Smudge's Halbach Motor

I have always been intrigued by Halbach arrays and some time ago looked into the possibility of using such a device in a magnet motor. I came up with modified versions of the Halbach array that could be the heart of a free running motor utilizing permanent magnets. The usual Halbach array is a long series of magnets where their magnetization direction changes by 90 degrees at each interface. This has the effect of yielding greater flux on one side of the array than that on the other side. However that greater flux is of little use for driving a permanent magnet as the field along the array is a series of peaks that alternate in field direction. My modification suppresses the negative field peaks leaving the positive peaks that are then capable of applying a unidirectional force onto a magnetic pole.

Figure 1 shows part of an array created in FEMM where it can be seen that the usual Halbach sequence of →↓←↑→↓←↑ has been changed to →↓→↑→↓→↑.

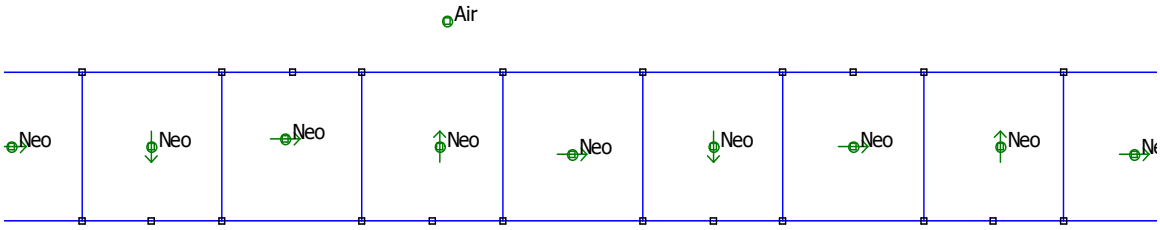

Figure 1. FEMM Array

The next image shows the results from two arrays, one being the mirror image of the other.

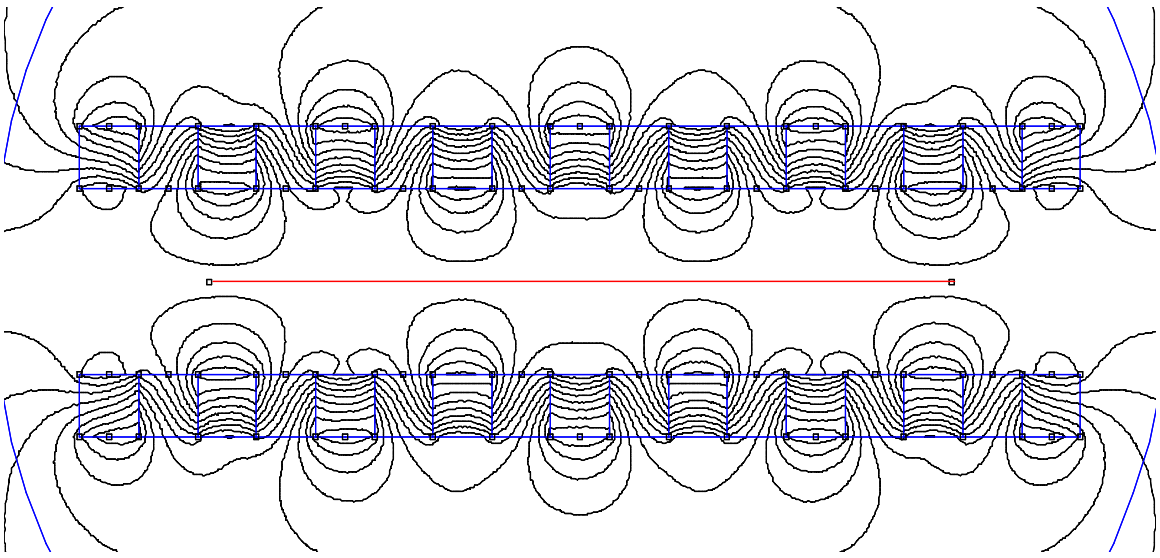

Figure2, Result from two arrays

A plot of the tangent B field along the red line between these two arrays is shown in Figure 3 where it is seen to be predominantly positive. Thus a magnetic N pole

placed there (one end of a bar magnet) would endure a force pulling it along the centre-line of the array, hence this has the makings of a magnet motor.

