

THE MOTIONLESS ELECTROMAGNETIC GENERATOR: HOW IT WORKS.

T. E. Bearden, August 26, 2003

THE PROBLEM: DETAIL THE FUNCTIONING OF THE MOTIONLESS ELECTROMAGNETIC GENERATOR (MEG) {1} AND WHY ITS COP > 1.0 OPERATION IS PERMISSIBLE.

THE SOLUTION: WE EXPLAIN:

- The overwhelming importance of the magnetic vector potential, particularly when one looks through quantum electrodynamic “eyes” and in various gauges.
- The Aharonov-Bohm mechanism {2} utilized by the MEG {3,4,5}.
- Why the potential energy of any EM system (such as the MEG) can be freely changed at will, and for free, in accord with the gauge freedom principle {6}.
- The difference between symmetrical and asymmetrical regauging {7,8}.
- Why a nonequilibrium steady state (NESS) system freely receiving energy from its environment can exhibit COP > 1.0.
- The direct analogy between the MEG and a common COP = 3.0 heat pump {9}.

DISCUSSION 1: POTENTIALS ARE REAL AND FORCE FIELDS ARE DERIVED.

- The old notion that potentials were merely mathematical conveniences has long been falsified, particularly by the Aharonov-Bohm effect {2}, extended to the Berry phase {10}, and further extended to the geometric phase {11}. There are some 20,000 physics papers on geometric phase, Berry phase, and Aharonov-Bohm effect.
- In quantum electrodynamics, potentials are primary and force fields are *derived*.
- The force fields only exist in mass, and are the *effects* of the interaction of the “force-free fields” in space that exist as curvatures of spacetime. There are no force fields in space; there are only gradients of potentials. *Spacetime itself is an intense potential.* Quoting Feynman {12}:

"We may think of $E(x, y, z, t)$ and $B(x, y, z, t)$ as giving the forces that would be experienced at the time t by a charge located at (x, y, z) , with the condition that placing the charge there did not disturb the positions or motion of all the other charges responsible for the fields."

- The distinction between E-field and B-field is blurred. As Jackson {13} points out:
"... E and B have no independent existence. A purely electromagnetic field in one coordinate system will appear as a mixture of electric and magnetic fields in another coordinate frame. ... the fields are completely interrelated, and one should properly speak of the electromagnetic field $F^{\alpha\beta}$, rather than E or B separately."

- In other words, one can have a magnetic component and at least partially turn it into an electric component, or vice versa. This is important to the MEG's operation.
- Jackson {14} also points out that, for the Coulomb or transverse gauge:

"...transverse radiation fields are given by the vector potential alone, the instantaneous Coulomb potential contributing only to the near fields. This gauge is particularly useful in quantum electrodynamics. A quantum-mechanical description of photons necessitates quantization of only the vector potential. ... [In the Coulomb gauge] the scalar potential 'propagates' instantly everywhere in space. The vector potential, on the other hand, satisfies the wave equation ... with its implied finite speed of propagation c."
- Thus it is of primary importance to consider both the scalar potential ϕ and the vector potential A in a system or circuit, and in its surrounding space. In the MEG, one must *particularly* consider the magnetic vector potential A .
- Indeed, the magnetic vector potential A is so important that it can be taken as the basis of EM energy inherent in the active vacuum {15}.
- Magnetic vector potential A comes in two varieties: (i) the normal A -potential, which has a curl component called the B-field, and (ii) a curl-free A -potential without a curl component and therefore without the B-field (also called a "field-free" A -potential).

DISCUSSION 2: THE AHARONOV-BOHM EFFECT.

- In the Aharonov-Bohm effect {2}, the B-field is localized in a specific region. Outside that region, there *freely* appears a field-free (curl-free) magnetic vector potential A . This is a free regauging process, and its occurrence does not require work.
- This "field-free" A -potential *still affects and moves electrons*. The difficulty in believing the physical reality of the potentials required 25 years for physicists to overcome before they would accept the publication of the Aharonov-Bohm effect in 1959 {2a}.
- By perturbing the A , one can produce an E-field from it by $E = -\partial A/\partial t$.
- It is stressed that, in the AB effect, a *regauging* has taken place. The potential outside the localization zone has been freely changed, with an extra spacetime curvature and extra energy transferred there by gauge freedom, at no cost to the operator.

DISCUSSION 3: ENGINES, GAUGE FREEDOM, AND REGAUGING.

