Some Musings on Magnetization

The historical manner in which magnetism developed has created a science which has some serious disconnects in its formulation, never more so than in the physics of ferromagnetic materials. Even though modern scientists know that the magnetization comes from arrays of discrete atomic dipoles, where in that micro-universe the separation between atoms is huge compared to their size, that inter-atomic space and the magnetic fields therein are generally ignored. Scientists use a term called *magnetization* (usually denoted **M**), which is a volume-density of a "substance" called *dipole-moment*, and pretend that "substance" is smoothly spread through all space within the material. They know that dipole-moment is a characteristic of a discrete dipole, and that **M** should really be a discrete number-density, but because that number-density is so very high (like 10^{28} atomic dipoles per cubic meter) it has been found more convenient to imagine **M** as a smooth function. That inconsistency, the filling of inter-atomic space with that imaginary substance, prohibits the calculation of the actual magnetic fields there and so continues to hide the magnetic energy stored in that space and its vital connection to the atomic dipoles, the *Quantum Dynamos*® that Nature has supplied. For permanent magnets those inter-atomic fields are not trivial, and the stored energy has a density close to the magnet's maximum BH energy product.

Again for permanent magnets that inconsistency has lead to the nonsense of a negative **H** residing within the magnet, i.e. **H** opposing the **B** field. And it has hidden the true meaning of the reluctance of the air space occupied by the magnet, something that is used when calculating the load line. This calculation is done by rote with little thought as to why it works, yet the answer is very simple. The equivalent circuit for a permanent magnet is an mmf source (i.e. the combined effect of all the atomic dipoles) in series with that air-space reluctance, and the load-line procedure is simply a graphical method of calculating the mmf drop across it. Another clue to the inconsistency is the known feature of permanent magnets having a permeability of unity, i.e. they act like air to alternating fields (eddy currents excluded).

The same arguments apply to soft ferromagnetic material, when magnetized there is within the inter-atomic space magnetic energy that is far in excess of that used to create the magnetization. In the case of alternating excitation this store of hidden energy is cyclic, which opens the door to methods of extracting a portion on each cycle, with that "loss" (which is our gain) being replenished from the quantum forces driving each dipole. Put simply, while Nature supplies most of the energy to align the dipoles during the magnetizing phase, we can load each dipole *electrically* by the presence of a circular electric field, since a dipole is simply a current loop. Although an applied magnetic field is generally required for the creation of circular electric loops, the electric field is proportional to the rate of change of the magnetic field, hence the electric field can be present while the applied magnetic field passes through zero. At this condition of zero external magnetic field there is no magnetic force (torque) present, but each dipole or current loop is working against a retarding electric field. If the dipoles were spinning charged spheres their spin speed would be reduced. Fortunately Nature's spinning and orbital electrons are supported by quantum forces.

It will be appreciated that supplying a circular electric field in phase with the magnetization represents a 90° phase shift between the magnetization and the external field. In electromagnetic machines anomalous effects often show up when there is excessive phase shift, i.e. when the machine is used outside of its usual operating envelope, and there is increasing evidence that some machines do exhibit anomalous power gains.

Of particular interest are ferromagnetic materials that are electrically conductive, where the itinerant conduction electrons traverse that inter-atomic space. In that inner world, not only are those electrons influenced by the static field (cyclotron effect), but they are also driven by the RF magnetic fields coming from Larmor precessions of nearby atomic dipoles. Recent studies of electron gases in the presence of both a static magnetic field and microwave irradiation have demonstrated that electrons can be transported through the gas while gaining energy from the microwaves, and this rectification effect occurs when the microwave frequency coincides with the cyclotron frequency. Since the formulae for Larmor frequency and cyclotron frequency are identical, this condition is automatically met if atomic-dipole precession is the source of the microwave power. Thus it can be expected that conduction electrons within ferro-magnetic material can be pumped by the *Quantum Dynamos*® to exhibit anomalous effects, and there are many examples where anomalies have occurred only to be spurned by a sceptical scientific community. Harold Aspden reported anomalous effects from eddy currents on transformer cores. And patent archives have many examples of machines exhibiting anomalous effects using moving magnets where these magnets are electrically conductive and where eddy currents can be expected to flow within the magnets. Usually eddy currents are assumed to be associated with energy loss, but it seems possible that they could also be responsible for the anomalous effects found.