

# FRANK S. BARNES

## Title

Distinguished Professor  
Department of Electrical & Computer Engineering, CB 425  
University of Colorado, Boulder, Colorado 80309-0425  
303/492-8225; barnes@schof.colorado.edu

## Home Address

225 Continental View Drive  
Boulder, Colorado 80303-4516  
303/499-9144

## Date and Place of Birth

July 31, 1932 -- Pasadena, California

## Education

B.S., Princeton University, 1954 (Electrical Engineering)  
M.S., Stanford University, 1955 (Electrical Engineering)  
Engineer, Stanford University, 1956 (Electrical Engineering)  
Ph.D., Stanford University, 1958 (Electrical Engineering)

## Professional Experience

Distinguished Professor, Department of Electrical Engineering  
University of Colorado, Boulder, Colorado 1997-

Professor, Department of Electrical Engineering  
University of Colorado, Boulder, Colorado 1965-1997

Interim Director of Interdisciplinary Telecommunications Program  
University of Colorado, Boulder, Colorado 1996-1998

Acting Chairman, Department of Electrical Engineering  
University of Colorado, Boulder, Colorado 1989-1990

Acting Dean, College of Engineering and Applied Science  
University of Colorado, Boulder, Colorado 1980-1981

Chairman, Department of Electrical Engineering  
University of Colorado, Boulder, Colorado 1964-1980

Associate Professor, Department of Electrical Engineering  
University of Colorado, Boulder, Colorado 1959-1965

Physicist, U.S. National Bureau of Standards  
Boulder, Colorado 1959-1962

Research Associate, Colorado Research Corporation  
Denver, Colorado 1958-1959

Fulbright Professor, College of Engineering  
Baghdad, Iraq 1957-1958

Research Assistant, Stanford University  
Stanford, California 1955-1957

Engineer, Denver Research Institute  
Denver, Colorado 1954 (summer)

### **Selected Professional Activities**

Chairman of the committee to assess potential health effects from exposures to PAVE PAWS low-level phased-array radiofrequency energy for the National Research Council of the National Academies. 2001-2005

President, Bioelectromagnetics Society 2000-2001

U.S. Chair Commission K of URSI 1999- 2002

Member, Educational Advisory Board, National Communications Forum, 1990-1999

Executive Editor, *Annual Reviews of Telecommunications*, 1993-

Editor, *IEEE Transactions on Education*, 1988-1994

Member, IEEE Press Board, 1986-1992

Chair, IEEE Publication Review Board, 1986

Chair, University of Colorado, Telecommunications Executive Committee

Member, WHO Document Review on VDT's, 1985

Chair, IEEE Educational Activities Board - Pre-College Guidance Brochure

Commission A of URSI

Board of Directors, Engineering Information, 1984-1990

Board of Directors, Bioelectromagnetics Society (BEMS), 1981-1982 and 1996-1998

Board of Trustees for the Engineering Index, Inc., 1979-1984

Vice Chair, Electrical Engineering Department Heads Association, ASEE, 1978-1979; Chair, 1979-1980

Member, Princeton University, Advisory Council, Electrical Engineering Department, 1971- 1983

Member, ANSI Committee on Laser Safety, 1965-1975

Member, ANSI C95 Committee on Microwave Safety Standards, 1976-1992

Member, URSI Steering Committee, 1976

Chair, ECPD (now ABET) Committee on Advanced Level Accreditation, 1976-1978

Member, NCRP Committee #S39, 1975-1980

Member, IEEE Board of Directors, 1974-1975

Member, IEEE Executive Committee, 1974-1975

Chair, IEEE Electron Devices Society, 1975, Vice Chair 1973-4

Chair, IEEE Publications Board, 1974-1975

Vice President of IEEE for Publications, 1974-1975

Technical Program Committee, MTT International Meeting, 1973

Member, IEEE Nominations and Appointment Committee, 1972

Chair, 1971 NSF Workshop on Non-Ionizing Radiation

Chair, 1971 Electron Ion and Laser Beam Technology Symposium

Chair, Device Research Conference, 1971;

Vice Chair, Student Activities Board, IEEE, 1970

Vice Chair, IEEE Editorial Board, 1970

Member, Editorial Board of *IEEE Spectrum*, 1970-1971

Regional Editor, *IEEE Electronic Letters*, 1969-1975

Member, IEEE Editorial Board, 1968-1970 and 1972

IEEE Electron Device Group, 1968-1973 (AdCom)

Editor, *IEEE Student Journal*, 1968-1970

Member, ECPD Accreditation Team, 1968

### Selected Service on Advisory and Peer Review Panels

**NIH** A Think Tank Working Group Meeting on Biofield Energy Medicine 2006  
 NIH Study Section Member for Nonionizing Radiation 2004,2006  
 Chair of National Research Counsel Committee on Pave Paws Radar, 2001-2006  
 IEEE Prize Paper Selection Committee 1998-2003  
 NATO Post Doc Review on Toxicology for NSF, January 1993  
 Chair, Grant Panel on Toxicology of ELF for NIEHS, February 1992, Durham, NC  
 Study Section on Radiation Biology, NIH, January 1992, Taos, NM.  
 Member, National Science Foundation Review Panels, 1966-1997  
 NIOSH Review, 1996, NIEHS Review, 1997

### Professional and Honor Societies

Institute of Electrical and Electronics Engineers, Inc.  
 Sigma Xi; President of Boulder Chapter, 1971  
 American Physical Society  
 American Association for the Advancement of Science  
 Eta Kappa Nu  
 Tau Beta Pi  
 Bioelectromagnetics Society  
 American Society for Lasers and Medicine  
 Aviation Space and Environmental Medicine Society

