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The Father Of Modern Spy Radios

The Man Who Spurred American Superiority

Allen S. Clarke

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The Father Of Modern Spy Radios—Allen S. Clarke

The Man Who Fostered Critical Receiver Innovations During The Tumultuous Fifties

by Terry O'Laughlin

Allen S. Clarke, whose businesses nurtured the engineers who created early American superiority in VHF and UHF receivers.

To the few radio hobbyists who have seen one, a Clarke Instruments 167 receiver is just another unremarkable, old VHF receiver. Nothing about the radio hints that it is the root of decades of American superiority in telemetry and surveillance radios. Even more obscure is the remarkable man who made it, Allen S. Clarke.

Starting with Clarke Instruments, which he founded in his home immediately after World War II, Clarke and his employees founded an impressive group of early high-performance VHF and UHF radio manufacturers, including Nems-Clarke, Communication Electronics, Inc., (later known as Watkins Johnson, Gaithersburg, Maryland, division), Astro Communication Laboratories, Defense Electronics Inc., and Regco. Despite his many achievements and a Presidential Award, Clarke has simply slipped into oblivion.

Early Years

Allen Clarke's interest in radio started when he built his first radio and transmitter and went on the air as an amateur radio operator in 1913. In 1917, he enlisted in the Signal Corps, where he rose to instructor for the 79th Division Signal School at Camp Meade, Maryland. Posted overseas, he became a technical sergeant in charge of communication equipment for the 157th Infantry Brigade and the 79th Division Headquarters.

After World War I, Clarke started a business supplying parts and radios to people who wanted to hear the early commercial AM broadcasts. Soon, he obtained an FCC commercial license and moved into the commercial radio supply business. He turned this business over to his brother in 1928, when he started a new business installing sound motion picture equipment for the new "talkies" in theaters across Virginia and North Carolina.

In 1930, Clarke obtained a construction permit for WBTM, a 100 watt AM station on 1370 kHz in his hometown of Danville, Virginia. He built and ran it as the sole owner until selling it in 1933. He then went to work for the Radio Research Corporation (RRC), starting at the bottom. By the time Vincent Bendix bought RRC in 1936, Clarke was running the company. Though RRC became the core of the new Bendix Radio Division, the ever restless and ambitious Clarke quit to found his first engineering consulting firm.

Engineering His Own Success

Clarke's consulting firm specialized in design and construction of AM radio stations and, as was often true throughout his career, he was in the right business at the right time. He engineered and supervised installation of broadcast stations all over the U.S. His business prospered until the prospects of another war put a damper on new station licenses.

When the U.S. entered World War II, Clarke was asked to join a small group at the National Bureau of Standards charged with adapting proximity fuse prototypes for large scale production. After practical designs had been developed, Clarke was promoted to the National Defense Research Committee (NDRC) of the Office of Scientific Research and Development. He set up and managed plant operations for producing proximity fuses at the Zell Corporation in Baltimore and Bowen and Co. in Bethesda, Maryland. For his efforts in making the proximity fuse a plentiful weapon in the war effort, Clarke received the Presidential Certificate of Merit in 1946.

At the end of World War II, Clarke became a consultant for the Ordnance Development Division of the National Bureau of

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Clarke Instruments 167-E. Many different versions were manufactured. Most surviving models have Nems-Clarke name plates.

Standards (NBS). He set up an engineering and design firm, Clarke Instruments, to handle this and other consulting work. His first employee was Miller Reddin, who later co-founded Defense Electronics, Inc. (DEI). His third employee was Ralph Grimm, who went on to found Communication Electronics, Inc. (CEI) and Regco. Clarke's company expanded to nine employees while still working out of his house.

Clarke Instruments' volume of work and reputation for quality grew rapidly. In mid 1946, Clarke Instruments moved into a 5,500-square-foot area in the rear of the National Electric Machine Shops (NEMS) plant at 919 Jessup Blair Drive in Silver Spring, Maryland. Clarke Instruments had its own entrance and used a King Street address. Clarke knew NEMS and its history because he began his radio career using Signal Corps radios built by NEMS' progenitor, the National Electrical Supply Company (NESCO).