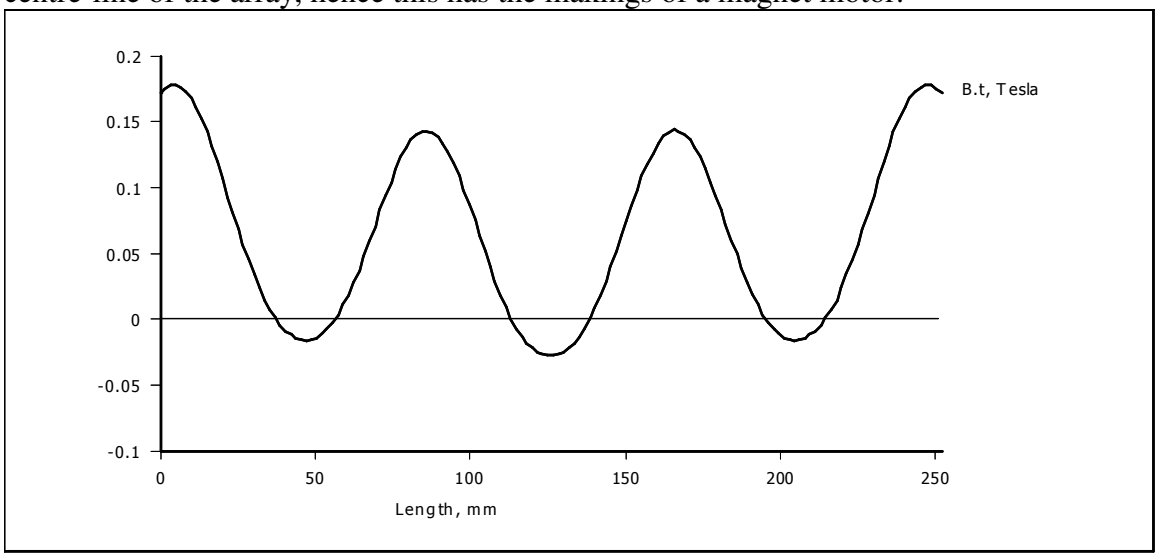

Figure 3. Tangent B field along the centre-line.

An alternative version of the Halbach array uses permeable material such as Fe in place of certain magnets as shown in Figure 4.

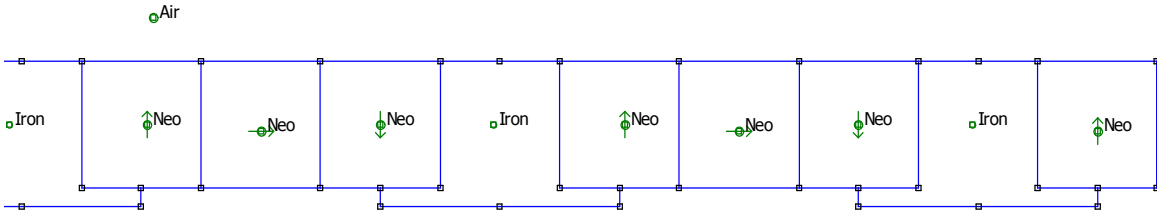

Figure 4. Alternative Array.

The next image shows the result of this alternative array.

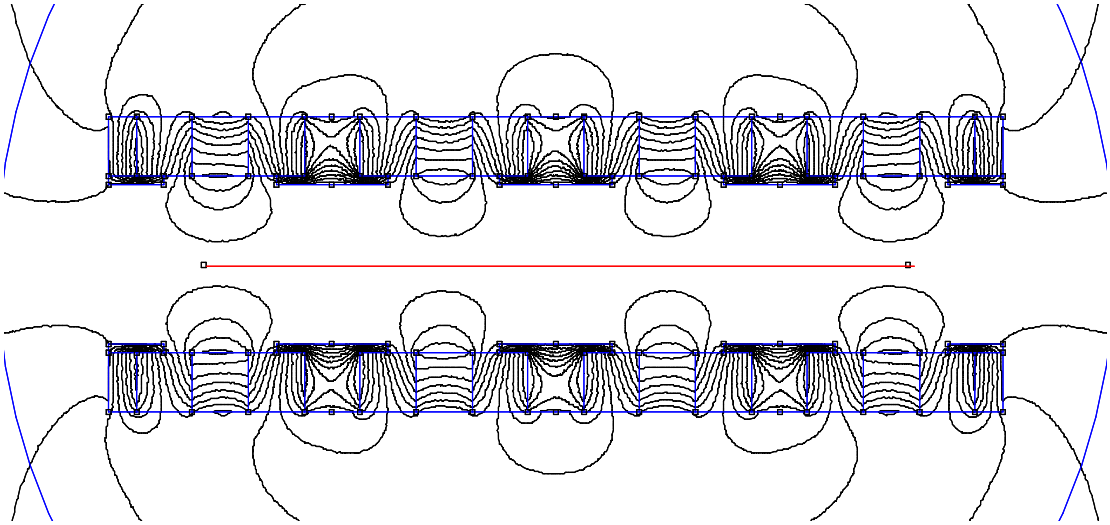

Figure 5. FEMM result

This gives the following tangent B field along the centre-line.

