Displacement Current 2.

The first article "Displacement Current" was in *Wireless World* in December 1978.

" .... displacement current, 'a leap of genius' when Maxwell put it there" - G. W. Carter, *The Electromagnetic Field....*, pub. Longmans 1954, p262

" .... displacement current .... This term was introduced, in a stroke of genius, by Maxwell .... " –Bo Thide, Dept. Of Astronomy .... , Uppsala University, *Electromagnetic Field Theory*, 2011

" .... lesser mortals have been able to partially rationalize Maxwell's leap of insight .... Heaviside said it was Maxwell's invention of the displacement current that "boldly cut the Gordian knot of electromagnetic theory. – Paul J Nahin, "*Oliver Heaviside*", pub. IEEE 1988

The displacement current term is now seen as a crucial addition that completed Maxwell's equations and is necessary to explain many phenomena, most particularly the existence of electromagnetic waves. – Wikipedia.

Now although in the case of a capacitor, displacement current needed to be regarded as just like a real current, for instance causing a magnetic field; in the case of the D flux at the front of a step of TEM (ExH) energy current travelling down a telegraph line, the displacement clearly must not behave like a real current - for instance by creating a magnetic field which would reach out ahead of the wave front and ruin its TEM nature. - *The History of Displacement Current* by Catt, Walton and Davidson, *Wireless World*, March 1979.

The Transverse Electromagnetic (TEM) Wave.

First we close the switch in the top conductor near the battery.

Traditionally , when the resulting TEM step (i.e. logic transition from low to high) travels through a vacuum from left to right, guided by two conductors (the signal line and the 0v line), there are four factors which make up the wave;

- electric current in the conductors i
- magnetic field, or flux, surrounding the conductors B
- electric charge on the surface of the conductors +q , -q
- electric field, or flux, in the vacuum terminating on the charge (Figure 2), D

I quote Wikipedia, 1 February 2012, on "Displacement current" at http://en.wikipedia.org/wiki/Displacement_current ;

The scalar value of displacement current may also be expressed in terms of electric flux:

$I_D = \mathcal{E}\ \delta\Phi_E/\delta t$

$$I_{\mathrm{D}} = \varepsilon \frac{\partial \Phi_E}{\partial t}.$$

End quote.

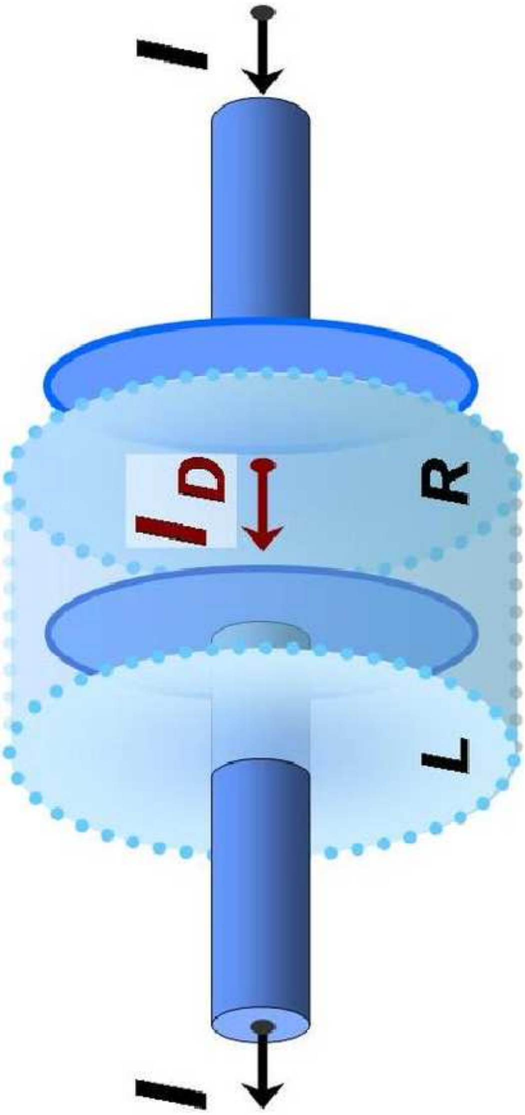
Displacement Current is the changing electric field.

At the front face of the voltage step (in the middle of the figures) there is a changing electric field D or E when the voltage changes from 0 to 10v. That is, there is a vertical displacement current. This must not cause a magnetic field, because its magnetic field would be in the horizontal plane. A TEM Wave only has magnetic field (B or H) in the vertical plane.