### Awards, Honors, etc.

ITERA's , First Distinguished Researcher Award, from the International Telecommunications Education and Research Association 2006  
 Pinnacles of Inventorship Award from Tech Transfer Univ. of Colo. 2006  
 Colorado Institute of Technology Catalyst Award 2004  
 Bernard M. Gordon Prize from National Academy of Engineering for Innovations in Engineering Education 2004  
 IEEE Education Society 2003 Achievement Award  
 2002 ECE Distinguished Educator Award from ASEE ECE Section  
 National Academy of Engineering, 2001  
 Distinguished Professor, University of Colorado - Boulder, 1997  
 Fellow, International Engineering Consortium, 1995  
 Fellow, American Society for Lasers and Medicine, 1986  
 Fellow, American Association for the Advancement of Science, 1977  
 Fellow, IEEE, 1970  
 Distinguished Lecturer for IEEE Electron Device Society 1994-1997  
 University of Colorado's Centennial Celebration, Engineering Recognition, 1994  
 International Communications Association, Leon Montgomery Award, 1994  
 IEEE Education Meritorious Service Award, 1993  
 American Society for Engineering Education, Centennial Certificate, 1993.  
 IEEE, EAB Meritorious Service Award, 1989  
 International Communications Association, Certificate of Merit, 1989  
 Distinguished Engineering Alumni Award, University of Colorado, 1986  
 Max S. Peters Service Award, College of Engineering, 1985  
 IEEE Centennial Award, 1984  
 Stearns Award, University of Colorado, 1980  
 Faculty Mentor for two President's Senior Award Winners, 1967 and 1969  
 Faculty Research Lecturer, 1965

Curtis McGraw Research Award, ASEE, 1965

1.

## Patents

- 13 Patent filed for May ,2006 “MULTI-EXCITATION DIAGNOSTIC SYSTEMS AND METHODS FOR CLASSIFICATION OF TISSUE” with Priya N. Werahera, John Daily, M. Scott Lucia, Adrie van Bokhoven, E. David Crawford,
- 12“A Voltage-Tunable Phased Array Antenna Apparatus Including Ferroelectric Material,” U.S. Patent #5,589,845 (Yandrowski, Price, Barnes, Hermann, Scott)( Zhang, Wu) issued Dec. 31, 1996.
- 11" Tuneable Microwave Devices Incorporating High Temperature Superconducting and Ferroelectric Films" (Barnes , Price, Herman, Yandrowski, and Scot), U. S. Patent #5,472,935 issued Dec. 5, 1995.
- 10" Amplifying and Synchronizing Signals In Optical Computing System" (Barnes) U.S. Patent #5,295,010 issued Mar. 15, 1994.
- 9"Recording Head Suspension Utilizing Superconductor Means," U.S. Patent # 5,082,827 issued January 21, 1992.
- 8" Storing Information-bearing Signals in a Superconductive Environment Using Vortices as Digital Storage Elements," U.S. Patent # 5,079,219 issued 1992.
- 7" Unitary Skate Assembly Having Vertical Spring Means" (Barnes and Baer), U.S. Patent # 4,993,725 issued February 19, 1991.
- 6" Superconductor Magnetic Reading and Writing Heads" (Barnes and Dugas), U.S. Patent #4,971,947 issued November 20, 1990.
- 5" Superconductor Devices for Disk Drives," U.S. Patent # 4,926,082 issued May 15, 1990.
- 4" Superconductor Magnetic Reading and Writing Heads," U.S. Patent #4,971,947 issued Nov. 20, 1990 and reissued as U.S. Patent # RE35212 on Apr. 16, 1996.
- 3" Superconductor Devices Useful for Disk Drives and the Like," U.S. Patent # 4,843,504 issued June 27, 1989.
- 2" Resonant Pile Driving System," U.S. Patent # 4,645,016 issued February 24, 1987.
- 1" Quantum State Memory," U.S. Patent #3,754,988 issued Aug. 28, 1973.

## Publications

- 186 “The effect of ultrasonic irradiation on doxorubicin-induced cytotoxicity in three human bladder cancer cell lines” with Caroline Arthur<sup>a</sup>, Thomas Flaig<sup>b,\*</sup>, Lih-Jen Su<sup>b</sup>, Richard Denney<sup>c</sup>, , L. Michael Glodé<sup>b</sup>. to be published in Ultrasonics.
- 185 *The CRC Handbook on Biological Effects of Electromagnetic Fields*, 3<sup>rd</sup> Edition Edited with Ben Greenebaum Nov. 2006
- 184 “Interaction of DC and ELF Electric Fields with Biological Materials and Systems," Chapter 5 in *The CRC Handbook on Biological Effects of Electromagnetic Fields*, 3<sup>rd</sup> Edition Edited by Frank Barnes and Ben Greenebaum Nov. 2006
- 183 “Setting Standards in the Presence of Developing Scientific Understanding” *Electromagnetic Biology and Medicine* To be published Nov 2006
- 182 “Online Laboratory for Optical Circuits Courses: Effective concept mapping” with Driss Benhaddou and Deniz Gurkan, Harshita Kodali Engineering Technology Department, University of Houston Ed McKenna, Alan Mickelson ASEE-GSW regional meeting 2006

