Spiral Magnetic Gradient Motor Using Axial Magnets

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Space, Propulsion & Energy Sciences International Forum (SPESIF), February 23-26, 2010, Johns Hopkins University, sponsored by the American Institute of Physics, DOI: 10.13140/2.1.4755.7126

Archived on ResearchGate.net, ScienceDirect.com

IEEE Magnetics Society, DC Chapter, April 23, 2021

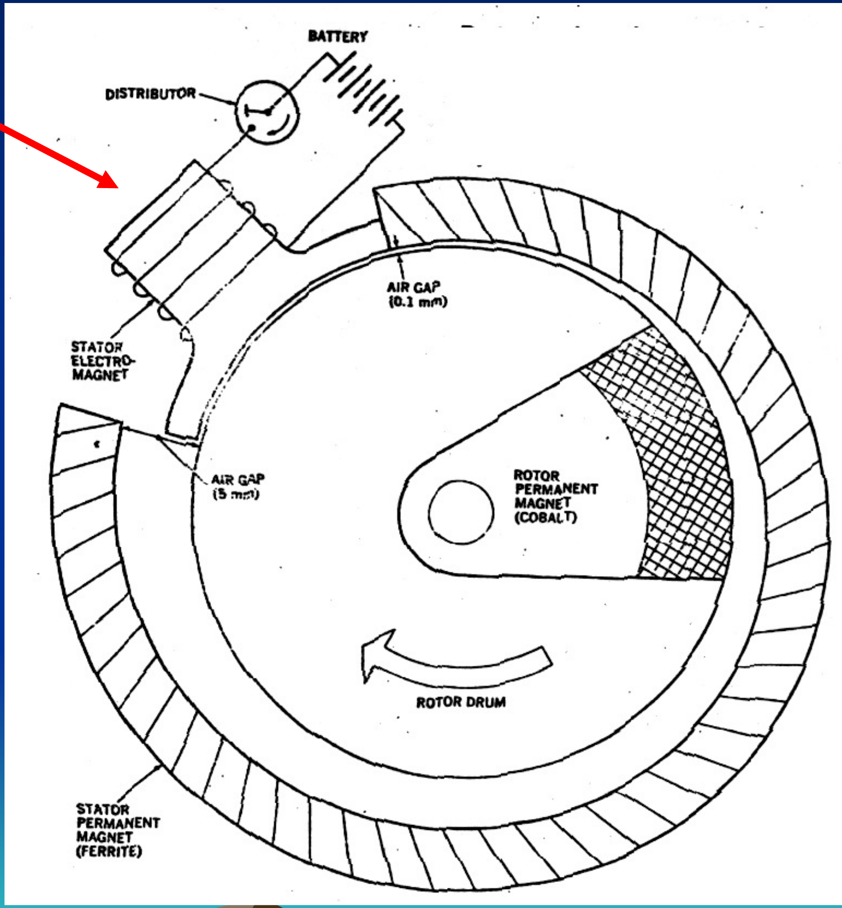
Spiral Magnetic Motor Explanation

Electromagnetic Switch

Diagram taken from

***Popular Science*, 1979**

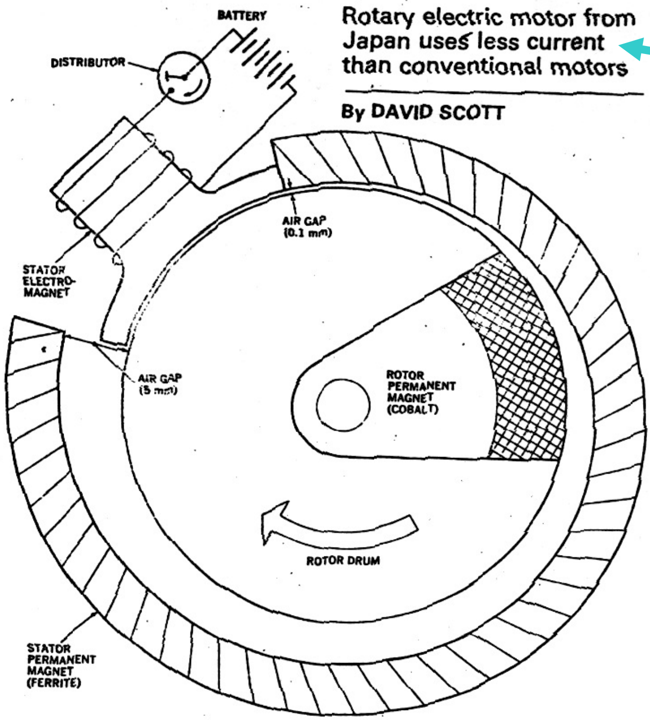
Reviewing Kure Tekko Japanese patents



Magnetic "Wankel" for electric cars

Rotary electric motor from Japan uses less current than conventional motors

By DAVID SCOTT

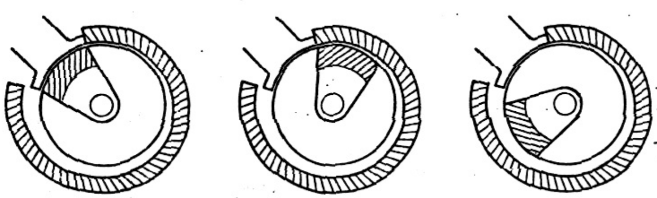


In this time of uncertain gasoline supplies, electric cars look increasingly attractive. So what's keeping them off our roads? Inefficient batteries are the main problem. Battalions of researchers are working to develop better batteries [PS, Feb.] and thus improve the electrics' speed and cruising range. But Kure Tekko, a Japanese engineering firm, has attacked the problem from the other end by developing an engine that reduces the power requirements of electric vehicles. The new engine both weighs less and draws less current than conventional electric motors, so fewer batteries are needed to power the car. Jettisoning batteries, in turn, trims an electric's weight, improving its speed and range.

The Japanese nicknamed the new design the "magnetic Wankel" because the engine's working principles resemble those of a Wankel-type rotary. In fact, the new engine has some things in common with a conventional auto engine. Unlike most electric motors, the rotary electric needs crank starting and has a distributor.

Like the Wankel, the new design is also lighter and smaller than a gas engine of the same power. And the electric rotary is a pygmy when compared to other electric engines. The

How the magnetic rotary engine works



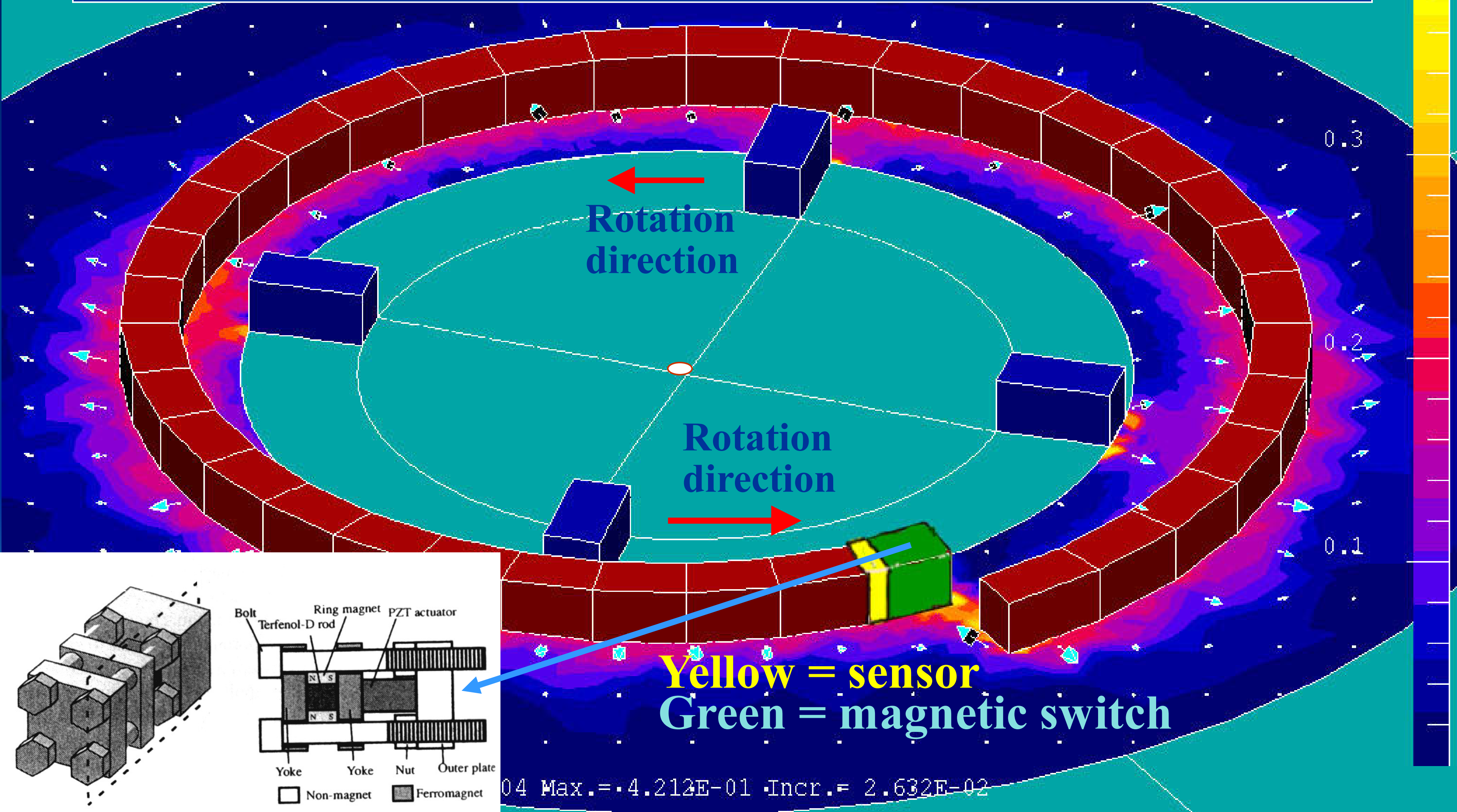
Rotary electric motor has a small cobalt magnet mounted on the edge of its drum-like rotor. The magnet spans a narrow 60-degree sector of the rotor's circumference. The drum spins within a stator ring composed mainly of a permanent ferrite magnet. But the stator has a 60-degree gap spanned by an electromagnet. A distributor geared to the rotor's center shaft times the flow of current to the electro-

June 1979

Spiral Magnetic 'Wankel' Uses Less Current than Conventional Motors

New Switch for Spiral Motor

"The amazing thing is that the energy fields of a crystal can be used without plugging it into a power station." - Dr. Seth Putterman, Nature, May 4, 2005



Single-Phase Motors, Linear Motors, and Special Machines

Spiral Magnetic Motor is a Linear Induction Motor

7.3 LINEAR INDUCTION MOTOR

A *linear induction motor* (LIM) can be derived from its rotary counterpart by "cutting" the rotary motor axially and laying out flat the stator (or primary) and the rotor (or secondary), as shown in Fig. 7-2. The rotating magnetic field is thereby transformed into a translating magnetic field, and instead of an electromagnetic torque we have an electromagnetic force or thrust. Whereas numerous topological variations of LIMs are possible, the two common forms are shown in Fig. 7-3.

