

Energy: No Such Thing as a Free Lunch

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Fermilab

First: some acknowledgements

- Donna Askins
 - This originally started as a proposed guest lecture for a class she was going to give at a local community college
- Prof. Janet Conrad
 - For letting me try this lecture the first time at Columbia University.
- Prof. Bob Park
 - For writing “Voodoo Science”
 - and a lifetime spent at the thankless task of trying to educate the public about science
- Eric Krieg
 - Catalogs free energy claims and scams as a public service
- Craig Dukes
 - For inviting me to give this lecture
- Fermilab
 - For encouraging public outreach
- **Google, Wikipedia, and YouTube!!!**

Outline

- Introduction and motivation
- A brief history of perpetual motion
- The science of perpetual motion
- Some case studies
 - John Keely: the father of the free energy scam
 - Joseph Newman: patent-ly absurd
 - Tom Bearden: the power of technobabble
 - Cars the run on water: people never learn
 - Genesis World Energy: yes, people really are *that* stupid.
- Getting it wrong:
 - How honest people convince themselves and others of crazy things.
- Good science gone bad
 - Cold fusion
 - Hafnium reactors
- The point?

Why give this lecture?

- Education

- The concepts of work and energy are central to our understanding of nature, and it's good for everyone to have some knowledge of them.
- Some seemingly arcane (and boring) principles turn out to be very important.
- You can learn a lot about good science by studying *bad* science.

- Public Service

- Maybe I can prevent someone from losing money in some energy based investment scam or wasting their lives on a quixotic search for something that doesn't exist.

- Reality Check

- Energy is likely “The Big Issue” of the 21st century
 - Availability
 - Impact
- *As long as people believe there's a magic technology just around the corner, they will avoid addressing these problems!*

Why give this lecture to you?

- Obviously, you don't need to be lectured about the laws of thermodynamics.
 - I'll leave those parts out
- Nevertheless, educators need to know “what they're up against”, particularly when teaching non-technical audiences.
- I think it's our duty as scientists and educators to take a stand against destructive non-science whenever we can.
- For all their knowledge, scientists can be gullible, too
 - Scientific peer review is based on honesty.
 - *Many* actual scientists have been duped by these claims.

Why now?

- The basic facts:
 - The energy consumption of the human race is increasing.
 - Soon, the developing world will pass the US and Western Europe in energy usage.
 - Our reliance on fossil fuels is impacting our environment, perhaps catastrophically.
 - Fossil fuels will run out – maybe in 10 years, maybe in 100, but they will run out.
- The current emphasis on “going green” has raised the stakes for alternative energy sources:
 - Scientifically, this is very exciting, but...
 - It will also not be lost on the con men.

Is this lecture necessary?



Unfortunately, Homer's conceptual understanding is well above average!

Evidence: Amazon search "free energy"

Top 5:



Free Energy Pioneer: John Worrell Keely by Theo Pajmans (**Paperback** - Sep 2004)

Buy new: ~~\$19.95~~ **\$14.96** 26 Used & new from ~~\$9.26~~

Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.
Eligible for **FREE** Super Saver Shipping.

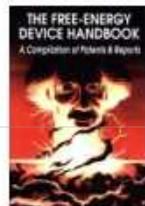
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Other Editions: Paperback



Free Energy Generation Circuits & Schematics by Tom Bearden and John Bedini (**Paperback** - 2006)

1 Used & new from ~~\$59.99~~

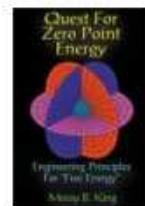


The Free-Energy Device Handbook: A Compilation of Patents & Reports (Lost Science Series) by David Hatcher Childress (**Paperback** - Nov 1994)

Buy new: ~~\$16.95~~ **\$13.22** 31 Used & new from ~~\$6.45~~

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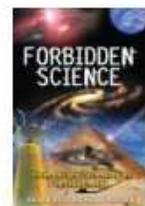


Quest for Zero Point Energy Engineering Principles for Free Energy by Moray B. King (**Paperback** - Jan 30, 2002)

Buy new: ~~\$14.95~~ **\$10.17** 39 Used & new from ~~\$9.06~~

Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.
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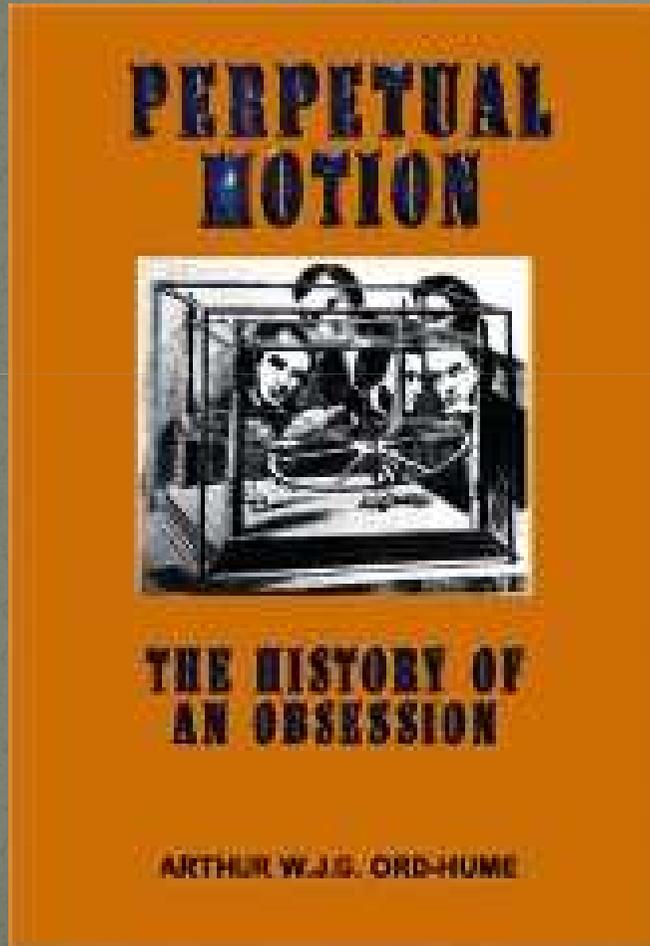
Forbidden Science: From Ancient Technologies to Free Energy by J. Douglas Kenyon (**Paperback** - Feb 22, 2008)

Buy new: ~~\$18.00~~ **\$12.24** 22 Used & new from ~~\$9.75~~

Get it by **Tuesday, April 22** if you order in the next **51 hours** and choose one-day shipping.
Eligible for **FREE** Super Saver Shipping.

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Even legitimate books are marketed to pander to “believers”



- Product description (italics mine)
“...despite the naiveté and even the blatant trickery of many inventors, *there still exist a handful of mechanisms which defy explanation*”
- Fact:
 - This is a very decent book, which I have used heavily in this talk. All devices described are well-explained by the author.

Working definition: How free is "free"?

- For the purposes of this discussion, “free energy” refers to transformative technologies that:
 - Can be implemented on an individual basis
 - i.e. non-centralized
 - Will enable dramatic reduction in domestic and/or transportation energy expenses
 - say, a factor of four or more
 - Do not require a lifestyle change
 - Involve only modest capital costs
 - Pay for themselves in less than a year or so
- Some examples which do NOT qualify:
 - Trading in your Hummer for a motorcycle
 - Lifestyle change
 - Converting your home to 100% solar
 - Takes many years to recover the cost

Types of “free energy”

- Perpetual Motion: A device which produces useable output energy with no input energy or fuel.
 - To the extent science declares anything “impossible”, this is impossible.
 - Dramatically improved efficiency in utilizing an existing power source.
 - A legitimate idea, but there limits
 - A new source of energy or radically different way of tapping and established source of energy
 - Examples: cold fusion, zero point energy, hydrinos, etc.
- 

In many cases, claims of the second two types really imply the first

Science: Definition

- The Good:
 - Make observations and measurements
 - Develop a model to explain these with the fewest possible variables and assumptions (must also be consistent with all other scientific data).
 - Investigate the predictions and consequences of this model.
- The Bad
 - Like good science in principle, but lack of rigor and/or bias (intentional or unintentional) lead to erroneous conclusions.
- The Ugly
 - Propose theories or claim experimental results which cannot possibly be reconciled with significant body of real world data.
 - Can be the product of profound ignorance or deliberate fraud.
 - Aka “Crackpot Science”, “Voodoo Science”, etc

Most free energy resides solidly here

Science: Myth vs. Reality

- Myth



- Independent
- Maverick
- Makes lots of important discoveries in career
- Results come quickly

Society loves this...

- Reality



- Systematic and meticulous
- Often work in large groups
- Results take time!!
- One significant discovery = Nobel Prize!

... but benefits from this

But what about Jobs and Wozniac?

- It's important to make a distinction between “science” and “technology”
 - Science concerns the fundamental rules of nature
 - Technology is the application of these rules.
- Science and technology are closely intertwined, but they are still distinct.
 - New science enables new technology
 - New technology is used to push the boundaries of science.
- Although we live in a time of amazing technological advances, fundamental scientific advances are still few and far between.
 - Last new source of energy was nuclear power (early 20th century)

"Voodoo Science"

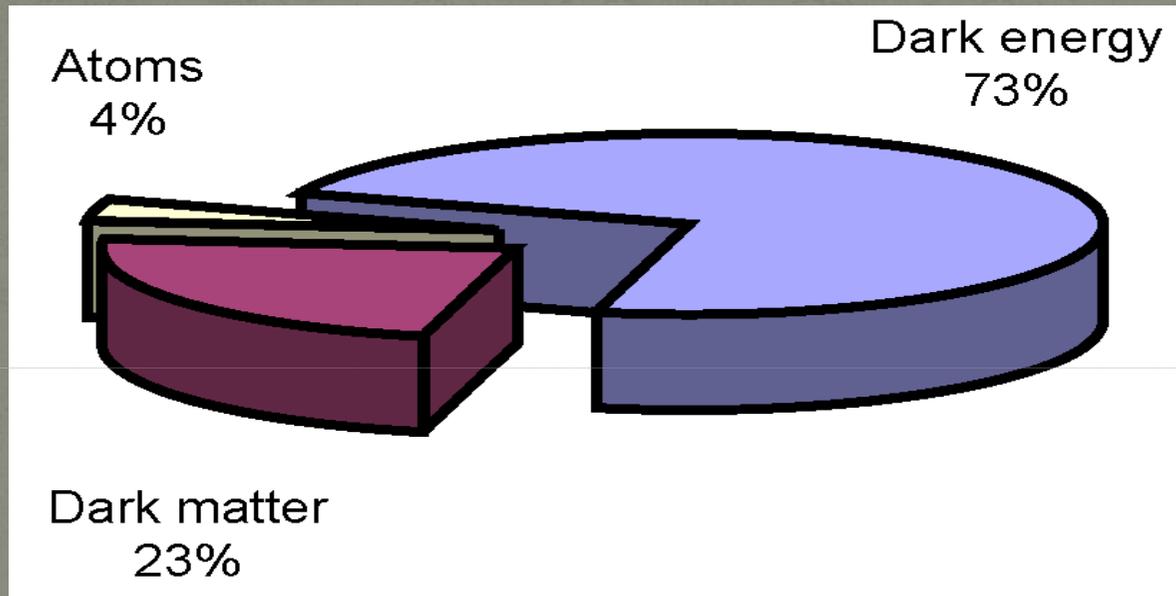
- Bob Park's seven warning signs
 1. Discoverers make their claims *directly to the popular media*, rather than to fellow scientists.
 2. Discoverers claim that a *conspiracy* has tried to suppress the discovery.
 3. The claimed effect appears so weak that observers can hardly distinguish it from noise. *No amount of further work increases the signal.*
 4. *Anecdotal evidence* is used to back up the claim.
 5. True believers cite *ancient traditions* in support of the new claim.
 6. The discoverer or discoverers work *in isolation* from the mainstream scientific community.
 7. The discovery, if true, would require a *change in the understanding of the fundamental laws of nature.*

"Voodoo Science" (cont'd)

- Eric's extra three warning signs
 8. Relying on *overly complex* demonstrations and protocols.
 9. Claims are *vague and contradictory*.
 10. Claims have *profound and obvious consequences* which are not addressed.

How can we be so sure of ourselves?

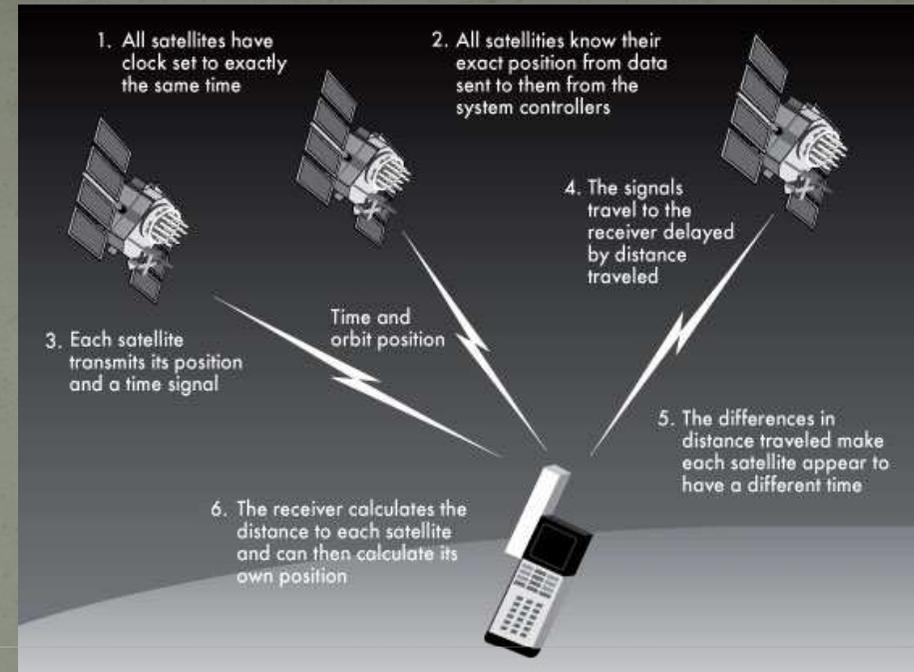
- After all, we only know what 4% of the universe is made of.



