On Novel Forms of Surface Charge Flow
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1. Introduction

This paper discusses flow of charge along a cylindrical conductor examining both the internal flow as expressed by the known conduction electron drift velocity and the external flow along the outside surface. Although the drift velocity is very slow this low velocity is not generally seen since any change in potential travels along the surface at light velocity, or slightly slower if the conductor is embedded in a dielectric. Hence, at frequencies where the wavelength is large compared to the length dimension, electric effects and the establishment of drift (hence current) over the entire length responds almost instantaneously to any change. The electrons are like a line of stationary cars on a motorway, on receiving a command via radio they all start moving instantaneously.

The actual drift velocity is related to the volume-density of conduction electrons (for Cu this is 8.46E28 electrons per m^3), their mean free path and the applied potential difference. Of consideration in this paper are conductors that have a deliberately induced static surface-charge, the conductor forms one plate of a charged capacitor. In particular we deal with the case where the conductor is charged negatively so that there is a surplus of surface electrons. Although the volume-density of these surface electrons, some of which reside a few Angstroms off the notional surface plane which itself has a roughness of a few Angstroms, is significantly less than those in the bulk material, their mean free path is greater. Hence their drift velocity is much greater than that of the bulk material, but again this is not normally noticeable.

We then look at means for creating moving waves on those surface electrons using techniques akin to those used in linear magnetic motors where each successive coil has a 90 degree phase shift from the previous one. The velocity of such waves is determined by the separation between coils and the drive frequency, hence differs entirely from the normal electron conduction along the wire. We show that it is possible to create electron transport, hence a current, that does not obey normal Ohm's Law. Furthermore it appears we can pump DC current along a wire from an AC input, and we can do this through any practical number of turns, thus achieving something that acts like a step-up transformer but with DC output.

2. Theory

Figure 1 shows a straight length of wire passing through two ring cores. The cores have primary coils driven in phase opposition so that each supplies the same voltage to the centre section between the cores. With that induced voltage there will be excess surface electrons on that area on one half cycle, and a lack of electrons on the outside areas, as indicated by the blue and red colours.

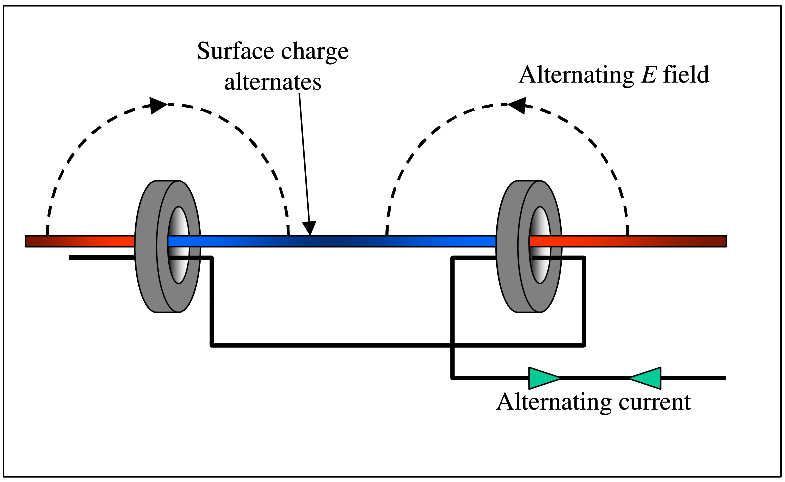

Figure 1.

Moving on to figure 2 we see a sequence of ring cores along the wire, with successive cores driven at a 90º phase advance (or retardation) with respect to its predecessor. Surface charge is shown for the time where the 90º channel is passing through zero.