- The vacuum (spacetime) is extraordinarily energetic. For practical purposes, it contains unlimited energy density {16}. Since the vacuum/spacetime contains energy and energy density, it is therefore an extraordinarily powerful *potential*—essentially infinite in its point intensity.
- A "curvature of spacetime" is identically a change in the ambient vacuum potential, and hence in the "available" vacuum energy. "Energy available" means that, to use it, there must exist a *potential difference* and gradient between two separated points—and thus an energy current (a "free EM wind", so to speak). Thus a dipolarity (polarization) is required, to produce a vacuum form or "engine" that will interact on mass to produce a force, by a constant "wind of vacuum energy" acting upon it.
- An *engine* {17} is defined as a set of spacetime curvatures and vacuum flux exchanges—and their dynamics—which can act upon the elements of a mass system

- to generate its state and its dynamics. The simplest engine is a gradient in the potential. Also, an engine is a set of controlled and dynamic “EM energy currents”.
- An engine is also referred to as a *vacuum engine* or a *spacetime curvature engine*.
 - The engine exists in spacetime as curvature(s) of spacetime, whether or not it is interacting with mass.
 - The engine itself is nonobservable; its *interacting with mass* is observable.
 - The engine may move or be moved through spacetime independently of interacting with matter. It is pure energy transfer, and it is work-free.
 - A *force* is just the coupling of the simplest engine to mass, with *mass-translating* orientation. Unless both the engine and mass are present and dynamically coupled, there is no force. *We strongly note that mass is a component of force, by $F \equiv \partial/\partial t(mv)$, and classical mechanics errs in assuming a separate massless force operating upon a separate mass.* That notion remains one of the great errors in modern physics.
 - When a force F translates through a distance, that is the classical notion of external mechanical work W , by the equation $W = \int F \cdot dl$. Note that—classically—mass has been moved, and the “system” engine has performed “external” work on the mass.
 - “Stress” on a mass or in a system is the simultaneous application of two or more engines working on the mass or system in such manner that all translation vectors sum to zero vectorially. Hence no *external* work is done, but *internal* work is done on the system to produce and continuously maintain this stress with zero translation.
 - Work is not the change of *magnitude* of energy in a single form! It is the *change of form* of energy, from one form to another.
 - Thus there is a century-old error in the present First Law of thermodynamics: Any change of *magnitude* of an external parameter (such as the field or potential of a system) has been erroneously defined as work. It is not work if the extra energy is input in the same form. In that case it is *asymmetric regauging*, and involves only energy transfer without change of form, which requires no work. Regauging is free, by the gauge freedom axiom. The present form of the First Law would rule out gauge freedom—a fact which seems not to have been previously noticed.
 - The *supersystem* {17} consists of the physical mass system together with its “engines” and all the ongoing mutual interactions. Hence supersystem dynamics is analyzed simultaneously between (i) the physical system, (ii) the local active curvatures of spacetime, and (iii) the local active vacuum. All three components of the supersystem continually interact with each other.

DISCUSSION 4: NONEQUILIBRIUM STEADY STATE (NESS) SYSTEMS CAN PERMISSIBLY EXHIBIT $COP > 1.0$ AND EVEN $COP = \infty$.

- A system far from equilibrium in its energy exchange with its environment can steadily and freely receive environmental energy and dissipate it in external loads, exhibiting $COP > 1.0$ (as does a heat pump) or $COP = \infty$ (as do the solar cell, windmill, waterwheel, sailboat, etc.).
- However, Lorentz symmetrical regauging selects only those Maxwellian systems in *net equilibrium* with their external vacuum environment. *Symmetrical* regauging systems can only use their excess free regauging energy from the vacuum to do internal work on the system, changing the stress on or in the system, with the dissipated energy then being returned from the stressing action to the vacuum. Such systems *cannot* use their excess vacuum energy to do free external work on the load.

