

where

$C$  = velocity of light,  
 $f$  = frequency,  
 $\epsilon$  = dielectric constant.

It is at this diameter that orthogonal  $TE_{11}$  modes can propagate in the ferrite acting as a dielectric waveguide. We have observed an additional phenomena which can also be explained by this dielectric waveguide model. This effect is discussed by Weiss<sup>4</sup> and is associated with the large amount of periodic loss which occurs as one increases the microwave frequency above a critical value. I believe a simple explanation of this behavior can be attributed to the excitation of the next higher order mode, the  $TM_{01}$ . This mode can only propagate in the ferrite region and is not matched to the rectangular waveguide by the transformer that matches the  $TE_{11}$  mode. Multiple reflections, therefore, occur between the ferrite ends with periodic losses resulting. In a similar manner to that used by Rizzi and Gatlin, the frequency at which this mode propagates is computed by

$$f > \frac{C}{1.309 d \sqrt{\epsilon}}. \quad (2)$$

The dashed curve in Fig. 1 has been calculated using this relationship with  $\epsilon = 13$ . Also presented is an experimental curve obtained with R-1 ferrite. The two curves show a general agreement. Some of the differences in the two curves can be possibly explained by the value of  $\epsilon$  used as well as the effect of the waveguide height. Since all the microwave energy is not trapped to the ferrite, especially at low applied fields, a reduction in the narrow dimension should raise the frequency at which the  $TM_{01}$  mode can propagate. We have experimentally observed the above to be true.

#### ON TEMPERATURE SENSITIVITY

The temperature sensitivity of the Reggia-Spencer phase shifter has been of concern in those applications which require precise phase control or phase modulation. In applications that require both phase advances and delays, bias currents are required because of the reciprocal nature of

the phase shifter. The phase delay, as a function of temperature at a bias point of 85 ampere-turns for R-1 ferrite 1.4 inches long with 0.6-inch conical tapers, is shown in Fig. 2. It can be observed that over very large temperature ranges as much phase shift can be obtained from this effect as from applied magnetic fields.

The type of phase modulation characteristics obtainable about the 85-ampere-turn bias points as a function of temperature, is shown in Fig. 3. These curves are plotted on a relative basis; *i.e.*, they all use the same zero field phase-shift value. Note that the peak-to-peak phase shift is quite constant. This is illustrated by Fig. 4, which indicates the variation in the peak-to-peak phase shifts as a function of temperature. There is a fairly large range of temperature possible with little change in phase modulation characteristics. Therefore, if one desires to use these devices as phase modulators it is possible to do so with little change in the index of modulation with temperature.

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## Contributors

Barbara A. Begg was born in Boston, Mass. on July 2, 1920. She received the A.B. degree from Boston University, in 1942; a special certificate in aeronautical engineering from New York University, in New York City, in 1944; and in 1956, the masters degree in library science from Carnegie Institute of Technology in Pittsburgh, Pa.



B. A. BEGG  
 in the Experimental Flight Test Group at

Chance Vought Aircraft, Dallas, Texas; in the Wind Tunnel Computing Section at North American Aviation; and, from 1950 to 1955, in the Aircraft Gas Turbine Division of General Electric Company. In 1956, she joined the ITT Laboratories, Nutley, N. J., as assistant librarian. She became the engineering librarian at Drexel Institute of Technology, Philadelphia, Pa. in July, 1959.

Miss Begg belongs to the AIEE, Special Libraries Association, American Libraries Association, and American Documentation Institute.



Robin M. Chisholm (S'52-A'54) was born in London, Can., in January 11, 1930. He attended Queen's University in Kingston,

Ontario, where he received the B.S. degree in engineering physics in 1952. He studied in the graduate school of the University of Toronto where he received the M.A.Sc. degree in electrical engineering in 1954 and the Ph.D. degree in 1958.

Since graduation he has worked during the summers for the National Research Council of Canada at Ottawa, Ontario. In



R. M. CHISHOLM

1956 he joined the staff of the Department of Electrical Engineering at Queen's University, Kingston, Ontario, where he is at present an assistant professor.