- 182 Biological Effects and Electromagnetic Fields" with Bonnie Slaten Handbook of Electrical Engineering Editor Richard Dorff. Chapter 7.3 pp7-33 to 7-54 CRC January 2006
- 180 "Mechanisms for Electric and Magnetic Fields Effects on Biological Cells" Advances in Magnetics IEEE Transactions on Magnetics, Vol41, No 11, November 2005. pp 4219- 4224
- 179 "Dielectric Slab Rotman Lens with Tapered Slot Antenna Array" with Jaeheung Kim IEE Proceeding Microwave Antenna Propagation , 2005 online no. 20045118 pp 1-6, doi:101049/ip-map:20045118
178. ASSESSING THE EFFECTIVENESS OF DISTANCE NETWORKING LABORATORY EXPERIENCES [Session S3F: Labs: Remote & Local] Douglas C. Sicker, Tom Lookabaugh, Jose Santos and Frank Barnes, At FIE in October of 2005
177. "Carriers' Spatial Separation Nonlinearity in Quantum Wells" with Fahhad Alharbi, Journal of Modern Optics, Vol. 52, No. 16, 10 Nov. 2005, pp 2279-2292
- 176 E-learning Environmental Design of a Distributed Online Laboratory for Optical Circuits Courses Edward McKenna\*, Randal Direen\*, Frank Barnes\*, Deniz Gurkan, Alan Mickelson\*, and Driss Benhaddou University of Houston/\*University of Colorado June 2005 ASSEE
- 175 "Dielectric Slab Rotman Lens for Microwave/Millimeter-Wave Applications" with Jaeheung Kim and Choon Sik Cho. IEEE Transactions on Microwave Theory and Techniques Vol. 53. No 8 August 2005
- 174 " An Assessment of Potential Health Effects from Exposure to PAVE PAWS Low-Level Phased-Array Radiofrequency Energy" National Academic Press. Committee chair, 14 coauthors. February 2005
- 173 "Dielectric Slab Rotman Lens" with Jaeheung Kim, Choon Sik Cho, IEEE Microwave and Wireless Components Letters, Vol 15, No 5 May 2005
172. "Frequency and Amplitude Windows in the Combined Action of DC and Low Frequency AC Magnetic Fields on Ion Thermal Motion in a Macromolecule: Theoretical Analysis" with Mikhail Zhadin, Bioelectromagnetics Vol. 26, No 4, pp323-330, May 2005
- 171 " A Theoretical Study of the Effects of RF Fields in the Vicinity of Membranes" with Y. Kwon, Bioelectromagnetics Vol 26 , No 2 p 118-124 ,2005
- 170 "Opportunities and Challenges for Engineering Education as Seen from an Interdisciplinary Telecommunications Master's Degree Program" The Bridge winter 2004, p55-61
- 169 Some Frontiers for Engineering Education" 2004 Gordon Prize Lecture, Journal of Engineering Education July 2004
- 168 " Iterative method for designing a dual-phase-conjugation- mirror-resonator with multiple apertures" with Young Kwon, , Applied Optics January 2004
- 167 "A New Frontier In Engineering Education: Importing Courses" Proceeding of FIE Oct 2003
- 166 "Inadequate Models Make For Evaluation Make Universities Less Than They Can Be" Proceeding of FIE Oct 2003
- 165 "Analysis of Bragg fiber with unequal layers" with Anak Muthitachoen, Submitted Applied Optics Nov. 2002
- 164"Effects of Low-Level 50 Hz Magnetic Fields on the Level of Host Defense and on Spleen Colony Formation," H. A. Korneva, V. A. Grigoriev, E. N. Isaeva, S. M. Kaloshina, F. S. Barnes, *Bioelectromagnetics* 20:57-62, 1999.
- 163"A Model for the Detection of Weak ELF Electric and Magnetic Fields," *Bioelectrochemistry and Bioenergetics*, 47(1998)207-212, 1999.

- 162"Combined Action of Static and Alternating Magnetic Fields on Ionic Current in Aqueous Glutamic Acid Solution" (Zhadin M.N., primary author) *Bioelectromagnetics* 19:41-45, 1998.
- 161"Doped Ba<sub>0.6</sub>Sr<sub>0.4</sub>TiO<sub>3</sub> Thin Films For Microwave Device Applications At Room Temperature," with Huey-Daw Wu, *Integrated Ferroelectrics*, 22(1-4)291-305, 1998.
- 160"Real-Time, Multi-Channel Computerized Electrogastrograph," with Mingying Zhou, Hui Zhang, Robert Shaw, *IEEE Transactions on Biomedical Engineering* . 44(12): 1228-1236, December 1997.
- 155"Vibratory Excavation and Anchoring Tools for the Lunar Surface," with J. L. Klosky, S. Sture, H. Ko, *Proceedings of SPACE '96 Conference*, Albuquerque, NM, June 1996.
- 154"Mechanical Properties of JSC-1 Lunar Regolith Simulant," with J. L. Klosky, S. Sture, and H. Ko, *Proceedings of SPACE '96 Conference*, Albuquerque, NM, June 1996.
- 153"Effects of Pulsed Acoustic and Mechanical Stimuli on the Excitability of Isolated Neuronal and Cardiac Cells," with Richard T. Mihran, Sean K. Lineaweaver, and Howard Wachtel, *Appl. Occup. Environ Hyg.* 11(4), 1-4, April 1996.
- 152"Biological Effects of Radio Frequency Fields," with V. E. Irizarry-Sepulveda, *Worldwide Wireless Communications*, Frank S. Barnes, Ed., National Engineering Consortium, 1995 (released February 1996).
- 151 *Worldwide Wireless Communications*, Frank S. Barnes, Ed., National Engineering Consortium, 1995 (released February 1996).
- 150"Interaction of DC and ELF Electric Fields with Biological Materials and Systems," in *The CRC Handbook on Biological Effects of Electromagnetic Fields*, C. Polk and E. Postow, Eds., 103-147, CRC Press, Boca Ration, Florida, Jan 1, 1996.
- 149"The Effects of Electric and Magnetic Fields on Chemical Reaction Rates in Biological Systems," *Biofizika* (Russian Journal of Biophysics), 41/4, p.790-797, 1996.
- 148"The Effects of Electric and Magnetic Fields on Chemical Reaction Rates in Biological Systems," *Biological Effects of Magnetic and Electromagnetic Fields*, S. Ueno, Ed., Plenum Press, 1996.
- 147"Coaxial Lines for Multiphase Power Distribution," with P. Harwick and A. Banerjee, *Journal of Bioelectromagnetics* 17, 162-164 (1996).
- 146"Typical Electric and Magnetic Field Exposures at Power Line Frequencies and their Coupling to Biological Systems," in *Advances in Chemistry Series No. 250, Biological Effects of Environmental Electromagnetic Fields*, Martin Blank, Ed., American Chemical Society Books, Washington, D.C., Dec 1995.
- 145"Effect of Electromagnetic Fields on the Level of Host Defense Reaction and on the Spleen Colony Formation," with V. A. Grigoriev, E. N. Isaeva, S. M. Kaloshina, E. A. Korneva, *Proceedings of Abs. Int. Co-Conf. on Environmental Pollution (ICEP'95) and Proceedings of Neuroimmuno Interactions and Environment (ICONE'95)*, St. Petersburg, Russia, 114, July 17-24 , 1995.
- 144"Augered Foundation Elements for Lunar Operations," with J. Ledlie Klosky, Stein Sture, Hon-Yim Ko, *Proceedings of the Colorado School of Mines at Meeting on Mining and Construction*, 1995.
- 143"Some Microwave Applications of BaSrTiO<sub>3</sub> and High Temperature Superconductors" with John Price, Allen Hermann, Zhihang Zhang, Huey-Daw Wu, David Galt, Ali Naziripour, *Integrated Ferroelectrics*, vol. 8 , 171-184, 1995.

