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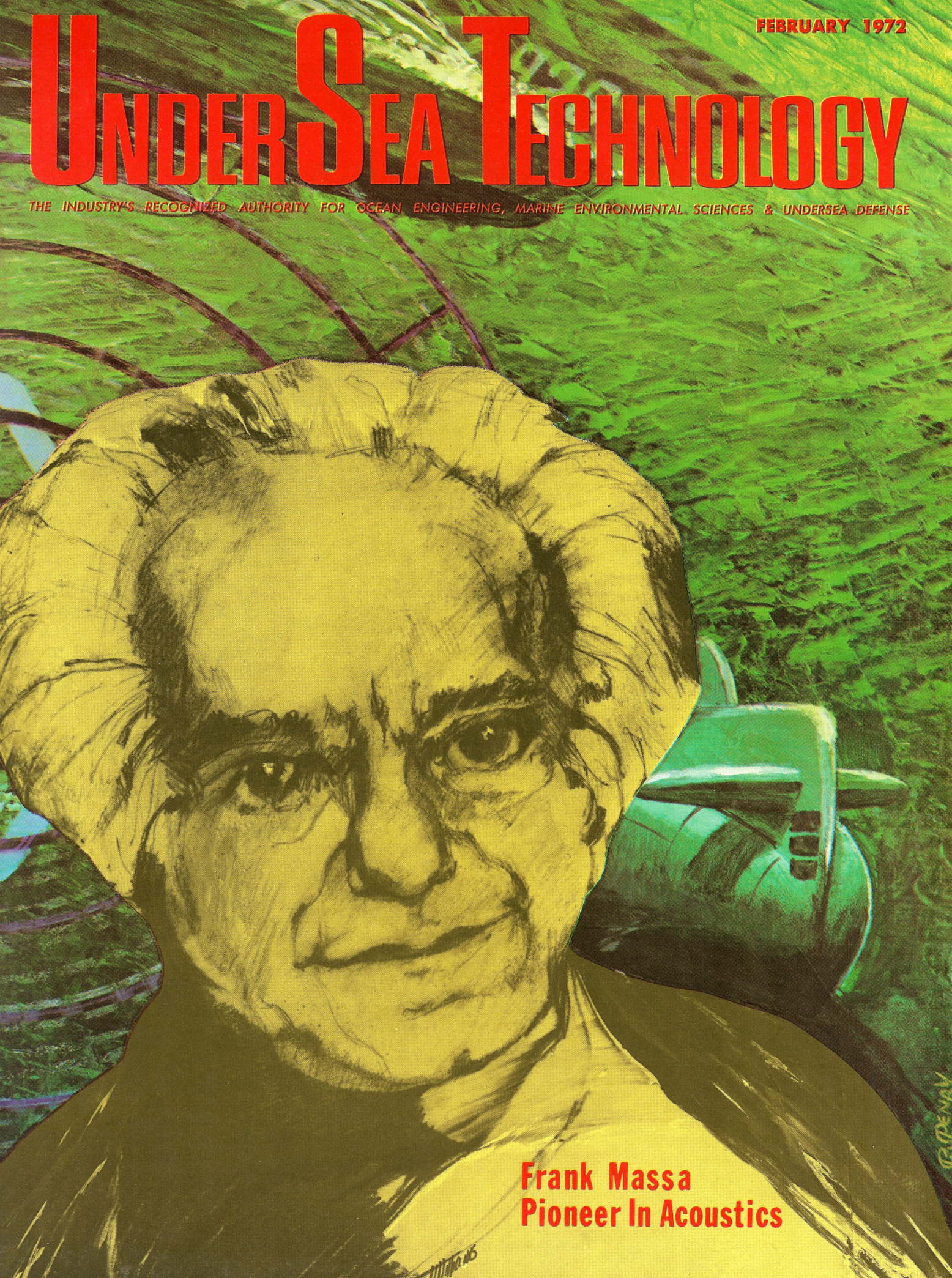


Frank Massa
Pioneer In Acoustics

FRANK MASSA — A PIONEER IN ELECTROACOUSTICS

EXCLUSIVE UST REPORT

Staff Report

Frank Massa is recognized worldwide for his pioneering accomplishments in electroacoustics. His career spans almost 45 years with over 70 patents, scores of technical and scientific publications, and development of hundreds of new products for a wide variety of applications in the electroacoustics field. He is one of those rare individuals with the unique ability to quickly get to the basic elements of a problem, and convert good ideas into reliable hardware.

After graduation from Massachusetts Institute of Technology in 1928 with a Master of Science degree, Mr. Massa went to work for the Victor Talking Machine Co. in Camden, N.J. where he spent 12 very productive years. For the next five years he was with Brush Development Co. in Cleveland as Director of Acoustical Engineering. Then in 1945 he formed his own company, Massa Laboratories. A major portion of his life work has been for the U.S. Navy.