He is a member of the Association of Professional Engineers of the Province of Ontario.



John R. Cogdell was born on May 24, 1936 in Quanah, Tex. He received the B.S. degree in electrical engineering in May, 1958, and the M.S. degree in electrical engineering in August, 1959, both from the University of Texas, Austin.



J. R. COGDELL

From June, 1958 to July, 1959 he was research engineer at the Electrical Engineering Research Laboratory at the University of Texas.

Since July, 1959, he has been on the staff of Lincoln Laboratories, Massachusetts Institute of Technology, Cambridge.

Mr. Cogdell is a member of Tau Beta Pi and Eta Kappa Nu.



W. CULSHAW

From 1942 to 1954 he was a staff member of the Telecommunications Research Establishment, Malvern, Eng., where he was with the Microwave Receiver and the Millimeter Wave divisions. From 1954 to 1956 he was a member of the Radio Physics Laboratory, Ottawa, Can., where he worked on scattering, and antenna problems. Since 1956, he has been a member of the Microwave Physics Section of the National Bureau of Standards, Boulder Laboratories, Boulder, Colo., where his primary interests are in millimeter wave research and microwave optics.

Dr. Culshaw is a member of the Scientific Research Society of America.

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Andrew P. Deam (M'51) was born in Dallas, Tex. on December 10, 1917. He received the B.S. degree in electrical engineering from Texas A & M College, College Station, in 1940, and the M.S. degree in electrical engineering from The University of Texas, Austin, in 1949.

During 1941 and 1942 he was employed by the Dallas Power and Light Company as an assistant engineer.

Since 1942, he has been employed by The University of Texas, both in a teaching and research capacity, and is presently a radio engineer at the Electrical Engineering Research Laboratory, where his work has been primarily related to radio-wave propagation.

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James E. Eaton (A'46-M'47) was born in New York, N. Y. on March 27, 1912. He received the B.S. and Ph.D. degrees in 1936 and 1939, respectively, both from Yale University, New Haven, Conn.

He taught at Hofstra College, Hempstead, N. Y., until 1941 where he was associ-

ate professor and chairman of the department of mathematics. He was then appointed to the faculty of Queens College, Flushing, N. Y., where his present rank is associate professor of mathematics. During the latter part of the war, he was a member of the Antenna Group of Radiation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. He continued his work on micro-

wave antennas at the Naval Research Laboratory, Washington, D. C., where he was in residence until 1947, when he returned to Queens College. He remained associated with N.R.L. however, as mathematician and consultant until 1957.

Dr. Eaton is a member of Sigma Xi, the American Mathematical Society, and the Mathematical Association of America.



C. A. FINNILA

During the summer periods between academic years, he has been employed by Mare Island Naval Shipyard, Vallejo, Calif. (1957); Huggins Laboratories, Inc., Sunnyvale, Calif. (1958); and the Electronics Research Laboratory, University of California, Berkeley, Calif. (1959).

Mr. Finnila is a member of Tau Beta Pi and Eta Kappa Nu. In August, 1959, he received one of the WEMA scholarships awarded each year at WESCON to outstanding engineering students.

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Max P. Forrer (A'54-SM'57) was born on October 15, 1925, in St. Gallen, Switzerland. He received the Diploma in electrical engineering from the Swiss Federal Institute of Technology, Zurich, in 1950, and the Ph.D. degree from Stanford University, Stanford, Calif., in 1959.

From 1951 to 1952 he was with the Standard Telephone and Radio Corporation (IT&T) in Zurich, where he was concerned with carrier telephone developments. After coming to the United States in 1952, he joined the Western Electric Com-



M. P. FORRER

pany at Kearny, N. J., working on Microwave Radio Relay systems. Since February, 1955, he has been a member of the technical staff at the General Electric Microwave Laboratory at Palo Alto, Calif., and he also attended Stanford University under the General Electric Honors Cooperative Program. He has been engaged in studies on microwave harmonics suppression, microwave technology for computers, electron multifactor devices and klystron tubes.