- 142"Editorial: new challenges for engineering education", *IEEE Transactions on Education*, vol. 37, (2), 119-121, May 1994.
- 141"Editorial: engineering education under attack", *IEEE Transactions on Education*, vol. 37, (1), 1-2, February 1994.
- 140"Mechanisms for Biological Changes Resulting from Electric and Magnetic Fields," *Proceedings of the 1994 Japan-U.S. Science Seminar on Electromagnetic Field Effects Caused by High Voltage Systems (Modeling, Characterization, Measurements, Mitigation)*, Sapporo, Japan, 1994.
- 139"Typical Electric and Magnetic Field Exposures at Power Line Frequencies and Their Coupling to Biological Systems," *Proceedings of the 1994 Japan-U.S. Science Seminar on Electromagnetic Field Effects Caused by High Voltage Systems (Modeling, Characterization, Measurements, Mitigation)*, Sapporo, Japan, 1994.
- 138"Fabrication of  $Ba_{1-x}Sr_xTiO_3$  tunable capacitors with  $Tl_2Ba_2Ca_1Cu_2O_x$  electrodes," with A. Outzourhit, J. U. Trefny, Z.-H. Zhang, J. Cleckler and A. M. Hermann, *Physica C*, 387-394, 1994.
- 137"Dielectric properties of thin film  $SrTiO_3$  grown on  $LaAlO_3$  using  $YBa_2Cu_3O_{7-x}$  microstrip resonators", with H. D. Wu, D. Galt, J. Price and J.A. Beall, Proceedings for the SPIE - The International Society for Optical Engineering Conference, in January 1994, Los Angeles, California, High-T<sub>c</sub> Microwave Superconductors and Applications, R.B. Hammond and R.S. Withers, Eds., vol. 2156, 131-140.
- 136"Voltage tunable capacitors using high temperature superconductors and ferroelectrics", with H. D. Wu, Z. Zhang, C. Jackson and A. Kain, *IEEE Transactions on Superconductivity*, September 1993.
- 135"The case for liberal engineering programs - and an approach to implementing them", with H. Wachtel and R. Ravenel, 1992 Frontiers in Education Conference.
- 134"Mass and energy tradeoffs of axial penetration devices on lunar soil simulant", with M. P. Nathan, H.Y. Ko and S. Sture, Proc. of Amer. Civil Engrs., vol. I, 441-457, W. Z. Sadeh, S. Sture, and R. J. Miller, Eds., 3rd International Conference on Engineering, Construction and Operations in Space C, Denver, Colorado, 31 May-4 June 1992.
- 133"A theoretical basis for coupling via induced currents to biological systems for ultra fast switched magnetic fields," New York Academy of Sciences, 1992.
- 132"Some engineering models for interactions of electric and magnetic fields with biological systems", *Bioelectromagnetics*, Supplement 1, 67-85, 1992.
- 131"The use of high temperature superconducting films for the magnetic storage of information", with J. Cairns, Z.Zhang and M. Dugas, *IEEE Transactions on Magnetics*, vol. 28, (5), 2077-2080, 1992.
- 130"Radically focusing fiber optic probes for laser angioplasty", with R.T. Mihran and H. D. Wu, *Biomedical Optics*, January 1992.
- 129"Modification of the 1979 "Denver wire code" for different wire or Plumbing types", with E. Leeper, N. Wertheimer, D. Savitz and H. Wachtel, *Bioelectromagnetics*, vol. 12, (5), 315-318, November 1991.
- 128"A one room school house plan for education", with C.H. Marbury, L. Lawsine and R.N. Nicholson, *IEEE Transactions on Education*, vol. 34, (4), November 1991.

127"Editorial: some sources of hazards, safety, and electrical engineering," *IEEE Transactions on Education*, vol. 34, (3), 209-210, August 1991.

126"Modulation of nerve excitability *in vitro* by pulsed ultrasound", with R.T. Mihran and H. Wachtel, *Innovation Et Technologie En Biologie Et Medicine*, vol. 12, (1), 53-63, 1991.

