Permanent Magnet Motor Discovery
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Part One December 2020

1. Introduction

I have studied and used electromagnetic theory for over 70 years with 49 of those years working in an electromagnetic profession. In the last 26 years I have been interested in overunity systems, Those 26 years have taught me a lot that is not recognized in standard tutorials or reference books, enough to convince me that they have not covered their subjects fully. That deeper understanding convinced me that overunity was possible and that there should be a simple way of achieving it. There have been many moments when I thought I had succeeded, only to have my moment of triumph dashed when more thought and consideration was given to the proposed device. One of the tools that I have used most often is the FEMM finite element analysis because technical support is readily available. It only models in two dimensions where it effectively models devices that are infinitely long in the third dimension. If a 2D model can be shown to offer overunity while not breaking any known physical laws, then it can be reasonably assumed that a 3D model will also do so. The hundreds of FEMM simulations that still reside in odd corners of my trusty computer have dutifully recorded COP's of unity or less.

Now I believe I have finally found a means for designing free running motors that use permanent magnets as their power source. Such magnets obtain their magnetism from an enormous density of fundamental magnetic dipoles, either atomic electrons that are orbiting nuclei or from the spins of those electrons. In non-magnetic material these dipoles have a random distribution of their spin axes, but in permanent magnet materials the axes are aligned. We can induce electric field vortices onto these moving or spinning charges that can attempt to accelerate or decelerate their movement and in doing so obtain energy from their movement or spin, or feed energy back to them. The spins or orbits are perpetual, driven by some internal force of Nature that is not fully understood, and that is the power source for these machines, equivalent to a myriad of tiny coils each one driven by a current-source. Power taken from each current-source is that value of current multiplied by an induced voltage, the induction coming from the moving magnetic field present at each tiny coil, and that represents the induction attempting to slow down the electron orbital speed or spin.

This present discovery brings together hitherto unused (and possibly unknown and untaught) aspects of electromagnetic theory:-

(a) Any permanent magnet can be modelled by its surface-current equivalent; it can be modelled as a single layer conductive foil closely wound onto its surface carrying a large constant current.
(b) The forces between magnets can be deduced directly from those surface-currents using Ampere's Law for the forces between current elements.
(c) An electric potential can be induced into that surface conductor not only by transformer induction (where the magnetic flux through that loop is changing with time) but also by motional induction (where the magnetic field is sweeping by sections of the conductor).

(d) That combination of transformer plus motional induction allows the induction into the conductor closed loop to have a DC component, and that applies down to the atomic scale of the atomic dipoles.

The use of (a) and (b) unlocks the mystery of how to design magnetic motors that will work while (c) and (d) allows us to see how the energy obtained from the motor comes from the quantum forces that keeps atomic electrons in perpetual orbital motion or spin. DC induction into a closed loop (d) is unknown in classical theory, and even prohibited, but a simple integration of the voltage induced into a closed loop moving in a non-uniform permanent magnetic field shows that prohibition to be incorrect.

2. Equivalent surface-currents of magnets

Nussbaum [1] devotes a whole chapter to the equivalent current concept, but here we are only interested in the solenoid equivalent of a permanent magnet. The following image taken from Nussbaum shows the magnetic fields of (a) an air cored solenoid and (b) a permanent magnet.