- Can't there be some sort of energy source in the other 96%?
- Maybe, but even if we don't know what 96% is, we know a lot about what it *isn't*.

Consider the GPS

- For a GPS to work, we have to understand
 - The chemistry of the fuel
 - The dynamics of the launch and orbit
 - The physics of the onboard atomic clocks
 - The E&M involved in generating and transmitting the signal
 - The Special and General Relativity corrections required
 - $38 \mu\text{sec} = 11.4 \text{ km/day}$ error without them!
 - And then there's all the physics needed to put that much computing in your hand.
 - *None* of this would work if unknown particles and forces interacted significantly with ordinary matter.

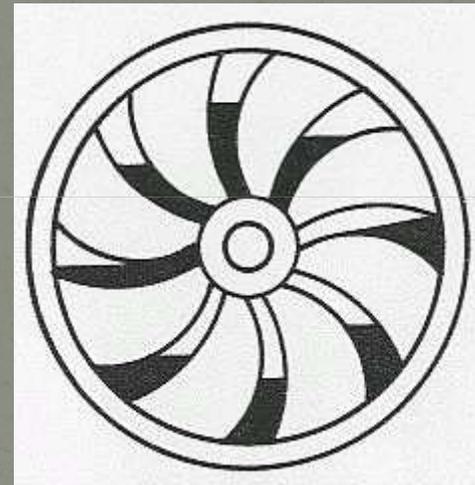
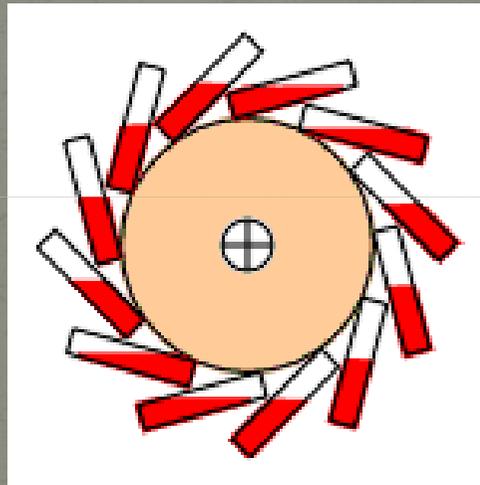


Perpetual motion: a brief history



Early perpetual motion machines

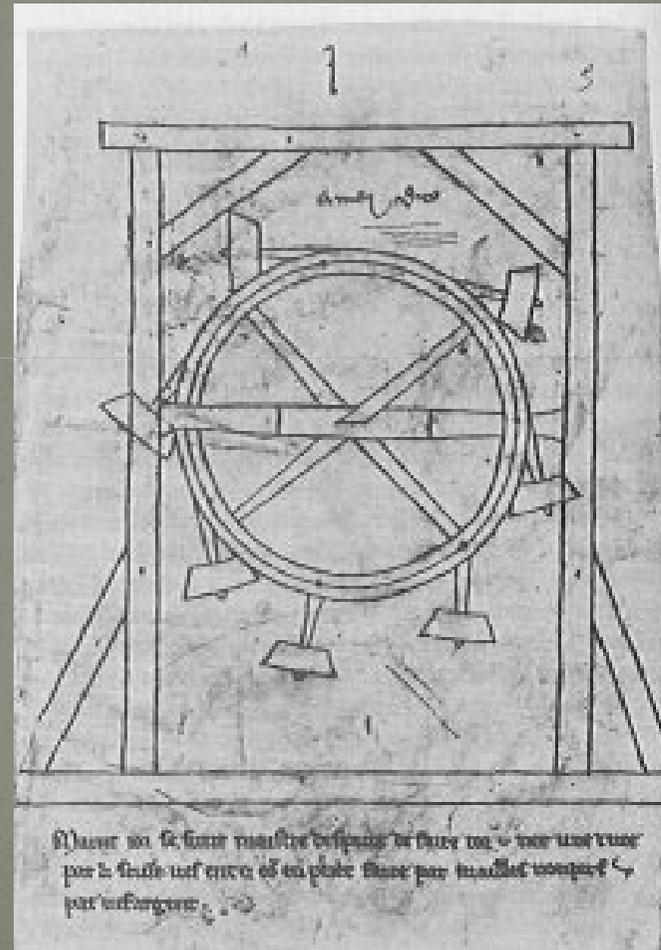
- Some of the oldest perpetual motion machines were documented by the Indian author Bhaskara (c. 1159), who made sketches of something called the “Persian Wheel”



- This device used flowing water (or sand) to create a “perpetual imbalance”

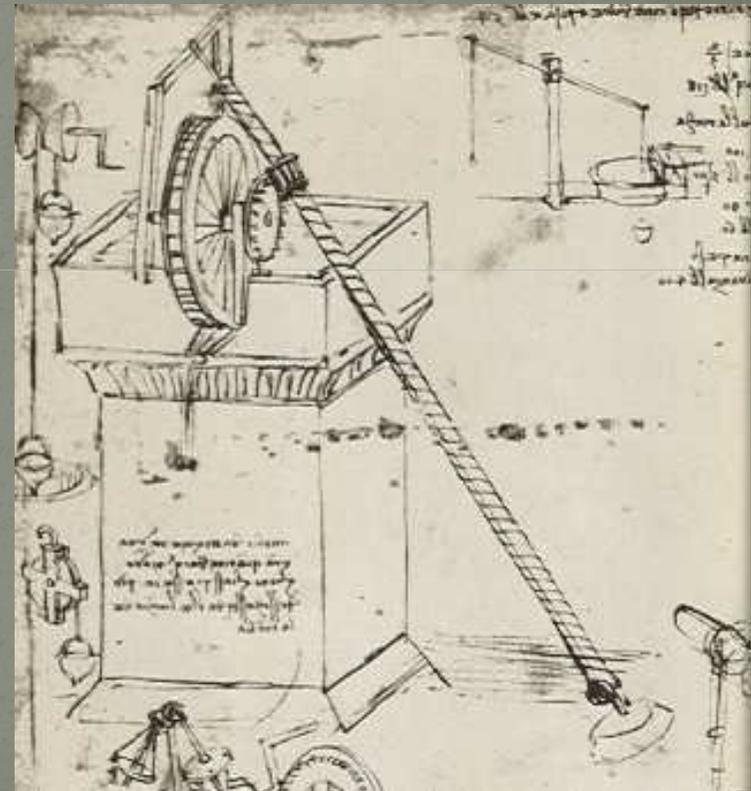
Perpetual motion in the West

- The first sketch of a perpetual motion machine in the Western world was made by Villard de Honnecourt (c. 1250).
- The principle was similar to the “Persian Wheel”, but it relied on levers and weights to achieve imbalance.
- Over the next several centuries, a number of conceptual machines were designed along these lines.



Leonardo da Vinci

- Historians like to point out that Leonardo da Vinci spent a lot of time debunking things like Honnecourt's wheel.
- They usually leave out that he personally believed that the key to perpetual motion was some combination of a water wheel and an Archimedes screw.
- Of course, there was no reason to believe this wouldn't work – then
 - In fact, can you prove it now?



Perpetual motion and physics

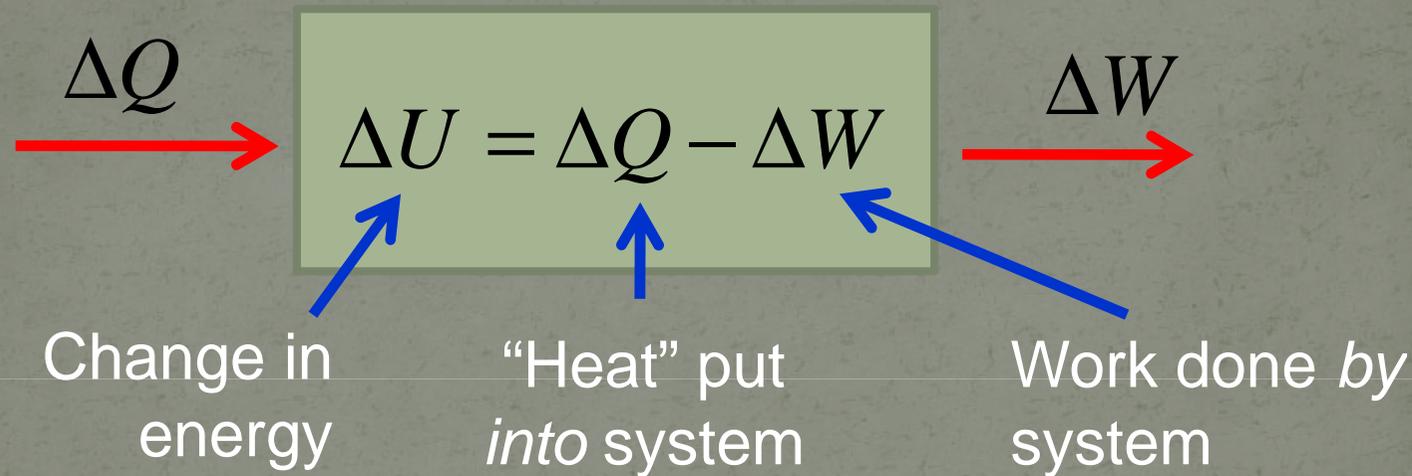
- We need to examine these early claims in the context of the time.
- Because there was no theoretical framework to rule out these machines, these people were behaving as good scientists.
 - The fact they didn't work was an important piece of experimental evidence.
- All of this changed with Newton
 - $F=ma$ and the “universal law of gravitation” held the mathematical key to ruling out all of these “imbalance” type perpetual motion machines in one fell swoop.

Physics and energy

- In the 18th and 19th centuries, a great deal of physics was done to formalize the concepts of work, energy, and conservation laws.
 - The non-observation of perpetual motion was taken as *input* to these theories.
- The 19th century saw the development of thermodynamics
 - Term originally coined by James Joule to describe the science of heat and power
 - Generalized to cover all physical systems
 - Lays out the specifics of the relationship between physical systems and usable energy
- As new types of physics were discovered, they still fit into this paradigm
 - Electricity and Magnetism
 - Relativity
 - Nuclear energy
 - Quantum Mechanics
- To date, no confirmed experimental result has violated conservation of energy or the laws of thermodynamics

First Law of Thermodynamics

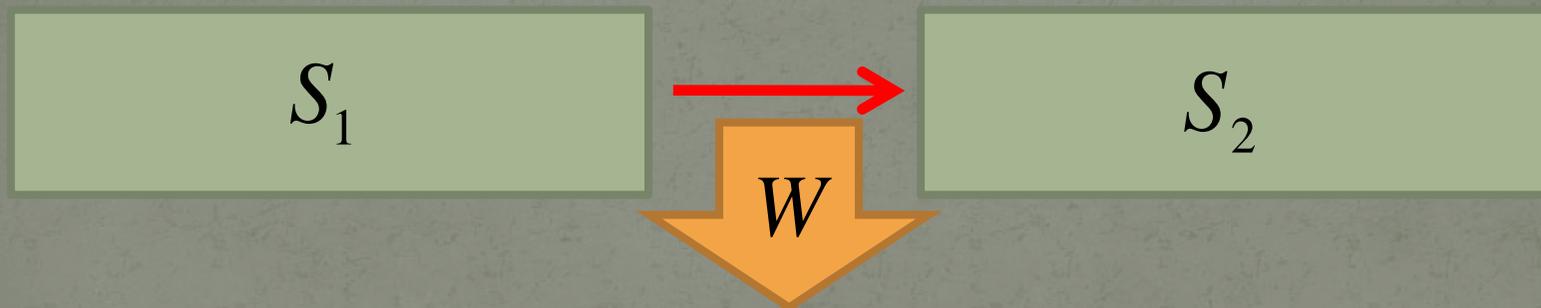
- Every system is characterized by an energy (U)



- This law is also known as “Conservation of Energy”

Second Law of Thermodynamics

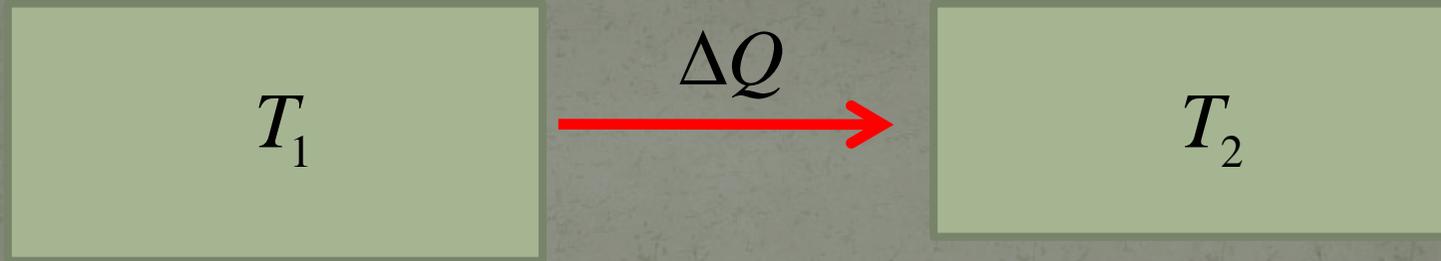
- Not all energy is useable!!
- Every system is characterized by an “entropy” (S)
 - A measure of energy and degree of order
 - Generally “Low entropy” = high energy and high order
- The entropy of a “closed” system can *never* decrease.
- Can only get work out of system in a *transition to a higher entropy state*. ($S_2 > S_1$)