- The standard Lorentz regauging of Maxwell’s equations thus *arbitrarily* discards all Maxwellian NESS systems using vacuum energy to do useful external work.
- In electrical power systems, the ubiquitous use of the closed current loop circuit self-enforces Lorentz symmetrical regauging. That is totally arbitrary, but unrecognized.
- The present-day absence of COP > 1.0 normal electrical power systems, doing external work and freely taking all their input energy from the local vacuum and spacetime curvature, is strictly due to the archaic electrical engineering model and the prevailing use of the closed current loop circuit.
- Electrical power engineers easily adapt for a COP = ∞ system such as a solar cell, utilizing energy from its observably active environment. They will not even go and learn (and adapt their archaic model) to properly utilize every system’s nonobservable active vacuum environment for energy to do external work. Instead, they will unwittingly only allow the active vacuum to produce stress in the system, by using only self-symmetrically-regauging systems (the closed current loop circuit).
- For a COP > 1.0 or COP = ∞ electrical power system—taking some or all of its input energy freely from its active external (vacuum) environment, analogous to a home heat pump—the system must violate the closed current loop condition (symmetrical regauging) for at least a significant fraction of the operational cycle of the system. In simple terms, the system must be open to receiving and transducing *translational* energy from its external environment—in this case, the active vacuum—rather than just *stressing* energy.
- There also emerge additional flaws in classical thermodynamics, including in its fundamental definitions:
 - An “open” system is defined as one that has mass transfer across its borders (and may have energy transfer as well).
 - A “closed” system is defined as one that has no mass transfer across its borders, but may have energy transfer across them. Since the early 1900’s, mass and energy are known to be identically the same thing, called “mass-energy”. Hence any “closed” system that has energy transfer also has its mass changed, and actually is an “open” system.
 - An “isolated” system is defined as one in which no energy or mass is exchanged across its boundary. There exists no such system in the entire universe, due to the universal exchange of energy and mass between vacuum and system.
 - The ubiquitous energetic exchange—between vacuum (and curved spacetime) and the system—does not appear in classical thermodynamics. Yet there is no final conservation of energy unless both the virtual and observable state energy exchanges are considered in one’s analysis.
 - In the presence of opposite charges and their broken symmetry, much of the *virtual* vacuum energy absorbed in a dipolar system becomes *observable* energy in the system. For that reason, the present classical thermodynamics rules are approximations, useful in a great many cases but not absolute. As Kondepudi and Prigogine point out {18}: “...*there is no final formulation of science; this also applies to thermodynamics.*”

DISCUSSION 5: OPERATION OF A HOME HEAT PUMP .

- Efficiency ξ of an energy or power unit is defined as the total useful energy or external work output of the system, divided by its total energy input *from all sources*. It is commonly expressed as a percentage.

- The home heat pump {19} may have a nominal efficiency ξ of $\xi = 50\%$, which means it wastes half of the total energy input to it from all sources.
- In addition to the operator's electrical input (which he pays for), the heat pump also utilizes some extra heat energy received from the environment {20}. Thus there are two energy inputs: (i) the electrical energy input paid for by the operator, and (ii) the *free* environmental energy input furnished by the external atmosphere and processed a bit by compressing, etc. at very low cost.
- The home heat pump thus has two “energy reservoirs”: (i) the electrical energy reservoir furnished by the operator and paid for by him, and (ii) the atmospheric heat energy reservoir furnished freely by the atmosphere.
- Coefficient of performance (COP) is defined as the total useful energy or work output of the system, divided by the *operator's energy input only*. It is stated as a decimal, and measures how much “bang for his buck” the system gives the operator.
- Operating in good conditions, a home heat pump of efficiency $\xi = 50\%$ will exhibit a COP = 3.0 to 4.0. The maximum theoretical COP = 8.0 or so. Note that energy is conserved, and all energy output as work is indeed input to the system. No energy is “created out of nothing”. However, the operator only inputs a *fraction* of the total input required, and the environment freely inputs the rest. The system permissibly outputs 3 to 4 times the useful energy and work as the energy furnished by the operator alone. The excess energy is freely input by the external environment.
- By “overunity power system” we refer to a COP > 1.0, which is permitted by the laws of physics and thermodynamics for NESS systems such as the heat pump. We *do not* refer to $\xi > 100\%$, which would require creation of energy from nothing at all.

DISCUSSION 5: OPERATION OF THE MEG, ANALOGOUS TO A HEAT PUMP.

- The MEG resembles a transformer, having a core of special nanocrystalline material, input coil or coils in the primary, and output coil or coils in the secondary. Its operation, however, is quite different from that of a normal transformer.
- The special nanocrystalline core material used in the MEG has a very special characteristic: The material itself freely localizes an inserted B-field (from the input coil, or from a separate permanent magnet, or both) within the core material itself. Therefore it also freely evokes the Aharonov-Bohm (AB) effect.
- Outside the core, there freely appears an *extra* curl-free magnetic vector potential A.
- The MEG thus has two energy reservoirs: (i) the normal B-field energy and flux of any transformer resulting from the energy input to its primary coil(s), but now totally localized within the core material, and (ii) an extra *free* A-potential energy reservoir freely appearing just outside the core material itself.
- Consequently, the MEG is free to output the normal amount of energy from the B-field flux that a normal transformer would output, and also as much *extra* energy as it receives and collects from the A-potential in space outside the core.
- The MEG thus has become directly analogous to the heat pump. It has one energy reservoir—the localized B-field in the core—whose energy the operator must furnish and pay for. But it also has a second, free, environmental energy reservoir—a curl-free A-potential—freely available in the external environment.
- Accordingly, for COP > 1.0 operation, the MEG must “process” the available A-potential reservoir energy into usable form, and use it to help power its load.
- By inputting nearly rectangular pulses to the input coil, the rise time and decay time of each pulse edge produces a resulting sharp change in the external A-potential, producing an E-field by the equation $E = -\partial A/\partial t$. Note particularly that, by adjusting the input pulse rise time and decay time, we can adjust the magnitude of