Dr. Forrer is a member of Sigma Xi.

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J. K. Hunton (SM'57) was born in Montreal, Canada on December 20, 1921. He received the B.A.Sc. degree in engineering physics from the University of Toronto, Canada, in 1943 and served in the Royal Navy as a radar officer until 1946.



J. K. HUNTON

He attended Massachusetts Institute of Technology, Cambridge, where he was an instructor in electrical engineering and received the S.M. degree in 1948. At this time he joined the Hewlett-Packard Company in Palo Alto, Calif. where he is now in charge of the waveguide instruments development group.

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E. T. Jaynes (SM'54) was born in Waterloo, Iowa, on July 5, 1922. He attended Cornell College, Mount Vernon, Iowa, and Iowa State University, Iowa City, receiving the B.A. degree in physics from the latter in 1942.

He studied in the graduate school of the University of California in Berkeley and at Princeton University, Princeton, N. J., from which he received the M.A. degree in 1948 and the Ph.D. degree in theoretical physics in 1950.

From 1942 to 1946, he was engaged in microwave research and development as a project engineer at the Sperry Gyroscope Co., Garden City, N. Y., and in the combined research group of the Naval Research Laboratory.

Since 1950, he has been on the faculty of Stanford University, Stanford, Calif. At present he holds the titles of associate professor in the microwave laboratory and lecturer in physics.

Mr. Jaynes is a member of the American Physical Society, the American Association of Physics Teachers, Sigma Xi and the New York Academy of Sciences.



E. T. JAYNES

E. M. T. Jones (S'46-A'50-M'55-SM'56) was born in Topeka, Kans., in 1924. He received the B.S. degree in electrical engineering from Swarthmore College, Swarthmore, Pa., in 1944 and the M.S. and Ph.D. degrees in electrical engineering from Stanford University, Stanford, Calif., in 1948 and 1950, respectively. He was a radar maintenance officer in the U. S. Navy from 1944 to 1946. From 1948 to

1950 he was a research associate at Stanford University, working on the microwave local oscillator project. He joined the staff of Stanford Research Institute, Menlo Park, Calif., in 1950, and in 1957 he became head of the Microwave Group of the Electromagnetics Laboratory.

Dr. Jones is a member of Sigma Tau and RESA.

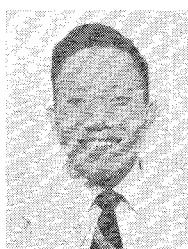


E. M. T. JONES

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Howard E. King (A'46-M'55-SM'55) was born in Seattle, Wash., on October 16, 1924. He received the B.S.E.E. degree in 1945 from the University of Washington, Seattle, and the M.S.E.E. degree in 1955 from the University of Illinois, Urbana.

From 1946 to 1952 he was a member of the broadcast section of the RCA Victor Division, designing FM and television transmitting antennas; he took part in the development of the Empire State Building multiple television antenna system. After a year with the Andrew Corporation, he was appointed as a research assistant of the Antenna Laboratory of the University of Illinois, where he remained until 1955. In 1955, he became a member of the technical staff of the Communications Division of the Ramo-Woolridge Corporation. Here he was engaged in the development of ground and airborne electronic counter measures, antennas, and components. In 1955 he joined the Space Technology Laboratories, Inc., Los Angeles, Calif., where he is presently employed.



H. E. KING

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Ronald W. P. King (A'30-SM'43-F'53) was born in Williamstown, Mass., on September 19, 1905. He received the A.B. degree in 1927 and the S.M. degree in 1929, both from the University of Rochester, Rochester, N. Y., where he majored in physics. He was awarded the Ph.D. degree by the University of Wisconsin, Madison, in 1932 after having done graduate work at the University of

Munich (Germany), and Cornell University, Ithaca, N. Y.