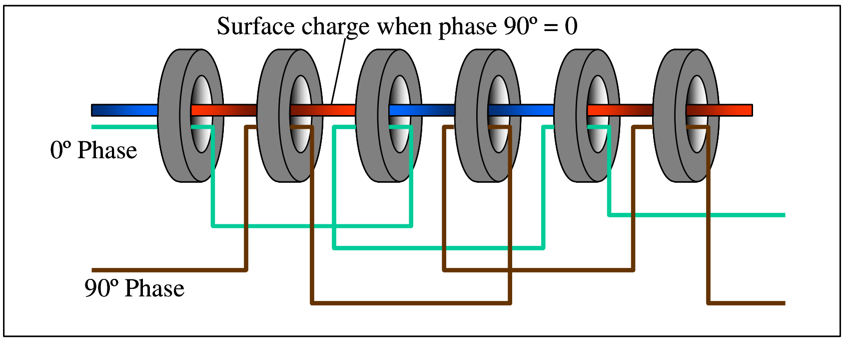

Figure 2.

A quarter cycle later the charged areas have moved to the right, as shown in figure 3.

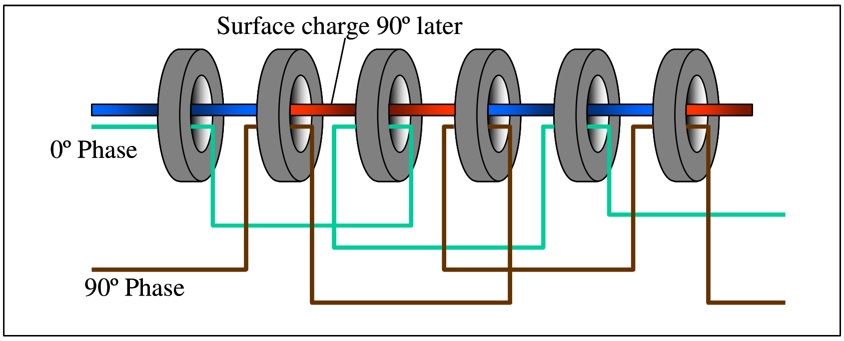

Figure 3.

Over many cycles the charged areas continually move to the right, we have a means for pumping charge along the wire.

The next figure shows the conductor in the form of a loop having two diametrically opposite ring cores. The polarity of current in the two primaries causes one half of the loop to have negative surface charge while the other is charged positive.

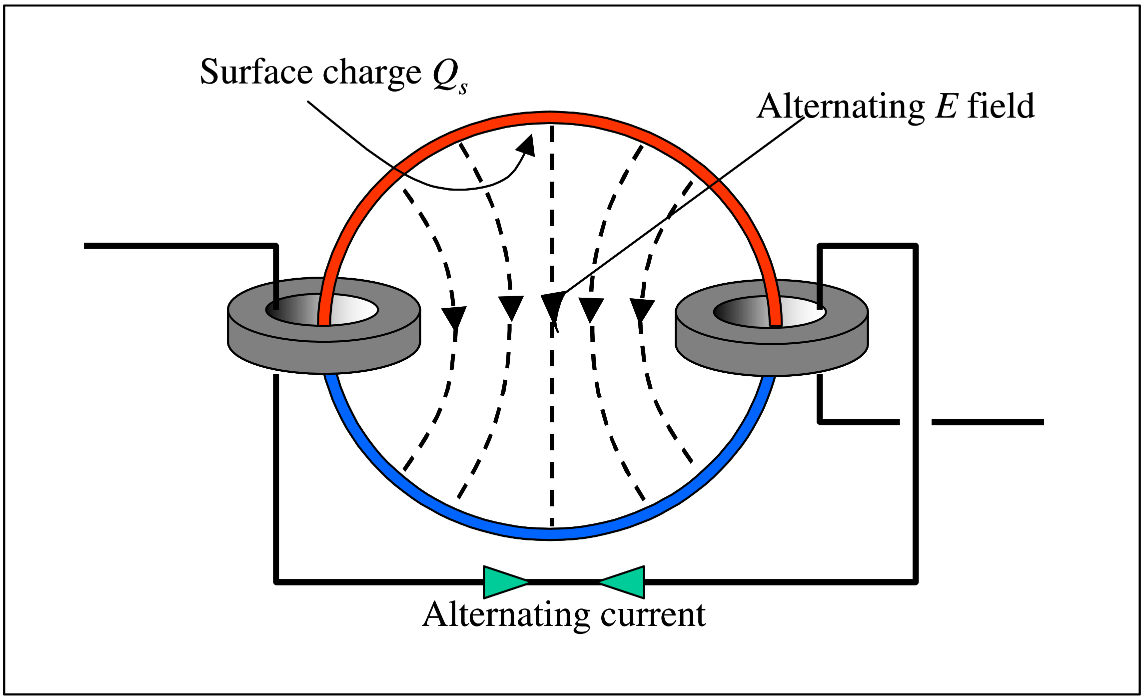

Figure 4.

