Further Evolution of a Free-running Magnet Motor

1. Introduction

In my previous paper [1] I showed how forces on a magnet could be calculated using its Amperian surface current equivalent, then using Ampere's force law on that current when the magnet is in presence of a field from another magnet. I also showed that energy gained from incremental movement caused by that force could be directly related to the voltage induced onto that imaginary surface current, thus loading its source. Since that source is the atomic current circulations within the magnet (electron spins or orbits) that are responsible for its magnetization, this leads to the concept that the energy gained comes directly from those atomic currents. Those currents are perpetual, so it should be possible to create a magnet motor that creates perpetual motion. This paper reveals such a possibility.

2. The FEMM Axisymmetric Facility

Although I have used the FEMM 2D finite element program for many years, only recently have I used its axisymmetric solution. This is interesting because although it gives only a 2D plot it actually solves a 3D case. Instead of the xyz rectangular coordinates used in the planar solution it uses rθz cylindrical coordinates, and its 2D rz plot applies throughout the full 360º θ dimension, thus tells you the full 3D picture for axisymmetric systems. This is particularly useful for finding the field from a circular disc magnet. As the θ dimension is normal to the screen or paper FEMM only plots half the space, as shown in Figure1.

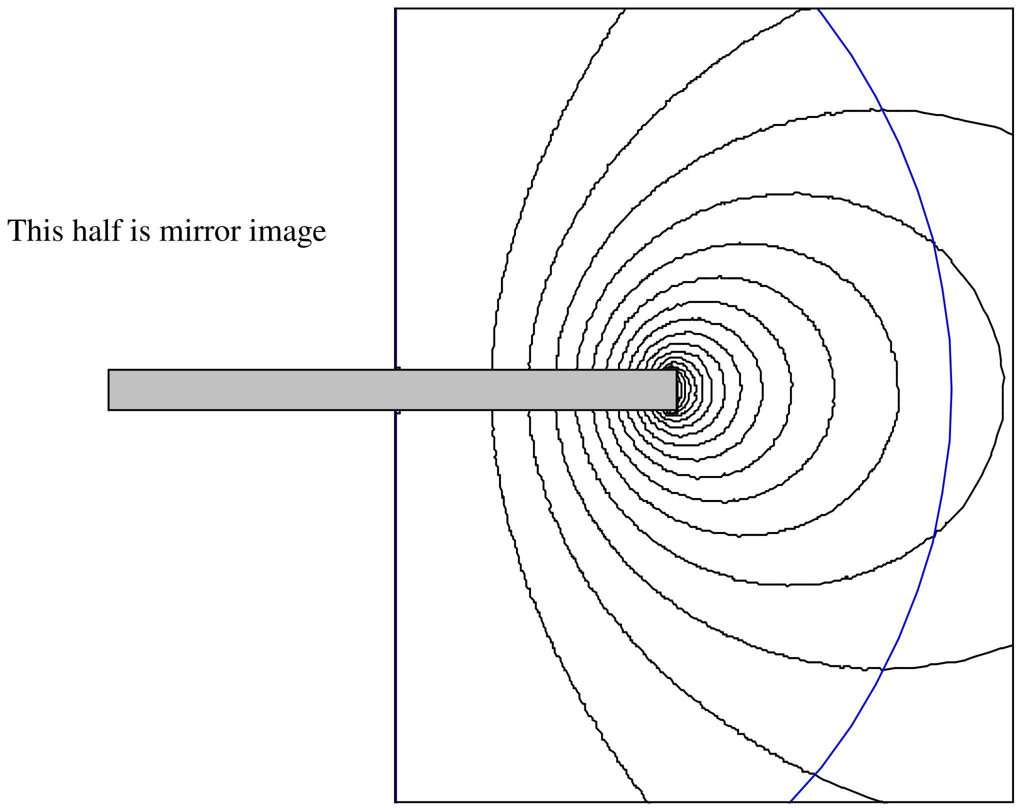

Figure 1. Field from a circular disc magnet

In this simulation the disc is arbitrarily chosen to be 30mm diameter and 2mm thick, magnetized through the 2mm dimension. We could also use the surface current equivalent for the disc magnet where that current flows around the curved surface. The next figure shows current flowing into the screen/paper within a small rectangle (shown red) simulating that surface current. The flux lines are seen to be identical to those of Figure 1.