the *extra* E-fields freely produced in space just outside the core, and this effect is easily measured.

- We strongly stress that sharp gradients—such as used for leading and trailing edges of the input pulses to the MEG, with resulting sharp field gradients in the core materials and in the uncurled A-potential—are already recognized to permissibly violate the second law of thermodynamics {21}.
- By adjusting the magnitude of the E-fields outside the MEG core and their frequency (and therefore the energy received from them), one can adjust the available converted E-field energy in the free external reservoir, and thus adjust how much of it is then collected by the MEG.
- This free E-field energy impinges directly upon the MEG’s “output” coil, which now also serves as an *input* coil. Almost all the B-field produced by the output coil is localized in the core material running through it and held therein.
- The E-field energy from space outside the core thus activates the output coil in almost a purely electric field manner, rather than in a mostly magnetic field manner. The MEG becomes almost a purely “electrical” transformer!
- The output current from the coil is almost in phase with the output voltage (within about 2 degrees). Hence the MEG is almost completely using its induced Aharonov-Bohm effect for its energy input—very different from any other power system transformer.
- Due to its “heat pump” type operation, the MEG becomes a NESS system, freely receiving excess energy from its second (environmental) energy reservoir that is furnished “for free” by the Aharonov-Bohm effect.
- Accordingly, as a NESS system {22} the MEG can permissibly exhibit $COP > 1.0$. For the MEG, a $COP = 3.0$ or so is readily achievable, and even higher COP can be achieved by special measures.
- However, one notes the MEG’s high nonlinearity, and thus its susceptibility to nonlinear oscillations and the need for nonlinear control theory and implementation. Also, the $\partial A/\partial t$ operation and its E-fields produced, do interact with other coils on the core, including the primary, etc. Hence timing and phasing are critical. An out-of-phase MEG-like unit can worsen the $COP < 1.0$ a normal transformer would produce! But a properly phased MEG with proper nonlinear control will produce all signals additive as needed at their individual locations. That “optimized” MEG then will produce $COP > 1.0$. Scale-up also is highly nonlinear, and requires extensive phenomenology buildups and testing to achieve proper stability and control.
- $COP = \infty$ (self-powering operation similar to a solar cell) is permitted for the MEG (as a NESS system) by the laws of thermodynamics and physics. However, with scale-up phenomenology, materials variations, and the high nonlinearity of the situation, at least one year’s hard work by a team of multiple specialists in geometric phase, nonlinear oscillation theory, nonlinear oscillations control theory, etc. is needed, and modeling must be done in a higher group symmetry electrodynamics. It is certainly doable (just as a home heat pump can be “close looped” for self-powering operation). But it is not a trivial little conventional EM transformer task. It is not simple, and it is not cheap.
- The end result is that we have a successful proof-of-principle MEG experimental device, and a patent has been granted, with additional patent work continuing. But we still have an expensive year or more of complex and specialized lab work before we have prototype scaled-up robust power units ready for mass production and world marketing. We are presently seeking the major funding for that completion.

CONCLUSIONS:

- COP > 1.0 and COP = ∞ electrical power systems are perfectly permissible by the laws of thermodynamics and physics; as witness the existence of solar cells with COP = ∞ .
- Rigorous proof is given by the Aharonov-Bohm effect itself {2}, gauge freedom, the solar cell, Bohren's experiment {23}, and several other experimental entities such as the patented MEG. Bedini {24}, e.g., has viable, proven processes for producing COP > 1.0 in battery-powered systems, and for regauging batteries {25} and charging them with more energy than is furnished by the operator alone (the excess energy comes from free regauging).
- Overunity and self-powering electrical power systems cleanly taking their energy from the local vacuum can be developed any time the U.S. scientific community will permit it and allow it to be funded. The naïve objection of "perpetual motion machines being prohibited because they would be working systems with no energy input" is utter nonsense, as is easily demonstrated {26}. Every windmill, waterwheel, sailboat, and solar cell demonstrates that, if the energy input is continuously and freely received from the environment, continuous external work can freely be done indefinitely. Every motion also demonstrates Newton's first law: an object placed in a state of motion remains in that state of uniform (perpetual) motion so long as an external force does not intervene to change it. It does not receive any additional energy to do so, nor does it perform any external work in so doing. Even an electrical circuit in a shorted superconducting circuit will circulate indefinitely (perpetually) without any additional input and without doing any work {27}. Experimental proof of it is part of the standard physics literature.

