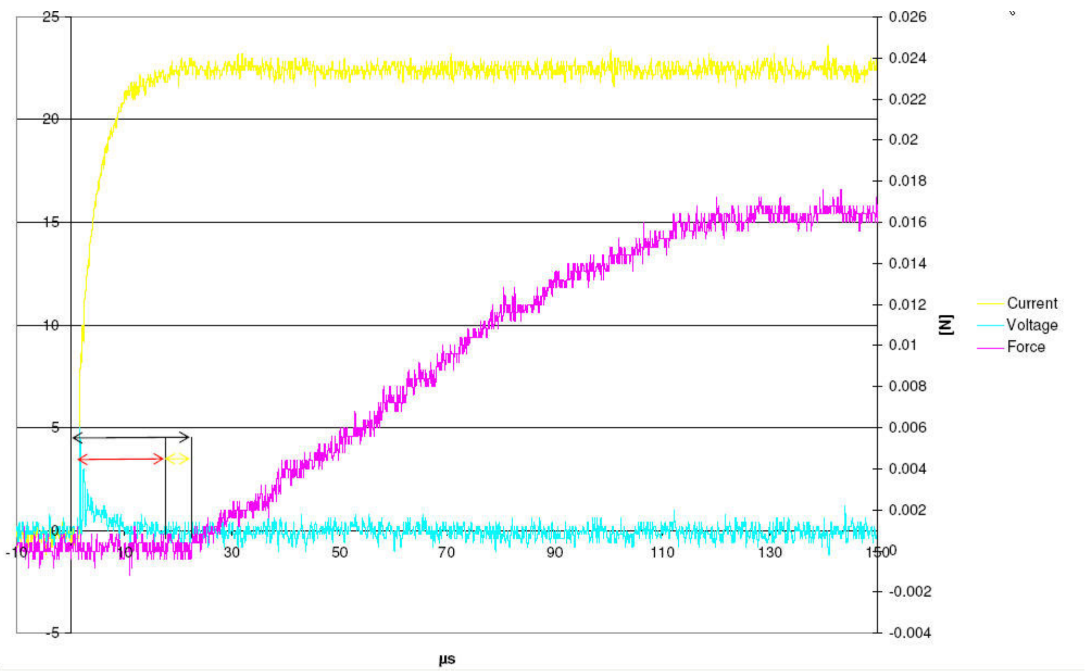
Considerations on the Steorn Technology

1. Introduction.

Steorn have let slip various snippets of information on how their OU system works. Of these the most significant is references to magnetic viscosity. From discussions, questions and Steorn replies on their Forum, it is clear that Steorn firmly believe they are utilizing this phenomenon. This paper examines that claim and suggests that Steorn are wrong in that surmise. It is proposed here that the "Steorn effect" is nothing more than a force time-delay due to the finite propagation of stress waves through materials. This realization opens the door to novel OU devices that utilize this time delay to good advantage.

2. The Steorn Evidence.

Steorn have posted the result of a simple experiment involving the measurement of the force between an energised coil and a NdFe magnet. The coil, which has no core, is given a current step with a fast rise time. Because there is no core material it is assumed that the magnetic field follows that fast rise. The force time-profile is measured with an instrument of sufficient bandwidth to resolve force changes within this rise time. The coil current, coil voltage and force are plotted in the following graph.



It can be seen that the current (hence also the magnetic field) reaches its plateau level within 15µS. However the force on the magnet does not follow this rise, it takes a further 100µS for the force to ramp up to its plateau level. Steorn say that this graph applies to a "good" magnet. Without defining what constitutes "good" or "bad", Steorn have said that much longer time ramps occur with bad NdFe magnets.

Steorn put this phenomenon down to the well know effect of magnetic viscosity. However such viscosity effects are always associated with changes in magnetization. The fact that the force rises from zero while under constant applied field cannot be put down to magnetization changes unless the magnetization itself starts from zero. That would be the characteristic for a soft magnetic material, and Steorn are adamant that this measurement is performed on a hard NdFe magnet. The majority of domains in NdFe are strongly pinned and hence the material does not exhibit significant changes of magnetization even under relatively strong applied fields, so the Steorn judgement is flawed. We must search for other reasons for this time delay.

3. Stress Waves in Materials.

As a general rule the force due to the proximity of another magnet or energized coil is not evenly distributed over the volume of a magnet, but is concentrated at the nearest point, and for simplicity of argument can be considered a point force. Thus when dealing with the sudden presence of the other magnet or coil, there is a time delay between the sudden application of this point force and its presence on the support structure. During this time a stress wave is propagating through the magnet material at "particle velocity". Particle velocity is not the same as acoustic velocity. Particle velocity varies with stress, the plot of this velocity against stress is known as the Hugoniot for the material. The following graph is the Hugoniot for aluminium when subjected to a sudden pressure impulse.