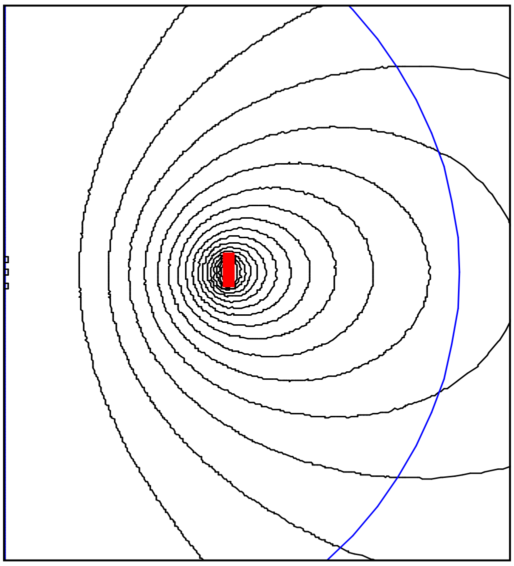

Figure 2. Field from the equivalent surface current

3. Using Axisymmetric FEMM to obtain Force and Torque

It is now possible to examine the force that would be applied to a small element of current flowing into/out of the screen/paper placed anywhere in that field. We are interested in an element moving around a circle so we choose to draw a semicircle showing the locus of that movement. Then the product of the normal component of the field crossing that line and the current value will give the differential force along that locus. FEMM has the facility to chart the normal component B.n and to extract it as a data set. The next image shows such a locus.

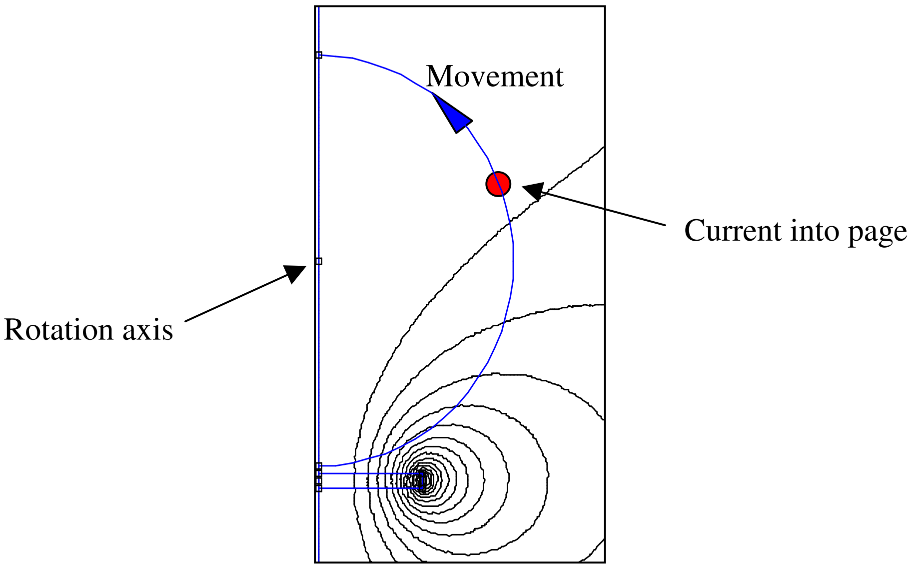

Figure 3. Locus of moving current element

Here is the B.n chart for that locus where the stator magnet is 32MGOe NdFeB.