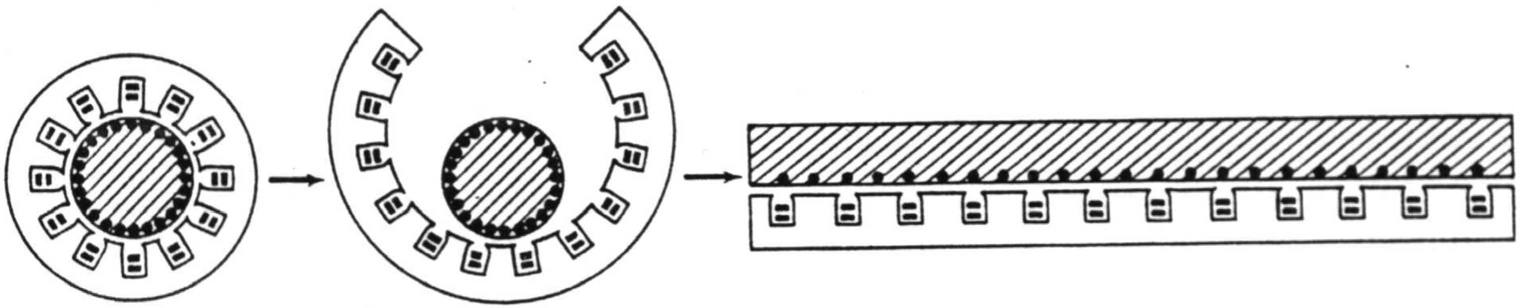


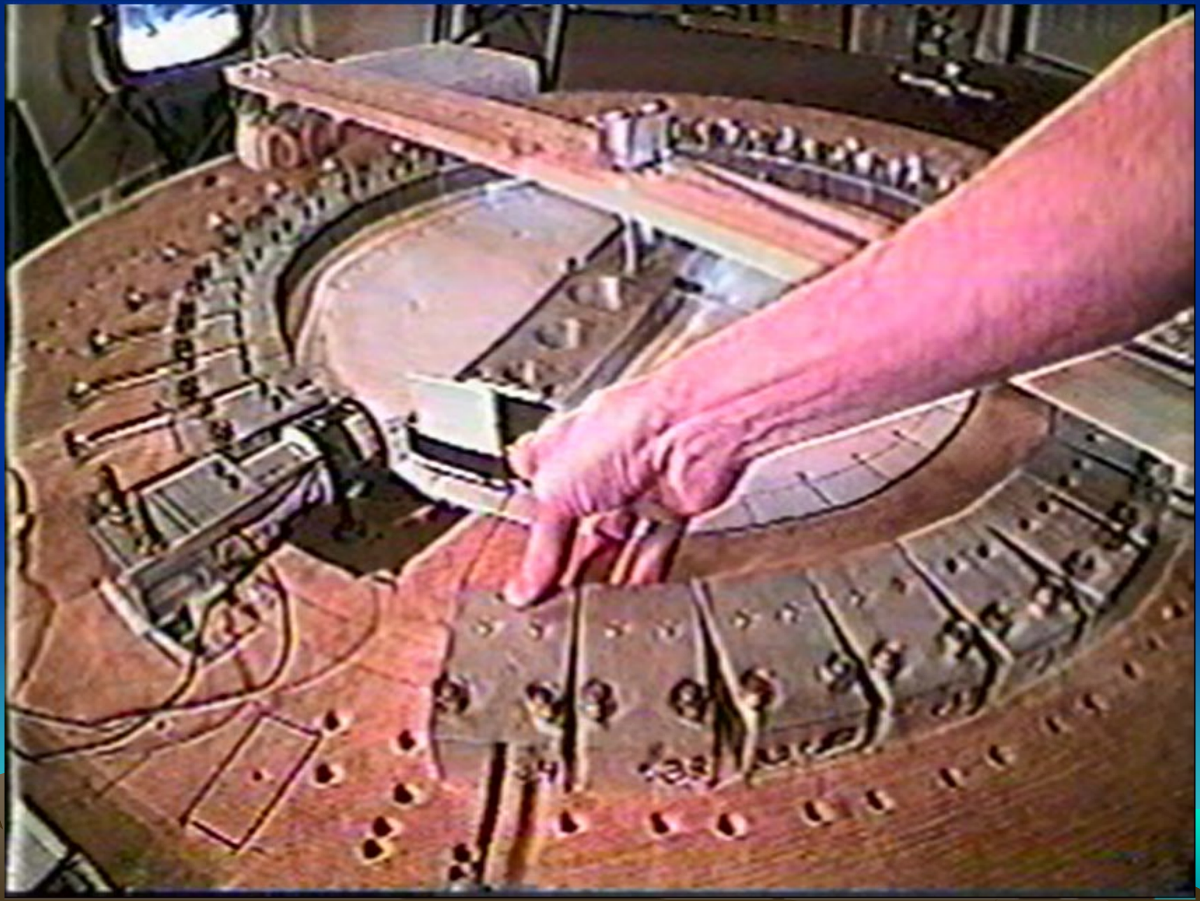
Fig. 7-2

For a refined mathematical analysis certain basic differences between a LIM and its rotary counterpart must be taken into account. In the following, however, we shall consider an idealized model only.

Magnetic Wankel Replication

Requires Substantial Pulsed Electrical Input

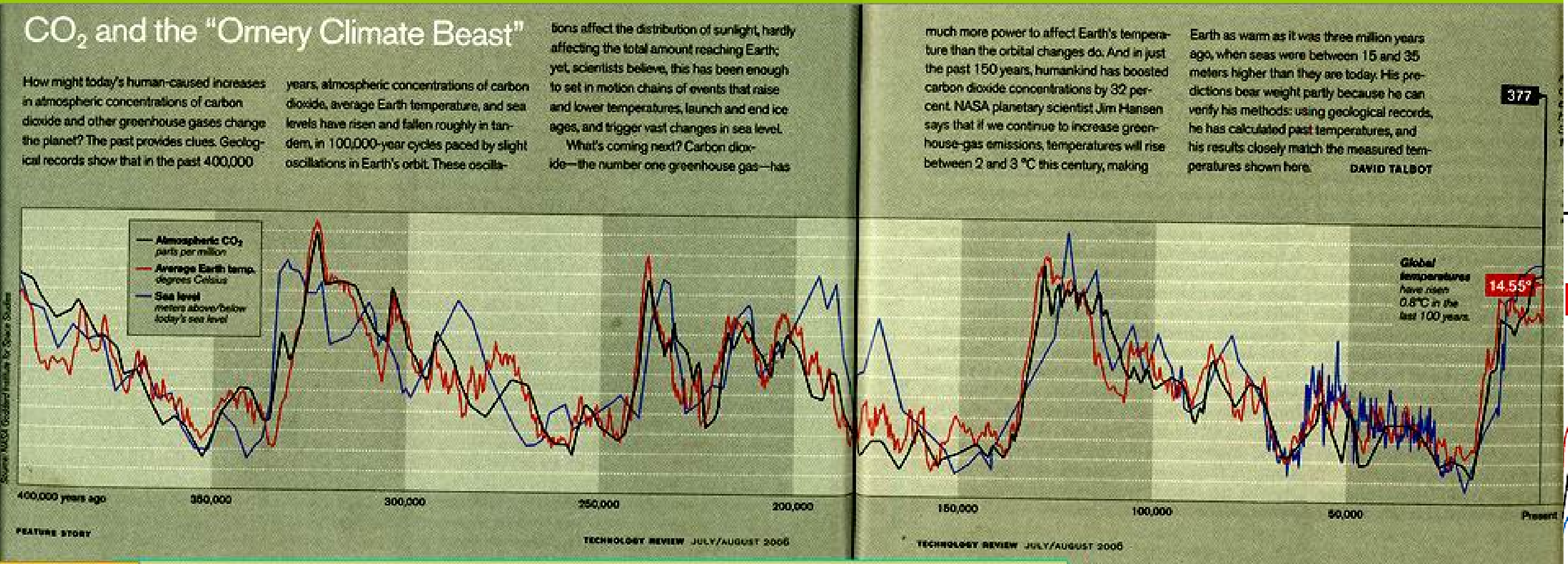
Built by Harry Paul Sprain, 2001, US Patent #**6,954,019**



Why Switch to Magnetic Energy?

Earth's Last 400,000 Year Climate History

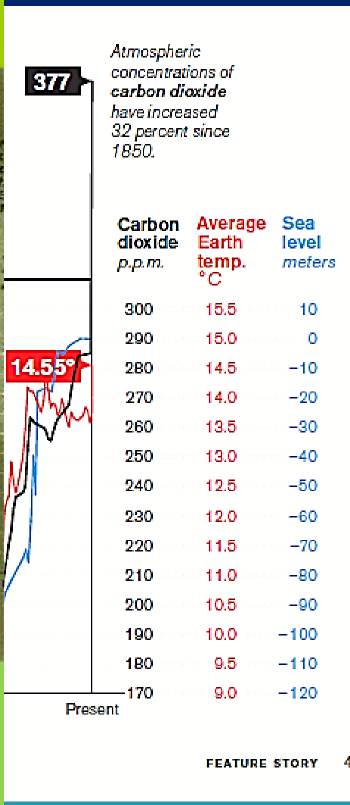
credit: Dr. Jim Hansen, NASA Goddard Inst. for Space Studies



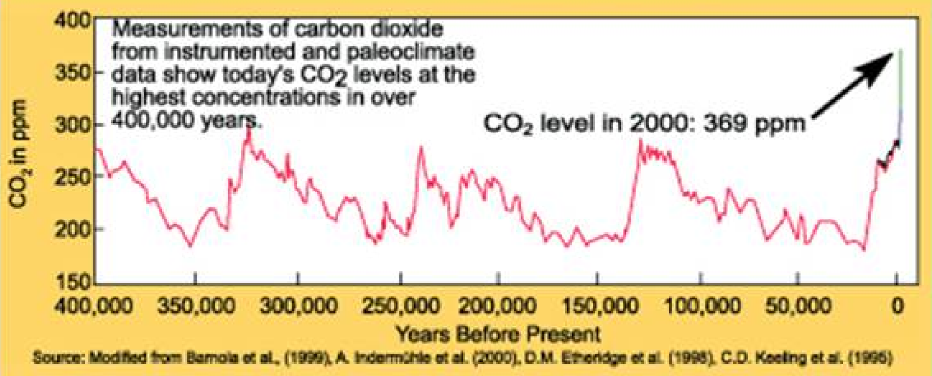
CO_2 and the "Ornery Climate Beast"

How might today's human-caused increases in atmospheric concentrations of carbon dioxide and other greenhouse gases change the planet? The past provides clues. Geological records show that in the past 400,000 years, atmospheric concentrations of carbon dioxide, average Earth temperature, and sea levels have risen and fallen roughly in tandem, in 100,000-year cycles paced by slight oscillations in Earth's orbit. These oscillations affect the distribution of sunlight, hardly affecting the total amount reaching Earth; yet, scientists believe, this has been enough to set in motion chains of events that raise and lower temperatures, launch and end ice ages, and trigger vast changes in sea level.