The amount of surface charge can be increased by placing additional conductors close to top and bottom halves, connected by a wire that does not thread the two cores, and with the gap filled with dielectric. Of course this produces displacement current flowing through that connection, see figure 5.

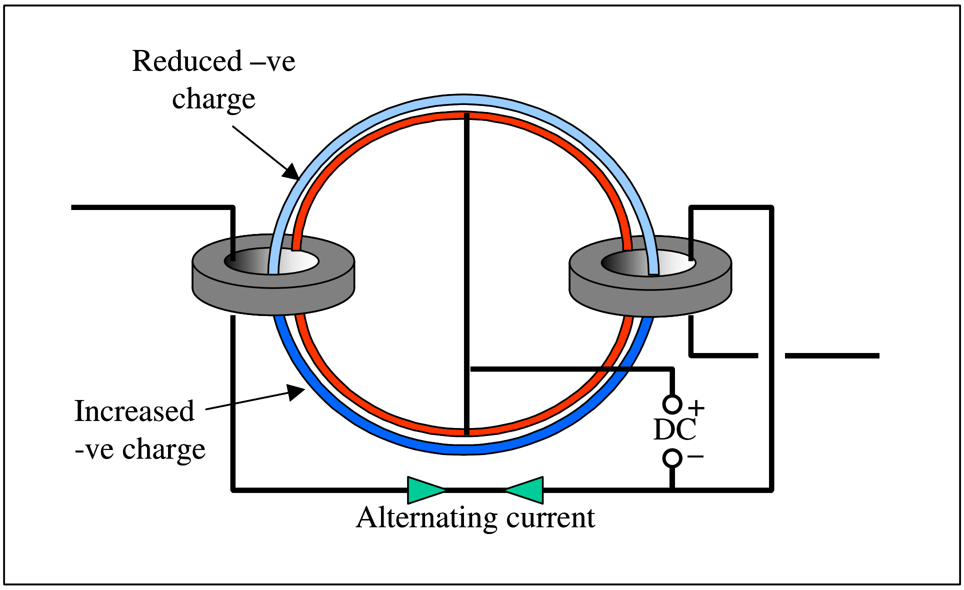

Figure 5. Addition of DC surface charge.

We can supply DC to charge the upper and lower capacitors so that the loop obtains negative surface charge. Then the induced charge simply adds to the surface electrons on one half, and reduces them on the other half , and if the DC voltage is great enough *the surface charge is never positive*.

If we now introduce two more ring cores driven at phase quadrature we have the situation shown in figure 6 where there is a successive 90 degree phase advance or retardation around the loop. The additional electrodes for the DC excitation are not shown.