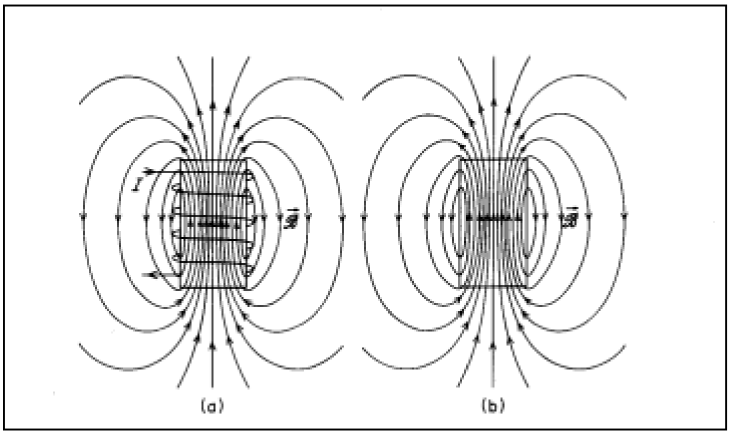


Figure 1. Magnetic field from (a) a solenoid and (b) a permanent magnet

It is seen that the fields are identical showing that the equivalent surface current concept is a valid method for calculating the field from a magnet. But is goes further than that. We now allow the equivalent solenoid, driven from a constant current source, to do some work, like pick up a lump of permeable material against gravity. The work done is then *mgh* as shown in Figure 2.

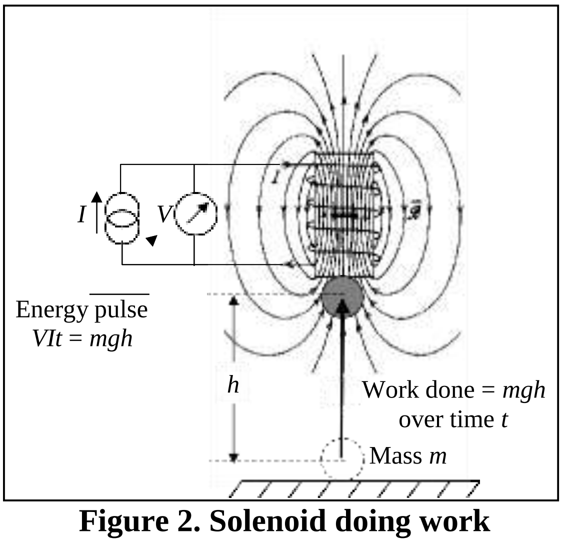


Figure 2. Solenoid doing work

Now ignoring any copper loss in the coil (we could use super-conducting material) the source supplying the coil current *I* will see an induced voltage *V* due to the increasing field within the coil as the permeable material rises. That voltage represents a load on the current source, the source supplies energy, and the *VI* power supplied over the time *t* is energy equivalent to *mgh* plus the increase in energy stored in the now increased inductance. Thus we have a full accounting for the work done, there is no free energy, the current source supplies that energy.

Now when we consider a permanent magnet doing the same work, it is a valid question to ask where the energy comes from.

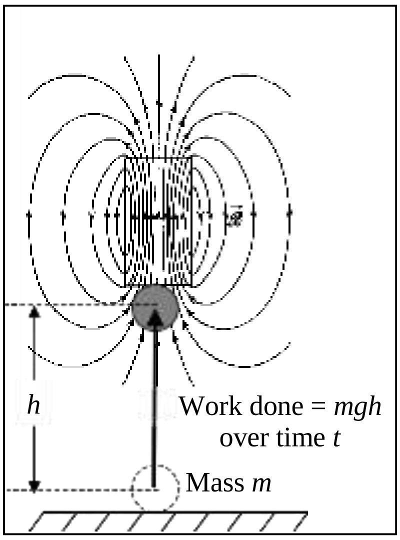


Figure 3. Magnet doing the same work

The magnet will also see an increasing internal field as the permeable material rises, and that will induce voltage into the atomic electron circulations, or rather will induce *E* field vortices that apply forces to the moving electron charges. Those forces will load the electron circulations attempting to slow them down, which of course can't happen. Whatever is driving those perpetual motions is the source of the energy. Now since the current *I* in the equivalent solenoid represents the net effect of all those atomic electron circulations, then the voltage *V* induced into that equivalent solenoid over the time *t* yields the energy supplied from that inner atomic world. Here we have a means for examining a magnetic motor, placing imaginary coils around each magnet, and seeing where energy is extracted from the atomic domain and where energy is fed back. We can analyze in detail these energy flows, but more importantly we have a method for evolving motor concepts that will work.