NESCO had been founded in 1899 in Arlington, Virginia. The earliest evidence of radio work by NESCO is a 1909 photograph of a radio built for the Navy and a 1910 order from the Signal Corps for a receiver-transmitter. NESCO grew rapidly during World War I as a prominent producer of military radios, from mule-pack radios, to windmill-powered airplane radios, to complete truck-transported transmitting and receiving sets.

NESCO survived Black Friday and the early years of the Depression only to hit the ropes during the aftershock of 1937. NESCO was liquidated and the assets transferred to the employees and a small group of investors who incorporated as the National Electrical Machine Shops on March 24, 1937. The business survived by workers voluntarily rotating through planned three-month layoffs and nine-month hires. After a few shaky years, NEMS prospered and, by the end of World War II, it had grown into a sizable and well-respected production house making equipment for many well-known electronics firms.

As a small engineering and design firm, Clarke Instruments did not have the resources to manufacture the equipment its engineers designed. Clarke was well aware of NEMS production capabilities through a contract he had with RCA to design a new AM broadcast field intensity meter, the WX-2A, which RCA had manufactured by NEMS. Locating his design firm on the backside of a reliable production house was good business.

The 167—Clarke's First Radio

In the late 1940s, Clarke Instruments was awarded a large contract to develop telemetry equipment for the early hydrogen bomb tests. As part of Operation Greenhouse, scientists were trying to take field strength measurements during the tests. Existing scientific equipment often did not survive atomic bomb blasts. Clarke's contract arose from scientists trying to find out more about the intense bursts of radio energy, now known as an electromagnetic pulse (EMP), originating from the explosions.

Clarke's engineers received preliminary designs for the test equipment from the NBS and made them practical for mass production and field reliability. Clarke assigned the telemetry receiver development to Grimm. The receiver was designated the 167, probably because the design was capable of covering 1 through 6.7 meters.

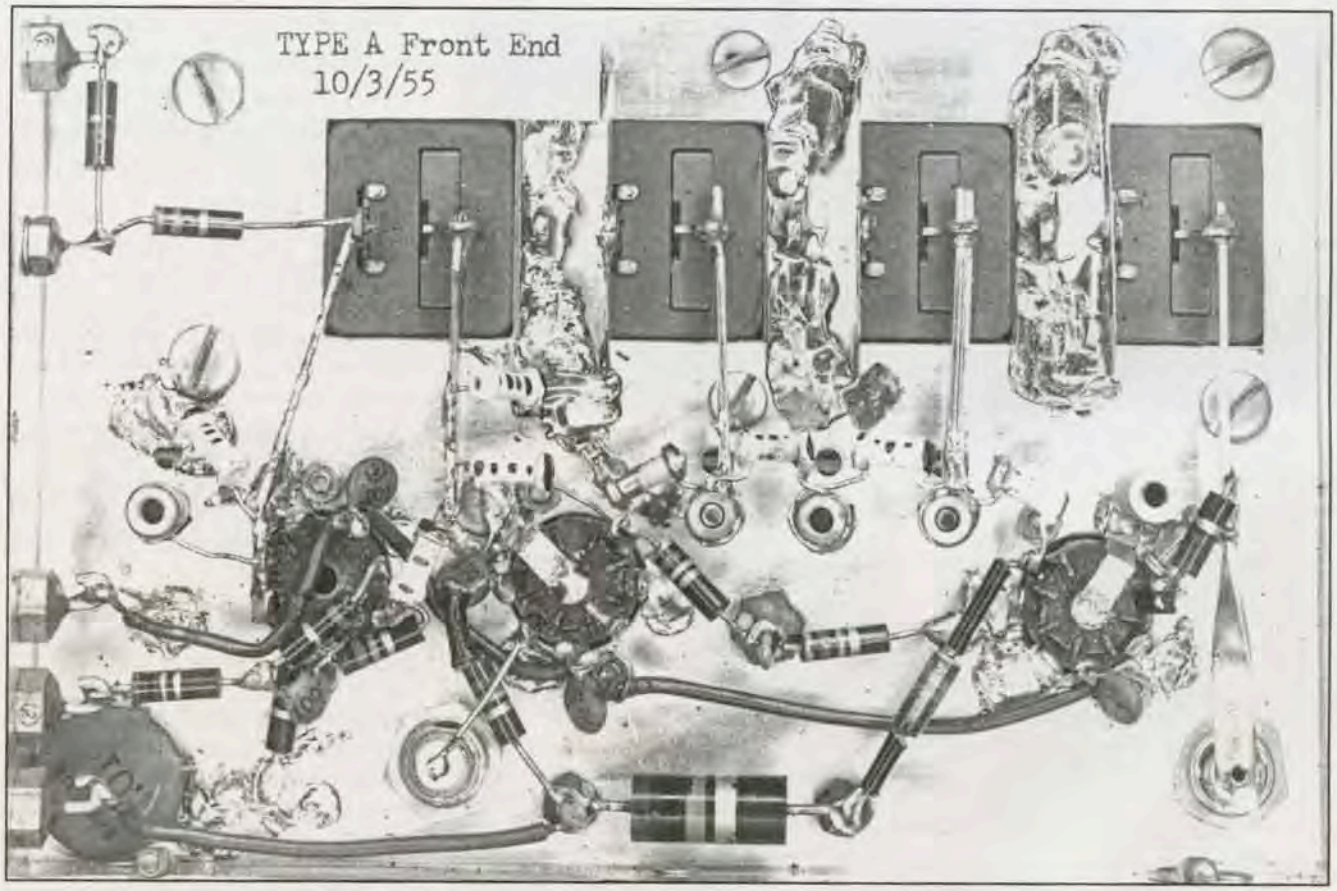
"The rise of the Cold War and the Missile Gap mania saw the 167 receiver move from scientific and medical work to extensive roles on the Florida Missile Test Range."