What's coming next? Carbon dioxide—the number one greenhouse gas—has much more power to affect Earth's temperature than the orbital changes do. And in just the past 150 years, humankind has boosted carbon dioxide concentrations by 32 percent. NASA planetary scientist Jim Hansen says that if we continue to increase greenhouse-gas emissions, temperatures will rise between 2 and 3 °C this century, making Earth as warm as it was three million years ago, when seas were between 15 and 35 meters higher than they are today. His predictions bear weight partly because he can verify his methods: using geological records, he has calculated past temperatures, and his results closely match the measured temperatures shown here. DAVID TALBOT



On right is the same CO_2 data from ncdc.noaa.gov



MIT's *Technology Review*

July/August, 2006

Scientific Research Publishing

Journal of Geoscience and Environment Protection, 2021, 9, 84-135
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

Linear Global Temperature Correlation to Carbon Dioxide Level, Sea Level, and Innovative Solutions to a Projected 6°C Warming by 2100

52-page review article Published March 17, 2021
Open Access
https://doi.org/10.4236/gep.2021.93007

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Email: iri@erols.com

How to cite this paper: Valone, T. F. (2021). Linear Global Temperature Correlation to Carbon Dioxide Level, Sea Level, and Innovative Solutions to a Projected 6°C Warming by 2100. *Journal of Geoscience and Environment Protection, 9,* 84-135.
https://doi.org/10.4236/gep.2021.93007

Received: October 13, 2020
Accepted: March 14, 2021
Published: March 17, 2021

Abstract

Too many climate committees, conferences, articles and publications continue to suggest a one and a half (1.5°C) to two degrees (2°C) Celsius as an achievable global limit to climate change without establishment of any causal link to the proposed anti-warming mechanism. A comprehensive review has found instead that observationally informed projections of climate science underlying climate change offer a different outlook of five to six-degree (5°C - 6°C) increase as "most accurate" with regard to present trends, climate history and models, yielding the most likely outcome for 2100. The most causative triad for the present warming trend from 1950 to the present is identified in this paper: 1) the tripling (3×) of world population; 2) the quadrupling (4×) of carbon emissions; and 3) the quintupling (5×) of the world energy consumption. This paper presents a quantitative, linear global temperature correlation to carbon dioxide levels that has great predictive value, a short temporal feedback loop, and the finding that it is also reversible. The Vostok ... sea ... ph".

Since 1950:
Population 3x
Carbon Emissions 4x
Energy Consumption 5x

3-4-5 Triad

https://www.scirp.org/journal/paperinformation.aspx?paperid=107789

Simple Demo 88% Perm-Mag Powered

Spiral-Design Permanent Magnet Motor V3

4,362 views • Dec 7, 2017 31 3 SHARE SAVE

Spiral-Design Permanent Magnet Motor V3 www.youtube.com/watch?v=2edLkAk0YOU

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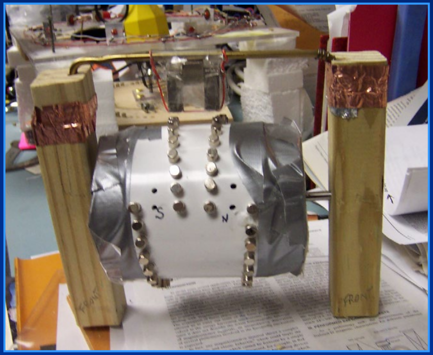
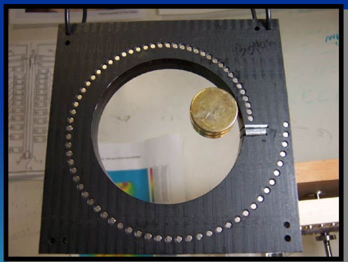
2-minute promo video for our successful 2017 Indiegogo campaign





Credit: Tom Schum for spiral stator construction

Click on arrow > above to run short SMM video promo or visit YouTube link.

Gradients Are Used for All Power

- Thermal gradient is used for heat pump
- Voltage gradient is used for electricity "pumping" of current
- Gravity gradient is used for hydroelectric power
- Pressure gradient used for natural gas and water pumping
- Magnetic gradient is used for nothing so far

Inhomogeneous Magnetic Fields = Magnetic Gradient

The Stern–Gerlach Experiment and Electron Spin

--*Modern Physics*, Schaumm's Outline Series, Gautreau et al., McGraw Hill, 1978

21.1 THE STERN-GERLACH EXPERIMENT

In the *Stern-Gerlach experiment*, performed in 1921, a beam of silver atoms having zero total orbital angular momentum passes through an *inhomogeneous* magnetic field and strikes a photographic plate, as shown in Fig. 21-1. Any deflection of the beam when the magnetic field is turned on is measured on the photographic plate.

<u>Their experimental setup:</u> The magnetic field B is more intense near the pointed surface at the top than near the flat surface below, creating a slope in a graph of B vs. z , which is the gradient dB/dz.

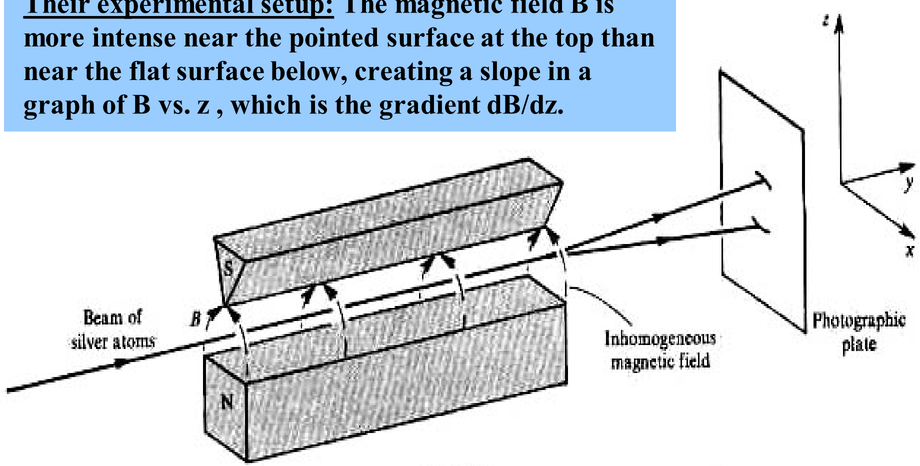
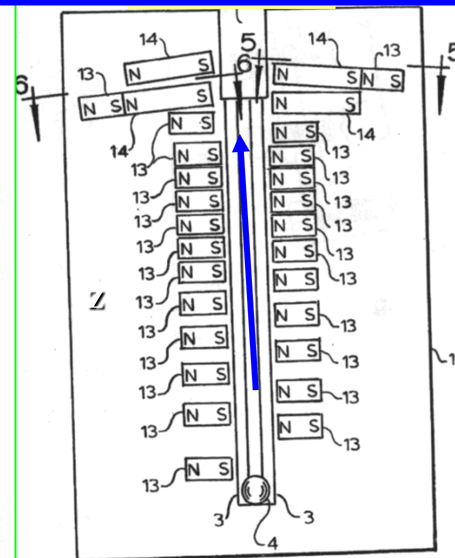


Fig. 21-1

The purpose of the *inhomogeneous* magnetic field is to produce a deflecting force on any magnetic moments that are present in the beam. If a homogeneous magnetic field were used, each magnetic moment would experience only a torque and no deflecting force. In an inhomogeneous magnetic field, however, a net deflecting force will be exerted on each magnetic moment μ_s. For the situation of Fig. 21-1,

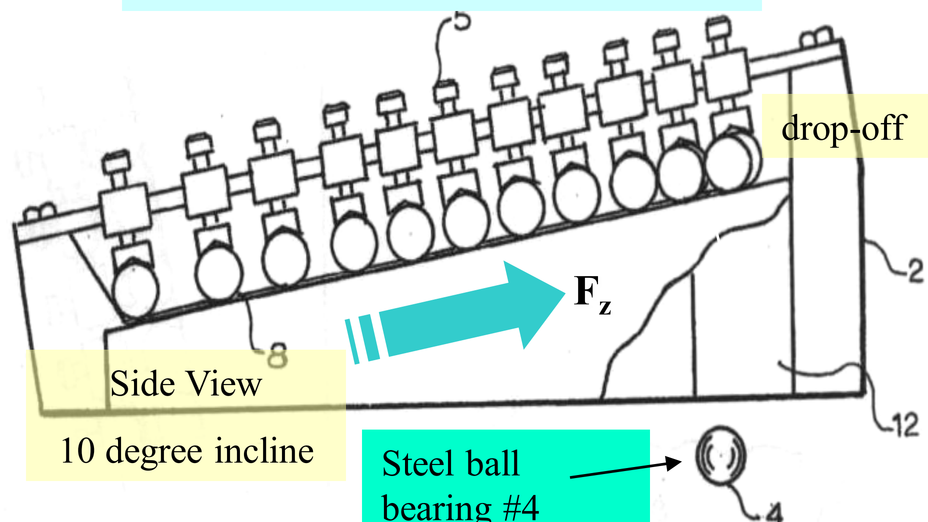
$$F_z = \mu_s \cos\theta \frac{dB}{dz} \qquad (21.1)$$

where θ is the angle between μ_s and **B**, and dB/dz is the gradient of the inhomogeneous field



The net <u>Force</u> created on the ball bearing = the <u>magnetic field gradient</u> multiplied by the induced magnetic moment, as with the Stern-Gerlach Experiment

Hartman Patent #4,215,330



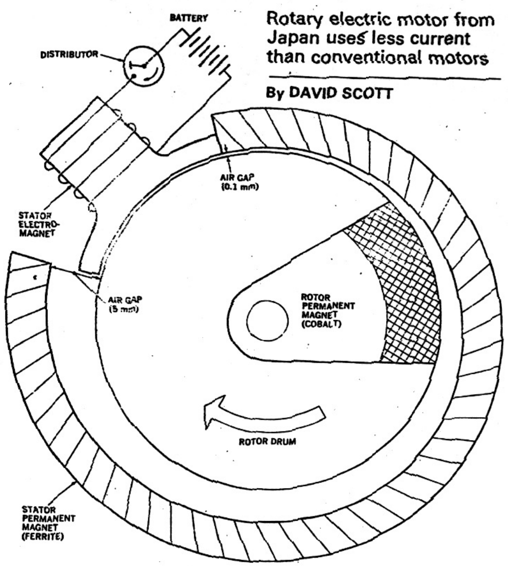
Two experimental examples that utilize the magnetic field gradient

Spiral Magnetic Motor (SMM) Uses the Magnetic Gradient

$$F_\theta = M \cos\phi \frac{dB}{d\theta}$$

Magnetic "Wankel" for electric cars

Popular Science, June 1979



Rotary electric motor from Japan uses less current than conventional motors

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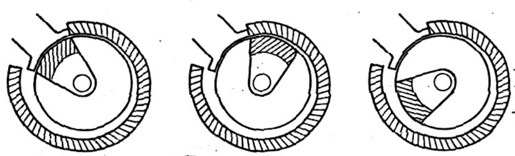
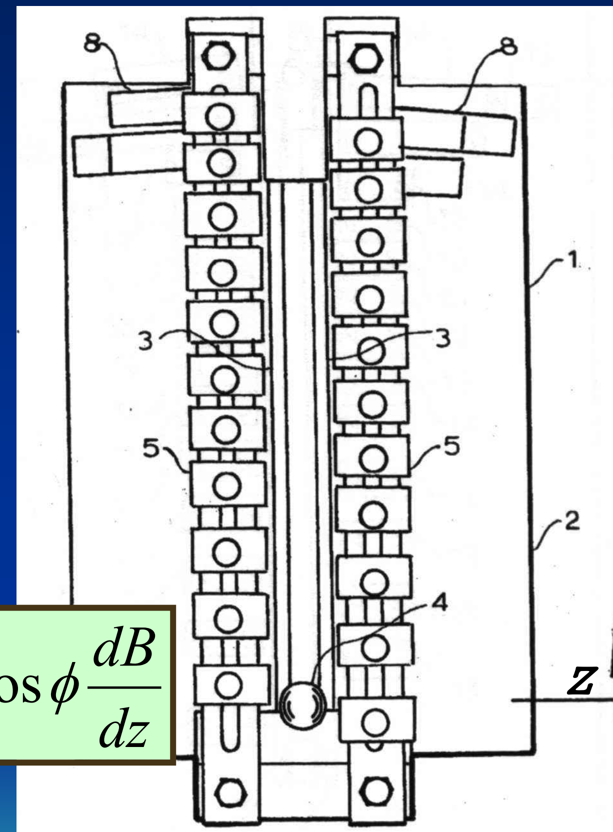