OUTLOOK AND FORECAST (THE AUTHOR'S OPINION):

- The blame for the terribly fragile and highly vulnerable present power system and power grid monstrosity lies squarely upon the shoulders of the scientific community, since the discovery and proof of broken symmetry in 1957 {28}.
- From our direct experience with several legitimate COP > 1.0 EM systems, we are of the opinion that the scientific community will uphold its present dogma, its present severely limited and flawed electrical engineering model, and its present slavish attachment to fuel cells, big nuclear power plants, hydrocarbon combustion, etc.
- Not only will the present scientific and electrical engineering communities fiddle while Rome burns, but they will help burn it. The only way that will change is for a huge boot to be applied—such as the economic collapse of the United States.
- The scientific community has always been this way, in its fierce resistance to really innovative developments. A few examples are as follows: The scientific community:
 - Fiercely resisted ultrawideband radar, slandering and libeling its pioneers.
 - Resisted Mayer's original statement of energy conservation; hounded him so much that he attempted suicide and was institutionalized.
 - Laughed and slandered Ovshinsky on his "insane" amorphous semiconductor. "Everybody knew" a semiconductor had to have a crystalline structure. The Japanese who funded Ovshinsky are still laughing all the way to the bank.
 - Made Wegener's name a synonym for "utter fool" because of his continental drift theory. Why, imagine continents floating and moving! Insane!"
 - Refused to accept the Aharonov-Bohm effect for 25 years (as pointed out by Feynman). Prior to the MEG, the AB effect appears never to have been applied for COP > 1.0 from "two-energy reservoir" electrical power systems.

- Uses an EE model that assumes every EM field, EM potential, and joule of EM energy in the universe has been freely created from nothing, by their associated source charges *without any energy input*. Even very few EE professors are aware of that terrible faux pas of their model. It is not pointed out in any EE textbook, to our knowledge.
- Uses an EE model that assumes the material ether, a flat spacetime, an inert vacuum, and creation from nothing of all EM fields and potentials—all long falsified in physics. These flaws are not pointed out in any EE text or department to our knowledge, and indeed they are hidden from the students.
- Ubiquitously uses the closed current loop circuit in power systems, dooming them to $COP < 1.0$ and directly causing the present mess of the inadequate, monstrous, fragile, splintered, relatively unstable, and highly vulnerable power grids. This also is directly responsible for the continuing and ever-increasing hydrocarbon combustion, global warming gases, pollution of the planet, and strangling of species.
- Still largely pontificates in official publications that perpetual (uniform) motion is impossible in machines, which is ridiculous since that is merely Newton's first law. A continuous freely working machine is also possible, so long as it freely receives the necessary energy input from its environment (so long as it operates as a NESS system). Examples are the windmill, waterwheel, and solar cell—and indeed a hydroelectric power system, if one speaks of the entire system including the river's flow.
- Ridicules anyone who seriously speaks of the active vacuum or active ST curvature as energy reservoirs and environments to be utilized practically—even though all EM power systems and circuits are powered by EM energy extracted directly from the local vacuum by the source charges {22b}.
- Continues to ruthlessly ignore the impact of the long-discarded Heaviside giant nondiverged energy flow component, for both power systems and antigravity systems.
- Places an iron muzzle on “out of the box” innovation by professors, grad students, and young post doctoral scientists, particularly in anything smacking of $COP > 1.0$ EM power systems. They must compete for available funding attached to research packages that come down from on high, with the research already specified. Any professor who really rocks the boat will be either parked or destroyed, as will any grad student or post doc. Science is controlled by controlling its funding. Since its funding is already controlled, our science is already muzzled and constrained with respect to energy research and development.
- Hence, based on his available scientific advice, a Presidential decision was made to (i) allow updating old power plants without additional pollution controls, (ii) go for drilling wherever oil is to be found, (iii) massively increase the grid and the number of power plants, (iv) go for fuel cells as an intended answer to the transport problem, etc. Given the scientific advice he receives, the President sees no other choice available. That is sad, because the “energy from the vacuum” choice is available, particularly with accelerated development and funding.
- As an example from the standard physics literature, the Bohren-type experiment {23} in “negative resonance absorption of the medium” outputs some 18 times as much energy as one inputs in one's accounted Poynting energy input. Poynting's energy flow theory {29} does not account for a huge Heaviside nondiverged energy flow component (30) that is often a trillion times greater than the accounted Poynting component. Lorentz arbitrarily discarded the Heaviside nondiverged component circa the 1890s {31}, and EEs continue to blindly discard it and ignore it {32}.