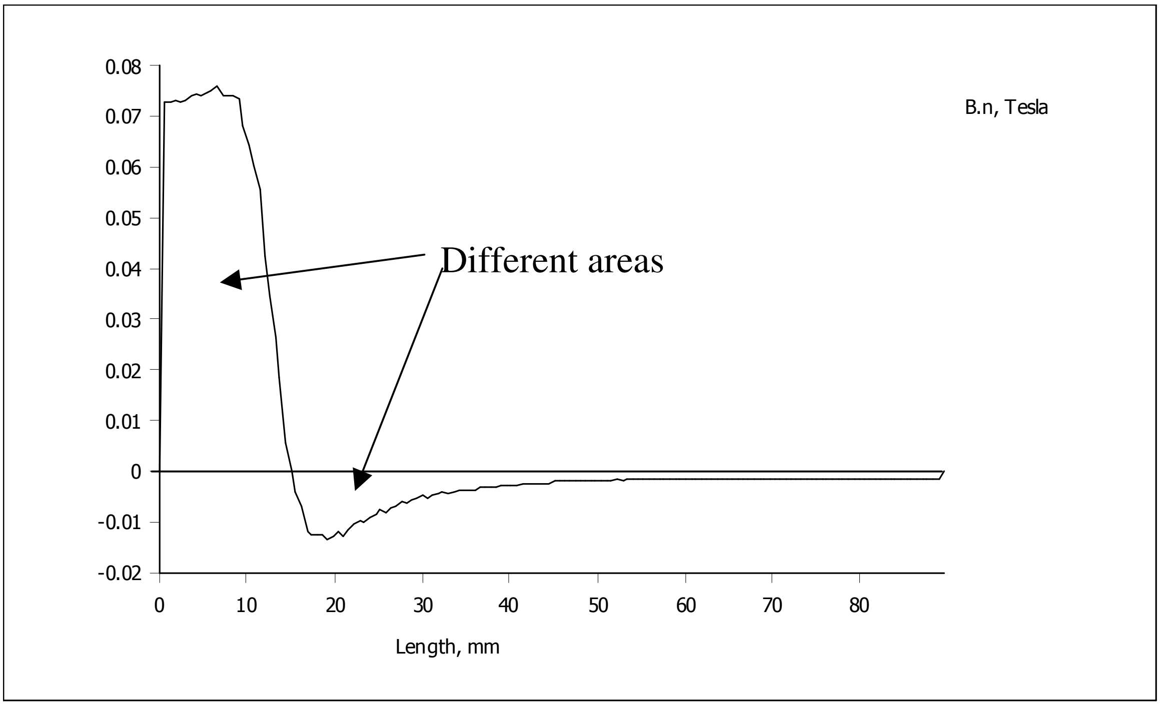

Figure 4. B.n chart indicating Force hence Torque values

Note the areas above and below the zero line are not equal. This indicates that a current element following that 180º path will endure a net torque that is non-zero. That also applies to the full 360º movement. The intention here is to have that current element as the surface current on a thin strip magnet as shown next. This is magnetized across the thin dimension.

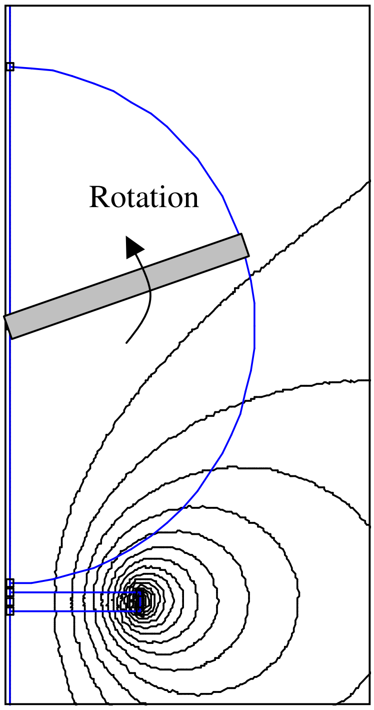

Figure 5. Rotating magnet

Current returning in the other direction at the other end of the rotor magnet is at the rotation axis, therefore does not contribute to torque. It now remains to show that the surface currents flowing along the other two long edges of the magnet do not negate the result. We can show this for case where the magnet starts vertical in Figure 5 by taking the view rotated 90º about the vertical axis.

