

### Application of Rayleigh-Ritz Method to Dielectric Steps in Waveguides\*

Collin and Vaillancourt<sup>1</sup> write that in a previous paper of mine<sup>2</sup>: "the coupling of the LSE modes by the step when a LSM mode is incident is neglected."

This remark is true, only in reference to the approximate numerical results obtained in my paper, but does not apply to the varia-

tional expressions. All derivations and results about the four-terminal network equivalent to the discontinuity, are perfectly general and include  $H_y$  as well as  $E_y$  modes. The summations in all the expressions in my paper extend to both types of modes.

The particular trial field chosen for the numerical computation of the admittance is such that the contribution of the  $H_y$  modes is zero. It is with this thought in mind that I asked the reader, at the beginning of the paper, to ignore the  $H_y$  modes. I did not mean to say that they are not excited. In fact, if another trial field is inserted into the expressions given for the admittances in my paper, they will yield contributions from the  $H_y$  modes.

It is actually very easy to show that  $H_y$  modes are excited at the discontinuity, simply by matching all the fields at that plane.

In my thesis at the Polytechnic Institute of Brooklyn, I discussed both types of modes. My intention in the paper, was to reduce its length to a minimum by not including the  $H_y$  mode functions.

This opportunity to point out the generality of the theory and the limitations of the numerical results, I owe to Dr. Collin who, before the publication of his paper, called my attention to the possibility of misinterpreting the statement in mine.

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\* Received by the PGMMT, June 21, 1957.

<sup>1</sup> R. E. Collin and R. Vaillancourt, IRE TRANS., vol. MTT-5, pp. 177-184; July, 1957.

<sup>2</sup> C. M. Angulo, "Discontinuities in a rectangular waveguide partially filled with dielectric," IRE TRANS., vol. MTT-5, pp. 68-74; January, 1957.

## Contributors

Wesley P. Ayres (M'56) was born on September 26, 1924, at Los Angeles, Calif. He served as an electronic technician aboard a

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tronic Defense Laboratory of Sylvania Electric Products, Inc., Mountain View, Calif., where he engaged in ferrite research at microwave frequencies. In 1956, Dr. Ayres helped to found Microwave Engineering Laboratories, Inc., Palo Alto, Calif., where he is presently doing research on microwave components.

Dr. Ayres is a member of RESA and the American Physical Society.

Saul M. Bergmann (M'56) was born in Antwerp, Belgium, on September 7, 1927. He graduated in electrical engineering from the

Institute of Technology, Haifa, Israel, in 1951. He then joined the Societe Belge-Radio-Electrique in Brussels.

From 1953 to 1956 he did postgraduate work in physics at the University of London under R. Furth. He then joined the Microwave Research In-

stitute in Brooklyn as Research Associate. He is currently employed by the Raytheon Manufacturing Company doing work on microwave ferrite devices with the Special Microwave Device Group.

Kenneth R. Bushore was born in San Diego, Calif. on April 27, 1915. After graduating from the Navy's Radio Materiel Schools at Chicago, Ill., Del Monte, Calif., and Treasure Island, Calif., he served as an electronic technician with the Pacific fleet during World War II.

In 1949, Mr. Bushore was employed by the Navy Electronics Laboratory, San Diego, Calif., where he engaged in microwave research and development as a member of the Microwave Components Group of the Radar Branch from 1950 until early 1957. He is currently a member of a newly organized group at N.E.L. which is investigating optical system applications for radar use.

Robert S. Elliott (A'51-SM'53) was born in Brooklyn, N. Y., on March 9, 1921. He was a Pulitzer Scholar at Columbia University, New York, N. Y., where he received the A.B. degree in 1942 and the B.S. degree in 1943.

From 1943 to 1946, he was employed by the Applied Physics Laboratory of Johns Hopkins University, serving as a junior engineer on problems in radar, guided missiles, and the proximity fuse. In 1946, he became a member of the electrical engineering staff

at the University of Illinois, where his duties included undergraduate and graduate teaching and research in antennas and microwave

tubes. While at Illinois he received the M.S. degree in 1947, and the Ph.D. degree in 1952.

Summer employment in the antenna groups at Sperry Gyroscope Co. in 1949, and North American Aviation, in 1950, supplemented his Illinois employment. Upon leaving Illinois

in 1952, Dr. Elliott served one year of active duty in the U. S. Navy and then joined the technical staff of the Hughes Aircraft Company, where he was in charge of the antenna research section of the Microwave Laboratory. At Hughes, Dr. Elliott specialized in surface wave antennas and uhf arrays. He is presently technical director and vice-president of the RANTEC Corporation.