- **This law can be generalized to any potential source of energy.**

Entropy in classical thermodynamics

- Entropy defined by heat transfer and temperature



- Classically

$$\Delta S \equiv \frac{\Delta Q}{T}$$

- This means if $T_2 < T_1$, then

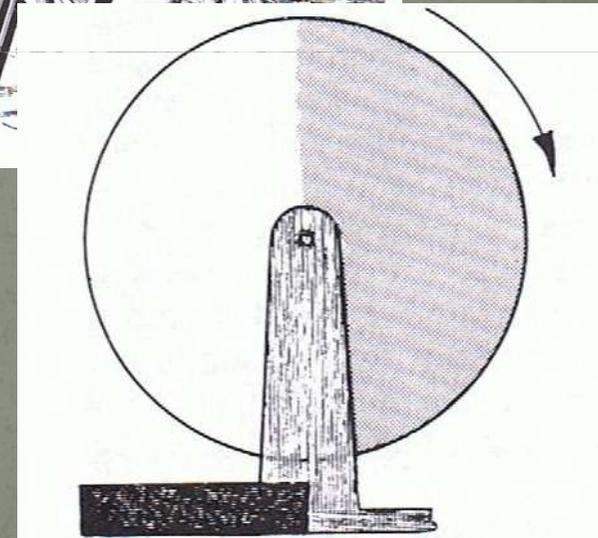
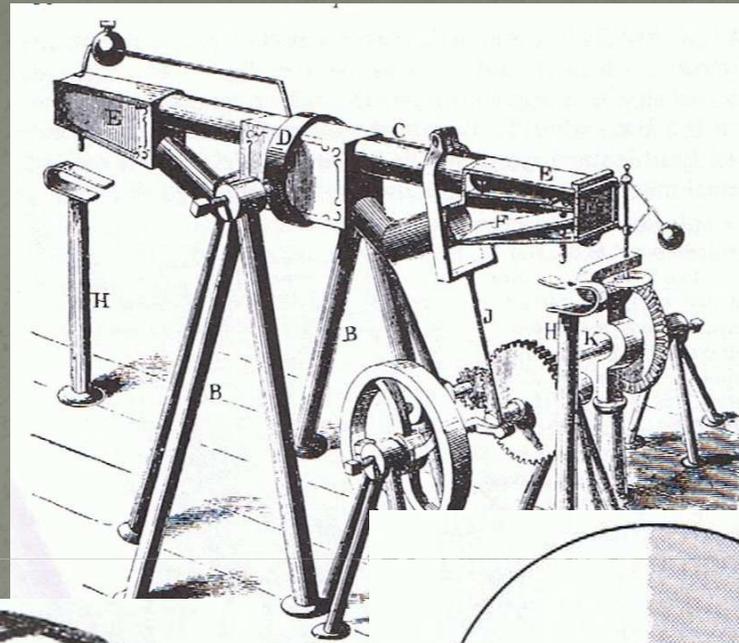
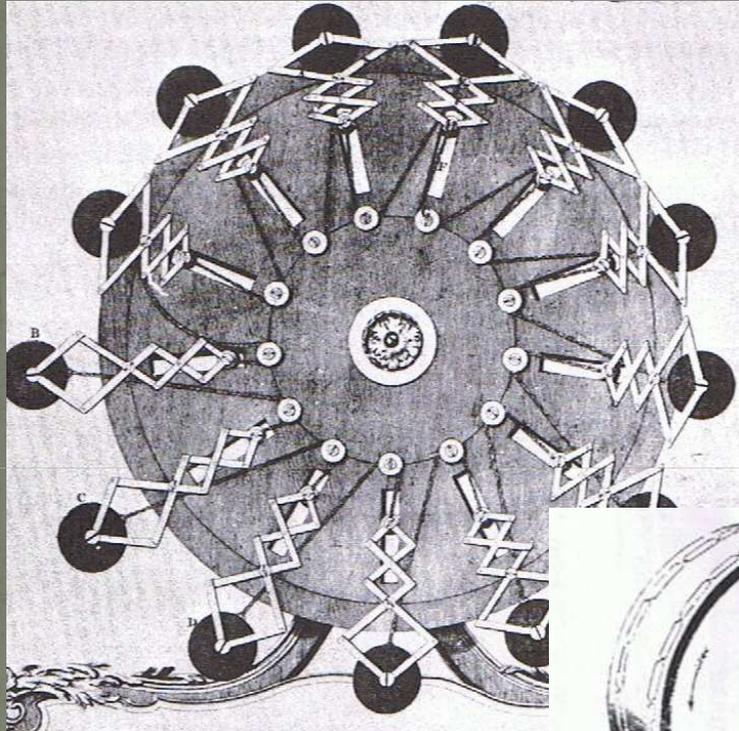
$$\Delta S = \Delta S_1 + \Delta S_2 = \frac{-\Delta Q}{T_1} + \frac{\Delta Q}{T_2} > 0$$

- Total entropy has increased, *and we can never decrease it* without doing work on the system.

Case closed (right?)

Interest continued, undaunted by facts

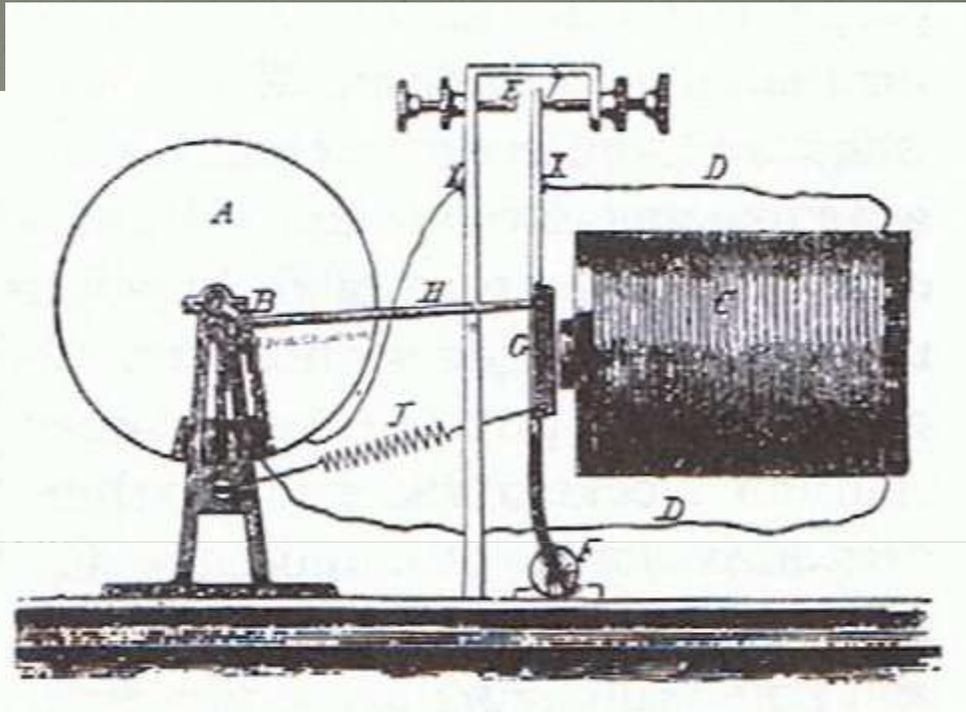
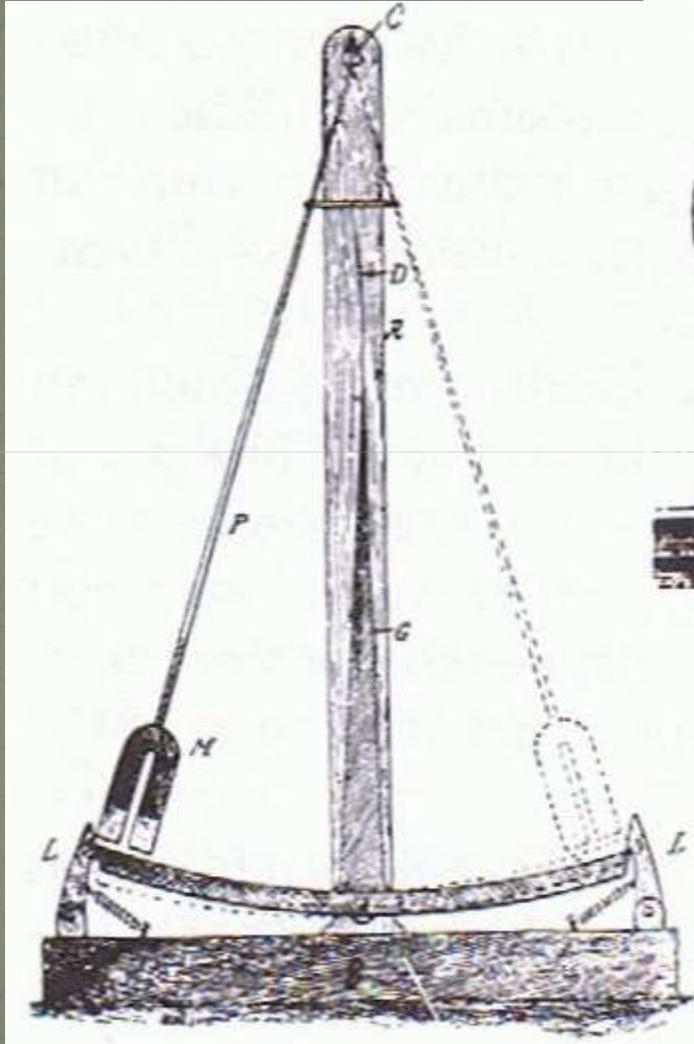
Gravitational imbalance...



Gravitational shield!

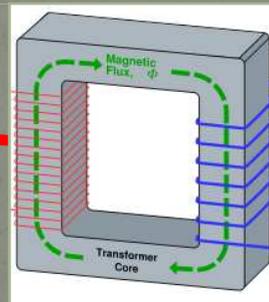
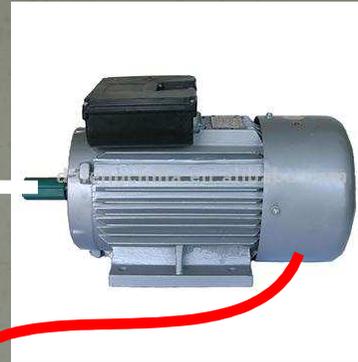
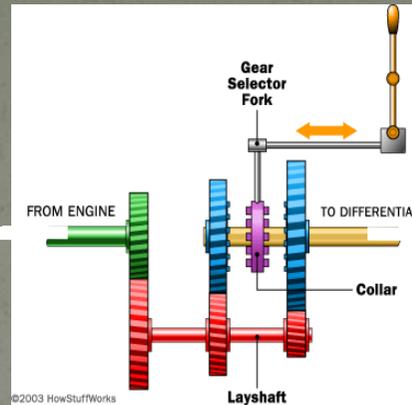
Hope springs eternal

E&M based...



As we'll see, this is the class with the most staying power today

Perpetual Motion 101 (electricity example)



Start with a motor...
which turns a generator...
which powers the motor...
with perhaps some left over!

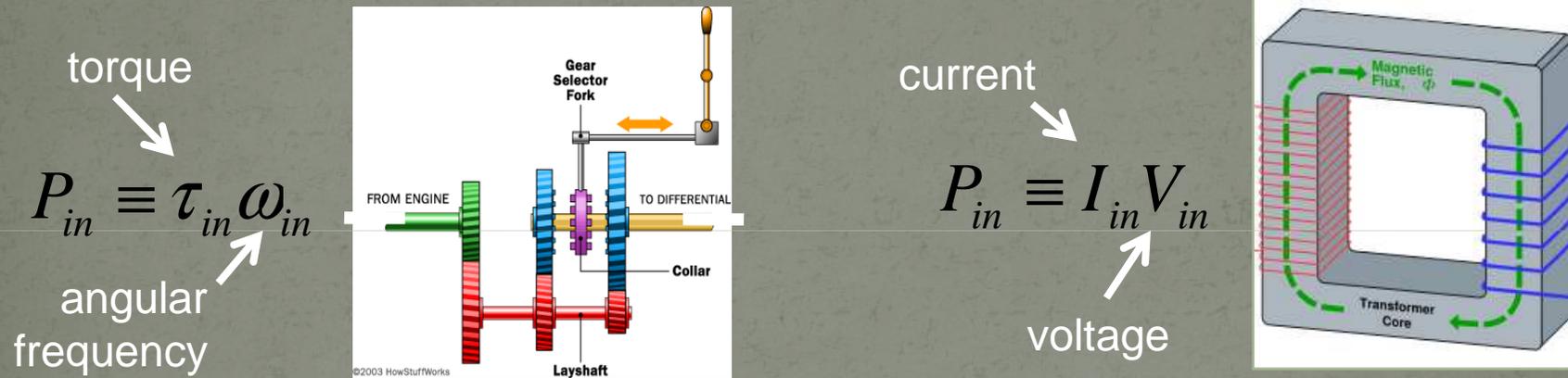
Doesn't work??

Try adding some gears...
or maybe a transformer

etc, etc, etc...

Redefining the problem

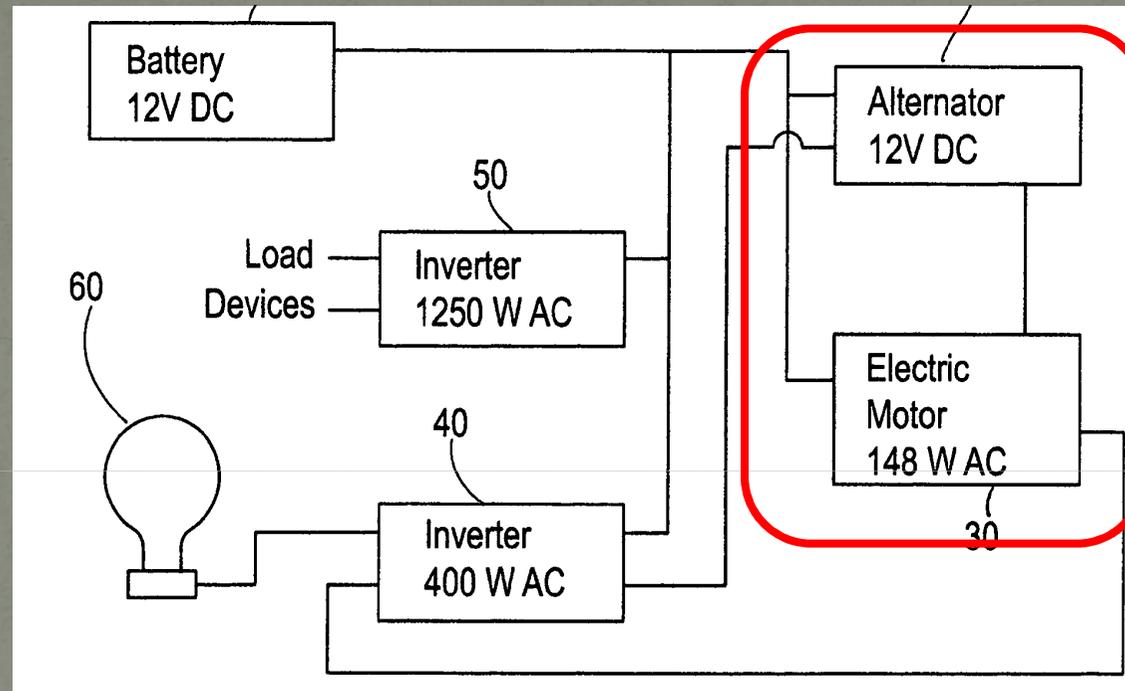
- Instead of talking about “perpetual motion”, talk about “over-unity”; that is, gearboxes, transformers, etc, in which the power out is greater than the power in



- Physically, $P_{out} \leq P_{in}$ - ALWAYS
- “Over-unity” = “perpetual motion” - PERIOD

In case you thought my example was silly

US Patent #7,095,126: "Internal Energy Generating Power Source" (2006)



ABSTRACT

An external power source such as a battery is used to initially supply power to start an alternator and generator. *Once the system has started it is not necessary for the battery to supply power to the system. The battery can then be disconnected.* The alternator and electric motor work in combination to generator (sic) electrical power.