According to Harley Peter, a former engineer, the design of the 167 grew out of early post WWII television sets like the DuMont RA-103 series and the enormously popular RCA 630 series. The DuMont RA-103 featured continuous tuning with FM radio coverage and the picture could be switched off to use the set as just a radio. The 167 contains many design elements adapted from these early television sets .

DuMont's continuous tuning relied on a Mallory Inductuner for the radio frequency (RF) and local oscillator (LO) tuning elements. The Inductuner was a ganged variable spiral inductor. Adapting this multi-stage variable inductor to a telemetry receiver was tricky. The inductance of each section changed in a manner that could not be mathematically modeled. Since the LO section operated at a higher frequency than the RF sections, proper tracking was a tough design goal. Grimm developed a usable design, but construction and alignment of the radios on the assembly line remained an arcane, almost black art.

For the intermediate frequency (IF) amplifier stages, Grimm selected 21.4 MHz because he could use another tele-

Polly Gilbert, whose meticulous RF construction skills enabled Nems-Clarke to mass produce early VHF receivers.



A photographic print from Ralph Grimm used by Polly Gilbert to assemble Clarke 167-A tuners in her home.

vision part, the 21.25 MHz IF transformers used in audio stages in the 1940s. Grimm told fellow engineer Peter Pao that he selected 21.4 MHz to gain the component selection advantages of using the second harmonic of the standard 10.7 MHz FM receiver IF.

The most obvious external sign of the 167 receiver's origins in television is the 75 ohm antenna input impedance. The performance of the 6J4 RF amplifier tube in the Inductuner front end suffered at the standard 50 ohm radio antenna impedance. Grimm simply left the antenna impedance at 75 ohms until tubes better suited to 50 ohm input had been developed.

Clarke contracted with NEMS to manufacture the 167 receiver under his name, Clarke Instruments. NEMS had little trouble manufacturing low frequency test equipment like the AM broadcast band RCA WX-2A, but the 167 VHF receiver was a high spirited beast. RF design in the early 1950s was a mysterious art. Even today many hobbyists who tackle point-to-point wiring for homebrew VHF projects encounter similar vexing problems. (There's an ongoing banter between RF and digital engineers wherein the digital guys make snide remarks about the Voodoo and pocketed chicken bones RF guys use to work their magic. Going from building a single prototype to a successful production run further compounds these mysteries.)

Clarke had encountered and conquered similar problems moving proximity fuses from a prototype to production while working for the NDCR in World War II. The breakthrough on the 167 came as an outgrowth of one of Grimm's hobbies: photography. Grimm took close-up photographs under the chassis of a 167 tuner that met specifications and printed them as 8 x 10s for guidance in assembly.