He served as teaching and research assistant at the University of Wisconsin in 1932-1934 and as instructor and assistant professor of physics at Lafayette College, Easton, Pa., in 1934-1937. The year 1937-1938 he spent in Germany as a Guggenheim Fellow. In 1938 he joined the faculty of Harvard University, Cambridge, Mass., where he advanced to the rank of professor in 1946. He is now Gordon McKay Professor of applied physics at Harvard University. In 1958 he studied and traveled abroad as a Guggenheim Fellow. His research has been primarily in the field of antennas, transmission lines, and microwave circuits.

Dr. King is a Fellow of the American Physical Society and the American Academy of Arts and Sciences, a corresponding member of the Bavarian Academy of Sciences, and a member of the American Association of University Professors and the American Association for the Advancement of Science. He is also a member of Phi Beta Kappa and Sigma Xi.

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Hiroshi Kogō (M'55) was born on August 16, 1921, in Tokyo, Japan. He received the B.S. degree in electrical engineering in 1944 from the Tokyo Institute of Technology, and the Ph.D. degree in engineering in 1958 from the same institution.

From 1946 to 1947 he was employed by the Nippon Acoustic Co., and from 1947 to 1952 he worked for the Electro-Communication University in Tokyo. Since 1952 he has been an assistant professor in the faculty of engineering, Chiba University, Chiba, Japan.

Dr. Kogō is concerned with the development of microwave circuits, special BALUN, antennas, television receivers and ITV.



H. KOGŌ

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Ellis Mount (M'56) was born in Connersville, Indiana, on September 25, 1921. He received the B.S. degree in physics from Principia College, Elsah, Illinois, in 1948, and the M.S. degree in physics from Northwestern University, Evanston, Ill., the following year. In 1950 he received an M.S. degree in Library Science from the University of Illinois.

He served for three years as a communications officer in the Air Force. He was on the staff of the John Crerar Library in Chicago, Illinois, from 1950-1951 and again from 1953-1955. From 1951-1953 he was librarian for the General Electric Company, Aircraft Nuclear Propulsion Project, Cincinnati, Ohio. Since 1955 he has been Chief Librarian for ITT Laboratories, a Division of International Telephone and Telegraph Corporation, Nutley, New Jersey.

Mr. Mount belongs to the Special Libraries Association and the American Documentation Institute.



E. MOUNT

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Gilbert H. Owyang was born in Tientsin, China. He received the B.S. degree in electrical engineering from La Universitato

Utopia, Shanghai, China, in 1944, and the S.M. degree in electrical engineering in 1950, and the Ph.D. degree in applied physics in 1959, both from Harvard University, Cambridge, Mass.

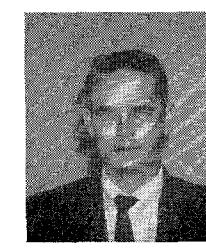
From 1944 to 1949, he worked with the Shanghai Power Company, China, as an engineer. He was on the engineering staff of Devanco, Inc., and Frank L. Capps and Company, both in New York, N. Y., between 1950 and 1954, and from 1955 to 1959, was a research assistant at Gordon McKay Laboratory, Harvard University. Since June 1959, he has been with the Radiation Laboratory of the University of Michigan, Ann Arbor.

Dr. Owyang is a member of Sigma Xi and the Harvard Engineering Society.

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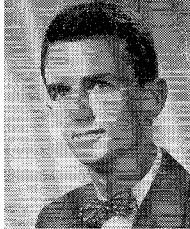
D. A. Parkes (S'57-M'58) was born on October 21, 1931, in Jacksonville, Florida. He received the Bachelor of Electrical Engineering degree, in 1958, from the University of Florida, in Gainesville.

In 1958, he joined the Sperry Microwave Electronics Company, in Clearwater, Florida, a division of the Sperry Rand Corporation. There, he has been engaged in the development of ferrite microwave components and solid-state devices.



D. A. PARKES

H. J. Riblet (A'45-M'55-F'58), for a photograph and biography, please see page 306 of the July, 1959, issue of these TRANSACTIONS.



