

My 1967 paper corrected.

I introduced a narrow voltage spike into the left, active conductor.

Using Faraday's Law of Induction and the principle of conservation of charge, the mathematics showed the following;

http://www.ivorcatt.co.uk/4_1.htm

<http://www.ivorcatt.co.uk/x147.pdf>

<http://www.ivorcatt.org/x0330.jpg>

<http://www.ivorcatt.org/x0331.jpg>

The only possible signal that can travel down two conductors as shown is either the Even Mode, or the Odd Mode.

In the Even Mode, equal signals travel down each conductor.

In the Odd Mode, equal and opposite signals travel down the two conductors.

In Figures 28 and 29, we see that the Odd Mode travels faster, and so arrives earlier in traces 2 and 1. This is because more of the field in the Odd Mode is in the faster air above the board.

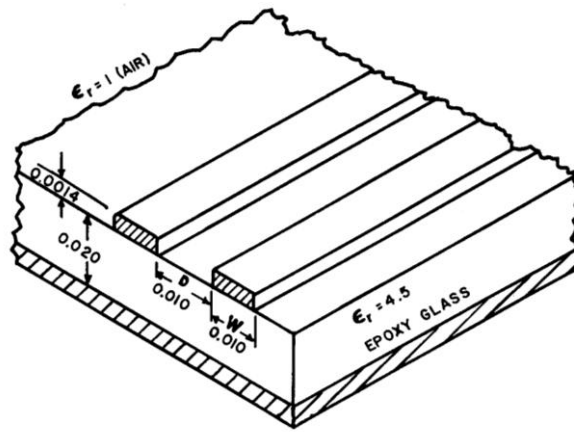


Fig. 26. Dimensions of board used to produce photographs.

Third trace in Fig. 28, pulse 400 picosec wide, or 6cm wide, introduced into left hand (active) line.

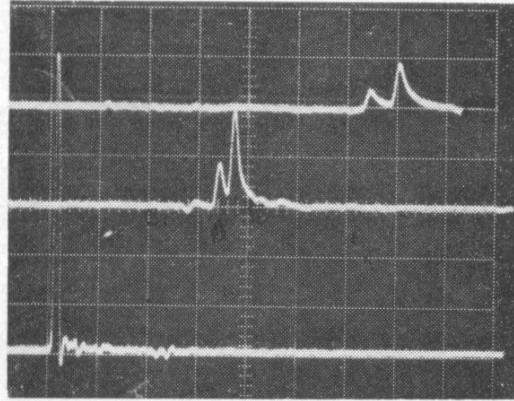


Fig. 28. Active line. Third trace: front end of line. Second trace: 120 inches down line. First trace: 234 inches down line. Vertical scale 20 mV/div. EH-125 generator. 10-volt pulse thru 10-dB pad into line. Probing by 500-ohm (10X) probe thru 10-dB pad into 50-ohm input of Tektronix 4S2 plug-in unit of 661 oscilloscope. Horizontal scale: 5 ns/div.

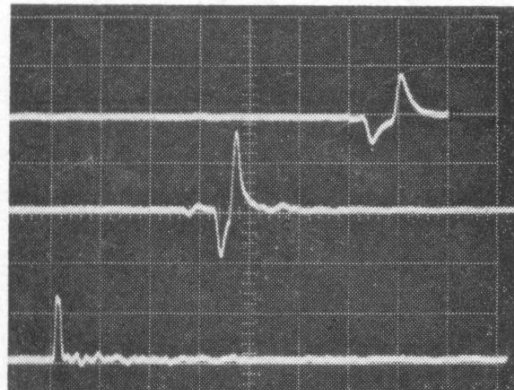


Fig. 29. Passive line. Third trace: front end of line. Second trace: 120 inches down line. First trace: 234 inches down line.

The problem is that in the case of surface conductors above, the signal is not pure TEM. In the case of buried conductors, below, both signals see only epoxy glass, and travel at the same velocity. They are therefore TEM, and form a third mode, disallowed by the mathematics. They must comprise the two modes superposed, which Faraday's Law disallows.

Now in Figures 28 and 29, electric current flows to the right, into the paper, except for the current in the passive line in the odd mode, when it travels to the left, out of the paper.

This means that, trace 3, before they separated out, electric current was flowing in and out, in both directions, in the passive line, in the same piece of conductor.

The mathematics, based on Faraday's Law, does not permit the traces showing the two modes superposed.

My 1967 article was wrong;

<http://www.ivorcatt.co.uk/x147.pdf>

it is equally valid for buried lines. The proof implies that any signal traveling down the pair of lines must be a combination of signals in the two modes superposed.

The proof, based on Faraday's Law and the Law of Conservation of Charge, did not allow the first trace.

