Frederic R. Morgenthaler, PhD, joined the faculty of the Massachusetts Institute of Technology in 1960, becoming a Full Professor in 1968. He retired from MIT in 1996 and is currently Professor Emeritus of Electrical Engineering. Dr. Morgenthaler has served as a consultant to the U.S. government as well as private industry. A Fellow of the IEEE and the holder of approximately one dozen patents, Dr. Morgenthaler has authored over 100 scientific publications and papers.

The Power and Beauty of Electromagnetic Fields

By Frederic R. Morgenthaler 2011 pub. John Wiley & Sons, Inc.

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Chapter 18

TEM TRANSMISSION LINES

An idealised uniform transmission line is comprised of two or more perfect conductors that are parallel to one another and extend to infinity without any change in their transverse geometries. In the simplest cases, the conductors are surrounded by free-space and the guided electric and magnetic fields are transverse to the direction of propagation and so denoted TEM (transverse electric and magnetic).

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.... the electric and magnetic fields are both zero inside the conductors ....

.... It is tempting, but incorrect, to conclude that the conductors merely provide a path for the charge distribution to zip along at the speed of light, keeping pace with the generated fields. If this were true, ... the charges would be traveling .... with incredibly large energies. .... Yet somehow the individual charges .... act together to simulate a relativistic current density .... Mobile negative charge which is neutralised by the fixed positive charge of the lattice simply moves very slightly toward or away from the surface of the conductor as the electric field of the *TEM* pulse moves by. [This is the Southerner view. – I Catt]

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by. This creates the surface charges that are needed in order to originate and terminate the electric field. As the pulse moves on (at or near the speed of light), those charges move back into the metal and different charges further down the line repeat the action to produce new surface charge as required. [**This is the Southerner view. – I Catt**] Simply put, the *same* charge does not travel with the wave, but the distribution as a whole acts as if it did. The macroscopic Maxwell Equations cannot, of course, distinguish between the individual charges. .... If n_o (and consequently rho) approach infinity, ... The result is dispersion-free propagation.

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http://www.ivorcatt.co.uk/2812.htm 1993

Professor M Pepper FRS on "The Catt Question"

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As the wave travels at light velocity, then charge supplied from outside the system would have to travel at light velocity as well, which is clearly impossible.

Sir Michael Pepper, knighted for services to physics.