H. J. RIBLET

E. Schlömann, for a photograph and biography, please see page 126 of the January, 1960 issue of these TRANSACTIONS.

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Lester A. Roberts (S'47-A'50) was born in Los Angeles, Calif., on July 31, 1925. He received the B.S. degree in electrical engineering from Iowa State College, Ames, in 1946, and the M.S. and Ph.D. degrees from Stanford University, Stanford, Calif., in 1947 and 1951, respectively.

From 1950 to 1954 he was a research associate at the Electronics Research Laboratory, Stanford University,

engaged primarily in the study and development of traveling-wave tubes and related microwave devices. From 1954 to 1959 he was employed at Huggins Laboratories as chief engineer, where he directed design and development of traveling-wave tubes. In 1959 he joined the Watkins-Johnson Company as a member of the Technical Staff, where he is conducting research and development on microwave electron devices.

Dr. Roberts is a member of Sigma Xi, Tau Beta Pi, and Eta Kappa Nu.

C. B. Sharpe (S'46-A'52) was born in Windsor, Ontario, Can., on April 8, 1926. He attended Northwestern University,

Evanston, Ill., and the University of Michigan, Ann Arbor, Mich., receiving the B.S. degree in electrical engineering from the latter in 1947. He received the S.M. degree from Massachusetts Institute of Technology, Cambridge, Mass., in 1949 and the Ph.D. degree from the University of Michigan in 1953, both in electrical engineering.

From 1953 to 1955 he served as assistant project officer in the guided missile branch of the U. S. Navy Bureau of Ordnance and as a technical aide in the Office of Naval Research.

Since returning to the University of Michigan in 1955, he has done research in microwave circuit theory, microwave measurements of ferroelectrics, and the application of solid-state materials to microwave devices.

He now holds the title of associate professor of electrical engineering at the University and is a faculty consultant to the Electronic Defense Group.

Mr. Sharpe is a member of Tau Beta Pi and Sigma Xi.

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Norman O. Robinson, Jr. (S'54-M'56) was born in Baltimore, Maryland on January 26, 1928. He received the B.S. degree

from the University of Maryland, College Park, in 1955 and the M.S. degree from the University of Southern California, Los Angeles, in 1957, both in electrical engineering.

He served with the U. S. Marine Corps as a radar technician and as an instructor in an advanced electronics school from 1946 to 1949.

Recalled to active duty during the Korean War, he was a member of a team developing an automatic close air support bombing system at Point Mugu, Calif. He worked in the missile division of Sperry Gyroscope Company, Point Mugu, Calif., in 1952, and in the research and development department of Bendix Radio Company, Baltimore, Md., in 1953.

Mr. Robinson joined the technical staff of the Hughes Aircraft Company, Culver City, Calif., in 1955, as a member of the Master of Science fellowship program. He has been involved in the development of circuitry for pulse and pulse doppler radar systems, with emphasis on design of frequency and phase locked loops.

He is a member of Tau Beta Pi.

William Silvey was born in New York, N. Y. on April 13, 1931. He received the B.S. degree in applied physics in 1956 and the M.S. degree in applied physics in 1959 from the University of California, Los Angeles.

From 1956 to 1959, he was a member of the technical staff at Hughes Aircraft Co. Research Laboratories, Culver City, Calif. There Mr. Silvey worked in the Quantum Physics

Section and was primarily concerned with microwave spectroscopy and maser research.

Since 1959, when he joined Space Technology Operations of Aeronutronic, a division of Ford Motor Company, Newport Beach, Calif., he has been engaged in the coordination and integration of experiments in Cis-Lunar research vehicles.

Mr. Silvey is a member of the American Physical Society.