Speaking of patents

- A *partial* list of US patents purported to support perpetual motion:
 - 2,006,676: “Electrolytic Carburetor” (Garrett Carburetor)
 - Launched a whole kook industry
 - 4,074,153: “Magnetic propulsion device”
 - 4,151,431: “Permanent magnet motor”
 - 4,215,330: “Permanent magnet propulsion system”
 - 6,246,561: “Methods for controlling the path of magnet flux...”
 - 6,362,718: “Motionless electromagnetic generator”
 - More about this one later
 - 6,523,646: “Spring driven apparatus”
 - 6,526,925: “Piston driven rotary engine”
 - 6,962,052: “Energy generation mechanism, device and system”
 - 7,095,126: “Internal energy generating power source”
 - The one we just talked about

Patents and perpetual motion

- The Patent Office has had so much trouble with perpetual motion machine patents that it's developed special rules.:

“With the exception of cases involving perpetual motion, a model is not ordinarily required by the Office to demonstrate the operability of a device. If operability of a device is questioned, the applicant must establish it to the satisfaction of the examiner”

- 35 U.S.C 101 (Examiners' Handbook)

Translation: “If the Patent Office didn't ask for a working model, they didn't believe it was a perpetual motion machine”.

More about patents

- Also from the Examiners' Manual

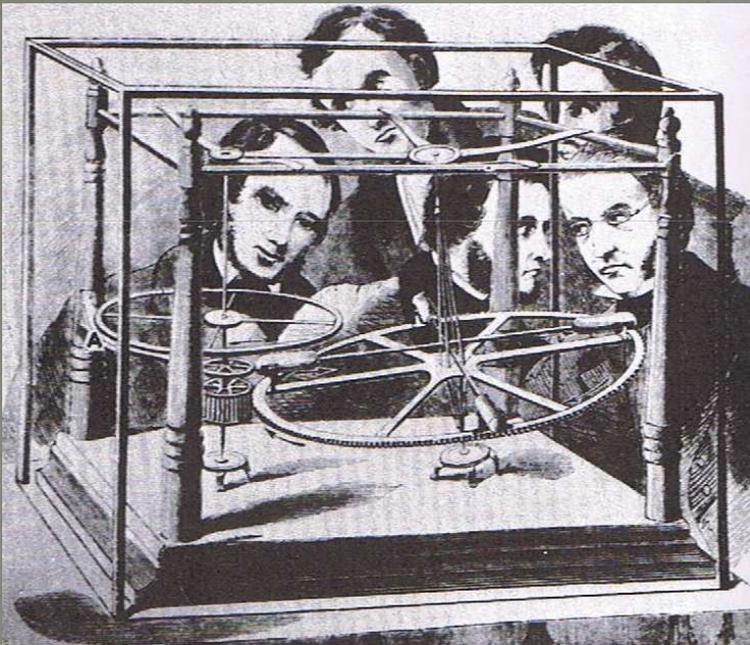
“A rejection under 35 U.S.C. 101 for lack of utility should not be based on grounds that the invention is frivolous, fraudulent or against public policy.”
- In a judicial case involving this statute, the judge ruled

“...we find no basis in section 101 to hold that inventions can be ruled unpatentable for lack of utility simply because they have the capacity to fool some members of the public.”

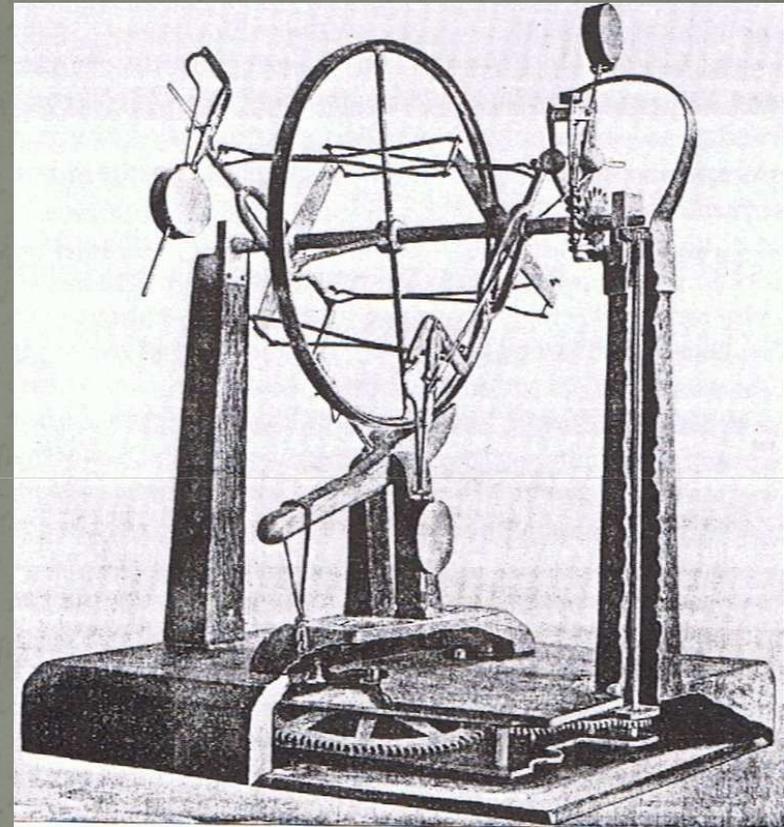
Translation: “The Patent Office will patent things *even if it's clear they will be used to defraud people*”

Early frauds

- Perpetual motion was mostly an intellectual curiosity, until the Industrial Revolution convinced people of its “value”



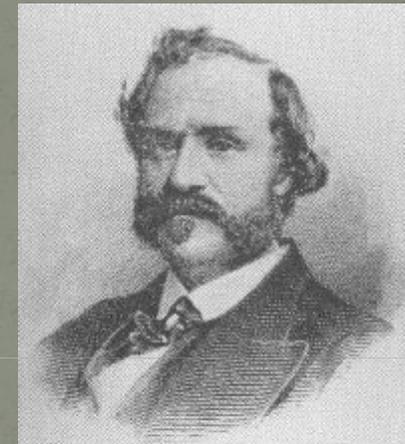
- E.P. Willis' “overbalanced wheel” ran on hidden compressed air. (1850's)



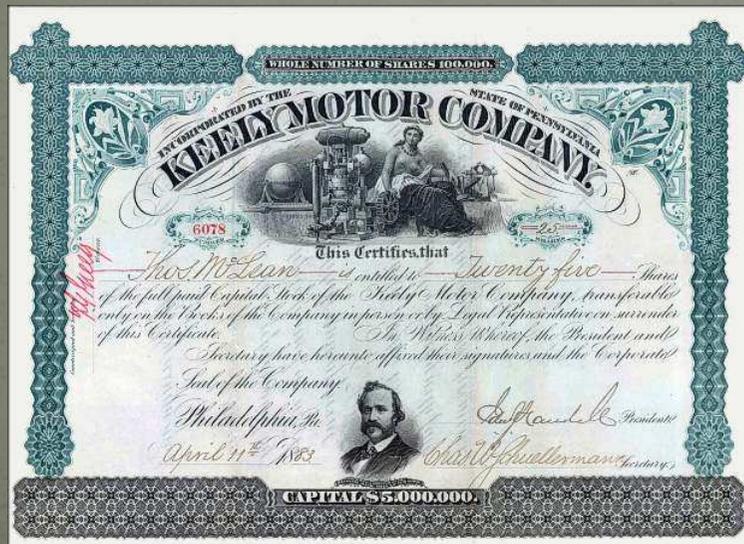
- J.M. Aldrich's machine ran on hidden springs (1899)

John Keely: the father of the free energy scam

- There were numerous perpetual motion frauds in the 19th century, but most were pretty small scale
- In 1872, John E. Worrel Keely claimed to have discovered a new type of motor, which used some sort of musical resonance to extract energy from the “luminiferous ether”.



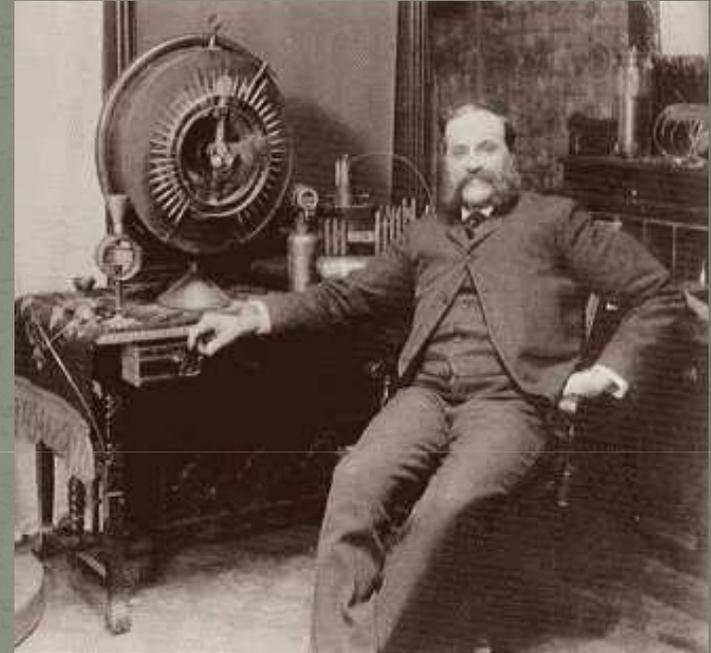
John Worrell Keely



- He formed the “Keely Motor Company”, began giving public demonstrations and selling stock.

Keely and his times

- In the context of the times, Keely's claims were not all that unbelievable:
 - This was before Special Relativity, and "Luminiferous Ether" was the hypothetical fluid through which electromagnetic waves, including light, propagated.
 - This was the golden age of empirical physics, and finding a way to extract energy from this medium was not yet experimentally ruled out.
- Keely's *behavior*, on other hand, should have raised some alarm bells
 - He never published any data regarding the mode of operation of his machine in scientific journals.
 - He never allowed any independent test or even inspection of his machine.

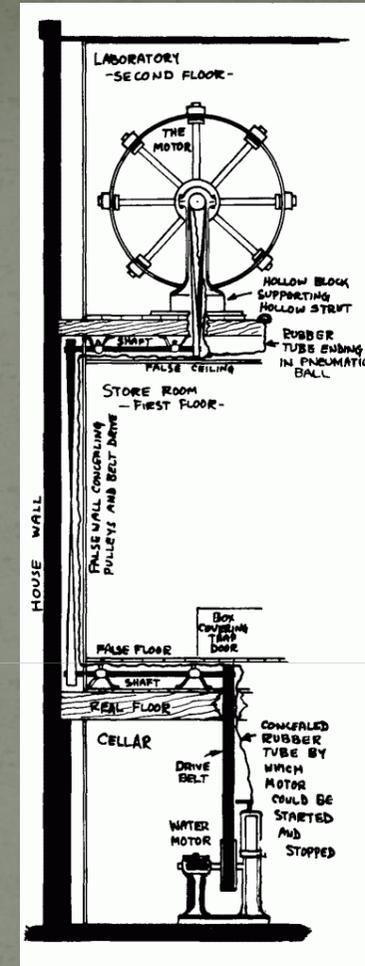
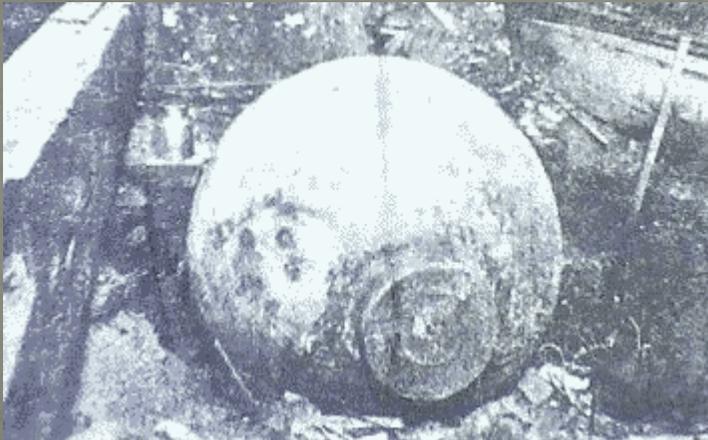


The end(?) of Keely

- After many years of delays, investors were becoming frustrated with Keely's failure to produce a commercial device, and his refusal to allow independent testing.
 - They began withdrawing their investments and advising others to do the same.
- Clara Bloomfield-Moore, a wealthy Philadelphia widow, came to the rescue with a large sum of cash and a monthly stipend.
 - However, she insisted on a review by the engineer E.A. Scott.
 - She dramatically reduced her support when it came back negative.
- In 1890, Keely announced a new product, "The Liberator", which would allow a motor to run on water.
 - Few people believed him.
- Keely was hit and killed by a streetcar on November 18, 1898.