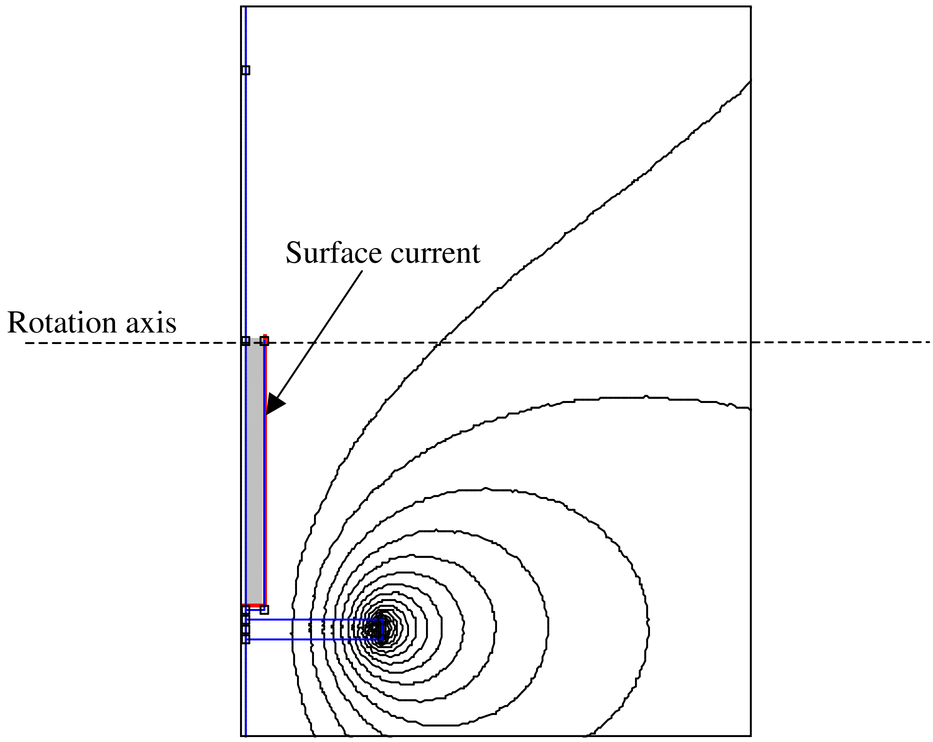

Figure 6. 90ºview

Here the surface current is shown red, the rotor magnet is 4mm thick but in the half space we only see 2mm of current at the bottom (that is the current element in Figure 4 going into the page). The vertical current is along the magnet's 28mm long surface. The next image shows B.n along that L shaped line.

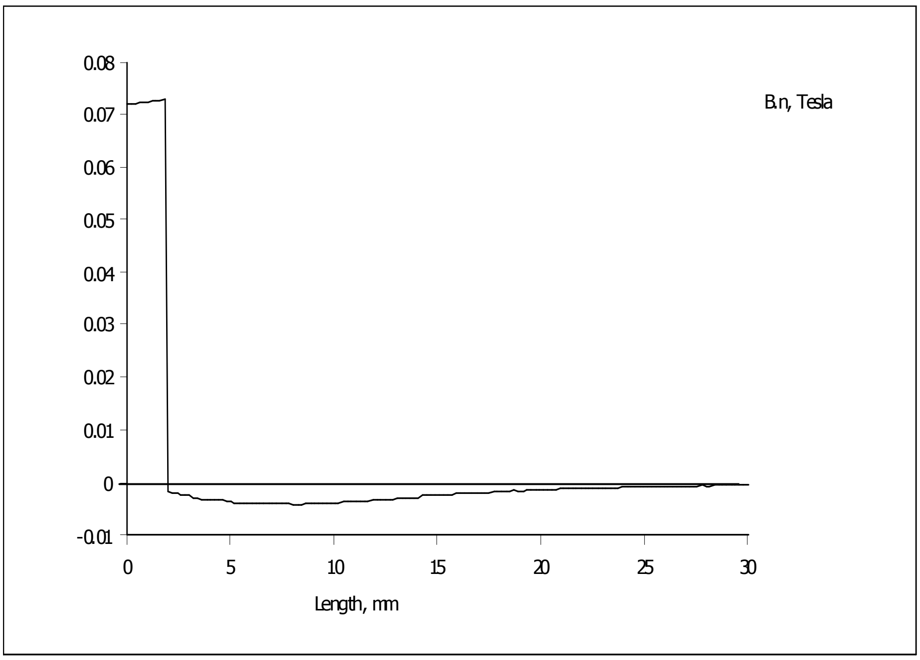

Figure 7. B.n along two surfaces.

Note that the area under the positive region that represents the horizontal edge closest to the stator magnet is greater than the area above the negative region that represents the vertical edge. When used to calculate torque the negative area is even more diminished as at each point the force obtained from Ampere's law has to be multiplied by the radius that reduces in value along that negative region. Thus at this rotation point the surface currents along the long edges do not negate the torque. To show that this situation prevails at other angles of rotation cannot be done here, it requires a full 3D simulation, or maybe better still a functional model. As a matter of interest using the FEMM information for 32MGOe NdFeB having H_c = 883310 A/m the surface current around a 4mm thick magnet is 3533 amps.

Looking back at Figure 4 the Torque moves from positive to negative at a distance of 15mm along the circular path. Thus we can show these torque regions on Figure 5 as shown next.

