How does the TPU create high voltage DC supposedly without the use of rectifiers? Well I thought that some form of vibrating wire in a magnetic field could produce DC if the field was alternating at the vibration frequency. Put simply, for a wire obeying Fleming's RH rule where the field ***B***, the wire direction and the wire velocity **v** are all mutually at right angles to each other, the induction ***E*** field has a magnitude of Bv. I reasoned that if v was sinusoidal $v = v\sin(\omega t)$ and **B** was also sinusoidal $B = B\sin(\omega t)$ then the product Bv would be $Bv\sin^2(\omega t)$ which has a DC component of $Bv/2$. However I now discover this is not the case.

I considered a ring core that had a small air gap cut into it, with the moving wire crossing this air gap. Thus the **B** field was confined to a small region of air space within the gap and the voltage would simply be Bv times the wire length l within the gap. For a static **B** field that voltage V can be derived in two ways

(a) via the motional **E** field given by Fleming's RH rule $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ and

(b) via $V = -\dfrac{d\Phi}{dt}$, the varying flux Φ that passes through the closed electrical circuit comprising the moving wire and the voltmeter.

Both methods yield the same result $V = Bvl$. However when the **B** field is changing value during the wire movement the two methods (a) and (b) do ***not*** give the same result. Clearly something is wrong there.

The dilemma is resolved by the realization that with a static **B** field the only thing that is causing the induction is the moving wire in the gap, the remainder of the closed circuit is not getting additional induction. Nowhere in space is there an E field except in the moving wire. However when B is changing with time there is an **E** field set up around the core that extends out into space and that **E** field can induce voltage into the remainder of the closed circuit. Thus the voltmeter reads the instantaneous $V = Bvl$ motional induction in the length of wire within the gap (where B and v are the instantaneous values) ***plus*** the $V = -\dfrac{d\Phi}{dt}$ induction in the remaining length of wire that completes the closed circuit (where $\dfrac{d\Phi}{dt}$ is the rate of change of flux that is passing through the closed circuit at that instant). Although the motional induction can have a DC component as I surmised, when added to the other induction the resultant voltage is purely sinusoidal without a DC component. Without boring you with the detailed math the resultant voltage waveform is a combination of two sinewaves, one at the fundamental frequency and the other at twice the frequency.

Smudge