125"Engineering properties of lunar regolith and their impact on mining", with Perkins, S. Sture and H. Y. Ko, *Proceedings of the International Symposium on Mine Mechanization and Automation*, June 1991.

124"Laser ablation of biological material using focused and pulsed laser beam", with K.S. Lee and M. Mertz, Sung Kyun Kwan University Collection of Technical Papers (Science & Technology Section), vol. 42, (1), special edition, April 1991.

123Microlenses. coupling light to optical fiber, H.D. Wu and F.S. Barnes, Eds., IEEE Press, New York, 1991.

122"A theory of shot noise in quantum wells and applications in resonant tunneling heterojunction bipolar transistors," with J. Han, *IEEE Transactions on Electron Devices*, 38, 2, 237-241, February 1991.

121"Editorial", *IEEE Transactions on Education*, vol. 33, (4), 313, November 1990.

120"The effects of time varying magnetic fields on biological materials," *IEEE Transactions on Magnetics*, vol. 26, (5), September 1990.

119"Transient modification of membrane potential and conductance by single ultrasound bursts modulates neuronal excitability," with R.T. Mihran and H. Wachtel, Annual International Conference of IEEE Engineering in Medicine and Biology Society, vol. 12, (1), 1990.

118"Optical response of bulk Bi-Sr-Ca-Cu-O," with W. Eidelloth, *IEEE Journal of Quantum Electronics*, 25 (11), 2405-2409, 1989.

117"Suspension in magnetic recording using high  $T_c$  superconductors," with B. R. Scharf and M. Dugas, *IEEE Transactions on Magnetics*, 25 (5), 3230-3232, 1989.

116"Radio-microwave interactions with biological materials," *Health Physics*, 56 (5), 759-766, 1989.

115"Josephson junctions with bulk  $YBa_2Cu_3O_{7-x}$ ,  $Bi_2Sr_2CaCu_2O_x$  and  $Tl_2Ca_2Ba_2Cu_3O_{10+x}$ ," with W. Eidelloth, S. Geller, K.-Y. Wu, Z.Z. Sheng, and A.M. Hermann, *IEEE Trans. on Magnetism*, 25 (2), 939-942, 1989.

114"The use of wiring configuration and wiring codes for estimating externally-generated electric and magnetic fields," with D. Savitz, H. Wachtel and J. Fuller, *Bioelectromagnetics* 10, 13-21, 1989.

113"Applications of high temperature superconductors to recording heads," with M. Dugas, W. Eidelloth, *IEEE Trans on Magnetism* 24 (6), 2395-2397, 1988.

112"Pair tunneling and weak links in bulk  $Tl_2Ca_2Ba_2Cu_3O_{10+x}$  up to 77 K," with W. Eidelloth, Z. Z. Sheng and A. M. Hermann, *Applied Physics Communications* 8 (4), 191-200, 1988.

111"An M.S. curriculum in telecommunications," with Julian Holtzman, *IEEE Transactions on Education* 31, (3), 213-214, August 1988.

110"Interdisciplinary M. S. Program in Telecommunications at the University of Colorado," with R. Shain, *Telematics and Informatics* 5 (2), 115-120, 1988.

- 109"Case-control study of childhood cancer and exposure to 60-hertz magnetic fields," with D. Savitz, H. Wachtel, E. John and J. Tvrdik, *Amer. J. Epidemiol.* 128 (1), 21-38, 1988.
- 108"Mechanisms of interaction of magnetic fields with biological systems," *IEEE Trans. on Magnetics* 24 (4), 2101-2104, 1988.
- 107"Case control study of childhood cancer and electromagnetic fields," with D. Savitz, *Amer. J. Epidemiol.*, 126 (4), 780, 1988.
- 106"Editorial: new directions for the IEEE Transactions on Education", *IEEE Transactions on Education*, vol. 21, (2), 53, May 1988.
- 105"Case-control study of childhood cancer and residential exposure to electric and magnetic fields," Contractor's Final Report, with D. Savitz and H. Wachtel, report for the New York State Power Lines Project, Wadsworth Center for Laboratories and Research, Albany, NY, 1987.
- 104"Simple side coupler for coupling between laser diode and single-mode optical fiber," with K. S. Lee. *Applied Optics* 26 (12), 2294-2296, June 1987.
- 103"A Potentially Low-Noise Avalanche Diode Microwave Amplifier," with W.-H. Su and K. F. Brennan, *IEEE Transactions on Electron Devices* ED-34 (5), 966-972, May 1987.
- 102"Vertical cavity surface emitting laser structure in molecular beam epitaxial GaAs/AlGaAs using a multilayered dielectric mirror", with Dave Christenson, topical meeting on semiconductor lasers Southwest Optics Conference of Optical Society of America, February 1987. NOTE: This was first the conference on surface emitting lasers.
- 101"Some possible limits on the minimum electrical signals of biological significance," pp. 339-347 in Mechanistic approaches to interactions of electric and electromagnetic fields with living systems, M. E. Blank and E. Findl, Eds., Plenum Press, New York, 1987.
- 100"Use of optical fiber heads for optical disks," with K. S. Lee and A. W. Smith, *Applied Optics* vol. 25 (22), 4010-4012, November, 1986.
- 99Chapters 1: "Interaction of DC electric fields with living matter," and 2: "Extremely low frequency (ELF) and very low frequency electric fields, rectification, frequency sensitivity, noise, and related phenomena," pp. 99-138 of Part II of The CRC handbook of biological effects on electromagnetic fields, Charles Polk and Elliot Postow, Eds., CRC Press, Boca Ration, Florida, 1986.
- 98"Injection Locking of Pacemaker Cells", with A. Smoller, A. Sheppard, Proceedings of the 9th Annual Conference, IEEE Engineering in Medicine and Biology Society, 1986.
- 97"Microlenses on the End of Single Mode Optical Fibers for Laser Applications," with K.S. Lee, *J. Applied Optics*, vol. 24, 3134-3139, October, 1985.
- 96"Forces on Biological Particles in Electric Fields," invited article, *J. Bioelectricity*, vol. 4 (2), 285-299, 1985.
- 95"Cell membrane temperature rate sensitivity as predicted from the Nernst equation," *J. BEMS*, vol. 5, 113, 1984.
- 94"An exposure system for variable electromagnetic field orientation electrophysiological studies," with J.D. Forster, H. Wachtel, R. Bowman and J. Frazer, *IEEE Microwave Theory & Technology*, Vol. MTT-33, (8), 674-680, August 1985.
- 93"Thickness dependence of the reflection coefficient from thin semiconductor films and measurements of the conductivity," with Baruch Divon, *Solar Cells*, vol. 6, 125-132, 1982.
- 92"Graduate school or work?," *IEEE Potentials*, December 1981 (Winter 1982 issue).