June 1979



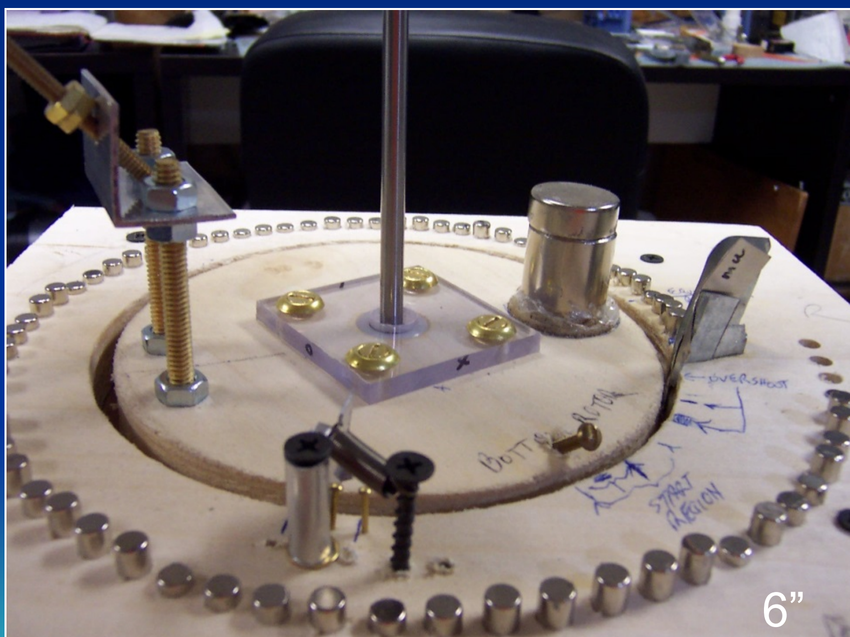
$$F_Z = \mu \cos\phi \frac{dB}{dz}$$

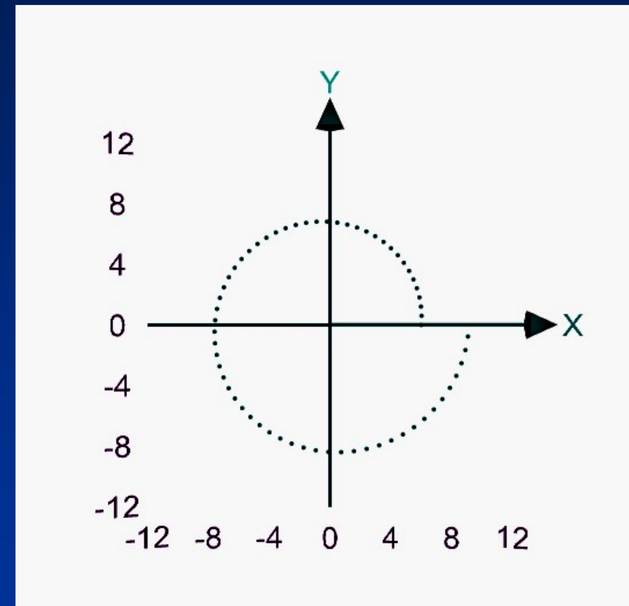
Hartman Patent 4,215,330

$U = M_r B_r + M_\theta B_\theta$

Spiral Magnetic Motor (SMM)

Archimedean spiral is used for SMM stator magnets where r = 6 + θ/2 and B(r) is linearly dependent on θ





Creates a constant torque for 90% of each cycle

$F = \nabla U$ where $U = M \cdot B$ and

$$U = M_r B_r + M_\theta B_\theta$$

SMM Governing Equations

$$F = \frac{M}{r}\frac{\partial B_r}{\partial \theta} + M\frac{\partial B_r}{\partial r}$$

0

$$T = M\frac{\partial B_r}{\partial \theta}$$

$$W = \int T\, d\theta$$

Maximize radial B field (B_r) for maximum torque

ENERGY DENSITY CONSIDERATIONS: B-FIELD = 50K x E-FIELD

$$U_B = \tfrac{1}{2}\frac{B^2}{\mu_o}$$

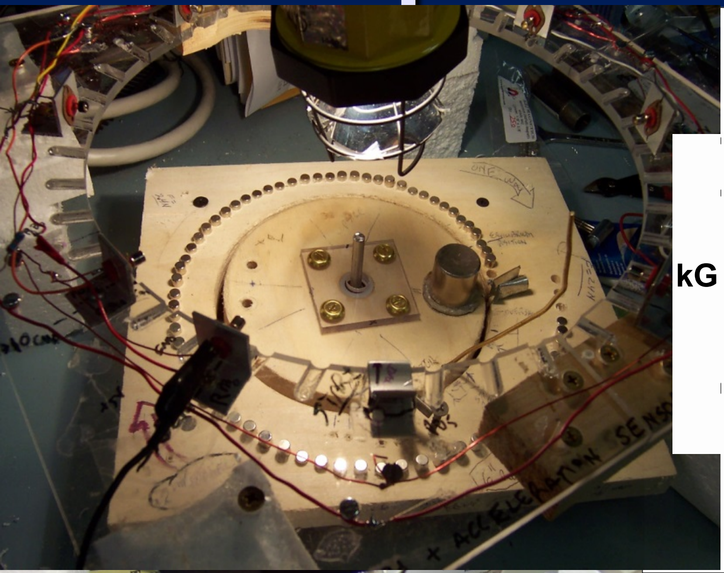
For a maximum B field in air of 20 kG (2 Tesla), U_B = 2 MJ/m^3

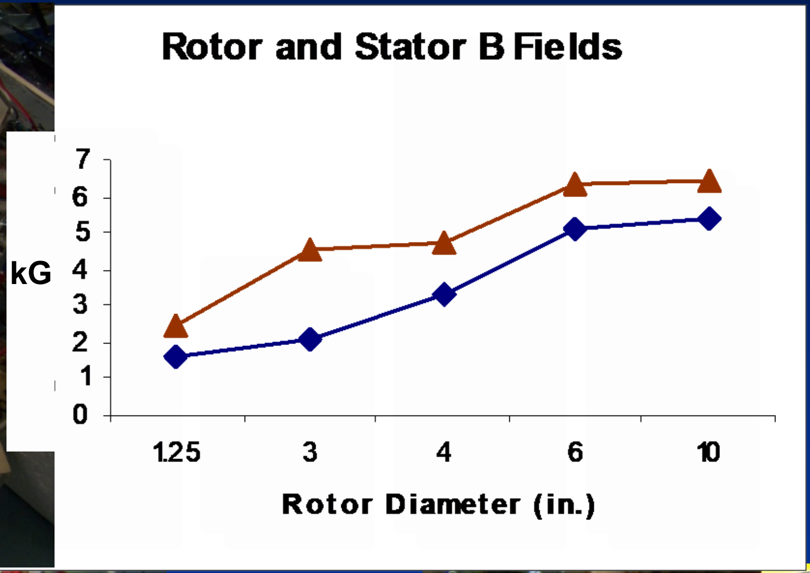
For a maximum E field in air of 3 MV/m, U_E = 40 J/m^3

$$U_E = \tfrac{1}{2}\varepsilon_o E^2$$

2,000,000 = 40 X 50,000 !