3. DC Induction

For a loop or coil carrying a constant (DC) current to be able to continuously deliver power there must be a constant (DC) voltage induced into that coil. Current scientific dogma tells us that any voltage induced into a closed loop must come from the magnetic flux passing through that loop changing with time (the so-called transformer induction). Thus to produce a constant (DC) voltage (or a DC component on an AC voltage) requires a magnetic field that rises continuously and ultimately going to infinity, which is of course impracticable. However there is another form of induction (motional induction) where a magnetic field sweeps past a conductor, or a conductor moves within a magnetic field. That a combination of these two effects might induce DC voltage is not known or accepted wisdom, but it appears from my theoretical investigations that this perception is wrong. I now firmly believe that a DC component of voltage can be induced this way, such that a motor consisting of a stator and a rotor both containing coils that carry DC current can produce shaft power that is fully accounted for by the currents and DC voltages induced into those coils. For practical coils and currents the power so obtained is miniscule, but when the coils are replaced by magnets (where the effective surface-currents are huge) useable power is delivered. The shaft power is fully accounted for by the DC voltages induced into the effective surface-currents, and that in turn means the shaft power is accounted for by the DC voltages induced into the atomic dipoles (current loops) of the magnet.

4. Simulating permanent magnet motors

There are many examples of free-running motors containing only permanent magnets that produce continuous shaft power. These are looked upon by the scientific establishment as scams, containing some hidden source of energy such as a battery, or compressed air. One such motor that I have had the privilege of seeing first hand is that invented by Muammer Yildiz. He partially disassembled this motor in front of his audience, which showed the complex construction of stator elements containing many magnets, and subsequent image enhancement of photographs showed the rotor (hidden under some translucent plastic) to also contain many magnets. The fact that some of the magnet positions in the stator were unoccupied told me that he got this motor to work by a trial and error selection process, which together with Yildiz's up-front cost demand of $2 million may explain why there are no takers for mass production of such a complex device.

Having seen the motor working I was convinced it was genuine, and have spent many hours trying to discover the secret for why these PM motors work. This has involved many computer simulations using the FEMM two-dimensional finite element program, all without success. Only recently have I come to the realization that this cannot be resolved by the 2D model, and not having the resources of a 3D model I have resorted to creating my own model using surface current elements for the magnets and Ampere's Law to deduce the forces. It is this approach that leads me to PM motor designs that can be theoretically shown to work, but it requires some practical experiments to validate this work.

In order to simplify the 3D model, I consider only rectangular magnets. Also since most of the motors that have been demonstrated use disc magnets that are magnetized across the thickness dimension, I restricted myself to thin rectangular slabs also magnetized across the thickness dimension. Thus the magnet is modelled as a rectangular loop of conductive strip carrying a specified current, and for thin magnets this can be further simplified to a thin conductor, figure 4.

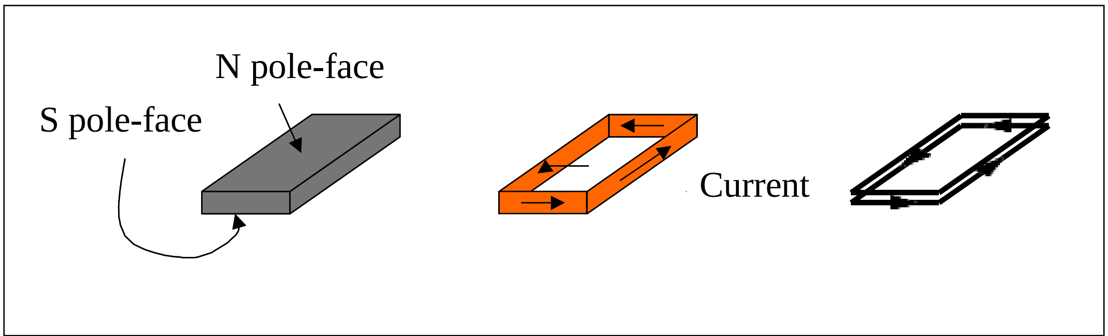


Figure 4. Rectangular magnet and its surface-current equivalents.