Keely: postmortem

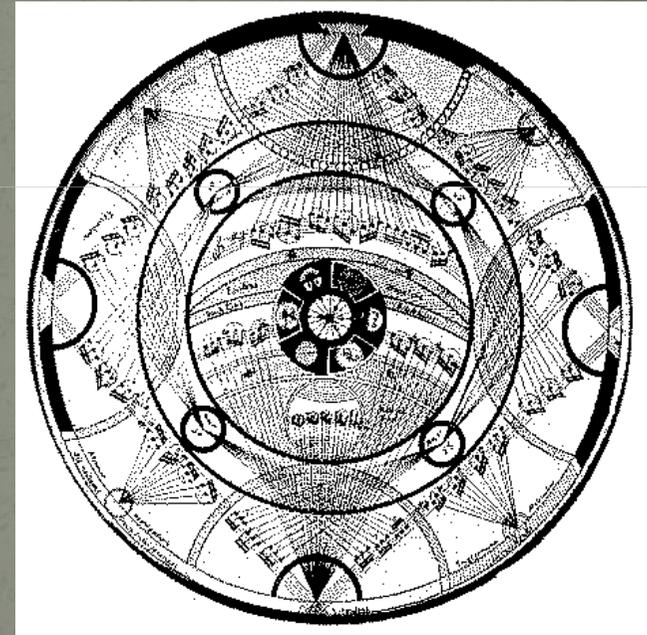
- “Scientific American” had always been skeptical of Keely. Following his death, they inspected his home.
- They discovered an elaborate system of pipes and hoses, connected to his machines through hollowed out legs on the furniture!



- The entire system was powered by a compressed air tank in the basement.

Lessons Keely taught future generations

- Focus on attracting “investors” rather than selling devices or demonstrations.
 - Can only charge so much for a demonstration.
 - Can only sell devices until people realize they don’t work.
 - In contrast, can get significant sums from investors and then keep them away with excuses for months or even years.
- Bring in religion/philosophy
 - Keely tapped into spiritualist/occult beliefs popular in his day, and this trend continued into the early 20th century.
 - Still around today, although many modern free energy gurus favor fundamentalist Christianity.
- Cultivate the “true believers”
 - Many people really want to believe in these technologies.
 - They will be easily convinced.
 - They will continue to believe in spite of all the evidence.

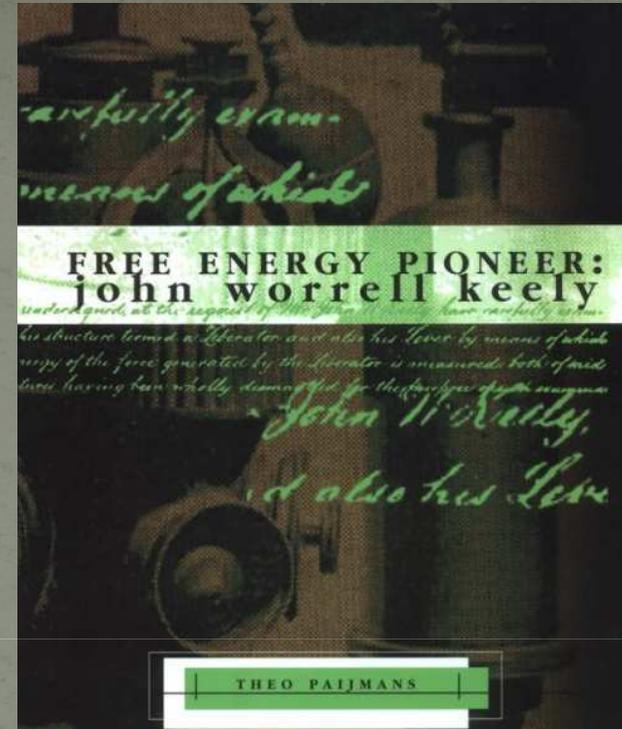


Keely today

- Keely's claims were thoroughly and completely debunked over a century ago.
- Nevertheless, thousands of people still believe Keely held the key to limitless power and much more.
- Example

- *“Over 100 years ago, John Ernst Worrell Keely (1827-1898), developed an advanced synthesis of science and philosophy. Keely was harnessing Sound, Light, Heart, Mind and Will to operate revolutionary new machinery and to improve Life and health. This is a science based on Natural Law governing Life, hope and Love and not Death, despair and destruction.”*

- from the Sympathetic Vibration Physics website

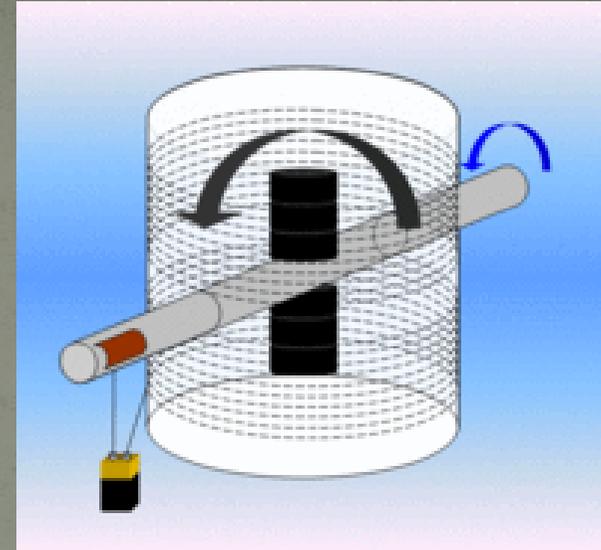


Major classes of modern free energy devices

- Motors that run on permanent magnets
 - Usually find excuses to connect them to batteries
- “Over-unity” transformers that put out more electrical power than they take in.
 - Rather than admit they are selling a perpetual motion machine, they will usually claim to be tapping the “Zero Point Energy” (ZPE)
- Engines that run on water
 - Generally deny being “perpetual motion machines”
 - Instead claim to split water into H and O with “very high efficiency”
- Fancy jars of goo
 - Cold fusion
 - Self-charging batteries
 - Yet more ZPE devices

Joseph Newman: patent-ly absurd

- Joseph Newman is *probably* not a con man (IMHO).
- He honestly believes he's created a motor that produces more output power than it takes in.



- Involves permanent magnets and Copper coils
- He stages elaborate, yet ultimately unimpressive, demonstrations.
 - Has a car which runs powered only by batteries. *at 4 mph* *68* *of 250 V each*
- Believes his motor is not perpetual motion because it converts the mass of the copper coils into energy.

Newman, his motor, and lots of batteries

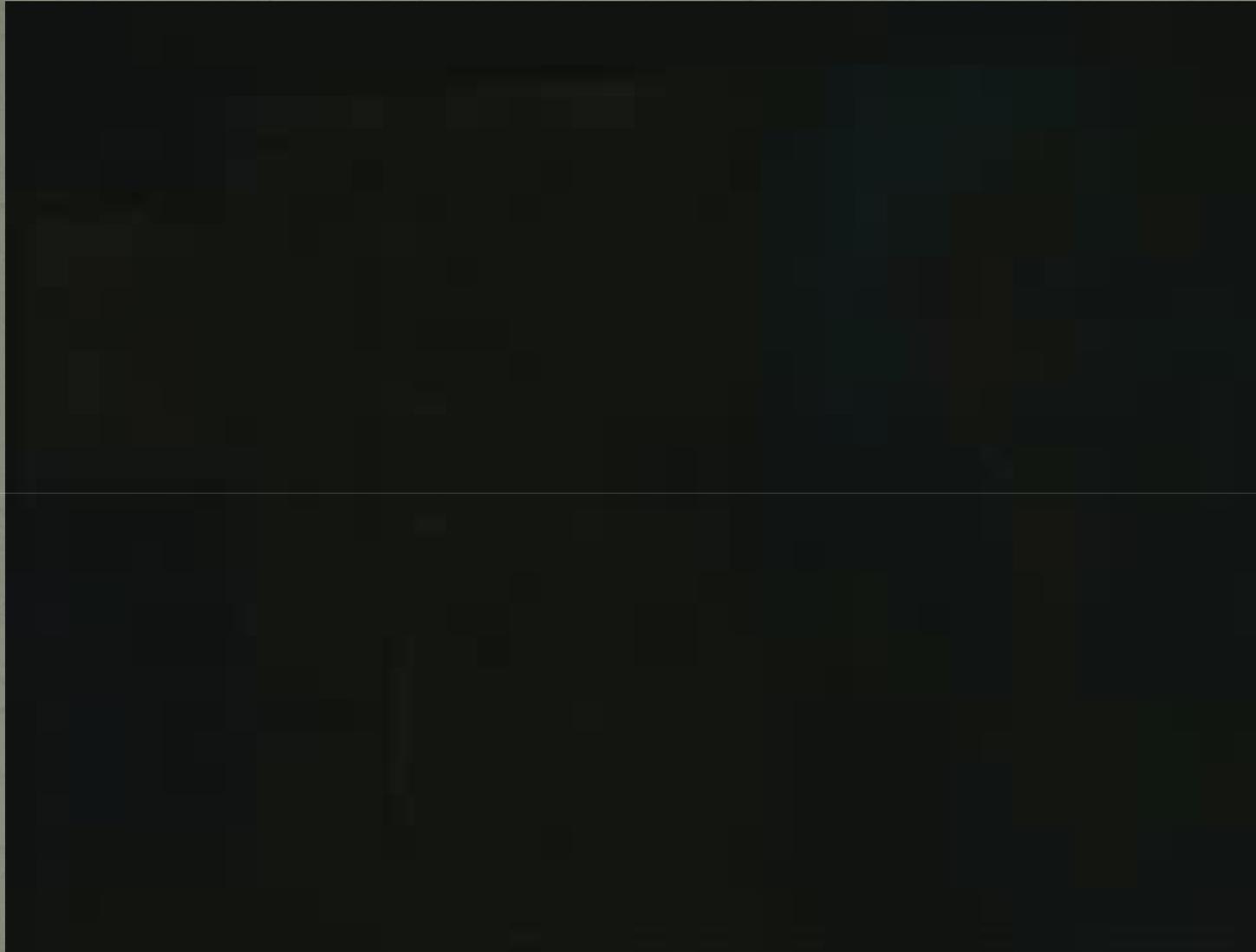


Although Newman has no technical background (never finished high school), he has appeared numerous times on the news (not to mention Johnny Carson), and *filled stadiums* for his demonstrations.

Joseph Newman's patent attempt

- Newman attempted to patent his motor *as an over unity device*.
 - Application initially rejected out of hand.
 - Under the terms of Patent Code 608.03, Newman supplied a working model.
 - This was evaluated by the National Bureau of Standards, which measured the efficiency at <100%, and the patent application was denied.
 - Newman took the case to court, producing an array of “experts”
 - eg, the “magnet expert” sold therapeutic magnets at New Age fairs
 - Court rejected Newman’s challenge.
- Newman ultimately withdrew his US patent application, and turned his attention elsewhere
 - Mexican Patent #MX158113: "MEJORAS A UN SISTEMA Y METODO PARA GENERAR ENERGIA"

Technical jargon can be confusing...



OK, that was a little fun nonsense

University of Virginia October 9, 2009

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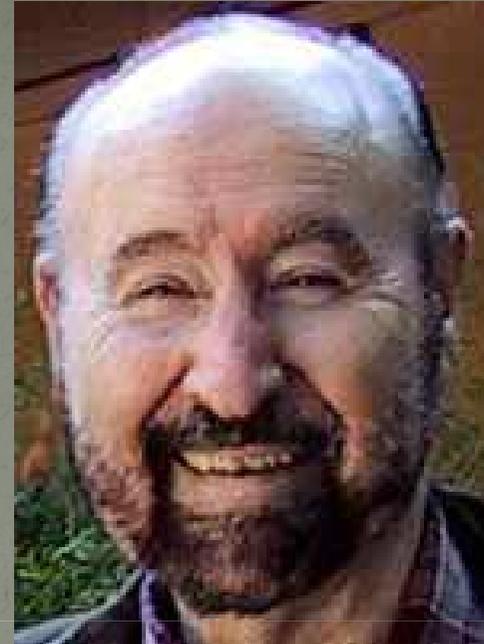
Compare to



And this guy takes himself seriously!

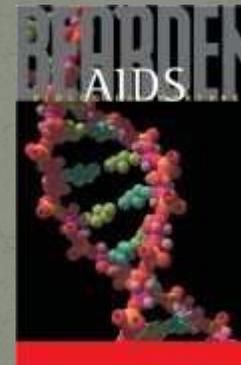
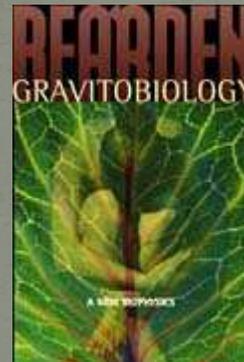
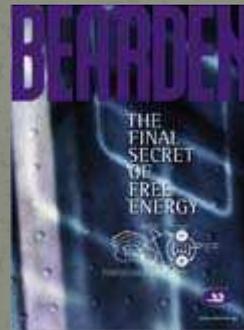
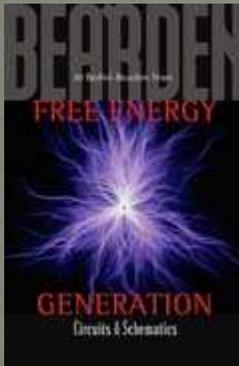
Who is Tom Bearden?

- In short, he's *the* cult figure in the free energy community:
 - Next to Tesla, of course
- He has a B.S. in Math from Northeastern Louisiana University, and a Master's in Nuclear Engineering from the Georgia Institute Technology.
- He retired from the Army at the rank of Colonel
 - This appears to have been his only real job .
- For a while he identified himself as “Thomas Bearden, PhD”
 - His PhD turned out to be purchased from “Trinity College and University” – a notorious degree mill.
 - He's back to just “Thomas Bearden” - usually



Bearden's claims

- For decades, Bearden has been making numerous claims involving “over-unity” physics (he avoids the term “perpetual motion”)
 - Claims that these technologies are being suppressed by governments and special interests
- He has written at least 10 books on free energy, conspiracy theories, AIDS ... and one on Aikido



- For example, he believes both the Challenger accident and Chernobyl were triggered by secret “scalar wave” weapons.