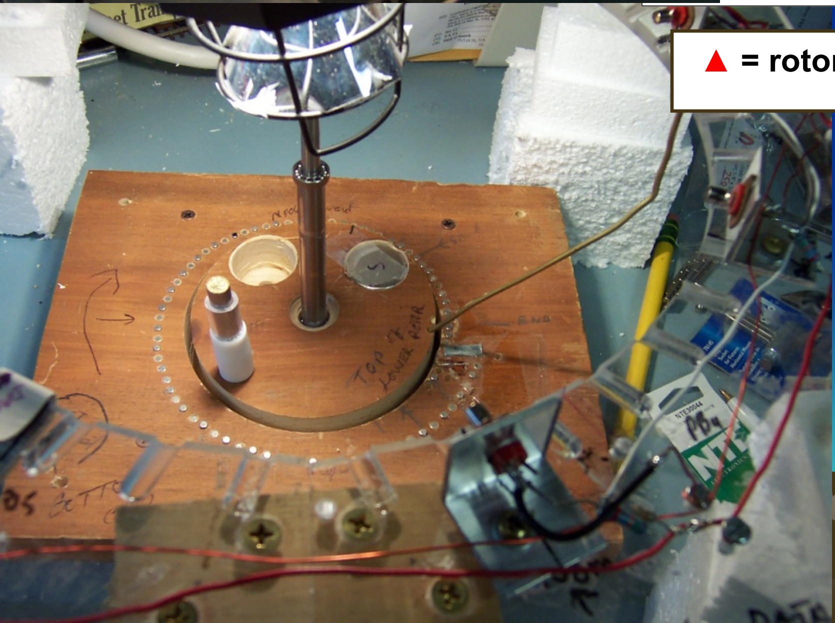
Experimental Results

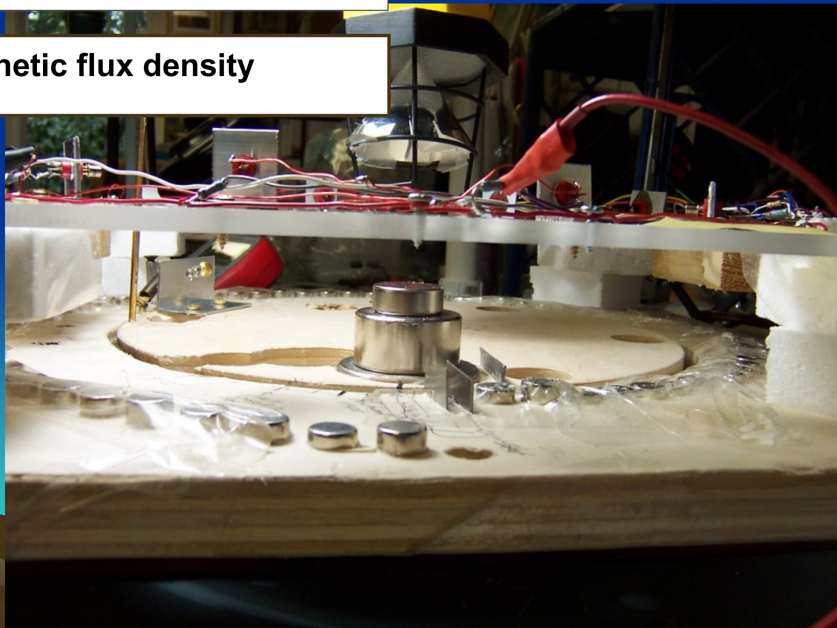




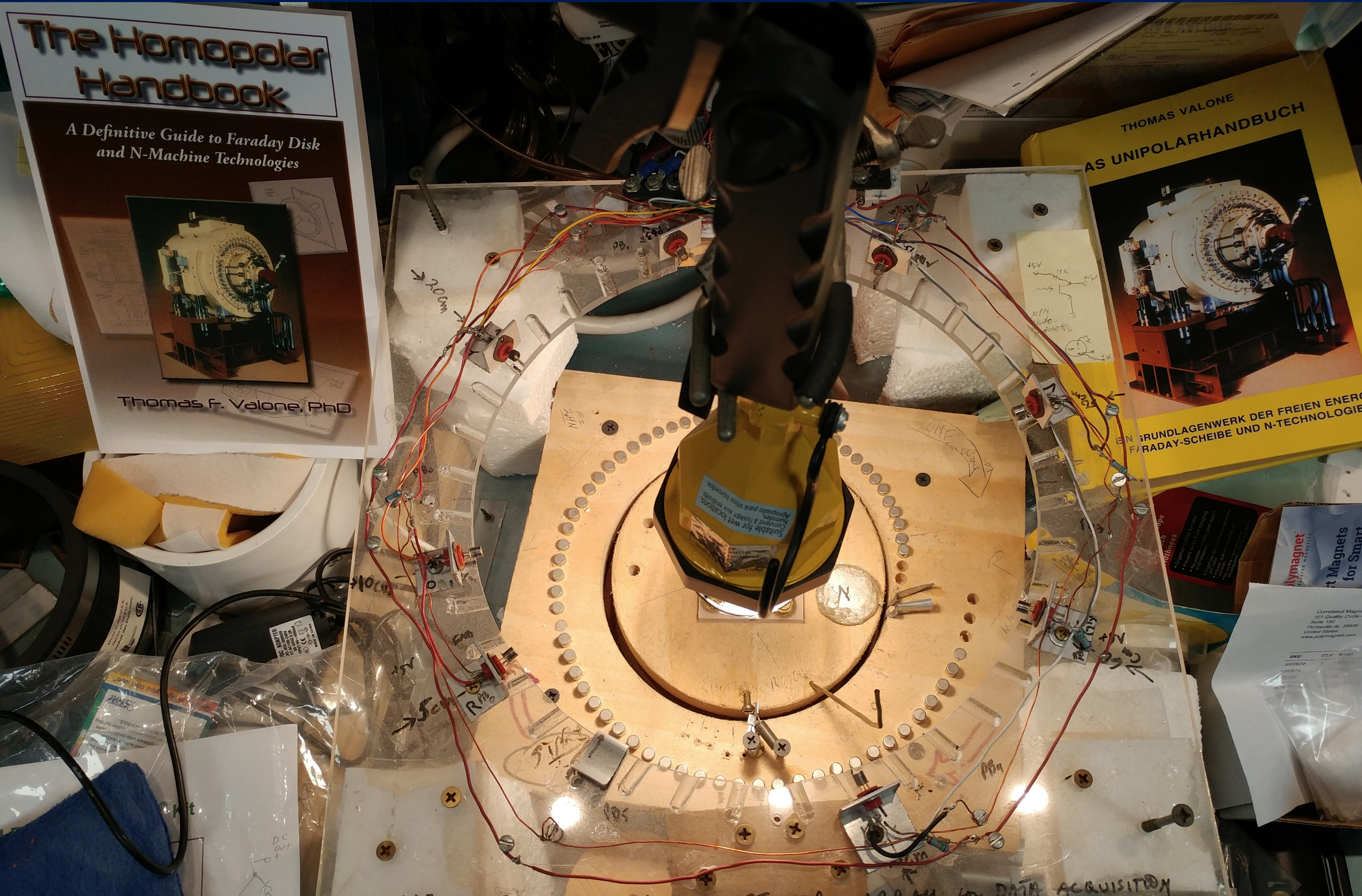
Five SMM rotor diameters were tested: 1, 3, 4, 6, 10 inches (25.4 cm)

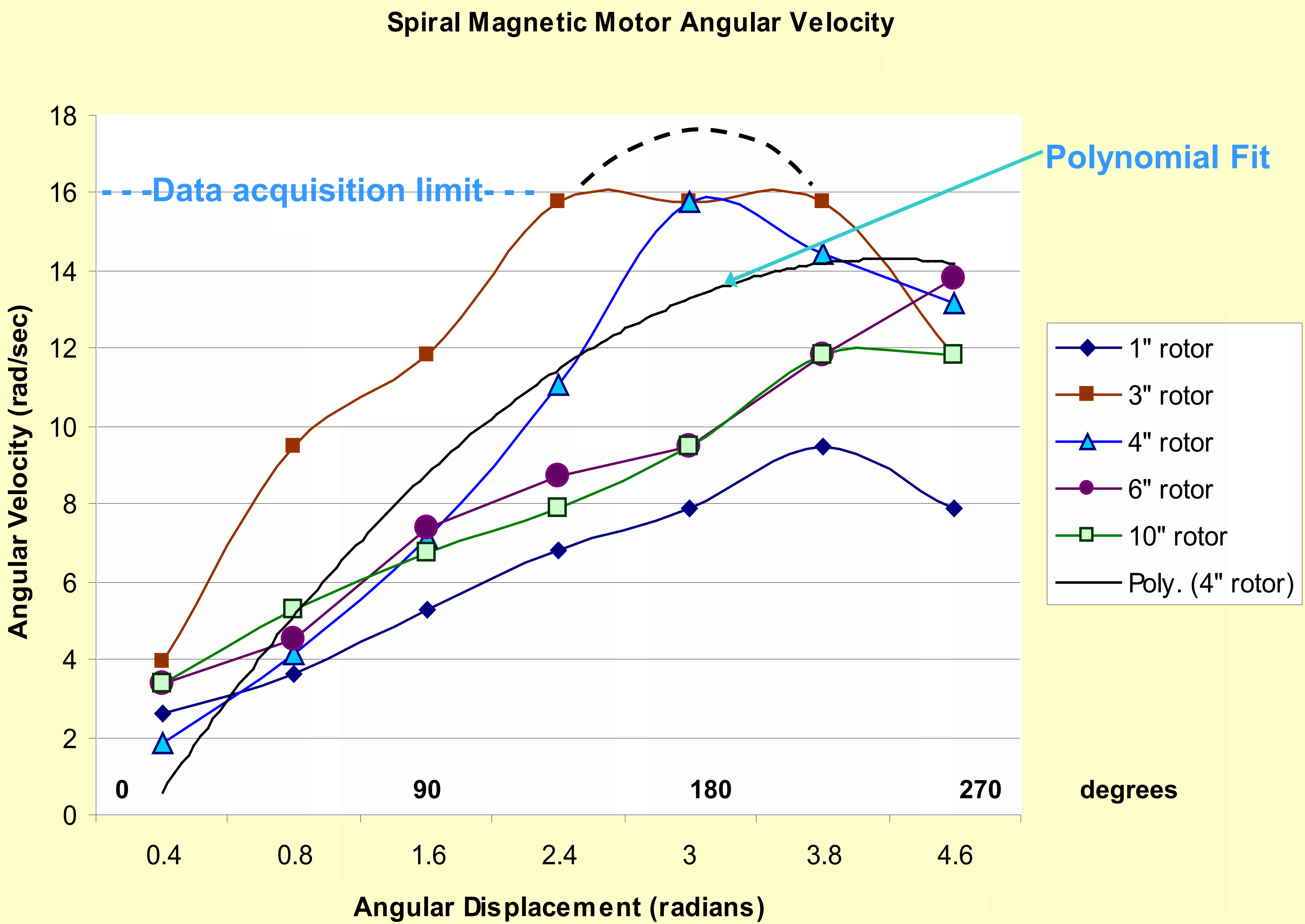
▲ = rotor, ♦ = stator magnetic flux density





Phototransistor Data Acquisition

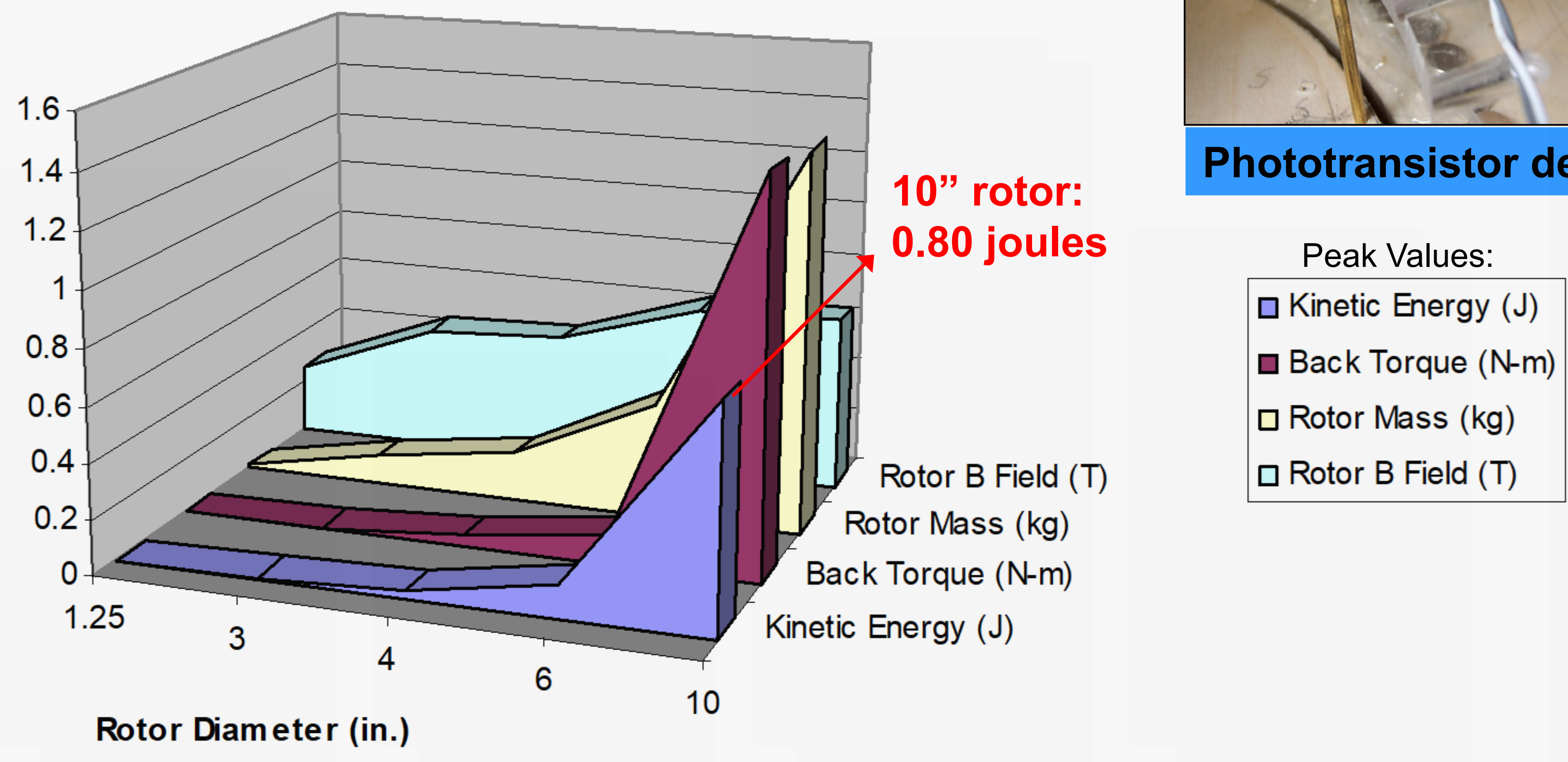


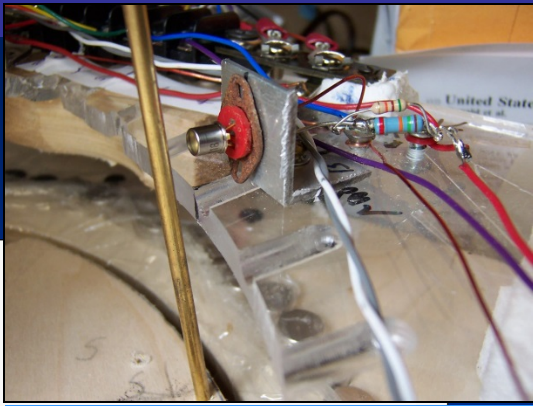


Spiral Magnetic Motor Angular Velocity
Angular Velocity (rad/sec)
18
16
14
12
10
8
6
4
2
0
- - -Data acquisition limit- - -
Polynomial Fit
0
90
180
270
degrees
0.4
0.8
1.6
2.4
3
3.8
4.6
Angular Displacement (radians)
1" rotor
3" rotor
4" rotor
6" rotor
10" rotor
Poly. (4" rotor)