It is now a matter of deducing the force on each current element of the rotor coming from each current element of the stator using Ampere's Law for the force between current elements. This is a combination of the Biot-Savart Law for the magnetic field from the stator current element and the force law for a current element in that field more readily known as Fleming's left-hand rule. We are interested in whether the force on the rotor element results in a torque that has a non-zero value when integrated over a 360 degree movement of the rotor. We can immediately discount the fields from stator current elements over the long dimension of the magnet as (a) my failed 2D simulations show that they create zero average torque on the long dimension conductors of the rotor magnet and (b) for the short end conductors of the rotor magnet the fields create only longitudinal compression or tension forces in the rotor magnets. Thus the simulation models the stator magnet as two isolated current elements, one at each end of the magnet.

My first step was to deduce the force on one end of the rotor magnet due to the field from one end of the stator magnet, figure 5.

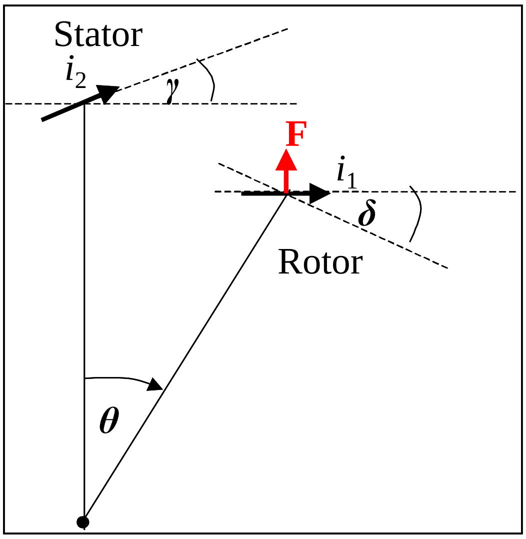


Figure 5. Stator and Rotor current elements

Both magnets were given tilt angles (γ and δ). The field from the stator element is everywhere normal to the paper (or screen) plane and points away from the reader, hence by Fleming's LH rule the force on the rotor element is as depicted by the red arrow. ***This creates a torque on the rotor that has the same polarity for all angles of θ.*** This is obvious when explained in that manner, but it was not obvious to me until I charted the torque over 360º movement for typical stator and rotor sizes. Figure 6 is the chart that drew this to my attention, where even at 180º the torque although small has not changed direction. That was my Eureka moment!!

Of course it is also necessary to consider the forces between that stator element and (a) the longitudinal elements of the rotor current and (b) the far end of the rotor. For (a) although I went to the trouble of integrating the force along the two rotor currents I need not have bothered, because the force there from one end stator element is exactly cancelled by the force from the other end of the stator. And for (b), although that gives a reversed torque it is lower in amplitude because of the distance, hence does not cancel the result. It can therefore be concluded that an arrangement of rectangular current