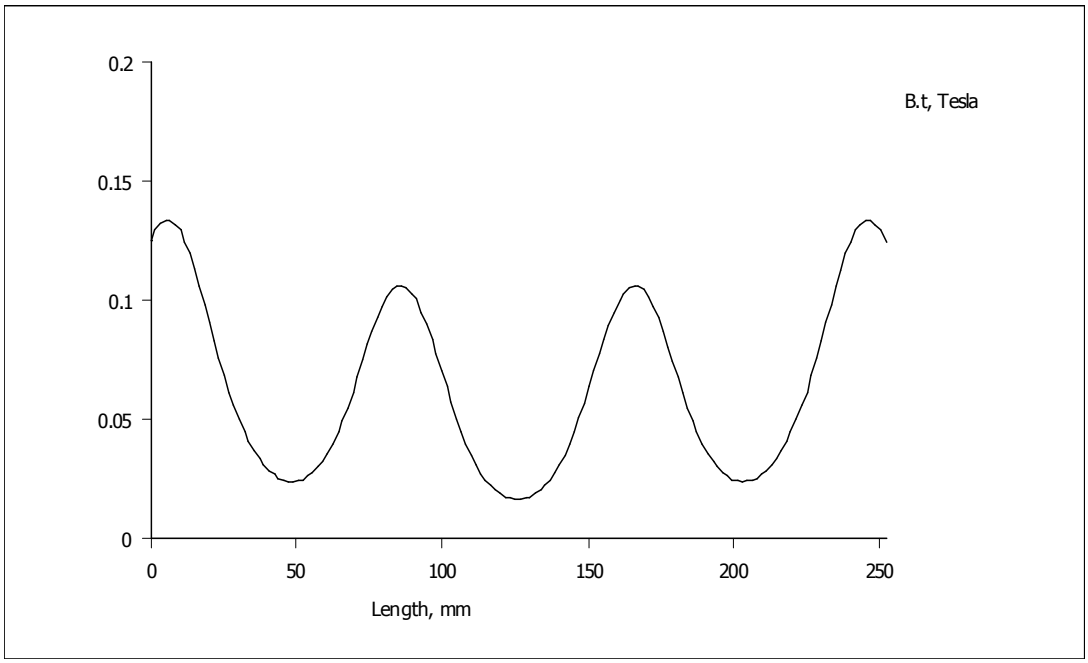

Figure 6. Tangent B field along the centre-line.

Here it is seen that the field is all positive, there are no negative excursions.

The idea now is to create circular arrays instead of long linear arrays. Figure 7 shows this idea where for clarity only one array is shown. The rotor consists of one or more radial bar magnets with one pole near the rotation centre, the other pole of course sitting between the two arrays.

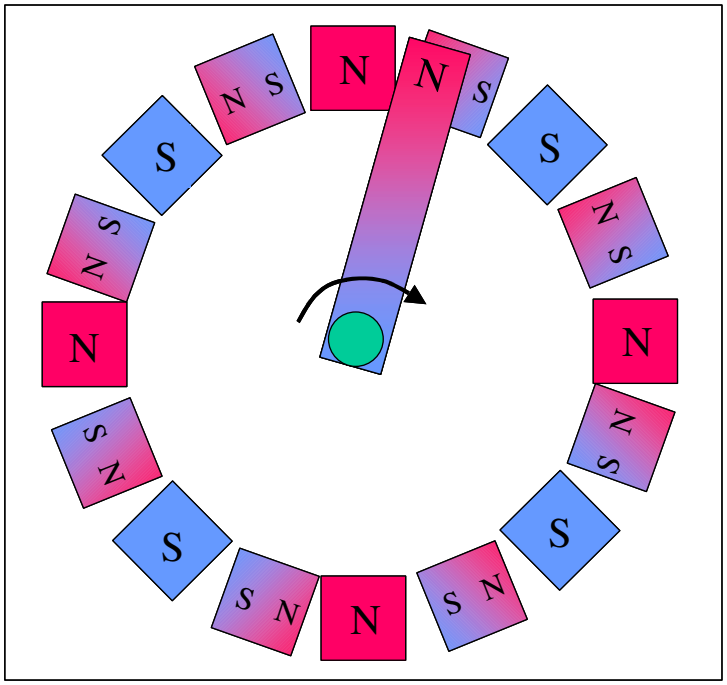

Figure 7. Proposed motor