Peak KE, Back Torque, Mass, B-Field

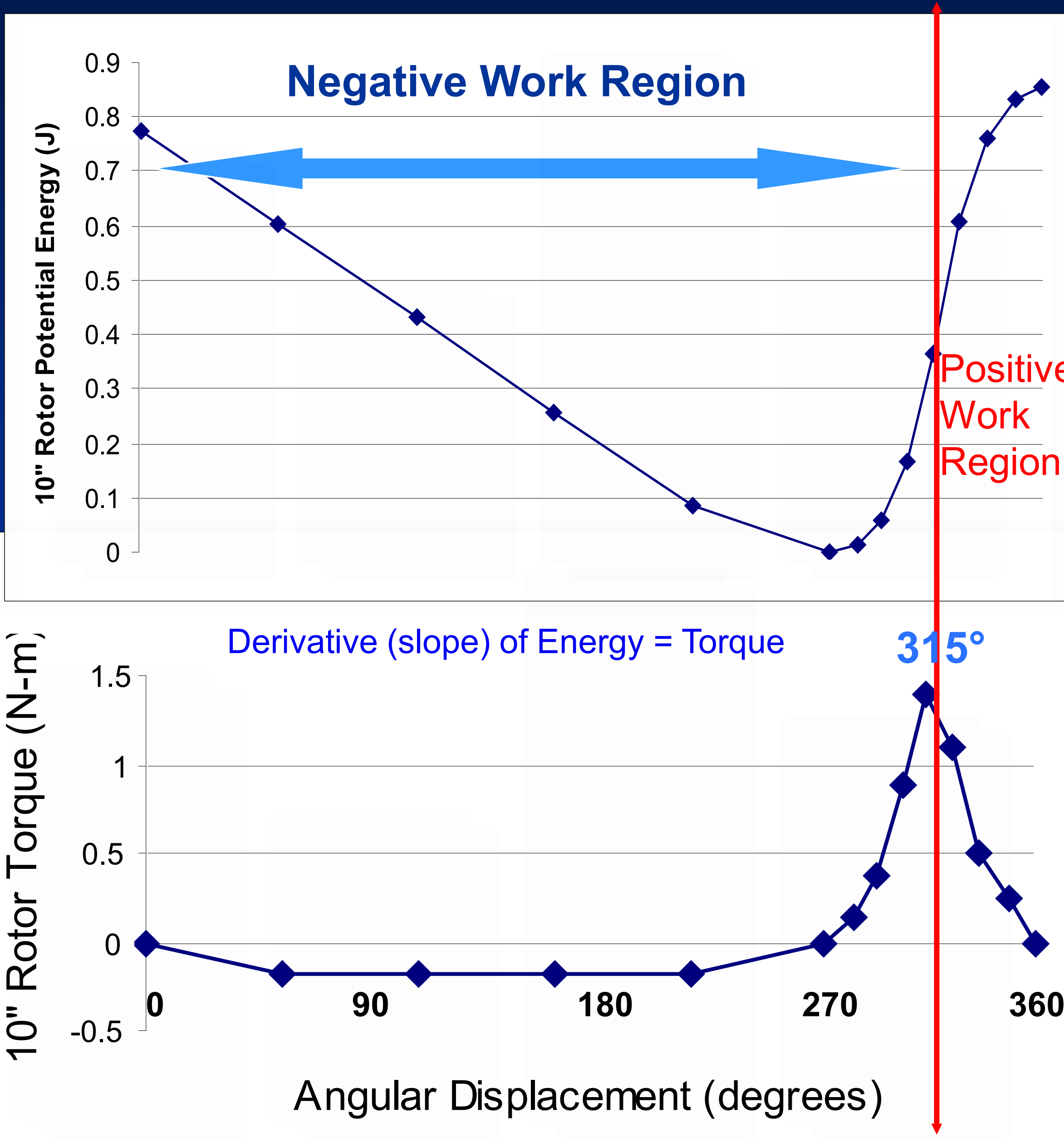
5 Rotors Tested: 1.25", 3", 4", 6", 10"





Phototransistor detail

Rotor Torque and Potential Energy for One Cycle



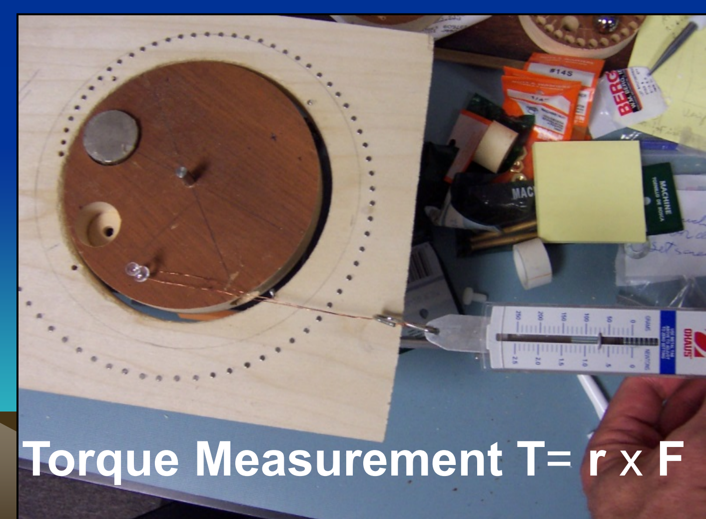
$$W = \int T \, d\theta$$

Positive net work required to move latched rotor at 315° to end (starting point) at 360° :

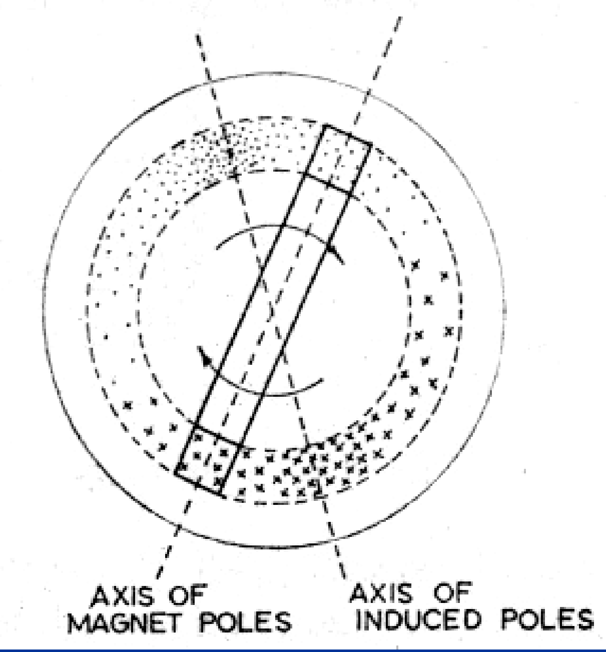
W = <u>0.52 Joules</u>

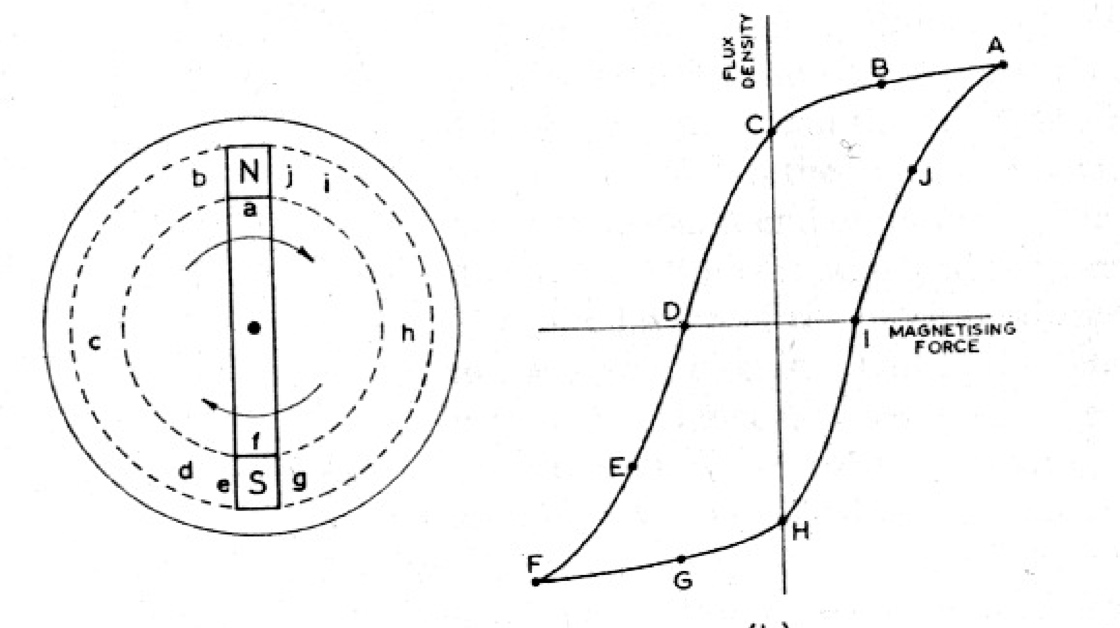
when starting at 0.78 J KE

Note: 315/360 = 87.5%



Prof. Eric Laithwaite's Suggestion for Increased Torque





(a) (b)

Place metal plate of particular permeability underneath rotor in order to produce:

Favorable Hysteresis Currents

Laithwaite Eric, *Propulsion Without Wheels,* English Univ. Press, 1970

$\frac{B}{\mu H} = 1 - \frac{8}{\pi^2} e^{-\beta t}$

Hysteresis Depends on Permeability and Resistivity*

$$\frac{B}{\mu H} = 1 - \frac{8}{\pi^2} e^{-\beta t}$$

$$\beta = \pi\rho / (4\mu\delta^2)$$

Designing the Growth of Eddy Currents to Match Rotation Speed

Choosing **aluminum or copper** for example, the permeability will be the same as free space ($\mu_o = 4\pi \times 10^{-7}$), which is very low and the resistivity is also low. Choosing an aluminum plate that is about a centimeter (1 cm) thick would also be a good choice since the thickness of the sheet "delta" is squared and also in the numerator. Altogether, the calculation shows a relatively *slow build-up* over a tenth of a second and only about 30% at a millisecond after the stator field magnet is applied to the rotating disk, which is in keeping with a delayed eddy current that will **push instead of retard the changing flux** as would be normally expected from Lenz' Law.

