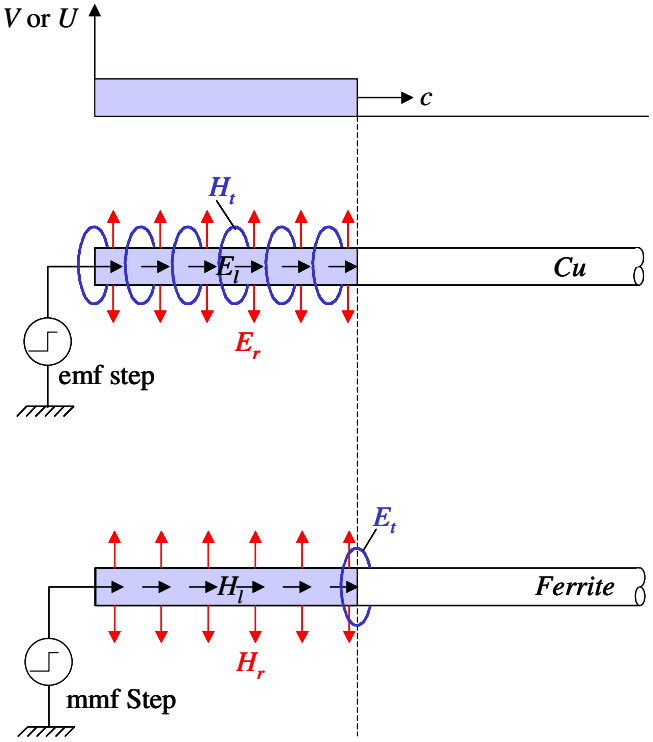
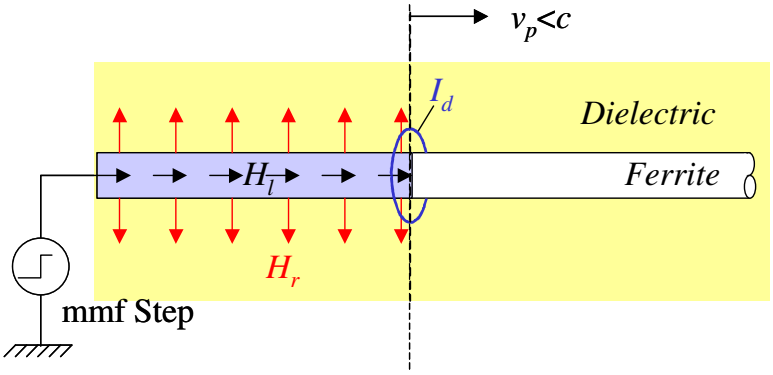
Magnetic Delay Line

If you consider a surface wave travelling along the outside of a copper conductor, like the step-function shown in the figure here

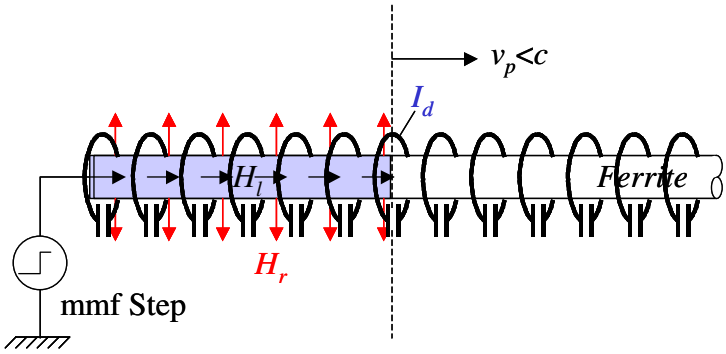


you get radial E_r field and tangential H_t field outside the wire, i.e. a TEM wave, and you get a longitudinal E_l field inside the copper obeying $E_l=J/\sigma$ where σ is the conductivity. Because σ is large E_l is relatively small. Now consider a mmf step applied to a magnetic "conductor" like ferrite, you also get radial field but this time radial H_r. You also get tangential E_t at the wavefront, so there too a TEM wave. And inside the ferrite you get a longitudinal H_l field, obeying $H_l=B/\mu$ but because μ is high H_l is relatively small.