Jim Gilbert, a quality control technician working for Clarke, took the tuner parts and the photographs home to his wife Polly who assembled them in the basement of their home. Polly would meticulously duplicate the point-to-point wiring following Grimm's photographs while her sons, Russ and Bob, were in school. The project was so secret that Polly has remained silent about her work to this day. Her sons never knew any details about the "rectangular boxes with a shaft coming out of them." Polly's work was excellent, and she would eventually wire large numbers of RF tuners for several different Nems-Clarke units. Years later, she built tuners for Potomac Instruments field strength meters and Potomac co-founder Dave Harry refers to her as "the best coil winder in the business."

Once in production, the 167 receiver was a big success, with sales expanding across a variety of research institutions and projects. The Naval Medical Research Institute published groundbreaking work based on data obtained through a 167 receiving telemetry from miniature transmitters strapped to patients as they moved freely through exercises.

National Geographic magazine printed a picture of the 167 receiver in a story on Dr. Paul Dudley White of Harvard University, who was a noted pioneer in heart research. Dr. White was using the 167 to obtain the first electrocardiogram transmitted from sensors on a whale. The electrodes were applied to the whale in mid-ocean using a twin harpoon gun with wires trailing back to a transmitter enclosed in a small boat carried below a helicopter. When the electrodes were successfully implanted, the helicopter

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A Nems-Clarke 1400 receiver. Hundreds of these radios were installed in the "Tel-4" building at Cape Canaveral, Florida.

dropped the transmitter boat, which the whale towed by a wire sending its heartbeat to a 167 receiver on an airplane circling overhead. Heart diseases were poorly understood at the time and Dr. White became quite famous for his research. When President Dwight D. Eisenhower experienced heart problems, Dr. White was appointed his personal physician.

Clarke's Star Continues To Rise

Clarke Instruments had expanded rapidly based on Clarke's ability to secure government contracts for his design firm and the high-quality manufacturing standards at NEMS. The combination of Clarke Instruments, a well-respected engineering firm and NEMS, a well-respected production house would strengthen both aspects of their businesses. Within months of the Operation Greenhouse contract, Clarke shrewdly negotiated a favorable merger of the two firms.

On January 1, 1951, Nems-Clarke was born, with Clarke appointed Engineering Vice President. Clarke Instruments had started less than six years earlier with nine employees, and NEMS had been around for one half century with hundreds of employees. After the merger with the much larger company, Clarke continued to rise, becoming the president of the entire company in October 1954.

Clarke's star rose because he astutely expanded the business in whatever direction yielded profits. While working with research scientists on the 167, Clarke discovered they were having trouble taking certain photographs using microscopes. Grimm's interest in photography and engineering skills helped Clarke start a microscope illumination line with the Mercarc, Pulsarc, and Zenarc for medical and scientific research. Grimm also developed the Megalume portable electronic strobe light for photographers.

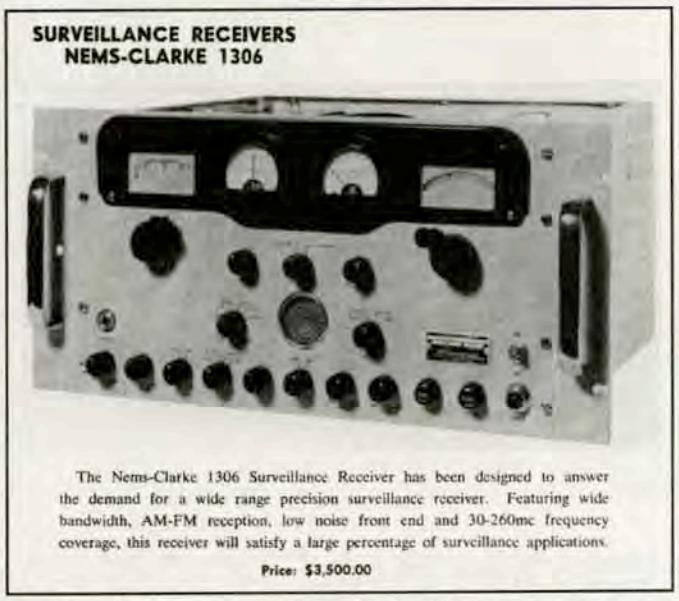
Mechanical engineers, like Grimm's brother Robert, developed chart recorders to collect data. They also developed mechanical CW keyers for automated ID transmissions from lighthouse and aviation navigational beacons. They revised and expanded a line of RF patch bays originally developed by RCA for quickly routing wideband signals with minimal loss.