ρ = resistivity, μ = permeability, δ = thickness of plate, H field is suddenly applied

***Bozorth, *Ferromagnetism*, J. Wiley & Sons, 2003**

New frontiers in magnetics

Wiegand's wonderful wires

IEEE TRANSACTIONS ON MAGNETICS, VOL. MAG-21, NO. 5, SEPTEMBER 1985

PULSE GENERATION WITH SHORT COMPOSITE WIRES

C. Radeloff and G. Rauscher

IEEE TRANSACTIONS ON MAGNETICS, VOL. 31, NO. 6, NOVEMBER 1995

Induced Pulse Voltage in Twisted Vicalloy Wire with Compound Magnetic Effect

Susumu Abe and Akira Matsushita
Department of Electrical Engineering, Kanagawa University, Yokohama, Japan

Comparison of pulse generators used in electronic ignition

	Signal-noise ratio	Rate sensitivity	Temperature range (°F)	Gap sensitivity	Electrical input	Pulse amplitude
WIEGAND EFFECT	Very good	Not rate sensitive	-95 to +500 (approx.)	Minimal	None	Volts
VARIABLE RELUCTANCE	Fair	Poor	-95 to +500 (approx.)	Critical	Not required	Millivolts to volts
HALL EFFECT	Poor	Good	-40 to +275	Moderate	Required	Millivolts
LED	Poor	Not rate sensitive	-40 to +275	Minimal	Required	Millivolts

MAY 1979

Vicalloy creates Barkhausen jumps of magnetic domains that align quickly

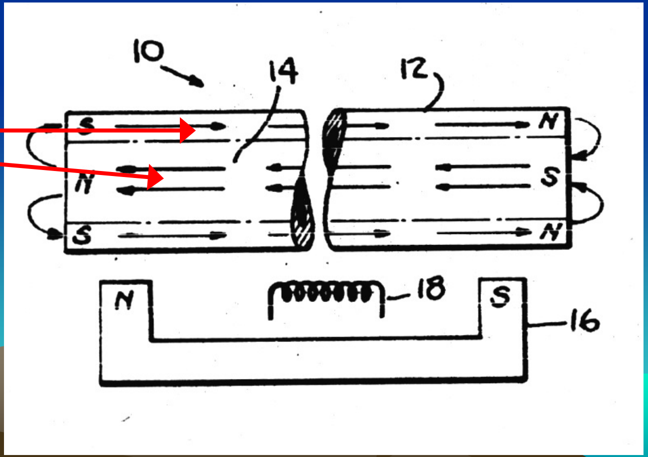
Pop. Science May, 1979

Wiegand wires are FeCoV bistable **Vicalloy** (2 coercivity regions)

US 1973 patent **# 3,757,754**

Used for years for auto ignitions

Provides repeatable magnetic pulse



IEEE TRANSACTIONS ON MAGNETICS, VOL. 43, NO. 8, AUGUST 2007

Zero-Power Magnetic Levitation Using Composite of Magnetostrictive/Piezoelectric Materials

MS-PZT

Toshiyuki Ueno and Toshiro Higuchi

Department of Precision Machinery Engineering, The University of Tokyo, Bunkyo-ku, Tokyo 113-8656, Japan

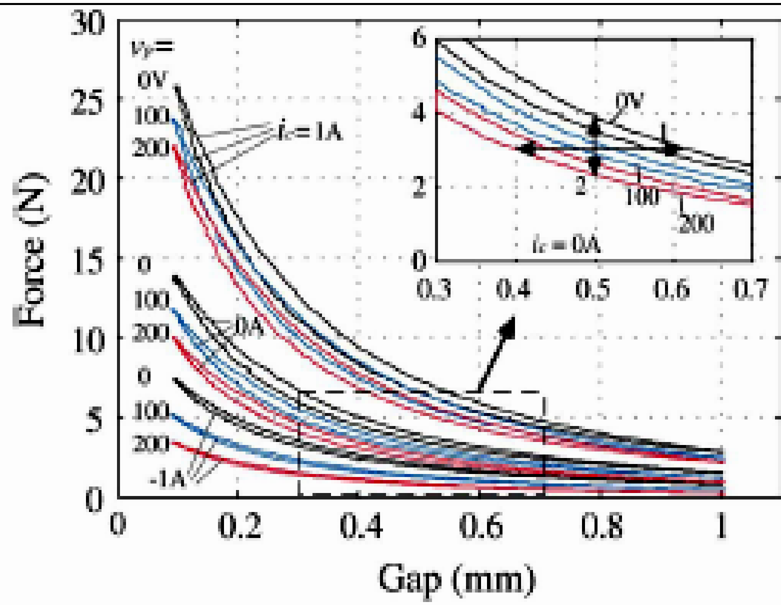


Fig. 11. Magnetic force versus gap for various current (coil) i_c and voltage (PZT) v_p, and its magnification around $x = 0.5$ mm, $F = 3$ N and $i_c = 0$ A.

COMPARISON OF POWER CONSUMPTION OF ELECTROMAGNET AND DEVICE IN STATIC AND DYNAMIC OPERATION

	E.M.	Device
Static operation		
Max input voltage [V]	2	200
Power consumption [W]	3.0	0.0
Dynamic operation (10Hz)		
Max input voltage	2	200
Power consumption	1.2	0.27
Dynamic operation (100Hz)		
Max input voltage	2	200
Power consumption	1.2	2.47

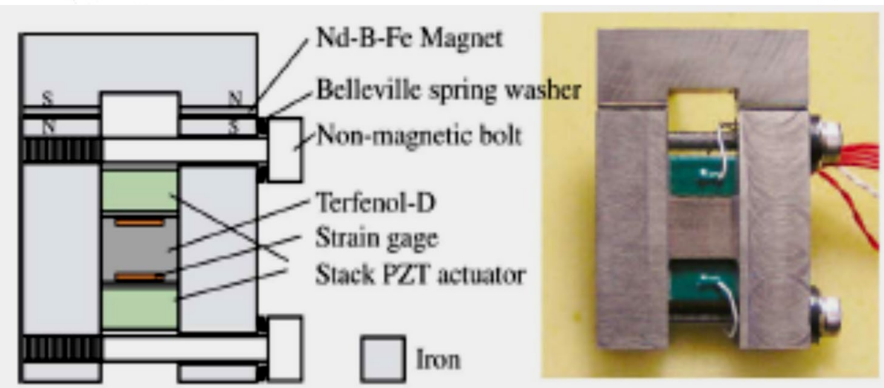
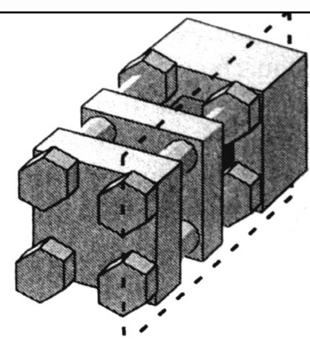
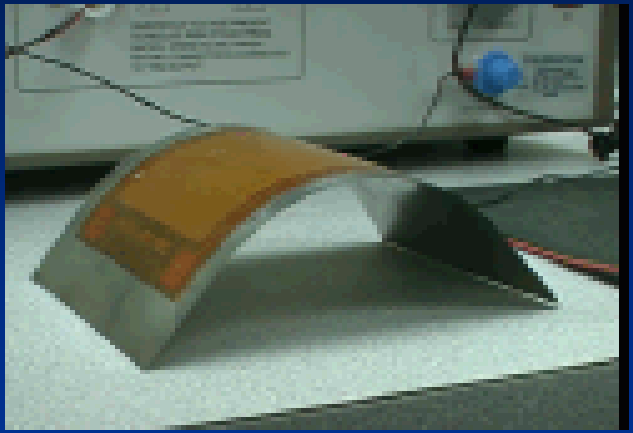


Fig. 1. Configuration. Terfenol-D and stack PZTs bonded to iron yokes are applied prestress by nonmagnetic stainless bolts via Bellville springs.

Inverse magnetostrictive (MS) effect combined with a piezoelectric material (PZT) and voltage

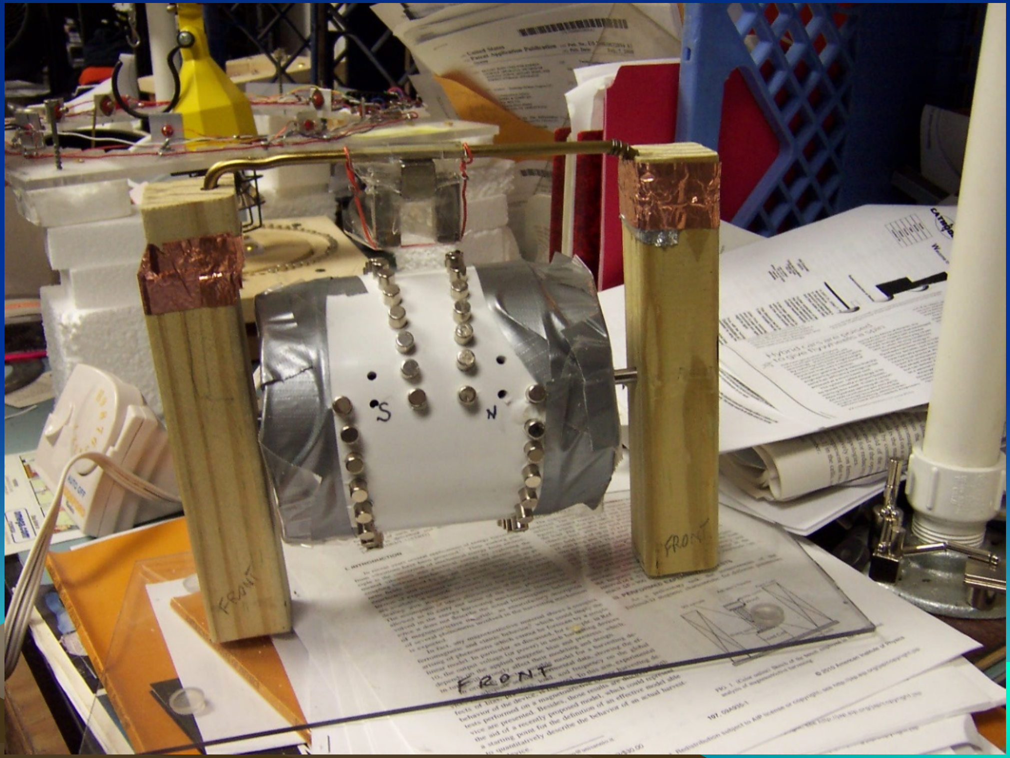


Magnetic Switching for SMM

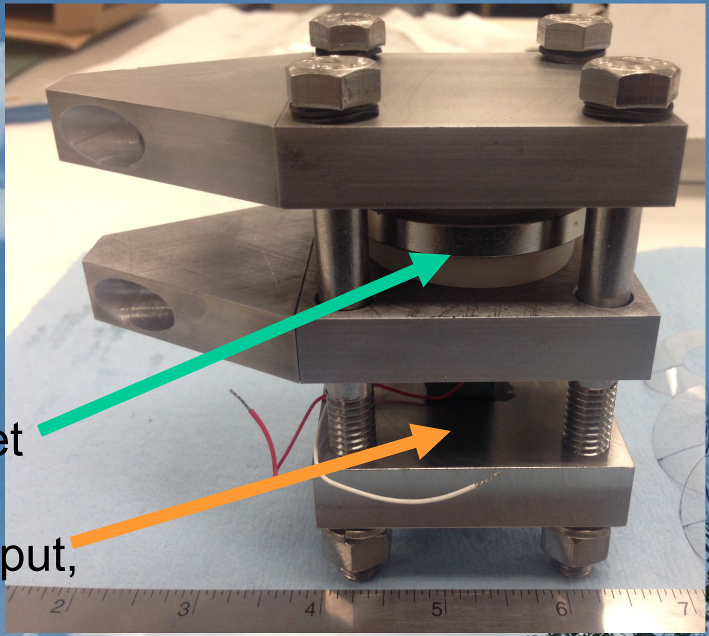


Piezoelectric Actuator that bends with very little voltage applied

IRI V-Track Dual SMM with Radial Magnets
Switching can be applied to the top stator magnet