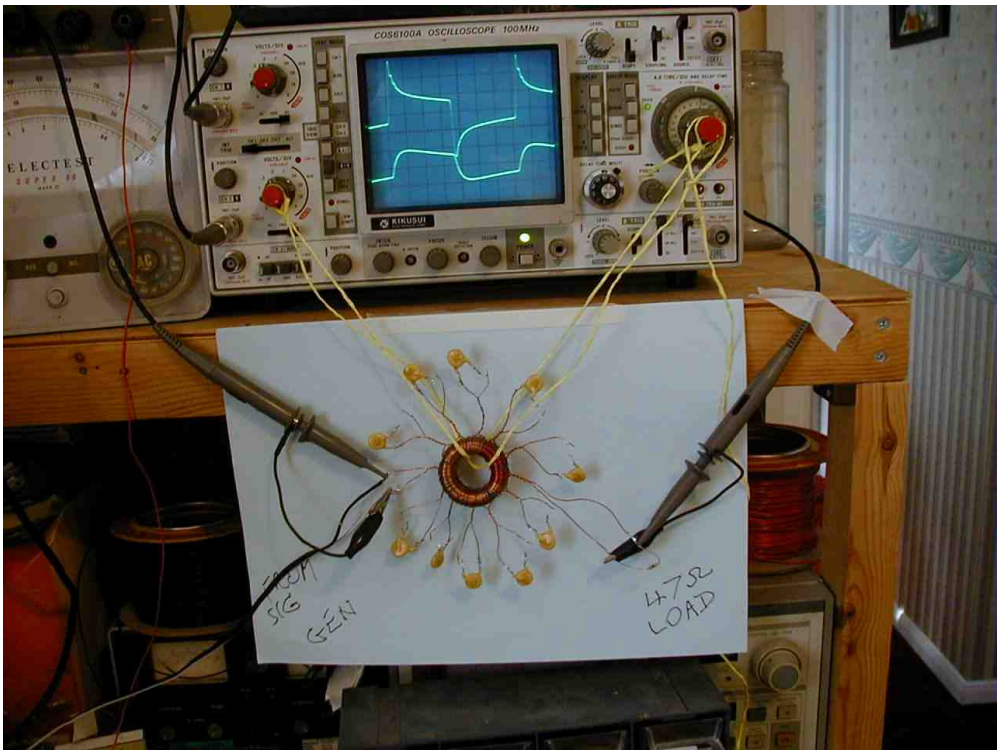
In the first case we know that the wavefront velocity in the copper is c, but if we immerse the copper in a magnetic or electric dielectric the velocity is reduced. The velocity inside the copper is determined by the space characteristics outside the copper, it appears that the longitudinal wavefront is locked to the external TEM wavefront. My contention was that the same thing would happen in the ferrite case, the wavefront inside the ferrite would be linked to the velocity of the TEM wavefront outside. So if we immersed the ferrite in a high K dielectric we would get a reduced velocity as shown here.



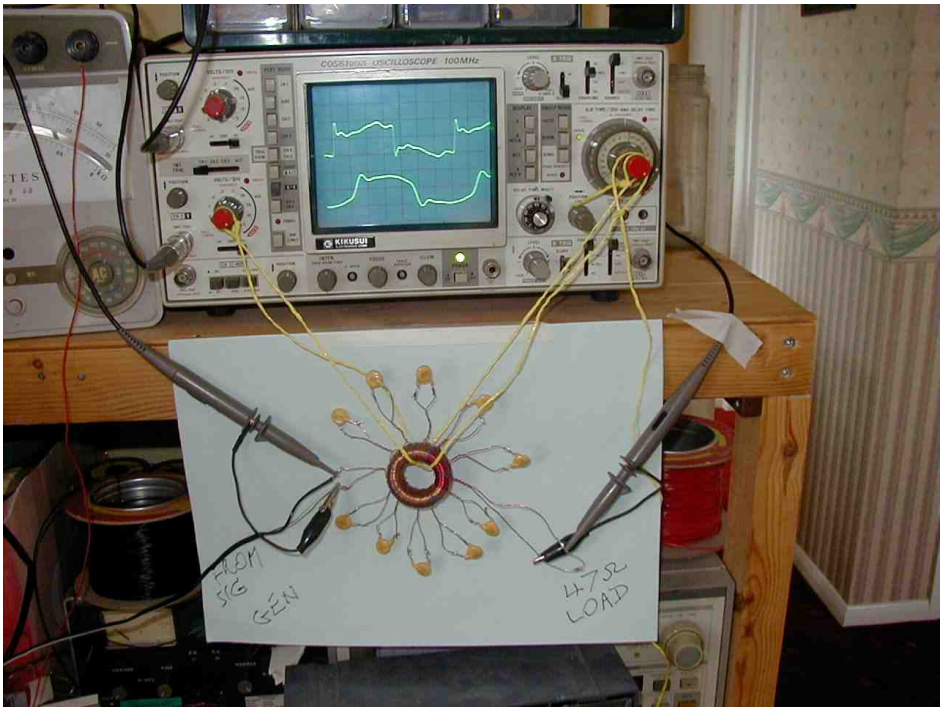
The E_t field at the wavefront drives displacement current I_d so another method of getting the effect of increased K is to place coils around the ferrite attached to high value capacitors as shown next.



This lumped-constant approach does work, I posted results some 10 years ago on Dave Squire's oubuilders forum. Here is a picture of the transformer with the capacitors disconnected. The output square wave at the bottom of the scope screen is in time synch with the input at the top.



The next picture shows the result with the capacitors connected. The time delay can clearly be seen.



Of course such a crude delay line of only 5 sections each side does not exhibit ideal characteristics, but quite good enough for use in a magnetic motor I would think.