When asked to identify the most important aspect of his career, Mr. Massa very quickly said *production engineering*, and recounted an experience early in his career which has had a profound influence on his work and accounts for many of his successful projects.

This began in the latter half of the 1930's when he was responsible for development and production design of electroacoustic items for Navy shipboard application. Working with him were a dozen highly skilled production engineers, each a specialist in a different phase of production. Through intimate association with these experts, Massa acquired a broad gauge experience and appreciation for producing hardware — equally important as his formal education. Coupling the fundamentals of electroacoustics with production know-how gave him a unique capability to create the simplest and most practical hardware.

Today, Frank Massa is concerned that the enormous growth in electroacoustics, with increasing specialization, has unfortunately removed the development engineer from the practical problems of production design. As a result, many transducers have impractical structural configurations, leading to unnecessary high costs, low-reliability, and variable performance. His advice to his young contemporaries is to take better advantage of opportunities to develop a practical viewpoint to supplement their theoretical skills. Good engineering is merely the application of good common sense; if an unnecessary structural component can be eliminated from the design, the final product will be less expensive and more reliable, Frank Massa contends.

In 1928 when he began work, vacuum tube amplifiers were still scientific curiosities. The Victrola was a mechanical phonograph that reproduced sound directly from a steel needle in the record groove. Phonograph records were also mechanically recorded without benefit of amplifiers. The recording studio in Camden was a small room on the eighth floor, deliberately placed there so that a steel weight could drop eight floors for three minutes under gravity and unwind a thin cord wrapped around the shaft of a massive turntable. This achieved constant speed without flutter of the wax blank as the recording was made by a steel stylus attached to a small diaphragm. The diaphragm was attached to the small end of a large horn with its opening near one corner of the studio. The orchestra sat facing the horn and the vocal artist would stand directly in front of the horn so that all the sound could be used efficiently for mechanically vibrating the stylus.

Even at this early date, the home entertainment field had achieved economic stature, and it was obvious that electroacoustics would be important to further growth. During his first year at Victor, Massa designed an electromagnetic pickup used in the first Victor radio-photograph. The following year, RCA acquired Victor, and Massa began development of some of the earliest loud speakers and microphones for the newly-emerging sound motion picture industry.

Electroacoustics was unknown, and the only tools available were the fundamental principles of electrical engineering. Equivalent electrical circuits for representing mechanical vibrating systems were utilized for analyzing transducer designs. The most serious handicap was no sound pressure measurement equipment. Massa recalls building a beat frequency oscillator in 1929 for use as a variable frequency source to drive a loud speaker, using an early condenser broadcast microphone as a sound pressure measuring probe. A garden hose was fitted with internal bakelite spacers for locating a wire along its center axis. The hose was then covered with a metal shield to form a low capacity coaxial cable for connecting the microphone to the preamplifier. The output from the microphone amplifier was read on a thermal meter to which was attached a manually-operated linkage system for moving a pen to follow the meter reading and plot a curve showing the acoustic output of the loud speaker as a function of frequency. This crude equipment permitted quantitative measurements of frequency-response characteristics at Victor during early 1929 and became a most useful tool.

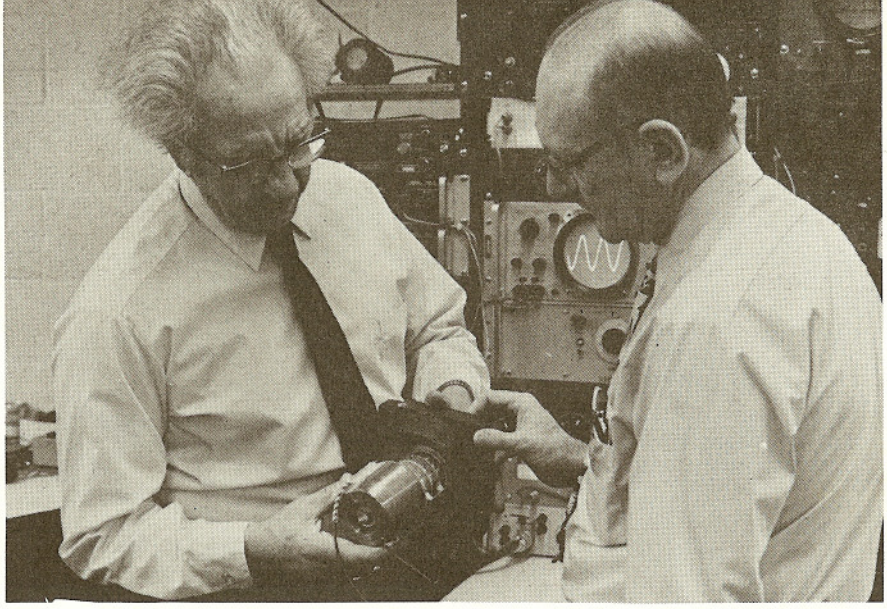
Having successfully weathered the depression years of the early thirties, primarily because of the rapid growth in sound motion picture installations, Massa turned his talents to the development of electroacoustic equipment for the U.S. Navy. He designed a battle announce speaker utilizing a molded cotton cloth diaphragm dipped in bakelite resin prior to molding. This

was the first speaker to successfully withstand gun blast pressures, and the basic design is still in use. He also developed the first high-power speaker capable of generating 600 watts of acoustic power at 60% efficiency. The voice coil used aluminum ribbon which was anodized for insulating between turns in order to withstand the temperature rise. One of the lightweight models of this speaker employed by aircraft, uses helium sealed in the air gap to reduce temperature rise.