The burgeoning postwar broadcast industry, now including television, opened doors for Clarke's sharp electrical engineers to develop new products. Some were developed under their own name like the TR-1, a television rebroadcast receiver but most were for other companies. For example, Nems-Clarke made most of RCA's television signal, sweep and marker generators. When RCA abandoned the RF field intensity meter business, the WX-2A reappeared as the Nems-Clarke 120-E, a widely respected meter among broadcast engineers. Grimm redesigned the RCA WX-1A VHF field intensity meter which was subsequently marketed as the Nems-Clarke 107-A.

From Telemetry To Surveillance

The rise of the Cold War and the Missile Gap mania saw the 167 receiver move from scientific and medical work to extensive roles on the Florida Missile Test Range. As research expanded, the 167 was updated and emerged as the 1400, of which several hundred were installed in the "Tel-4" building at Cape Canaveral, Florida, and along the expanded and renamed Atlantic Missile Test Range. To maintain the integrity of the data, these radios ran 24 hours per day and were calibrated daily by technicians like Jim Lyon, who later became a Watkins-Johnson engineer.

These missile tests attracted the attention of the Soviet Union who monitored the launches and communications from their trawlers in the Atlantic. The increased radio traffic sometimes led to conflicting frequency usage, perhaps deliberate, that sometimes destroyed months of work by interfering with reception of the launch and flight performance data. The Air Force, in response, requested telemetry radios adapted for monitoring



The top-of-the-line Nems-Clarke 1306. The 1300 series were probably the first commercial surveillance radios offered in a catalog ($3,500 in 1961).

the spectrum use around the missile test range. The 1301 and 1302 receivers and matching spectrum display units were developed for this special purpose.

The 1301 and 1302 were multi-mode receivers with AM, FM and, for the first time at Nems-Clarke, CW. The 1302 featured a high sensitivity, low noise figure RF stage using the Western Electric 416B tube. These high performance radios were noticed by newly developing agencies seeking better equipment for signal intelligence (SIGINT) and communications intelligence (COMINT) applications. These agencies typically made their own spy radios, but found increasing uses for mass produced surveillance receivers.

Through Clarke's extensive government, military, and national security connections, sales of the widely respected Nems-Clarke receiver line steadily grew. New models and accessories were added as requested by customers. In later catalogs, these "Special Purpose Receivers" were more forthrightly labeled "Surveillance Receivers." The 1301, 1302 and top of the line 1306 were, to my knowledge, the first surveillance radios ever to be advertised as such in a catalog.

Despite the appearance of these "Precision Surveillance Receivers" front and center in Nems-Clarke catalogs from this period, they were not shown at some trade shows, like the 1961 Institute of Radio Engineers convention in New York City.

At these shows, Clarke exhibited a fully restored 1915 NESCO receiver from his personal collection. Built for the Bureau of Steam Engineering in a finely crafted walnut cabinet, Clarke used this receiver to highlight the decades of experience Nems-Clarke had in the industry. Clarke was proud of these connections and kept photographs of himself in uniform operating NESCO-built Signal Corp radios at Fort Meade, Maryland, and during World War I in France.

Nems-Clarke equipment in the Vitro Electronics booth at the 1961 Institute of Radio Engineers convention in New York City.

Big Business Moves In

The aggressive growth in revenue and government contract awards at Nems-Clarke did not go unnoticed. As business suitors emerged, Clarke, in his usual fashion, negotiated a handsomely profitable sale of Nems-Clarke to Vitro Corporation, in September 1957.

Vitro was one of the first true conglomerates, with holdings spanning chemical, nuclear, aircraft, and a variety of other lucrative industries. Its aim was to make money through its holdings. The company renamed its newly acquired property "Vitro Electronics," but kept the Nems-Clarke name on the product line and nomenclature plates for continuity.

Clarke sold Nems-Clarke to Vitro with little advance notice to most of the middle managers and almost no notice to the engineering staff. The acquisition created widespread dissatisfaction as many of these employees had few or no stock options. Several popular long-time managers began to seek other employment.

Rather than promote internally, Vitro brought in new managers from its New York offices. Vitro's plan for Nems-Clarke was to eliminate what it saw as the wasteful profusion of customized products and channel the output to a standard catalog of equipment with set features.