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Elizabeth Laverick (SM'55) was born in Amersham, Buckinghamshire, England in November, 1925. She received the B.S. degree in physics from

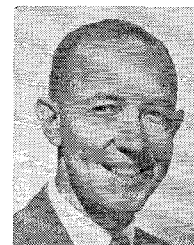
Durham University in 1946, and the Ph.D. degree in 1950. From 1950 to 1953, she worked at the Research Laboratories of the General Electric Company, Ltd., at Stanmore, Middlesex, in charge of a section on microwave antennas. In Decem-



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ber, 1953; she joined Elliott Brothers (London), Ltd., where she is head of the research group in the Microwave Division of that company. This group is currently engaged on investigation into microstrip, ferrite devices, antenna design and millimeter wave techniques.

Miss Laverick is an associate member of the IEE and Institute of Physics.



Lowell E. Norton was born on August 12, 1909, in Arlington, Minn. He received the B.S. degree in electrical engineering in 1932, and the M.S. degree in communications in 1935, both from the University of Minnesota.



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Mr. Norton is a member of Sigma Xi.



Karle S. Packard (M'50-SM'56) was born in Boston, Mass., on July 15, 1921. He received the A.B. degree in physics in 1943 from Columbia University and the M.S. degree in physics in 1951 from New York University. During 1943-1944, he worked on the development of the magnetic airborne detector at Columbia University's Division of War Research. From 1944 to 1946, he was employed by the National Carbon Company where he worked on the proximity fuze and later on dielectric heating.



K. S. PACKARD

In 1946, Mr. Packard joined Airborne Instruments Laboratory, Mineola, N. Y., as a project engineer. He has been responsible for the development of equipment for magnetic surveying, automatic swr and impedance plotting, and video recording and reproduction. More recently he has been engaged in the development of microwave systems and components, particularly in the field of strip

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Peter A. Rizzi (S'50-A'54-M'57) was born in Providence, R. I., on December 10, 1930. He received the B.S. degree with high honors from the University of Rhode Island in 1951, and the M.E. and D.E. degrees in electrical engineering from Yale University in 1952 and 1955.



P. A. RIZZI

During his graduate studies, he received the Yale University Scholarship and the Charles LeGeyt Fortescue Fellowship. Since August, 1954, Dr. Rizzi has been engaged in the development of microwave components at the Missile Systems Division of the Raytheon Manufacturing Company where he is presently head of the ferrite section.

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Florian Shnurer was born on May 29, 1929, in Blakely, Pa. He entered Union College in 1946 and received the B.S.E.E. degree in 1950. In 1952, he received the M.S. degree from Northwestern University, Evanston, Ill., for which he did research in coated conductor antennas. He is a candidate for a Ph.D. from the same university.



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From 1950 to 1954, he was a research associate in the Microwave Laboratory at Northwestern University, where he did research in microwave antennas.

In 1954, Mr. Shnurer joined the General Electric Advanced Electronics Center at Cornell University as an engineer in the Electronic Warfare Subsection where he is presently engaged in working on special microwave circuits.

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W. L. TEETER

From 1944 to 1946, while in the Navy, he was in the Centimeter Wave Research Section at the Naval Research Laboratory in Washington, D. C. He joined the U. S. Navy Electronics Laboratory in 1947, where he was a group leader in the Radar Equipment Section in charge of uhf and microwave component design for the Radar Branch. In 1956, he joined the Palo Alto Research Laboratory of Lockheed Missile Systems Division where he is presently a group leader in the Radar and Data Link Department.

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Lucien G. Virgile was born in New York, N. Y., on January 11, 1925. He received the Bachelor degree in aeronautical engineering from the Polytechnic Institute of Brooklyn in 1944 and the M.S. degree in mechanical engineering from Stanford University in 1948. He was engaged as a materials and process engineer for the Bell Aircraft Corporation from 1944 to 1945, and as a structural design engineer for Fairchild Aircraft Corporation from 1946 to 1947. From 1948 to 1949, he was associated with the George S. May Company as a consulting engineer and subsequently was owner-manager of a design studio for four years. Since 1953, Mr. Virgile has been employed by the Sperry Gyroscope Company where he is presently product engineer responsible for mechanical engineering development and production of a wide variety of microwave systems and components.



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