91"Noncontact measurement of microwave induced changes in frog heart beating rhythms," with R. Chalker and H. Wachtel, paper no. I-11, Bioelectromagnetic Society 3rd Annual Conference, Washington, D.C., August 9-12, 1981.

90"Microwave induced hypokinesia -- Effects of varying pulse intensity and width," with H. Wachtel, W.B. Stavinoha, A.T. Modak, and A.P. Dean, paper no. E-7, Bioelectromagnetic Society 3rd Annual Conference, Washington, D.C., August 9-12, 1981.

89"Some thoughts on accreditation in light of the experiment on advanced level accreditation," *Engineering Education*, Spring 1981.

88"Nonlinear impedance and low frequency dispersion effects of a polyelectrolyte under high sinusoidal fields," with C.J. Hu, in *Proceedings of the Division of Physical Chemistry Symposium on Biological Effects of Non-Ionizing Radiation*, ACS Symposium Series, No. 157, K.F. Illinger, Ed., 255-270, 1981.

87"Enrollment: expansion, limitations, or retrenchment: possible courses of action," presented at ASEE Annual Meeting, Amherst, Massachusetts, June 1980. Also in *Engineering Education*, February 1981.

86"Millimeter wave ellipsometer," with T. L. Thorpe and D. S. Gage, *Proceedings of the Society of Photo-Optical Instrumentation Engineers*, vol. 248, S.K. Deb, Ed., 158-165.

85"Millimeter wave Fabry-Perot interferometer for the measurement of the conductivity of thin films for solar cells," with D. S. Gage and L. Lewin, *Proceedings of the Society of Photo-Optical Instrumentation Engineers*, vol. 248, S. K. Deb, Ed., 148-157.

84"Nonlinear interactions of electromagnetic waves with biological materials," with C. J. Hu, in Nonlinear Electromagnetics, P. Uslenghi, Ed., Academic Press, New York, 391-426, 1980.

83"Short microwave pulses cause ultrastructural membrane damage in neuroblastoma cells," with M. M. Webber, L. A. Seltzer and K. N. Prasad, *Journal of Ultrastructure Research*, vol. 71, 321-330, 1980.

82"A review of the U.S.-Japan seminar on electrical conduction and breakdown in dielectrics and some thoughts on problems to be solved," *IEEE Transactions on Electrical Insulation*, vol. EI-15, (3), 131-133, June 1980.

81Review of Laser Safety Handbook, by Mallow and Chabot, *IEEE Spectrum*, April 1980.

80"Improved phonocardiogram system based on acoustic impedance matching," with R. Schwartz, J. Reeves, I. Sodal, *American Journal of Physiology*, vol. 238, (4), H604-609, April 1980.

79"Report on E. E. Department Heads Association Meeting," *IEEE Education Society Newsletter*, 4, February 1980.

78"Resistivity measurement of thin film semiconductor films on metallic substrates," with S. Hogan and S. Wagner, *Applied Physics Letters*, vol. 35, (1), 77-78, July 1979.

77"What is modern electronics?," with D. S. Gage, presented to ASEE Annual Meeting, Baton Rouge, Louisiana, June 24-26, 1979.

76"Measurement of the resistivity of thin CdS films on brass substrates," with S. Hogan and S. Wagner, *Solar Cells*, vol. 1, (3), 323-326, May 1980. (Extended abstract of paper presented at the Photovoltaic Material and Device Measurement Workshop, "Focus on Polycrystalline Thin Film Cells", Arlington, Virginia, June 11-13, 1979.)

75"Curriculum development in an era of rapid change," contributor, Special Issue, *IEEE Transactions on Education*, M.E. Van Valkenburg, Ed., May 1979.