During this same period, Massa designed a low-cost blast-proof, sound-powered telephone for the Navy. It employed an electromagnetic vibrating system with the laminations molded as inserts within two bakelite parts which became the main assembly sections of the telephone. This design became the only structure to fully meet all Navy specifications, and resulted in considerable production for RCA Victor.

After a few months in his new position at Brush, Massa became interested in underwater sound. The approaching certainty of World War II focused attention on our extremely inadequate sonar equipment. The standard sonar system at the beginning of World War II employed a small circular piston-type transducer comprising an array of Rochelle salt crystal plates which produced a searchlight beam at its ultrasonic operating frequency. The sonar operated in a manner similar to today's depth sounder. A short burst of sound would be transmitted along the axis of the transducer, and if a reflection occurred from a submerged object in its path, the return echo would cause a spinning neon light to glow at a particular point in its rotating orbit which would indicate the round trip time for the reflected ping, and thus give the range of the target. The transducer would be rotated progressively about its vertical axis to examine the presence of a submerged target along different bearings in azimuth.

Two conclusions were reached by Massa as he began his work on underwater transducers. First, Rochelle salt was not suitable as a transducer material, primarily because of its very low melting point, and because of its nonlinear piezoelectric properties. Its low Curie point of about 75°F., produced large variations in operating characteristics. Second, it because immediately apparent that there were no adequate instruments for making sound pressure measurements under water. One of the first undertakings by Massa was the development of a wide-range underwater measurement microphone which had to employ Rochelle salt, because in 1940 it was the only available piezoelectric material with a sufficiently high dielectric constant to permit the practical design of a tiny sound pressure probe capable of wide-range free-field measurements. It was also necessary to construct a constant temperature tank for accurate day-to-day calibrations.



Frank Massa (left) discusses fabrication techniques of the TR-208 A/SQS-23 transducer with a production specialist at the Massa Division plant. When Massa designed this unit in the early 1960's, it was considered a radical departure from then existing art. It has become a mandatory standard for Navy procurement.

Massa developed the first sonar transducer using ammonium dihydrogen phosphate crystals to replace the Navy's standard Rochelle salt searchlight transducer. Because the ADP transducer eliminated all temperature limitations and non-linearity characteristics of Rochelle salt, the Navy constructed an ADP crystal growing plant in Cleveland. Under Massa's guidance, tens of thousands of ADP crystal transducers were manufactured during World War II for a wide variety of Navy underwater applications, including acoustic mines, passive arrays, acoustic torpedoes, and scanning sonars.

In 1945 Frank Massa, with the encouragement and assistance of his wife, founded Massa Laboratories, Inc. Among the first new products were several wide-range ADP reference standards for free-field sound pressure calibrations in air from 10 Hz to100 kHz. Several ADP accelerometers were developed, which permitted for the first time, precise vibration measurements over the frequency range from less than 1 Hz to 100 kHz. A stable ADP wide-range underwater sound measurement reference standard was also developed for precise calibrations of sound fields at depths down to 2000 ft. over the frequency range 10 Hz to 100 kHz. These underwater reference standards have been in use by the Navy and other underwater calibration facilities for the past twenty-five years. In 1964 Massa Labs became a division of Dynamics Corporation of America.

With the advent of polarized ceramics, Massa made major contributions in the design, production engineering, and processing of ceramic elements. The company has manufactured tens of thousands of stable sonar transducers with extremely uniform performance characteristics, even though the piezoelectric characteristics of the basic materials vary widely. The Massa designed TR-208A/SQS-23 scanning sonar transducer overcame the variations and aging limitations of the ceramic material and produced, for the first time, a transducer with the necessary uniformity among elements to permit accurate beam steering over a wide band. The design was adopted as a mandatory requirement for Navy procurement because it was the only transducer among several other prior competitive designs to completely meet the performance requirements of the SQS-23 sonar specifications.

Massa has just turned over the management of the Massa Division to his very capable son, Frank, Jr., who has held several positions of responsibility in the company during the past thirteen years, and is now President. Frank, Sr. continues as Engineering Consultant to Dynamics Corporation of America, with most of his efforts applied to the solution of engineering problems at Massa.