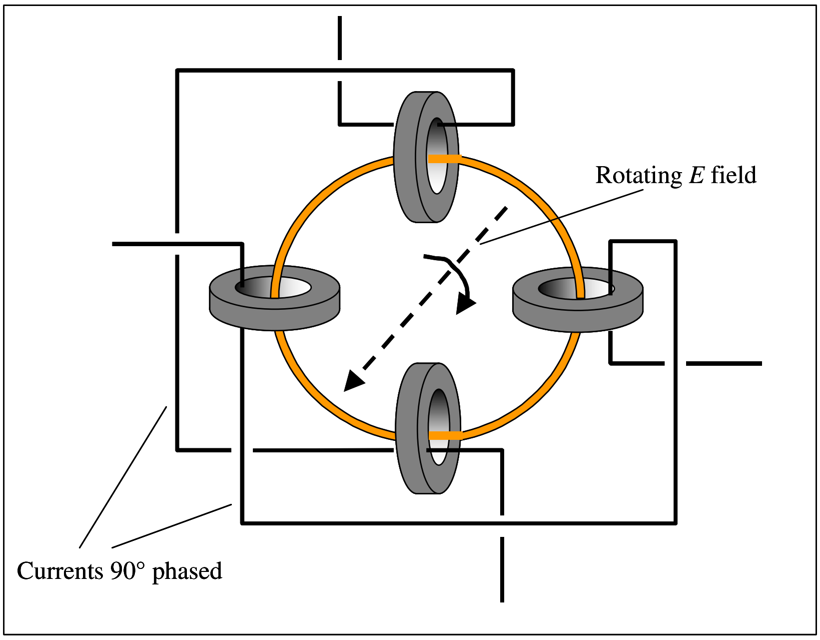

Figure 6. Four drive cores

In effect we create an electric field across the loop that is rotating at the drive frequency such that a bunch of surface electrons existing over a quadrant moves around the ring at a determined velocity. We can have a number of turns and provided that each turn receives DC charge from the additional electrodes we will get higher DC output voltage, figure7.

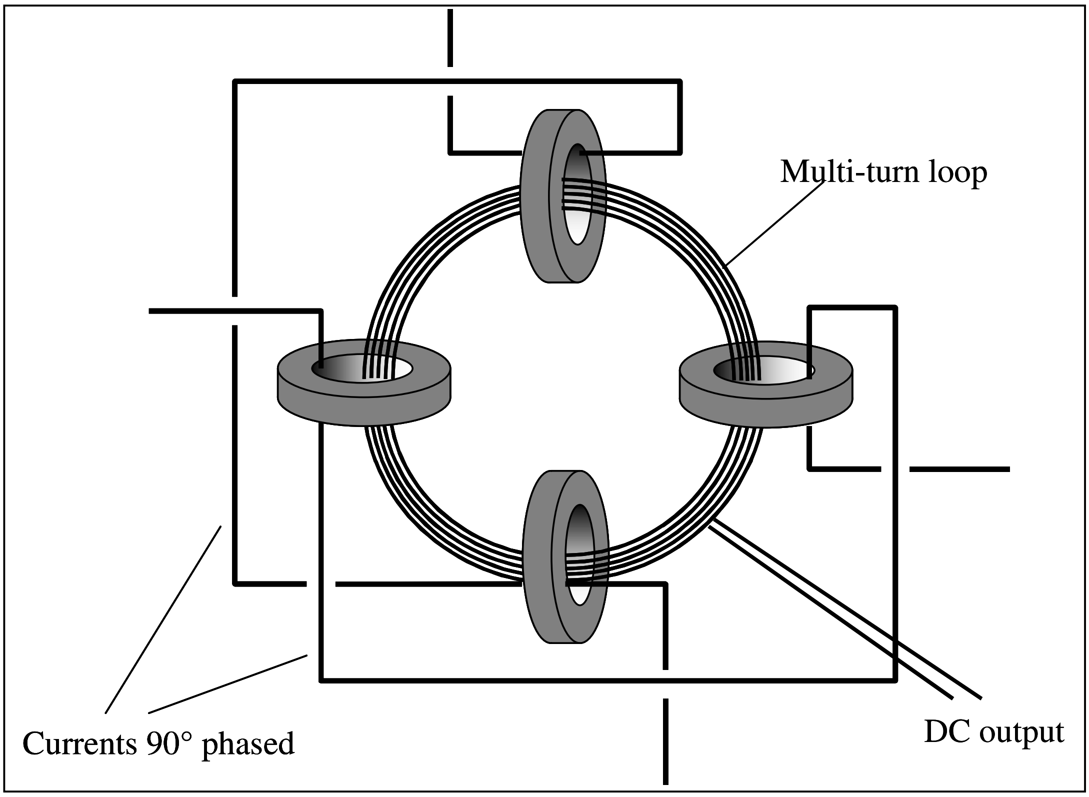

Figure 7