MS-PZT Magnetic Switch Replicated



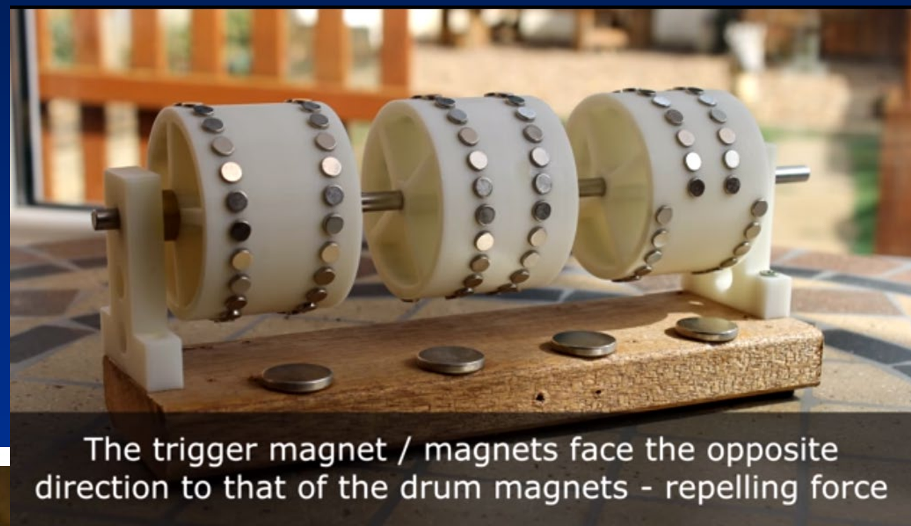
MagnetoStrictive (MS) rod surrounded by ring magnet

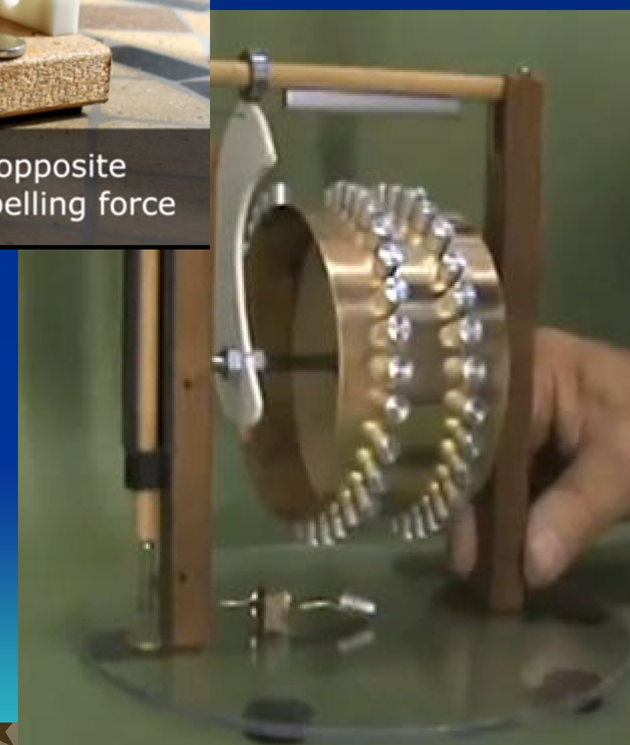
Piezoelectric (PZT) cube with DC pulsed electrical input, timed to rotation speed

Short demo video online by Dr. Valone, showing various spiral magnetic motors, that have a commutation point at the end of the spiral which requires a magnetic pulse to overcome the barrier.

The above MS-PZT switch converts a voltage pulse, with virtually no current, directly into a magnetic pulse, at very high efficiency

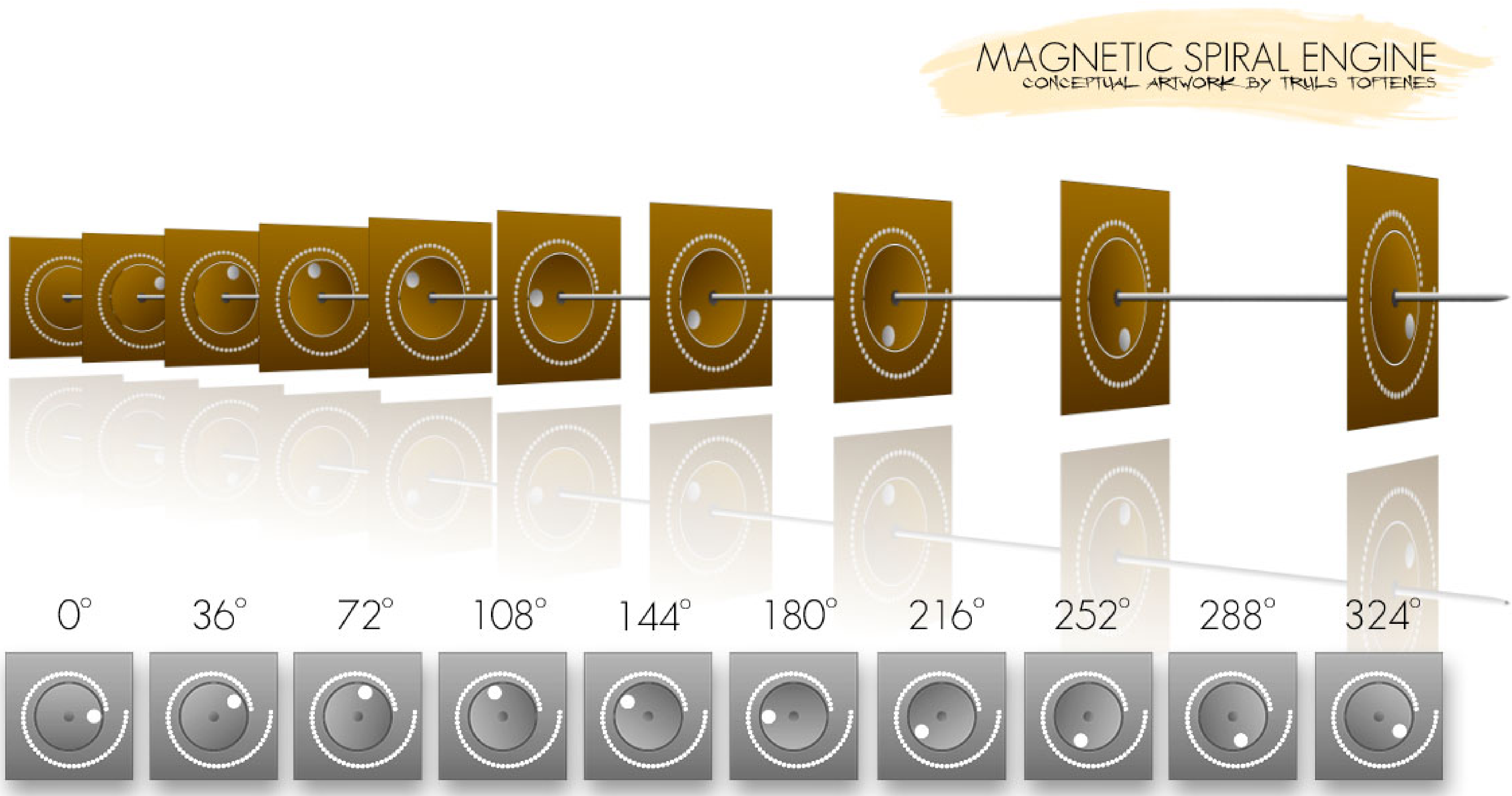
Spiral Magnet Motors Online



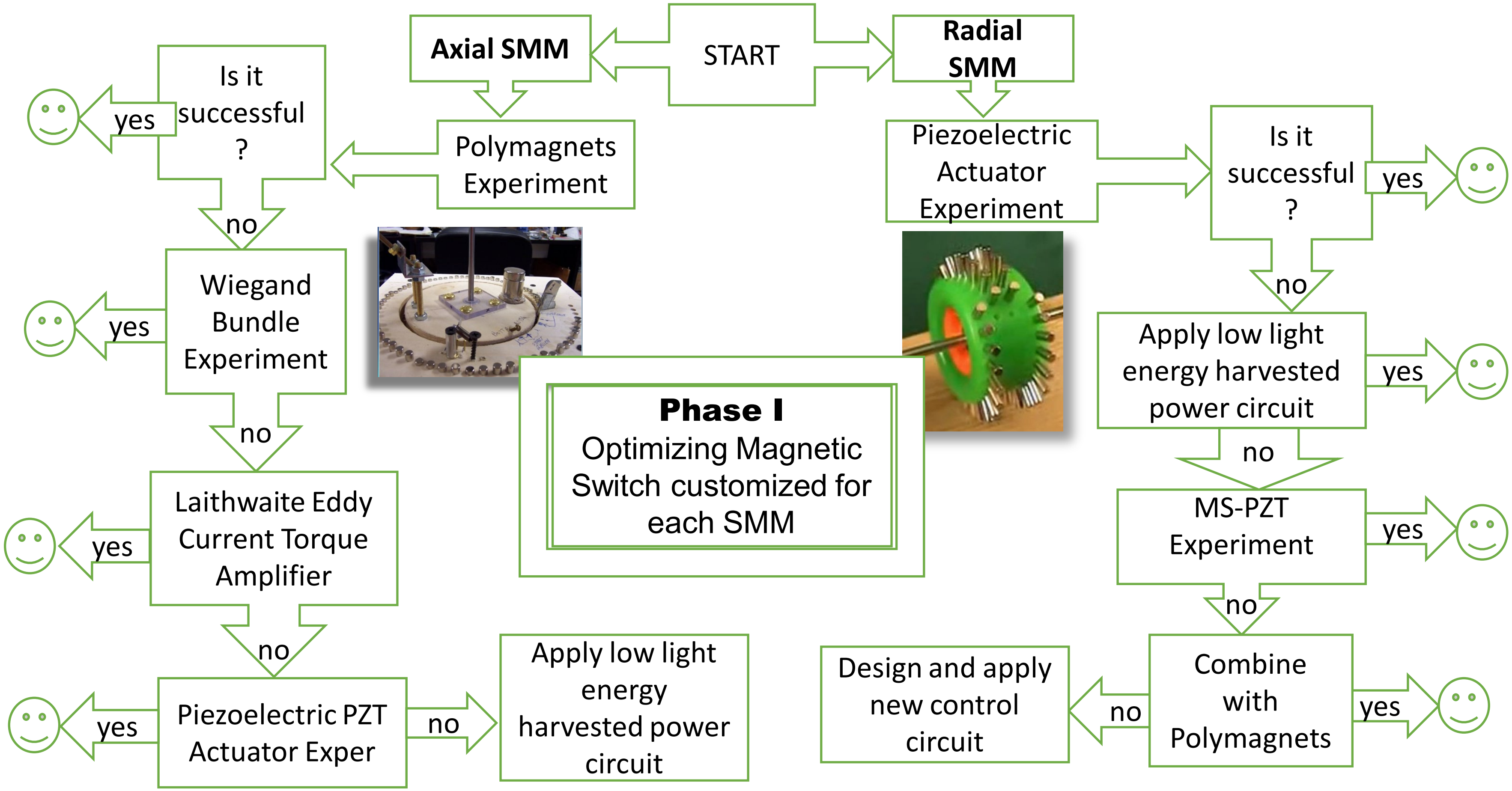


Roobert33

Multi-Stage SMM



Conceptual Block Diagram for SMM Switching Module 2018



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Email from Session Chair at AEE World, 2019

"I look forward for the advancements in this unique area. PS, I do a lot of work in the energy efficiency space, and your motor would be welcome, so let's please keep in touch."

Richard Costello, PE, MSEM, BSME, CEM
President - Acela Energy Group, Inc.