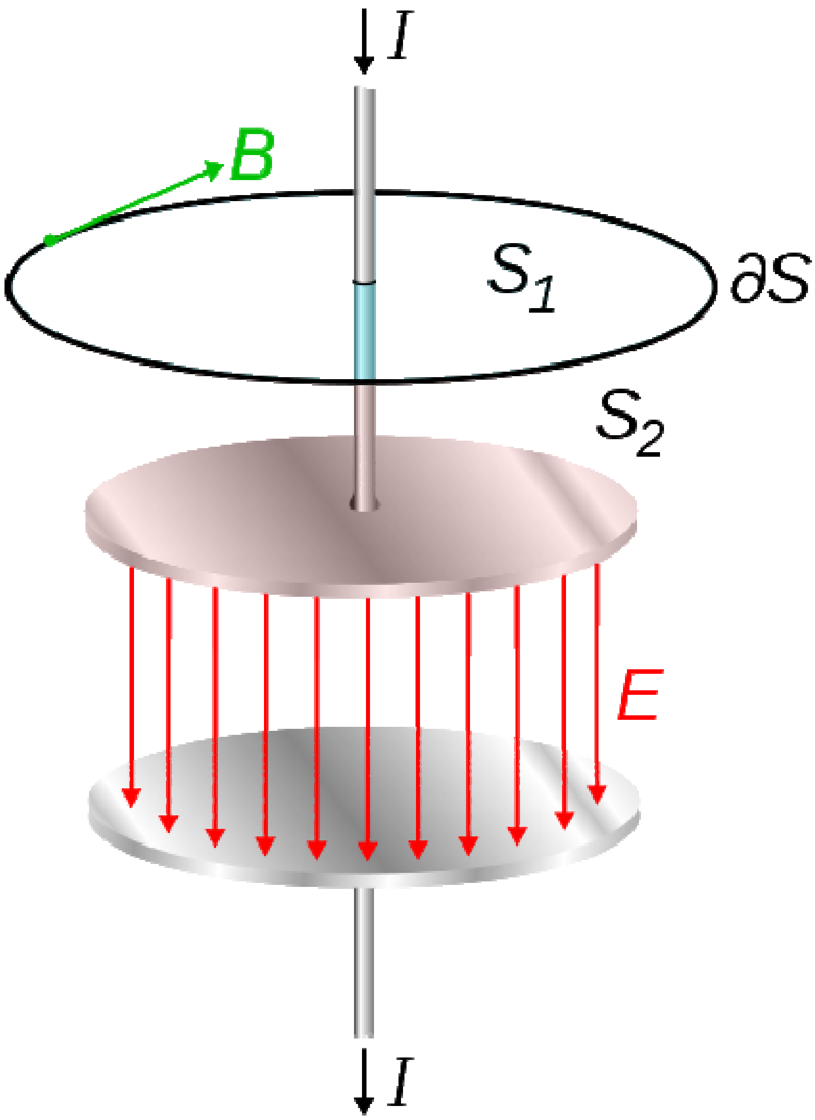
Again quoting Wikipedia;

An example illustrating the need for the displacement current arises in connection with capacitors with no medium between the plates. Consider the charging capacitor in the figure. The capacitor is in a circuit that transfers charge (on a wire external to the capacitor) from the [top] plate to the [bottom] plate, charging the capacitor and increasing the electric field between its plates. The same current enters the [top] plate (say *I*) as leaves the [bottom] plate. Although current is flowing through the capacitor, no actual charge is transported through the vacuum between its plates. Nonetheless, a [horizontal] magnetic field exists between the plates as though a current were present there as well. The explanation is that a *displacement current* I_D flows in the vacuum, and this current produces the magnetic field in the region between the plates according to Ampère's law.

Wikipedia has two illustrations.



An electrically charging capacitor with an imaginary cylindrical surface surrounding the left-hand plate. [Upper] surface *R* lies in the space between the plates and [lower] surface *L* lies [below the bottom] plate. No conduction current enters cylinder surface *R*, while current *I* leaves through surface *L*. Consistency of Ampère's law requires a displacement current I_D = *I* to flow across surface *R*.



Example showing two surfaces S_1 and S_2 that share the same bounding contour ∂S. However, S_1 is pierced by conduction current, while S_2 is pierced by displacement current. End second quote from Wikipedia.

Displacement Current was invented by Maxwell to generate magnetic field. Since it is incompatible with the TEM Wave, we have to jettison either Displacement Current or the TEM Wave. However, the 5v TEM step is the fundamental factor in virtually all of today’s electronics, when a logic gate signals to the next logic gate.

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