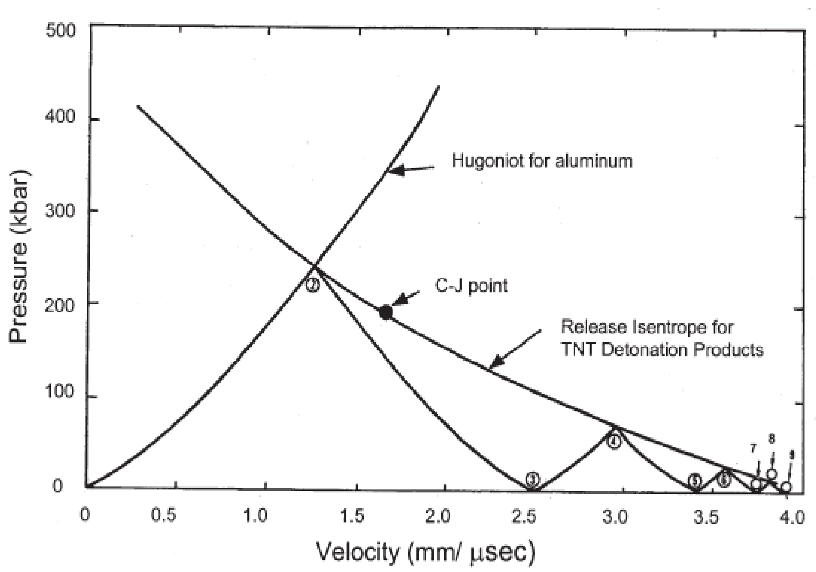
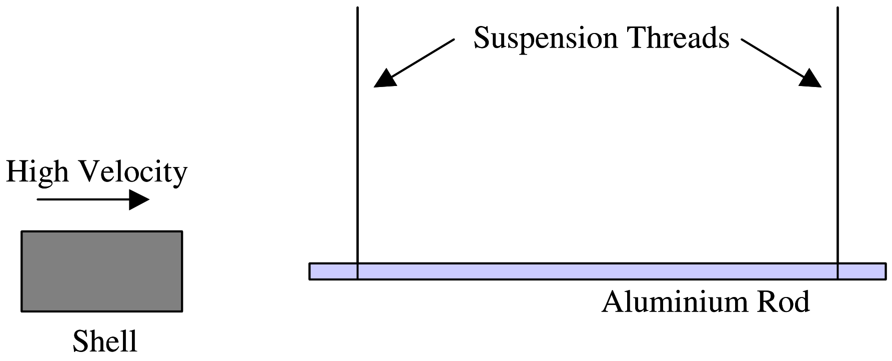
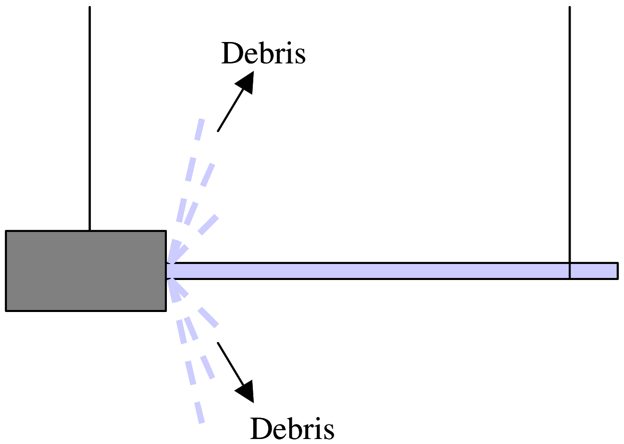


Figure 2:
Pressure versus particle velocity for explosively loaded aluminum plate

Of interest here is the low particle velocities (below 1mm/µS) for low pressures (below 150kbar). If the Hugoniot for NdFeB bears any similarity to that for Al then the 100µS delay measured by Steorn could be associated with the dimensions of the NdFeB magnet used. This argument is enhance by evidence that Steorn use small magnets moving against large magnets. It may also be noted that what Steorn call "bad" magnets (having long time delays) could be of the bonded NdFeB type where magnet in powder form is suspended within a plastic binder.