The new managers, unpopular with the old staff from the start, failed to correctly understand the customer base. Engineers were used to tweaking "a dB here and adding a feature there" upon customer request. The Vitro managers attempted to discontinue this practice and tried to force development of stock items for an expanded catalog. Their heavy handed style riled the engineers who were used to managing the technology on their own terms. Customers complained and engineers chafed, but revenue for Vitro Electronics held steady for a while due to the contractual nature of the business.

Before the Vitro buyout, Nems-Clarke was an engineer's company. The phenomenal growth of Clarke Instruments and Nems-Clarke arose from their experienced and capable engineering staff. Miller Reddin and Ralph Grimm were excellent electrical engineers, deftly creating and adapting designs for a variety of customers.

Nems-Clarke mentored young engineers, giving them substantive challenges as soon as they were hired. Peter Pao's first assignment was to develop a 250 - 500 MHz tuner first used in the REU-100-A. He became a highly respected RF designer under Grimm's tutelage. Harley Peter's first assignment was to develop a stealth version of the 1306 surveillance receiver which he accomplished by eliminating the noisy fan for the 416B RF tube, replacing it with a heat pipe and beryllium oxide heat sink at no sacrifice in performance. As the profit-oriented Vitro managers tightened their grip, this engineering culture changed.

When Vitro managers announced that profit sharing for engineers was being discontinued, the staff began to bolt. A string of departures starting in 1959 and 1960 crippled Vitro Electronics. First, a cluster

Allen S. Clarke views the RS-111 at its debut in the 1964 open house at Communication Electronics, Inc. (see *Pop'Comm* June 2008 for more on the RS-111).

of Nems-Clarke personnel led by Miller Reddin, Clarke Instrument's first employee, left to found DEI, which captured much of the telemetry receiver business. Then Dave Harry and another group left to start Potomac Instruments, capturing the field intensity meter business where Vitro was milking its decade-old designs in the absence of competition. The West Coast sales representative, Ed Trompeter, started a business that undercut Nems-Clarke prices with a lower cost manufacturing technique and garnered the bulk of the unpatented RF patch bay sales.

The fatal blow came when Ralph Grimm, the third employee Clarke had hired, and another cluster of staffers left to found CEI. Nems-Clarke built its reputation on telemetry receivers but, by the late 50s, the surveillance receiver and accessory line was big business. CEI attracted the best and the brightest from Nems-Clarke. CEI in short order started capturing most of the surveillance receiver business. Peter Pao, who had left with Grimm, quickly moved on as one of the founders of Astro Communication Labs.

A Fine Legacy Fades Away

Allen Clarke resigned from Vitro Electronics on April 1, 1960. Almost immediately, he was seen in the offices of CEI, Grimm's fledgling company, though he supposedly had no official role. After the no-competition clause from his Vitro contract expired, he became a director on the board of CEI. He participated in public events like the 1964 CEI Open House at their new Rockville, Maryland, headquarters, where the RS-111, later made notorious by Watergate, made its debut (see *Pop'Comm* June 2008). He was edged off the board in the mid 1960s as, true to form, he agitated for increased director compensation.

The Nems-Clarke name and the remains of the telemetry line were sold to DEI in the mid 1960s. The R-1037 and R-2074, developed by Nems-Clarke for the Mercury and Gemini space programs and the Saturn rocket program, appeared briefly with nomenclature plates bearing DEI over "Nems-Clarke Division." The remaining Vitro Electronics - Nems-Clarke Division equipment was sold at public auction and the few remaining employees moved to nearby Vitro Laboratories. After that, the Nems-Clarke name quietly disappeared.

Allen S. Clarke's business acumen, his canny use of government contacts, his sharp eye for talented people, and his ability to keep good employees happy were well honed by the time he'd started Clarke Instruments. Beginning with this small firm run from his house, Clarke's businesses nurtured the people who became the nucleus of America's superiority in VHF and UHF radio receivers, a technological edge that served us well through the Missile Gap, the Cold War, the Space Race, and beyond. In light of all his contributions, it's remarkable how this fascinating electronics pioneer has virtually disappeared from radio history.

Nems-Clarke R-1037A receiver widely used in the space program including the Mercury and Gemini flights (as shown, it was $3,200 in 1964).