- 74"The effects of nonlinear membrane capacity on the interaction of microwave and radio frequencies with biological materials," with G. Berkowitz, *IEEE Transactions on Microwave Theory and Techniques*, vol. MTT-237, (2), 204-207, February 1979.
- 73"The application of engineering to the design of bureaucratic structures," *Electron Device Society Newsletter*, (53), 4-5, June 1978.
- 72"Microwave and laser damage to biological materials," IntelCom 77 in Atlanta, Georgia, October 9-15, 1977, *Exposition Proceedings*, vol. 2, Paul Polishuk and Michael O'Bryant, eds., 671-675, 1977.
- 71"A model for some non-thermal effects of radio and microwave fields on biological materials," with C.J. Hu, *IEEE Transactions on Microwave Theory and Techniques*, vol. MTT-25, (9), 742-746, September 1977.
- 70"Breaking up residual gallstones with an ultrasonic drill," with H. Davies and W.J. Bean, *The Lancet*, 278-279, August 6, 1977.
- 69"Ultrasonic fragmentation of large residual biliary tract stone," with William J. Bean and Hywel Davies, *Journal of Clinical Ultrasound*, vol. 5, (3), 188-190, June 1977.
- 68"A system for automatically tracking white blood cells," with F.M. Greene, Jr., *Review of Scientific Instruments*, vol. 48, (6), 602-604, June 1977.
- 67"The correlation between the static stress distribution and the explosion energy of fused quartz flash- lamps," with J. Tippet, *IEEE Transactions on Electron Devices*, correspondence, 153-156, February 1977.
- 66Editorial, *IEEE Electrolatina*, vol. IX, (2, 3), published in Spanish.
- 65"An introduction to lasers as a source for optical communications," lecture notes for short course on optical communications via glass fiber waveguides, sponsored by Office of Telecommunications, Department of Commerce and the University of Colorado, August 1976.
- 64"A simplified theory of pearl chain phenomena," with C.J. Hu, *Rad. and Environm. Biophys.*, vol. 12, 71-76, 1975.
- 63"Applications of lasers to biology and medicine," *Proceedings of the IEEE*, vol. 63, (9), 1269-1278, September 1975 (invited paper).
- 62"Laser generated thermoelastic shock waves in liquids," with S. Bushanam, *Journal of Applied Physics*, vol. 46, (5), 2074-2082, May 1975.
- 61"Threshold effects of microwave radiation on embryo cell systems," with S.D. Pyle, D. Nichols and E. Gamow, in *Annals of the New York Academy of Sciences, Biologic Effects of Non-Ionizing Radiation*, vol. 247, 401-407, February 1975.
- 60"Transmitted ultrasound for relief of obstructions in ureters and arteries: current status," with H. Davies, R. Schwartz and R. Pfister, *Journal of Clinical Ultrasound*, vol. 2, (3), 217-220, September 1974.
- 59"Directional effects of cyclic AMP on platelets," with E. Gamow, A. Burns and A. de Boisfleury, *Clinical Science and Molecular Medicine*, vol. 456, 307-309, March 1974.
- 58"An ultrasonic image of arteriosclerotic deposits," with A. Korpel, R.L. Whitman, M. Ahmed, H. Davies and P. Steele, *IEEE Transactions on Biomedical Engineering*, 171, March 1974.

- 57"Changing patterns in electrical engineering enrollments," *Electronic Engineering Times*, 4, February 25, 1974.
- 56"Chemotactic responses of human PMN's to cyclic GMP and other compounds," with E. Gamow, *Experimental Cell Research*, vol. 87, 1-7, 1974.
- 55"Biological damage resulting from thermal pulses," chapter in Laser Applications to Medicine and Biology, vol. II, Dr. Myron Wolbarsht, Ed., Plenum Press, New York, 205-221, 1974.
- 54"Acoustic visualization technique for the diagnosis of arteriosclerotic diseases," with M. Ahmed, R.L. Whitman, A. Korpel, H. Davies and P. Steele, *Proceedings of the 1973 Ultrasonics Symposium*, November 1973.
- 53"Engineering at the sociotechnical interface," *IEEE Spectrum*, October 1973.
- 52"A technique for studying chemotaxis of leukocytes in well-defined chemotactic fields," with G. Grimes, *Experimental Cell Research*, vol. 79, 375-385, July 1973.
- 51"Laser-generated thermoelastic shock waves in liquid," Electron, Ion and Laser Beam Technology Symposium, May 21-23, 1973, Boston, Massachusetts.
- 50Laser Theory, reprint volume, IEEE Press, New York, February 1973.
- 49"A technique for studying chemotaxis of leukocytes in well-defined chemotactic fields," with G. Grimes, Methods in Cell Biology, vol. VI, David M. Prescott, Ed., Academic Press, Inc., New York, 1973.
- 48"Effects of non-ionizing electromagnetic radiation on biological materials," *Proceedings of the 1971 Workshop on Non-Ionizing Radiation*, October 7-8, 1971, Boulder, Colorado.
- 47Book Review on Laser Applications to Medicine and Biology, vol. I, M.L. Wolbarsht, Ed., Plenum Press, New York in *IEEE Spectrum*, 91, August 1971.
- 46"Analysis of chemotaxis in white blood cells," with R.I. Gamow and B. Bottger, *Biophysical Journal*, vol. 11, 860-867, July 1971.
- 45"Laser generated acoustic waves," with L. Hutcheson and O. Roth, *Proceedings of the 1971 Electron, Ion and Laser Beam Technology Symposium*, May 13-15, 1971, Boulder, Colorado.
- 44"Review of rare gas flashlamps," with J. Oliver, *Proceedings of the IEEE*, vol. 59, (4), 638-644, April 1971 (Invited Paper).
- "A Theory of Necrotaxis," with Chia-Lun Hu, *Biophys. J.*, Vol. 10, No. 10 pp. 958-969, 1970.
- 43"Thermal damage to biological materials," with C.J. Hu, *IEEE Transactions on Biomedical Engineering*, vol. BME-17, (3), 220-229, July 1970.
- 42"An ultrasonic drill for cleaning blood vessels," with J. Ycas, *Proceedings of the 7th Annual Rocky Mountain Bioengineering Symposium*, 165-166, May 1970, Denver, Colorado.
- 41"The electrical engineer and public policy," editorial, *IEEE Spectrum*, vol. 7, (5), 21, May 1970.
- 40"The motion of white cells and the chemotaxis of laser destroyed red blood cells by white cells," with C.J. Hu, *Biophysical Journal*, vol. 10, (10), 958-969, 1970.