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3. (a) M. W. Evans, P. K. Anastasovski, T. E. Bearden *et al.*, "Classical Electrodynamics Without the Lorentz Condition: Extracting Energy from the Vacuum," Physica Scripta 61(5), May 2000, p. 513-517; (b) — "Explanation of the Motionless Electromagnetic Generator with O(3) Electrodynamics," Found. Phys. Lett., 14(1), Feb. 2001, p. 87-94; (c) — "Explanation of the Motionless Electromagnetic Generator by Sachs's Theory of Electrodynamics," Found. Phys. Lett., 14(4), 2001, p. 387-393. See also (d) M. W. Evans, T. E. Bearden, and A. Labounsky, "The Most General Form of the Vector Potential in Electrodynamics," Found. Phys. Lett., 15(3), June 2002, p. 245-261.
4. (a) T. E. Bearden, "Extracting and Using Electromagnetic Energy from the Active Vacuum," in M. W. Evans (ed.), Modern Nonlinear Optics, Second Edition, 3 vols., Wiley, 2001, Vol. 2, p. 639-698; (b) — "Energy from the Active Vacuum: The Motionless Electromagnetic Generator," in M. W. Evans (Ed.), Modern Nonlinear Optics, Second Edition, 3-vols., Wiley, 2001, Vol. 2, p. 699-776; (c) — Energy from the Vacuum: Concepts and Principles, Cheniere Press, Santa Barbara, CA, 2002, Chapter 7: "Aharonov-Bohm Effect, Geometric Phase, and the Motionless Electromagnetic Generator".
5. M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "Runaway Solutions of the Lehnert Equations: The Possibility of Extracting Energy from the Vacuum," Optik, 111(9), 2000, p. 407-409.
6. To see how Maxwell's equations are conventionally regauged symmetrically, see J. D. Jackson, Classical Electrodynamics, Wylie, New York, Third Edition, 1999, p. 240-246.
7. For a discussion of asymmetrical regauging, see M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "Some Notes on 'Asymmetric Regauging'," J. New Energy 4(3), Winter 1999, p. 325-326.
8. For a discussion on symmetrical regauging, see Jackson, 1999, *ibid.*
9. T. E. Bearden, "Motionless Electromagnetic Generator: Production of an Additional Energy Reservoir Freely Furnishing Extra EM Energy Input to the System from Its External Environment," 10 June 2003 (in press).
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11. Y. Aharonov and J. Anandan, "Phase Change During a Cyclic Quantum Evolution," Phys. Rev. Lett., Vol. 58, 1987, p. 1593-1596.
12. Richard P. Feynman, Robert B. Leighton, and Matthew Sands, The Feynman Lectures on Physics, Addison-Wesley, Reading, MA, Vol. II, 1964, p. 1-3.
13. J. D. Jackson, *ibid.*, p. 558.
14. J. D. Jackson, Classical Electrodynamics, 2nd Edn., Wylie, 1975, p. 223.
15. M. W. Evans, P. K. Anastasovski, T. E. Bearden et al., "The Aharonov-Bohm Effect as the Basis of Electromagnetic Energy Inherent in the Vacuum," Found. Phys. Lett. 15(6), Dec. 2002, p. 561-568.
16. See R. Podolny, Something Called Nothing: Physical Vacuum: What Is It?, Mir Publishers, Moscow, 1986, p. 181. In mass units, the energy density of the virtual particle flux of