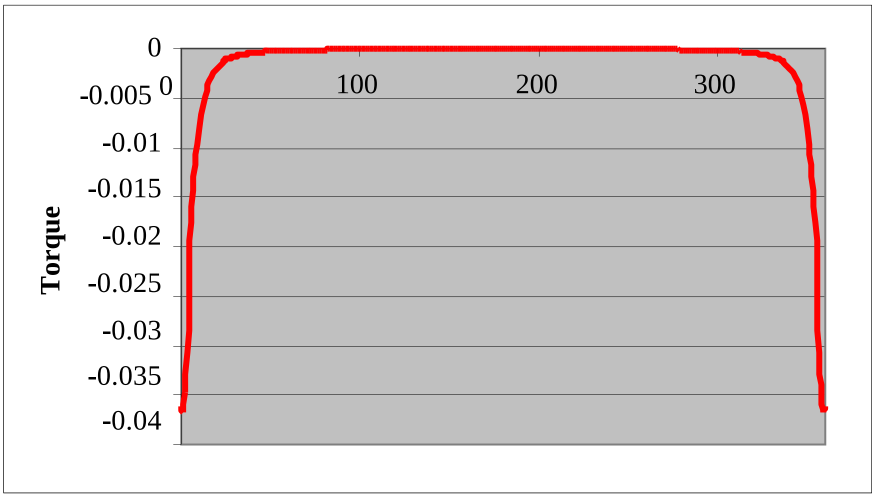


Figure 6. Torque on rotor element

loops in a stator and a rotor, each carrying a direct current, can perform as an electric motor. The question may be asked as to why such a motor has never been demonstrated, and perhaps the answer is that it requires enormous stator and rotor currents to get useful results. For a typical NdFeB magnet that is say 5mm thick the equivalent surface current is about 5,000 amps, and that current would vaporize any practical coil trying to simulate the magnet.

Another feature of this revelation is that, like any electric motor having current carrying conductors moving in a magnetic field, the delivered shaft power is fully accounted for by the voltage induced into that conductor by the movement, the so-called motional induction (Fleming's RH rule). Hence the same applies to the permanent magnet motor, but there the induction applies to the atomic current loops which are the so-called *quantum dipoles* responsible for the power.

Figure 7 shows the motor concept where for ease of illustration the magnets are shown as thin sheets.

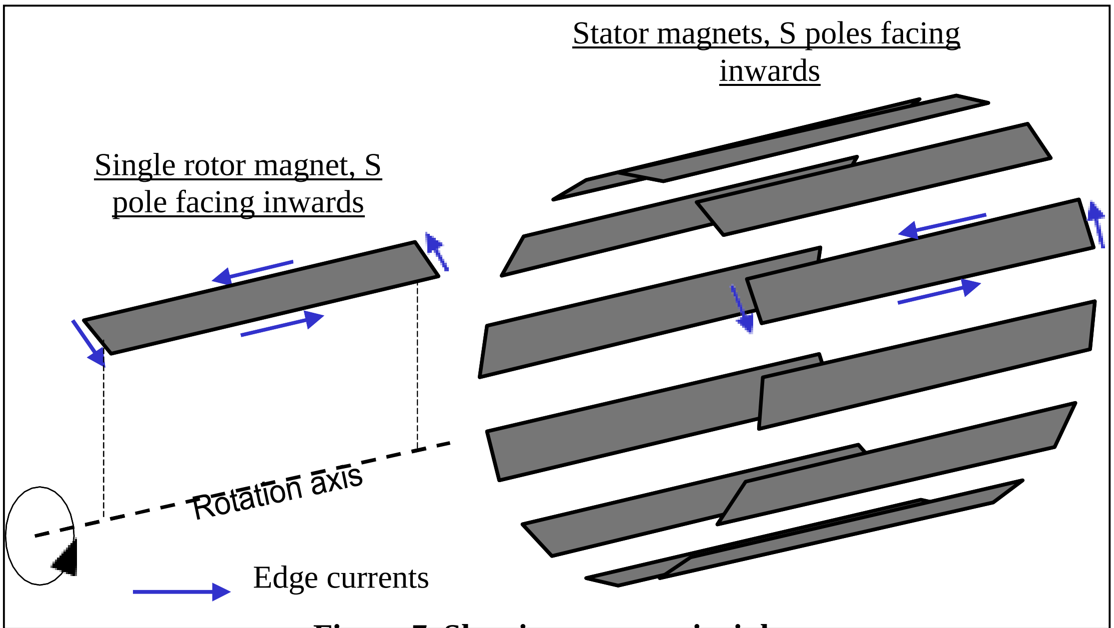


Figure 7. Showing motor principle

Not shown are the structures holding the magnets in place, and these of course must withstand the considerable non-torque forces on the magnets. A typical motor would have a number of rotor magnets. Of course there will be cogging torques (that integrate to zero over 360º), but these can be reduced by having one less rotor magnet than that of the stator.