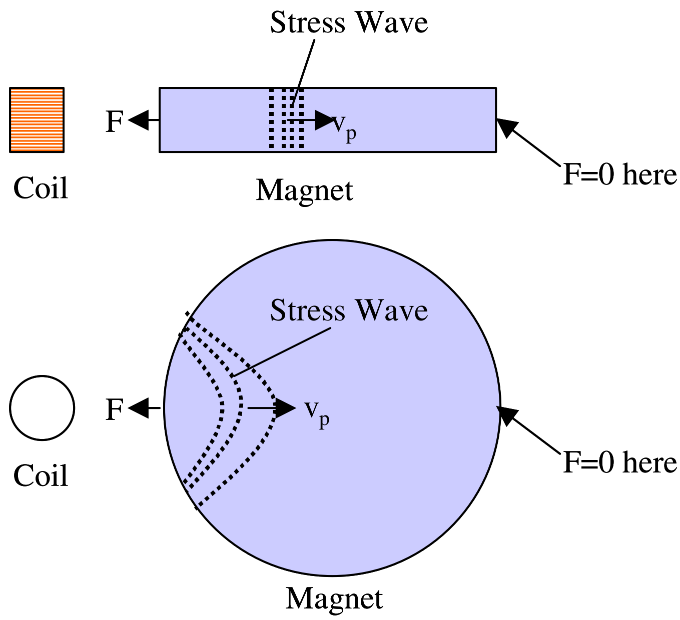
The study of forces with very fast rise times is a specialist subject not generally taught to electromagnetic engineers. It is mainly of interest to scientists involved with hypervelocity impacts or detonation waves. The important thing to realize is that the sudden application of a force at one point on a body does not immediately give rise to that force being available at another point on the body. This is particularly noticeable in high-speed impacts. To illustrate this the following picture is of an aluminium rod suspended on threads. A flat nosed shell has been fired at the rod so as to impact at one end of the rod, and the second picture depicts the situation a short time after initial impact.





Of significance is the lack of movement of the rod furthest from the shell face, even though the forces presented by the moving shell have destroyed the first part of the rod. The reason for this is that force cannot be transmitted along the rod faster than the aluminium particle velocity, the shell is moving faster than this so the shell gets there quicker than any acceleration force. Conservation of mass has to apply, so while the shell gradually "consumes" the space occupied by the rod the aluminium gets spread out sideways as debris.

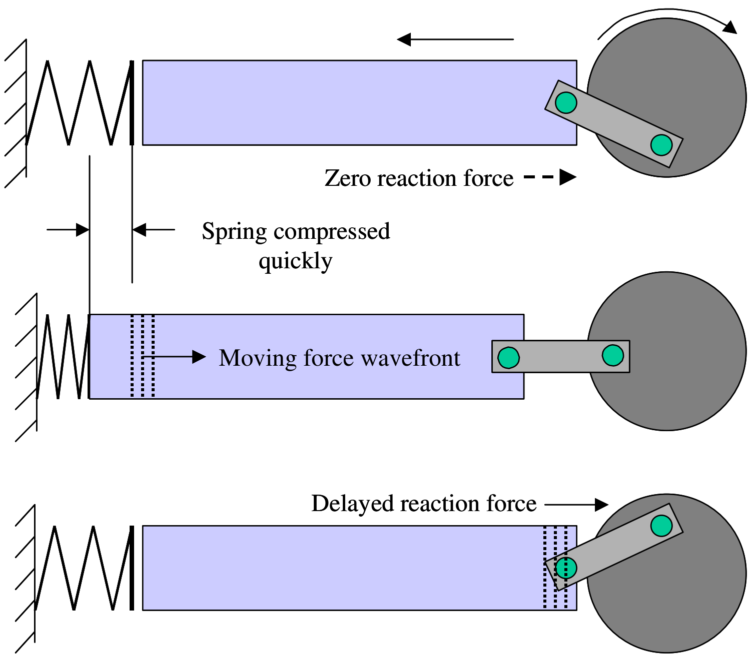
In the Steorn measurement we are not dealing with such drastic forces, but the same argument applies. The next picture illustrates two possible set-ups for the Steorn test. The coil has received a fast current step that results in all the dipoles within the magnet enduring the sudden arrival of a force. Most of the total force on the magnet occurs at the point nearest to the coil, and the pictures depict that force being carried through the magnet as a wave-front travelling at particle velocity v_p. During the time taken for that front to travel the length of the magnet there is no force contribution at the far side. When account is taken of the actual spontaneous arrival of forces distributed over the volume of the magnet, and the differing path lengths to the measuring point, it will be realized that the force seen at that point will not be a step function, but will have a rising characteristic.



This is a more rational explanation for the Steorn data than their magnetic viscosity claim. The next section applies this theory to the case for moving materials that may have the ability to give overunity operation.

4. Moving Materials

The next figure shows a long rod of say aluminium material that is driven as a piston in a reciprocating motion. The piston head compresses a spring. The device is driven at a sufficient speed that the reaction force appearing at the crank end is significantly delayed in time from the force appearing at the piston head. Thus the reaction force impulse at the crank obtains a phase retardation with respect to crank rotation that in the limit applies a driving force to the crank instead of a drag force, as illustrated.



Of course there will be the forces needed to accelerate and retard the piston as determined by the mass of the piston, but these should cancel out over a complete cycle. This purely mechanical OU machine seems too good to be true but it may be worth a punt using a long thin aluminium rod as the piston with appropriate sliding supports along its length to prevent it from bending. It may be that such a machine cannot be driven fast enough to achieve the wanted effect, and the interesting thing about the Steorn work is the ease with which fast rise time force pulses can be done with the use of coils, so a magnetic equivalent of the cranked machine is possible.