- vacuum is on the order of 10^{80} grams per cubic centimeter. To express it in joules per cubic centimeter, it is $(c^2)(10^{80})$.
17. See T. E. Bearden, Fact Sheet: "Supersystem and Engines: Understanding Energetics," Aug. 25, 2003.
 18. Dilip Kondepudi and Ilya Prigogine, Modern Thermodynamics: From Heat Engines to Dissipative Structures, Wiley, New York, 1998, reprinted with corrections 1999, p. 459. On the same page, several areas that are known to violate present thermodynamics are given.
 19. William C. Reynolds, Thermodynamics, 2nd Edn., McGraw-Hill, New York, 1968, p. 250-252 gives an analysis of the Carnot heat pump.
 20. See Robert H. Romer, "Heat is not a noun," Am. J. Phys., 69(2), Feb. 2001, p. 107-109. Heat is not a substance, not a thermodynamic function of state, and should not be used as a noun, unless one risks falling into error. AJP Editor Romer also exposes another serious EM error: In endnote 24, p. 109, he takes to task "...that dreadful diagram purporting to show the electric and magnetic fields of a plane wave, as a function of position (and/ or time?) that besmirch the pages of almost every introductory book. ...it is a horrible diagram. 'Misleading' would be too kind a word; 'wrong' is more accurate." "...perhaps then, for historical interest, [we should] find out how that diagram came to contaminate our literature in the first place." As the reader can see, many physics professors and journal editors are quite aware of numerous foundations errors in present science.
 21. Kondepudi and Prigogine, *ibid.*
 22. (a) See particularly D. J. Evans and Lamberto Rondoni, "Comments on the Entropy of Nonequilibrium Steady States," J. Stat. Phys., 109(3-4), Nov. 2002, p. 895-920. In theory a proper NESS system can produce continuous negative entropy. Evans and Rondoni were so shocked at their own theoretical results, that they felt no physical system could exhibit such a negative entropy, continually decreasing toward negative infinity as time passes. However, every charge does this already; see (b) T. E. Bearden, Fact Sheet, "The Source Charge Problem: Its Solution and Implications," Aug. 18, 2003; (c) — Fact Sheet, "Leyton's Hierarchies of Symmetry: Solution to the Major Asymmetry Problem of Thermodynamics," Aug. 22, 2003. The MEG as a NESS system appears to be a prototype *macroscopic* power system that exhibits such permissible continuous production of negative entropy.
 23. (a) Craig F. Bohren, "How can a particle absorb more than the light incident on it?" Am. J. Phys., 51(4), Apr. 1983, p. 323-327. Under nonlinear conditions, a particle can absorb more energy than is in the light incident on it. Metallic particles at ultraviolet frequencies are one class of such particles and insulating particles at infrared frequencies are another. See also (a) H. Paul and R. Fischer, {Comment on "How can a particle absorb more than the light incident on it?";} Am. J. Phys., 51(4), Apr. 1983, p. 327. The Bohren experiment is repeatable and produces COP = 18.
 24. See T. E. Bearden, "Bedini's Method For Forming Negative Resistors In Batteries," Proc. Cong. 2000, St. Petersburg, Russia, Vol. 1, July 2000, p. 24-38. Also published in J. New Energy, 5(1), Summer 2000, p. 24-38. Also carried on restricted DoE website <http://www.ott.doe.gov/electromagnetic/> and on <http://www.cheniere.org>.
 25. (a) John C. Bedini, "Device and Method for Pulse Charging a Battery and for Driving other Devices with a Pulse," U. S. Patent #2003/0117111 A1, June 26, 2003. For another legitimate overunity Bedini process, see (b) John C. Bedini, "Device and Method of a Back EMF Permanent Electromagnetic Motor Generator," U.S. Patent # 6,392,370, May 21, 2002.
 26. See Fact Sheet, T. E. Bearden, "Perpetual motion vs. 'Perpetual Working Machines Creating Energy from Nothing'," Aug. 21, 2003 for a rigorous discussion of perpetual motion (which is just Newton's First Law), and how it differs from purported machines that create energy from nothing. Oddly, the greatest—though totally unwitting—proponents of energy creation from nothing, in all human history, are the electrical engineering departments, professors, textbooks, and engineers. Their standard electromagnetics model assumes that all EM fields and potentials and their energy are freely created out of nothing, by the associated