5. Conclusion.

It has been shown that permanent magnets can be modelled by their equivalent surface currents, and this not only gives their magnetic fields but also allows forces between magnets to be calculated by Ampere's force Law. Using this approach it has been shown that motors employing only permanent magnets can deliver so-called *free* power. More importantly this shows that the power comes directly from the electron orbits or spins responsible for the permanent magnetism, or rather from whatever keeps those electrons in perpetual motion.

Part Two January 2021

This is a continuation seeking a possible explanation for why permanent magnet motors work, disclosing where the energy comes from and suggesting a means for designing such motors from first principles. Since writing Part One I have looked further at certain aspects in order to resolve doubts that this really is a breakthrough in the search for an environmentally clean source of energy.

1. Equivalent Currents

In Part One I reproduced an image from Nussbaum's book [1] that shows the field from a cylindrical magnet to be identical to that from a solenoidal coil close wound onto a cylindrical surface that is the same size as the magnet, the solenoid being air cored.
As that image could have been an artist's impression I wanted to convince myself that replacing a magnet with its equivalent surface current really did reproduce the magnet's field, and particularly for the case of disc magnet where the surface has little length. As the main focus was on rectangular discs (figure 1) I used the FEMM 2D finite element model to look at this problem.

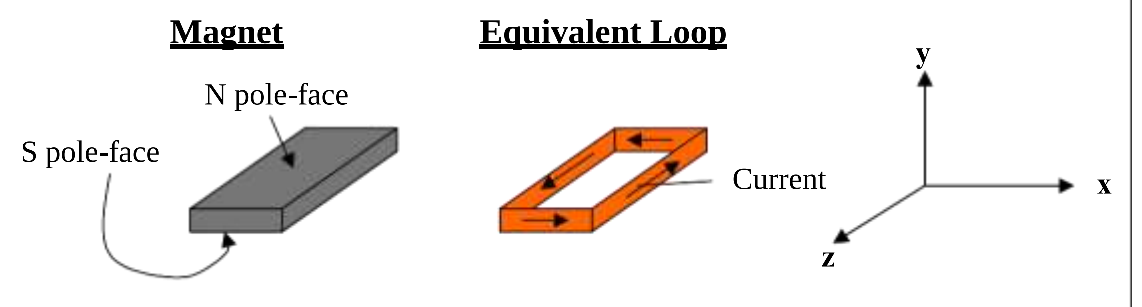


Figure 1. Permanent magnet and its equivalent current loop

FEMM models systems that are infinitely long in the **z** dimension hence on its output image of the **xy** plane the magnet appears as a single rectangle and the current sheet appears as two rectangles depicting the conductors, figure 2.