The "science" of Tom Bearden

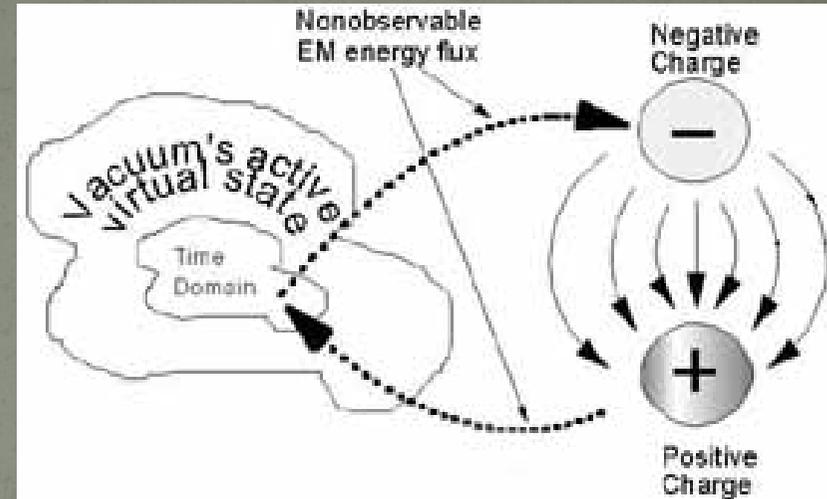
- Bearden supports his claims with a random stream of physics jargon and famous names:

- “Zero Point energy”, “Scalar waves”, “Nikola Tesla”, “broken symmetry”, “Aharonov-Bohm Effect”, etc, etc, etc.

- One analysis of his theories (by real physicists) described them as:

“full of misconceptions and misunderstandings concerning the theory of the electromagnetic field”

- Carvalho and Rodrigues, *“The non sequitur mathematics and physics of the New Electrodynamics proposed by the AIAS group”*



The motionless electric generator (MEG)

- Patented in 2002 by a group led by Bearden.
- Purports to be a device for extracting energy from the vacuum (or from “scalar waves”, the explanation is not clear).
- In 2002, Bearden promised a commercial model in “a year or so”
- As of 2005, he claimed he still needed “\$10-\$12 million dollars” to develop the MEG into a commercial product.
 - It’s not clear what the money is for, since he claims it has already produced “100 times more energy than was input”.
- To date, there is still no commercial product.
- Independent analyst essentially describe it as “a fancy transformer”.
- Cited by many as “absolute proof” of “over-unity” physics.



Other claims by Bearden*

- Numerous “over-unity” technologies exist, but are actively suppressed by government or special interests, using means up to and including murder.
- Believes that something called “scalar waves” are being secretly developed as a weapon, and in fact are responsible for:
 - Chernobyl
 - The disintegration of the space shuttle Challenger
 - The 2001 Indonesian tsunami
 - Hurricane Katrina, which was engineered by a combination of the KGB, the Japanese Yakuza, and remaining members of the Aum Shinrikyo cult
- What conclusion would you draw about the guy?

*from his website <http://www.cheniere.org/>

So how can you tell the difference...

- ...between real science, and scientific sounding jargon?
- Science is very complex and specialized. Some things can really only be understood by experts.
- For example, consider the two journal articles

Chang and Georgi,
“Quantum modified mooses”
Nuclear Physics B672 (2003)

Real paper by real physicists
in a respected journal (Nucl.
Phys. B)

Ganformina and Valdes,
“Studies on the Tsagas-
Sourlas-Santilli Isotopology”
Algebras, Groups, and
Geometries (2003)

Nonsense, self-published
by kooks

- Even scientists sometimes have to avoid the “Emperor's New Clothes” syndrome.

Energy from water*



*this is the clip that got me started on this crusade

Digression: the popular news media

- With a few exceptions, when it comes to science, news media are awful.
- When it comes to pseudo-science, the media are *godawful*.
- When it comes to free energy con games, news media should arguably be charged as accomplices.
- If you remember nothing else from this lecture, remember this:
 - *No significant scientific result has ever been reported first by the evening news (or a YouTube video)*

What a good reporter might have noticed

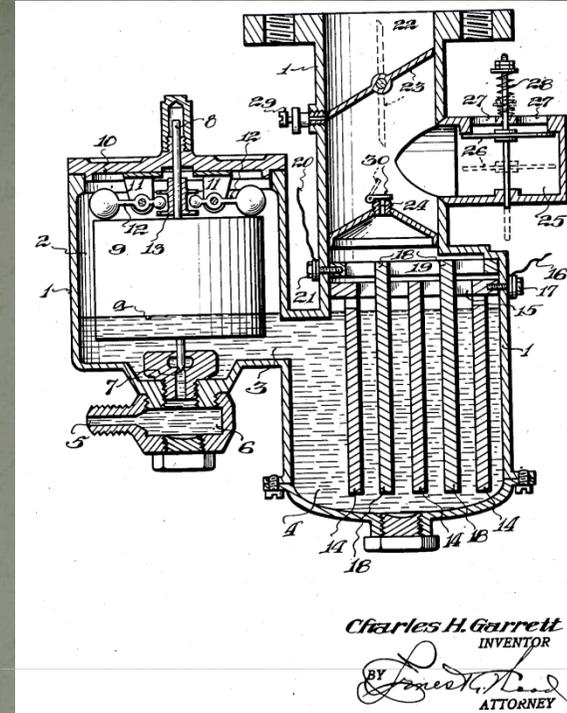
- If you could build a car that runs on water, why would you build a “gas-water hybrid”? Nostalgia?
- They used “4 ounces of water”, but *how much gas*?
- Do you have a lot of call to cut through charcoal?
 - Could it be the Oxygen was combining directly with the Carbon and the charcoal was simply burning itself?
- Nothing magic about making a flame with Hydrogen from electrolysis.
 - Particularly with a unit the size of an arc-welder.
- This sort of thing has been tried many times before
 - Google “Brown’s gas” or “Klein’s gas”, for example

The "science" of Aquygen

- Like many free energy scams, Aquygen claims their product is based on revolutionary new physics.
 - In this case, a new molecular state of Hydrogen and Oxygen (HHO)
- Their website includes a scientific paper by R. Santilli at the "Institute for Basic Research"
- What is the IBR?
 - Well, it has four locations, one for each of its four members:
 - Florida
 - Italy
 - Kazakhstan (and this was before Borat!)
 - Nigeria (OK, should have expected that)
- Basically, they publish scientific sounding nonsense in support of free energy scams.

Motors that run on water

- Tapping the energy of water is to the “free energy community” what the Philosopher’s Stone was to alchemists.
- Recall, Keely himself claimed to have a motor which ran on water in 1890.
- A patent was issued in 1935 for the “Garrett Carburetor”, which set the standard for countless water schemes to follow. The principle is quite simple:
 - Invent an “efficient” way to use electricity to separate water into Hydrogen and Oxygen.
 - Burn the Hydrogen.
 - Use a small amount of the energy to generate electricity to produce more Hydrogen.



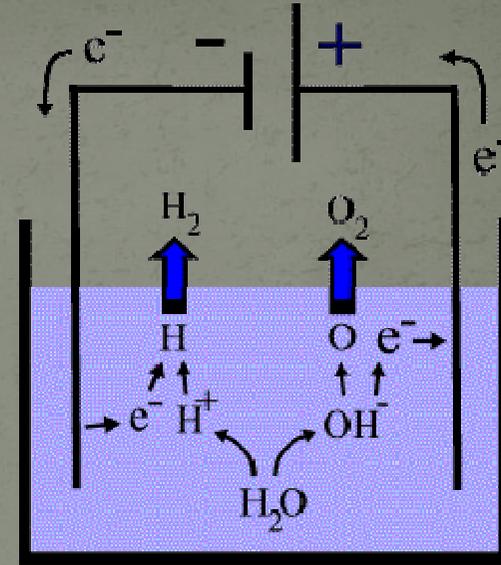
The problem

- Burning Hydrogen and Oxygen produces water.
- Remember the First Law of Thermodynamics
 - **An engine that runs on water**
 - Starts with water
 - Ends with water (i.e. in the same state)
 - Extracts useable energy

Cars that run on water violate the laws of physics as we know them

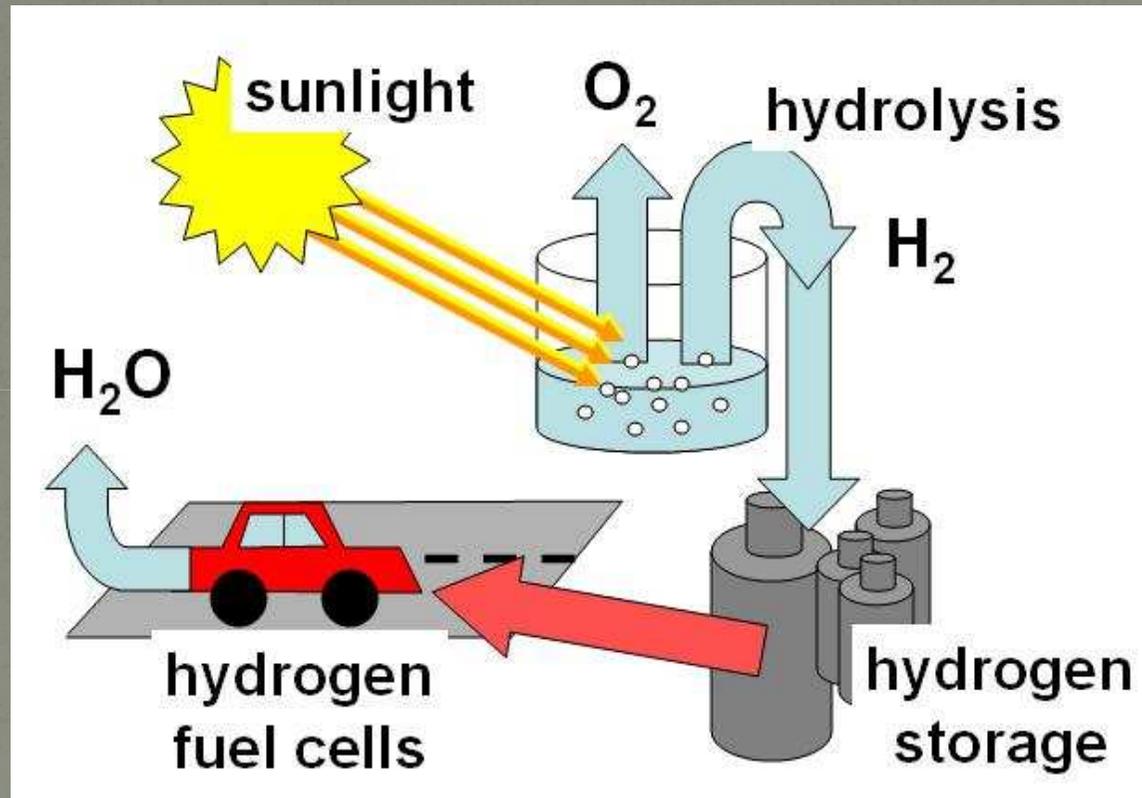
Electrolysis: in the real world

- Electrolysis is the process by which electricity is used to break water into Hydrogen and Oxygen
- Energy is released when the Hydrogen and Oxygen are recombined, which again produces water
- The energy release in recombining the Hydrogen and Oxygen is *always less than the energy used in electrolysis.*



Application of Hydrogen cycle

- Hydrogen can be used to store energy from inherently intermittent sources like wind and solar



- Lots of practical problems to solve, but no problem with the laws of physics

You can fool some of the people all of the time

- No matter how many times the notion of extracting power from water is debunked, *people still believe it*.
- I could fill a whole talk with cars that run on water
- Example: Stan Meyer (look for videos on YouTube)
 - Claimed in 1990 to have a dune buggy that ran on water.
 - Got a lot of news coverage, and took a lot of money from investors.
 - In 1996, Meyer an Ohio court found Meyer guilty of “gross and egregious fraud” and ordered him to repay (some) investors \$25K
 - In 1998, Meyer died suddenly, at the age of 58
 - The coroner ruled that Meyer, who suffered from high blood pressure, died of an aneurism
 - Conspiracy theories persist that he was “killed by big oil”
 - Oddly, *complete plans remain available on the web* – but no one has made them work.
- You’d think people would be done with energy from water...

Genesis World Energy:

- On December 5, 2002, Genesis World Energy issued a press release announcing “a scientific breakthrough that allows consumers to easily access the energy contained within the hydrogen and oxygen molecular structure of ordinary water”
- This technology had reportedly been developed by “more than 400 visionaries from a wide range of disciplines”.
- Oddly, none were named, but we were assured they were very impressive.



More oddities

- In addition to the mysterious “400”, none of the company officers are named, nor does the company appear to have any facilities, or even an address.
- Skeptics point out that the press release specifies the output of their “Edison Device” in “kilowatts per day” – a nonsensical unit.
 - This error is never corrected
- The company releases some pictures, but allows no independent inspections.



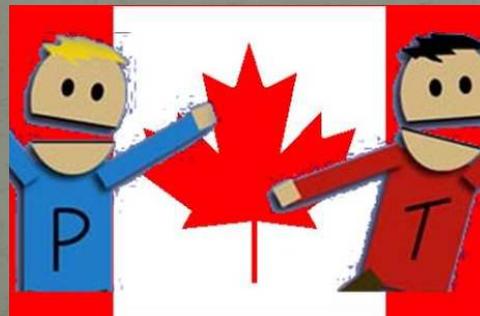
The plot thickens

- On March 18, 2003, the company announces that it is poised to invest *\$20 billion* in manufacturing facilities to begin producing commercial units in 2004, ramping up to *2 million units per day* by the end of the year.
- Even assuming they mean per business day, at the stated price of \$3000 for the domestic unit, this translates to *\$1.5 trillion* in gross annual sales

• $\sim 4_x$

WAL★MART®

• $\sim 1_x$



Beginning to unravel

- On April 23, 2003, still having never produced a commercial product, GWE announces a new automotive technology.
- Many recognize their demonstration device as a child's toy which had been used in a previous free energy scam.
- 2004 comes with no commercial product. In response to nervous investors, GWE releases a report from an unnamed "independent lab".
 - Skeptics immediately jump on numerous errors – *including the same unit confusion that was in the original press release.*



The end of Genesis World Energy

- On September 23, 2005, Patrick Kelly was arrested in Idaho on a New Jersey warrant. Although his name had never appeared in any news releases, Kelly was identified as the president of Genesis World Energy (which had changed its name at least twice by that time).
- On September 31, 2006, Kelly pled guilty to securities fraud and was sentenced to five years in prison and a \$400,000 fine. In sentencing, the judge stated, “the defendant is going to prison because he stole from investors”
 - It’s estimated he took in about \$2.5M in “investments”
- In the end, the “400” turned out to be Kelly and one partner, whose involvement so limited that he wasn’t even convicted.

