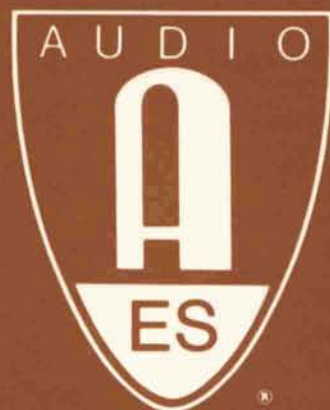


MICROPHONES



**An anthology
of articles on
microphones
from the pages of the
Journal of the
Audio Engineering
Society
Vol. 1-Vol. 27
(1953-1979)**

preface

During more than a century of use, the microphone has become one of the most common and useful technological servants of mankind. Historically, this device is traced back to J.P. Reis' loose-metal-contact transducer which was used in 1875 to convert vibration into electrical impulses. Reis was able to transmit tones of different frequencies but no intelligible speech. On 1875 June 3, Alexander Graham Bell achieved the latter using a magnetic microphone. Since Bell's microphone was not sufficiently sensitive for telephone work, Berliner, Edison and others shortly thereafter developed the loose-contact carbon transducer, which is used in telephony to this day. However, Bell's efforts were not forgotten; and magnetic devices were subsequently improved and used for microphones and receivers in various applications.

During this same era, the Curies were performing the basic research which led to the modern understanding of the piezoelectric effect. Yet, it was not until 1931 that Sawyer developed the first practical piezoelectric microphone with the invention of the "bimorph" Rochelle Salt transducer. Piezoelectric technology continued to develop with the introduction of the lead zirconate titanate family of materials and more recently with the piezoelectric polymer films.

Early efforts and concepts in connection with moving-coil transducers are associated with the names of Cuttriss, Redding and Siemens, but the credit for developing a wide-range practical moving-coil microphone goes to Wente and Thuras, circa 1930. Devices based on moving-coil technology are perhaps the most commonly used today in broadcasting and public address applications.

While Edison and others proposed the use of the electrostatic transducers, it was Wente who developed the first truly precision condenser microphone in 1917. This device has always been associated with the highest quality pickup and is used in recording and measurement industries. The more recent electret versions have made this quality available in an inexpensive format, increasing the popularity of electrostatic transducers.

In recent years, microphone technology has advanced rapidly. Newer materials and fabrication techniques, better electronics and more precise calibration methods have been developed by the many scientists and engineers working throughout the world in this audio discipline. Clearly, no single book can totally describe all of these efforts — both present and past. However, it is hoped that this anthology can serve as a useful primary reference in microphone technology.

In reviewing the list of microphone papers submitted to the AES during the past 25 years, it became obvious that this *Journal* has become a focal point for documentation of many of the most important technical developments in this field. Papers describing developments which occurred prior to the publication of the *Journal* have frequently been presented, which has added to the historical perspective of this anthology. The major task has been to select the most pertinent information and to organize it into meaningful sections. To this end, I have attempted to select papers from past AES Journals which give me an accurate cross-section of microphone technology and to add to this group papers which depict some of the

history of microphone development during the past century. The references cited in these articles form a valuable secondary set of information for the reader. To augment this reference list more fully, a section of related reading references is added at the end of the technical papers, which includes a list of books and papers from other journals pertinent to this topic.

The separation of papers into related topic areas was a difficult task, and I hope readers will agree with the choice of topic areas and the papers contained therein. In some instances, papers could have been listed in more than one section, but my choice was made to agree best with the content of the paper. While the final choice was mine, I received valuable assistance from James Kogen, Geoffrey Langdon, Harry Olson, and Daniel Queen.

The major credit for this anthology, however, belongs to the many authors whose papers represent the results of innumerable hours of research efforts, and to whom we are indebted for technological advances that are, today, commonplace in our society.

Louis A. Abbagnaro

October 1979

contents

A. CALIBRATION AND TESTING

Free-Field Technique for Secondary Standard Calibration of Microphones. Arnold L. Seligson (1956 July)	3
The Reduction of Wind Noise in Microphones. L.R. Burroughs (1961 April)	9
Real Voice Microphone Calibration as a Utility Laboratory Method. William B. Snow (1966 January)	10
The Application of Reverberant Field Measurements to the Evaluation of Loudspeakers and Microphones. Daniel Queen (1966 July)	14
An Electronic Dummy for Acoustical Testing. E.L. Torick, A. Di Mattia, A.J. Rosenheck, L.A. Abbagnaro and B.B. Bauer (1968 October)	20
Calibration of Microphones by the Principles of Similarity and Reciprocity (reprint). Harry F. Olson (1969 December)	27
Acoustic Impedance Calibrator for Mask and Microphone Measurements. Charles T. Morrow and Austin J. Brouns (1970 October)	31
Microphone Accessory Shock Mount for Stand or Boom Use. Gerald W. Pllice (1971 February)	36
Field-Type Artificial Voice. Harry F. Olson (1972 July/August)	41
Vibration Sensitivity Measurements on Subminiature Condenser Microphones. Mead C. Killion (1975 March)	48
Microphone Considerations in Feedback-Prone Environments. Robert B. Schulein (1976 July/August)	53
An Effective Mechanopneumatic Shock Mount for a Dynamic Microphone. Terry R. Locke (1978 September)	65