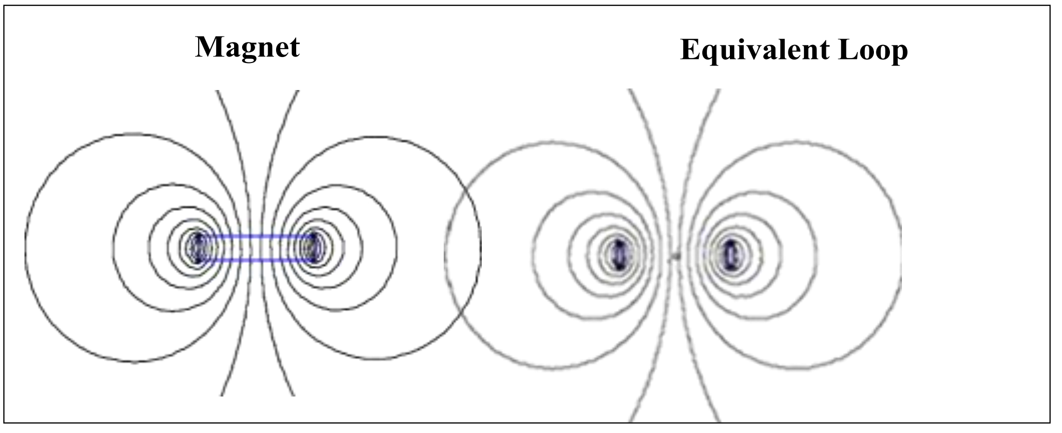


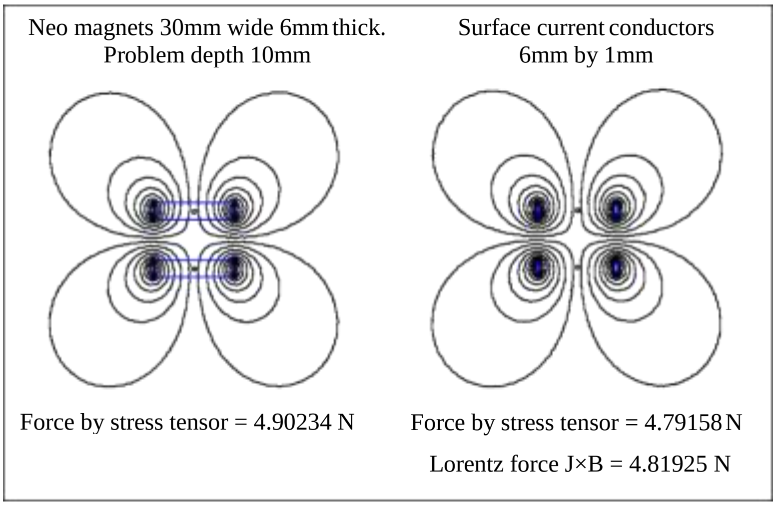
Figure 2. Field from a magnet and its equivalent current loop

It can be seen that the current loop produces an identical field to that from the magnet.

The next thing I looked at was whether the forces between magnets could be accurately determined from the forces between the equivalent currents. FEMM calculates the force on a magnet by using the Maxwell stress tensor, it creates a stress tensor mask surrounding the magnet (in the air space) and integrates around that mask, thus it is obtaining the force directly from the magnetic field. The same method can be used for obtaining the force on a current loop, and since both the magnet and its equivalent loop create the same field, it would be expected that the same results would be obtained. But FEMM also calculates the Lorentz force on a conductor, so it has two methods for determining the force on a current loop. I wanted to convince myself that force on a magnet can be accurately determined from the fictitious surface current, and FEMM gave me the opportunity to do so.

Figure 3 shows two identical magnets in repulsion, and their equivalent current loops. Also shown are the forces as determined by FEMM. As this is a finite element model where accuracy is seriously affected by the mesh size, which here was 1mm for the air space (and note the conductors are 1mm thick), the results are not expected to be identical, but they do show that the force on magnets ***can*** be determined from the forces on the fictitious surface currents.

Figure 3. Magnets and loops in repulsion



I find this result quite significant, since it offers an alternative means for calculating the forces between magnets using Ampere's Law for the force between current elements.
Now for completeness the following figures show magnets and loops in attraction mode and in torque mode.