Some Lessons from GWE

- The Good News
 - Kelly went to prison.
 - To the best of my knowledge, no one claims he was framed.
- The Bad News
 - Even in the normally credulous free energy community, there was skepticism about GWE, because of the outlandish marketing claims, *not because of the dubious science.*
 - In spite of this skepticism, people invested \$2.5M
 - Kelly fell victim to his own greed. There are plenty of equally bogus technologies bilking investors with impunity: Xogen, Aquygen, Black Light Power, etc.

Prosecuting energy con men

- Kelly was convicted for misappropriating corporate funds for personal expenditures (houses, credit cards for his daughter, etc)
 - Only accused of mishandling about 10% of investment money.
 - Ultimately irrelevant that the technology was bogus
- Difficult to prosecute based on scientific claims. Must prove:
 - Technology doesn't work
 - Technology *can't possibly* work
 - The people asking for your money know this
- Most con men are smarter than Kelly
 - Classify investments as “venture capital”
 - Pay themselves a large salary
 - Divert a little money to meaningless “R&D”
 - Continue with impunity

Getting it wrong

- Many of these people are quite sincere in their beliefs.
- How can they get something as simple as conservation of energy so wrong?
- A little knowledge is a dangerous thing.
- One of the most common mistakes is to apply approximate physics formulae to situations where they aren't relevant.

Example: complex waveforms

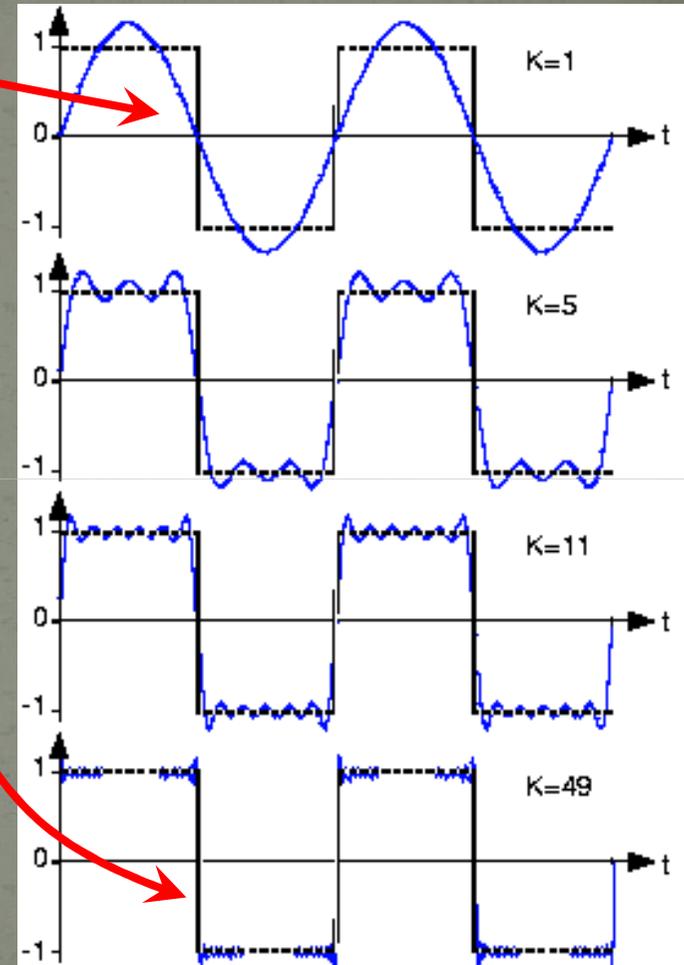
- For a sine wave

$$P_{ave} = \frac{I_{peak} V_{peak}}{2}$$

- but for a square wave

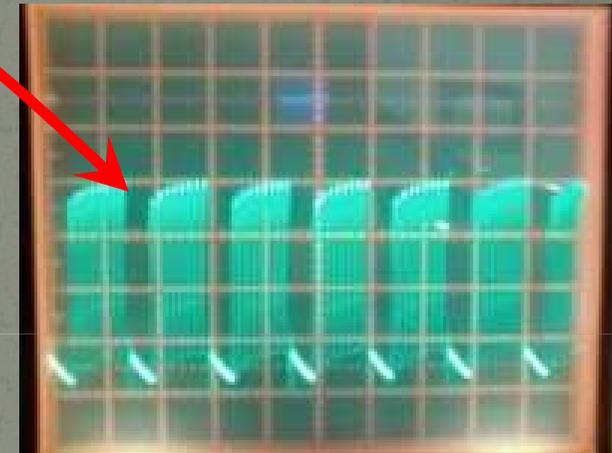
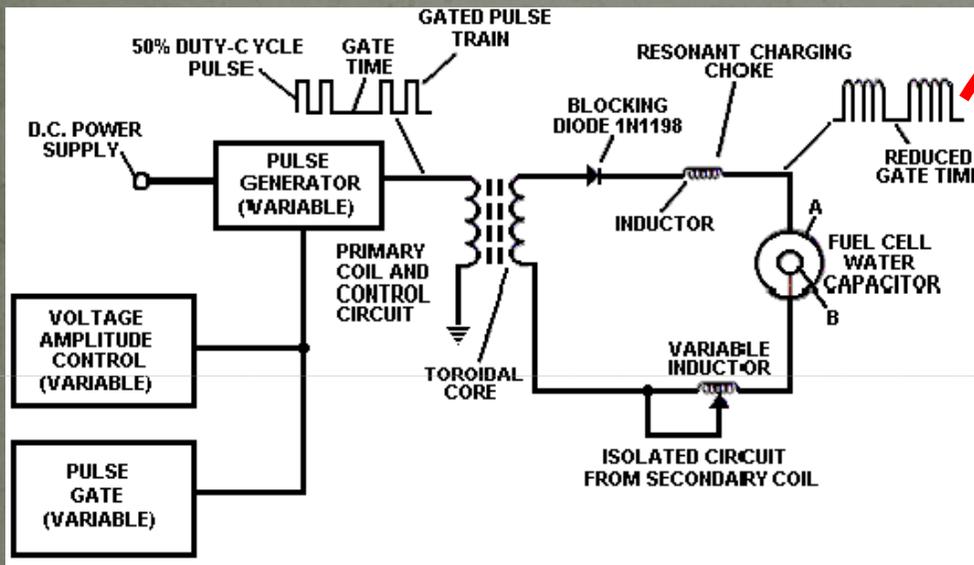
$$P_{ave} = I_{peak} V_{peak}$$

- No simple formula works all the time.



Can it be that simple?

- Power circuit from Stan Meyer's "Water Fuel Cell"
 - Electrolysis driving waveform



- All "over-unity" claims regarding Meyer's cell result from erroneous evaluation of the power in this complex waveform.
- Complicated waveforms are a very common feature of "over-unity" circuits.

Digression: Nikola Tesla

- You won't get far in the “free energy” world without encountering Nikola Tesla, who's become something of a patron saint.
- Nikola Tesla was a brilliant, iconoclastic inventor at the turn of the (last) century who holds over 300 patents.
- Among his most important contributions was the introduction of AC power for power distribution (something Edison fought against)

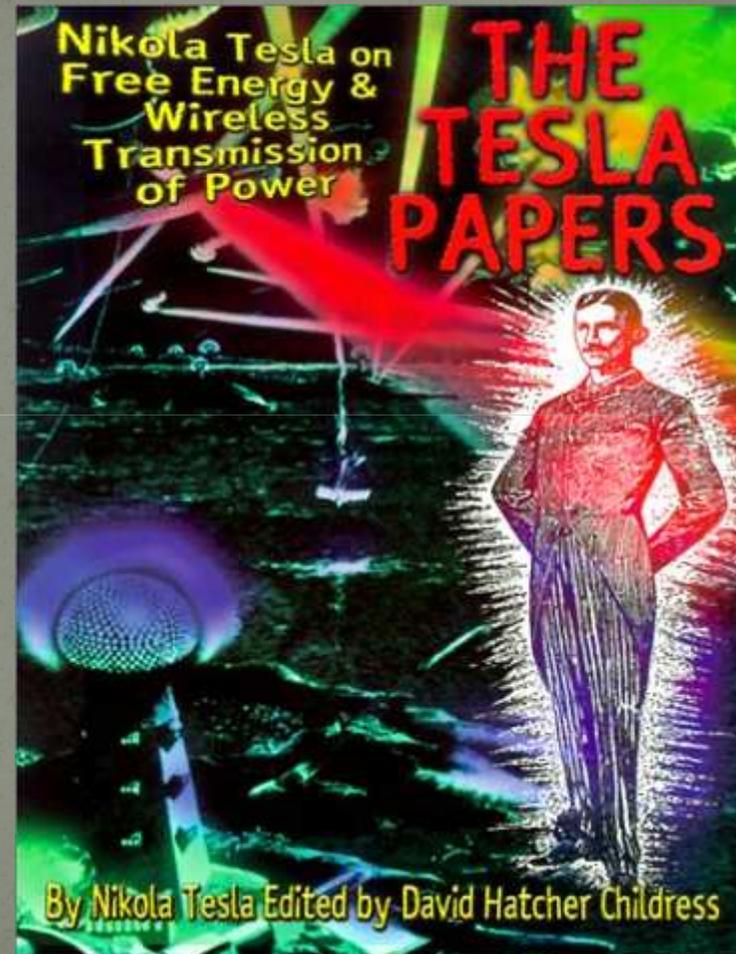
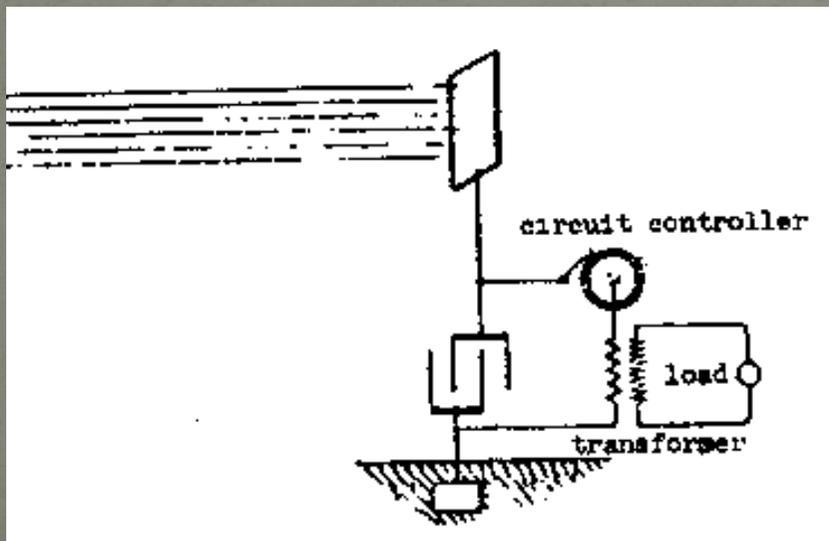


Tesla's later years

- Most historians agree that Tesla really invented (and patented) the radio.
- He became very bitter that Marconi got the public credit, possibly triggering a downward mental slide.
- He began to make increasingly odd statements
 - He claimed he got his ideas from extraterrestrials.
 - He admitted he was developing a fear of “round objects”
 - He claimed to have developed a working “death ray”
 - He also claimed to have patented “free energy devices”

Tesla's free energy

- Tesla had long been pushing a plan to “broadcast” electric power.
- It only works if energy is “too cheap to meter”
- Also patented a “radiant energy receiver”



Tesla: the facts

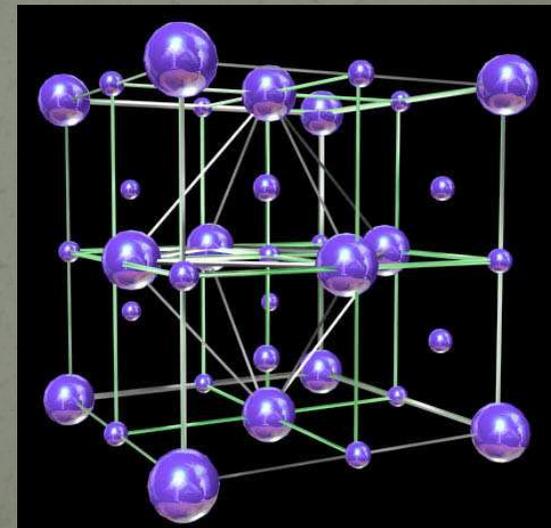
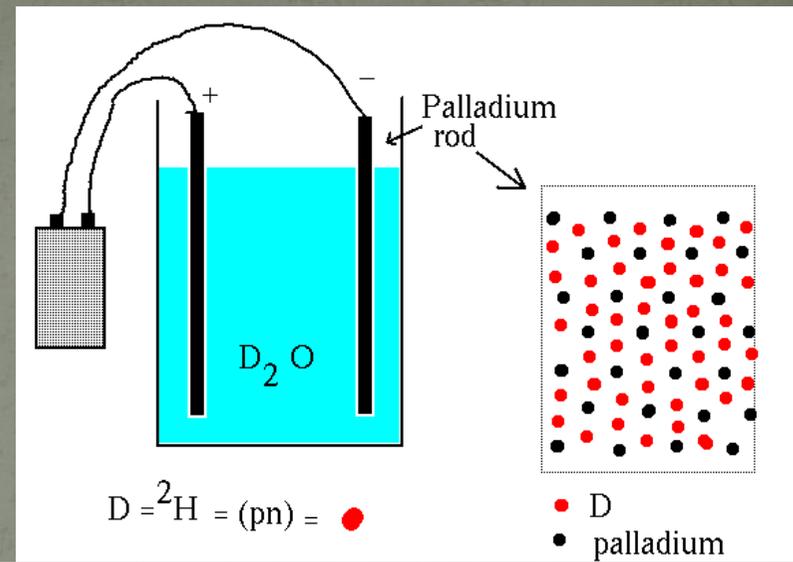
- Tesla was an prolific and innovative inventor, but not a cutting edge scientist
 - Made no fundamental *scientific* contributions
 - Not even clear he really understood the science behind his inventions.
- All of his inventions were understood in terms of the physics of the time.
- His extreme claims, such as the death ray, simply don't work.
- His “radiant energy device” is just an antenna of sorts
 - Would work if EM radiation or cosmic rays were many orders of magnitude greater than they are.
 - Of course, we'd be dead.