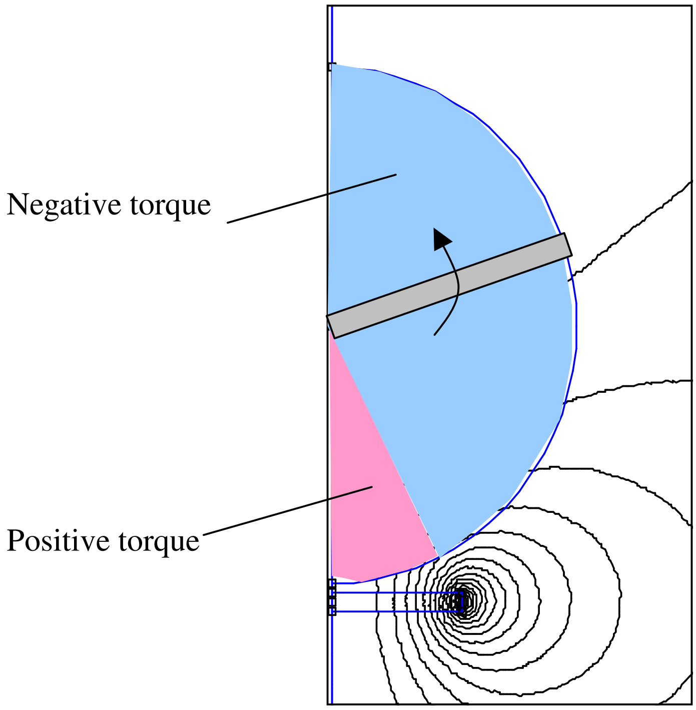

Figure 8. Torque regions

There is a small angular region of high positive torque and a large angular region of low negative torque. The intention is to place more stator magnets around the circle to create more positive torque regions as shown next. As we add more inward facing stator magnets the positive torque values decrease and the negative torque values increase. Whether the net result shows an overall non-zero torque over a full revolution remains to be see. What is clear is the fact that the magnet arrangement in Figure 9, if solved by the planar FEMM where it models magnets that are all infinitely long in the z dimension (into/out-of the page), the result is zero torque. That is easily explained by the flux lines from the stator magnets obeying conservation of flux so that the total inward flowing flux in the positive torque regions has to balance the total outward flowing flux in the negative torque regions. Even if we put our finger-like rotor magnet into this infinitely long stator the flux pattern will ensure that the net torque is zero. But our rotor magnet rotating in the xy plane inside disc magnets moves through a different flux pattern where flux conservation in that xy plane no longer applies. So it may be possible for the net torque to be non-zero. Should this be the case we would be able to show that not only can the torque be calculated via the surface current concept and

Amperes force law but also that the source of the output power can be calculated from the surface current and the motional induction law.

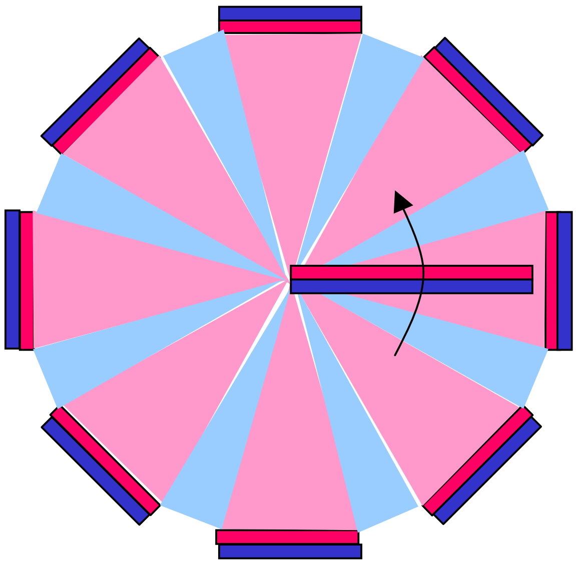

Figure 9. Multiple stator magnets.

If this does prove to have non-zero torque then the system could have multiple rotor magnets in the form of spokes. And to minimise the torque ripple due to the cogging action it could have say 7 rotor spokes moving against the 8 stator magnets.

4. Reference.

[1] Evolution of a Free-running Magnetic Motor Concept, https://www.overunityresearch.com/index.php?action=dlattach;topic=4202.0;attach=42058