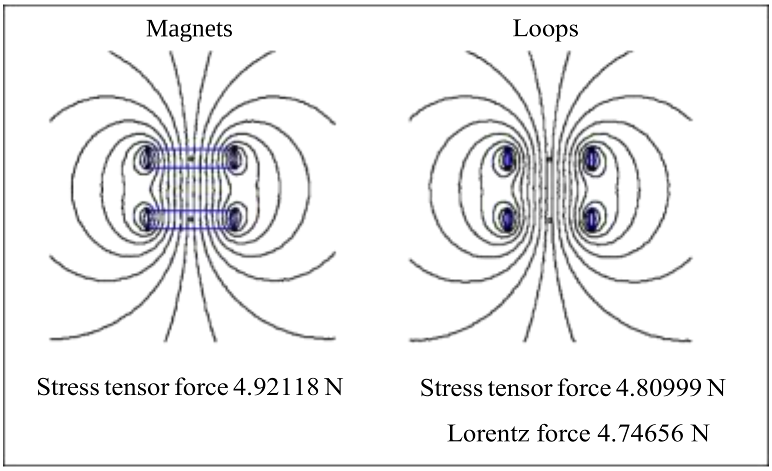


Figure 3. Magnets and loops in attraction

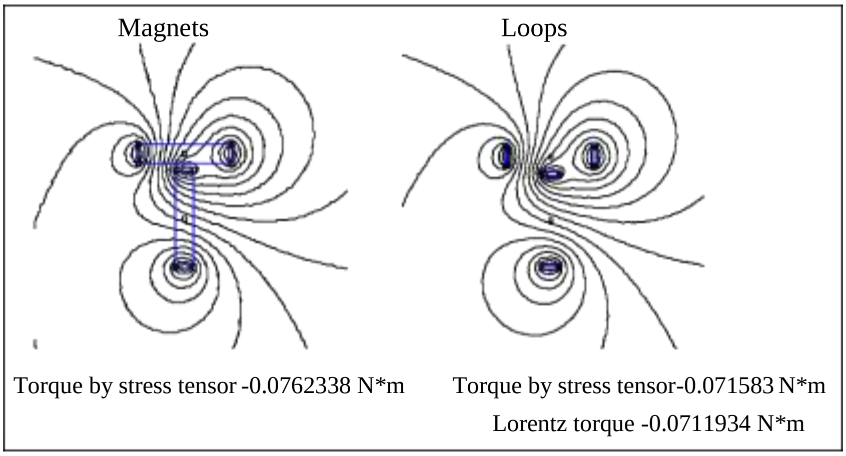


Figure 4. Magnets and loops in torque mode

Having rectangular magnets the surface currents are represented by straight conductors, and it is a simple process to calculate the force on each segment, on each edge of the rectangular magnet.

2. Correction to Part One

For the forces on the long edges of the rectangular rotor magnet I stated in [1] "the force there from one end stator element is exactly cancelled by the force from the other end of the stator". That is incorrect, and I have found it necessary to perform more calculations in order to show that these forces do not cancel the non-zero average torque forces over a complete cycle. This involves integrating the force along each edge for which a math expression was derived. In the past I have used Wolfram's online integrator, but for some reason their latest version doesn't work and I had to do it the hard way by summing each increment value. I am pleased that my results do still show that non-zero torque, so the conclusions in Part One are still valid.

3. Conclusions

For performance calculations permanent magnets can be replaced by loops carrying the magnet's equivalent surface currents. The magnetic fields from those loops exactly replicate the fields from the actual magnets. Forces on the loops can be calculated by Ampere's force Law between current elements, and this exactly replicates the forces on the actual magnets. This method has been shown to produce non-zero torque on a rotor magnet when averaged over a full cycle of rotation. Voltage induced into the current loop can be deduced by the $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ motional induction for conductors moving through a magnetic field, and it is reasonable to assume that the mechanical power from that non-zero torque is accounted for by the product of the average induced voltage and the loop current. Since that current is a representation of all the atomic current loops within the magnet, the power thus obtained represents the power derived from those atomic currents, the electron orbits and spins responsible for the permanent magnetism.

Reference: Electromagnetic Theory for Engineers and Scientists by Allen Nussbaum Prentice Hall Inc. Page 291