Leaving aside the second Law, we deduce that the third traces experimentally disproved Faraday's Law of Induction. <http://www.ivorcatt.co.uk/x29j.htm>

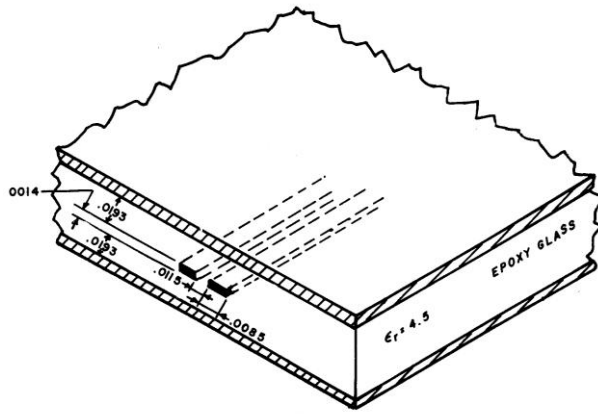


Fig. 5. Dimensions of board used to produce photographs.

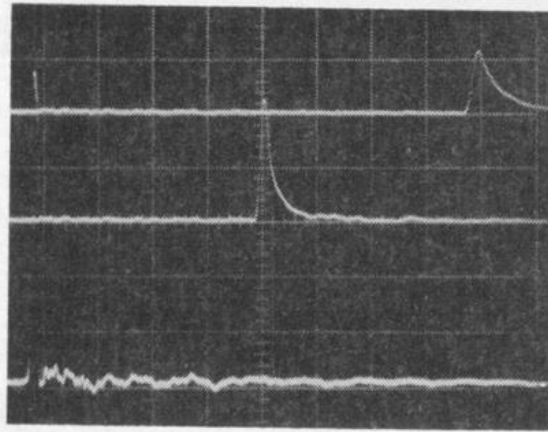


Fig. 7. Active line. Third trace: front end of line. Second trace: 120 inches down line. First trace: 234 inches down line. Vertical Scale: 20 mV/div. E-H-125 generator. 10-volt pulse through 10-dB pad into 50-ohm input of Tektronix 4S2 plug-in unit of 661 oscilloscope. Horizontal scale: 5 ns/div.

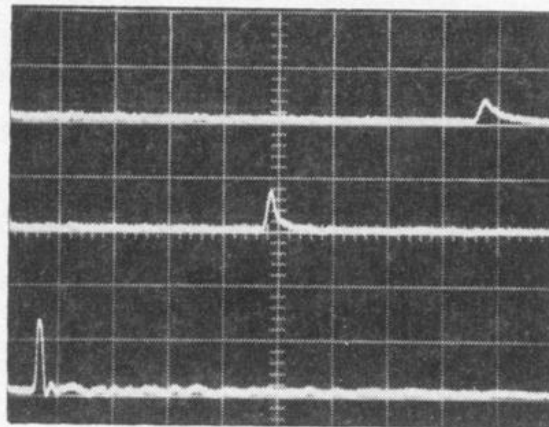


Fig. 8. Passive line. Third trace: front end of line. Second trace: 120 inches down line. First trace: 234 inches down line.

In Figures 7 and 8 we have only the illegal mode, Even Mode and Odd Mode superposed.

In Heaviside's magnificent, regal statement, "We reverse this." In his *Electrical Papers*, vol. 1, 1892, page 438, Heaviside wrote;

<http://www.ivorcatt.co.uk/x3117.htm>

Now, in Maxwell's theory there is the potential energy of the displacement produced in the dielectric parts by the electric force, and there is the kinetic or magnetic energy of the magnetic force in all parts of the field, including the conducting parts. They are supposed to be set up by the current in the wire [Theory N]. We reverse this; the current in the wire is set up by the energy transmitted through the medium around it [Theory H].... [1](#), [2](#)

Many years before, Malcolm Davidson sent pulses in opposite direction along coaxial cable. When they passed through each other, there was no electric current. Or, as in the above case, we had two equal currents travelling through each other.

Heaviside's joke:

<http://cat-lovers-almanac.blogspot.co.uk/2017/05/may-18-1850.html>

Prior to 1853 it is said to have been the current belief of those best qualified to judge, that to send two messages in opposite directions at the same time on a single line was an impossibility; for it was argued that the two messages meeting would get mixed up and neutralize each other more or less, leaving only a few stray dots and dashes as survivors, after the manner of Kilkenny cats...who devoured one another and left only their tails behind.

<http://www.forrestbishop.4t.com/DEDV2/DEDV2p324-5.jpg>

<http://www.forrestbishop.4t.com/DEDV2/DEDV2p326-7.jpg>

<http://www.forrestbishop.4t.com/DEDV2/DEDV2p328-9.jpg>

Ivor Catt 8 September 2017