C. B. SHARPE

Malcolm L. Stitch (SM'58) was born on April 23, 1923 in Elizabeth, N. J. He attended Rensselaer Polytechnic Institute, Troy, N. Y., from 1940-1943. After military service in the Army, he received the B.S. degree in physics, and the B.A. degree in French literature from Southern Methodist University, Dallas, Texas, in 1957. He entered Columbia University, New York, N. Y., and received the Ph.D. degree in physics in 1953. While at Columbia, he was an instructor in physics at Cooper Union, New York, N. Y., and Sarah Lawrence College, Bronxville, N. Y., and research assistant at the Columbia Radiation Laboratory. His field of interest was high-temperature microwave spectroscopy.

From 1953-1956 he was at the Research Laboratories of Varian Associates, Palo Alto, Calif., where he made contributions in microwave spectroscopy and microwave stabilization by high-Q cavities. He joined the Atomic Physics Department of Hughes Aircraft Company, Culver City, Calif., in 1956 where he has made contributions to the physics and technology of masers. He is currently Head of the Atomic Resonance Group, and senior staff physicist.

Dr. Stitch is a member of Sigma Xi, The New York Academy of Science, RESA, The American Physical Society, American Association of Physics Teachers, AAAS, FAS, Physical Society of Japan and Societa Italiana di Fisica.

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Archie W. Straiton (M'47-SM'49-F'53) was born in Arlington, Tex. on August 27, 1907. He received the B.S. degree in electrical engineering, the M.A. degree and the Ph.D. degree, all from the University of Texas, Austin.

He taught at Texas College of Arts and Industries, Kingsville, from 1931 to 1943. Since 1943 he has been at the University of Texas, where he is now professor of electrical engineering and director of the Electrical Engineering Research Laboratory.

Dr. Straiton is a member of Eta Kappa Nu, Tau Beta Pi, Sigma Xi and American Society for Engineering Education. He is a former member of U. S. A. National Committee and chairman of Commission II of the International Scientific Radio Union.

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Donald J. Sullivan (S'51-A'54-M'57) was born on Staten Island, New York, N. Y. on October 19, 1932. He received the B.S.



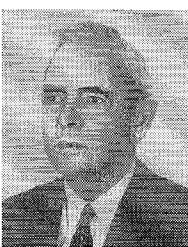
M. L. STITCH



N. O. ROBINSON



W. SILVEY

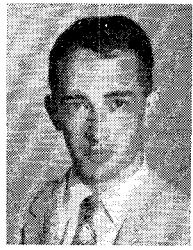


A. W. STRAITON

degree in electrical engineering from Manhattan College, New York, N. Y. in 1954.

After graduation he joined the Sperry Gyroscope Company, Great Neck, N. Y., as an assistant engineer in the Microwave Component Group. In 1957, he moved to Clearwater, Fla., to assist in starting the newly-formed Sperry Microwave Electronics Company.

Since joining the company, he has been engaged in research and development work on high-power and low-frequency solid-state components. He is a senior engineer



D. J. SULLIVAN

and group leader in the Advanced Microwave and Solid-State Devices Group.

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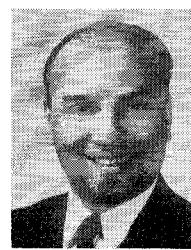
Charles Süsskind (A'47-M'52-SM'53) was born in 1921, in Prague, Czechoslovakia, and received his secondary education in Czechoslovakia and in Great Britain. He graduated from the California Institute of Technology, Pasadena, in 1948, and received the M. Eng. and Ph.D. degrees from Yale University, New Haven, Conn., in 1949 and 1951, respectively.

During the war, he served with the 8th Air Force in Europe as an airborne-radar specialist. From 1951 to 1955, he was a research associate at Stanford University,

where he also acted (after 1953) as lecturer in electrical engineering and assistant to the director of the Microwave Laboratory. In

1955, he joined the electrical engineering faculty of the University of California, Berkeley, where he is now associate professor.

Dr. Süsskind is an associate member of the British IRE, and a member of the American Physical Society, the American Society for Engineering Education, the History of Science Society, the History of Technology Society, Sigma Xi, and Tau Beta Pi.



C. SÜSSKIND