The recipient of the Edison Medal in 1963 was John R. Pierce (Fig. 1). He was cited “for his pioneer work and leadership in satellite communications.” The citation also noted “his stimulus and contributions to electron optics, traveling-wave tube theory, and the control of noise in electron streams.” He later became one of a select few to receive both prestigious awards when the IEEE presented its Medal of Honor to him in 1975 (Fig. 2). He spent most of his professional career in research and research management at the Bell Telephone Laboratories. He was a prolific author of technical books and articles and received more than 90 patents for inventions.

I. EARLY INTERESTS
John Robinson Pierce was born 27 March 1910 in Des Moines, IA. He became a science fiction enthusiast at an early age and enjoyed reading stories by Jules Verne, H. G. Wells, and others. He also developed an interest in flying machines and helped a friend construct an experimental glider. He moved with his family to Long Beach, CA, and later enrolled in the engineering curriculum at the California Institute of Technology. While still an undergraduate, he won an award for a science fiction story. He earned a B.S. degree in electrical engineering in 1933. He continued his education at Caltech, where he received a master’s degree in 1934 and a doctorate in 1936. In April 1936, he published a paper titled “A Proposed Wattmeter Using Multielectrode Tubes” in the Proceedings of the Institute of Radio Engineers (IRE). Soon after completing his graduate education, he joined the staff of the Bell Telephone Labs and was assigned to a vacuum tube research group.

One of Pierce’s early assignments was to work on photoelectron multiplier tubes. These devices employed a photo cathode to emit electrons which were accelerated enough to produce secondary emission from a series of electrodes. The result was a highly sensitive amplifier with applications including television camera tubes, scintillation counters, and a noise-modulation source in jamming transmitters for electronic countermeasures. Pierce and his colleague William Shockley (Fig. 3) coauthored an IRE paper published in March 1938 with the title “A Theory of Noise for Electron Multipliers.” Shockley later became well known for his pioneering work on transistors. He was a coreipient of the Nobel Prize in Physics in 1956 and received the IEEE Medal of Honor in 1980.

II. RESEARCH ON MICROWAVE TUBES
Just before the outbreak of World War II, Pierce became a participant in research on microwave tubes. These were expected to be utilized in a microwave relay system to enable broadband transmission of television, radio, and telephone signals over long distances. However, the development of a commercial system was soon interrupted due to military applications, including radar. Pierce is credited with significant improvements in the design of velocity-modulation tubes including the reflex klystron. This microwave source employed an internal

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John R. Pierce received the 1963 Edison Medal “for his pioneer work and leadership in satellite communications” as well as for his other contributions. Later, in 1975 he became one of the select few to also receive the IEEE Medal of Honor.
resonant cavity and a “repeller plate” which served to reverse the direction of bunched electrons. The output frequency could be changed by varying the voltage on the repeller. The reflex klystron was employed as a local oscillator in microwave radar receivers and enabled automatic frequency control. It also was used in low-power, frequency-modulated transmitters. Pierce was the coauthor with William G. Shepherd of a paper titled “Reflex Oscillators” published in the Bell System Technical Journal in July 1947.

In 1944, Pierce learned about a newly-invented microwave amplifier during a visit to the Clarendon Laboratory at Oxford University in England. The new device, known initially as a “helical coaxial-line amplifier,” soon became known as a “traveling-wave tube.” Its inventor, Rudolf Kompfner, had obtained amplification from an experimental tube for the first time in early November 1943. The tube utilized an interaction between a traveling electromagnetic wave and an electron beam to produce amplification over a broad frequency band. Pierce developed a sophisticated theory of traveling-wave tubes although the remarkable properties of the tubes remained secret until after the war. Kompfner’s colleague, Joseph Hatton, presented a paper on the traveling-wave tube at an electron tube conference at Yale University in June 1946. Kompfner and Pierce contributed papers on the tube to the February 1947 issue of the Proceedings of the IRE. Pierce authored a book titled Traveling-Wave Tubes, published in 1950. Kompfner came to Bell Labs to join a research team headed by Pierce in 1951.