Defense of "fringe" science

- It's important to distinguish "crackpot science" from "fringe science"
- "Fringe science" is science that involves measurements or theories which are extremely difficult to reconcile with the prevailing theoretical framework, *but are nevertheless not yet ruled out experimentally.*
 - Fringe science is not only legitimate but vital.
- Many accepted theories were once "fringe"
 - Plate tectonics
 - Theory of relativity
 - Quantum mechanics
 - Expanding universe
- Some examples of current fringe experiments include
 - Search for tachyons
 - Gravitational mass of antimatter
- Unfortunately, unless care is taken, fringe science can easily become crackpot science...

Cold fusion: the revolution that wasn't

- In 1989, two teams announced they had seen evidence for nuclear fusion at room temperature taking place in a Palladium rod which had been loaded with Deuterium from heavy water.
- One team, Pons and Fleischmann, claimed energy release at a level which promised practical application.
- Although difficult to reconcile with solid state physics, there's nothing a priori impossible about the claim, and theorists struggle to accommodate the result.



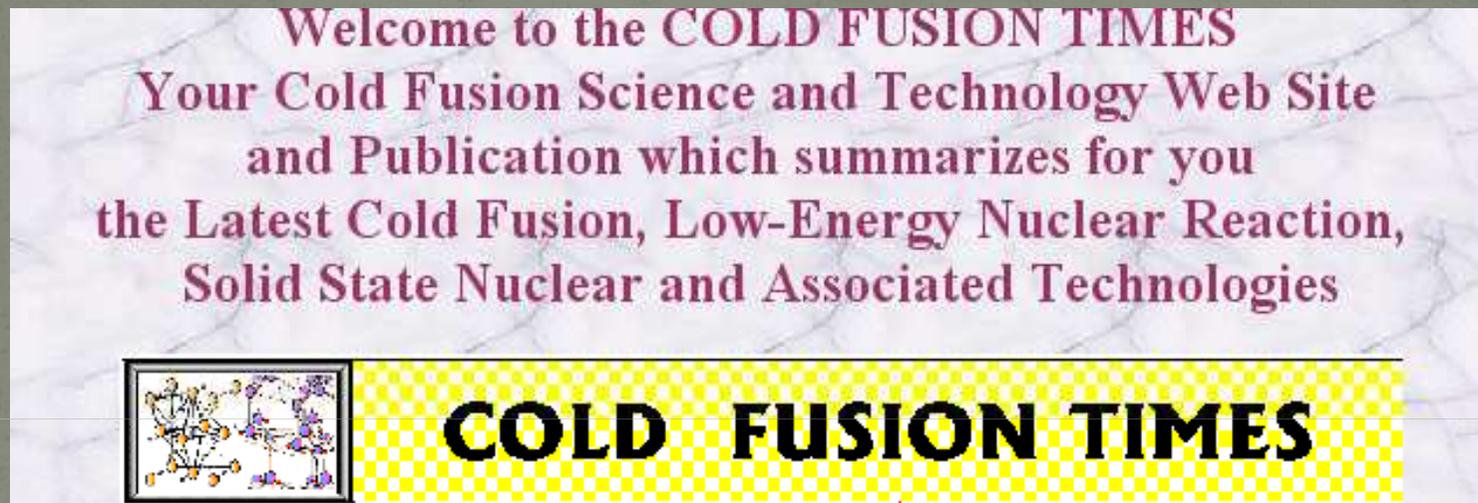
The road from fallacy to fraud

- At the 1989 APS meeting, no one was able to confirm Pons and Fleischmann's results*
- Nathan Lewis, a chemist at Cal Tech, offered an explanation for all of their results in terms of sloppy experimental techniques:
 - Pons and Fleischmann did not attend, as they were busy soliciting funds.
- In addition, obvious cross-checks were not done
 - Control test with ordinary water
 - Assay for Helium, the product of fusion
- Cold fusion was dead – scientifically anyway.

*eg, see E. Buchanan, R. Hirosky, J. Jorne, A.C. Melissinos, J. Toke,
"Search For Neutron Production In A Palladium Heavy Water Electrolytic Cell."
. UR-1111, ER13065-578, (1989)

And yet...

- Cold fusion is alive and well in the minds of believers



- There are magazines, websites, books, products, and conferences.
- Still makes the news ~once/year
 - Recent “60 Minutes” episode
- Pons and Fleischmann continue to carry out “research” in France, funded by private investors.

Hafnium: the other revolution

- Nuclear physicists have long investigated the possibility that some sort of resonant process would allow one to stimulate the decay of a quasi-stable isomers with low energy X-rays.
 - Known as Induced Gamma Emission (IGE)
 - Lots of interest by JASON (DARPA)
- In 1999, scientists led by C.B. Collins at UT Dallas claimed a statistically significant enhancement in the decay of 2.446 MeV quasi-stable excited state of ^{178}Hf using a 70-90 keV dental laser
 - The claimed enhancement was $4\pm 2\%$
- In spite of the small signal, this immediately created great excitement in the scientific world and the popular press
 - Every popular article mentioned the “dental laser”
 - None mentioned the 2σ significance
 - Also not mentioned: cost of Hafnium

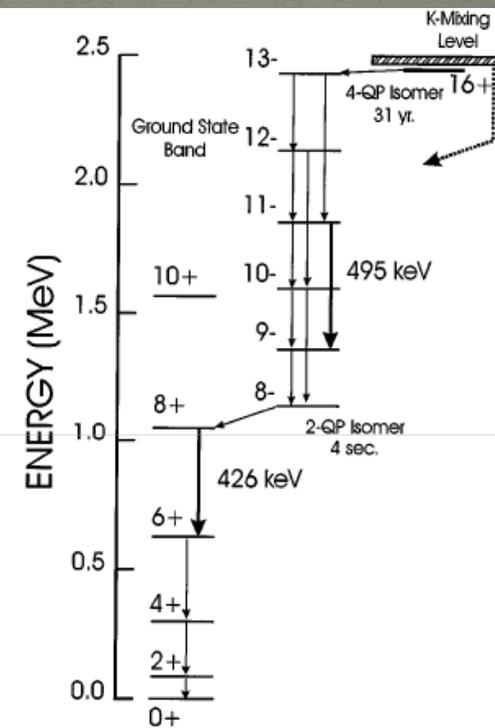


FIG. 3. Energy level diagram for ^{178}Hf showing a selection of levels relevant to this experiment. The spontaneous decay of the 31-yr, 16^+ isomer is shown by the thin arrows. The thick solid arrows show components studied in this work from the particular cascade from the decay forced by the x-ray irradiation. Heavy dotted arrows are inferred transitions needed to feed those shown.

*C. B. Collins, *et al*, Phys. Rev. Lett. 82, 695 (1999)

The great Hafnium rush

- Groups quickly scrambled to confirm the Dallas signal
- Other groups scrambled to secure federal funding for Hafnium applications
 - Nuclear Batteries
Hafnium bombs
 - Nuclear powered aircraft
- In 2001, groups from Argonne, Los Alamos and Livermore used the Advanced Photon Source to recreate the experiment with *five orders or magnitude* more sensitivity
 - No signal was observed*
 - Dallas result deader than disco – scientifically, that is

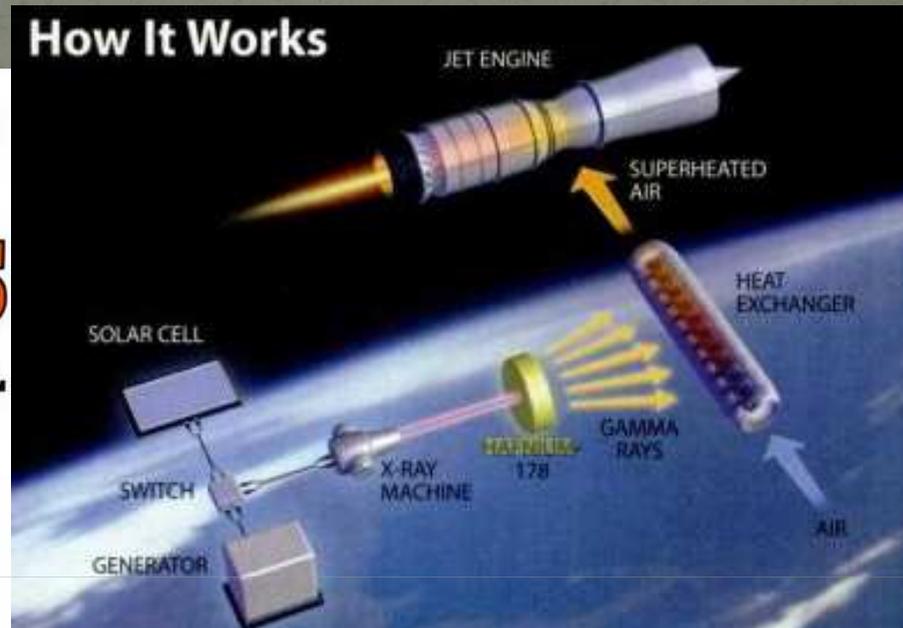
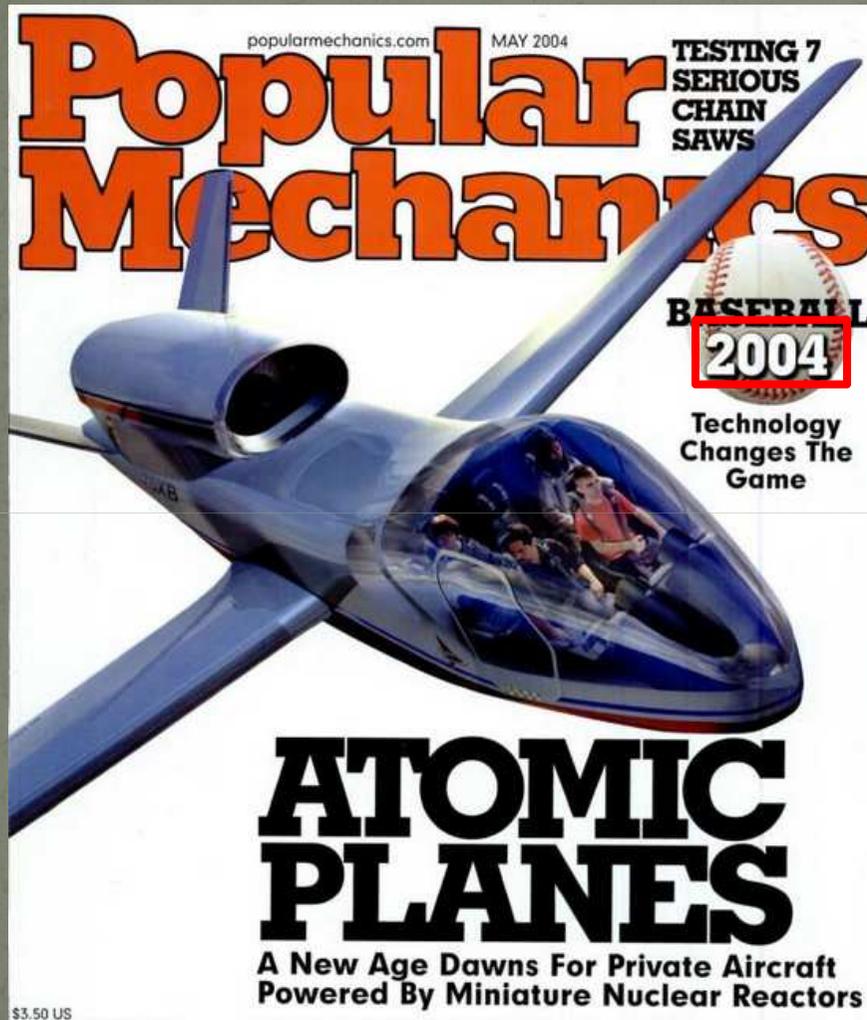
*I. Ahmad, *et al*, Phys. Rev. Lett. 87, 072503 (2001)

“When the going gets weird, the weird turn pro”

- Hunter S. Thompson

- Following the APS measurement, the JASON group dropped its support for IGE.
- Collins criticized the APS measurement (and later APS measurements) on increasingly ridiculous grounds
 - Continued to claim positive results, but could only get them published in obscure journals
 - In danger of losing funding, when...
- Under the Bush Administration, JASON kicked out of DARPA
- In 2002, Martin Stickley took over as program manager for DARPA
 - Stickley was true believer in IGE
 - Pushed Hafnium to Donald Rumsfeld as a potential new weapon
 - Shouted down scientific objections with the argument that “Russia was working on the idea, too”
- DARPA increased IGE funding, and in 2004 launched a major new initiative.

Hafnium reactors: alive and well



- Although based entirely on debunked nonsense, Hafnium reactors still generate great interest among defense contractors

Some final comments

- This is just the tip of the iceberg
 - Just go to YouTube and search for
 - Tom Bearden
 - Joe Newman
 - Stan Meyer
 - Bedini Motor
 - Or just “free energy”
 - Watch the videos and *read the comments*
- Perpetual motion is just one facet of our society’s obsession with pseudo-science
 - Compare the *Atsrology* section of B&N with the Science section.
- We will never solve the daunting (and exciting) energy challenges facing us unless we first face reality.

So what can a scientist/educator do?

- Know your audience. Like it or not, most people
 - Don't know much about science (or even what it is, really)
 - Don't care much about science.
 - Really want to believe crazy things.
- When teaching physics, stress “big picture” things like energy conservation:
 - Particularly when teaching non-technical people
- When you simplify things for popular consumption, remind people that you are leaving out a lot of quantitative detail, supported by experimental data
 - Example: Feynman diagrams
- Don't be silent
 - Write the editor
 - Write your congressman
 - Edit Wikipedia
 - etc