- 39"Physical parameters characterizing the selective thermal damage of mitochondria by laser micro-irradiation," with C. Salet and M. Lutz, *Journal of Photochemistry and Photobiology*, vol. 11, 193-205, 1970.
- 38"A comparison of rare-gas flashlamps," with J.R. Oliver, *IEEE Journal of Quantum Electronics*, vol. QE-5, (5), May 1969.
- 37"Rare-gas pumping efficiencies for neodymium lasers," with J.R. Oliver, *IEEE Journal of Quantum Electronics*, vol. QE-5, (5), May 1969.
- 36"Some applications of lasers to the study of cells," *Proceedings of the Laser Industry Association Meeting*, Oct 26-28, 1968, Washington, D.C.
- 35"A parallel-strip point-contact diode mount for video detection of millimeter waves," with M. Gerdine, *PGMTT of IEEE*, vol. MTT-4, (4), 41-42, January 1968.
- 34"Cooperation of universities and utilities for the education of power-system engineers," with E.A. Erdelyi, *IEEE Spectrum*, December 1967.
- 33"Thermal damage to biological materials by lasers," with C. Hu and J. Lauridson, *Proceedings of the 9th Annual IEEE Symposium on Electron, Ion and Laser Beam Technology*, May 1967.
- 32"Holography," *Proceedings of the 8th Annual Engineering Symposium*, Brigham Young University, Utah, April 1967.
- 31"Teaching vs. research -- some thoughts on student/faculty relations," *The Colorado Engineer*, March 1967.
- 30"Recruiting graduate students," reader comment, *Journal of Engineering Education*, vol. 57, (5), January 1967.
- 29"Characteristics of biological damage by lasers," with C. Hu, J. Lauridson and A. McGibbon, *NEREM Abstracts*, Boston, Massachusetts, 1966.
- 28"Invest in the future of young electric utility engineers," with E.A. Erdelyi, 1966 issue of *IEEE Region VI Conference Record*, vol. 1 of 2 volumes, pp. 346-353; also in June 1966 issue of *IEEE Transactions on Education*. *IEEE*, vol. 54, (4), 672-673, April 1966.
- 26"An ideal harmonic generator," with G. Eiber, *Proceedings of IEEE*, vol. 53, (7), July 1965.
- 25"Harmonic generation using non-linear inductors and capacitors," with G. Eiber, *Proceedings of IEEE*, vol. 53, (7), July 1965.
- 24"High-frequency tunnel-diode oscillations using a new parallel-strip point-contact diode mount," with M. Gerdine, *Electronic Letters*, May 1965.
- 23"The poor are getting richer," letter to *Science*, vol. 147, (3660), 823, February 19, 1965.
- 22"Tunnel diode millimeter wave harmonic generator," with T. Gaddess and R. Temple, *PGMTT of IEEE*, vol. 54, (4), 672-673, April 1966.
- 21"Laser-induced shock waves in biological systems," with K. Takahashi and J. Daniel, *Proceedings of the 2nd Annual Rocky Mountain Bioengineering Symposium*, 1965.
- 20"Some uses of a laser," *IEEE Student Journal*, Nov 1964.

- 19"Characterization of xenon flash tubes," Society of Motion Picture and Television Engineers, July 1964 (Invited Paper).
- 18"A discussion of the properties of four molecular beam detectors,"with S. Andresen, C. Shipley and D. Foiani, *18th Annual Frequency Control Symposium Proceedings*, 1964.
- 17"Developmental disturbances of vertebrate embryos induced by laser radiation," with J.C. Daniel and K.R. Lang, *First Annual Rocky Mountain Bioengineering Symposium*, USAF Academy, Colorado, 1964.
- 16"Lasers as tools for embryology and cytology," with K. Lang, J. Daniel and M. Maisel, *Nature*, February 15, 1964.
- 15"Shock waves and tube deterioration in xenon flashtubes," with K. Lang, *Journal of Applied Physics*, vol. 35, 107-110, January 1964.
- 14"An investigation of confine arc discharges in xenon," with A. Buck and R. Erickson, *Proceedings of the Third International Symposium on Quantum Electronics*, Columbia University Press, 1964, 1379-1396.
- 13"The detection statistics of a molecular beam frequency standard," with W.R. Turner, *IEEE Transactions on Instrumentation*, September 1963.
- 12"The design and operation of xenon flash tubes," with A. Buck and R. Erickson, *Journal of Applied Physics*, July 1963.
- 11"Masers and millimeter waves," *Proceedings of the IEEE*, January 1963.
- 10"Choice of a molecule for a beam frequency standard," *IRE Transactions on Instrumentation*, December 1962.
- 9"On the modulation of optical masers," *Proceedings of IRE*, July 1962.
- 8"A tunnel diode frequency multiplier with gain," with Lloyd Morris, *Proceedings of IRE*, Dec 1961.
- 7"A magnetic shield for beam frequency standards," *Proceedings of IRE*, August 1961.
- 6"Choice of a molecular transition for frequency control in the millimeter wave region," with D.G. Burkhard and M. Mizushima, *Proc. of the 15th Annual Symposium on Frequency Control*, June 1961.
- 5"A beam maser for three millimeters using hydrogen cyanide," with D. Maley, *Electronics*, March 17, 1961.
- 4"The feasibility of building beam type masers in the millimeter and submillimeter wave range," The University of Columbia Press, *Proceedings of the Conference on Quantum Electronics and Resonance Phenomena*, 1960.
- 3"Operating characteristics of an ammonia beam maser," *Proceedings of IRE*, December 1959.
- 2"The forward switching transient in semiconductor diodes at large currents," *Proceedings of Institute of Radio Engineers (IRE)*, July 1958.
- 1"Hydrogen cooling of generators," *Princeton Engineer*, November 1953.