- source charges *without any energy input at all*. So they unwittingly assume that every joule of EM energy in the universe has been and is created from nothing. This is the unwitting ansatz that has given us COP < 1.0 standard electrical power systems, horrid pollution of the biosphere and strangling of species, accelerated global warming, and a far more poisonous and hostile environment in which to live. And, to the delight of many of the energy cartels, it is also what has kept the electrical power meter on our homes and offices and industry, and has kept the gas pump meter on the gas pumps for our automobiles and transport. One must keep one's sense of humor! By failing to update and extend their grossly inadequate electrical engineering model, our scientific community is directly contributing to the decimation of the planet and the future collapse of the industrialized national economies.
27. Decay time for a current flowing in a closed superconducting loop has been experimentally shown to be greater than 10^5 years, and theoretically shown to be greater than $10^{40,000,000}$ years.
 28. (a) T. D. Lee, "Question of Parity Conservation in Weak Interactions," Physical Review, 104(1), Oct. 1, 1956, p. 254-259. Errata in Phys. Rev. 106(6), June 15, 1957, p. 1371; (b) T. D. Lee, Reinhard Oehme, and C. N. Yang, "Remarks on Possible Noninvariance under Time Reversal and Charge Conjugation," Phys. Rev., 106(2), 1957, p. 340-345. Experimental proof was given by Wu and her colleagues in (c) C. S. Wu, E. Ambler, R. W. Hayward, D. D. Hoppes and R. P. Hudson, "Experimental Test of Parity Conservation in Beta Decay," Phys. Rev., Vol. 105, 1957, p. 1413. So revolutionary was this discovery that the Nobel Committee with unprecedented speed awarded Lee and Yang the Nobel Prize in December 1957—the same year that Wu *et al.* experimentally proved the prediction by Lee and Yang.
 29. (a) J. H. Poynting, "On the transfer of energy in the electromagnetic field," Phil. Trans Roy. Soc. Lond., Vol. 175, 1884, p. 343-361; (b) J. H. Poynting, "On the Connection Between Electric Current and the Electric and Magnetic Inductions in the Surrounding Field," Phil. Trans. Roy. Soc. Lond., Vol. 176, 1885, p. 277-306.
 30. (a) Oliver Heaviside, "Electromagnetic Induction and Its Propagation," The Electrician, 1885, 1886, 1887, and later. A series of 47 sections, published section by section in numerous issues of The Electrician during 1885, 1886, and 1887; (b) — "On the Forces, Stresses, and Fluxes of Energy in the Electromagnetic Field," Phil. Trans. Roy. Soc. Lond., 183A, 1893, p. 423-480. Also, particularly see (c) E. R. Laithwaite, "Oliver Heaviside – establishment shaker," Electrical Review, 211(16), Nov. 12, 1982, p. 44-45.
 31. H. A. Lorentz, Vorlesungen über Theoretische Physik an der Universität Leiden, Vol. V, Die Maxwellsche Theorie (1900-1902), Akademische Verlagsgesellschaft M.B.H., Leipzig, 1931, "Die Energie im elektromagnetischen Feld," p. 179-186. Figure 25 on p. 185 shows the Lorentz concept of integrating the Poynting vector around a closed cylindrical surface surrounding a volumetric element. This procedure arbitrarily selects only a small component of the energy flow associated with a circuit—specifically, the small Poynting component being *diverged into* the circuit to power it—and then treats that tiny component as the "entire" energy flow. Thereby Lorentz arbitrarily discarded the huge Heaviside circuital energy transport component that is usually not diverged into the circuit conductors at all, does not interact with anything locally, and is just wasted.
 32. We address this Heaviside extra energy flow phenomenon—and many others—in our book, Energy from the Vacuum: Concepts and Principles, *ibid.*, 2002. When the Heaviside component is accounted, every generator and power source ever built already outputs enormously more energy than is accounted by the mechanical shaft energy input to the generator, or by the chemical energy dissipated by the battery. Accounting its total energy output as an energy transducer of virtual vacuum energy into observable energy, every power source exhibits COP >> 1.0. The Heaviside component usually has little or no effect because it is in vector curl form, and the divergence of the curl is zero—in a flat spacetime. The usual power application is in an approximately flat spacetime, so the Heaviside curled flow component is of little physical significance (using Lorentz's original argument). However, by

deliberately curving the local spacetime (e.g., as in Bohren's experiment and in the negative resonance absorption of the medium), the divergence of the curl is not zero, and additional energy is freely collected from the neglected Heaviside component. Bohren's straightforward experiment yields $COP = 18$. The simple funding of a few doctoral theses and post-doctoral physics projects in this area for three years or so would very quickly solve the energy crisis forever, very cheaply. *All EM power systems already exhibit $COP \gg 1.0$, if their arbitrarily discarded Heaviside energy flow component is accounted and if it were deliberately used as an extra huge environmental energy reservoir from which copious extra EM energy were freely extracted.*

E.g., if a present coal-burning plant were modified with a Bohren-process so that it "amplified" the heat input of the combustion process by a factor of 10, then only 10% of the present coal would have to be burned in that modified plant to produce its same electrical power output. The beneficial impact on the environment would be incalculable, and with less coal burned, additional pollution-reducing methods could be afforded and applied. No one in DoE, any other federal agency, the National Academy of Sciences, the National Science Foundation, DARPA, the national laboratories, or our universities has even considered it—or apparently even thought of it.