Pierce received the Morris N. Liebmann Memorial Award from the IRE in 1947 as recognition for his role in the “development of a traveling-wave tube having both high gain and very great bandwidth.” It is interesting to learn that traveling-wave tube amplifiers have continued to find applications to the present. An article in the October 2007 issue of the Proceedings of the IEEE reported that they continue to “outperform solid-state components” as reliable amplifiers of space communication signals.

Pierce took advantage of his experience and understanding of electron beam optics to design what came to be known as the “Pierce gun” employed in various types of vacuum tubes. The gun used geometric arrangements of thermionic cathodes and grids to maximize the density of electron beams. In December 1947, Pierce’s colleagues, Walter Brattain and John Bardeen (Figs. 4 and 5) produced amplification using a semiconductor triode. Pierce is credited with proposing the name “transistor” for the new amplifier prior to the public announcement of the invention in May 1948. Bardeen and Brattain published a paper on the physical principles of transistors in the Physical Review in April 1949.

Pierce became the Director of Electronics Research at Bell Labs in 1952. He presented a lecture at an IRE chapter meeting in Princeton, NJ, in 1954 on the potential of Earth satellites for facilitating long distance communication. He discussed both active and passive repeater systems and repeaters in near orbits and in a 24-hour synchronous orbit. The paper later was published in Jet Propulsion in April 1955 with the title “Orbital Radio Relays.” He served as Editor of the Proceedings of the IRE in 1955.

### III. RESEARCH ON SATELLITE COMMUNICATIONS

In March 1959, Pierce and Kompfner published an IRE paper titled “Transoceanic Communications by Means of Satellites.” They predicted that “the
time will certainly come when we shall need a great increase in transoceanic electronic communications.” They noted some of the limitations of submarine cables and ultrahigh-frequency scatter links. They stated that “a microwave system using satellite repeaters” might provide significant advantages over available alternatives. They continued that rocket technology and the “microwave art” were such that it seemed feasible to put a communication satellite into orbit quite soon. They thought that the cost of a satellite link “would probably be less than the cost of a cable of far less bandwidth.” They included quantitative information on the transmitter power, antenna type, and other characteristics of a variety of active and passive satellite systems in different orbits. They concluded that “because they appear to be serious contenders for the future, it is important that research on satellite systems be given serious attention.”

A passive satellite known as “Echo” was put in orbit on 12 August 1960 by the National Aeronautics and Space Administration (NASA). Echo was a 100-ft diameter sphere with a reflective coating. Bell Labs researchers at Holmdel, NJ, were successful in using the satellite to reflect microwave signals between Holmdel and a station at the Jet Propulsion Laboratory in Goldstone, CA. This was followed by the launch of the active repeater satellite known as “Tel star” on 10 July 1962. Telstar was designed as a communication satellite by Bell engineers under Pierce’s leadership. He published a book titled The Beginnings of Satellite Communications in 1968.

**IV. AWARDS AND ACHIEVEMENTS**

Pierce’s achievements were recognized by numerous awards in addition to the Edison Medal and the IEEE Medal of Honor. In 1960, he received the Stuart Ballantine Medal from the Franklin Institute. He received the Valdemar Poulsen Medal from the Danish Academy of Sciences in 1963 and the National Medal of Science the same year. He was a member of the National Academy of Sciences and a founding member of the National Academy of Engineering. He received at least ten honorary degrees.
After his retirement from Bell Labs in 1971, Pierce joined the electrical engineering faculty at Caltech. During his career, Pierce published a number of science fiction stories under the pseudonym J. J. Coupling. He also authored books intended for a wider audience than professional engineers including *Electrons, Waves, and Messages* and *Science and Musical Sound*. During 1980 to 1982, he served as Chief Technologist at the Jet Propulsion Laboratory. He held a visiting professorship at the Center for Computer Research in Music and Acoustics at Stanford University during 1983. His autobiography titled *My Career as an Engineer* was published in 1988. He died 2 April 2002 at age 92 in Sunnyvale, CA.

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