Warner inquired as to whether Western Electric might also be interested in him. The representative asked about his particular technical experience, and upon learning that Mr. Warner had cut crystalline quartz, and was in the process of making measurements with the resulting crystal samples, hired him on the spot. War time needs for radio transmitters had resulted in a huge demand for quartz crystal technology. Western Electric crystal production skyrocketed during the war to a daily rate surpassing the pre-war annual production rate.

Mr. Warner worked for Western Electric from 1942 to 1943. During this time he actually spent considerable time at the Bell Telephone Laboratories, in Whippany, NJ. In 1943, he was hired by Bell Labs, where he spent the next 34 years of his professional career as a Member of the Technical Staff.

Initially at Bell Labs, he worked on improvements to the GT cut crystal plate, which during World War II represented the best frequency-temperature performance available in quartz crystals. However, he soon became interested in what was then the high frequency range for quartz crystals: 1 to 10 MHz. During the following years Mr. Warner made a series of discoveries which revolutionized the field of quartz crystal resonator technology. He was first to apply direct plating of electrodes onto crystal blanks in oscillator-crystal applications, as well as the first to use pure gold electrodes. He first recognized the advantage of contoured resonators, discovering that although resistance might increase, resonator Q also increased. This led him to the study of high overtone modes which, like the contoured blank, had been considered the wrong approach because of the increase in resistance with overtone. He was motivated in this study by the improved impedance match to available oscillator circuits

of a 100 to 200 ohm crystal compared to a 10 ohm fundamental crystal. This line of study led Mr. Warner to the development of the 5 MHz, fifth overtone, AT-cut resonator. He systematically perfected this and similar designs during the 1950's and 60's. Many improvements, which are now part of the standard processing of precision crystals, were first implemented and perfected by Mr. Warner during this period: surface polishing, chemical etching, and high vacuum enclosures, to name a few.

During the late 60's and early 70's he began to work more and more on the development of new materials, and in particular on electro-optic materials for use in the development of fiber optics. He received numerous patents for devices related to this work, including a low insertion loss connector for optical fibers which was produced in large quantities for use in early fiber optic systems.

In 1977 he retired from Bell Laboratories, and began to work for Frequency Electronics, Inc. as a technical consultant. He worked at Frequency Electronics, Inc. in this capacity continuously from 1977 to 1995. During this time he actively participated in (and in many ways led) the development of practical doubly-rotated quartz crystal resonators with much improved acceleration sensitivity, and fast thermal stabilization. More recently he led the development of lateral field excitation designs for SC-cut resonators, for which he received a patent. He continued to participate in the development of quartz crystal resonator technology at FEI, where his experience, technical insight, and never flagging desire to "roll up his sleeves and get his hands dirty" bore fruit right up to his retirement last year (1995).

In his long career, Mr. Warner authored over 50 papers related to quartz and its application in precision frequency sources. In addition, he holds 14 patents related to this field. His pioneering work on precision quartz resonators represents the foundation upon which most advances in this field in the last 30 years have been built.