B. GENERAL PURPOSE MICROPHONES

An Adventure in Microphone Design. Howard T. Souther (1953 April)	73
New High-Grade Condenser Microphones. F.W.O. Bauch (1953 July)	79
A Stable Laboratory Standard Condenser Microphone. J.F. Houdek, Jr. (1954 October)	88
The Use of Polyester Films in Microphone Designs. Alexis Badmaieff (1961 July)	93
A Small Unidirectional Dynamic Probe Microphone. Ernest Seeler (1961 October)	100
Personal Microphones. H.F. Olson, J. Preston, and J.C. Bleazey (1961 October)	104
Condenser Microphones with Electret Foil. G.M. Sessler and J.E. West (1964 April)	111

Transistor Microphones. M.E. Sikorski (1965 July)	114
Self-Calibrating Condenser Microphone with Integral rf Circuitry for Acoustical Measurements. Hans Joachim Griese (1966 January)	125
A New Low-Noise Condenser Microphone. A.R. Soffel (1966 July)	128
Transistor Microphone Small Signal h Parameters. T.F. Longwell (1967 January)	132
Design Evolution of a FET Condenser Microphone System. James J. Noble (1967 July)	135
Electret Condenser Microphones of High Quality and Reliability. Preston V. Murphy and Freeman W. Fraim (1968 October)	141
A Self-Contained Condenser Microphone with Improved Transient Response. Alan Dauger and Charles F. Swisher (1968 October)	148
Electroacoustic Transducers with Piezoelectric High Polymer Films. Masahiko Tamura, Tadahiro Yamaguchi, Takashi Oyaba, and Toshikazu Yoshimi (1975 January/February)	152
Comments on "Electroacoustic Transducers with Piezoelectric High Polymer Films" (Forum). S. Edelman and A.S. DeReggi (1976 September) . . .	158
More About Electroacoustic Transducers and High Polymer Films. Masahiko Tamura (Forum). (1976 December)	160
Equivalent Circuit Analysis of Mechano-Acoustic Structures. B.B. Bauer (1976 October)	162

C. DIRECTIONAL MICROPHONES

The Design and Use of a Double Cardioid Stereophonic Microphone. Anthony Jamroz (1960 April)	177
Two-Way Cardioid Microphone. B. Weingartner (1966 July)	182
Directional Microphones. Harry F. Olson (1967 October)	190
Development of a Versatile Professional Unidirectional Microphone. Robert B. Schulein (1970 February)	195
Ribbon Velocity Microphones. Harry F. Olson (1970 June)	202
Third-Order Gradient Microphone for Speech Reception. B.R. Beavers and R. Brown (1970 December)	208
Quadraphonic One Point Pickup Microphone. Takeo Yamamoto (1973 May) .	213
A History of High-Quality Studio Microphones. Harry F. Olson (1976 December)	219
Microphones for Recording. Harry F. Olson (1977 October/November)	229
The Ghent Microphone System for SQ™ Quadraphonic Recording and Broadcasting. Benjamin B. Bauer, Louis A. Abbagnaro, Daniel W. Gravereaux, and Trevor J. Marshall (1978 January/February)	238
Design of a Studio-Quality Condenser Microphone Using Electret Technology. William R. Bevan, Robert B. Schulein, and Charles E. Seeler (1978 December)	248
The Stereo-180 Microphone System. Lynn T. Olson (1979 March)	259

D. MINIATURE MICROPHONES

History and Current Status of Miniature Variable-Reluctance Balanced-Armature Transducers. Richard W. Carlisle (1965 January)	267
Two Noise Cancelling Microphones for Aircraft Use. H. Teder (1967 January)	272
Miniature Electret Microphones. F. Fraim and P. Murphy (1970 October)	276
A Wideband Miniature Microphone. Mead C. Killion and Elmer V. Carlson (1970 December)	283
Experimental Wide-Bandwidth Tooth-Contact Microphone. Austin J. Brouns (1971 January)	288
Miniature Headband-Mounted Dynamic Microphone for Professional Applications. Alan R. Watson (1971 July/August)	293
Subminiature Electret Microphone in a Tie Tac. Alan R. Watson (1973 November)	299
Subminiature Directional Microphones. Elmer V. Carlson and Mead C. Killion (1974 March)	305
A Subminiature Electret-Condenser Microphoné of New Design. Mead C. Killion and Elmer V. Carlson (1974 May)	310

E. MICROPHONE ELECTRONICS

On Electrical Loading of Microphones. Richard E. Werner (1955 October)	319
Parametric Amplifiers Used in Electroacoustics. 2. Condenser Microphone Amplifier with Semiconductor Elements. Edmond de Niet (1964 July)	323
Circuits of Transistorized rf Condenser Microphones. Hans Joachim Griese (1965 January)	329
High Quality Microphone Amplifier for Professional Applications Using FETs. William A. Rheinfelder (1966 April)	335
A Low-Noise Two-Wire Condenser Microphone Preamplifier. Mead C. Killion (1967 April)	338
A Transistorized Amplifier for a Condenser Microphone. Jinichiro Nakamura and Rinske Wakabayashi (1967 April)	344
A VOX System for Operation at High and Variable Ambient Levels. E. Torick and R. Allen (1967 July)	352
Closing the Wireless Versus Wired Microphone Dependability Gap. Barry M. Kaufman (1971 January)	357
Applications and Design Considerations for a High-Quality Unidirectional Line-Level Microphone. R. Schulein, E. Seeler, and D. Smith (1975 May)	363
A Complementary Source Follower Circuit for Condenser Microphone Preamplifier. T. Ken Matsudaira and Osamu Kono (1975 September)	368
A Low-Noise High-Output Capacitor Microphone System. Richard S. Burwen (1977 May)	374